STUDIES ON THE GENUS *RICCIA* (HEPATICAE: MARCHANTIALES) IN SOUTH AUSTRALIA.

By

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A thesis submitted to the University of Adelaide in fulfilment of the requirements for the Degree of Master of Science.

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SUMMARY

A detailed taxonomic study of the genus *Riccia* (Ricciaceae: Marchantiales) in South Australia has been made.

Within the genus two subgenera are recognised. Twelve species belonging to the subgenus *Riccia* and two confirmed species belonging to the subgenus *Ricciella* are recognised in South Australia. An additional seven species of uncertain taxonomy belonging to the subgenus *Ricciella* have been found.

Twelve of the species found have not previously been recorded in South Australia.

A brief resume of the taxonomic history of the genus has been included.

An outline of the characters used in this study of the taxonomy of the genus is given.

A key to the species of *Riccia* in South Australia has been constructed and taxonomic descriptions of the species included. Specimens collected in South Australia have, where possible, been compared to type specimens and to specimens collected in other Australian States.

Scanning electron micrographs of the spores of the twelve species belonging to the subgenus *Riccia* and two confirmed species belonging to the subgenus *Ricciella* have been included.

Emphasis has been placed on spore morphology in an attempt to clarify the taxonomy of the species and to evaluate spore morphology as a taxonomic feature in the study of the genus *Riccia*.

A negative correlation between mean spore diameter and mean annual rainfall at collection localities was found for South Australian specimens of *Riccia crystallina*. A positive correlation between these two parameters was found for South Australian specimens of *Riccia nigrella*.

On the basis of both thallus and spore morphology two species proposed by Na-Thalang (1969) are reduced to synonymy of *Riccia crinita* Tayl. On the basis of spore morphology *Riccia crassa* Steph. is proposed as a synonym of *Riccia deserticola* Steph.

DECLARATION

This is to certify that the material contained in this thesis is the work of the author except where otherwise acknowledged and has not been accepted for the award of any other degree or diploma.

June 1974

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I express my thanks to Professor R.C. Carolin, Botany School, University of Sydney, for his encouragement, for providing on loan many of the *Riccia* specimens housed at the John Ray Herbarium, and for the loan of Dr. O. Na-Thalang's thesis on the genus *Riccia* in Australia.

Dr. Hj. Eichler, Keeper of Botany, State Herbarium of South Australia, kindly provided Herbarium facilities and permitted me to study the *Riccia* collections housed in the Herbarium.

I thank the Director of the Royal Botanic Gardens and National Herbarium of New South Wales for endeavouring to trace specimens of *Riccia*, including type specimens, housed in the Herbarium.

I wish to express my thanks to Dr. Obchant Na-Thalang, now of Chulalongkorn University, Bangkok, for permitting me to examine her Ph.D. thesis on *Riccia* in Australia prior to the publication of its contents.

Many people have forwarded to me collections of *Riccia* for identification and study. Amongst those to whom I owe my thanks are Mrs. K. Alcock of Comaum, via Penola; Mr. L.D. Williams of Meningie, and my colleagues in the Botany Department especially Mr. M.D. Crisp, Mr. B.G. Lay, Mr. R.J. Anderson, Mrs. N. Sharrad, Miss M.P. Cooke, Mr. C.R. Marsden and Mr. E.W. Beard.

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I have gratefully appreciated the patience of my wife who endured many lonely sojourns when unable to accompany me on field work.

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CHAPTER ONE

INTRODUCTION.

The genus *Riccia* (Marchantiales: Ricciaceae) is widespread in both tropical and temperate regions of the world, occupying habitats ranging from virtually aquatic conditions (members of the *R. fluitans* group) to those receiving only intermittent rainfall amounting to 15cm or less per annum. A total of more than 200 species of *Riccia* have been described from most countries of the world and it is likely that with further detailed taxonomic studies many of these taxa will be recognized as conspecific.

The genus was first described by Micheli (1729) in his "Nova Plantarum Genera .....". Micheli accurately portrayed and named a number of thallose hepatic genera, including *Targionia*, *Anthoceros*, *Blasia*, *Lunularia*, *Sphaerocarpos*, *Marchantia* and *Riccia*. Linnaeus (1737) in the first edition of "Genera Plantarum" accepted Micheli's interpretation of *Riccia* and, like him, attempted to describe the structural features of the reproductive organs in terms of the flowering plants, an interpretation which persisted until the researches of Hofmeister (1851).

The two types of thallus construction found in the genus *Riccia* were first illustrated by Schmidel (1762), although the significance of this difference was not realised at that time. In the subgenus *Riccia* the upper part of the thallus is composed of compactly arranged filaments of cells separated by narrow vertical air spaces. In the subgenus *Ricciella* the upper part

of the thallus is composed of polyhedral air chambers bounded by plates each of a single cell in thickness. Subgeneric rank was ascribed to these two types of thallus construction later (Stephani 1898).

Although Braun (1821) first separated *Riccia* into two genera, *Riccia* and *Ricciella*, his classification was not based on thallus construction but rather on the position of the capsule and the presence or absence of a "style", which may be interpreted as the old archegonial neck. However, Lindenberg (1836) in his "Monographie der Riccien" considered that the genus *Ricciella* Braun did not merit generic rank.

Nees (1838) in his studies on the European Hepaticae defined four sections of the genus *Riccia* based primarily on the construction of the upper layers of the thallus and the direction of liberation of the spores in relation to the surface of the thallus. Three sections "Spongodes", "Ricciella", and "Hemiseuma" were defined as "Frons cavernosa....." whilst the remaining section "Lichenoides" was defined as "Frons solida.....".

Stephani (1898) in the "Species Hepaticarum" grouped the species of *Riccia* into two sections, the first, *Riccia*, containing those species in which the photosynthetic tissue was composed of filaments of cells separated by narrow vertical air chambers, whilst in the second, *Ricciella*, were included those species with a chambered thallus and the photosynthetic region composed of large air chambers separated by plates of photosynthetic cells and usually opening to the surface by a more or less well defined air pore. In the former section, Stephani included 83 species whilst in the latter section were 45 species. The section *Riccia* was

further subdivided into 8 groups and the section *Ricciella* into 5 groups. The definition of these smaller units was based largely on morphological features such as thallus width, shape of the thallus apex, nature of the dorsal channel, and features of the thallus margin, which exhibit a degree of plasticity under different environmental conditions. Since these morphological features have been used as primary distinguishing features of the groups and also as a means for identification of individual species there exists a need for a thorough reinvestigation of all species. As a result it is likely that many of the species now regarded as distinct may be conspecific.

Recent studies on the taxonomy of *Riccia* species, such as those of Boulay (1904), Schiffner (1909), MacVicar (1926), Frye and Clark (1937), and Augier (1966), have referred to the subgenus *Euriccia* first proposed by Lindberg (1879). Boulay (1904) subdivided *Riccia* into three subgenera, *Ricciocarpus*, *Ricciella*, and *Euriccia*. Whilst Lindberg (1879) had included in *Euriccia* both types of thallus construction, Boulay referred to *Euriccia* only those species having compact thalli with narrow vertical air spaces. Schiffner (1909) divided *Riccia* into *Euriccia* and *Ricciella*, including in the latter only the species *R. fluitans*. MacVicar (1926) included in his subgenus *Euriccia* only those species with cilia and in the subgenus *Ricciella* all those species lacking cilia. Frye and Clark (1937) divided *Riccia* into two sections *Euriccia* and *Ricciella* whilst Augier (1966) erected four series in *Euriccia* and one in *Ricciella*.

In this study the genus *Riccia* has been subdivided into two subgenera *Riccia* and *Ricciella*, without further subdivision. The subgenus *Riccia* is taken to include all those species, ciliate and non ciliate, having the photosynthetic tissue composed of filaments of cells separated by narrow vertical air chambers. The subgenus *Ricciella* is taken to include all those species in which the upper part of the thallus includes polyhedral air chambers bounded by single cell thickness plates of photosynthetic tissue, the air chambers usually opening to the surface through a well defined air pore.

Until recently (Na-Thalang 1969) the genus *Riccia* had not been systematically studied in Australia. Taylor (1846) had described 8 new species from collections made by W.J. Drummond in Western Australia and Carrington and Pearson (1887) had recorded 3 species, including 2 new species, collected by T. Whitelegge in New South Wales. Bailey (1888), in his studies of the Queensland Flora, recorded only 2 species for that State. Stephani (1898 - 1924) recorded a total of 23 species for Australia, with an additional 5 unpublished species in his letters to Levier. Rodway (1916) in his studies on the Bryology of Tasmania included only 3 species of *Riccia*. Schuster (1963) considered that "these species all need careful revision".

Na-Thalang (1969) in an important revision of the genus *Riccia* in Australia recorded a total of 33 species with 8 varieties, including 8 new species and 4 new varieties. Her study included a comparison of the Australian plants with many Type specimens and other collections from northern hemisphere Herbaria. No previous

studies had included such a comparison. As further investigations are made the distribution of the species will become better known and it is likely that additional species will be recognized.

This study of the genus *Riccia* in South Australia was undertaken in order to elucidate the species present and their distribution in this State, to clarify their taxonomy, and to determine the possible extent of variation in thallus morphology due to environmental factors. Twenty one species are now recorded for the State, 12 of which had not previously been recorded from South Australia. As a result of the present studies it is likely that two of Na-Thalang's new species will be reduced to synonymy with *R. crinita* Tayl.

CHAPTER TWO.

MATERIALS AND METHODS.

Field Collections.

Collections have been made over a wide area of South Australia, chiefly during the months of June to September when most species reach sporangial maturity. The majority of collections have been made during August. Rosettes or patches of plants were removed from the ground with approximately 5mm to 1cm depth of soil attached. All specimens were given a herbarium number, packeted for drying and storage, or maintained in a fresh state for later laboratory examination. Notes on habitat, soil type, features of the living plant, associations, and other relevant details were recorded at the time of collection.

Most identifications were carried out in the field with the aid of a 10x hand lens. Species difficult to identify with certainty in the field, such as *R. crozalsii*, *R. macrospora*, and many species of the subgenus *Ricciella*, were examined in the laboratory with the aid of a stereo dissecting microscope.

Herbarium collections.

Existing herbarium collections of a number of species were examined. Where possible, permanent slide mounts of spores have been made.

Herbarium abbreviations used in the text are those of Lanjouw and Stafleu (1964), Fifth Edition.

Spore morphology.

Permanent preparations of spores were made by mounting spores from a single capsule in Hoyer's solution (Anderson 1954). These were examined and the diameter of 66 spores (an arbitrarily convenient number of statistical size) were measured. In addition, wing width and the number of areolae across the diameter were measured, where applicable.

Scanning electron microscopical studies of spore morphology.

Dried mature spores were mounted on aluminium studs using Davis GRIPIT-65 All Purpose Glue as an adhesive. Mounted spores were coated with gold and examined using a Siemens ETECH Autoscan scanning electron microscope at 20Kv.

Photography.

Selected fresh specimens of each species were photographed using a Leitz Reprovit copying apparatus with from 1-3 supplementary extension rings for most of the macrophotographic work. Supplementary bilateral oblique lighting at a distance of approximately 12cm from the specimens was used. Ilford FP4 film (ASA 125) was used for all black and white photography and Kodachrome II Professional Type A film (ASA 40) for all colour photography. Spore preparations for scanning electron microscopy were photographed using Kodak Plus X Pan film (ASA 125).

CHAPTER THREE

THALLUS AND SPORE MORPHOLOGY.

The taxonomic characters used in this study for defining the species of *Riccia* are based on features of thallus and spore morphology. Whilst thallus features exhibit some plasticity in response to different environmental influences, such as variation in light intensity, or abundance of moisture, spore morphology remains relatively constant and therefore provides the most reliable known taxonomic criterion. Spore morphology is of particular value when dealing with dried specimens, such as herbarium material, in which the thallus has become more or less distorted. In such circumstances spore morphology constitutes the only taxonomic feature known to be reliable.

Features which have been used in this study for the description and identification of species are outlined below:

Thallus morphology.

Habit:

A number of species commonly form either complete or incomplete rosettes. These rosettes may, in some instances, be distinguishable only in the early stages of thallus development, the plants later becoming scattered or forming gregarious patches.

Many species of the subgenus *Riccia* appear to be perennial, whilst those of the subgenus *Ricciella* appear to be annual.

Branching:

The thallus may be composed of unbranched lobes or, more commonly, may be furcate, bifurcate, trifurcate, or multifurcate when mature.

Thallus segment shape:

Thallus shape, although rather variable, differs between species. The shape of the thallus segment ranges from obcuneate to obcuneate-oblong, obovate-oblong, narrowly or broadly oblong to broadly or narrowly linear (Figure 3.1).

Length and breadth of the thallus vary considerably under differing environmental conditions. Abeywickrama (1945) found that the thallus of *Riccia crispatula* was longer and narrower under conditions of higher moisture. Field observations on several species found in South Australia (*R. asprella, R. sorocarpa, R. duplex)* indicate that thallus length may increase considerably under higher moisture levels whilst there is only slight increase in thallus width. Plants of some species (*R. limbata, R. crystallina, R. cavernosa*), vary considerably in thallus dimensions even under similar field conditions as sometimes seen in specimens growing within a few meters of each other. It is thus evident that thallus dimensions have restricted taxonomic use in the genus *Riccia.*

Arrangement of photosynthetic tissue:

The photosynthetic tissue is located mainly in the upper region of the thallus. Separation of the two subgenera of *Riccia* is based on arrangement of the photosynthetic tissue. In the subgenus *Riccia* the photosynthetic tissue is arranged in vertical filaments of cells, each filament terminated by a hyaline epidermal cell and separated from adjacent filaments by narrow vertical air chambers (Figure 3.2). In the subgenus *Ricciella* the photosynthetic tissue is arranged in a reticulate network of plates, each a single cell in thickness, forming polyhedral air

FIGURE 3.1

Thallus segment shape

a. Obcuneate

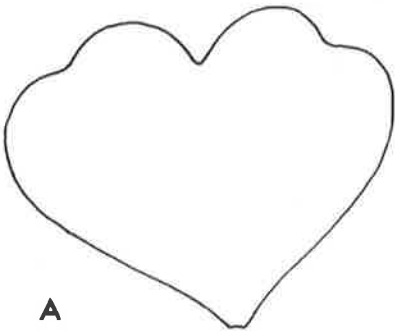
b. Obcuneate-oblong

c. Obovate-oblong

d. Narrowly oblong

e. Broadly oblong

f. Linear



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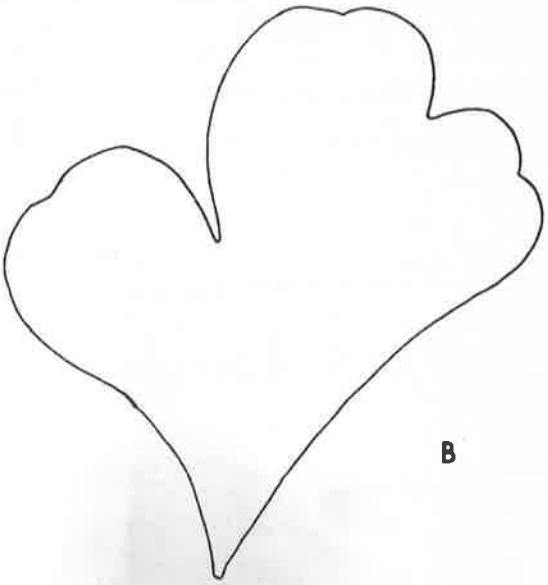

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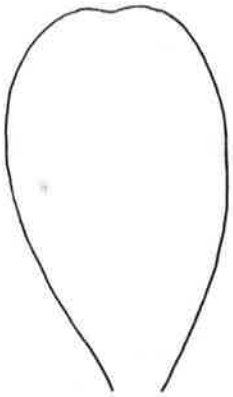

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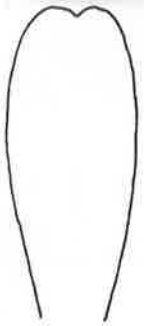

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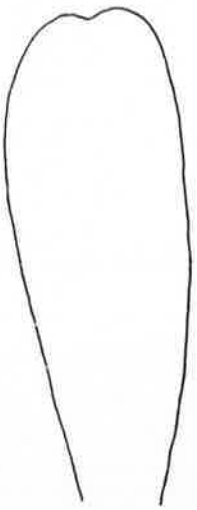

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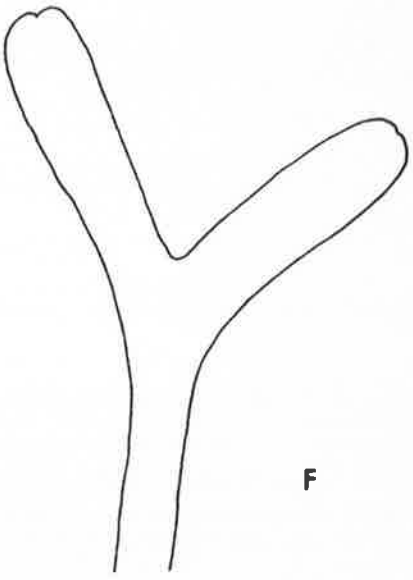

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FIGURE 3.2

Arrangement of photosynthetic tissue
in the subgenus RICCIA.

FIGURE 3.3

Arrangement of photosynthetic tissue
in the subgenus RICCIELLA.

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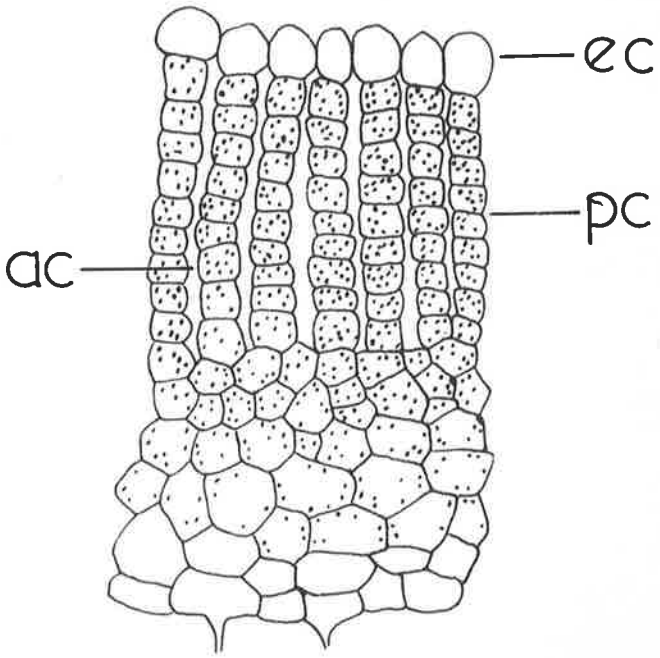
e.c ..... epidermal cell
p.c ..... photosynthetic cell
a.c ..... air chamber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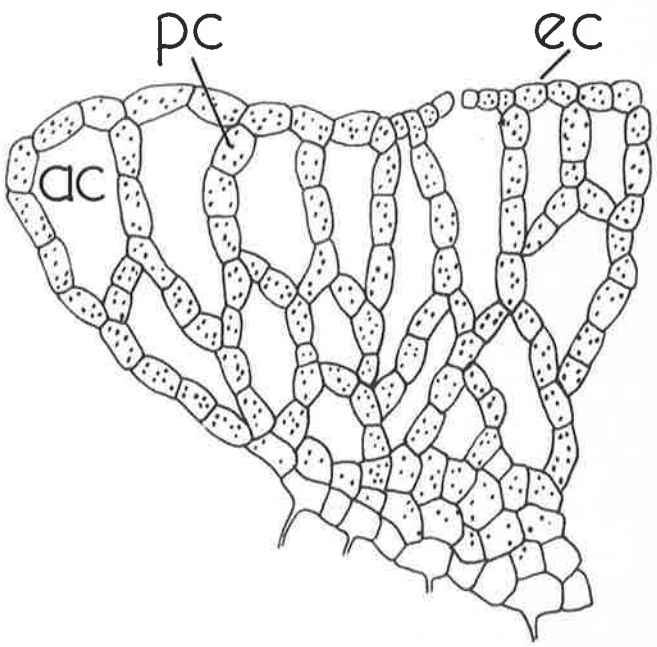
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chambers which are normally roofed over with photosynthetic epidermal cells and open to the exterior by means of a well defined air pore (Figure 3.3). The cells surrounding the air pore are the only achlorophyllous epidermal cells.

Upper surface of the thallus:

In the past several features of the upper surface of the thallus have been used taxonomically. The reticulate pattern (Figure 3.4) of the epidermis of the subgenus *Riccia* results from the vertical arrangement of the photosynthetic filaments and narrow air chambers, whilst in the subgenus *Ricciella* the outline of the air chambers is visible on the upper surface (Figure 3.5).

The dorsal groove or channel may be used for the characterisation of species, particularly in the subgenus *Riccia*. The shape of the dorsal groove in cross section and the degree of variation in its shape along the thallus has been applied in previous taxonomic treatments. However, in some cases the shape of the channel in cross section has led to some confusion in identification of species (see under discussion of *R. crinita*, Chapter 6). The following forms appear to be distinct:

(a) Narrow and deep at apex only, elsewhere broad and flat
e.g. *R. asprella* Figure 3.6.

(b) Narrow throughout
e.g. *R. sorocarpa* Figure 3.7.

(c) Narrow at apex, becoming shallower and flattened
e.g. *R. marginata* Figure 3.8.

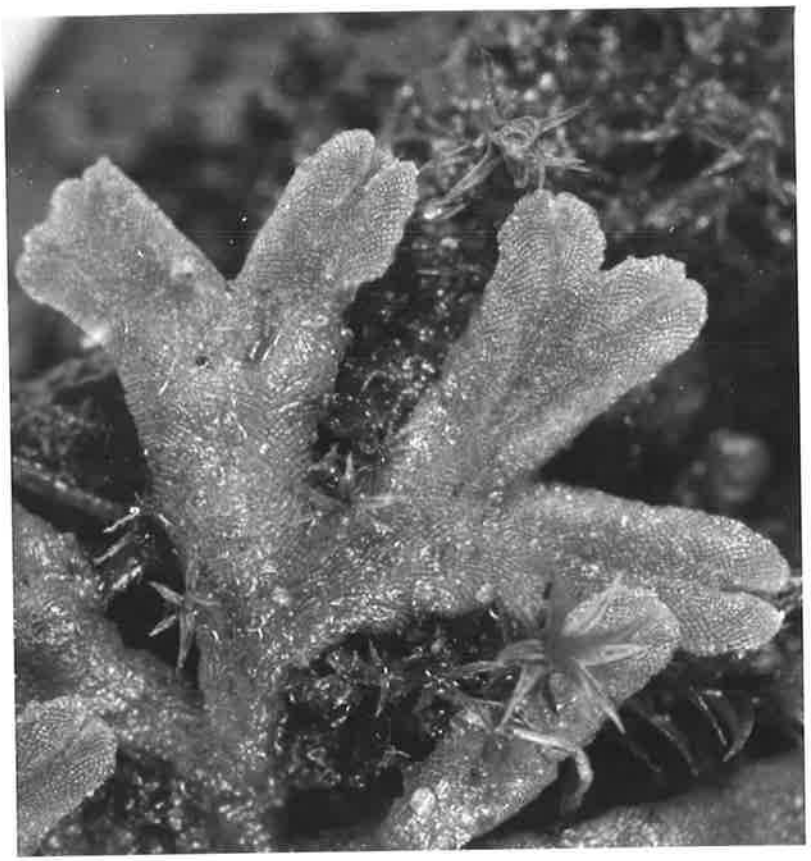
(d) Broad throughout
e.g. *R. crystallina* Figure 3.9.

FIGURE 3.4

Regularly reticulate pattern of cells on the upper surface of the subgenus RICCIA.

FIGURE 3.5

Pattern of air chambers and air pores on the upper surface of the subgenus RICCIELLA.



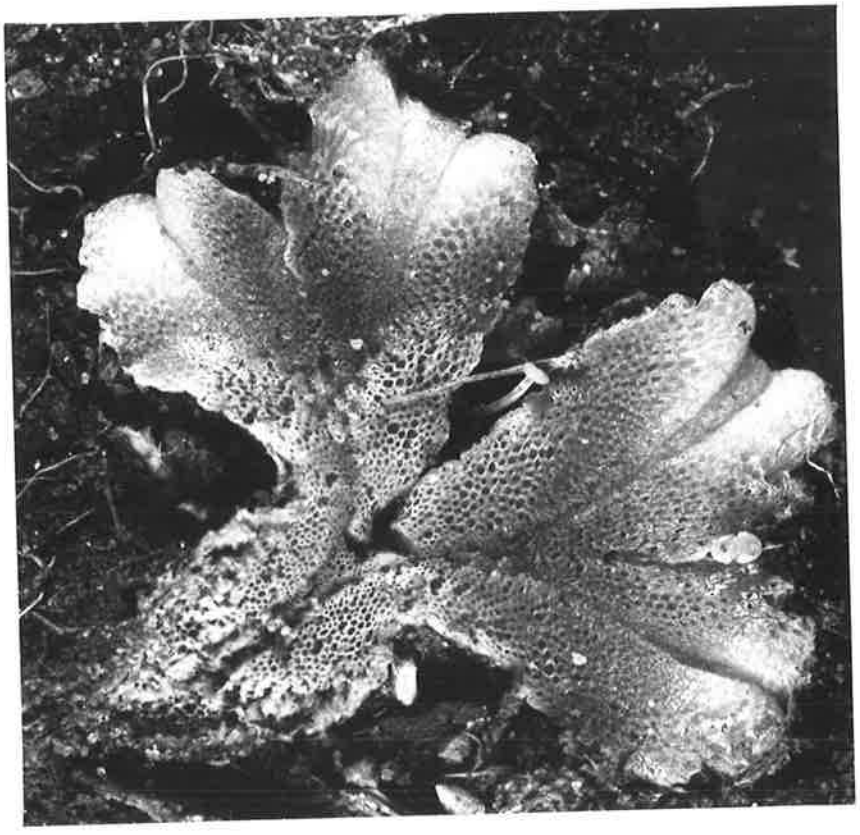


FIGURE 3.6

Riccia asprella - thallus with dorsal channel narrow and deep at apex only, elsewhere broad and flat. Thallus apex rounded.

FIGURE 3.7

Riccia sorocarpa - thallus with dorsal channel narrow throughout. Thallus apex more or less acute.

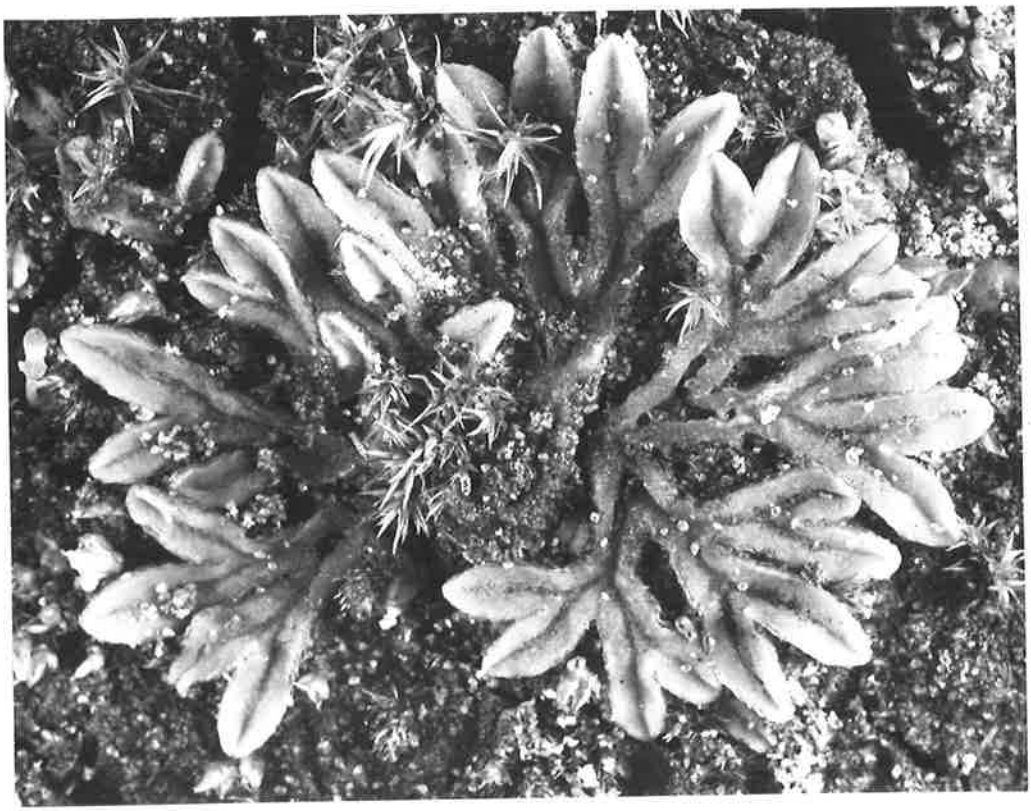
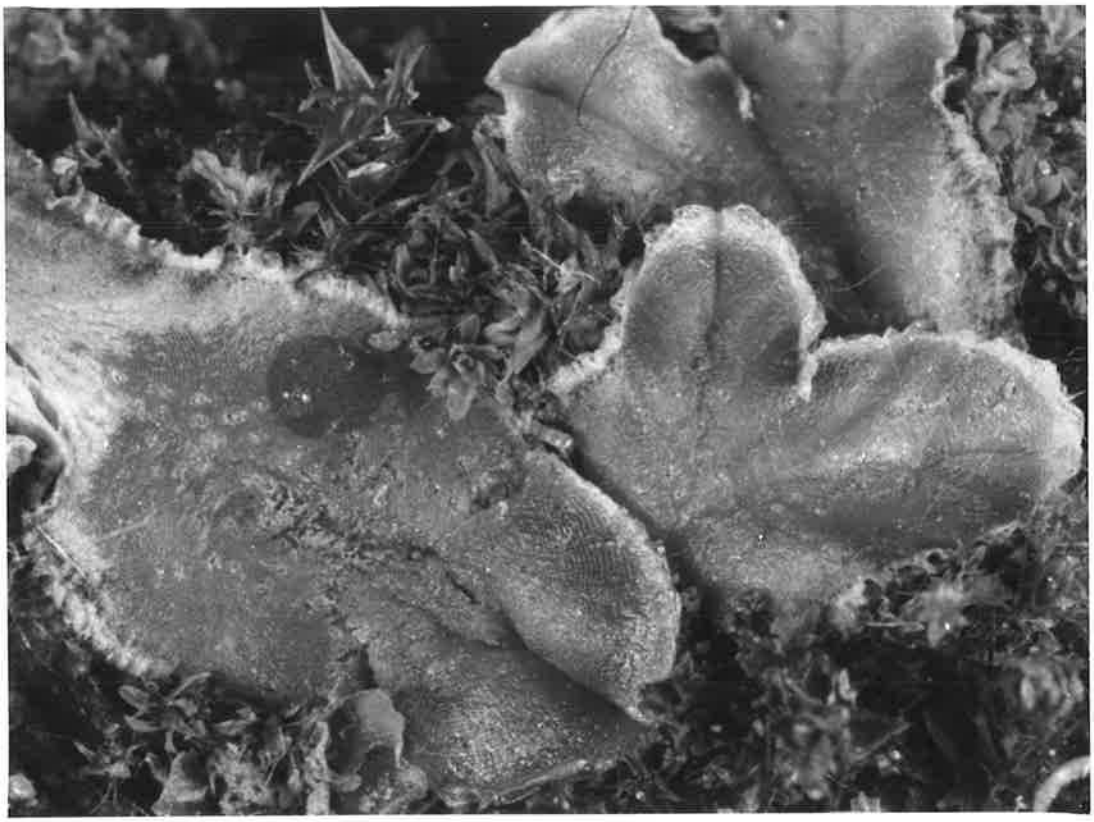


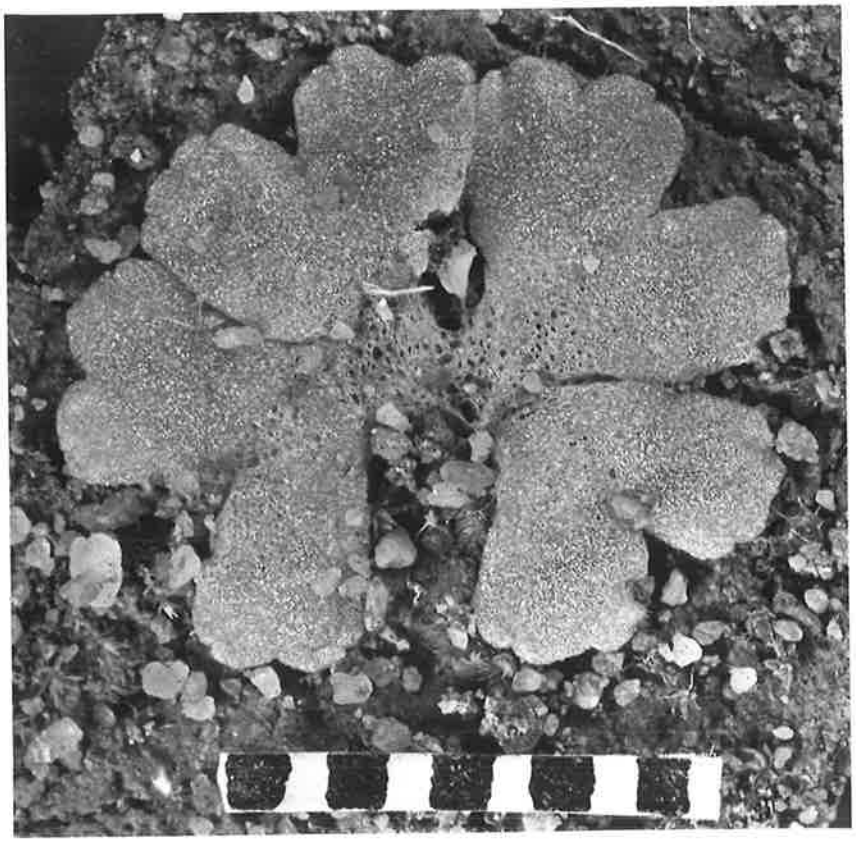
FIGURE 3.8

Riccia marginata - thallus with dorsal channel narrow at apex becoming shallower and flatter towards base. Thallus apex obtuse or rounded.

FIGURE 3.9

Riccia crystallina - thallus with dorsal channel broad throughout. Thallus apex truncate.





Thallus margin and apex:

The thallus margin in cross section may be acute, (e.g. *R. sorocarpa*), obtuse (e.g. *R. bifurca*), or rounded (e.g. *R. crinita*) Figure 3.10.

The thallus apex may be rounded or obtuse (e.g. Fig. 3.11, *R. limbata*), more or less acute (e.g. Fig. 3.7 *R. sorocarpa*), or truncate (e.g. Fig. 3.9 *R. crystallina*).

Cilia:

The thalli of a number of species of *Riccia* have marginal cilia. The cilia may be long and slender (*R. crinita*), short and stout (*R. asprella*), or short and slender (*R. crozalsii*). Some species, such as *R. crinita*, bear numerous cilia along the length of the thallus margin, at the thallus apex, and usually in groups on the thallus marking the positions of capsules. In other species, such as *R. asprella* and *R. crozalsii*, the distribution of cilia is usually restricted to the region of the thallus apex although some cilia may occur along the thallus margin.

The number of cilia and their length show considerable variation within a species (see discussion of the species *R. crinita*, *R. asprella*, and *R. crozalsii* in Chapter Five and Chapter Six).

Capsule position:

In most species of *Riccia* the capsule containing the spores lies deeply embedded in the thallus. In several species of the subgenus *Ricciella* (*R. duplex*, *R. multifida*) the mature capsules bulge out from the lower surface of the thallus.

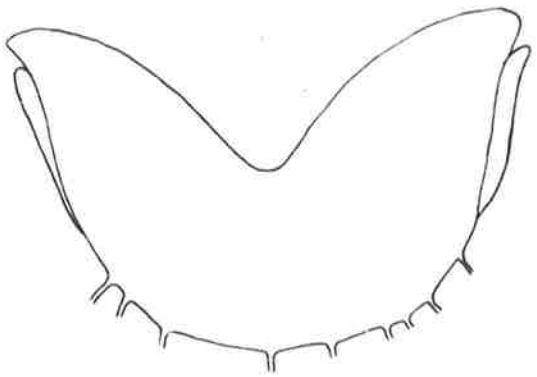
FIGURE 3.10

Cross-sections of the thallus showing:

a. Thallus margins acute

b. Thallus margins obtuse

c. Thallus margins rounded



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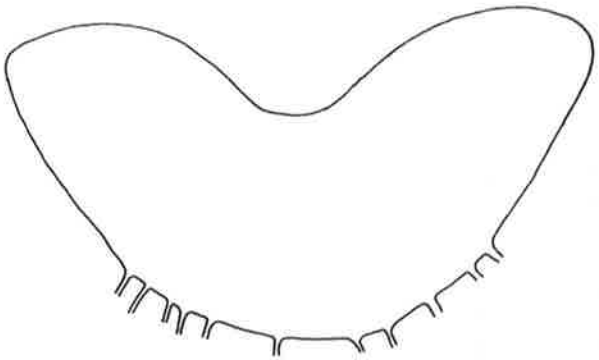

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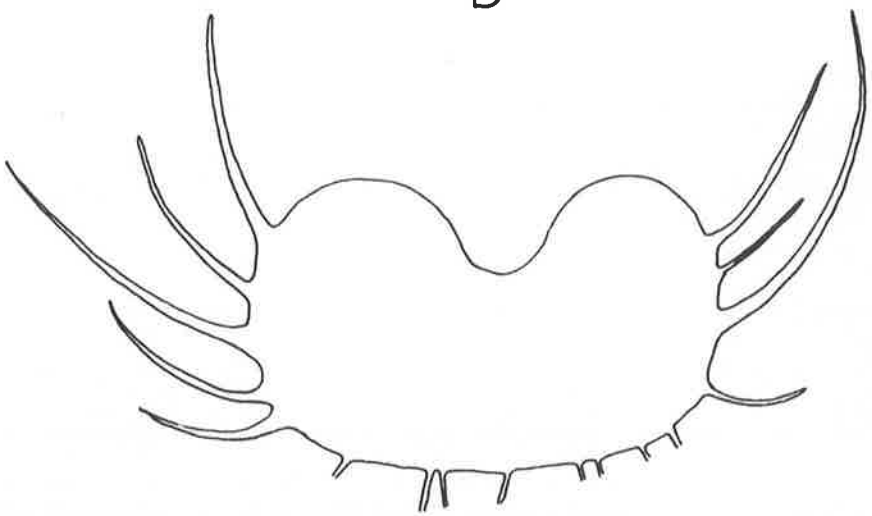

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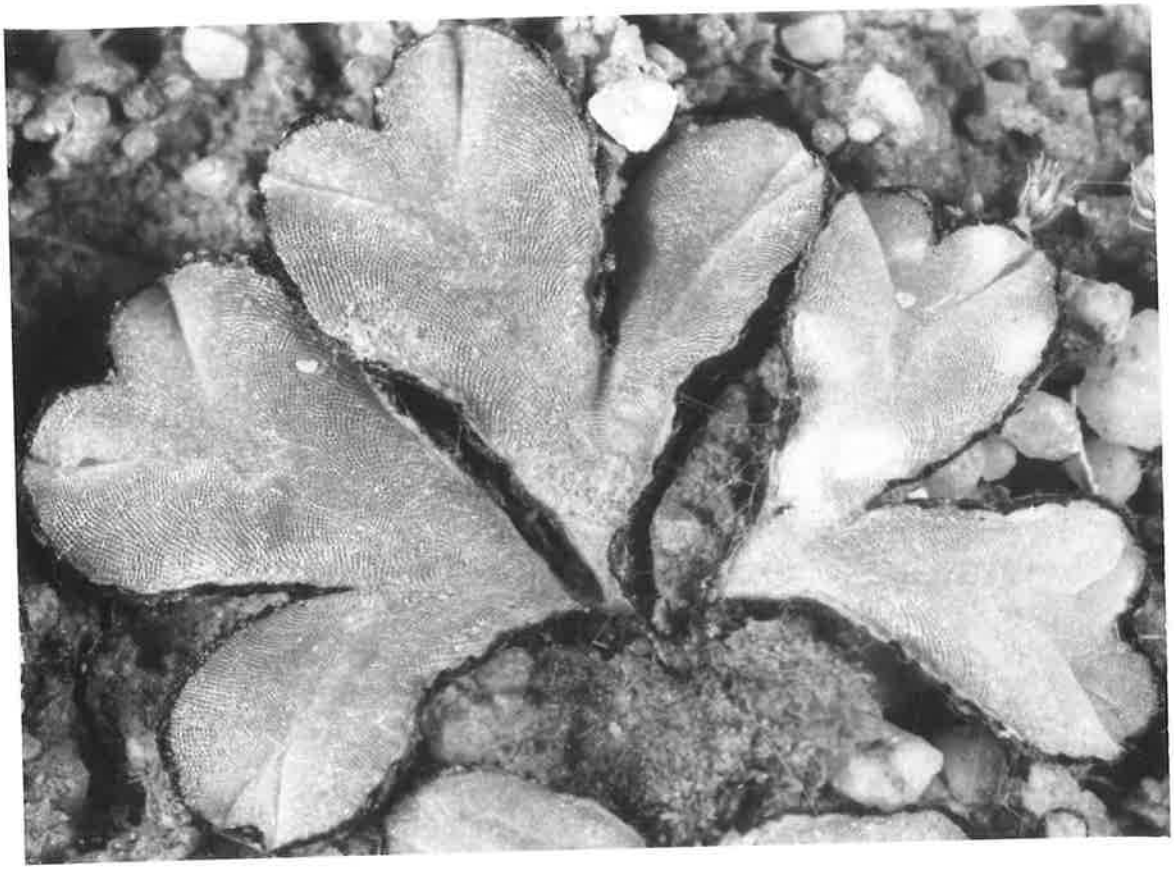
FIGURE 3.11

Riccia limbata - Thallus with dorsal channel narrow at the apex becoming broad and flat towards the base and with the thallus apex rounded or obtuse.



In some species of the subgenus *Riccia* the mature capsules become easily exposed by rupture of the tissues over the capsule (e.g. *R. nigrella, R. crinita*). In most other species of the subgenus, and of the subgenus *Ricciella*, the capsules remain deeply embedded in the thallus, becoming exposed by decay of the thallus tissue.

The swelling of the capsule due to enlargement of the developing spores may alter the shape of the dorsal channel and this feature has occasionally led to some confusion of species (see discussion of *R. crinita* in Chapter Six).

Spore Morphology.

Introduction:

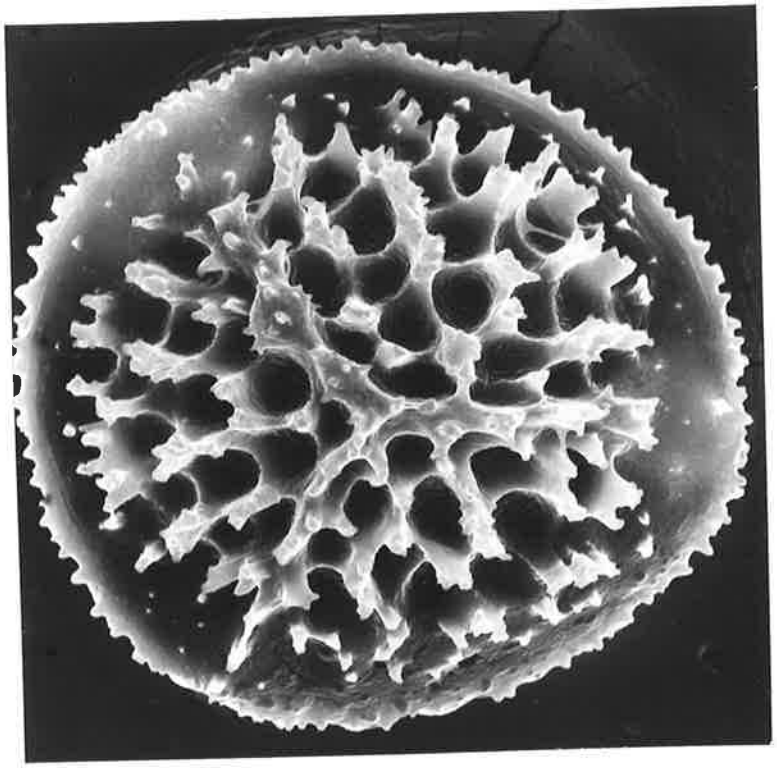
Many early descriptions of species of *Riccia* did not include descriptions or illustrations of the spores. However, due to distortion of the thallus on drying, spore morphology provides one of the most useful taxonomic features of herbarium specimens. A detailed examination of spore morphology has been undertaken during the course of this study.

Spore Size:

Spore size has been used as a means of separating closely related species. Detailed observations on spore morphology of a number of species made during the course of this study have shown that spore size is variable and should not be used alone as a means of species separation. Spore diameter measurements were made using the maximum diameter of the spore (Figure 3.12).

FIGURE 3.12

Proximal surface of the spore of *Riccia crystallina* indicating the spore diameter and wing width parameters.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Spore shape:

Spores are normally formed in tetrads or groups of four from thin walled spore mother cells. In some instances the individual spores of each tetrad remain united more or less firmly and are separated only at maturity or on release from the capsule. Khan (1955) described a new species from India, *R. perrsonii*, in which the spores remain permanently united in tetrads. Several species, such as *R. macrospora* and *R. albida*, have more or less globular spores, the spores presumably separating from the tetrads quite early in development. Most species have triangular-globular spores each with a rather rounded distal face and a more or less prominent triradiate ridge separating the flattened proximal faces (Figure 3.13).

Spore colour:

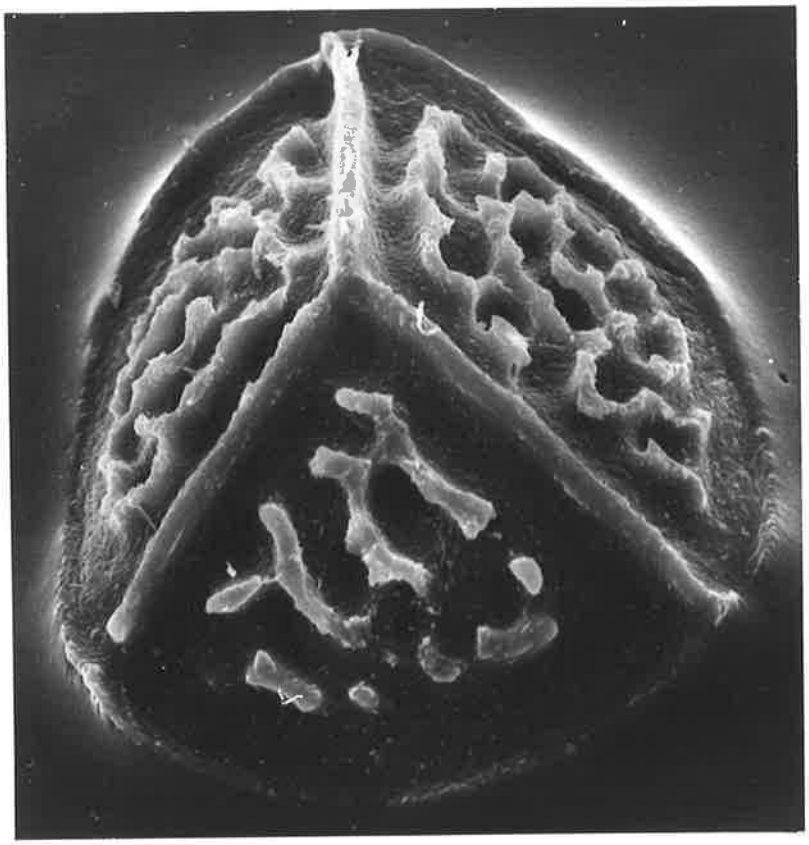
The colour of the spore may be taken as an indication of the stage of maturity reached although colour is of little use taxonomically. Most spores are more or less dark brown, sometimes opaque, at maturity.

Spore sculpturing:

The sculpturing of the exospore (or exine) is the most important single feature of spore morphology. This outer layer of the spore wall "is often ornamented with processes, reticulately branched and anastomosing ridges, etc., by which it can be possible to identify the family or genus of the spore, sometimes even the species or smaller taxonomic unit. The varied appearance of the exine and its resistance to decay and to various strong chemicals are the most important prerequisites of modern palynology". (Erdtman 1969).

FIGURE 3.13

Proximal surface of the spore of Riccia cavernosa indicating the prominent triradiate ridge which separates three flattened proximal faces.



One species, *Riccia albida*, has smooth surfaced spores unlike those known for any other species. The various types of sculpturing found in species of *Riccia* are illustrated under the descriptions of the species.

Spore wing:

Many species have spores which show a distinct marginal wing (Figure 3.13), although others, such as *R. macrospora*, have no wing. Wing width has been shown to vary within a given species. The margin of the wing may be smooth, uneven, or finely crenate or dentate. The nature of the wing margin may also be variable and has led to some taxonomic confusion (see discussion of *R. crinita* in Chapter 6). Thus characteristics of the wing have only limited taxonomic use.

CHAPTER FOUR.

KEY TO SPECIES OF RICCIA IN SOUTH AUSTRALIA.

Introduction.

This key to the species of *Riccia* has been constructed from observations on specimens collected in South Australia and consequently refers only to species found within the study area of South Australia. The key may be of limited use if tested on specimens collected outside the study area.

The section concerning the subgenus *Ricciella* remains incomplete owing to uncertainty of the taxonomic status of several species. Two species, *R. multifida* Steph., and *R. duplex* Lorbeer, are distinct from all other species of the subgenus found in South Australia in having a very narrow, strap-like thallus. *R. crystallina* L. emend Raddi and *R. cavernosa* Hoffm. emend Raddi are readily distinguished from the remaining species of the subgenus on the basis of thallus morphology and habit and on spore morphology. The remaining species, *R. spongiosa* Steph., *R. papulosa* Steph., *R. crassa* Steph., *R. muscicola* Steph., and *R. deserticola* Steph., all need careful revision and it is in the separation of these species that spore morphology will become important. It is likely that some of these species are conspecific.

KEY TO THE SPECIES OF RICCIA

1. Upper part of thallus with compactly arranged tissues forming narrow vertical air chambers; without specialised air pores; epidermal cells hyaline. Photosynthetic tissues of dorsal part of thallus composed of narrow vertical filaments..... SUBGENUS: RICCIA..... 2.

1. Upper part of thallus with loosely arranged photosynthetic tissues forming polyhedral or large air chambers with specialised air pores; epidermal cells, except those around air pores, containing chloroplasts. SUBGENUS: RICCIELLA...13.

2. Thallus normally with marginal and / or apical cilia; cilia 300 - 2000µm long..... 3.

2. Thallus normally without marginal cilia..... 5.

3. Cilia crowded along thallus margin, normally longer than 1000µm, curved over thallus when dry; channel narrow throughout in immature plants, becoming broad with mature capsules bulging on upper surface of thallus; thallus sometimes bearing cilia over capsules..... R. crinita

3. Cilia, if crowded, normally less than 1000µm; cilia normally at apex, sometimes along margin of thallus; channel narrow throughout, or narrow at apex elsewhere broad; mature capsules not bulging on upper surface; thallus never with cilia over capsules..... 4.

4. Thallus with numerous short (less than 500µm), stout cilia at apex, sometimes with marginal cilia; thallus margins rounded, swollen; channel narrow and closed at apex, elsewhere broad.....R. asprella

4. Thallus with longer (more than 500µm) cilia at apex, usually with marginal cilia; thallus margins rounded, channel narrow throughout.....R. crozalsii

5. Scales purple or pigmented..... 6.

5. Scales hyaline..... 8.

6. Plants large, 5-15mm long, 2.5-5mm broad; scales reaching beyond thallus margin. Plants forming rosettes, often scattered or in gregarious patches. Thallus not rusty coloured..... 7.

6. Plants small, 3-6mm long, 1-2mm broad; scales reaching only to thallus margin. Plants forming rosettes. Thallus rusty coloured towards base, at least over capsules..... R. nigrella

7. Mature plants in rosettes or scattered. Spores winged ..... R. limbata

7. Mature plants usually in gregarious patches. Spores not winged..... R. macrospora

8. Scales small, present only under apex..... 9.

8. Scales large, present along margins of thallus..... 10.

9. Plants white, sometimes tinged with green; spores smooth, capsules deeply embedded in thallus..... R. albida.

9. Plants green, spores ornamented; capsules becoming exposed by decay of older thallus tissues..... R. bifurca.

10. Plants dark green, upper surface shining. R. marginata.

10. Plants yellowish green or glaucous green, upper surface not shining..... 11.

11. Plants yellowish green or pale green, upper surface finely reticulate..... R. sorocarpa

11. Plants glaucous green; upper surface coarsely reticulate, more or less granular..... 12.

12. Thallus margin rounded and swollen at apex, elsewhere acute; channel narrow and closed at apex, elsewhere broad and flat; marginal scales prominent at apex. Plants small, 3-5mm long, 1.5-2.5mm broad. R. rorida.

12. Thallus margins acute throughout; channel narrow at apex, becoming broader and flatter towards base of thallus. Plants larger, 5-10mm long, 3-5mm broad. ..... R. lamellosa.

13. Thallus long and strap-like, 1-2mm broad; capsules, if present, bulging on lower surface of thallus..... 14.

13. Thallus not strap-like, broader than 1-2mm; capsules not bulging on lower surface of thallus..... 15.

14. Air chamber areas conspicuous on upper surface of thallus..... R. multifida

14. Air chamber areas inconspicuous on upper surface of thallus, occasionally conspicuous in older parts of thallus..... R. duplex.

15. Plants pale green, upper surface granular, not marked out with distinct air chamber areas; spores with a finely dentate wing, distal face regularly areolate, corners of areolae raised into tall papillae; proximal faces similar, with a distinct, narrow, triradiate ridge. R. crystallina

15. Plants forming compact rosettes, thallus always tinged with red or purple, at least at apex, often along thallus margins and on upper surface. Spores with a finely crenate wing, distal face with anastomosing ridges radiating from centre, sometimes forming areolae towards margin of spore; proximal faces with short irregular ridges, with a distinct triradiate ridge..... R. cavernosa

Note: Five additional species of the subgenus *Ricciella*, *R. spongiosa* Steph., *R. papulosa* Steph., *R. crassa* Steph., *R. muscicola* Steph., and *R. deserticola* Steph., have also been recorded in South Australia. These species are not clearly distinguished and all need careful revision.

CHAPTER FIVE

TAXONOMY

SUBGENUS: RICCIA.

1. *Riccia crinita* Tayl.

Taylor, T. 1846: 415.

Stephani, F. 1898: 9.

Holotype: Swan River, Western Australia.

Coll: W.J. Drummond, 1843. BM 42.

Isotype: MEL 19788.

Gametophyte monoicous, in rosettes, or in gregarious patches (Figure 5.1). Thallus 3-6mm long, 1-2mm broad. Upper surface finely reticulate, green to light green, often shining. Channel narrow throughout in immature plants, in mature plants becoming broad with swelling of capsules (Figure 5.2). Branches furcate to bifurcate. Thallus segment obovate-oblong to oblong, apex rounded to truncate. Margin of thallus tumid at apex, becoming flattened elsewhere. Numerous long cilia borne on lateral-ventral margins of thallus; cilia crowded, incurved, 500-2000µm long. Scales small, purple, or hyaline becoming tinged with purple, not extending beyond thallus margin. Capsules bulging on upper surface when mature; thallus tissue often bearing cilia over capsules, these cilia easily detached. Spores 77.5-137.5µm in diameter, dark brown, becoming opaque at maturity; wing 3.75-7.5µm wide, with a smooth to uneven or finely crenate margin; distal face regularly reticulate, forming 6-13 areolae across the diameter; proximal faces similar to distal face, with a faint to more or less distinct triradiate ridge (Figure 5.3).

Distribution:

South Australia (Figure 5.4): Wilpena Pound; Pichi Richi Pass, near Port Augusta; Tassie Creek, Corunna Stn., Iron Knob; Rockwater Hill, Coralbingie Stn., and Yardea, Gawler Ranges; Gibraltar Rocks, 80Km north of Tarcoola; near Coober Pedy.

New South Wales; Northern Territory; Western Australia.

Specimens Examined:

South Australia: Seppelt 0270, 0399, 0472, 0480, 0481, 2410, 2911, 2913, 2914, 2928, 2943, 2944, 2946, 2948, 2949, 3019, 3053, 3054, 3055, 3060, 3064, 3065, 3066, 3067, 3068, 3069, 3070, 3071, 3072, 3073, 3074, 3075, 3076, 3146, 3166, 3168, 3181, 3182, 3183, 3213, 3215, 3216, 3231, 3272, 3275, 3294, 3347, 3480 (ex B.G. Lay 810). L.D. Williams 4458; T.R.N. Lothian 2834 (in AD).

Western Australia: Holotype BM 42; Isotype MEL 19788, MEL 19786, MEL 19787.

Northern Territory: Seppelt 3495 (ex P.K. Latz 4092); 3496 (ex P.K. Latz 4093); 3542 (ex D. Nelson 2305); 3541 (ex D. Nelson 2308).

New South Wales: O. Na-Thalang 36.

R. areolata Na-Thalang (proposed):

Holotype: Prospect Reservoir, New South Wales.
Coll: O. Na-Thalang 1967. Na Thalang 236, in NSW.

Isotype: Na-Thalang 236, in SYD. Na-Thalang 236, in SYD.

R. longiciliata Na-Thalang (proposed):

Holotype: Palm Valley, Northern Territory.

Coll: O. Na-Thalang 1966. Na-Thalang 100A, in NSW.

Isotype: Na-Thalang 100A, in SYD.

Na-Thalang 100A, in SYD.

Discussion.

Taylor (1846) gave only a short description of the original specimen based on features of thallus morphology which have since been shown to vary under the influence of different environmental conditions. Taylor separated *R. crinita* from *R. ciliata* Bisch., on the basis of cilia length and pigmented thallus margins in the former species. He gave no description of spores and relied on variable morphological features to delimit the two species. It is thus possible that *R. crinita* may be conspecific with *R. ciliata.*

Na-Thalang (1969) proposed two new long-ciliate species, *R. longiciliata* and *R. areolata.* However, an examination of the holotype, isotype and other specimens of these species indicates that these proposed new species are synonymous with *R. crinita* (see Chapter 6).

Riccia trichocarpa Howe, a further long-ciliate species, closely resembles *R. crinita* in both thallus and spore morphology. A specimen of *R. trichocarpa* from Uganda, Africa (G 16117) was examined. Although the type specimen of this species has not been seen, it is likely that *R. crinita* and *R. trichocarpa* will prove to be conspecific.

Riccia crinita is the only long-ciliate species of the genus found in South Australia.

FIGURE 5.1

Riccia crinita Tayl. growing in association with Riccia limbata Bisch. and various moss species.

Scale in mm.

FIGURE 5.2

Transverse sections of the thallus of *Riccia crinita*.

a. 0.5 mm from thallus apex

b. 2.0 mm from thallus apex

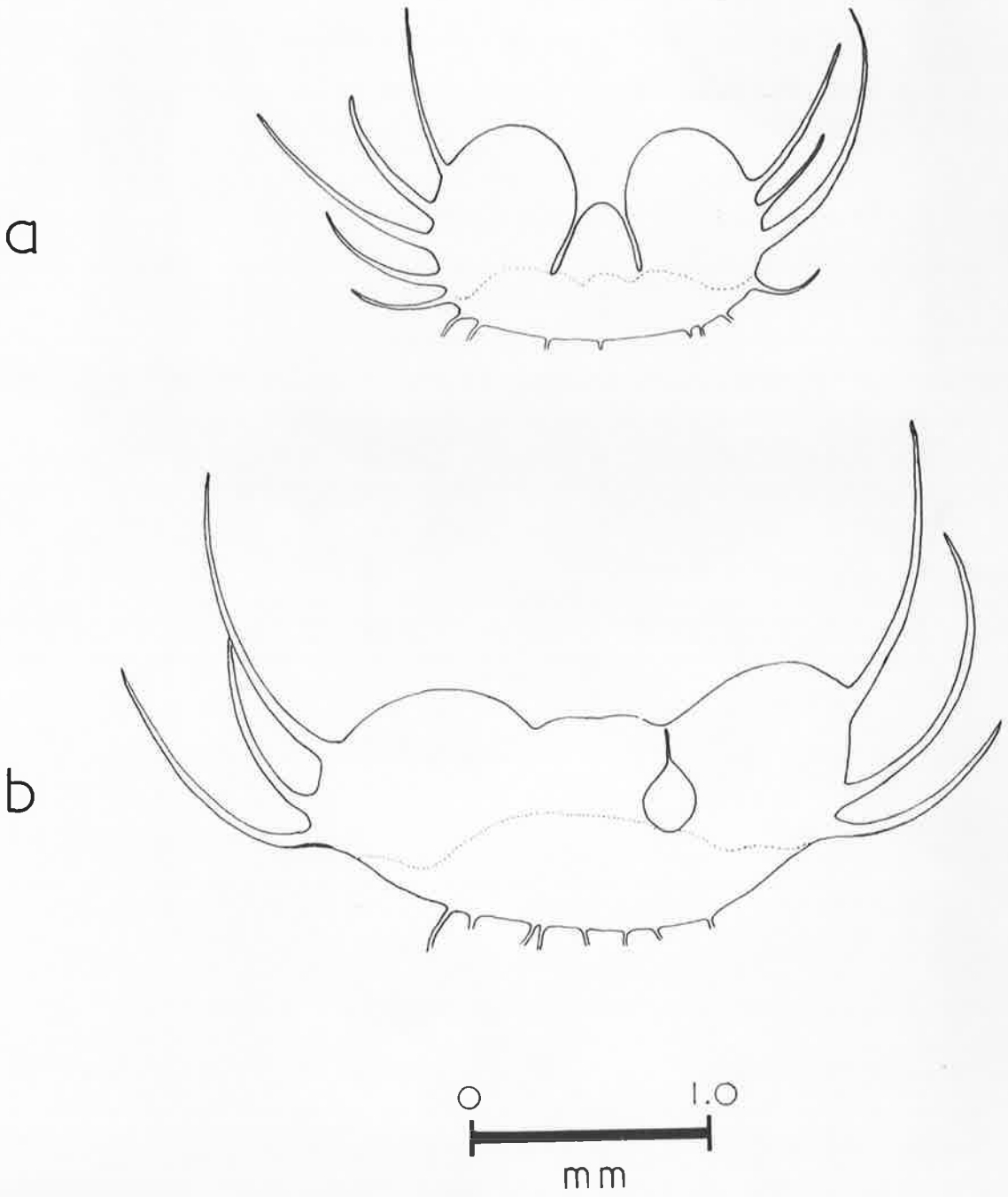
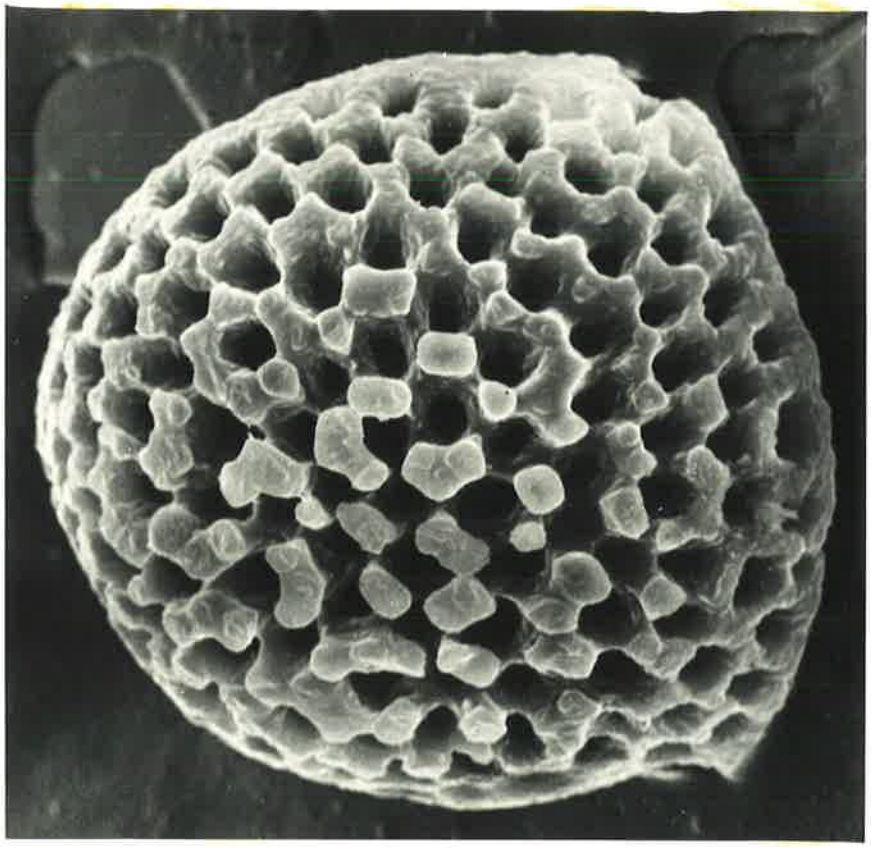

a
b
0
1.0
mm

FIGURE 5.3

Scanning electron micrographs of the spores of *Riccia crinita*.

a. Distal face

b. Proximal face



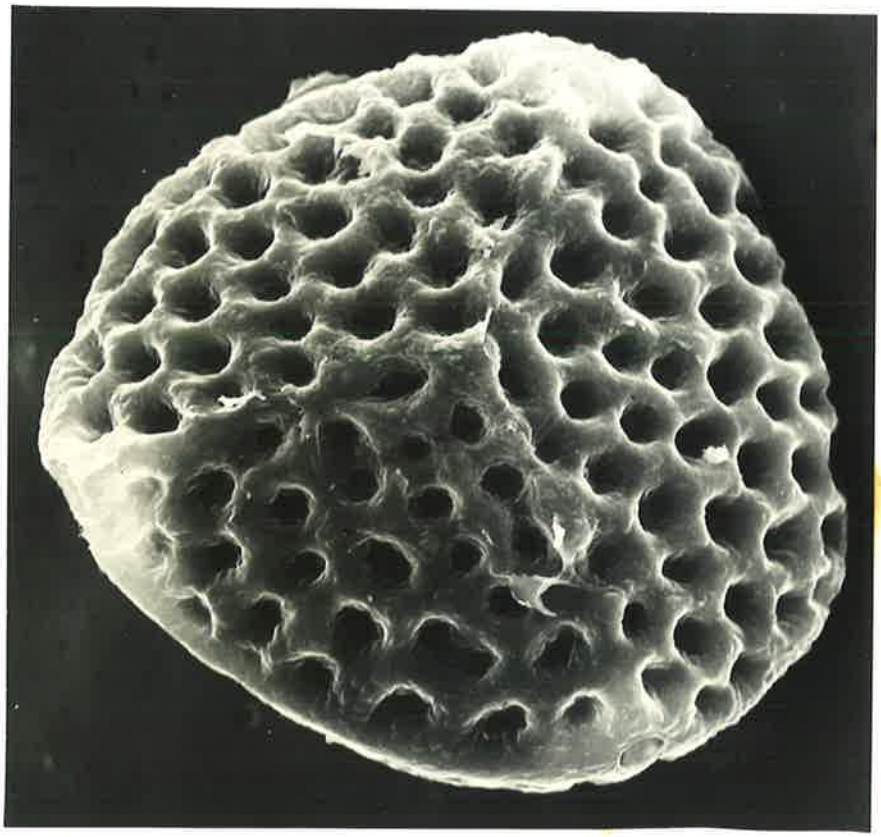
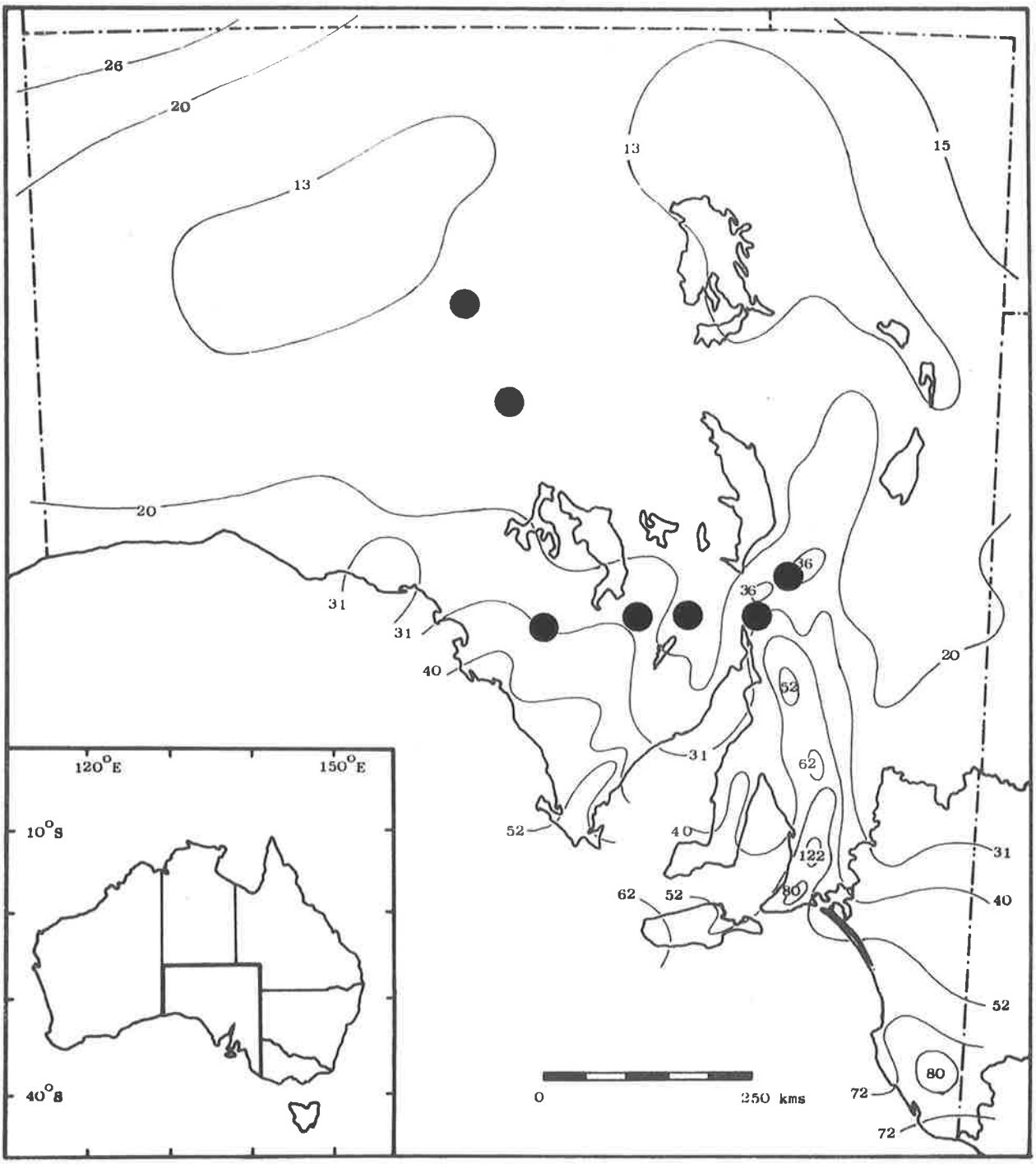


FIGURE 5.4

Distribution of collection localities of Riccia crinita in South Australia.

Rainfall isohyets give annual rainfall in cm.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20
52
31
62
52
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122
80
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52
31
40
52
80
72
72
0
250 kms
120°E
150°E
10°S
40°S

2. *Riccia asprella* Carr. et Pears.

Carrington B. and Pearson, W.H. 1887: 1059.

Stephani, F. 1898: 8.

Holotype: Double Bay, New South Wales.

Coll: T. Whitelegge, 1885. NSW H 94.

Isotype: NSW H 88.

Gametophyte monoicous, in rosettes or scattered patches (Figure 5.5). Thallus 5-10(15)mm long, 1-3.5mm broad. Upper surface finely reticulate, glaucous green to pale green. Channel narrow at apex, elsewhere broad and flat. Branches furcate to bifurcate, more or less divergent. Thallus segment obovate-oblong to broadly oblong, apex rounded to truncate. Margin of thallus obtuse or rounded, forming a broad elevated edge along thallus, bearing numerous short, stout cilia 300-500µm long (Fig. 5.6). Scales hyaline, present only under apex. Mature capsules slightly protruding; cilia lacking over capsules. Spores 85.0-142.5µm in diameter, dark brown; wing 5.0-10.0µm wide, with a smooth to uneven or finely dentate margin; distal face reticulate, forming (6)8-13(15) areolae across the diameter; proximal faces similar, with less distinct areolae; with a more or less distinct triradiate ridge (Fig. 5.7).

Distribution:

South Australia (Fig. 5.8): Wilpena Pound; Comaum Forest, south-east of Naracoorte.

New South Wales.

Specimens Examined:

South Australia: Seppelt 0400, 0403, 0487, 2480, 2481, 2526, 2538, 2544, 2915, 2916, 2919, 2929, 2932, 3033, 3034, 3035, 3036, 3155

New South Wales: Holotype: Double Bay, New South Wales. Coll: T. Whitelegge, 1885. NSW H 94. Na-Thalang 200, 310.

Discussion.

The species has previously been known only from New South Wales (Na-Thalang, 1969).

Riccia asprella differs from other ciliate species found in South Australia in having short stout cilia at the apex and occasionally along the thallus margin. The rounded and swollen margins at the apex further delimit this species vegetatively from other South Australian ciliate species.

Riccia beyrichiana Hampe and *R. californica* Aust. closely resemble *R. asprella* in thallus and spore morphology. Specimens of *R. beyrichiana* (G 13118, 13119, 13120, 13121, 13122, 13123) from North America and *R. californica* (Holotype - G 16099; 16100) also from North America, were examined. In the specimens examined the spores of *R. californica* range between 47.5 and 57.5µm in diameter with 8-10 areolae across the diameter, the borders of the areolae are narrow and the corners raised forming papillae. The proximal faces of the spores are less distinctly areolate. Similarly, the spores of *R. beyrichiana* range between 95.0 and 117.5µm in diameter with 6-7 areolae across the diameter, and the borders of the areolae are raised at the corners forming papillae. The proximal faces of the spores of *R. beyrichiana* are irregularly

roughened and non-areolate. The spores of *R. asprella* are larger (85.0-142.5µm in diameter), have a greater number of areolae across the diameter (6)8-13(15), the borders of the areolae are thicker and not raised into papillae at the corners. Further, the proximal faces are areolate. *Riccia asprella* is thus distinct from *R. beyrichiana* and *R. californica* in spore morphology.

FIGURE 5.5

<u>Riccia asprella</u> Carr. et Pears. in association with various moss species.

Scale in mm.

FIGURE 5.6

Transverse sections of the thallus of *Riccia asprella*.

a. 0.5 mm from thallus apex

b. 1.5 mm from thallus apex

c. 2.5 mm from thallus apex

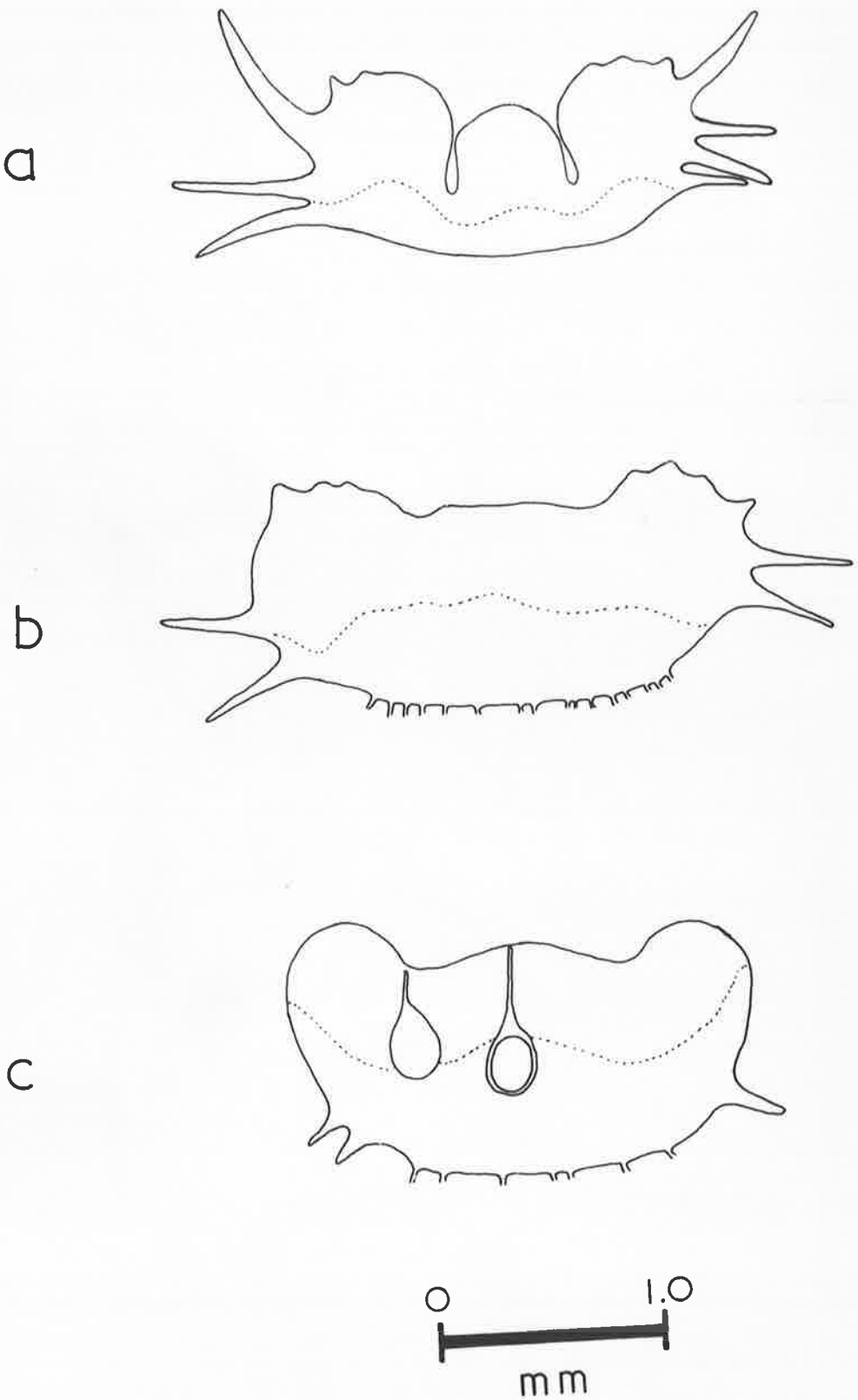
a
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FIGURE 5.7

Scanning electron micrographs of the spores of Riccia asprella.

a. Distal face

b. Proximal face

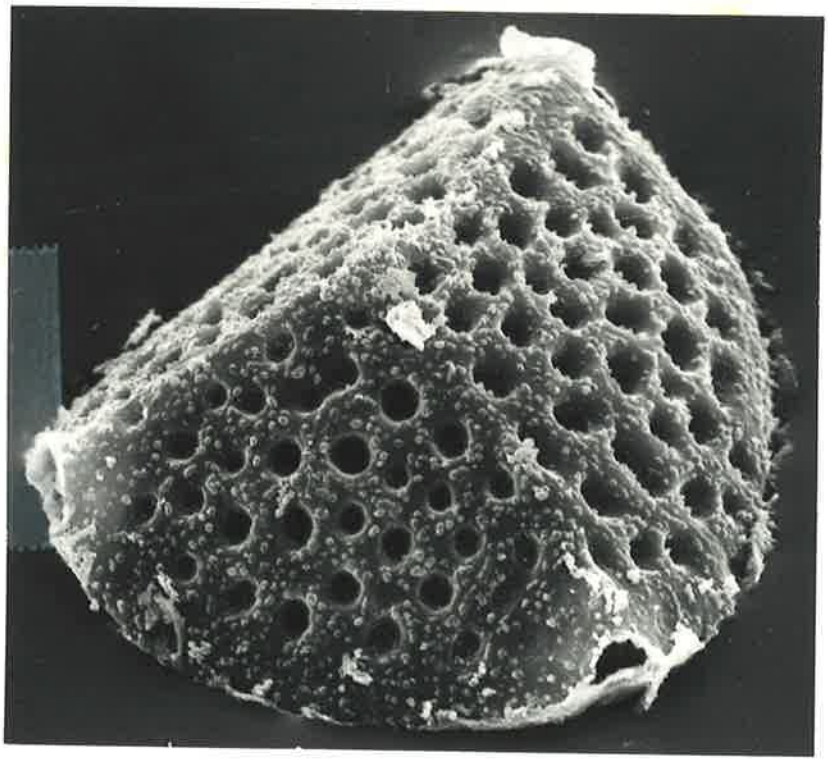
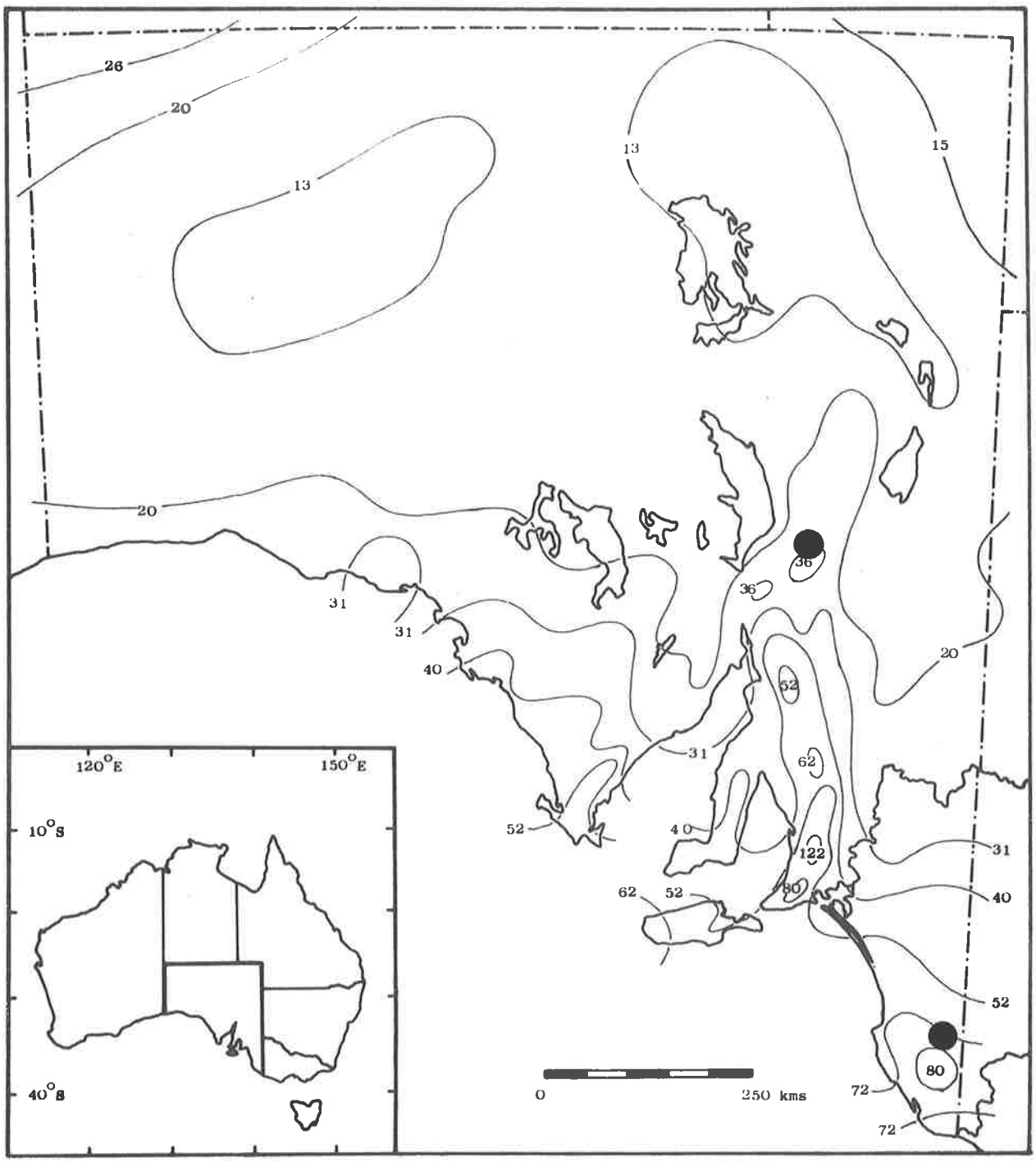


FIGURE 5.8

Distribution of collection localities of Riccia asprella in South Australia.

Rainfall isohyets give annual rainfall in cm.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31
40
52
80
72
72
120°E
150°E
10°S
40°S
0
250 kms

3. *Riccia crozalsii* Levier.

Levier, E. 1902: 73.

MacVicar, S.M. 1926: 16.

Arnell, S. 1963: 17-18.

Holotype: Mont Caroux, bord des petites sources, 400m.

Coll: A. Crozals, 1902. FI.

Gametophyte monoicous, forming complete or incomplete rosettes, occasionally in gregarious patches (Fig. 5.9). Thallus 4-10mm long, 1-2mm broad. Upper surface finely reticulate, light green, sometimes pigmented along thallus margin. Channel narrow throughout, deep at apex becoming shallower towards base of thallus. Branches bifurcate to trifurcate, sometimes overlapping. Thallus segment oblong to obcuneate, apex rounded. Margin obtuse or rounded (Fig. 5.10). Cilia short, slender, 200-500µm long, borne at apex or along margins of thallus, often sparse. Scales small, hyaline, present only beneath apex. Capsules not protruding; thallus tissues over capsules not bearing cilia. Spores 65.0-105.0µm in diameter, dark brown; wing 2.5-5.0µm wide, with a smooth to uneven margin; distal face regularly areolate, forming 8-13 areolae across the diameter, corners of areolae raised up; proximal faces similar to distal face, with a narrow, more or less distinct triradiate ridge (Fig. 5.11).

Distribution:

South Australia (Fig. 5.12): Seppeltsfield, approx. 50Km north east of Adelaide; Highbury, 11Kms east north east of Adelaide; Waite Arboretum, Urrbrae; Hindmarsh Valley Falls, near Victor

Harbour; 13Km east of Tailem Bend; Archibald Makin Reserve, Keith; Mt. Monster, 9Km south of Keith; Christmas Rocks, 25Km south of Keith; Rules Swamp, 25Km south east of Naracoorte; Comaum Forest, south east of Naracoorte.

New South Wales:

Specimens Examined:

South Australia: Seppelt 2414, 2415, 2416, 2418, 2421, 2463, 2465, 2466, 2482, 2500, 2527, 2539, 2541, 2545, 2547, 2566, 2567, 2581, 2583, 2584, 2587, 2589, 2592, 2689, 2691, 2717, 2729, 3537, 3540.

New South Wales: R.C. Carolin 5414.

Europe: G 13135, 13136, 13137.

Discussion.

Na-Thalang (1969) recorded *R. crozalsii* only from New South Wales. The geographical range of this species has now been extended to South Australia.

Riccia crozalsii resembles closely *R. bifurca* Hoffm. in appearance. Many specimens found in South Australia and identified as *R. crozalsii* have only sparsely distributed cilia at the apex or along the thallus margin. This feature is also reported in *R. bifurca* f. *subinermis* Heeg. (MacVicar 1926 and Arnell, 1956).

The spores of specimens collected in South Australia and identified as *R. crozalsii* and *R. bifurca* are similar. In additon, many specimens of both species have a pigmented thallus margin. The similarity of these two species makes identification difficult.

The South Australian and New South Wales specimens which have been examined agree well both in thallus and spore morphology with specimens identified as *R. crozalsii* from European localities. Although it has not been possible to obtain the Type specimen for comparison, it seems certain that this species occurs in South Australia.

FIGURE 5.9

Riccia crozalsii Levier

Scale in mm.

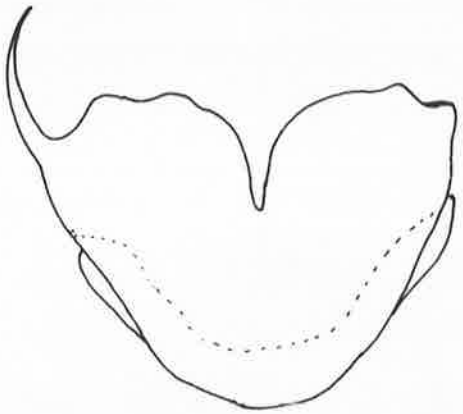
FIGURE 5.10

Transverse sections of the thallus of *Riccia crozalsii*.

a. 0.5 mm from thallus apex

b. 2.5 mm from thallus apex

a



b

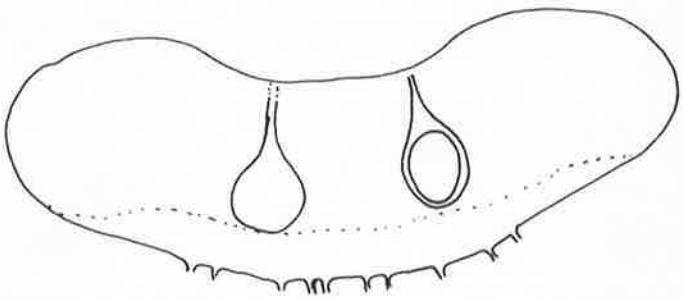
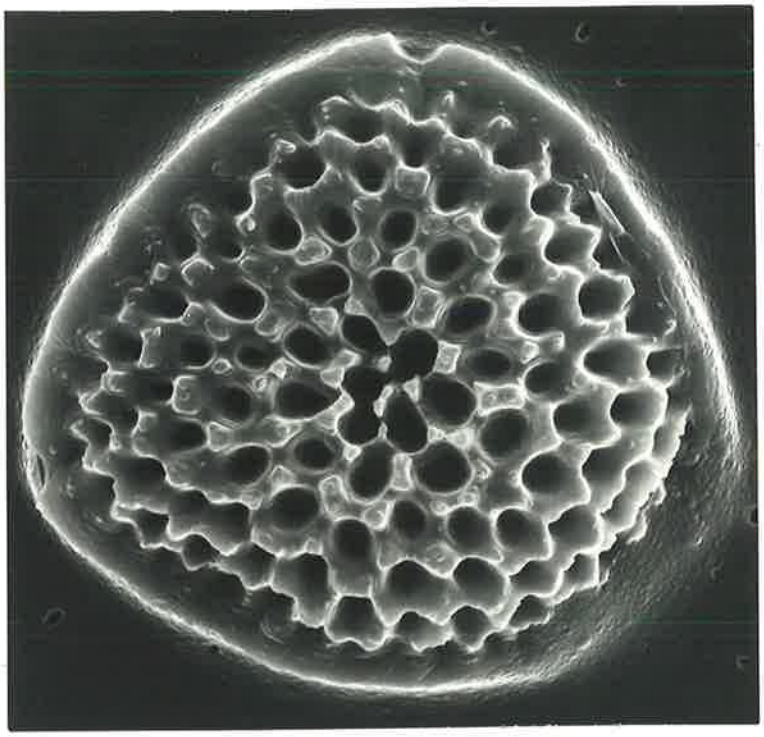


FIGURE 5.11

Scanning electron micrographs of the spores of Riccia crozalsii.

a. Distal face

b. Proximal face



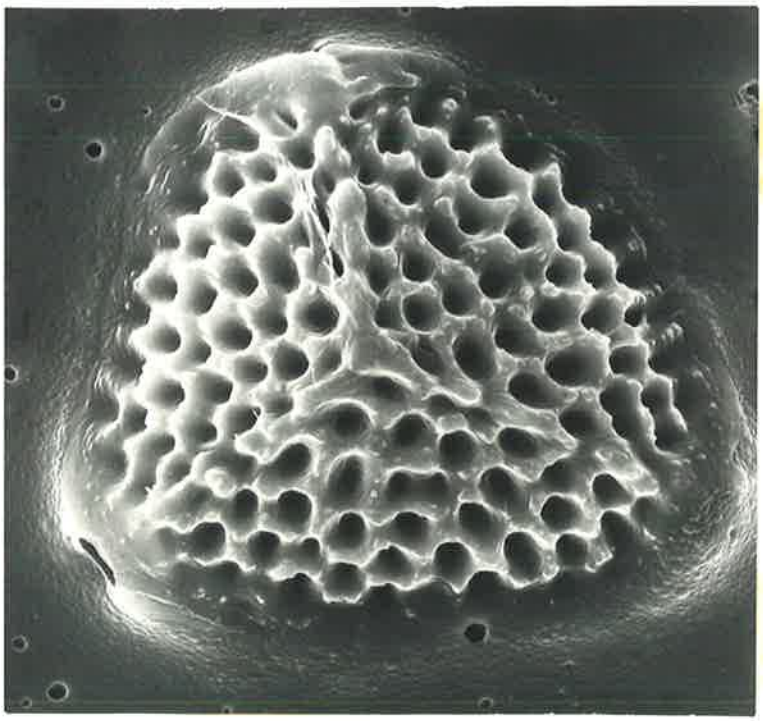
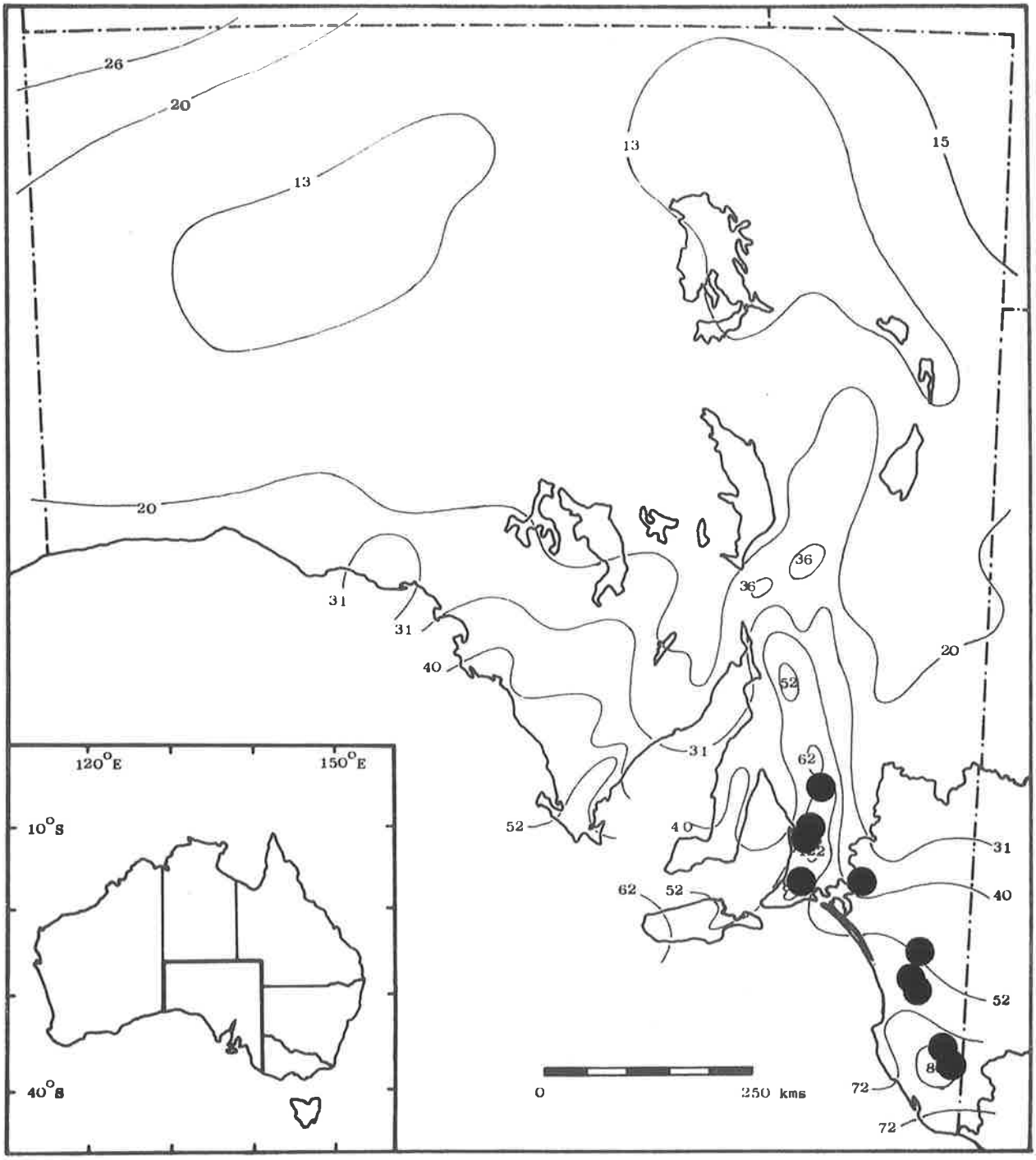


FIGURE 5.12

Distribution of collection localities of *Riccia crozalsii* in South Australia.

Rainfall isohyets give annual rainfall in cm.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36
36
20
52
31
62
52
40
62
52
31
40
52
72
72
0
250 kms
120°E
150°E
10°S
40°S

4. *Riccia nigrella* DC.

De Candolle, 1815: 193.

Stephani, F. 1898: 26.

MacVicar, S.M. 1926: 24-25.

Frye, T.C., and Clark, L. 1937-47: 21-22.

Synonyms:

R. minima L. 1753: 1139. Stephani, F. 1898: 26.

R. minima Raddi. 1818: 353. Stephani, F. 1898: 26.

R. aggregata Underw. 1894: 275. Frye, T.C. and Clark, L. 1937-47: 21-22.

R. pearsoni Steph. 1898: 335. Frye, T.C. and Clark, L. 1937-47: 21-22.

R. porosa Tayl. 1846: 416. Na-Thalang, O. 1969: 94-96.

Holotype: G ?

Gametophyte monoicous, forming rosettes or part rosettes (Fig. 5.13). Thallus 5-12mm long, 1.5-2.5mm broad. Upper surface finely reticulate, dark green, shining, becoming rusty coloured towards base, at least over capsules. Channel narrow and deep at apex, becoming shallower towards base. Branches furcate to trifurcate, slightly divergent. Thallus segment oblong or obcuneate-oblong, apex rounded. Margin of thallus acute, ascending (Fig. 5.14). Scales small, purple, reaching only to margin of thallus. Capsules large, occupying width of thallus, becoming exposed by decay of thallus tissue over capsule. Spores 62.5-92.5µm in diameter, dark brown to opaque; wing 1.5-5.0(6.5)µm wide, with a smooth to finely crenate margin; distal face with irregular ridges, occasionally forming areolae; proximal faces similar to distal face, with a distinct triradiate ridge (Fig. 5.15).

Distribution:

South Australia (Fig. 5.16): Chambers Gorge, west of Lake Frome; Yourambulla Caves, south of Hawker; Wilpena Pound; Warren Gorge and Buckaringa Gorge, north of Quorn; Tassie Creek, Corunna Stn., Iron Knob; Gibraltar Rocks, 80Km north of Tarcoola; Old Whydown Stn., Nackara; 15Km north of Terowie; Seppeltsfield; Eagle on the Hill, near Mt. Lofty; 13Km east of Tailem Bend; 15Km north of Kingston, south east of South Australia; Archibald Makin Reserve, Keith; Mt. Monster, 9Km south of Keith; Christmas Rocks, 25Km south of Keith. Comaum Forest, south east of Naracoorte.

New South Wales: Western Australia.

Specimens Examined:

South Australia: Seppelt 0397, 0415, 0417, 0425, 0443, 0446, 0447, 0454, 0462, 0479, 0483, 2384, 2388, 2417, 2419, 2423, 2479, 2486, 2487, 2491, 2494, 2507, 2508, 2610, 2671, 2679, 2719, 2720, 2721, 2722, 2724, 2734, 2735, 2835, 2847, 2935, 2958, 2968, 2993, 3018, 2058, 3325, 3327, 3505, 3507.

New South Wales: Na-Thalang 72, 218.

Europe: G 16102, 16103, 16104, 16105, 16106, 16107, 16108, 16109, 16110, 16111, 16112, 16113, 16114, 16115.

R. porosa Tayl: Holotype: Swan River, Western Australia. Coll: W.J. Drummond, 1843. BM 43.

Swan River, Western Australia.

Coll: W.J. Drummond, 1843. MEL 19773 (probably isotype).

Discussion.

The type specimen of *R. nigrella* has not been examined. However, South Australian specimens have similar thallus and spore morphology to European specimens identified as this species.

Na-Thalang (1969) considered *R. porosa* Tayl. to be a synonym of *R. nigrella*. An examination of the type specimen of *R. porosa* confirmed that this species is conspecific with *R. nigrella*. Taylor's description of *R. porosa* makes no reference to spore features although the description of the thallus features suggests that the species closely resembles *R. nigrella*. Each of the two packets of *R. porosa* examined (BM 43, MEL 19773) contained two species, one belonging to the subgenus *Ricciella*, the other being *R. nigrella*. On a priority basis, *R. porosa* must be regarded as a synonym of *R. nigrella*.

Because of its small size the species is often overlooked.

FIGURE 5.13

Riccia nigrella DC in association with various moss species.

Scale in mm.

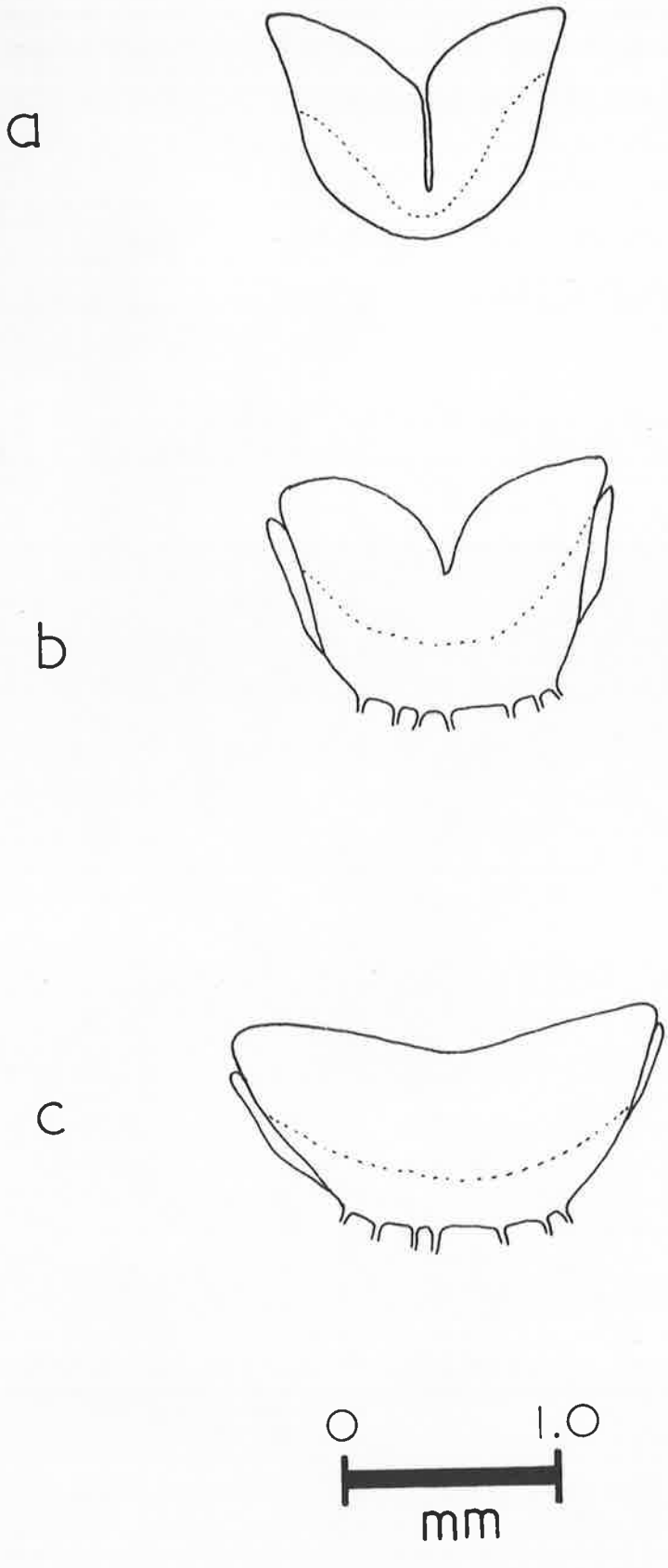
FIGURE 5.14

Transverse sections of the thallus of *Riccia nigrella*.

a. 0.5 mm from thallus apex

b. 1.0 mm from thallus apex

c. 2.5 mm from thallus apex


a
b
c
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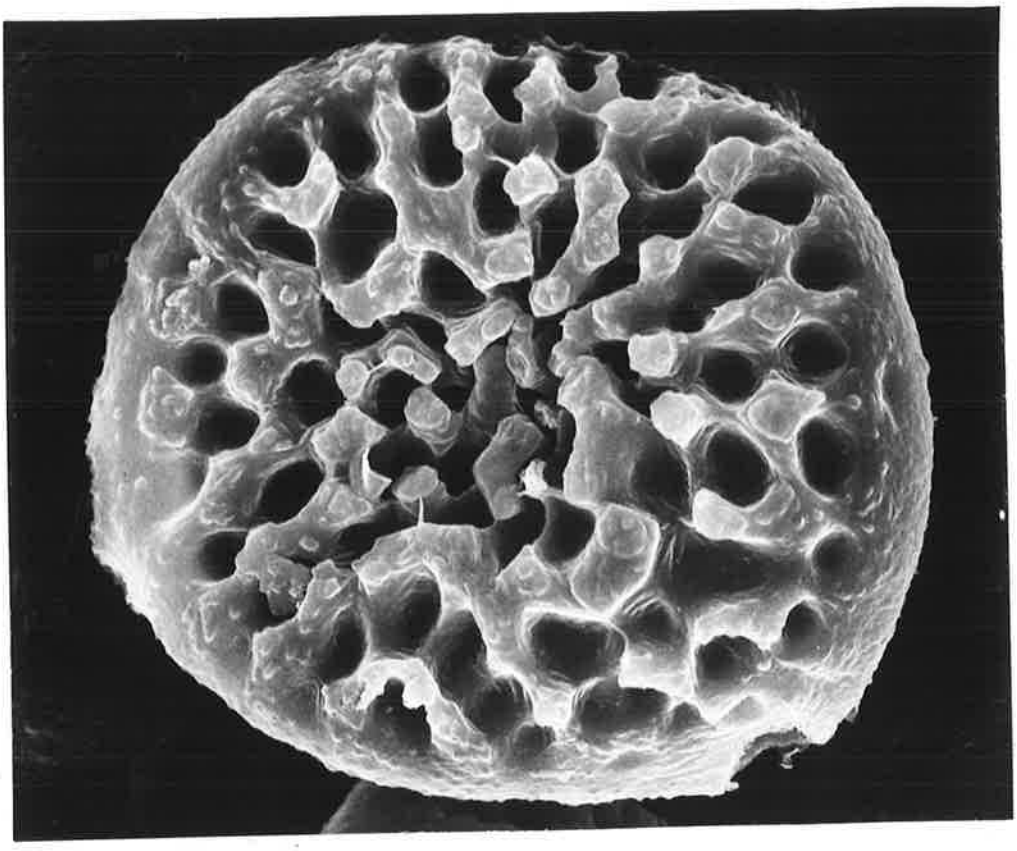
1.0
mm

FIGURE 5.15

Scanning electron micrographs of the spores of *Riccia nigrella*.

a. Distal face

b. Proximal face



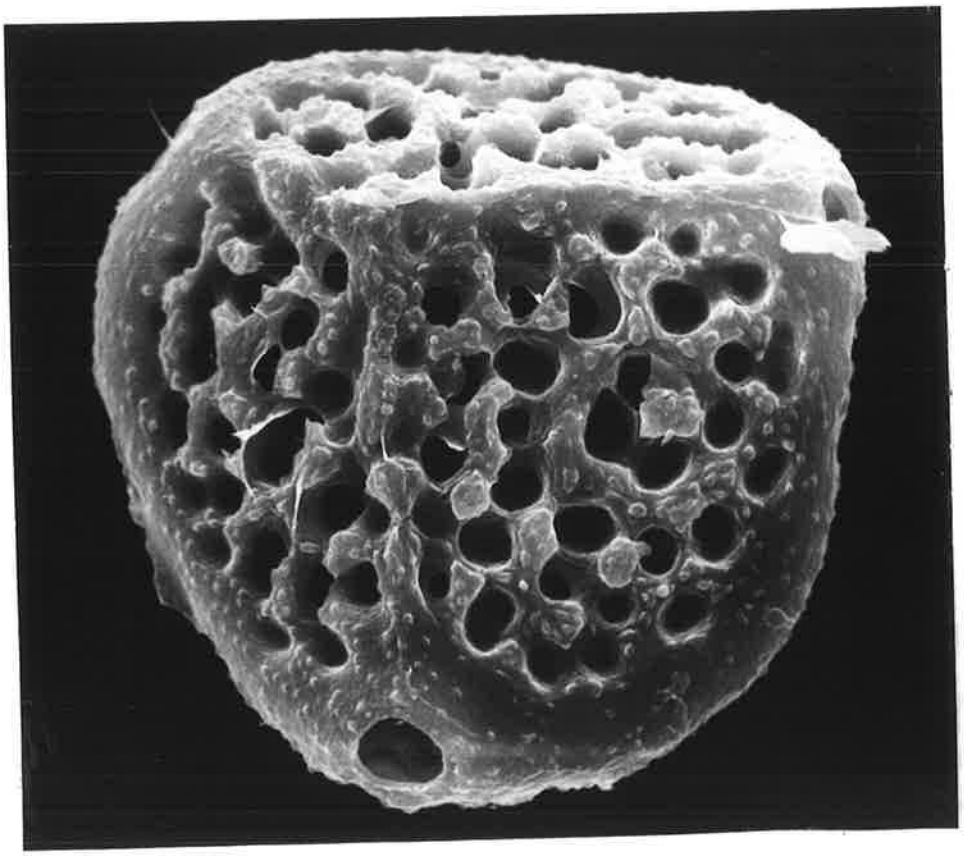
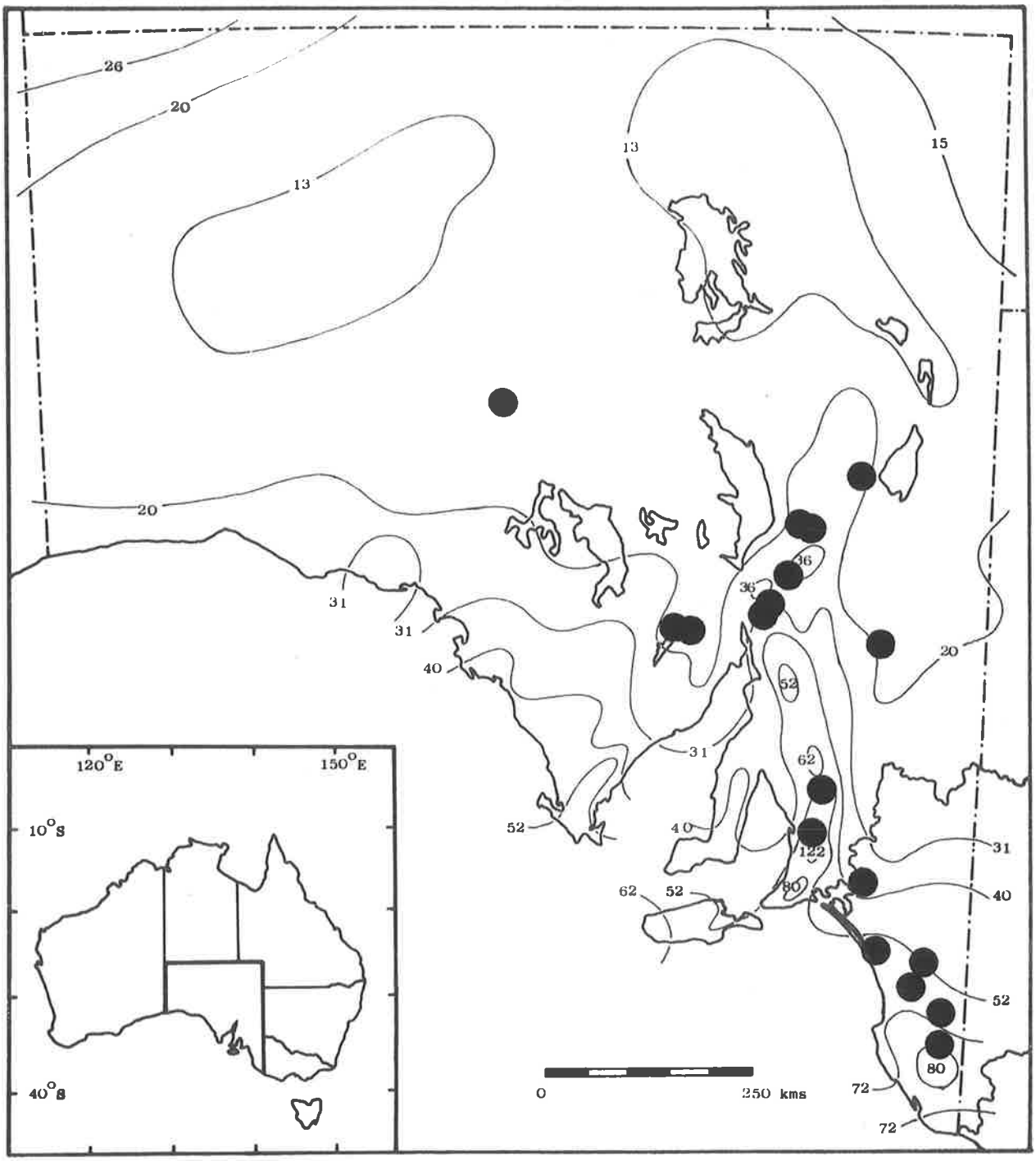


FIGURE 5.16

Distribution of collection localities of *Riccia nigrella* in South Australia.

Rainfall isohyets give annual rainfall in cm.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40
52
80
72
72
0
250 kms
120°E
150°E
10°S
40°S

5. *Riccia limbata* Bisch.

Bischoff in Synopsis Hepaticarum, 1845: 606.

Stephani, F. 1898: 18.

Sim, T.R. 1926: 12.

Arnell, S. 1963: 23-24.

Synonyms.

R. lata Tayl. 1846: 416. Na-Thalang, O. 1969: 89-91.

R. punctata Tayl. 1846: 416. Na-Thalang, . 1969: 89-91.

R. inflexa Tayl. 1846: 417. Na-Thalang, O. 1969: 89-91.

Holotype: Capb. spei, South Africa.

Coll: Krauss. G 13163.

Gametophyte monoicous, forming rosettes or part rosettes, or in scattered patches (Fig. 5.17). Thallus 5-15mm long, 3-5mm broad. Upper surface finely reticulate, green to grey-green. Channel narrow and deep at apex, becoming shallower and almost flat towards base. Branches furcate to trifurcate, often unequal. Thallus segment obcuneate-oblong, apex rounded. Margins of thallus flat, acute (Fig. 5.18). Scales large, purple, extending beyond thallus margin. Capsules becoming prominent in older parts of thallus. Spores 92.5-150.0µm in diameter, dark brown; wing 5.0-10.0µm wide, with an uneven to finely dentate margin; distal face reticulate, forming 9-16 areolae across the diameter, borders of areolae narrow; proximal faces similar to distal face but less distinctly reticulate; with a distinct triradiate ridge (Fig. 5.19).

Distribution:

South Australia (Fig. 5.20): East of Lake Frome; Chambers Gorge, west of Lake Frome; Martins Well Stn., Old Whydown Stn., Nackara; Angorichina Gorge, Parachilna Gorge,

northern Flinders Ranges; near Leigh Creek, near Copley; Edeowie Gorge; Rawlinson Range, northern Flinders Range; Wilpena; Yourambulla Caves, south of Hawker; Warren Gorge, Backaringa Gorge, north of Quorn; Woolshed Flat, Pichi Richi Pass; Tassie Creek, Corunna Stn., Iron Knob; Seppeltsfield; Cygnet River, Kangaroo Island; Wolsely, east of Bordertown.

New South Wales; Victoria; Northern Territory.

Specimens Examined:

South Australia: Seppelt 0084, 0258, 0269, 0387, 0388, 0395, 0408, 0409, 0414, 0430, 0435, 0438, 0439, 0442, 0447, 0453, 0456, 0461, 0470, 0482, 0484, 2165, 2424, 2666, 2667, 2870, 2872, 2874, 2904, 2924, 2985, 3016, 3017, 3041, 3046, 3047, 3048, 3049, 3101, 3103, 3108, 3167, 3237, 3330, 3331, 3332, 3333, 3334, 3487.

R.J. Chinnock 300B, O. Na-Thalang 82, 122, N.N. Donner 4161, N.N. Donner, in Ad.: Hj. Eichler 12841. P.G. Wilson 2454. T.R.N. Lothian 1284. T.R.N. Lothian in AD.

Northern Territory: Seppelt 3489 (Coll: P.K. Latz).

Africa: G 13163 (Holotype), G 13164, 13165, 13166, 13167, 13168.

Riccia lata Tayl. Holotype. Swan River, Western Australia. Coll: W. Drummond 1843. BM 45.

Swan River, Western Australia. Coll: W. Drummond. 1843 MEL 19780 (Isotype).

Riccia punctata Tayl. Holotype: Swan River, Western Australia. Coll: W. Drummond. 1843. In BM.

Riccia inflexa Tayl. Holotype. Swan River, Western Australia. Coll: W. Drummond. 1843. In BM.

Swan River, Western Australia. Coll: W. Drummond, 1843. MEL 19781. (Isotype).

Discussion:

The type specimen of *R. limbata* consists of one sterile thallus lobe. The marginal scales are large, purple, and extend beyond the thallus margins. The description of the species given by Stephani (1898), is based solely on features of thallus morphology and lacks reference to spore features. He also stated that the species may be dioicous.

Na-Thalang (1969) considered *R. lata* Tayl., *R. punctata* Tayl., and *R. inflexa* Tayl., to be conspecific with *R. limbata*. These species were inadequately described by Taylor (1846). In these descriptions Taylor made no mention of spores for *R. lata* and described *R. punctata* and *R. inflexa* as having "seeds large". All three species have the same thallus morphology as *R. limbata* and the spores of *R. punctata* and *R. inflexa* are now known to have similar morphology to those of *R. limbata*, which species exhibits considerable variation in thallus morphology and spore diameter.

Riccia limbata has similar thallus morphology to *R. macrospora* Steph. However, the spores of the latter species differ in being more or less globular, wingless and lack a triradiate ridge. Further, the corners of the areolae of *R. macrospora* are elevated into blunt papillae which give the appearance of a cog-wheel in optical section.

Riccia limbata is widely distributed in South Australia and of all the species known in this State, exhibits the greatest variation in thallus morphology.

FIGURE 5.17

Riccia limbata Bisch.

Scale in mm.

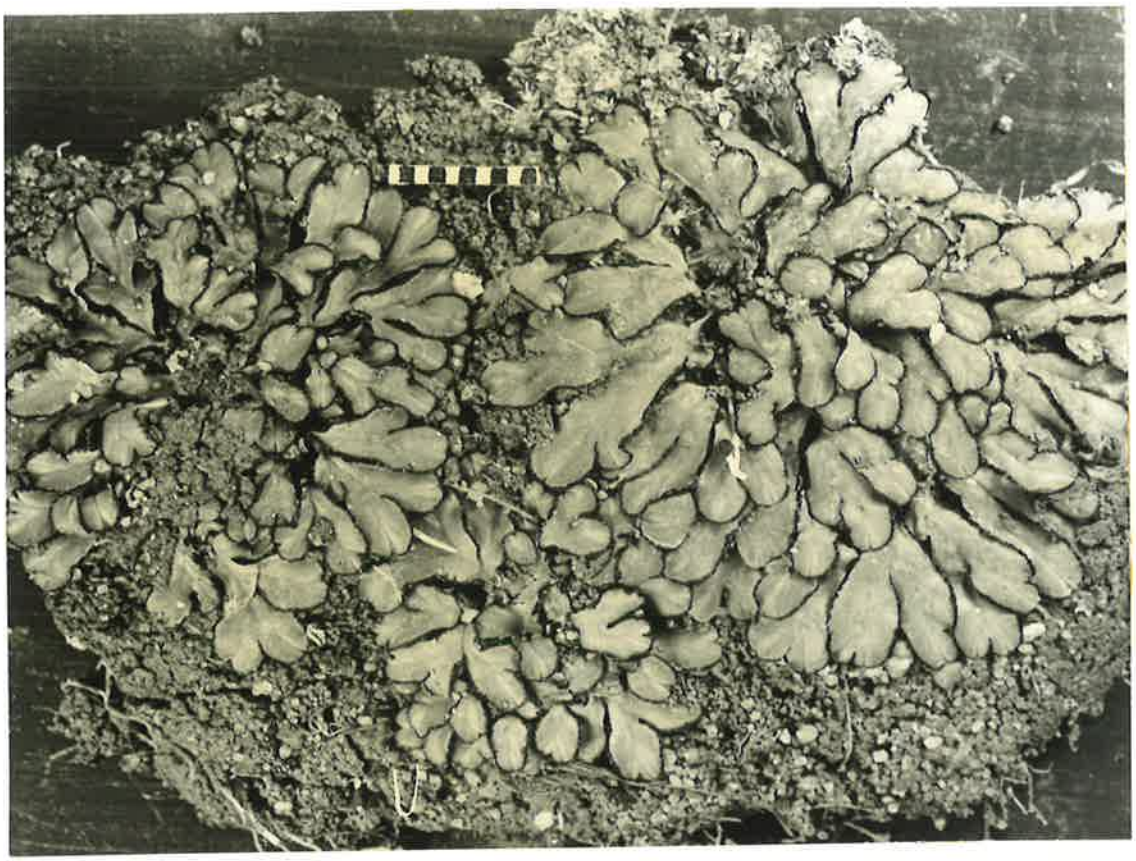


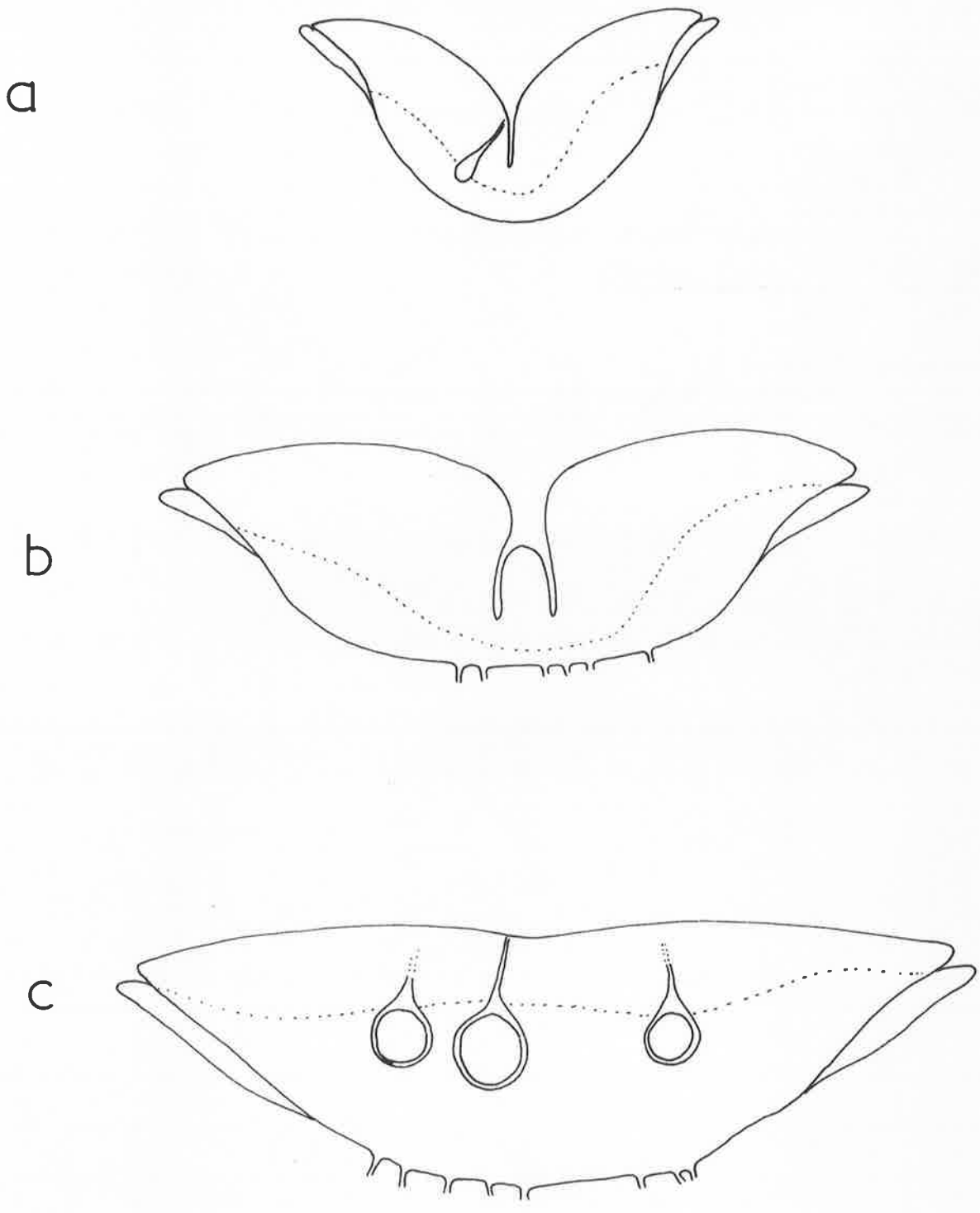
FIGURE 5.18

Transverse sections of the thallus of *Riccia limbata*.

a. 0.5 mm from thallus apex

b. 1.0 mm from thallus apex

c. 2.5 mm from thallus apex


a
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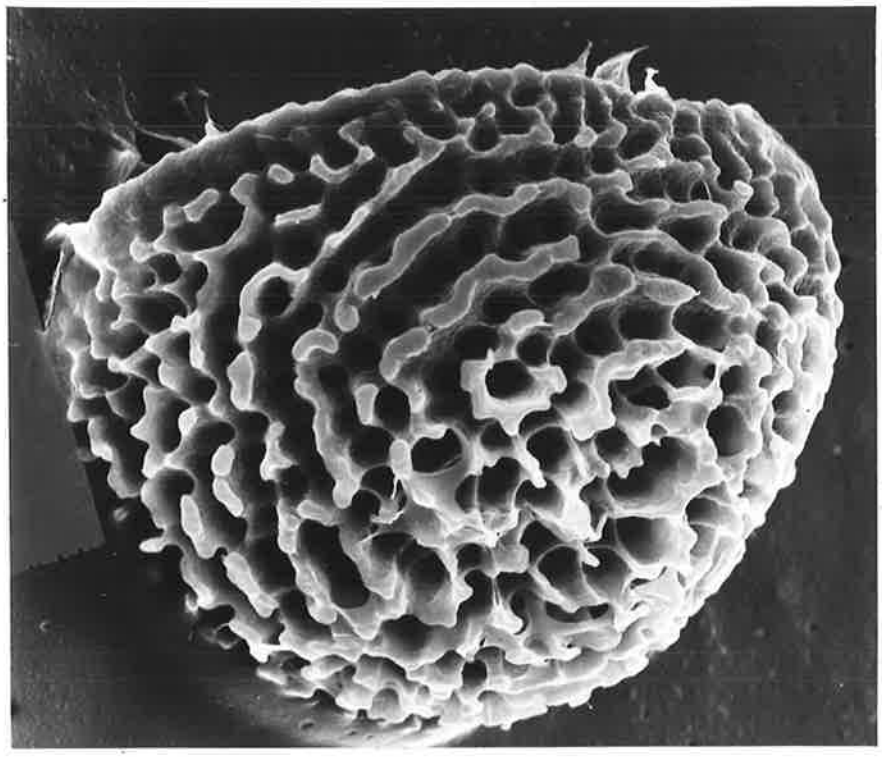
1.0
mm

FIGURE 5.19

Scanning electron micrographs of the spores of *Riccia limbata*.

a. Distal face

b. Proximal face



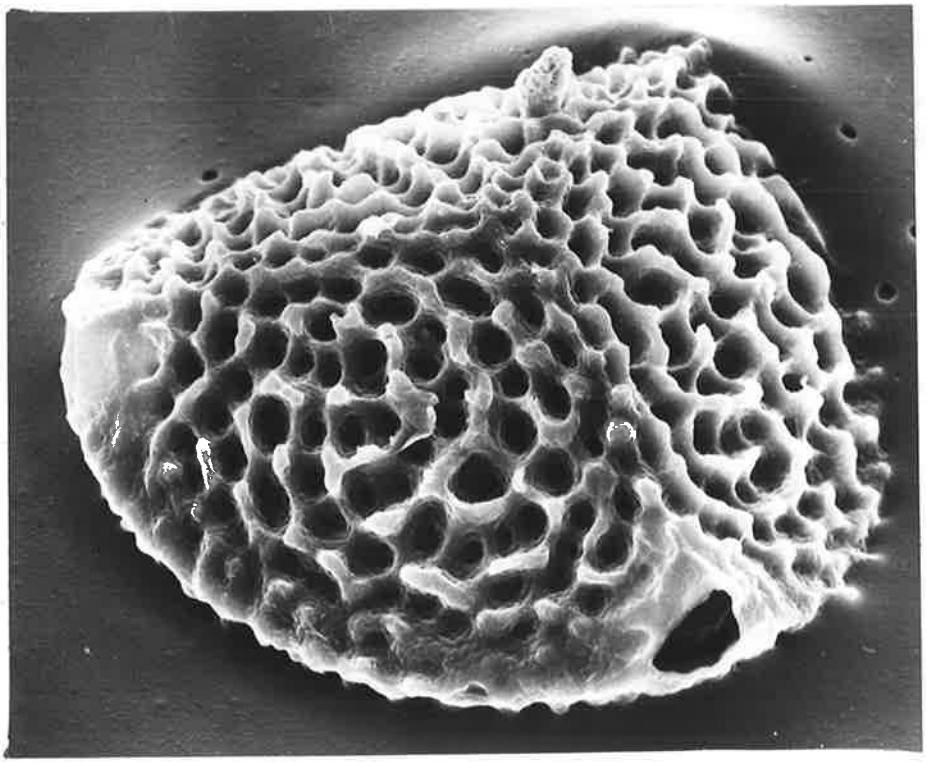
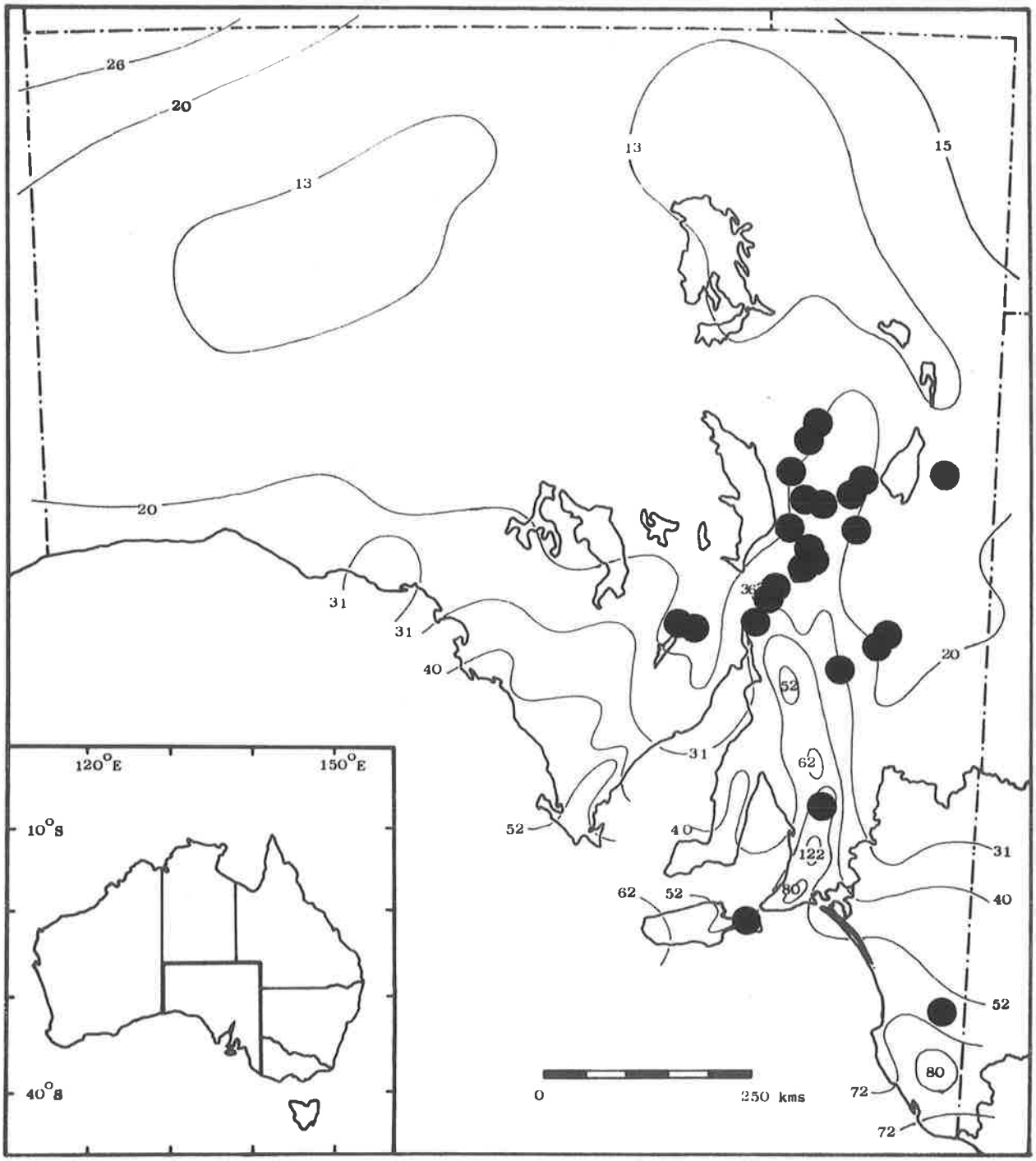


FIGURE 5.20

Distribution of collection localities of *Riccia limbata* in South Australia.

Rainfall isohyets give annual rainfall in cm.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52
40
122
80
62
52
31
40
52
80
72
72
20
120°E
150°E
10°S
40°S
0
250 kms

6. *Riccia macrospora* Steph.

Stephani, F. 1898: 20.

Synonyms:

R. runssorensis Steph. 1898: 22. Na-Thalang, O. 1969: 71-73.

R. rubrispora Steph. 1898: 24. Na-Thalang, O. 1969: 71-73.

R. sellingii Arnell. 1962: 311-313. Na-Thalang, O. 1969: 71-73.

Holotype: Arco-eillina Well, Everard Range, South Australia. Coll: R. Helms, 1891. G.16101.

Isotype: in AD.

Gametophyte monoicous, in gregarious patches (Fig. 5.21). Thallus 5-10mm long, 3-4mm broad. Upper surface finely reticulate, green to dark green. Channel narrow at apex becoming shallower towards base of thallus. Branches single to bifurcate, divergent. Thallus segment obovate-oblong, apex rounded. Margins of thallus flat, acute (Fig. 5.22). Scales large, purple, extending beyond margins of thallus. Capsules becoming prominent in older parts of thallus. Spores 100.0-140.0µm in diameter, dark red-brown, becoming opaque at maturity; more or less globular, wingless; regularly reticulate, forming 9-11 areolae across the diameter; borders of areolae forming high ridges, prominent in optical section of spore; without triradiate ridge (Fig. 5.23).

Distribution:

South Australia (Fig. 5.24): Everard Range; Roxby Downs Station, 160Km north of Woomera; Tassie Creek, Corunna Stn., Iron Knob; 35Km north east of Quorn; Waukaringa.

Northern Territory.

Specimens Examined:

South Australia: Holotype G 16101; Isotype - in AD;
Seppelt 0476, 2386, 2425, 2426, 2428, 2429, 2430, 2434, 2435, 2436, 2440, 2441, 2445, 2446, 2449, 2454, 3200, 3201, 3224, 3225, 3226, 3227, 3228, 3274, 3275, 3277. MEL 19778.
Northern Territory: MEL 19768; R.C. Carolin 5031, R.C. Carolin 5398, O. Na-Thalang 308.

R. rurispora Steph. Holotype: Arkaringa, South Australia. Coll: R. Helms, 1891. G 16116.

R. runssorensis Steph. Holotype: Mt. Ruwenzori Kinani, Central Africa. Coll: Scott Elliot. G 13176.
Marienthal, West Africa. Coll: H.A. Volk. G 13175.

Discussion.

The thallus features of *R. macrospora* are similar to those of *R. limbata*. However, the spores of the former species are more or less globose, wingless, and have no triradiate ridge. Sterile plants of *R. macrospora* are difficult to recognize from those of *R. limbata*.

Na-Thalang (1969) included *R. rubrispora*, *R. runssorensis* and *R. sellingii* as synonyms of *R. macrospora*. Further material of these species has now been studied with emphasis on thallus and spore morphology. A re-examination of the holotype of *R. rubrispora* has confirmed the conspecificity of this species with *R. macrospora*. However, the holotype of *R. runssorensis*, although similar to *R. macrospora* in thallus morphology, differs from this species in spore features in having smaller spores each

with fewer areolae across the diameter. Similarly, from the type description of *R. sellingii*, that species has a similar thallus morphology to *R. macrospora* but again the spores are smaller with fewer areolae across the diameter of each one. The spores of *R. runssorensis* and *R. sellingii* are thus alike in these features. They are also similar to those of *R. billardieri* Mont. et N. emend Pande et Udar and to those of *R. discolor* L. et L. emend Pande et Udar. *R. discolor* is reported (Stephani, 1898; Na-Thalang, 1969) to be dioicous, whilst the other species mentioned here are thought to be monoicous. Stephani (1898) reported 10 areolae across the diameter of each spore of *R. billardieri* whereas Na-Thalang (1969) reported only 5-8 areolae across the diameter of each spore of this species. It is thus apparent that further studies are necessary in order to clarify the identity of these species.

Collections of *R. macrospora* in South Australia indicate that the species is restricted to the more arid regions of the State.

FIGURE 5.21

Riccia macrospora Steph.

Scale in mm.

FIGURE 5. 22

Transverse sections of the thallus of *Riccia macrospora*.

a. 0.5 mm from thallus apex

b. 1.0 mm from thallus apex

c. 2.5 mm from thallus apex

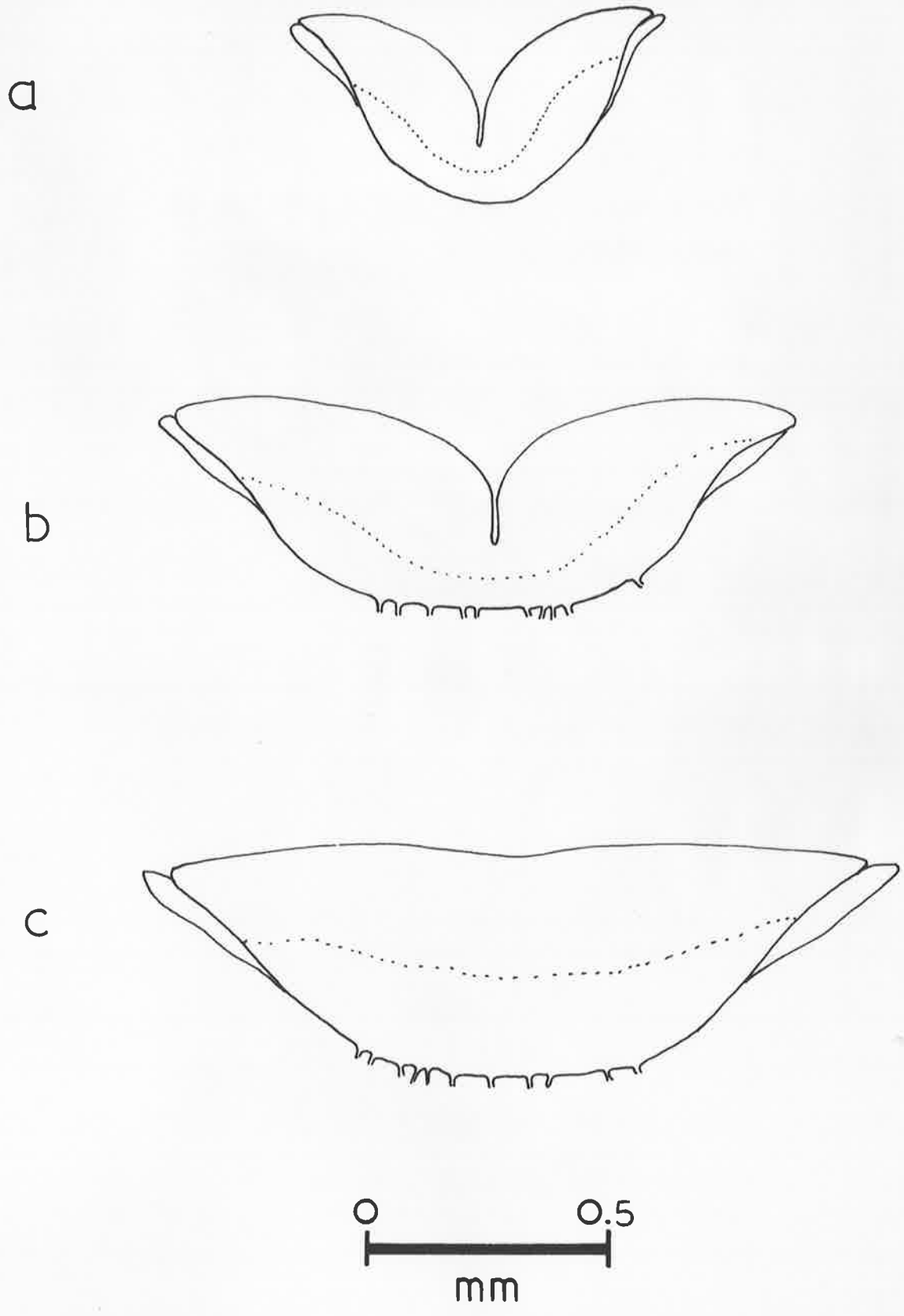

a
b
c
0
0.5
mm

FIGURE 5.23

Scanning electron micrograph of the spore of Riccia macrospora.

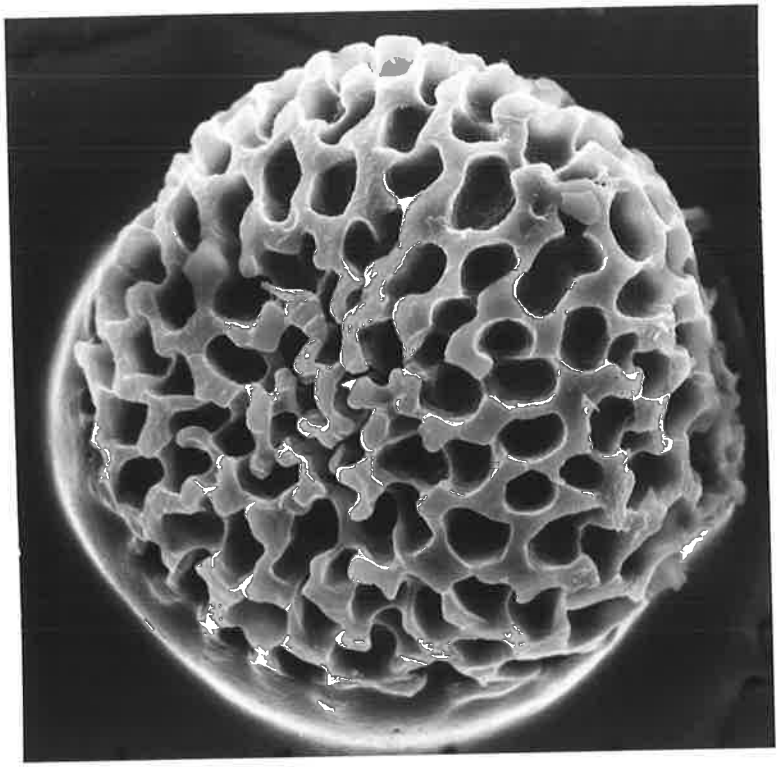
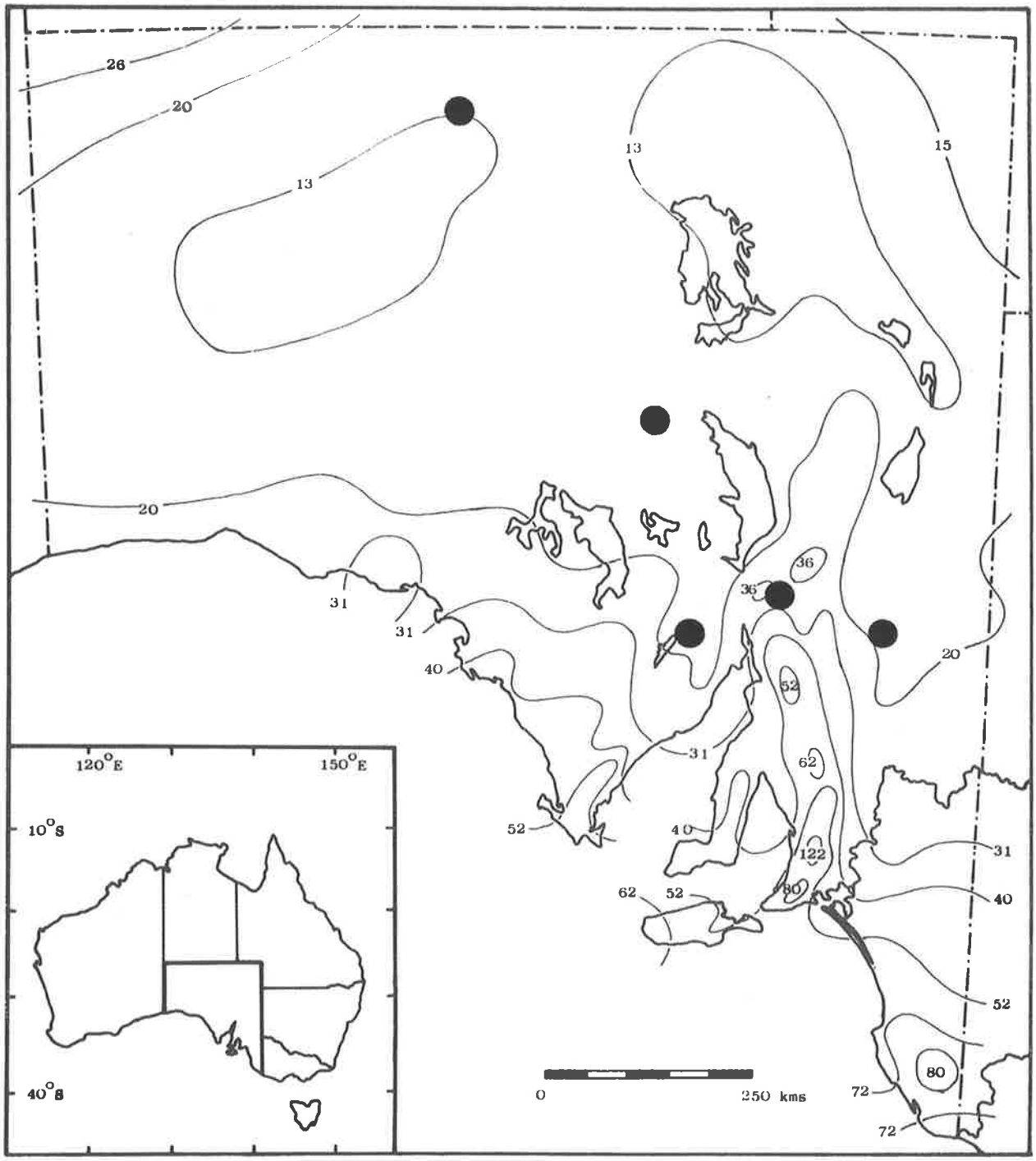


FIGURE 5.24

Distribution of collection localities of *Riccia macrospora* in South Australia.

Rainfall isohyets give annual rainfall in cm.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40
52
80
72
72
0
250 kms
120°E
150°E
10°S
40°S

7. *Riccia albida* Sull.

Austin, C.F. 1870: 231.

Stephani, F. 1898: 48.

Frye, T.C. and Clark, L. 1937-47: 18.

McGregor, R.L. and Menhusen, B. 1961: 71-74.

Holotype: Texas, U.S.A. Coll: C. Wright, 1849. FH 1325.

Gametophyte (?) dioicous, forming rosettes or in gregarious or scattered patches (Fig. 5.25). Thallus 4-10mm long, 1-2.5mm broad. Upper surface finely reticulate, white or whitish green, drying white. Channel narrow throughout. Branches single to bifurcate or trifurcate, divergent. Thallus segment obovate to oblong, apex rounded to truncate. Margin of thallus rounded (Fig. 5.26). Scales small, few, hyaline. Antheridial ostioles not prominent. Capsules few, deeply embedded. Spores 87.5-115.0µm in diameter, globular, dark brown becoming black and shining at maturity, smooth or nearly so, wingless (Fig. 5.27).

Distribution:

South Australia (Fig. 5.28): Chambers Gorge, west of Lake Frome; Koonamore Vegetation Reserve; Innes National Park, Pondalowie Bay, Yorke Peninsula.

Northern Territory; Western Australia.

Specimens Examined:

South Australia: Seppelt 0382, 0632, 2318, 2371; 2399, 3100, 3147, 3148, 3149, 3150, 3151, 3152, 3153, 3164.

Western Australia: N. Sammy - Windarra (1972).

Northern Territory: O. Na-Thalang 100.

Discussion.

There are no mature spores in the type specimen of *R. albida*. However, the smooth and more or less globular spores of the species are distinctive and not known for other species of *Riccia*.

The upper layers of the thallus appear to be more or less spongiose and the cells of the upper surface become more or less calcified, forming a hard "crust" when dry. According to McGregor and Menhusen (1961) "the incrustation of calcium is a regular characteristic of the species and appears when the sporeling is barely large enough to see with a 10x hand lens".

Only one collection of *R. albida* in South Australia (Seppelt 0632) has been found with mature spores. However, both the white upper surface of the thallus and the rounded, smooth spores (where present) are distinctive for this species.

Jovet-Ast (1973) reported *R. crustata* Trabut from near Mildura, Victoria. Although specimens of this species have not been seen the spores as illustrated in Jovet-Ast (1973), are almost smooth, having some irregular ridges on the outer surface of the spore. The illustration of the thallus given by Jovet-Ast indicates a morphological similarity between *R. crustata* and *R. albida*. A detailed comparison of specimens of these two species will be necessary in order to clarify their differences or similarity.

FIGURE 5.25

Riccia albida Sull.

Scale in mm.

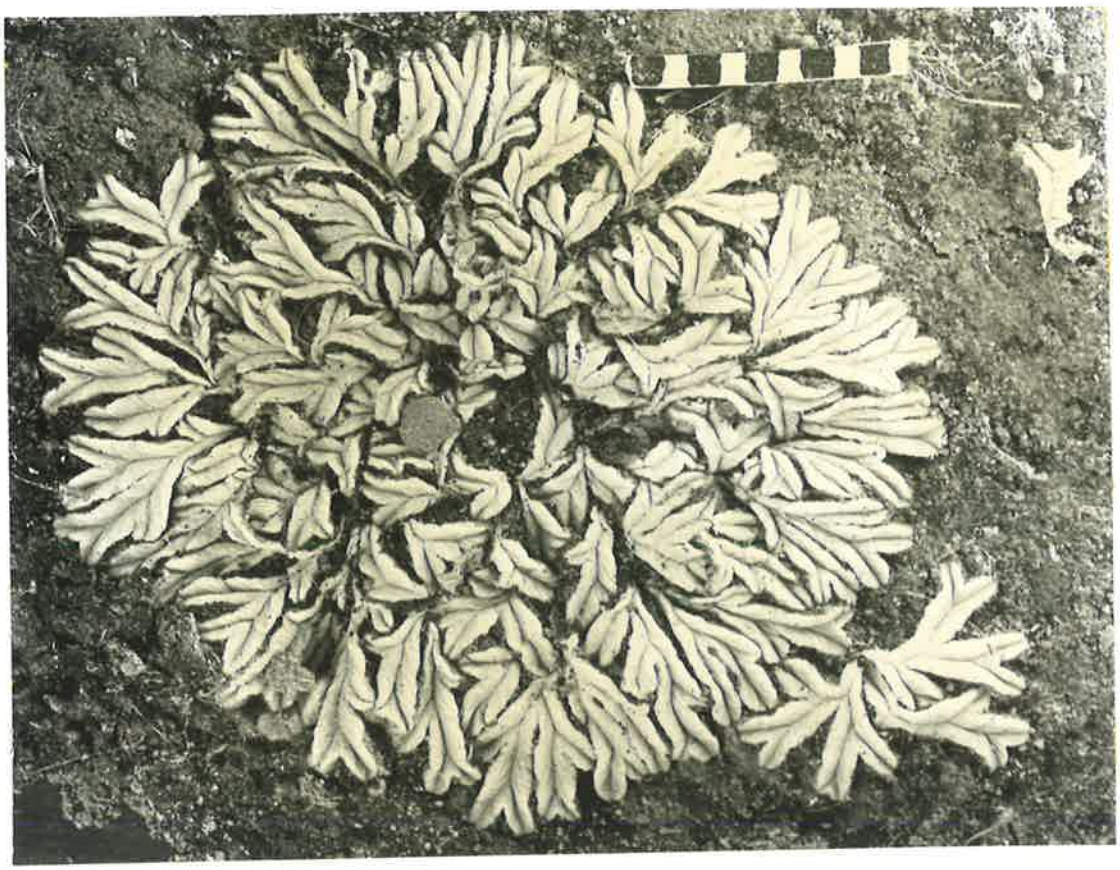


FIGURE 5.26

Transverse sections of the thallus of *Riccia albida*.

a. 0.5 mm from thallus apex

b. 1.0 mm from thallus apex

c. 2.5 mm from thallus apex

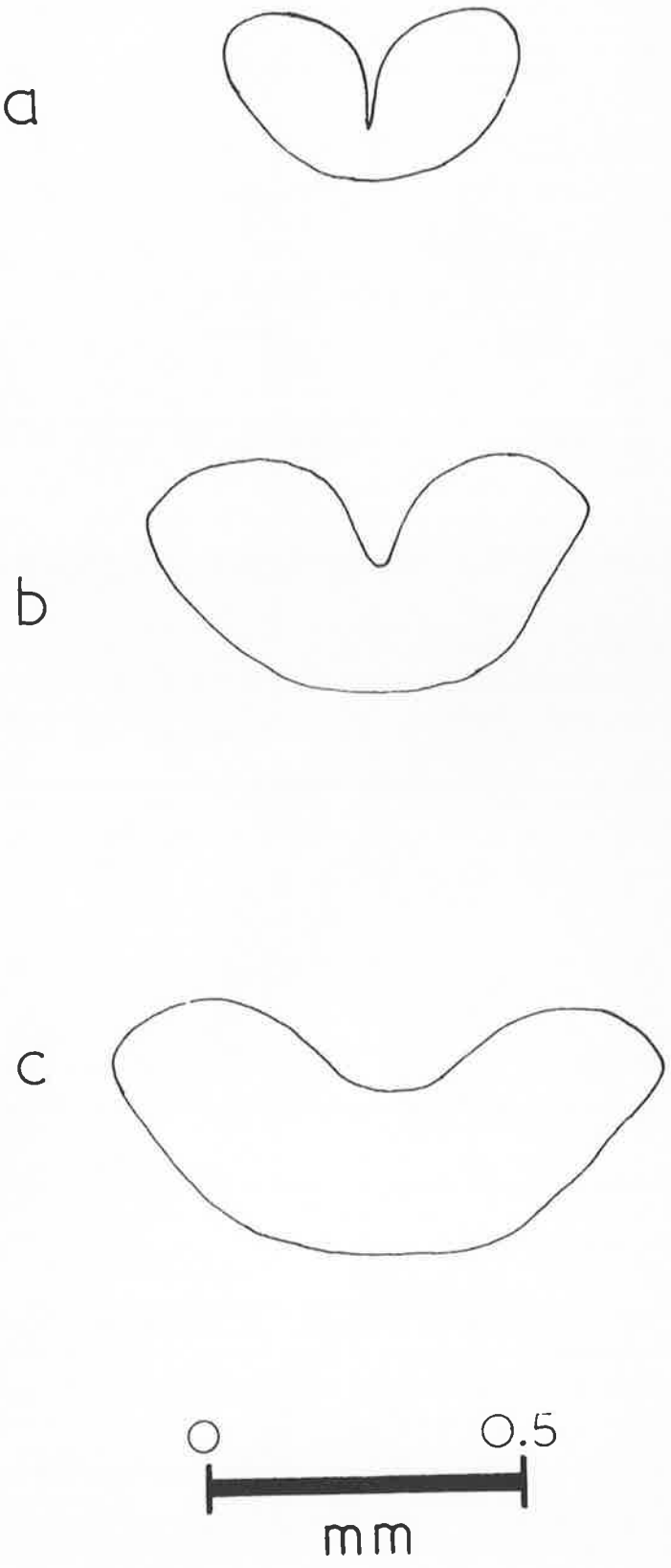
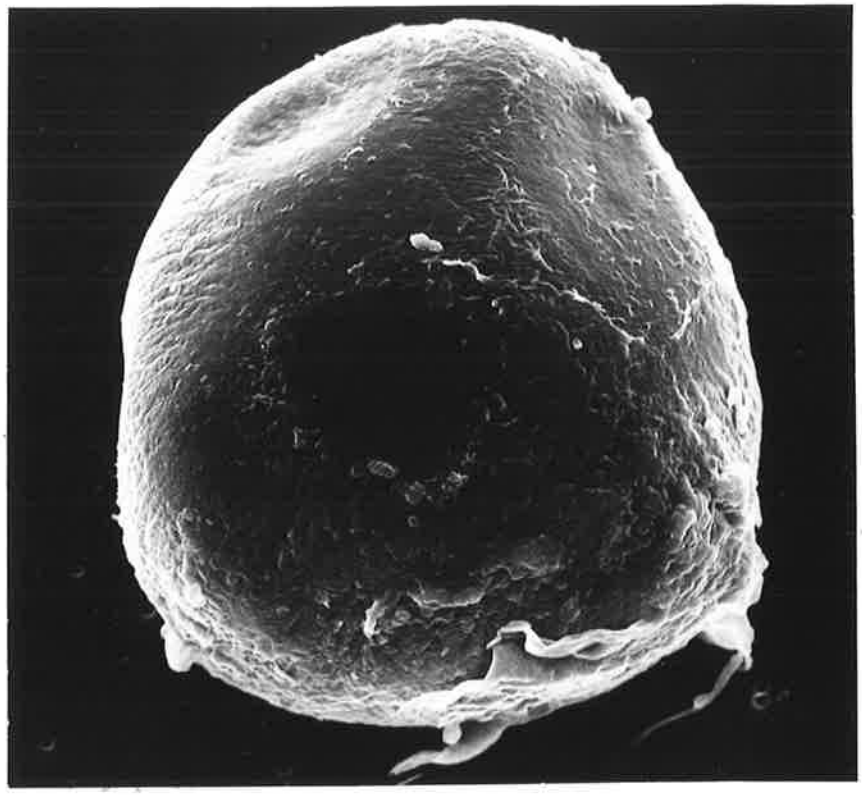

a
b
c
0
0.5
mm

FIGURE 5.27

Scanning electron micrographs of the spores of *Riccia albida*.

a. Single globular spore.

b. Tetrad of spores



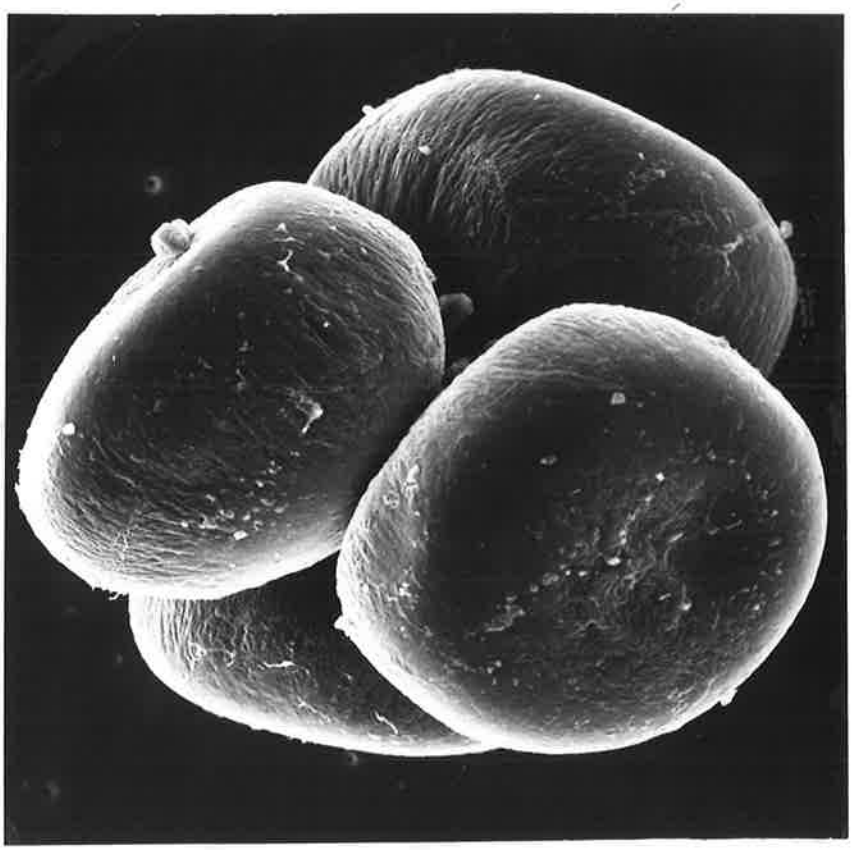
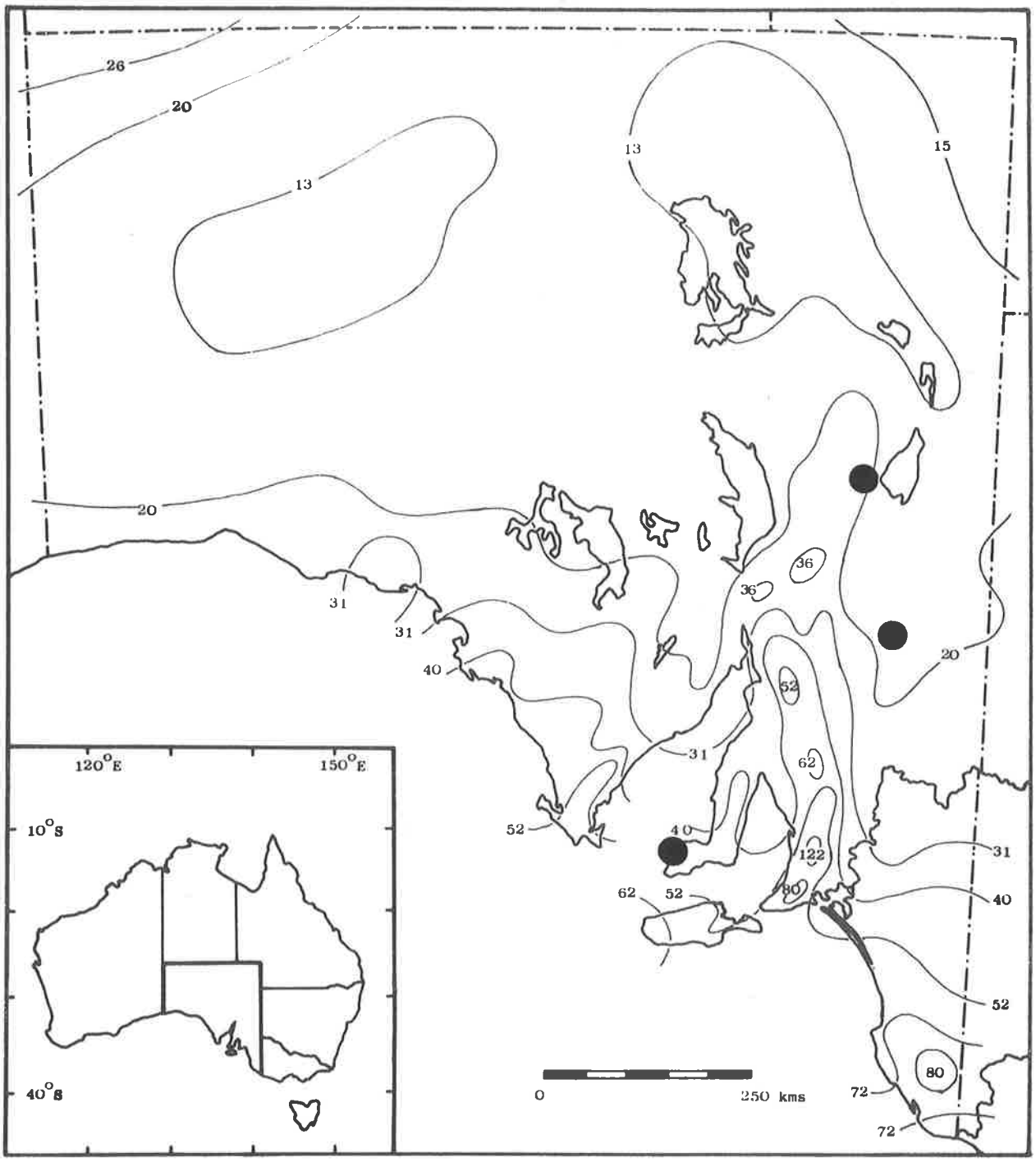


FIGURE 5.28

Distribution of collection localities of *Riccia albida* in South Australia.

Rainfall isohyets give annual rainfall in cm.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52
31
40
52
80
72
72
0
250 kms
120°E
150°E
10°S
40°S

8. *Riccia bifurca* Hoffm.

Hoffmann, in Deutsch. Fl. 1795: 95.

Stephani, F. 1898: 30.

MacVicar, S.M. 1926: 19.

Frye, T.C., and Clark, L. 1937-47: 15-16.

Arnell, S. 1956: 283.

Synonyms:

R. glaucescens Carr. 1878: 41. Stephani, F. 1898: 30.

R. marginata Lindberg 1879: 106. Stephani, F. 1898: 30.

R. arvensis Aust. 1869: 232. Frye, T.C. and Clark, L. 1937-47: 15.

R. subscripula Warnst. 1902: 76. Frye, T.C. and Clark, L. 1937-47: 15.

R. pusilla Warnst. 1895: 50. Arnell, S. 1956: 283.

R. minutissima Steph. 1898: 338. Arnell, S. 1956: 283.

Holotype: Germany. G (?)

Gametophyte monoicous, forming rosettes or gregarious overlapping patches (Fig. 5.29). Thallus 3-8mm long, 1.5-2.5 mm broad. Upper surface finely reticulate, green to pale green, epidermal cells swollen. Channel narrow and deep at apex, becoming broader and shallower towards base. Branches furcate to trifurcate, deeply divided. Thallus segment narrowly oblong, apex rounded. Margins of thallus obtuse (Fig. 5.30). Scales hyaline, small, present only under thallus apex. Capsules numerous, becoming exposed in older parts of thallus. Spores 67.5-97.5µm in diameter, dark brown, becoming opaque at maturity; wing 2.5-5.0µm wide, with a smooth to uneven margin; distal face regularly reticulate; forming 8-10 areolae

across the diameter; proximal faces similar to distal face, with a more or less distinct triradiate ridge (Fig. 5.31).

Distribution:

South Australia (Fig. 5.32): Clare; Tarnma, near Marrabel; Seppeltsfield; Cuddlee Creek, 32Km north east of Adelaide; Hahndorf; Lobethal; Summertown; Bridgewater; Torrens River Gorge; Botanic Park, Adelaide; Seaton, suburban Adelaide; Eagle on the Hill, near Mt. Lofty; Cleland Wildlife Reserve; Belair National Park; Clarendon; Hindmarsh Valley Falls, near Victor Harbour; Kangaroo Island - Emu Bay, Stokes Bay, near Ranger's house at Flinders Chase, Rocky River in Flinders Chase, Vivonne Bay, near Seal Bay, near Penneshaw, near Kingscote Airport, American River, Murray's Lagoon approx. 25Km south of Kingscote; Mt. Monster, 9Km south of Keith; near Naracoorte; Comaum Forest, south east of Naracoorte.

New South Wales.

Specimens Examined:

South Australia: Seppelt 0136, 0248, 0261, 0263, 0290, 0297, 0561, 0562, 0564, 0757, 0932, 0975, 2030, 2037, 2078, 2079, 2110, 2132, 2168, 2180, 2181, 2185, 2205, 2209, 2218, 2219, 2220, 2223, 2542, 2568, 2569, 2570, 2571, 2616, 2618, 2619, 2624, 2626, 2627, 2629, 2630, 2635, 2639, 2668, 2669, 2670, 2672, 2673, 2681, 2688, 2690, 2692, 2705, 3393, 3498.

New South Wales: O. Na-Thalang 45, 62.

Western Australia: G.G. Smith 373, Albany (- G.G. Smith), Porongurup (G.G. Smith), Guildford, (G.G. Smith); E. Walter 287; Lesmurdie Falls (G. Pearman).

New Zealand: Seppelt 3539 (Coll. E.O. Campbell, Levin).

Europe: G 13124, 13125, 13126, 13127, 13128, 13129, 13130, 13132.

G 13131 (*R. glaucescens* Carr. = *R. bifurca* Hoffm. teste Stephani).

Discussion.

The location of the type specimen of *R. bifurca* is not known (Stafleu, 1968). However, South Australian plants agree well with those described by Stephani (1898), MacVicar (1926), Frye and Clark (1937-47) and Arnell (1956) as *R. bifurca*. The Australian specimens examined resemble the European specimens both in thallus and spore morphology.

The spores of *R. bifurca* closely resemble those of *R. crozalsii* in morphology. As previously stated (see discussion of *R. crozalsii*) many specimens found in South Australia and identified as *R. crozalsii* have few cilia. *Riccia bifurca* f. *subinermis* is reported by MacVicar (1926) and Arnell (1956) to have "on the margin sometimes a few, straight and short hairs" (Arnell, 1956). Frye and Clark (1937-47) reported that specimens of *R. bifurca* had a thallus margin "occasionally tinged with violet purple, naked or very rarely with occasional short rather flaccid cilia...." Many specimens of both *R. crozalsii* and *R. bifurca* collected in South Australia have a pigmented thallus margin.

In view of the similarity of *R. crozalsii* and *R. bifurca* both in features of thallus and spore morphology it is possible that these species are phylogenetically closely related and possibly of relatively recent specific derivation.

FIGURE 5.29

Riccia bifurca Hoffm.

Scale in mm.

FIGURE 5.30

Transverse sections of the thallus of *Riccia bifurca*.

a. 0.5 mm from thallus apex

b. 1.0 mm from thallus apex

c. 2.0 mm from thallus apex

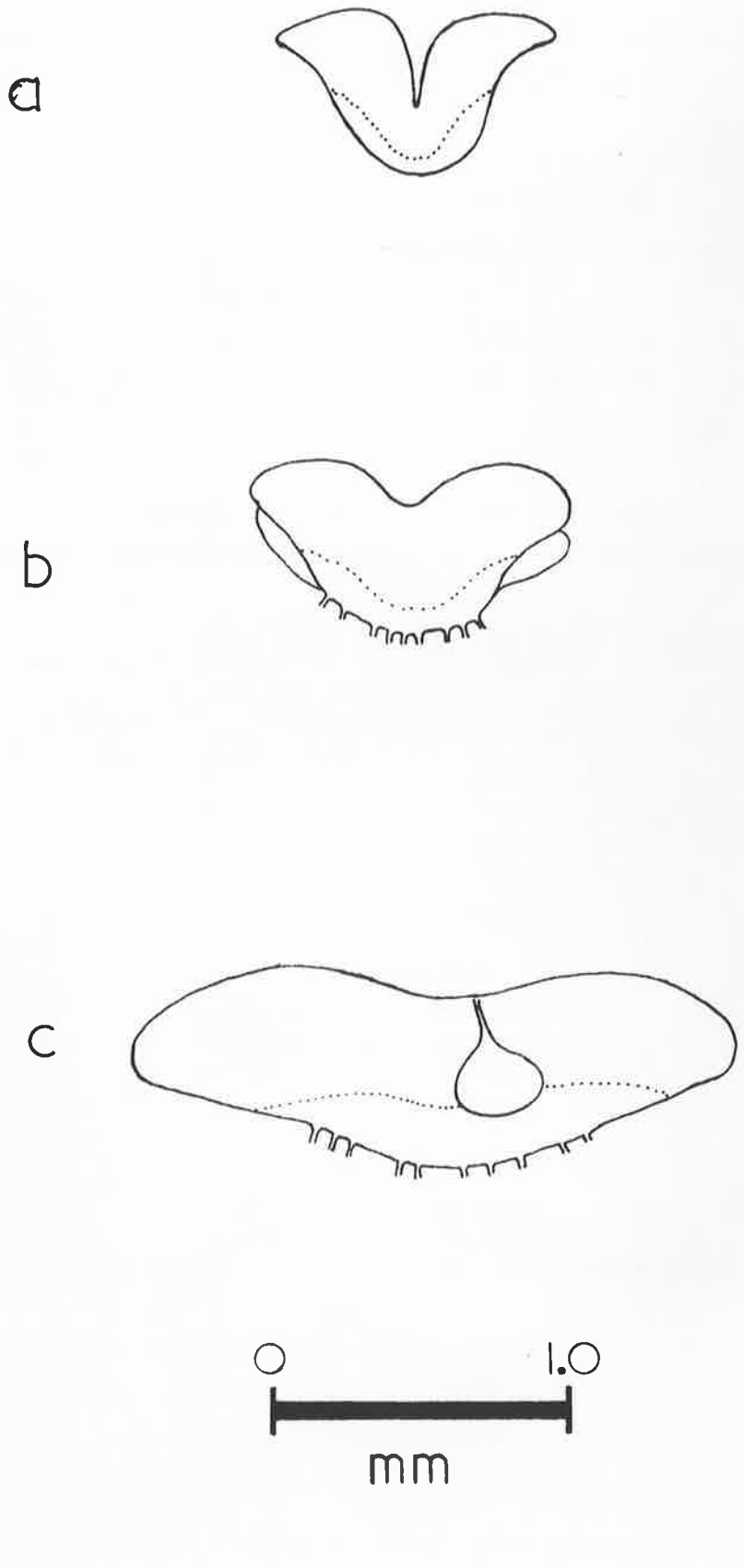
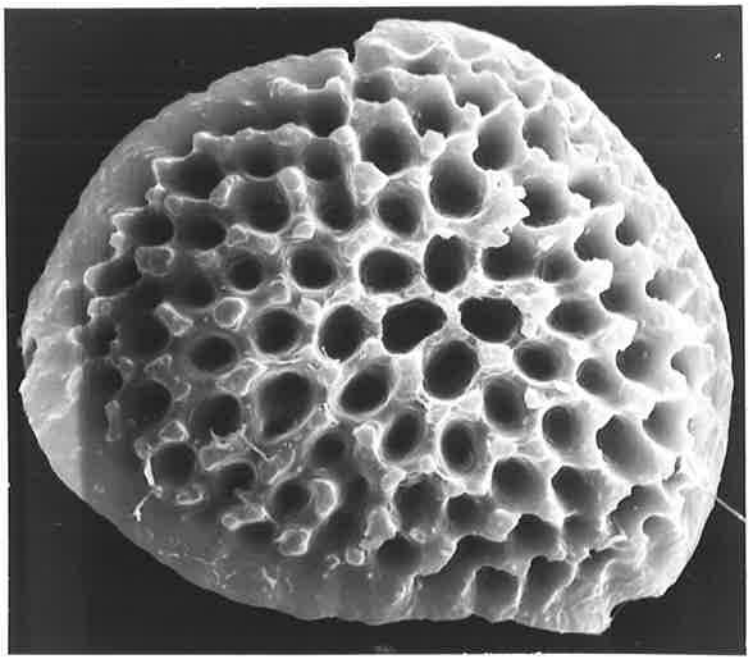

a
b
c
0
1.0
mm

FIGURE 5.31

Scanning electron micrographs of the spores of *Riccia bifurca*.

a. Distal face

b. Proximal face



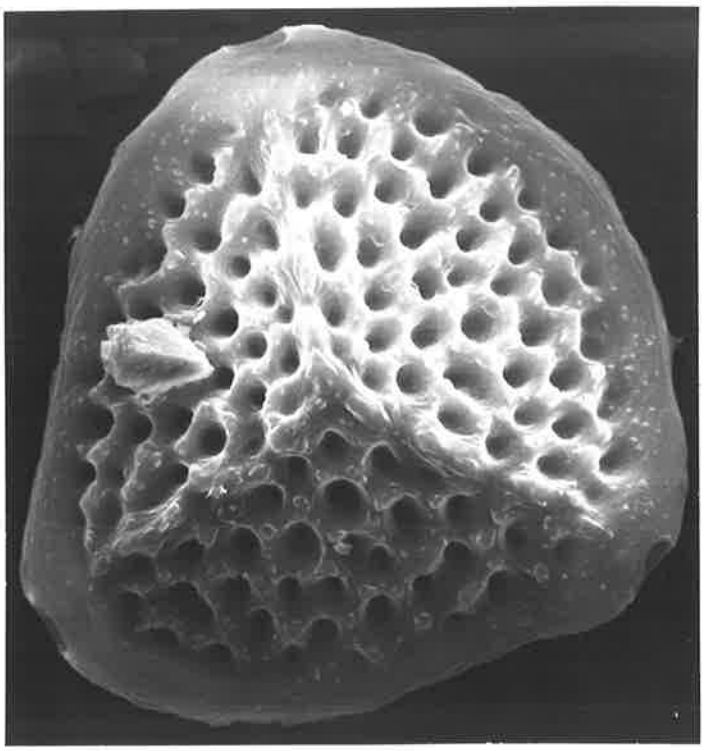
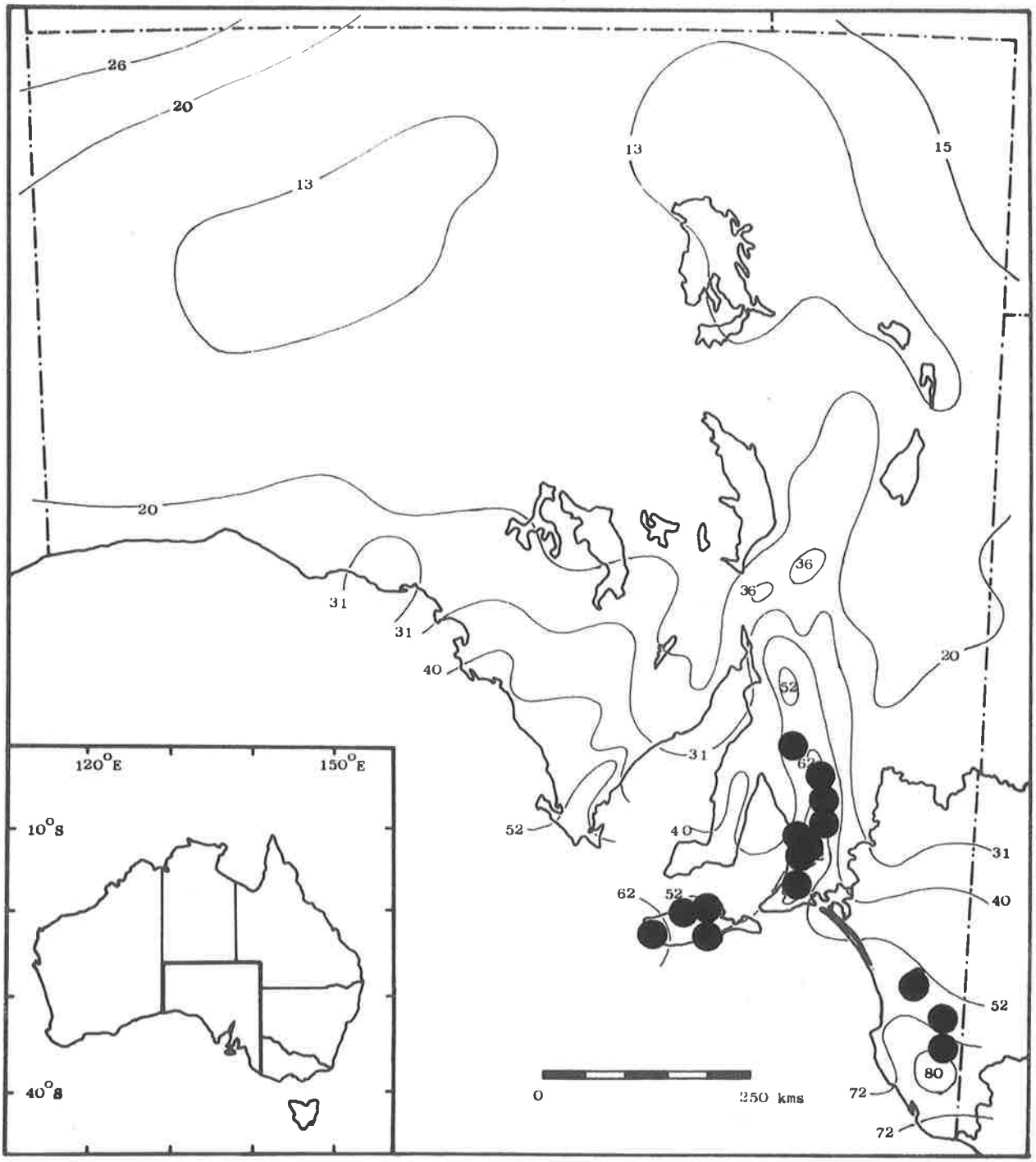


FIGURE 5.32

Distribution of collection localities of *Riccia bifurca* in South Australia.

Rainfall isohyets give annual rainfall in cm.


26
20
13
13
15
20
31
31
40
36
36
20
52
31
52
40
62
52
31
40
52
80
72
72
120°E
150°E
10°S
40°S
0
350 kms

9. *Riccia marginata* Carr. et Pears.

Carrington, B. and Pearson, W.H. 1887: 1056-1060.

Stephani, F. 1898: 24.

Synonyms:

R. cartilaginosa Steph. 1889: 44. Na-Thalang, O. 1969: 109.

Holotype: Parramatta, New South Wales, Coll: T. Whitelegge, 1880. NSW H89.

Isotype: NSW H 91.

Gametophyte monoicous, forming part rosettes or scattered (Fig. 5.33). Thallus 5-12mm long, 4-6mm broad. Upper surface finely and compactly reticulate, shining, dark green, hyaline along the thallus margins. Channel narrow at apex becoming flat towards base. Branches furcate to bifurcate, divergent. Thallus segment obcuneate-oblong to oblong, apex acute or rounded. Margin of thallus acute, hyaline, more or less undulate (Fig. 5.34). Scales large, hyaline, joined to margin of thallus. Capsules deeply embedded. Spores 62.5-97.5µm in diameter, dark brown; wing 2.5-6.25µm wide, with an uneven to crenate margin; distal face regularly reticulate, forming 8-10 areolae across the diameter; proximal faces irregularly ridged, without areolae, with an indistinct to more or less distinct triradiate ridge (Fig. 5.35).

Distribution:

South Australia (Fig. 5.36): Wilpena Pound; Tassie Creek, Corunna Stn., Iron Knob.

New South Wales.

Specimens Examined:

South Australia: Seppelt 0392, 0406, 0407, 0423, 0475, 0478, 2907, 2947, 2952, 2991, 2992, 2995, 2996, 3005, 3010, 3015, 3057, 3154, 3165, 3169, 3180, 3276.

New South Wales: O. Na-Thalang 146. Holotype - NSW H 89.

Queensland: O. Na-Thalang 22.

Riccia cartilaginosa Steph. Holotype: Queensland.

Coll: F.M. Bailey G 12728.

Discussion.

Carrington and Pearson (1887) described the scales of the type specimen of *R. marginata* as "having a purple waved line at the base". Although this characteristic has not been observed in specimens of *R. marginata* collected in South Australia, the specimens agree well with the type specimen in other thallus features and spore characteristics. There are no mature spores in the type specimen of *R. cartilaginosa* (G 12728) although the scales are tinged with purple. Without spores it is difficult to confirm the identity of *R. cartilaginosa* although the similarity of the thallus features of this species with *R. marginata* indicates that the two species are most likely conspecific.

The dark green, shining thallus and the hyaline crenate margin readily distinguishes *R. marginata* vegetatively from other species of *Riccia* in South Australia.

FIGURE 5. 33

Riccia marginata Carr. et Pears.

Scale in mm.

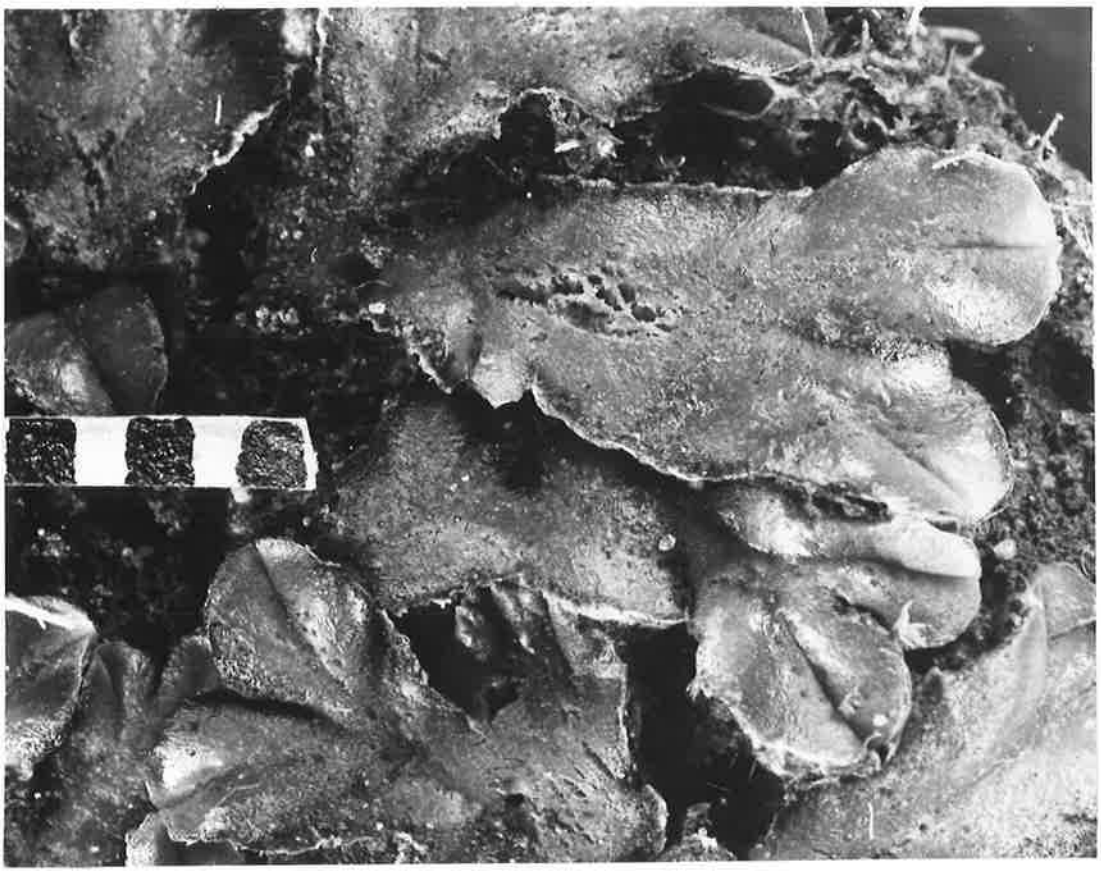


FIGURE 5.34

Transverse sections of the thallus of *Riccia marginata*.

a. 0.5 mm from thallus apex

b. 1.5 mm from thallus apex

c. 3.0 mm from thallus apex

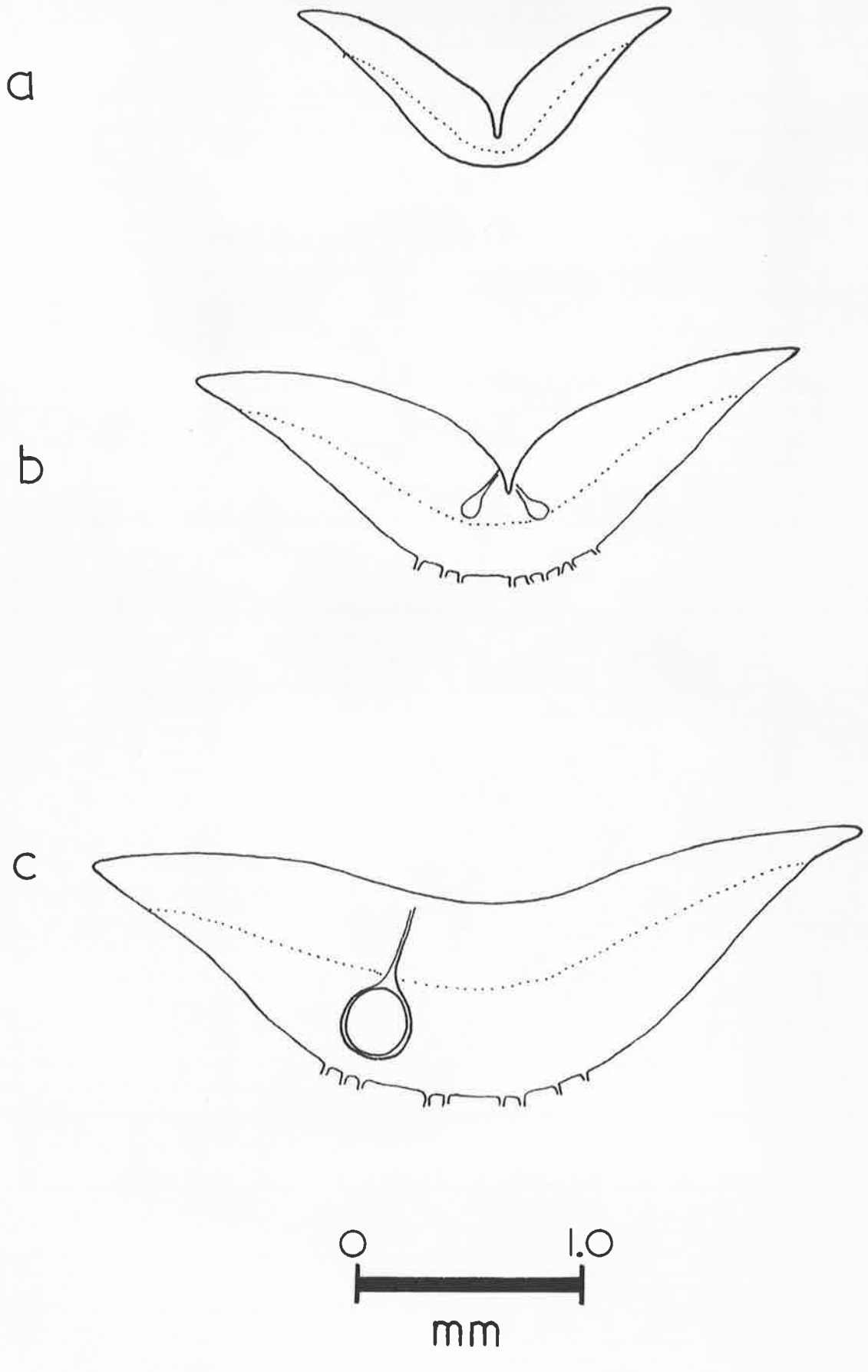
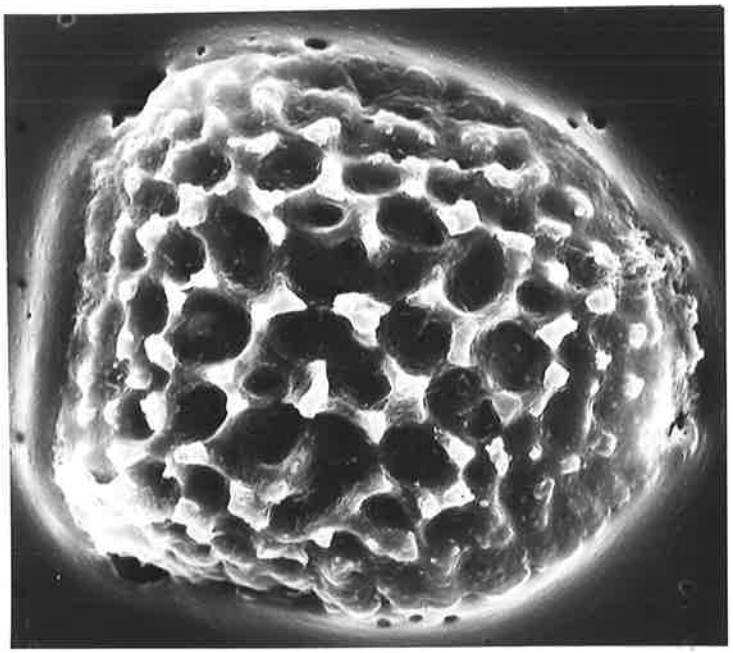

a
b
c
0
1.0
mm

FIGURE 5.35

Scanning electron micrographs of the spores of *Riccia marginata*.

a. Distal face

b. Proximal face



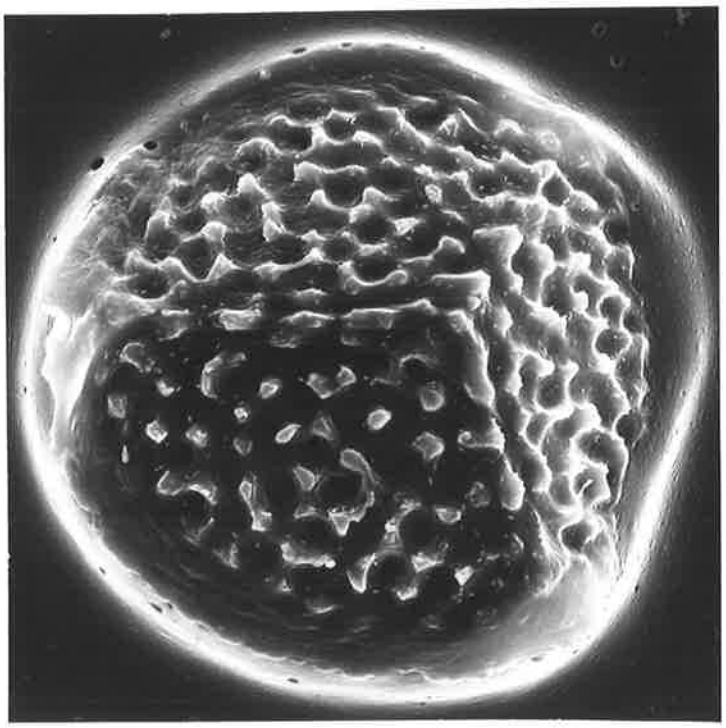
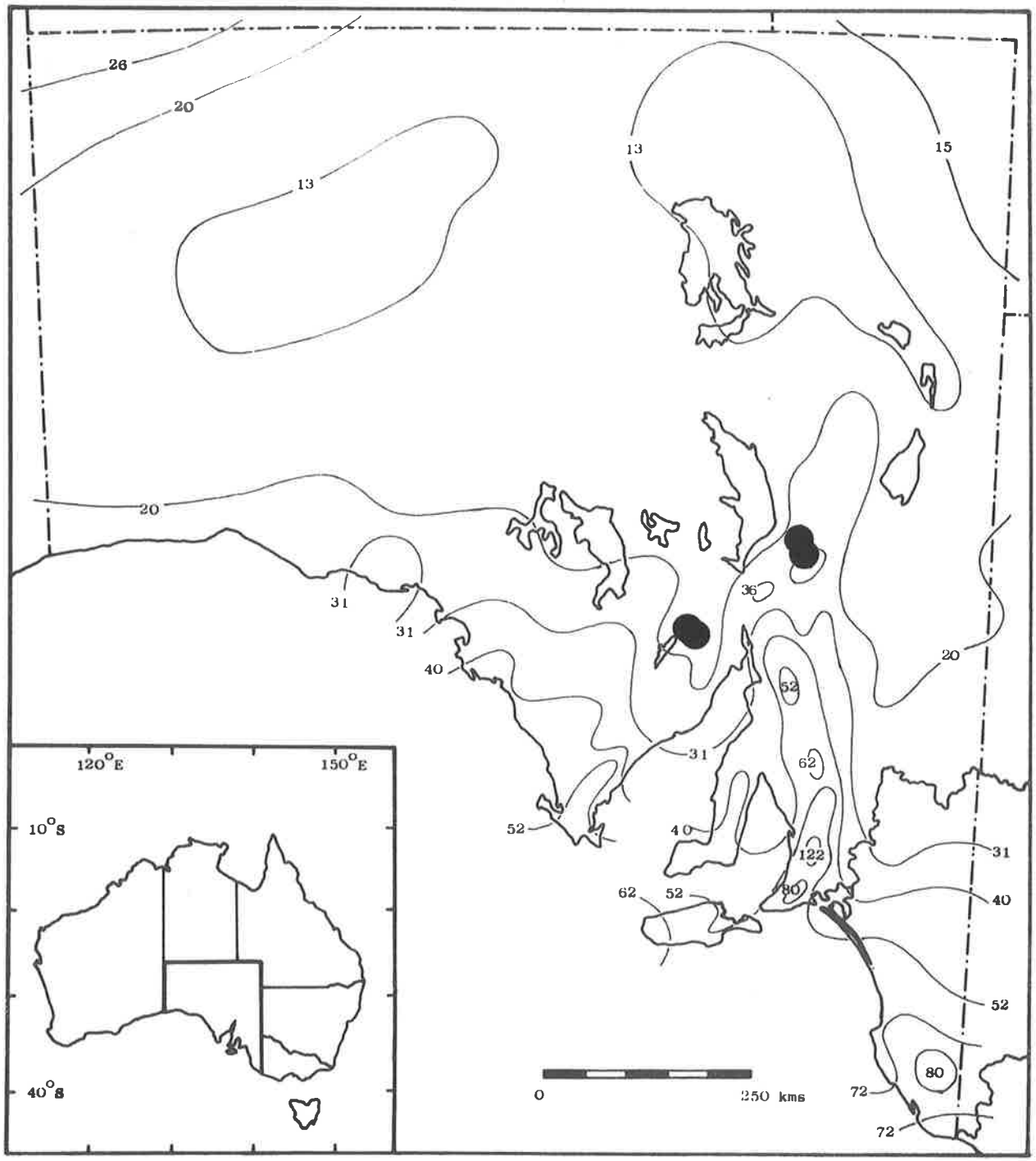


FIGURE 5.36

Distribution of collection localities of *Riccia marginata* in South Australia.

Rainfall isohyets give annual rainfall in cm.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52
31
62
52
40
122
31
62
52
80
40
52
80
72
72
0
250 kms
120°E
150°E
10°S
40°S

10. *Riccia sorocarpa* Bisch.

Bischoff 1835: 1053.

Stephani, F. 1898: 27.

MacVicar, S.M. 1926: 23-24.

Frye, T.C. and Clark, L. 1937-47: 19-20.

Arnell, S. 1956: 285.

Arnell, S. 1963: 20-21.

Synonyms:

R. minima L. 1753: 1605. Stephani, F. 1898: 27.

R. epicarpa Wallr. in Syn. Hep. 1846: 600. Stephani, F. 1898: 27.

R. lindenbergii Sauter in Syn. Hep. 1846: 611. Stephani, F. 1898: 27.

R. lindenbergiana Sauter 1845: 132. Frye, T.C. and Clark, L. 1937-47: 19.

R. raddiana Jack et Levier in Stephani, F. 1898: 28. Frye, T.C. and Clark, L. 1937-47: 19.

R. acuminata Tayl. 1846: 414. Na-Thalang, O. 1969: 103.

Holotype: Near Heidelberg, Germany. G (?)

Gametophyte monoicous, forming rosettes or part rosettes, sometimes in gregarious patches (Fig. 5.37). Thallus 5-10mm long, 2-3mm broad. Upper surface finely and compactly reticulate, plants pale green to yellowish-green. Channel narrow throughout. Branches furcate to bifurcate, deeply divided, divergent. Thallus segment broadly oblong to obovate-oblong, apex acute. Margin of thallus acute, hyaline, ascending (Fig. 5.38). Scales hyaline, reaching to margin. Capsules becoming exposed at maturity in older parts of thallus. Spores 65.0-122.5µm in diameter, dark red brown, becoming opaque at maturity; wing 2.5-7.5µm wide, with an uneven to finely crenate margin; distal face regularly reticulate forming 9-13

areolae across the diameter; borders of areolae raised at corners; proximal faces with numerous short, low ridges, not forming areolae; with a more or less distinct triradiate ridge (Fig.5.39).

Distribution:

South Australia (Fig. 5.40): Wilpena Pound; Warren Gorge, north of Quorn; Pichi Richi Pass, south west of Quorn; 15Km north of Terowie; Black Springs, south of Burra; Seppeltsfield; Botanic Park, Adelaide; Eagle on Hill, near Mt. Lofty; Hindmarsh Valley Falls, near Victor Harbour; 15Km north of Kingston south-east; 13Km east of Tailem Bend; Archibald Makin Reserve, near Keith; Mt. Monster, south of Keith; Comaum Forest, south east of Naracoorte; Rules Swamp, south east of Wrattenbully; Caroline Forest, south east of Mt. Gambier; Kangaroo Island - near Kingscote Airport, American River, near Seal Bay, Emu Bay.

New South Wales; Victoria; Australian Capital Territory; Western Australia.

Specimens Examined:

South Australia: Seppelt 0201, 0410, 0418, 0424, 0426, 0445, 0459, 2024, 2031, 2087, 2095, 2145, 2206, 2219, 2413, 2474, 2479, 2492, 2505, 2512, 2514, 2518, 2519, 2520, 2521, 2522, 2564, 2582, 2585, 2591, 2593, 2595, 2597, 2608, 2609, 2611, 2621, 2622, 2623, 2655, 2680, 2682, 2718, 2776, 2829, 2838, 2896, 2905, 2920, 2922, 2925, 2934, 2983, 2987, 2989, 2994, 2997, 3004, 3056, 3232, 3235, 3382, 3508. 2848.

Victoria: Seppelt 2560, 2561.

New South Wales: O. Na-Thalang 241,

Western Australia: G.G. Smith 293, 310, 321.

America: G 13183.

Japan: G 13192.

Europe: G 13162, 13177, 13178, 13179, 13180, 13181, 13182, 13184, 13185, 13186, 13187, 13188, 13189, 13191, 13193.

Riccia acuminata Tayl. MEL 19794. Swan River, Western Australia.
Coll: W. Drummond 1843. (possibly Isotype).
MEL 19795 Near Yarra, Melbourne.
Coll: R.A. Bastow.

Discussion.

The type description of *R. minima* L., (Linnaeus, 1753), "Riccia frondibus glabris bipartitis acutis", is inadequate to separate this species from other species of the genus. From the description of *R. epicarpa* Wallr. in litt. given in Gottsche, Lindenberg and Nees (1846), this species is closely related to *R. sorocarpa* Bisch. Gottsche, Lindenberg and Nees (1846) considered that *R. epicarpa* was close to *R. minima*. However, from their description the species seems to be more closely related to *R. sorocarpa*. From the type descriptions, *R. lindenbergiana* Sauter and *R. raddiana* Jack et Levier are also closely related to *R. sorocarpa*. The type specimens of these species have not been examined.

The type packet of *R. acuminata* contains plants of both *R. lamellosa* Raddi and *R. sorocarpa*. Taylor's description (1846) of *R. acuminata* is obviously based upon mixed material. He states that "the pale green frond looks as if sprinkled with a white powder" which is characteristic of *R. lamellosa* and describes the thallus lobes as "acuminatis canaliculatis" which is typical of *R. sorocarpa*. It is

thus evident that the name *R. acuminata* is based in part on specimens of *R. sorocarpa*. *Riccia acuminata* therefore becomes a *nomen confusum* and must be rejected (Art. 70).

Unfortunately the type specimen of *R. sorocarpa* has not been examined, although it had been sought in the Conservatoire et Jardin Botaniques, Geneva. Specimens collected in South Australia have been compared with specimens identified as *R. sorocarpa* collected from numerous northern hemisphere localities. The South Australian specimens agree well both in thallus and spore features with the other specimens examined.

Riccia sorocarpa is distributed over a wide climatic range in South Australia. Within this range the species exhibits variation both in thallus colour and size. Specimens from the northern limits of the distribution are yellowish-green and attain up to approximately 8mm thallus length. Those specimens from the more southerly districts are pale green and attain a thallus length of up to 10mm. The finely and compactly reticulate and narrowly sulcate upper surface are, however, distinctive throughout the geographical range of the species.

FIGURE 5.37

Riccia sorocarpa Bisch.

Scale in mm.

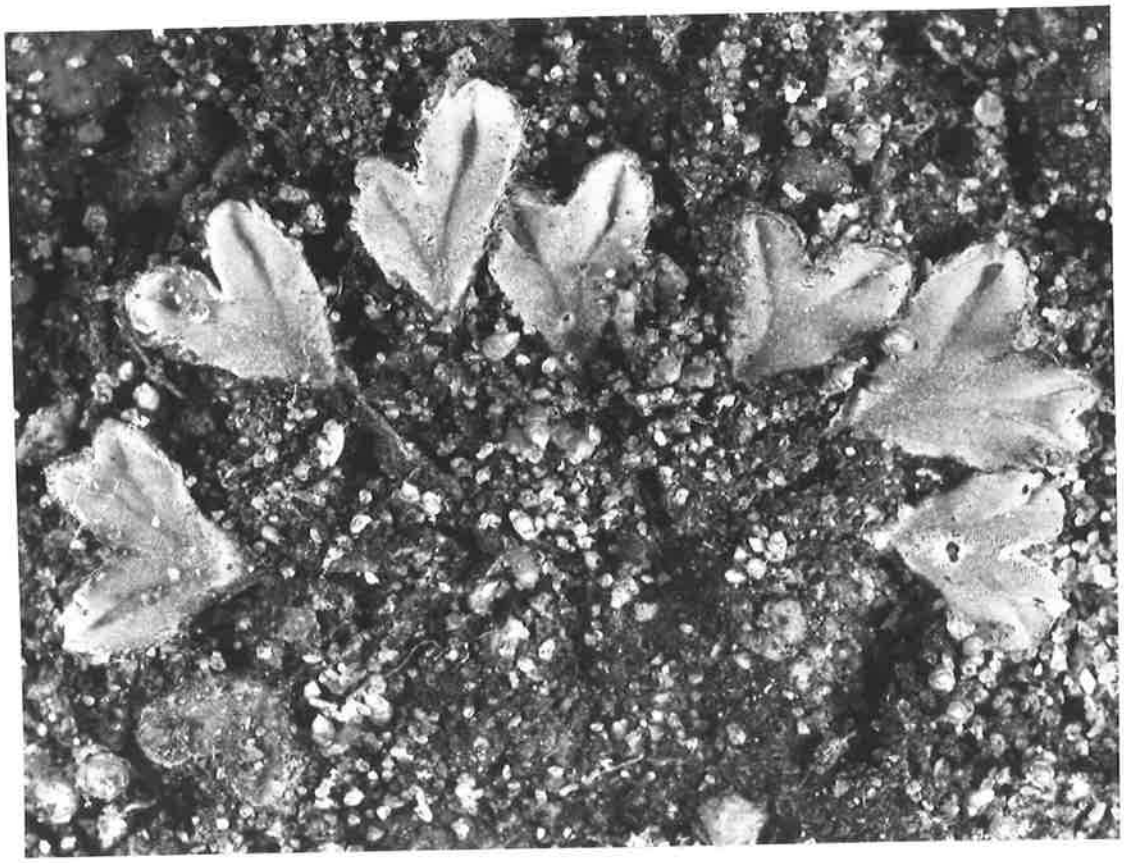


FIGURE 5.38

Transverse sections of the thallus of *Riccia sorocarpa*.

a. 1.0 mm from thallus apex

b. 2.0 mm from thallus apex

c. 3.0 mm from thallus apex

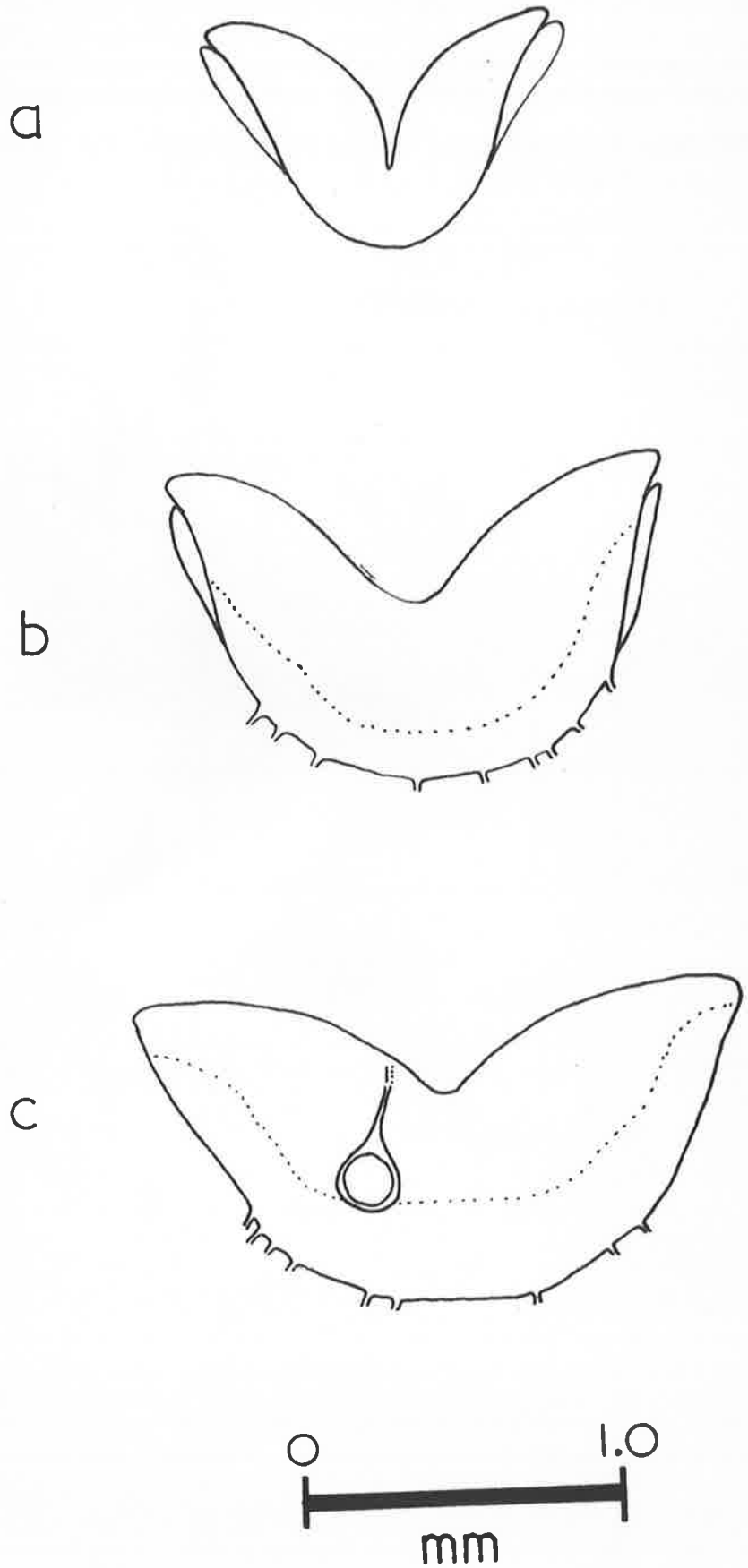
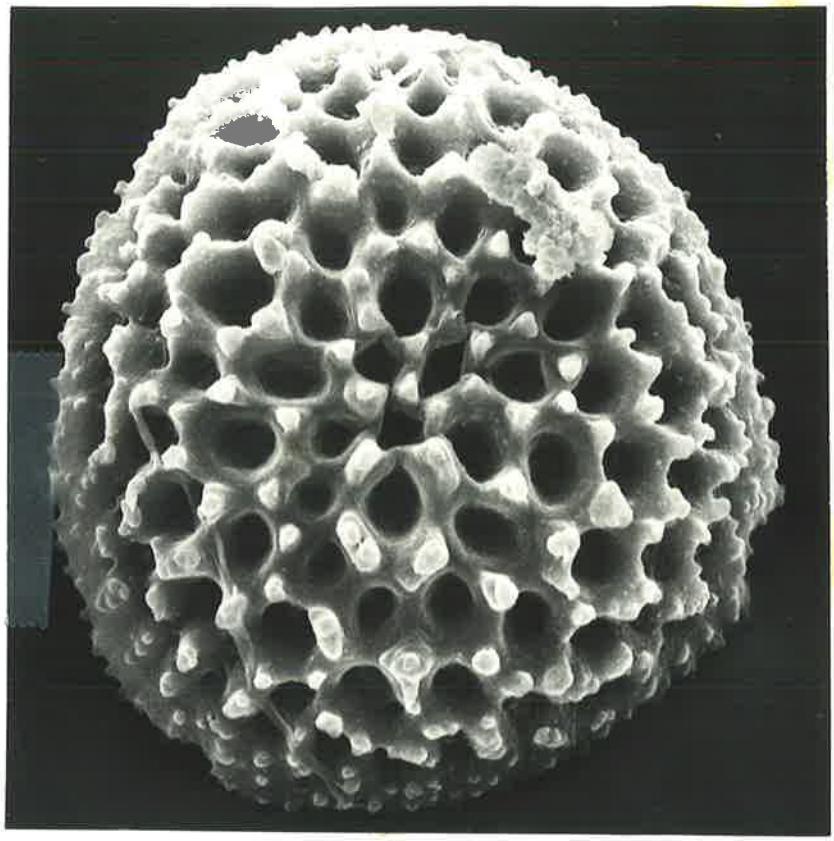

a
b
c
0
1.0
mm

FIGURE 5.39

Scanning electron micrographs of the spores of *Riccia sorocarpa*.

a. Distal face

b. Proximal face



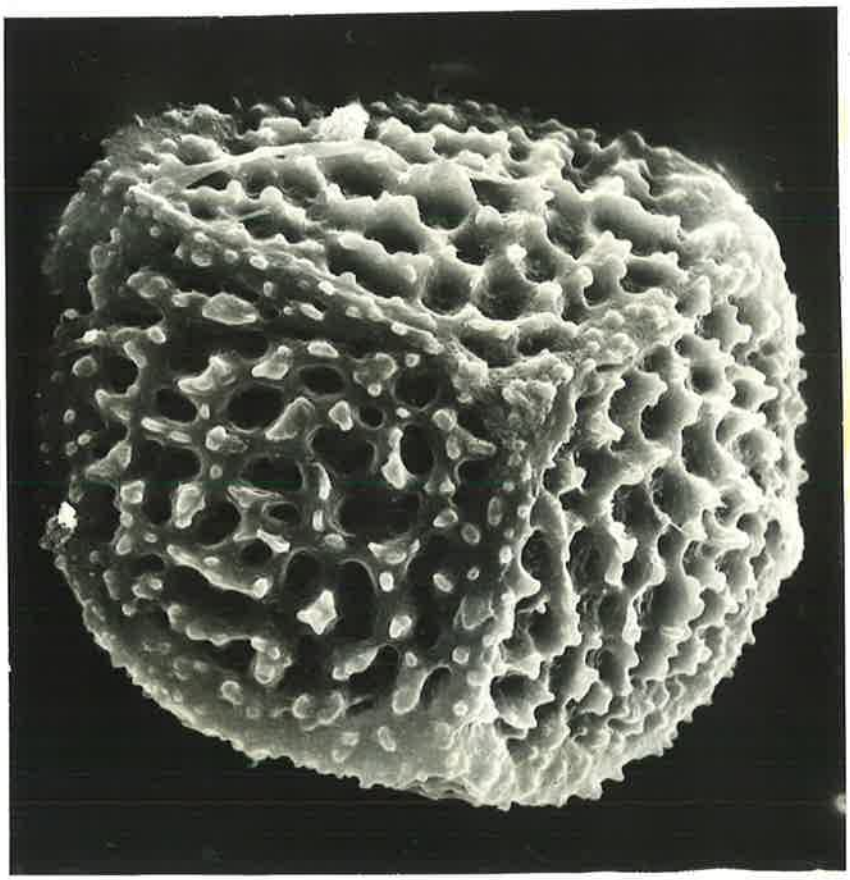
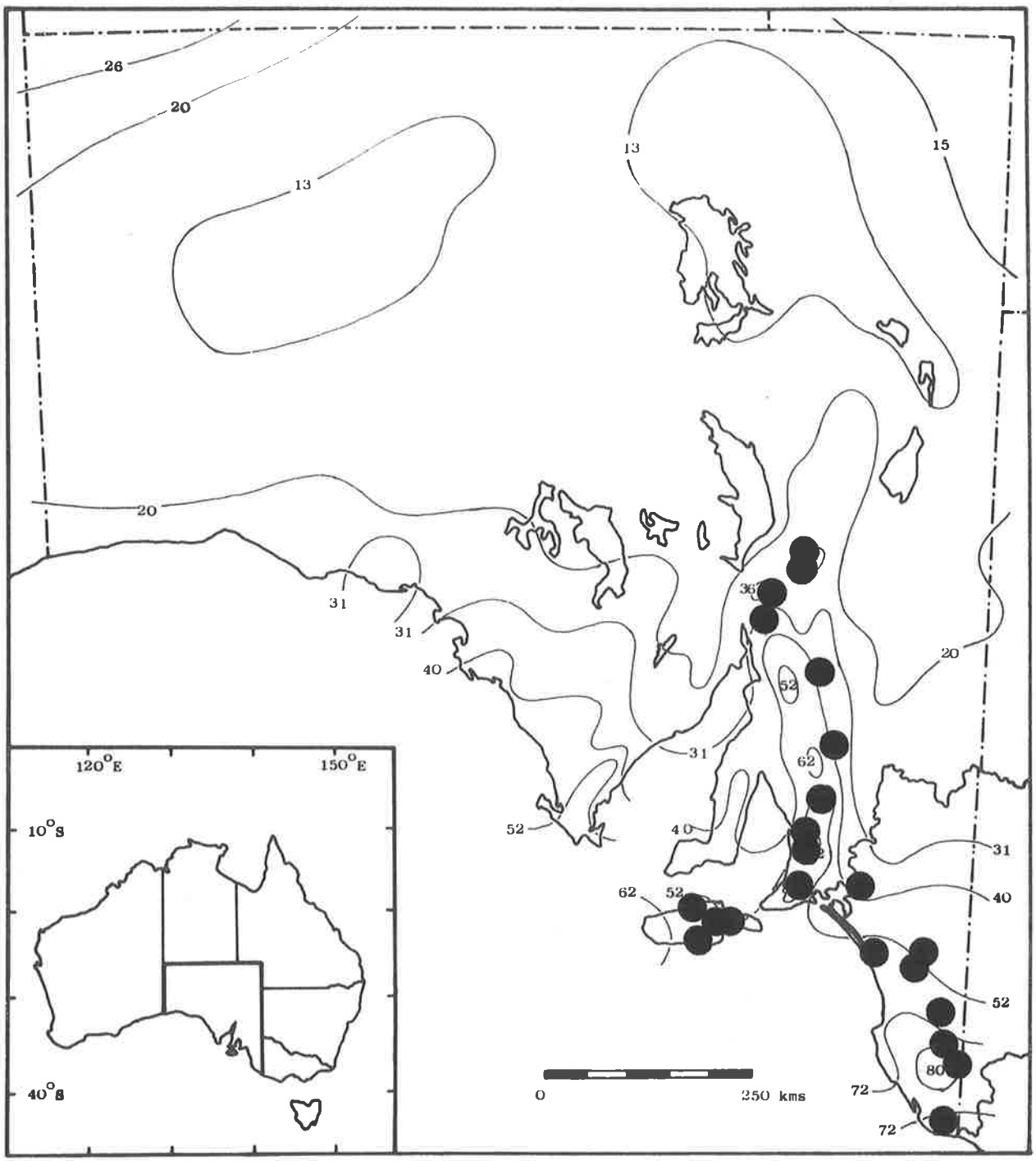


FIGURE 5.40

Distribution of collection localities of Riccia sorocarpa in South Australia.

Rainfall isohyets give annual rainfall in cm.


26
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20
31
31
40
36
52
20
31
62
52
40
31
62
52
40
52
80
72
72
120°E
150°E
10°S
40°S
0
250 kms

11. *Riccia rorida* Na-Thalang (Proposed).

Na-Thalang, O. 1969: Ph.D. Thesis, University of Sydney.

Holotype: Cotter River, Canberra, Australian Capital Territory.

Coll: O. Na-Thalang, 1967: SYD.

Gametophyte monoicous, forming incomplete rosettes or, more usually, in scattered patches (Fig. 5.41). Thallus 3-5mm long, 1.5-2.5mm broad. Upper surface roughened, glaucous green. Channel narrow and deep at apex, elsewhere broad and flat, closed at apex by inflexed thallus margins. Branches single to bifurcate, divergent. Thallus segment obovate-oblong to obcuneate-oblong, apex rounded to truncate. Margin of thallus more or less swollen at apex, elsewhere acute (Fig. 5.42). Scales hyaline, extending beyond thallus margin at apex, reaching only to margin elsewhere. Capsules deeply embedded. Spores 62.5-102.5µm in diameter, brown to dark brown; wing 2.5-7.5µm wide, with a smooth to finely crenate margin; distal face regularly reticulate, forming 8-12 areolae across the diameter; proximal faces similar, with a distinct triradiate ridge (Fig. 5.43).

Distribution:

South Australia (Fig. 5.44): Wilpena Pound.
Australian Capital Territory.

Specimens Examined:

South Australia: Seppelt 0393, 0401, 0411, 2942, 3020, 3156, 3157, 3158, 3159, 3160, 3161, 3162, 3163.

Australian Capital Territory: Cotter River, Canberra,

Coll: O. Na-Thalang 191 (SYD - Holotype).

Discussion.

R. rorida was proposed by Na-Thalang (1969) and at that time was known only from the type locality.

The granular or roughened upper surface of the thallus is similar to that of *R. crystallina* L. emend Raddi and to that of *R. lamellosa* Raddi. However, *R. crystallina* belongs in the subgenus *Ricciella* whilst both *R. rorida* and *R. lamellosa* belong to the subgenus *Riccia*.

A distinctive feature of the thallus of *R. rorida* is the inflection of the thallus margins at the apex exposing the hyaline scales. Further, the spores of *R. rorida* are 62.5-102.5µm in diameter, with proximal and distal faces regularly areolate (Fig. 5.43) whilst the spores of *R. lamellosa* are 82.5-127.5µm in diameter with proximal and distal faces sculptured with irregular high ridges which only occasionally form areolae (Fig. 5.47).

FIGURE 5.41

Riccia rorida Na-Thalang (proposed)

Scale in mm.

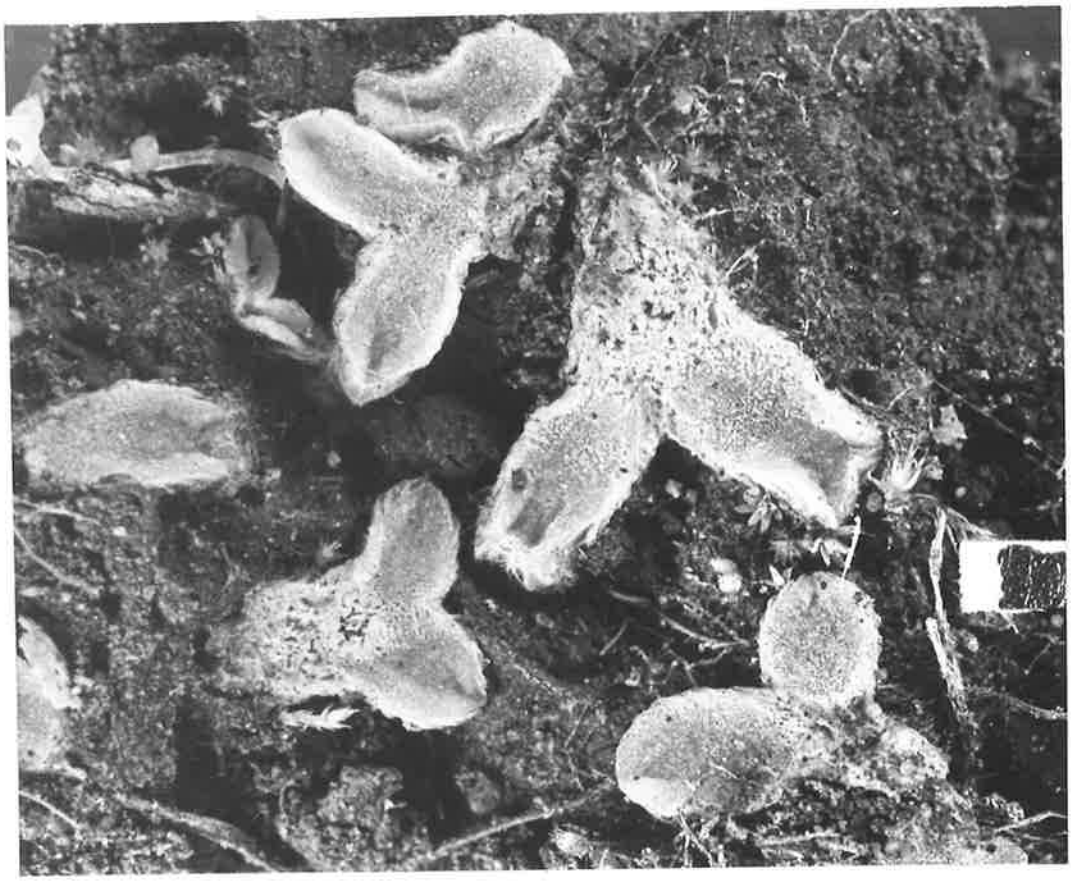


FIGURE 5.42

Transverse sections of the thallus of *Riccia rorida*.

a. 0.5 mm from thallus apex

b. 1.5 mm from thallus apex

c. 2.5 mm from thallus apex

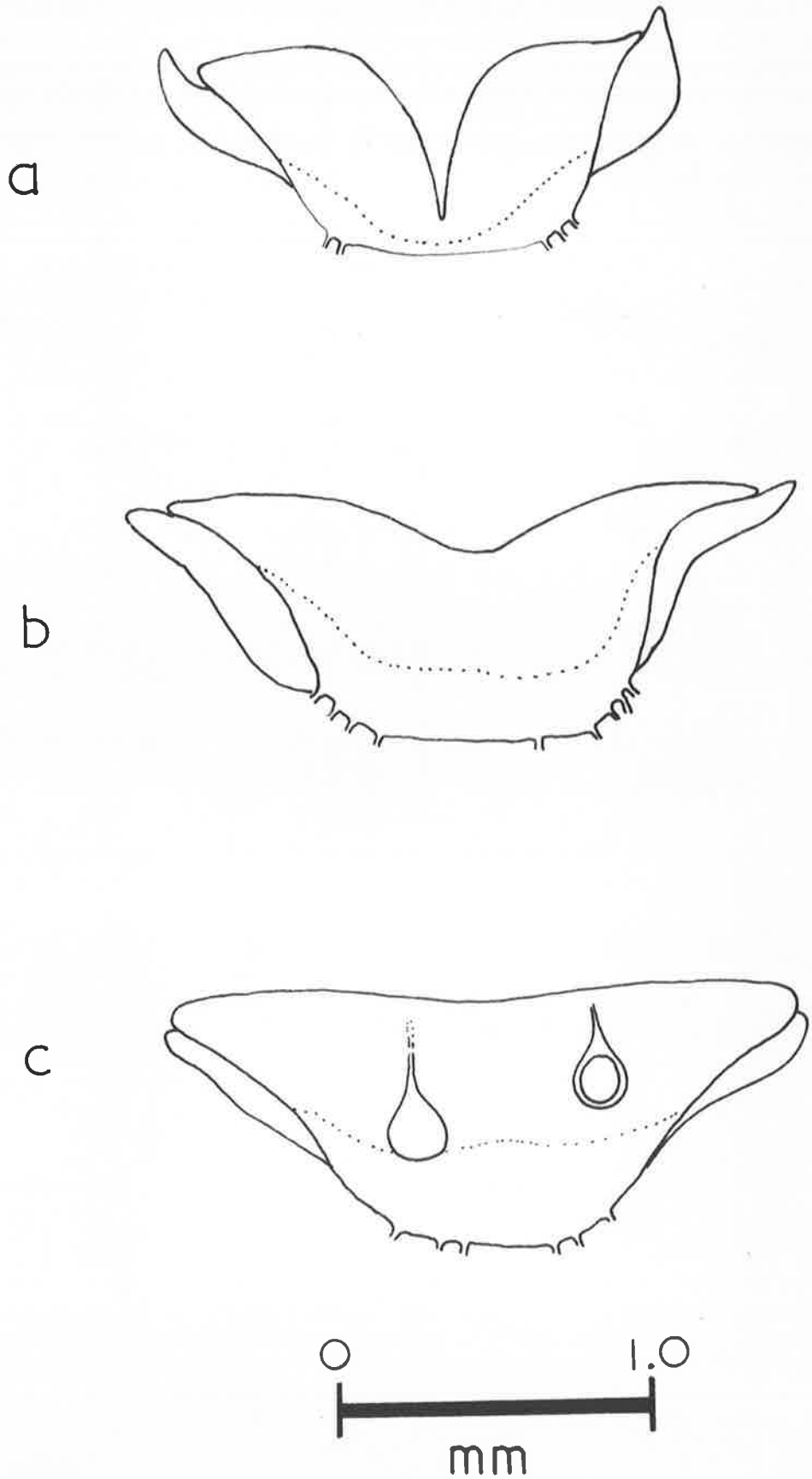
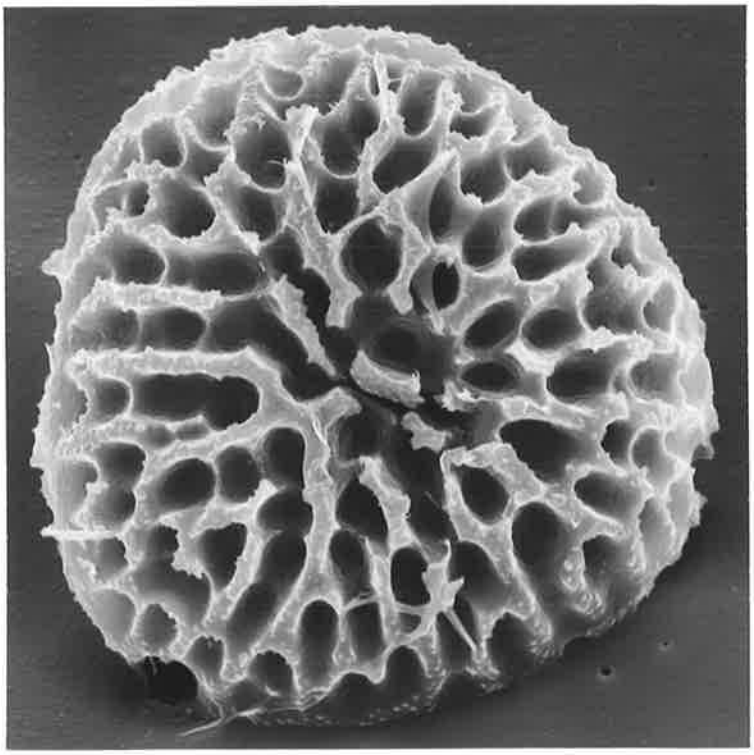

a
b
c
0
1.0
mm

FIGURE 5.43

Scanning electron micrographs of the spores of *Riccia rorida*.

a. Distal face

b. Proximal face



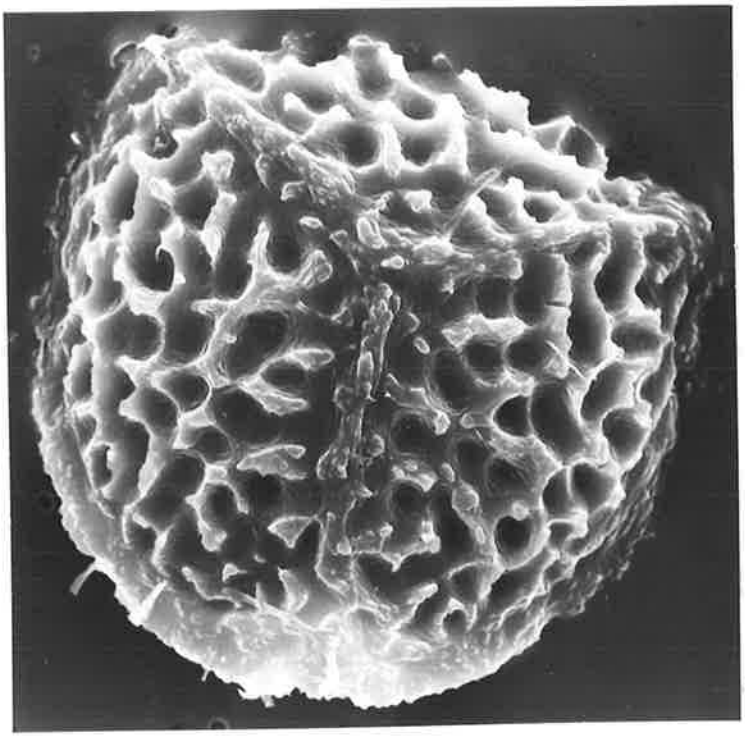
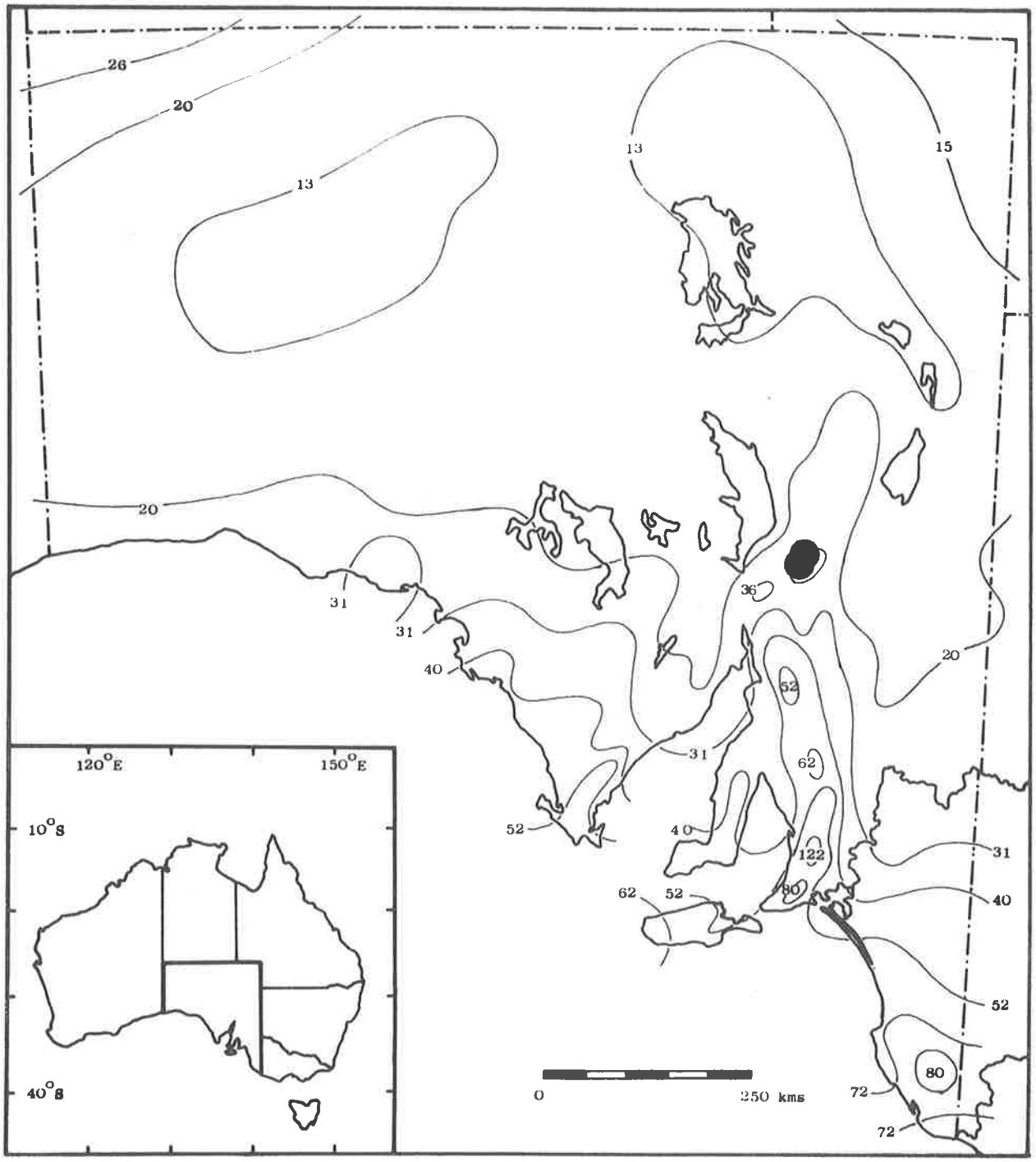


FIGURE 5.44

Distribution of collection localities of *Riccia rorida* in South Australia.

Rainfall isohyets give annual rainfall in cm.


26
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62
31
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52
40
122
31
62
52
80
40
52
80
72
72
0
250 kms
120°E
150°E
10°S
40°S

12. *Riccia lamellosa* Raddi.

Raddi, 1818: 351.

Gottsche, K.M., Lindenberg, J.B.W., and Nees von Esenbeck, C.G. 1846: 605.

Stephani, F. 1898: 32-33.

Rabenhorst, L. 1954: 468-469.

Synonyms:

R. dufourii Nees 1838: 390. Stephani, F. 1898: 32.

Holotype: Europe. G ?

Gametophyte monoicous, in scattered or gregarious patches (Fig.5.45). Thallus 5-10mm long, 3-5mm broad. Upper surface reticulate, more or less roughened, glaucous green, often whitish or powdery. Channel narrow at apex, becoming flattened towards base of thallus. Branches furcate to bifurcate or occasionally trifurcate, divergent. Thallus segment obovate-oblong to oblong, apex rounded to acute. Margins of thallus acute (Fig. 5.46). Scales large, hyaline, imbricate, extending beyond thallus margin. Capsules deeply embedded in thallus. Spores 82.5-127.5µm in diameter, light brown to dark brown; wing 3.75-7.5µm wide (rarely up to 10.0µm wide), with an uneven to finely dentate margin; distal face reticulate with irregular high ridges forming 9-12 areolae across the diameter; proximal faces similar, with a more or less distinct triradiate ridge (Fig. 5.47).

Distribution:

South Australia (Fig. 5.48): Koonamore Vegetation Reserve; Waukaringa; Old Whydown Stn., Nackara; Oodlawirra; 15Km north of Terowie; Chambers Gorge, west of Lake Frome; Martins Well Stn.; Angorichina Gorge to Wirrealpa; Blinman; Parachilna Gorge; Wilpena; Yourambulla Caves, south of Hawker; 35Km north east of Quorn; Warren Gorge, north of Quorn; Tassie Creek, Corunna Stn., Iron Knob; Seppeltsfield; Mt. Mary, 15Km west of Morgan; Waikerie; Mt. Barker; Eagle on Hill, near Mt. Lofty; Botanic Park, Adelaide; west of Port Vincent, Yorke Peninsula; Emu Bay, Kangaroo Island; 13Km east of Tailem Bend; 15Km north of Kingston, south east South Australia; 20Km north west of Bordertown.

New South Wales; Northern Territory; Victoria; Australian Capital Territory.

Specimens Examined:

South Australia: Seppelt 0085, 0086, 0102, 0131, 0194, 0246, 0259, 0260, 0298, 0357, 0380, 0381, 0383, 0386, 0390, 0402, 0419, 0422, 0427, 0429, 0431, 0432, 0436, 0441, 0449, 0465, 0471, 0631, 2209, 2331, 2334, 2335, 2360, 2361, 2362, 2363, 2370, 2372, 2382, 2383, 2387, 2420, 2422, 2464, 2470, 2473, 2483, 2554, 2559, 2573, 2594, 2559, 2573, 2594, 2596, 2612, 2884, 2852, 2858, 2863, 2864, 2877, 2889, 2890, 2897, 2898, 2910, 2921, 2936, 2970, 2971, 2988, 3000, 3012, 3099, 3106, 3107, 3109, 3110, 3111, 3126, 3132, 3133, 3134, 3135, 3136, 3138, 3140, 3142, 3194, 3219, 3488. Na-Thalang 104, 121.

Victoria: Seppelt 2562. MEL 19792.

Northern Territory: Seppelt 3491 (= P.K. Latz 4090).

Europe: G 13151, 13152, 13153, 13154, 13155, 13156, 13157, 13158, 13159, 13160, 13161.

Discussion.

Although sought at the Conservatoire et Jardin Botaniques, Geneva, the type specimens of *R. lamellosa* and *R. dufourii* have not been seen. The type descriptions include no reference to spore characteristics. However, from the descriptions of thallus morphology these two species are conspecific, thus confirming the opinion of Stephani (1898) who considered them as the same species.

Based on features of thallus and spore morphology, specimens from South Australia agree with plants identified as *R. lamellosa* obtained from Geneva.

The rather wax-like or powdery appearance of the epidermis of the species is found in only one other species (*R. rorida* Na-Thalang proposed) recorded so far in South Australia. However, the inflexed margin towards the apex and the prominence of the marginal scales at the apex of *R. rorida*, in addition to features of spore morphology distinguish this species from *R. lamellosa*.

Na-Thalang (1969) stated that "*R. lamellosa* is rather rare in Australia." However, field collections made during the course of this study have shown this species to be one of the most widely distributed and common species of *Riccia* in South Australia.

FIGURE 5.45

Riccia lamellosa Raddi

Scale in mm.

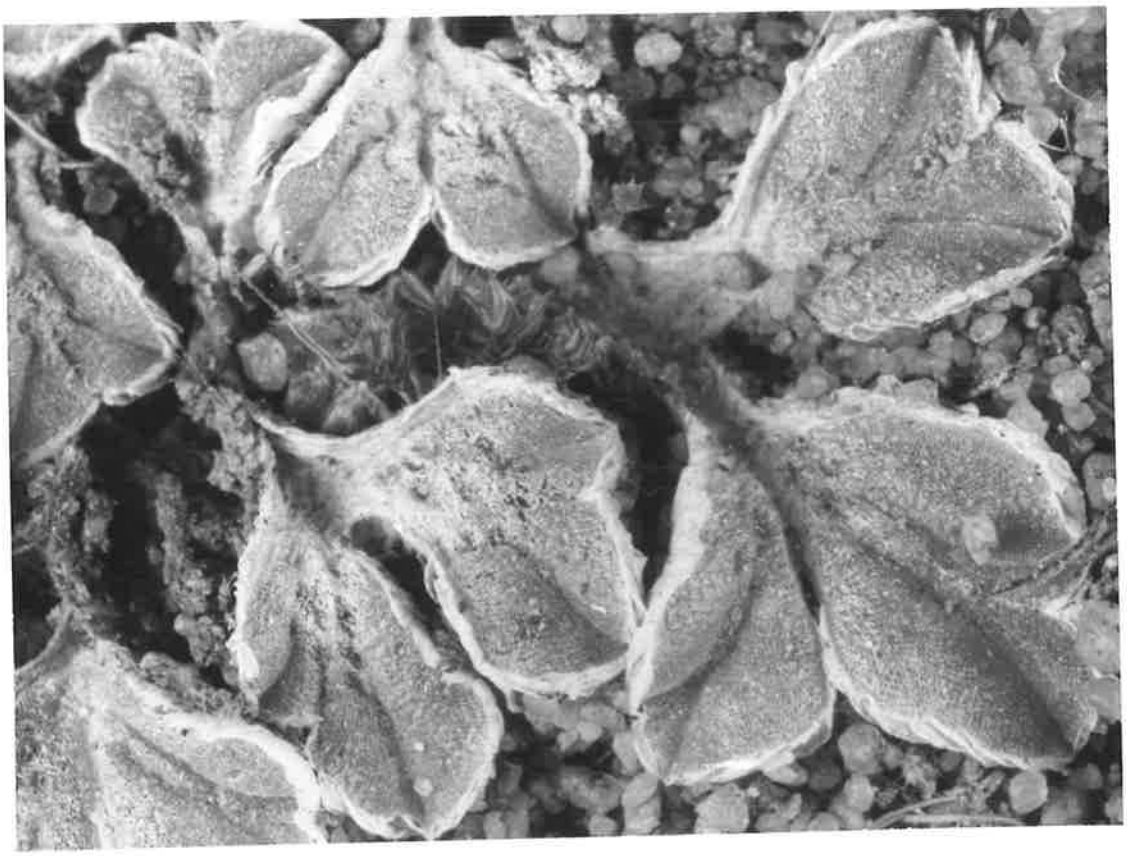


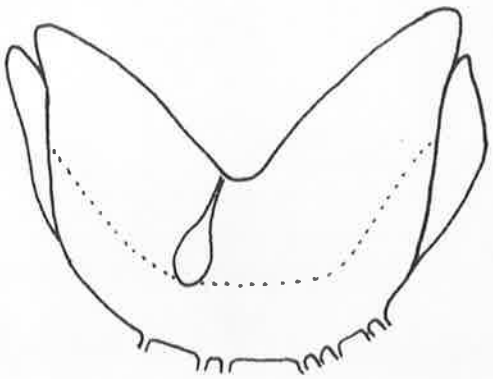
FIGURE 5.46

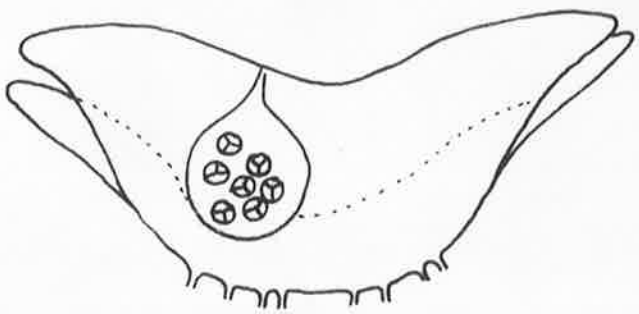
Transverse sections of the thallus of *Riccia lamellosa*.

a. 0.5 mm from thallus apex

b. 1.0 mm from thallus apex

c. 2.0 mm from thallus apex





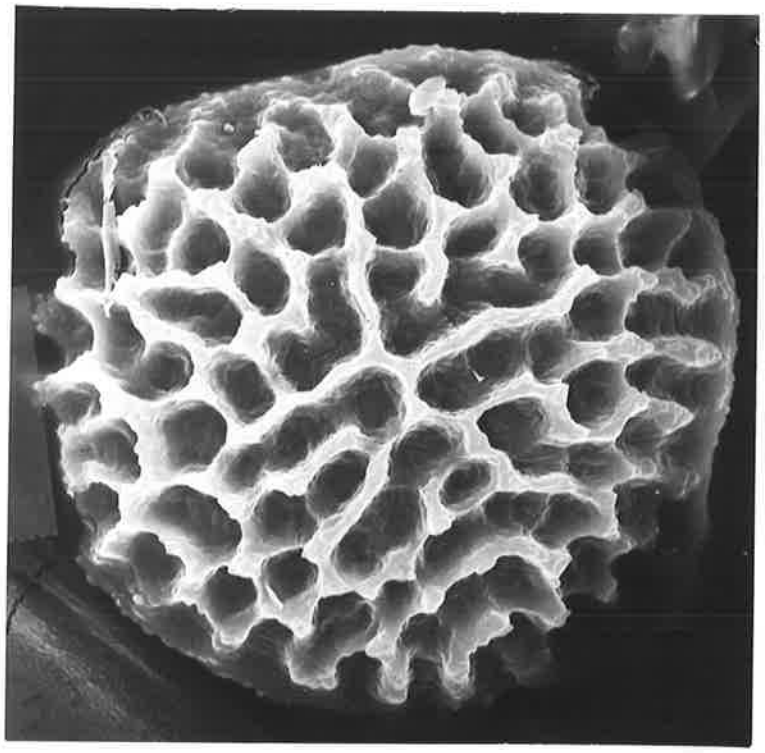

0
1.0

FIGURE 5.47

Scanning electron micrographs of the spores of *Riccia lamellosa*.

a. Distal face

b. Proximal face



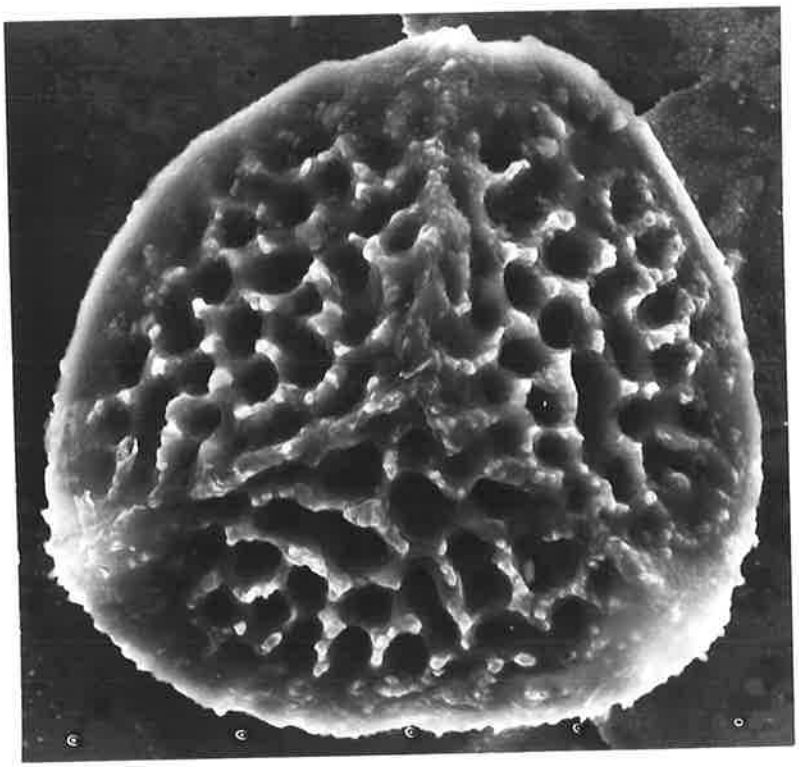
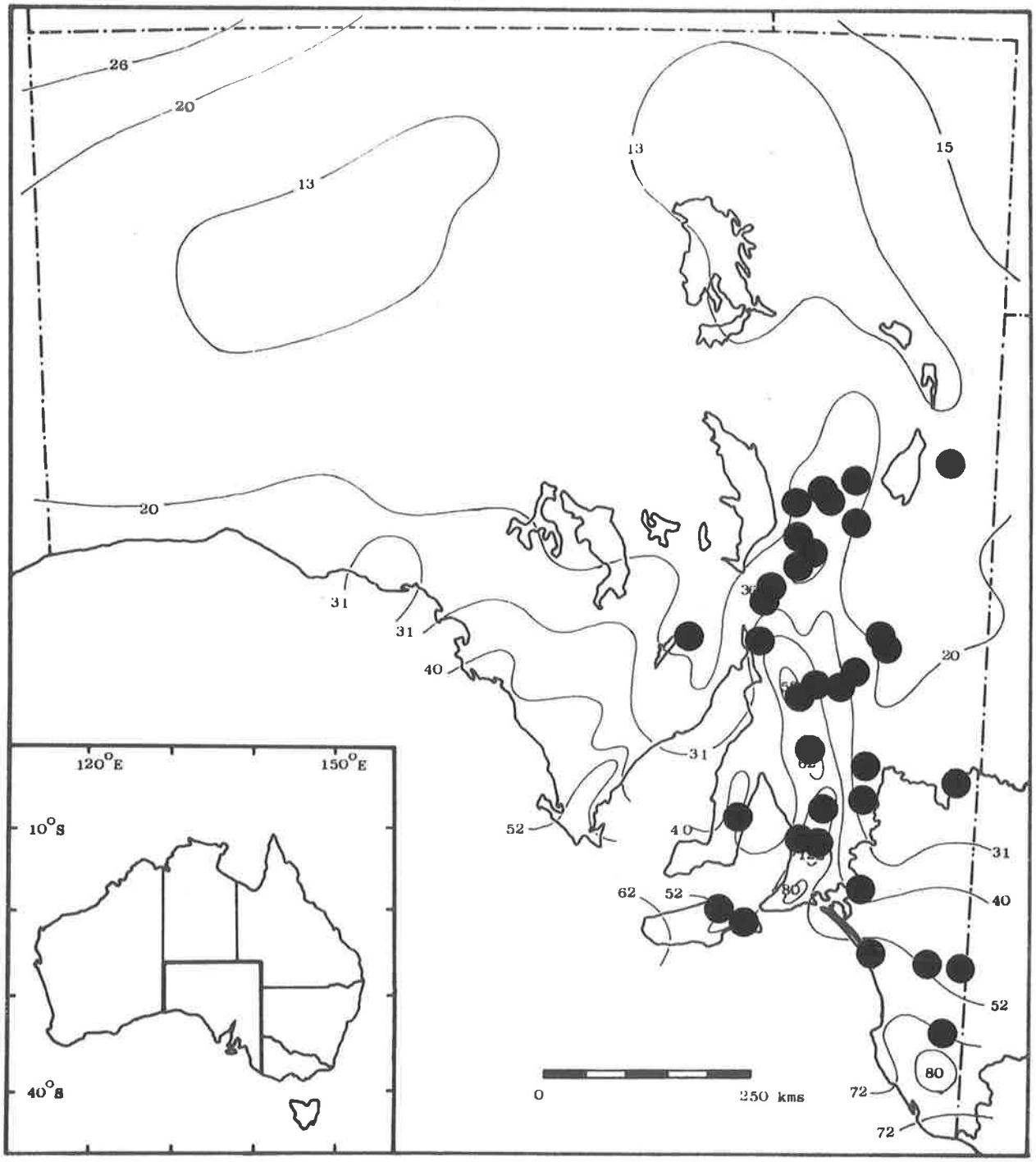


FIGURE 5.48

Distribution of collection localities of *Riccia lamellosa* in South Australia.

Rainfall isohyets give annual rainfall in cm.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40
31
62
52
40
52
80
72
72
0
250 kms
120°E
150°E
10°S
40°S

13. *Riccia crystallina* L.

Linnaeus, C. 1753: 1138.

Raddi, J. 1818: 351, 353.

Stephani, F. 1898: 43.

Riccia crystallina L. emend Raddi.

Jovet-Ast, S. 1964-65: 459-472.

Synonyms:

R. plana Tayl. 1846: 414. Jovet-Ast, S. 1964-65: 459-472.

R. negrii Gola 1915: 59-75. Jovet-Ast,S. 1964-65: 459-472.

Holotype: ?

Gametophyte monoicous, in rosettes or part rosettes, sometimes forming rings, occasionally scattered (Fig. 5.49). Thallus 5-12mm long, 3-5mm broad. Upper surface roughened, not marked with distinct air chambers, occasionally becoming cavernous in older parts towards base of thallus, plants pale green. Channel broad and short at apex, flat elsewhere (Fig. 5.50). Branches furcate to trifurcate, divergent. Thallus segment obcuneate, apex rounded to truncate, often shortly bilobed. Capsules numerous, deeply embedded in thallus. Spores 52.5-92.5µm in diameter, brown to dark brown; wing (3.75)5.0-7.5(8.75)µm wide, with a prominent pore in marginal angles, margin finely dentate; distal face regularly reticulate, forming 6-10 areolae across the diameter, borders of areolae raised at corners , forming papillae often shortly forked at tip; proximal faces similar but with areolae often incomplete, with a narrow, distinct triradiate ridge (Fig. 5.51).

Distribution:

South Australia (Fig. 5.52): Coopers Creek, near Innaminka, Chambers Gorge, west of Lake Frome; Southern Cross Bore swamp, Koonamore Station; Wilpena Pound; Warren Gorge, north of Quorn; Tassie Creek, Corunna Stn ., Iron Knob; 15Km north of Terowie; Seppeltsfield; Summertown; Bridgewater; Belair National Park; Sleeps Hill Railway Tunnel, near Belair; Adelaide University Campus; widespread in suburban Adelaide; Archibald Makin Reserve, near Keith; Mt. Monster, 9Km south of Keith; Wrattenbully; Rules Swamp, south east of Wrattenbully; Glencoe. New South Wales; Western Australia.

Specimens Examined:

South Australia: Seppelt 0255, 0256, 0257, 0291, 0345, 0346, 0356, 0440, 0450, 0486, 0599, 2402, 2403, 2404, 2407, 2408, 2414, 2459, 2460, 2706, 3002, 3177, 3178, 3179, 3238, 3239, 3240, 3241, 3245, 3254, 3255, 3256, 3258, 3261, 3267, 3268, 3269, 3270, 3279, 3280, 3281, 3289, 3291, 3292, 3335, 3339, 3340, 3341, 3342, 3343, 3344, 3345, 3353, 3364, 3485, 3486, 3516. Na-Thalang 108.

Victoria; Na Thalang 257. MEL 19793, 19803.

New Zealand: Seppelt 3538 (Coll: E.O. Campbell, Massey).

North America: G 13529.

Canada: G 13527.

Northern Africa: G 13354, 13355, 13532, 13540,

Europe: G 13528, 13530, 13531, 13533, 13534, 13535, 13536, 13537, 13538, 13539, 13541, 13542, 13543.

Riccia plana Tayl. Holotype: Swan River, Western Australia. Coll: W. Drummond, 1843. In BM. Isotype: MEL 19775.

Discussion.

Jovet-Ast (1964-65, 1967) undertook a detailed revision of *R. crystallina* in an attempt to clarify the taxonomic status of the species. She considered *R. plana* and *R. negrii* to be synonyms of *R. crystallina* based on spore and thallus morphology. Although the type specimen of *R. crystallina* L. has not been located, the specimens examined by Jovet-Ast were considered by her to bear a close resemblance to specimens in the herbarium of Raddi.

Specimens of *R. crystallina* have been collected over a wide climatic range in South Australia. A detailed study of thallus and spore morphology of this species has been carried out and the results presented in a paper accepted for publication in The Bryologist, 1974. A discussion of the study on spore morphology is given in Chapter 6.

FIGURE 5.49

Riccia crystallina L. emend Raddi

Variation in thallus form. All specimens contained mature spores.

All scales in mm.

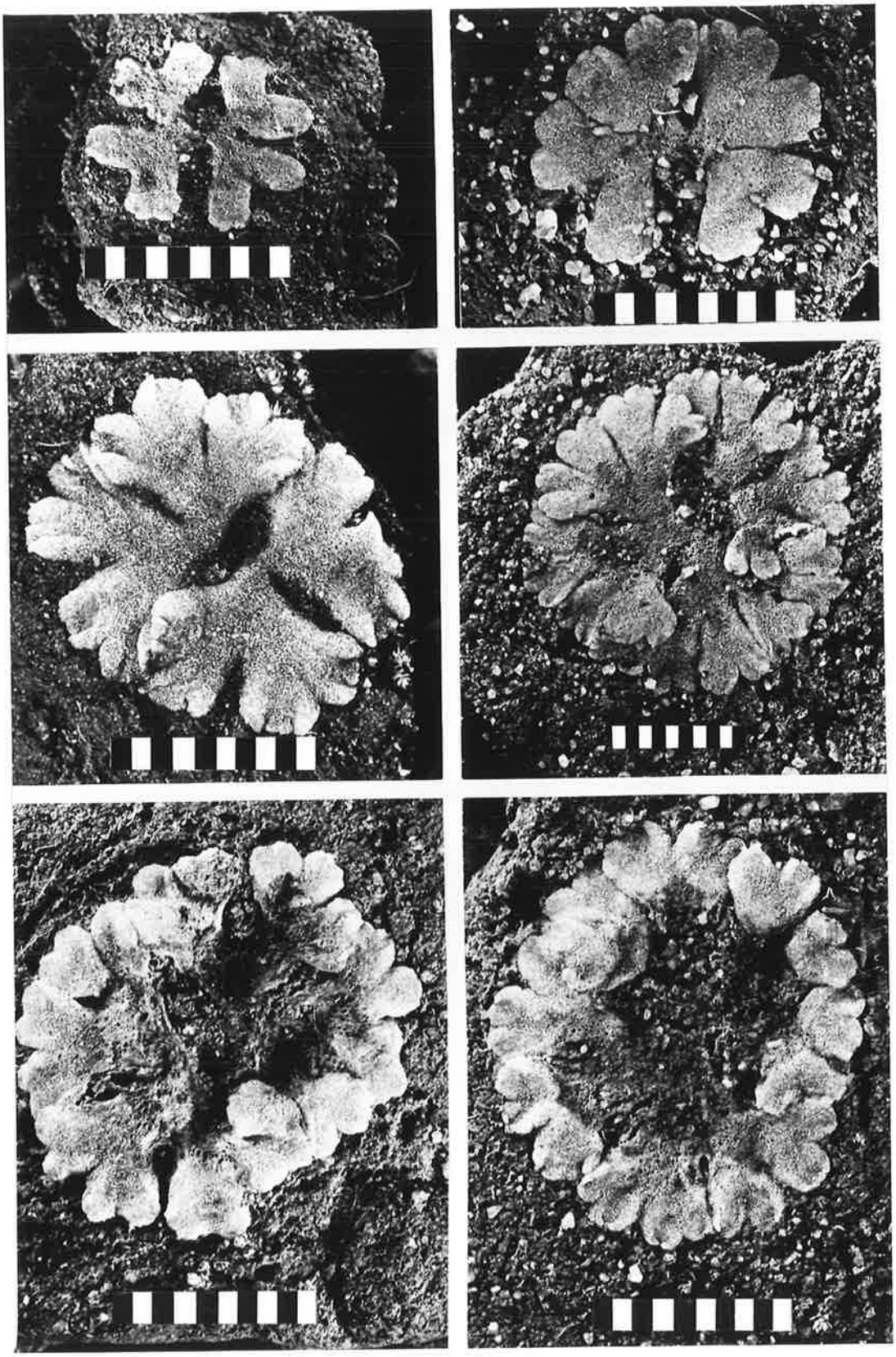
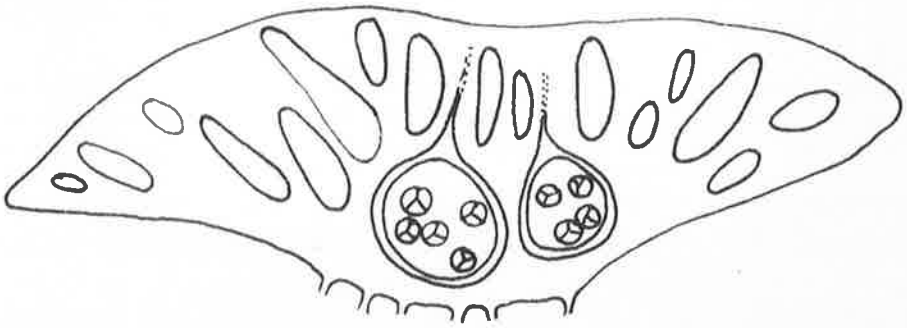


FIGURE 5.50

Transverse section of the thallus of *Riccia crystallina*.



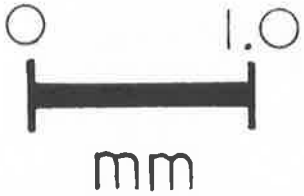
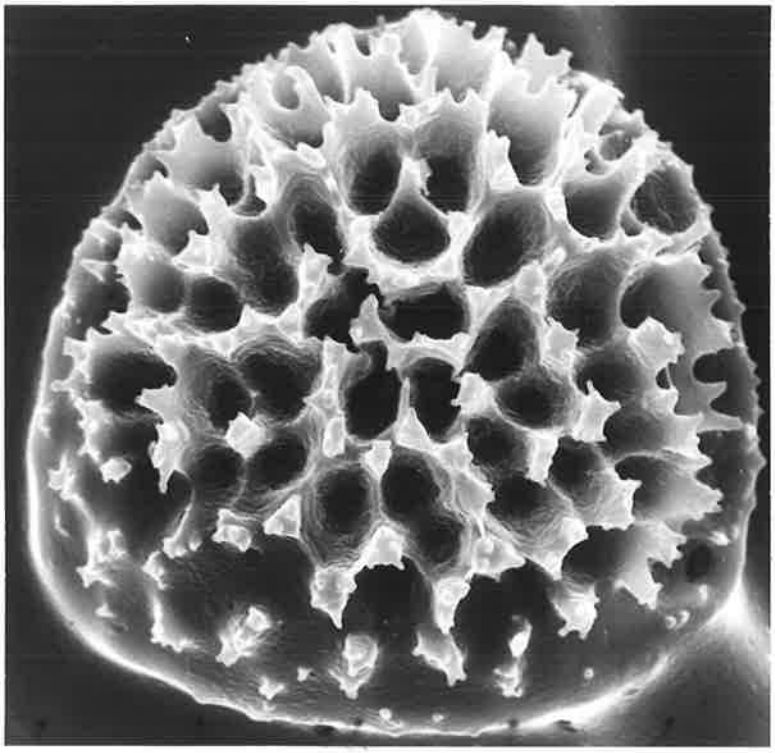

0
1.0
mm

FIGURE 5.51

Scanning electron micrographs of the spores of Riccia crystallina.

a. Distal face

b. Proximal face



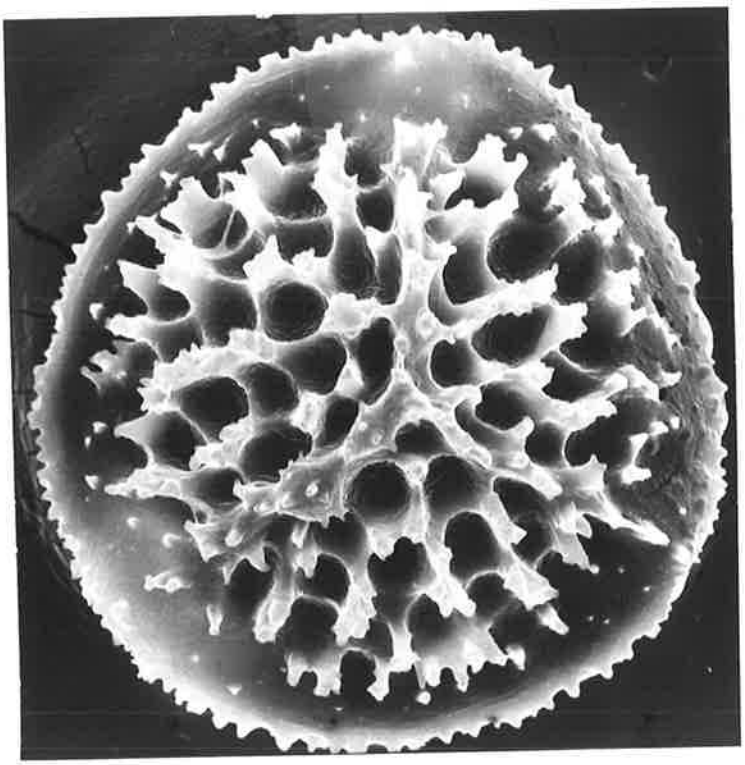
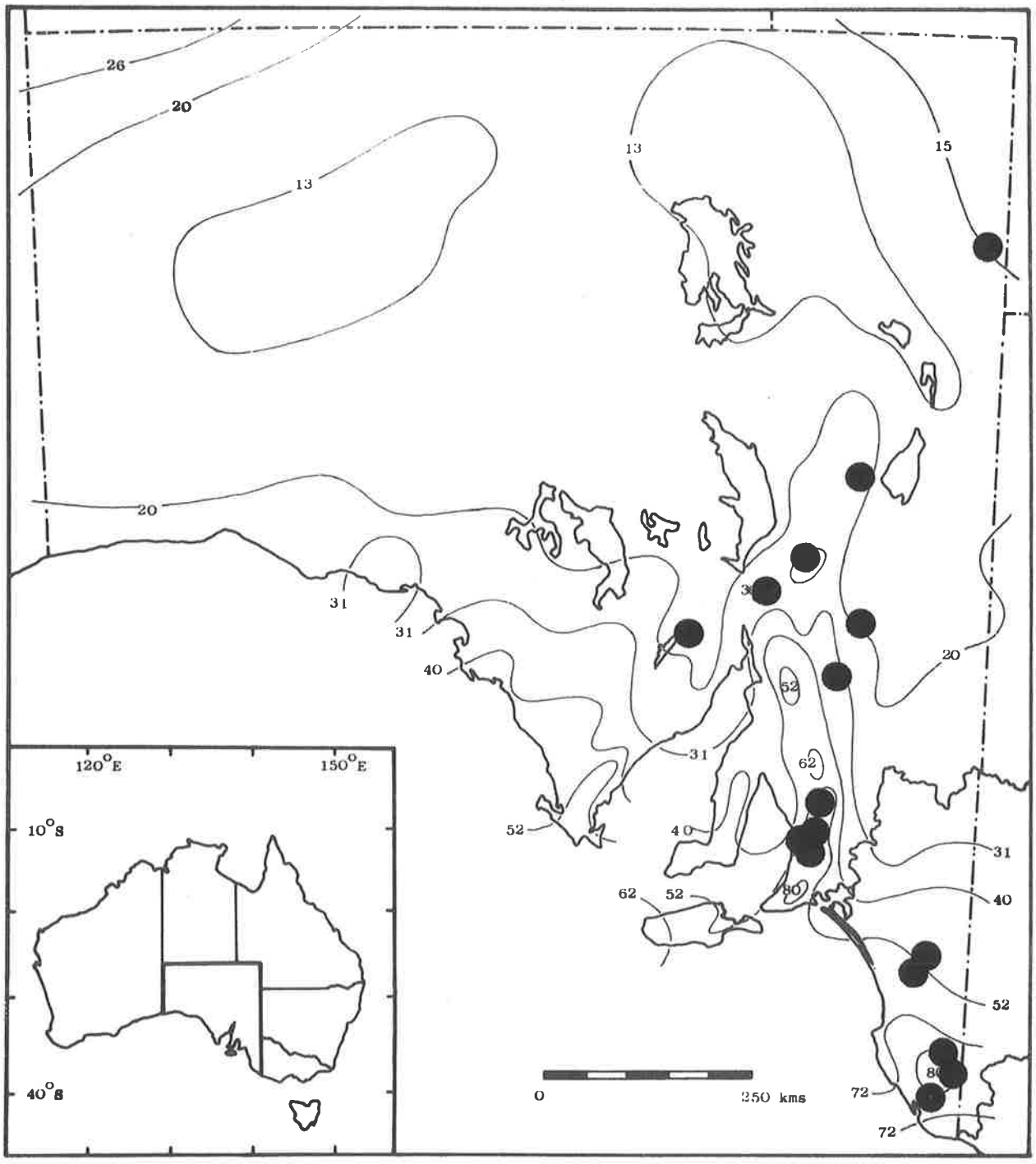


FIGURE 5.52

Distribution of collection localities of *Riccia crystallina* in South Australia.

Rainfall isohyets give annual rainfall in cm.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31
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40
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80
31
40
52
72
72
120°E
150°E
10°S
40°S
0
250 kms

14. *Riccia cavernosa* Hoffm.

Hoffmann, in Deutschlands Flora Cryptogamie, 1795.

Riccia cavernosa Hoffm. emend Raddi.

Raddi, J. 1818: 351, 353.

Jovet-Ast, S. 1964-65: 459-483.

Synonyms:

R. rautanenii Steph. 1898: 53. Jovet-Ast, S. 1964-65: 459-483.

R. bahiensis Steph. 1898: 51. Jovet-Ast, S. 1964-65: 459-483.

R. montagnei Steph. 1898: 44. Jovet-Ast, S. 1964-65: 459-483.

R. terracianoi Gola 1915: 59-75. Jovet-Ast, S. 1964-65: 459-483.

R. tellinii Gola 1915: 59-75. Jovet-Ast, S. 1964-65: 459-483.

R. multilamellata Steph. 1898: 48. Na-Thalang, O. 1969: 136-138.

Holotype: ?

Gametophyte monoicous, forming compact rosettes 15-40mm in diameter (Fig. 5.53). Thallus 5-15mm long, 2-4mm broad. Upper surface clearly marked with air chamber areas, green to yellowish green, usually tinged with red or purple on upper surface, sometimes only at margin or apex. Channel broad at apex, elsewhere flat (Fig. 5.54). Branches bifurcate to trifurcate, shortly to deeply divided, often overlapping. Thallus segment obcuneate or obcuneate-oblong, apex rounded to truncate, often shortly bilobed. Margin of thallus tumid, inflexed at apex, elsewhere thick and rounded. Capsules numerous, deeply embedded in thallus. Spores 70.0-112.5µm in diameter, dark brown; wing 2.5-7.5µm wide, with a crenate margin; distal face with dichotomous ridges forming areolae towards margin of spore; proximal faces with irregular ridges, with a distinct triradiate ridge (Fig. 5.55).

Distribution:

South Australia (Fig. 5.56): Chambers Gorge, west of Lake Frome; 20Km east of Lake Frome; Southern Cross Bore Swamp, Koonamore; Tassie Creek, Corunna Stn., Iron Knob; 15Km north of Terowie; Bower, 30Km west of Morgan; Walker's Flat, 45Km south of Blanchetown; Wrattenbully, south east of Naracoorte. Northern Territory.

Specimens Examined:

South Australia: Seppelt 0265, 0363, 0485, 0626, 2400, 2401, 2405, 2406, 2598, 3171, 3172, 3173, 3174, 3175, 3176, 3205, 3206, 3207, 3208, 3209, 3210, 3257, 3259, 3260, 3262, 3263, 3264, 3266, 3309, 3310, 3311, 3312, 3313, 3314, 3315, 3316, 3317, 3318, 3319, 3320, 3321. R. Schodde 512 (in AD).

Northern Territory: Na-Thalang 88, 98. MEL 19799, 19802.

Riccia multilamellata Steph. Holotype: Finke River, Central Australia. Coll: W.F. Schwarz, 1886: G 12732. Isotype: MEL 19799.

Discussion.

Jovet-Ast (1964-65, 1967) undertook a detailed revision of *R. cavernosa* in an attempt to clarify the taxonomic status of this species. On the basis of thallus and spore morphology she considered *R. rautanenii*, *R. bahiensis*, *R. montagnei*, *R. terracianoi* and *R. tellinii* to be synonyms of *R. cavernosa*. The type specimen of *R. cavernosa* Hoffm. has not been located. However, the specimens examined by Jovet-Ast were considered by her to bear a close resemblance to specimens in the herbarium of Raddi.

The type specimen of *R. multilamellata* is sufficiently similar in thallus and spore morphology to specimens verified by Mme. Jovet-Ast as *R. cavernosa* to be considered as conspecific with that species.

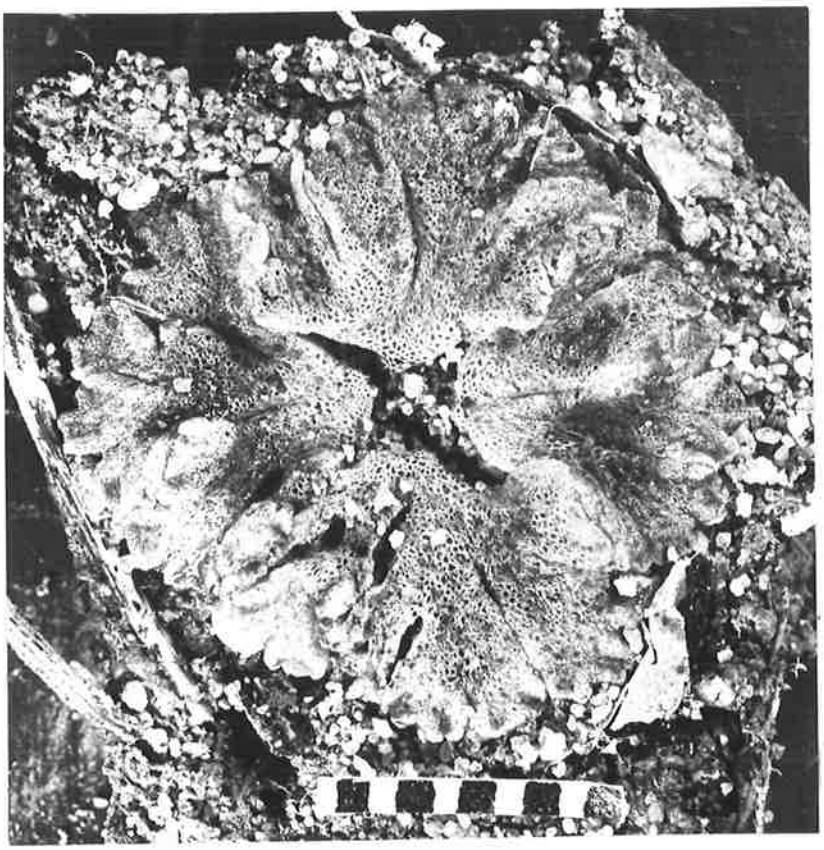
Specimens of *R. cavernosa* collected in South Australia exhibit a degree of variability in thallus morphology, particularly in size and colour. The distinctive features of the species are the pigmentation of the upper surface of the thallus and the morphology of the spores.

FIGURE 5.53

Riccia cavernosa Hoffm. emend Raddi

Variation in thallus form.

Scales in mm.



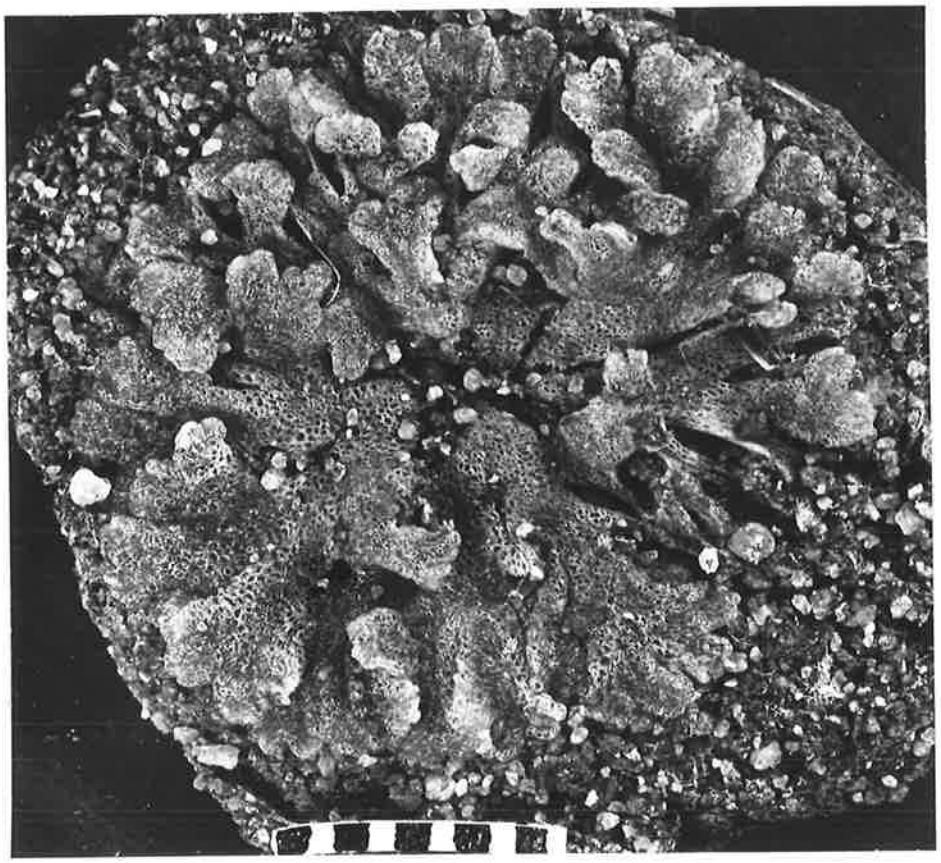
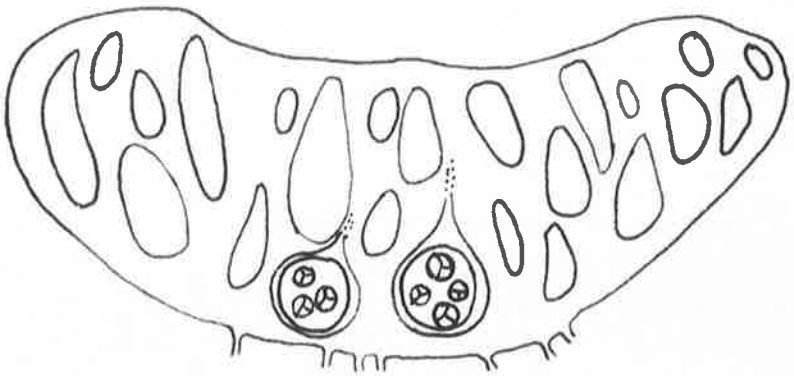


FIGURE 5.54

Transverse section of the thallus of *Riccia cavernosa*.



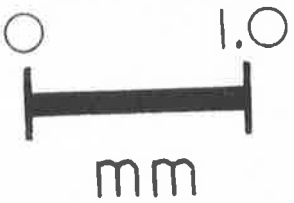
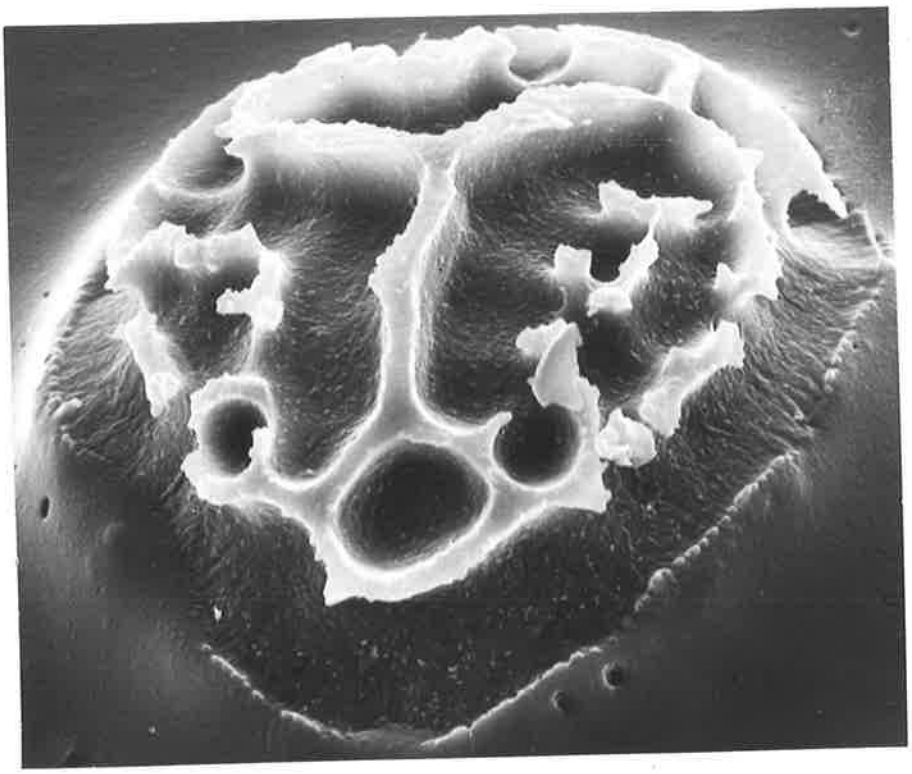

0
1.0
mm

FIGURE 5.55

Scanning electron micrographs of the spores of Riccia cavernosa.

a. Distal face

b. Proximal face



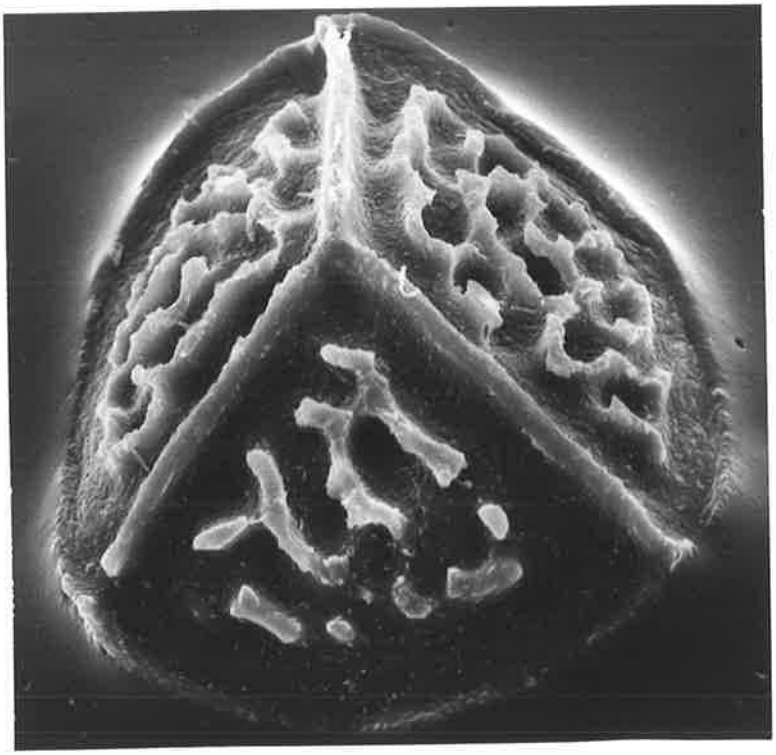
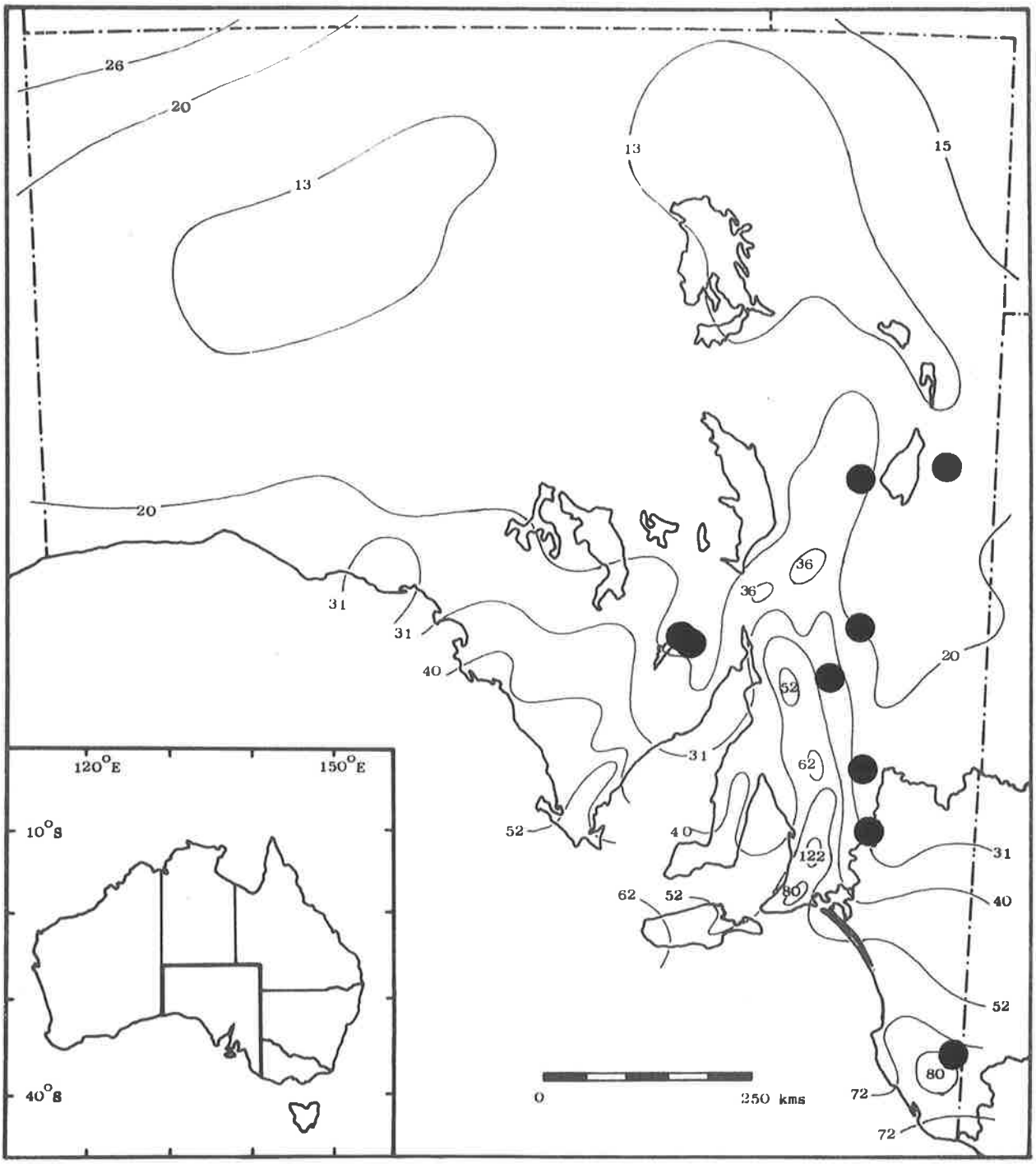


FIGURE 5.56

Distribution of collection localities of *Riccia cavernosa* in South Australia.

Rainfall isohyets give annual rainfall in cm.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52
80
72
72
120°E
150°E
10°S
40°S
0
250 kms

15. SPECIES OF UNCERTAIN TAXONOMIC STATUS.

Nine species of the subgenus *Ricciella* have been found in South Australia. Seven of these species are here regarded as being of uncertain taxonomic status. Two of the species, *R. multifida* Steph. and *R. duplex* Lorbeer have a long, narrow strap-like thallus and have not been found fertile in South Australia. However, sterile specimens which agree in form with specimens identified as *R. multifida* and *R. duplex* by Na-Thalang (1969) have been collected. The remaining five species, which have much broader and clearly spongiose thalli, probably belong to the following species: *R. spongiosa* Steph., *R. papulosa* Steph., *R. crassa* Steph., *R. muscicola* Steph., and *R. deserticola* Steph.

15.1 *Riccia multifida* Steph.

Stephani, F. 1889: 45.

Stephani, F. 1898: 365.

Synonym:

R. burnettensis Steph. 1898: 45-46. Na-Thalang, O. 1969: 187.

Holotype: West Ballender Ker Range, Queensland.

Coll: Karsten. MEL 19777.

Gametophyte (?) monoicous, forming rosettes in young stages, becoming gregarious. Thallus 5-15mm long, approximately 1mm broad. Upper surface with more or less distinct air chamber areas, green to light green. Channel narrow at apex, elsewhere flat. Branches bifurcate to multifurcate. Thallus segment narrowly linear.

Distribution:

South Australia: Comaum, south east of Naracoorte; Rules Swamp, south of Wrattenbully.

New South Wales: Queensland; Northern Territory; Western Australia.

Specimens Examined:

South Australia: Seppelt 2517, 2543, 2587, 2588.

Queensland: Holotype: West Ballender Ker Range,
Coll: Karsten. MEL 19777.

Discussion:

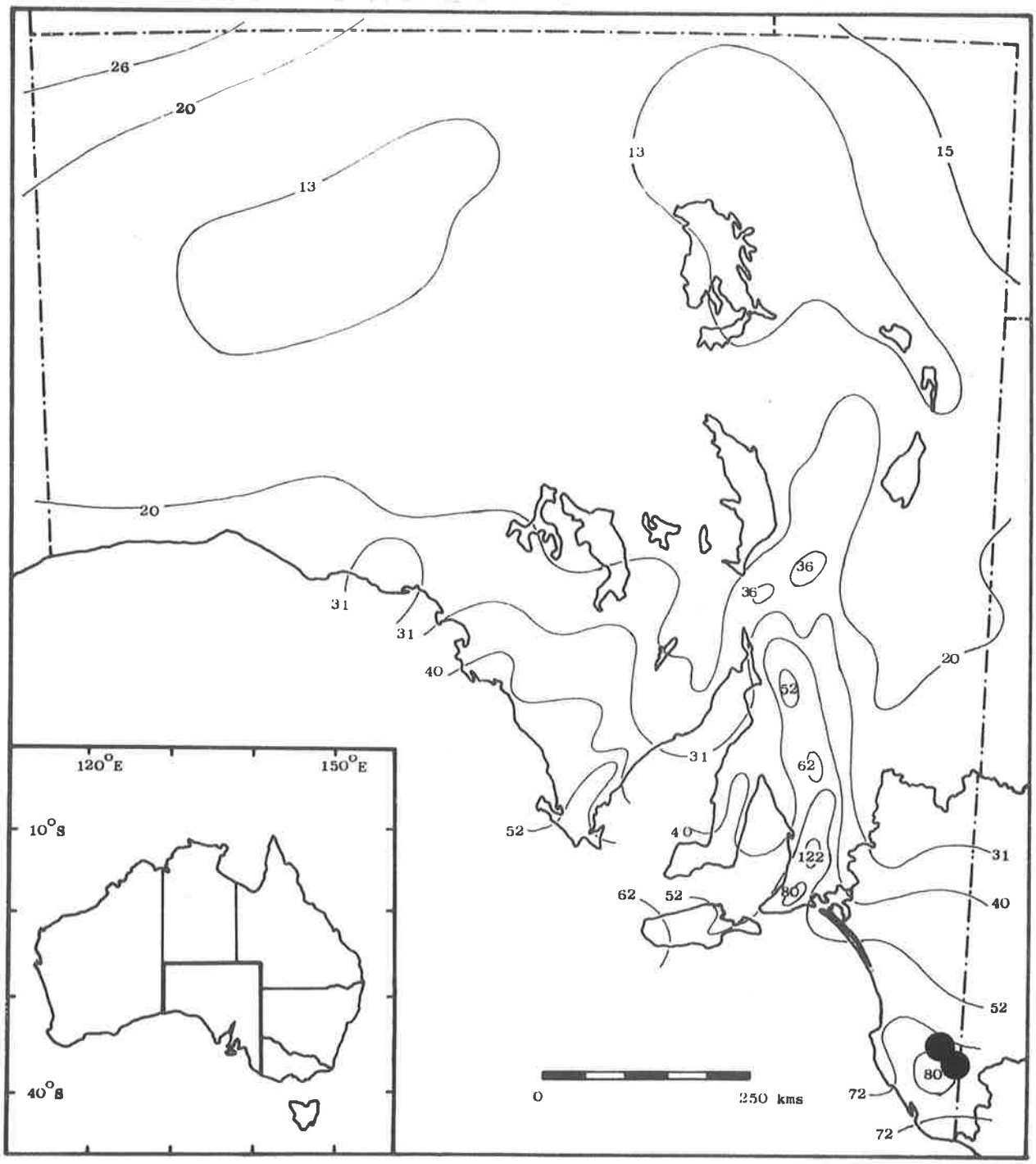
The species has only been collected in South Australia from the lower south east district. Unfortunately, it has not been found fertile in this State.

Stephani (1898) considered that the species was possibly dioicous. However, Na-Thalang (1969) described it as monoicous but made no reference to antheridia. She described the capsules as "single, prominent on ventral surface" and the spores as "65-100μ diameter; reticulate on both sides". South Australian plants have been compared with the holotype of *R. multifida* (MEL 19777) and although similar in thallus morphology, their identity cannot be confirmed until fertile specimens and mature spores are known.

FIGURE 5.57

Distribution of collection localities of *Riccia multifida* in South Australia.

Rainfall isohyets give annual rainfall in cm.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31
40
52
80
72
72
0
250 kms
120°E
150°E
10°S
40°S

15.2. *Riccia duplex* Lorbeer.

Müller, K. 1941: 90-118.

Rabenhorst, L. 1954: 429-430.

Arnell, S. 1956: 281.

Holotype: ?

Gametophyte monoicous, forming rosettes or more commonly in crowded circular patches. Thallus 10-20mm long, approximately 1mm broad. Upper surface not marked with air chamber areas, occasionally becoming cavernous towards base of thallus. Plants green to light green. Channel narrow at apex, elsewhere flat. Branches multifurcate. Thallus segment narrowly linear.

Distribution:

South Australia: Wilpena Pound; Mt. Crawford Pine Forest, near Williamstown; Comaum, south east of Naracoorte; Rules Swamp, south east of Wrattenbully; Penola; Glencoe.
New South Wales; Northern Territory; Victoria.

Specimens Examined:

South Australia: Seppelt 0329, 0378, 2458, 2531, 2577, 2633, 2659, 2931.
Victoria: R.J. Chinnock 195 (in AD).

Discussion.

Although this species has not been found fertile in South Australia, one fertile specimen (Chinnock 195) from Ballarat, Victoria, gave a spore diameter range of 105.0-125.0µm, with a wing width of 5.0-7.5µm, and 9-10 areolae across the diameter. The triradiate ridge was indistinct and the wing margin crenulate. Unfortunately,

the type specimen of *R. duplex* has not been located and South Australian plants have been tentatively placed as *R. duplex* following a comparison with specimens considered by Na-Thalang (1969) to be this species. In reference to her identification, Na-Thalang stated that "the type of *R. duplex* Lorb. has not been seen, but Müller's description is inadequate to decide that the Australian specimens are conspecific."

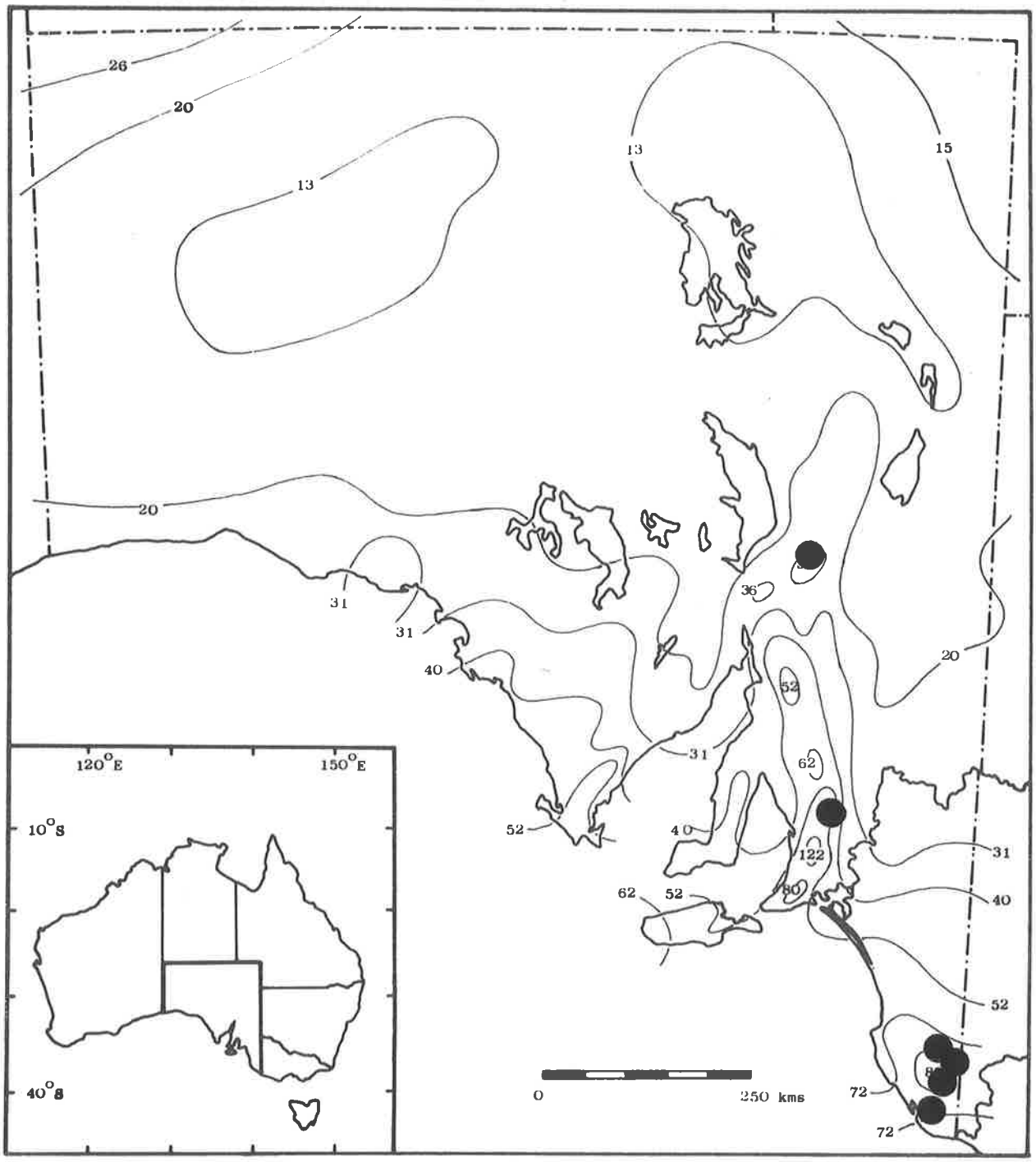
Paton (1973) has recently compared *R. canaliculata* Hoffm. and *R. duplex* Lorbeer and following a comparison of thallus dimensions, spore morphology and chromosome complement, she concluded that there was some uncertainty as to the taxonomic status of *R. duplex*.

A detailed comparative study of the *R. fluitans* group of species will be necessary to clarify the identity of *R. duplex* and other species of this group.

FIGURE 5.58

Distribution of collection localities of *Riccia duplex* in South Australia.

Rainfall isohyets give annual rainfall in cm.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72
72
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250 kms
120°E
150°E
10°S
40°S

15.3 *Riccia spongiosa* Steph.

Stephani, F. in litt. ad L. Levier, 1906.

Holotype: Jubbul, New South Wales.

Coll: W.W. Watts No. 144, 1903. NSW H 97.

Gametophyte monoicous, in gregarious patches. Thallus 8-12mm long, 4-6mm broad. Upper surface marked with distinct air chamber areas, plants green to whitish-green. Channel narrow and deep at apex, becoming broad and flattened towards base. Branches usually bifurcate, divergent. Thallus segment obcuneate to obovate-oblong, apex rounded, occasionally shortly bilobed. Margin of thallus acute. Scales small, hyaline, present only near apex. Capsules deeply embedded in thallus. Spores 82.5-110.0µm in diameter, dark brown; wing 2.5-8.75µm wide, with an uneven to finely crenate margin, distal face regularly reticulate, forming 10-12 areolae across the diameter; proximal faces similar to distal face, with a narrow, distinct triradiate ridge.

Distribution:

South Australia: Angorichina Gorge, northern Flinders Range; Wilpena Pound; Yourambulla Caves, south of Hawker; Warren Gorge, north of Quorn; Vivonne Bay, Kangaroo Island; near Kingscote Airport, Kangaroo Island; Archibald Makin Reserve, north of Keith; Christmas Rocks, 25Km south of Keith; Comaum Forest, south east of Naracoorte; Rules Swamp, south of Wrattenbully; Caroline Forest, near Mt. Gambier.

New South Wales.

Specimens Examined:

South Australia: Seppelt 0398, 0404, 0405, 0413, 0434, 0451, 0455, 0457, 0460, 0469, 0597, 0598, 2012, 2013, 2085, 2124, 2179, 2493, 2495, 2506, 2509, 2513, 2529, 2586, 2588, 2601. R.J. Chinnock 300A.

New South Wales: Holotype: NSW H 97. O Na-Thalang 31, 239.

Discussion.

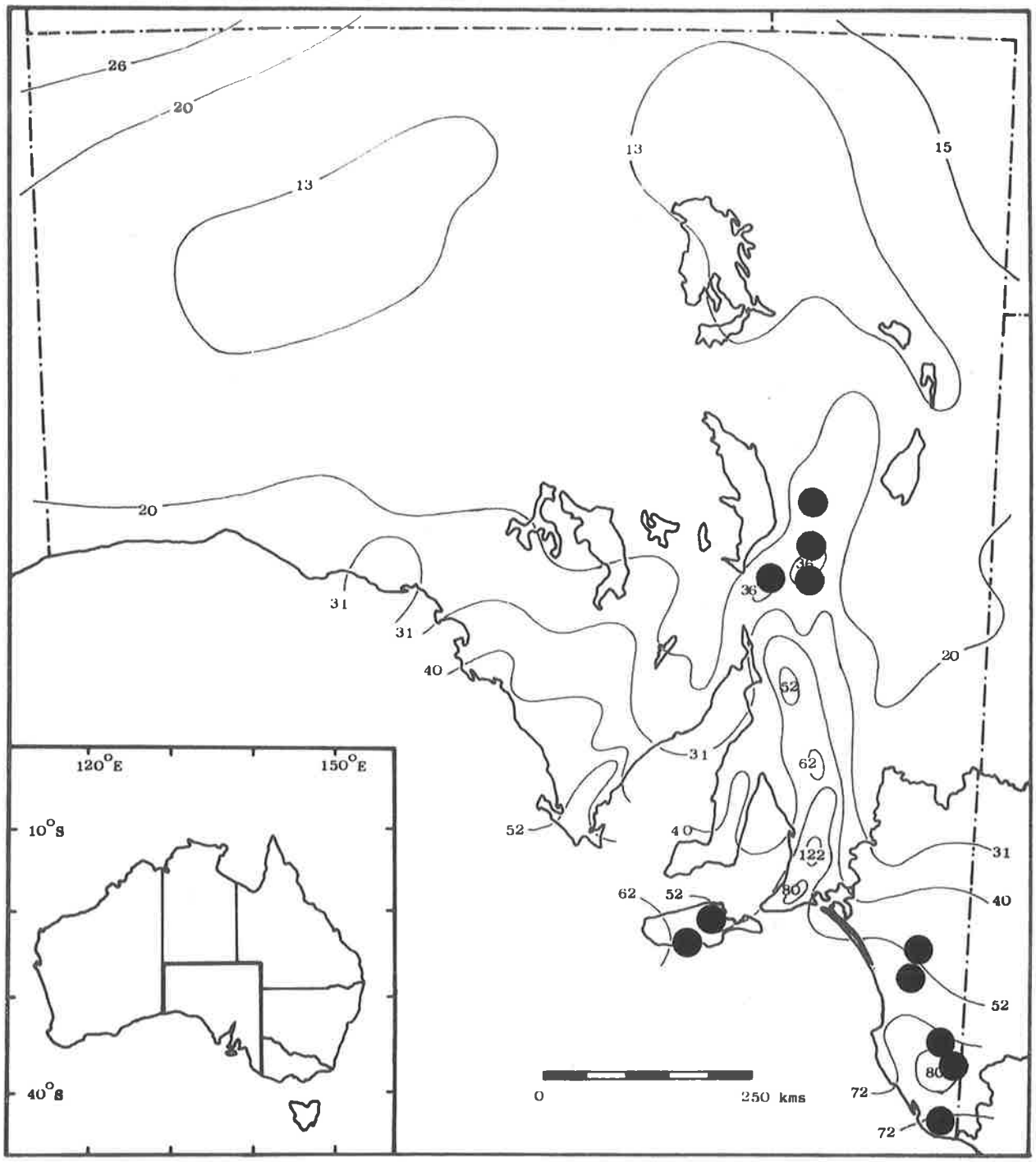
The specimen, firstly described by Stephani in a letter to Levier, was illustrated in the Icones Hepaticarum (IV, p. 388, fig. 14). This illustration has not been seen and the species has been tentatively identified following comparison with the type specimen and with specimens identified by Na-Thalang (1969).

The holotype (NSW H 97) bears no mature spores. Consequently it is difficult to verify the identity of specimens identified as *R. spongiosa* with the type specimen. However, South Australian specimens have a similar thallus morphology to that of the type specimen.

FIGURE 5.59

Distribution of collection localities of *Riccia spongiosa* in South Australia.

Rainfall isohyets give annual rainfall in cm.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120°E
150°E
10°S
40°S
0
250 kms

15.4 *Riccia papulosa* Steph.

Stephani, F. 1889: 45.

Stephani, F. 1898: 52.

Holotype: Silverton, Victoria. Coll: R.A. Bastow, 1888.

MEL 19776.

Gametophyte (?) monoicous, in part rosettes or occasionally forming rosettes. Thallus 8-20mm long, 3-6mm broad. Upper surface finely marked with air chamber areas, whitish-green to green. Channel narrow at apex, becoming broader and flatter towards base of thallus. Branches furcate to bifurcate. Thallus segment broadly oblong to obovate-oblong, apex rounded to truncate. Margin of thallus acute, attenuate. Scales small, hyaline, present only near apex.

Distribution:

South Australia: Wilpena Pound; Warren Gorge, north of Quorn; Tassie Creek, Corunna St., Iron Knob; Mt. Monster, 9Km south of Keith.

Victoria; Western Australia; New South Wales.

Specimens Examined:

South Australia: Seppelt 0391, 0452, 2727, 2728, 2786, 3170, 3184, 3288, 3308, 3322, 3326, 3328, 3329.

Western Australia: Narembeen, Coll: N. Marchant.

Victoria: Holotype: MEL 19776.

Discussion.

Spores of this species have not been found in specimens collected in South Australia. There are no mature spores in the type specimen (MEL 19776) and whilst South Australian specimens are similar to the holotype in thallus morphology, the identity of the specimens cannot be verified owing to the absence of spores.

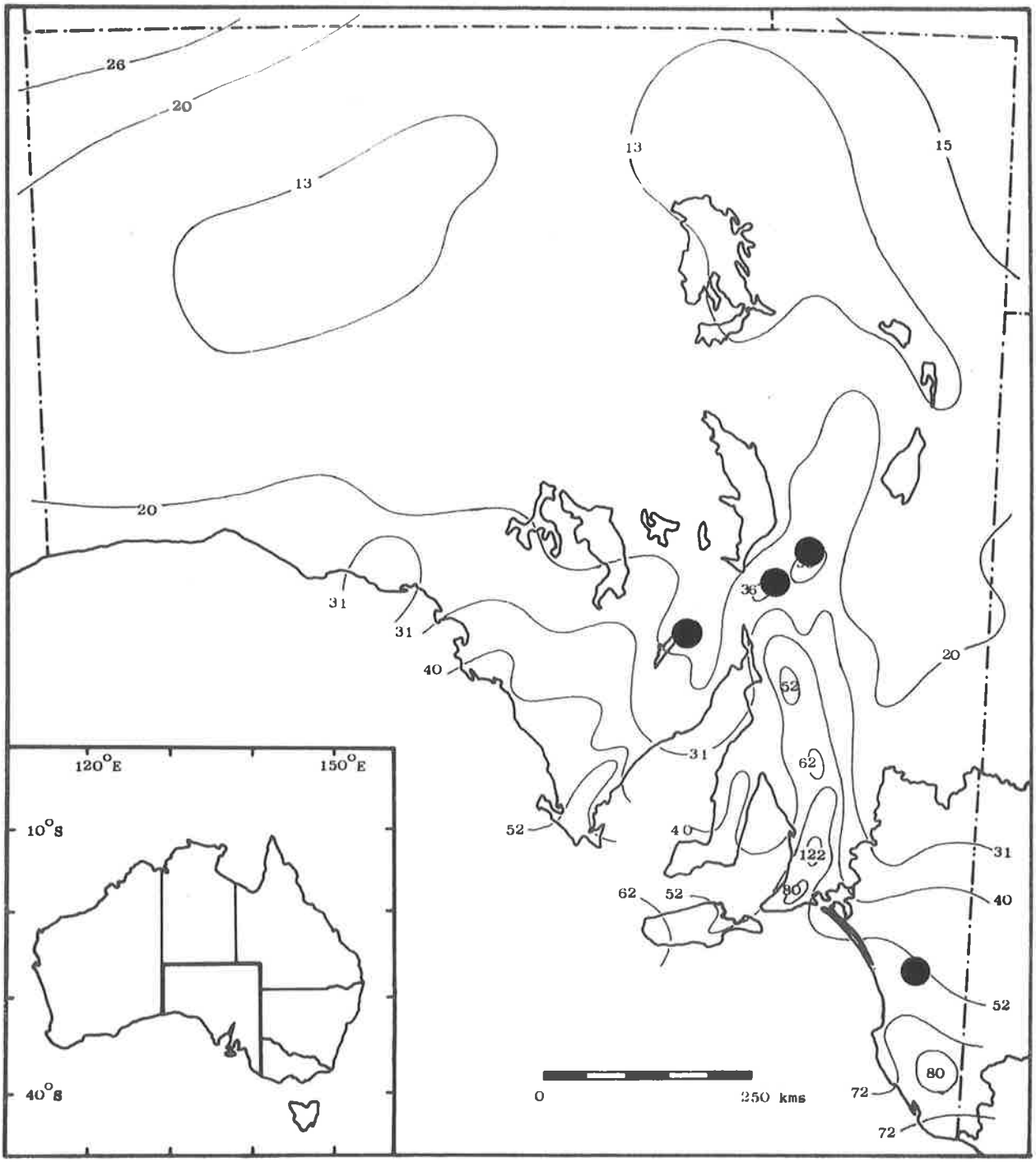
Na-Thalang (1969) gave the following data on spore morphology: "Spore 100-140µm, brown, almost rounded from distal face with or without wing; distal face finely reticulate forming 12-15 areolae across the diameter, areolae 5-6µm with a thick broad incompletely thickened border, ridges thick and short at the corners; proximal face with distinct triradiate mark or sometimes indistinctly marked".

Stephani (1898) considered this species to be dioicous whilst Na-Thalang (1969) reported the species to be monoicous. Stephani was not able to observe spores in the type specimen and may have been led to the conclusion that the species was dioicous. Na-Thalang (1969) reported "antheridia in two rows at both sides of the archegonia," and thus concluded that the species was monoicous. Neither antheridia nor archegonia have been observed in South Australian specimens.

FIGURE 5.60

Distribution of collection localities of *Riccia papulosa* in South Australia.

Rainfall isohyets give annual rainfall in cm.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120°E
150°E
10°S
40°S
0
250 kms

15.5 *Riccia crassa* Steph.

Stephani, F. 1898: 51.

Holotype: Arkaringa, South Au tralia, on clay pan.
Coll: R. Helms, 1891. G 12729.

Isotype: MEL 19765.

Gametophyte monoicous, forming incomplete rosettes. Thallus up to 10mm long, 2.5-3mm broad. Upper surface clearly marked with air chambers at apex, becoming cavernous towards base of thallus. Plants green, shining at apex. Channel narrow at apex, becoming flat towards base of thallus. Branches furcate, often shortly bilobed at apex. Thallus segment obcuneate-oblong, apex obtuse or rounded. Margin of thallus thick, acute to more or less obtuse. Scales small, hyaline, present only near apex. Spores 65.0-80.0µm in diameter, dark brown; wing 3.75-5.0µm wide, with an uneven margin, distal face regularly reticulate, forming 8-10 areolae across the diameter; proximal faces similar, with a distinct triradiate ridge.

Distribution:

South Australia: Arkaringa, west of Oodnadatta; near Port Augusta.

Specimens Examined:

South Australia: Holotype: Arkaringa on clay pan. Coll: R. Helms, 1891. G 12729.

Isotype: MEL 19765.

Discussion.

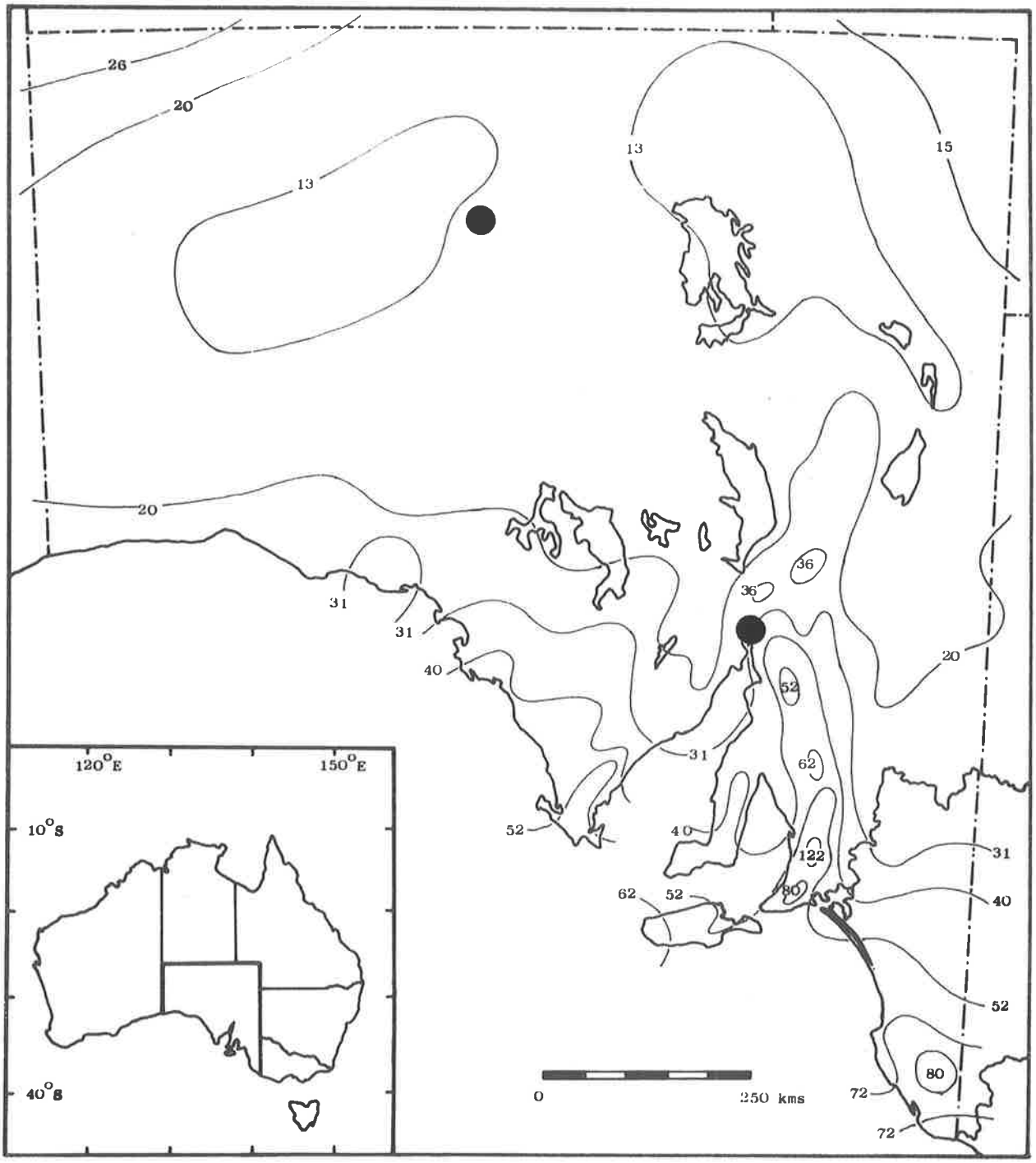
Na-Thalang (1969) considered *R. crassa* to be close to *R. deserticola* Steph. She reported that the spores of *R. crassa* were larger and that the areolae on the distal face were larger than those of the distal face of the spores of *R. deserticola*. Further, Na-Thalang stated that the thallus of *R. crassa* was more cavernous and shiny than that of *R. deserticola*.

Spore size and the number of areolae across the diameter of the spore have been shown to vary considerably under the influence of different environmental factors (see Discussion, Chapter 6). The cavernous nature of the upper surface of species of the subgenus *Ricciella* has also been shown to be a rather variable characteristic in South Australian specimens. In view of the variability shown in these thallus and spore characteristics, it is possible that *R. crassa* and *R. deserticola* may prove to be conspecific.

FIGURE 5.61

Distribution of collection localities of *Riccia crassa* in South Australia.

Rainfall isohyets give annual rainfall in cm.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250 kms
120°E
150°E
10°S
40°S

15.6. *Riccia muscicola* Steph.

Stephani, F. 1885:

Stephani, F. 1898: 38.

Holotype: ? G.

Gametophyte (?) monoicous, forming large rosettes or part rosettes. Thallus 10-20mm long, 3-4mm broad. Upper surface clearly marked with air chambers, green to yellowish-green, often pigmented towards base of thallus. Channel narrow and deep at apex, becoming flatter towards base of thallus. Branches furcate to bifurcate or occasionally trifurcate. Thallus segment oblong, apex rounded to truncate, occasionally shortly bilobed. Margin of thallus acute, attenuate. Scales hyaline, extending along thallus margins, not restricted to apex.

Distribution:

South Australia: Wilpena Pound; Mt. Monster, 9Km south of Keith.

New South Wales.

Specimens examined:

South Australia: Seppelt 2800, 2918, 2926, 2930, 2933, 2957, 2960, 3006, 3007, 3008, 3021, 3042, 3052, 3062, 3063.

Discussion:

The type specimen of the species has not been seen and specimens have been identified tentatively sensu Na-Thalang. South Australian specimens have not been found with mature spores. Na-Thalang (1969) described the spores as: "70-85µm, rarely up to 100µm, yellow brown, irregular in form with a

crenate wing 4-6μm wide; distal face regularly reticulate forming 7-9 angular areolae across the diameter each 10-15μm wide, the border of areola thin and low sometimes incomplete, raised up at the corners; proximal face with distinct triradiate ridge, therest being roughened by less distinct areolae and scattered high ridges."

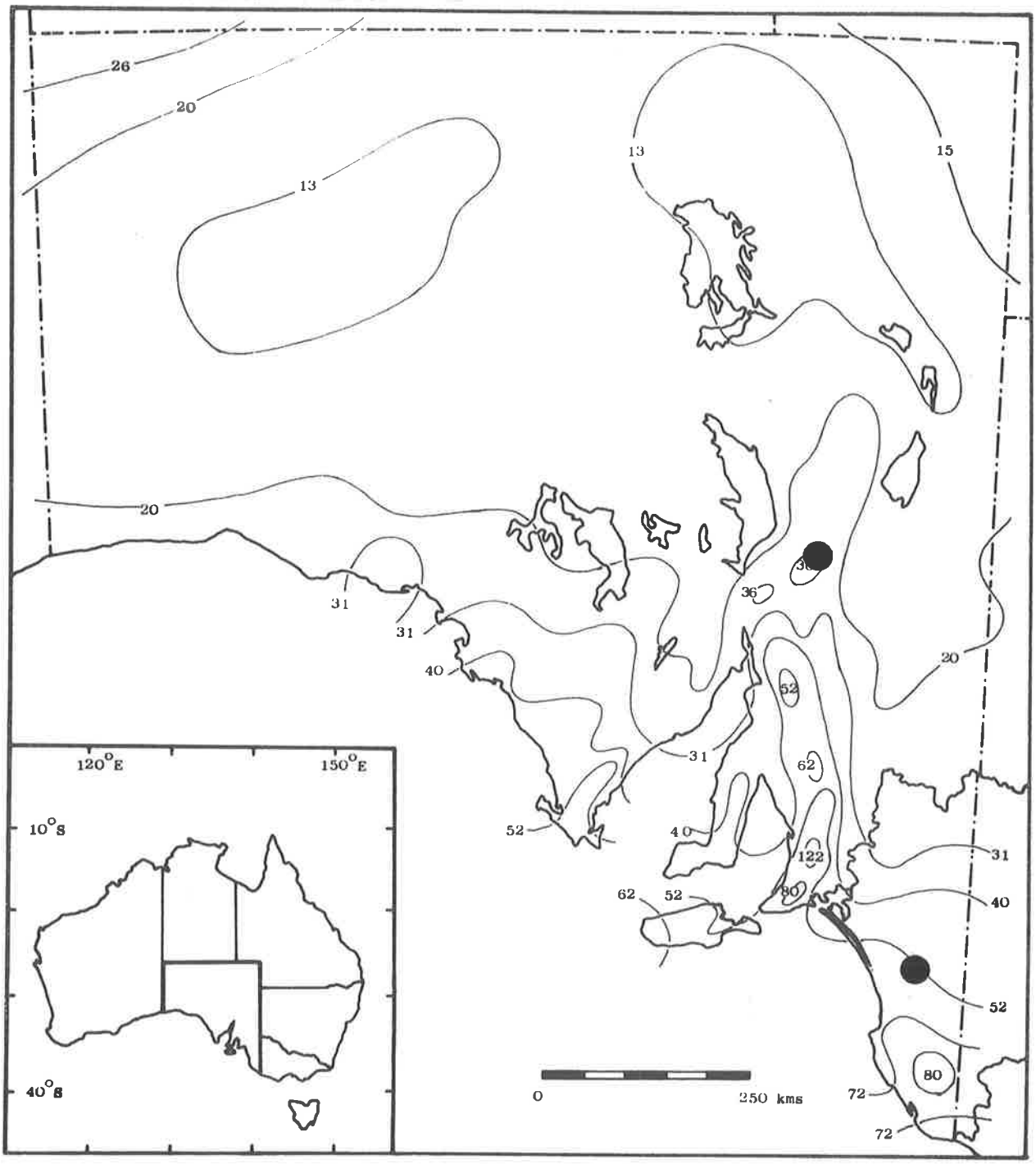
Stephani (1898) described the spores as being 60μm in dismeter with a broad wing, and having the surface densely lamellate, the lamellae (ridges) regularly branched (areolate). He also considered the species to be dioicous. However Na-Thalang (1969) considered the species as monoicous having "archegonia in single or alternate rows along the furrow with antheridia at both sides." Observations on specimens collected in South Australia and tentatively identified as this species would support the findings of Na-Thalang.

Specimens identified as *R. muscicola* exhibit considerable variation in thallus features. A comparison of these specimens with the type specimen will be necessary in order to clarify the taxonomy of the species.

FIGURE 5.62

Distribution of collection localities of *Riccia muscicola* in South Australia.

Rainfall isohyets give annual rainfall in cm.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150°E
10°S
40°S
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250 kms

15.7. *Riccia desertiocola* Steph.

Stephani, F. 1898: 48.

Holotype: Arco-eillina Well, Everard Range, South Australia. Coll: R. Helms, 1891. G 12650.

Isotype: MEL 19766.

Gametophyte monoicous, in compact patches. Thallus 10-15mm long, 3-5mm broad. Upper surface with distinct air chambers, pale green. Channel narrow at apex, becoming flat towards base of thallus. Branches furcate to bifurcate, divergent. Thallus segment oblong to obovate-oblong, apex rounded. Margin of thallus obtuse, thick. Spores 57.5-77.5µm in diameter, brown; wing 1.25-5.0µm wide, with a more or less crenate to uneven margin; distal face regularly areolate, forming 6-8 areolae across the diameter; proximal faces similar, with a more or less distinct triradiate ridge.

Distribution:

South Australia: Arco-eillina Well, Everard Range.

Northern Territory; Western Australia.

Specimens Examined:

South Australia: Holotype: Arco-eillina Well, Everard Range. Coll: R. Helms. 1891. G 12650. Isotype: MEL 19766.

Northern Territory: MEL 19706, 19798, 19800.

Western Australia: Northampton Gorge, Coll: G.G. Smith, 1964.

Discussion.

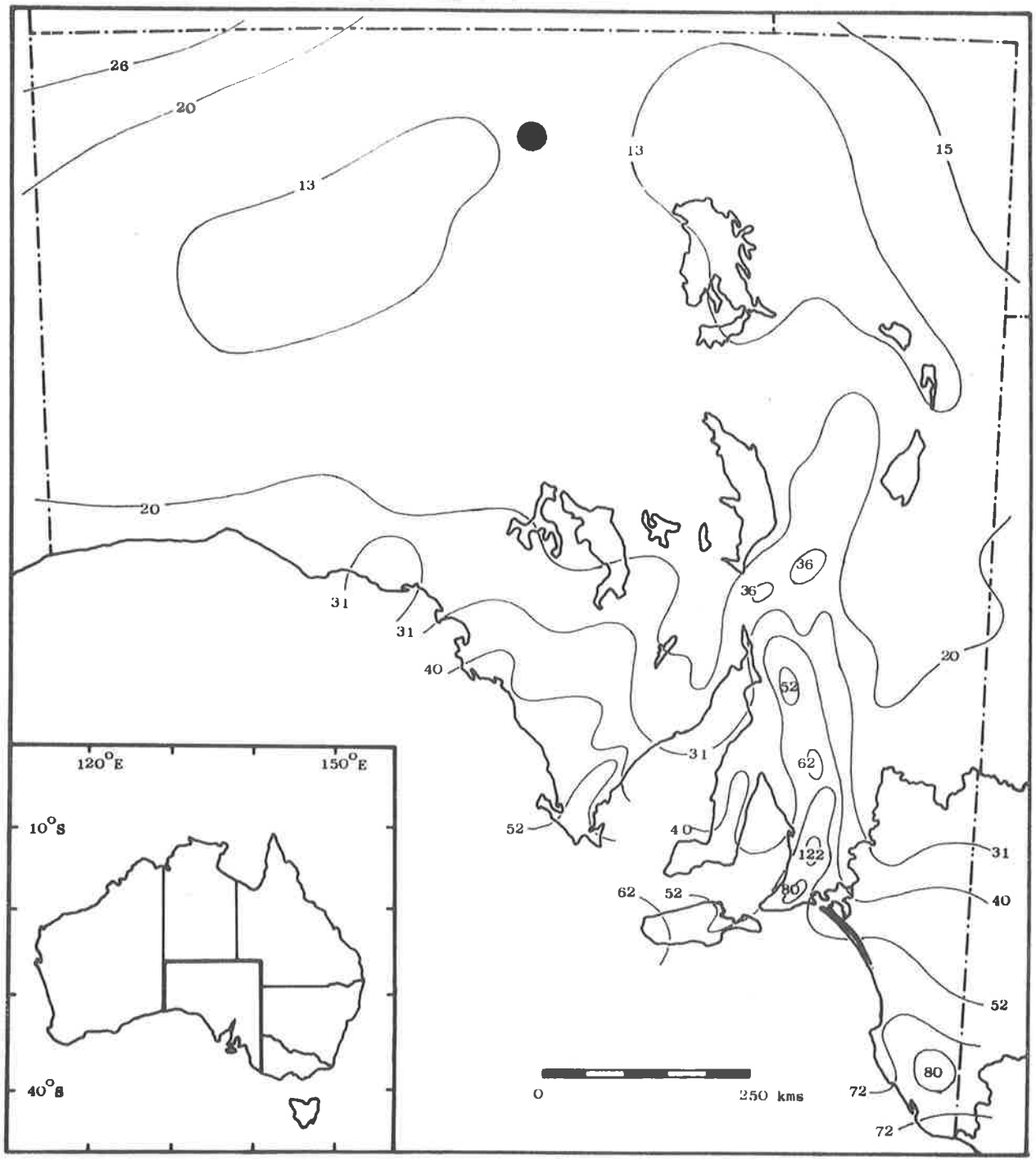
Na-Thalang (1969) considered *R. deserticola* to be close to *R. crassa* with the spores of *R. deserticola* being smaller and having smaller areolae on the distal face than *R. crassa*. However, plants identified respectively as *R. crassa* (MEL 19765) and *R. deserticola* (MEL 19766) have spores similar in both size and morphology.

It is thus clear that further studies are necessary to clarify the identity and the spore characteristics of plants referred to these taxa.

FIGURE 5.63

Distribution of collection localities
of Riccia deserticola in South Australia.

Rainfall isohyets give annual rainfall
in cm.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120°E
150°E
10°S
40°S
0
250 kms

CHAPTER SIX.

SPORE MORPHOLOGY.

Introduction.

The spores of Hepaticae vary greatly in size, from less than 10μm (e.g. *Marsupella, Lophocolea*) to more than 150μm in diameter (e.g. *Riccia, Exormotheca*). Variation is also found in the form, architecture and sculpturing patterns of the coat, colour, and manner of emergence of the sporeling on germination (Schuster, 1966).

Three general strata are usually distinguished as forming the spore wall. These are the endospore (intine), the inner layer; the exospore (exine), the outer layer; and the outer exospore (perineum), which lies on the surface of the exospore and represents the remnants of the old spore mother cell.

The sculpturing of the exospore may be used as a diagnostic feature to identify the family or genus of the spore, or sometimes even the species or smaller taxonomic unit (Erdtman, 1969). Erdtman further stated that "in some plants, certain inherent differences are expressed less clearly in the general appearance of the individuals than in the size and form of their spores or pollen grains". Observations on thallus and spore morphology of specimens of *Riccia* collected in South Australia have shown that whilst thallus morphology may vary considerably under different environmental conditions, spore morphology remains relatively constant. Much emphasis has therefore been placed on spore morphology in this study in order to clarify the taxonomy of the species occurring in South Australia, and in an attempt to assess the reliability of this character in taxonomy.

It is now generally accepted that an adequate species description must include reference to spore morphology. Much of the present taxonomic uncertainty within the genus *Riccia* has been due to lack of reference to this feature in earlier descriptions and the absence of mature spores in some type specimens.

Spore size, shape, colour, sculpturing, wing width and wing margin characteristics have been used in this study. Of these, spore sculpturing has been found to be the least variable and consequently the most useful feature for taxonomic purposes. Spore morphology is of particular taxonomic use for dried specimens in which thallus has become more or less distorted on drying and difficult to restore. However, for reliable identification of taxa spore morphology must, in most instances, be used in association with features of thallus morphology.

The four spores which result from meiosis of the spore mother cell are arranged in a tetrahedral formation. In species producing more or less globular spores (e.g. *R. albida, R. macrospora*) the developing spores possibly separate quite early in their development. However, in most species the developing spores remain united until maturity. Each spore enlarges asymmetrically to form a rounded distal face and a trilete proximal surface with an often distinct triradiate ridge marking the position of attachment of adjacent spores. In four species, *R. arnellii, R. compacta, R. curtisii* and *R. perssonii,* the spores remain permanently united in tetrads. Spore development and formation of the spore wall has been studied by Leitgeb (1884), Beer (1906), and Goebel (1930).

Schuster (1966) suggested that spore size in the Hepaticae could be linked, at least in part, with phylogeny, and that small (6-18μm) and numerous spores could be regarded as primitive. In *Riccia* and *Sphaerocarpos*, which have large spores (30-200μm), spore size is thought to be secondarily derived and in part related to spore number (Schuster, 1966). A detailed study of spore morphology of *Riccia crystallina* in South Australia has shown that spore size in this species is in part related to environmental features such as mean annual rainfall.

Spore size in the genus *Riccia* falls within the large (50-100μm) and very large (100-200μm) diameter categories of Erdtman (1965). Of the species known for South Australia the smallest spores are found in *R. crystallina* (52.5-92.5μm) whilst the largest spores occur in *R. limbata* (92.5-150.0μm). A summary of spore diameter range and wing width for the South Australian species is given in Table 6.1. These figures are based on observations made on specimens from South Australia, unless otherwise stated, and are not necessarily reliable for specimens from other localities.

TABLE 6.1

Spore diameter range and wing width of species of *Riccia* collected in South Australia.

	Diameter range µm	Wing width µm
R. crinita	77.5 - 137.5	3.75 - 7.5
R. asprella	80.0 - 142.5	5.0 - 10.0
R. crozalsii	65.0 - 105.0	2.5 - 5.0
R. nigrella	62.5 - 92.5	1.5 - 6.25
R. limbata	92.5 - 150.0	5.0 - 10.0
R. macrospora	100.0 - 140.0	wingless
R. albida	87.5 - 115.0	wingless
R. bifurca	67.5 - 97.5	2.5 - 5.0
R. marginata	62.5 - 97.5	2.5 - 6.25
R. sorocarpa	65.0 - 122.5	2.5 - 7.5
R. rorida	62.5 - 102.5	2.5 - 7.5
R. lamellosa	82.5 - 127.5	3.75 - 7.5
R. crystallina	52.5 - 92.5	3.75 - 8.75
R. cavernosa	90.0 - 112.5	2.5 - 7.5
* *R. multifida*	65.0 - 100.0	3.0 - 5.0
** *R. duplex*	105.0 - 125.0	5.0 - 7.5
R. spongiosa	82.5 - 110.0	2.5 - 8.75
* *R. papulosa*	100.0 - 140.0	2.0 - 3.0
R. crassa	65.0 - 80.0	3.75 - 5.0
* *R. muscicola*	70.0 - 85.0	4.0 - 6.0
R. deserticola	57.5 - 77.5	1.25 - 5.0

* data ex Na-Thalang (1969).

** specimen from Victoria.

A discussion of the value of spore morphology in clarifying the taxonomy of the species of *Riccia* yet found in South Australia follows.

Spore Morphology and Synonymy of *Riccia crinita*.

In her studies of the genus *Riccia* in Australia Na-Thalang (1969) recorded a total of six ciliate species including three species proposed as new and one species not previously recorded in Australia. These species were placed by her in two sections within the "Ciliata" group. In one group, characterized by long cilia and the capsule bearing cilia, she placed *R. longiciliata* Na-Thalang (proposed), *R. areolata* Na-Thalang (proposed) and *R. crinita* Tayl. In the other group, with short cilia and the capsule not bearing cilia, she placed *R. crozalsii* Levier, *R. asprella* Carr. et Pears., and *R. blackii* Na-Thalang (proposed).

Specimens of species belonging to the former group and collected in South Australia have been critically studied and compared with type and isotype specimens of *R. longiciliata*, *R. areolata* and *R. crinita* with special emphasis on spore morphology.

A summary of the results of measurements of spore diameter and wing width, the number of areolae across the diameter of the distal face of the spore, mean diameter and standard deviation, of specimens of *R. crinita* collected in South Australia are given in Table 6.2.

A comparison of similar features of *R. longiciliata*, *R. areolata* and *R. crinita*, as recognized by Na-Thalang, are given in Table 6.3.

It can be seen from Table 6.2 that for *R. crinita* the range of diameter for spores from a single capsule, the number of areolae across the diameter and wing width vary considerably, even between capsules from the same plant. Particular consideration has been

given to the variation in the number of areolae across the diameter of the spore. Na-Thalang (1969) used this feature as one of the major criteria for separation of the long-ciliate species (see Table 6.3). Variation also exists in the nature of the wing margin and the distinctness of the triradiate ridge on the proximal face of the spore.

Type specimens of *R. longiciliata* and *R. areolata* could not be found at the New South Wales National Herbarium (NSW). Hence isotype material of *R. areolata* from the John Ray Herbarium (SYD) was examined and spores of this material were found not to match those of the type description. Isotype spores of *R. areolata* (Na-Thalang 236) ranged from 67.5 to 97.5µm in diameter, with 6-11 areolae across the diameter, with a finely crenate margin (compare Table 6.3).

Two further herbarium packets labelled as containing *R. longiciliata* (Na-Thalang 100) were examined. Both packets containly only a few sterile thallus lobes of a long-ciliate species whilst the remainder of the material in each packet was *R. albida*. One of the packets, labelled "*Riccia albida* Sull. (with *R. longiciliata*)" was also marked "Isotype", whilst the second packet was labelled "*Riccia albida* Sull. and *Riccia longiciliata* sp. nov." A search at the New South Wales National Herbarium (NSW) and the John Ray Herbarium (SYD) failed to locate a specific holotype packet of *R. longiciliata*.

In addition to the similarity of *R. crinita*, "*R. longiciliata*" and "*R. areolata*" in spore morphology, long-ciliate specimens collected in South Australia have shown a considerable degree of variability in thallus morphology. Na-Thalang (1969) described

R. longiciliata as having a dorsal channel narrow throughout, a condition she considered this species to share with *R. crinita*. *Riccia areolata* was described as having a dorsal channel narrow at the apex and broad elsewhere. Specimens have been found in South Australia having a narrow channel throughout on one branch of a dichotomy whilst the other branch had a channel narrow at the apex and broad elsewhere. It has become apparent that in immature thalli the channel is narrow and that as the capsule develops and increases in size the channel becomes broad. Failure to recognize this aspect of developmental morphology has resulted in confusion of the species.

Na-Thalang (1969) obtained a chromosome number of n = 8 for both *R. crinita* and *R. areolata* whilst the chromosome number of *R. longiciliata* was determined as n = 16. Haploid - diploid species pairs in *Riccia* are well known (Berrie, 1964), and also in other hepatics (Schuster, 1966). A doubling of the chromosome complement can not be taken as a criterion for separation of species (Schuster, 1966).

As a result of the detailed investigation of both thallus and spore morphology undertaken in this study it is clear that both *R. longiciliata* Na-Thalang (proposed) and *R. areolata* Na-Thalang (proposed) should be regarded as synonymous with *R. crinita* Tayl.

TABLE 6.2

Spore characteristics of specimens of *R. crinita* Tayl. collected in South Australia.

Herbarium No.	Locality	Spore diam. µm	Mean diam. µm	s.d.	Wing Width µm	Areolae distal face
Seppelt 0472	Tassie Creek	77.5 - 120.0	96.86	9.23	3.75 - 7.5	8 - 10
0472	" "	77.5 - 115.0	99.96	7.20	2.5 - 6.25	9 - 12
0472	" "	77.5 - 105.0	92.96	6.38	2.5 - 7.5	8 - 11
0480	" "	80.0 - 100.0	91.78	4.18	2.5 - 7.5	9 - 12
2410	" "	80.0 - 107.5	93.14	5.38	5.0 - 7.5	10 - 12
3067	Wilpena Pound	102.5 - 125.0	113.94	4.66	5.0 - 7.5	9 - 12
3067	" "	102.5 - 137.5	120.19	6.21	6.25 - 7.5	9 - 11
3070	" "	87.5 - 112.5	106.89	6.59	5.0 - 6.25	10 - 13
3053	" "	105.0 - 132.5	119.85	5.37	6.25 - 7.5	11 - 13
3068	" "	105.0 - 130.0	118.18	6.10	5.0 - 6.25	9 - 13
3231	Pichi Richi Pass	92.5 - 112.5	102.16	3.85	5.0 - 7.5	8 - 10
3231	" "	80.0 - 105.0	89.05	5.20	3.75 - 5.0	8 - 10

TABLE 6.3

Spore characteristics of *R. longiciliata*, *R. areolata* and *R. crinita* (after Na-Thalang, 1969).

	R. longiciliata	*R. areolata*	*R. crinita*
Spore diam. µm	70 - 100	55 - 85	55 - 85
Wing width µm	2 - 3	3 - 4	2 - 4
Wing margin	almost entire	smooth	slightly crenate
Areolae, distal face	9 - 10	5 - 9	10 - 12
Triradiate ridge	distinct	distinct	faint

Spore Variability of *Riccia asprella*.

A study of spore morphology of this species in South Australia has shown that spore diameter, wing width and the number of areolae across the diameter of each spore varies considerably (Table 6.4), although measurements have been taken from only three South Australian specimens. Although it has not been possible to determine a relationship between mean spore diameter and environmental factors, such as mean annual rainfall (see later discussion of *R. nigrella* and *R. crystallina*), the mean diameter of spores from a specimen collected in the south eastern district of the State at Comaum (annual rainfall approximately 60.00cm) is significantly larger than the mean diameter of spores from specimens collected in the north of the State at Wilpena (annual rainfall 36.60cm).

The mean diameter of the spores of the South Australian specimens is significantly larger than the mean diameter of spores from specimens collected at Coonabarrabran, New South Wales (Table 6.4). Na-Thalang (1969) recorded a spore diameter range of 90-100μm for New South Wales specimens and a range of 6-7 areolae across the diameter of the spores. South Australian specimens have a range of 6-15 areolae across the diameter of the spores with a range of diameter of 30-40μm for spores from within a single capsule.

Riccia californica Aust. is similar in thallus morphology to *R. asprella*. However, an examination of the spores of the holotype of the former species (G16099) revealed a spore diameter range of 47.5-57.5μm ($\bar{x}$ = 52.69, s.d. = 2.80) with a wing width of 2.5-3.75μm. The borders of the areolae of *R. californica* are narrower than those of *R. asprella* and raised at the corners forming papillae. Thus on the basis of spore morphology these two species are clearly distinct.

TABLE 6.4.

Spore characteristics of *R. asprella*.

Herbarium No.	Locality	Spore diam. µm	Mean diam. µm	s.d.	Wing width µm	areolae distal face
Seppelt 0403	Wilpena Pound	85.0 - 127.5	107.16	8.85	5.0 - 10.0	7 - 15
2932	" "	95.0 - 125.0	111.44	7.60	5.0 - 10.0	12 - 14
2544	Comaum Forest	112.5 - 142.5	121.06	10.58	6.25 - 8.75	6 - 10
Na-Thalang 210	Coonabarrabran NSW	77.5 - 102.5	90.57	5.95	3.75 - 6.25	6 - 10

Similarity of the spores of *R. crozalsii* and *R. bifurca*.

The thallus of *R. crozalsii* bears cilia at the apex and often along the margin whilst that of *R. bifurca* is non-ciliate. Arnell (1956) reported that a few cilia were found on the margins of the thallus of *R. bifurca* var. *subinermis*. Frye and Clark (1937-47) considered that occasional specimens of *R. bifurca* bore marginal cilia. Further similarity of the thallus morphology between *R. crozalsii* and *R. bifurca* is found in the rather rounded, elevated thallus margins which are often pigmented.

A study of spore morphology revealed that the spores of these species were closely similar in diameter, wing width and the number of areolae across the diameter of each spore (Tables 6.5, 6.6). Frye and Clark (1937-47) recorded a spore diameter of 68-115µm and a wing width of 3-12µ for North American specimens of *R. bifurca*, whilst Pearson (1902) obtained a spore diameter of 95-100µm for British Isles specimens of this species. Muller, in Rabenhorst (1906-11), recorded a spore diameter of 80-90(100)µm with 6-8 areolae across the diameter of each spore for European specimens of *R. bifurca* and a spore diameter of 70-80µm with 8-12 areolae across the spore diameter for European specimens of *R. crozalsii*. Zodda (1934) gave a spore diameter of 75-95µm for *R. bifurca* and 70-90µm for *R. crozalsii* in Italy. MacVicar (1926) recorded a spore diameter of 75-90µm for *R. bifurca* and 65-80µm for spores of *R. crozalsii* in Britain. From these previously published findings it can be seen that the spores of these two species are similar in these features. It is also clear that specimens collected in South Australia are similar in spore morphology to European and North American specimens. Scanning electron micrographs of the spores of *R. crozalsii* (Fig. 5.11) and *R. bifurca* (Fig. 5.31) further reveal the similarity of the spores of these two species.

One of the most significant findings of this study of spore morphology of *R. crozalsii* and *R. bifurca* is that in South Australia these two species appear to be conspecific.

TABLE 6.5.

Spore characteristics of *R. crozalsii.*

Herbarium No.	Locality	Spore diam. µm	Mean diam. µm	s.d.	Wing width µm	areolae distal face
Seppelt 3537	Urrbrae	65.0 - 92.5	79.24	5.42	2.5 - 5.0	9 - 11
3537	"	70.0 - 90.0	80.19	4.14	3.75 - 5.0	8 - 9
3537	"	77.5 - 105.0	94.51	6.16	3.75 - 5.0	10 - 13

TABLE 6.6.

Spore characteristics of *R. bifurca.*

Herbarium No.	Locality	Spore diam. µm	Mean diam. µm	s.d.	Wing width µm	areolae distal face
Seppelt 2542	Tarnma	60.0 - 77.5	68.94	3.95	2.5 - 5.0	9 - 10
0262	Seppeltsfield	70.0 - 95.0	82.99	6.25	3.75 - 7.5	8 - 10
0361	Eagle on Hill	67.5 - 97.5	84.24	6.16	2.5 - 3.75	8 - 10
0362	" "	72.5 - 90.0	82.31	4.14	2.5 - 5.0	8 - 9
0362	" "	72.5 - 95.0	83.79	4.03	2.5 - 3.75	8 - 10
2539	Comaum Forest	72.5 - 95.0	84.89	6.18	3.75 - 5.0	6 - 12
2539	" "	70.0 - 95.0	83.33	5.14	2.5 - 6.25	6 - 10
2539	" "	57.5 - 92.5	67.42	5.42	3.75 - 6.25	7 - 8
Na-Thalang 45	Barralier, NSW.	72.5 - 87.5	79.66	3.82	2.5 - 5.0	8 - 10

Spore Characteristics of *R. nigrella.*

A summary of the data on spore morphology for this species is given in Table 6.7.

The spore diameter obtained for specimens of *R. nigrella* in South Australia is similar to that of specimens examined from New South Wales. Further, the diameter of the spores is similar to that given by Pearson (1902) of 50-75µm for specimens from the British Isles, 60-80µm for European specimens (Muller, in Rabenhorst 1906-11), 58-75µm for British specimens (MacVicar 1926), 60-80µm for Italian specimens (Zodda 1934), and 60-90µm for North American specimens (Frye and Clark 1937-47).

A regression analysis of the form $y = a + bx$ was performed on a plot of mean spore diameter versus mean annual rainfall (Fig. 6.2).

The significance of the regression analysis was tested using the equation

$$t = \frac{b - \beta}{\sigma b}$$

where $\beta = 0$.

Therefore $$t_{10} = \frac{2.0479}{0.3047}$$

$$t_{10} = 6.6121$$

$$t_{10} << 0.001$$

It is therefore apparent that a positive correlation exists between mean spore diameter for spores from a single capsule and mean annual rainfall, such that an increase in mean spore diameter is associated with an increase in mean annual rainfall.

FIGURE 6.1

Mean spore diameter of spores from single capsules plotted against mean annual rainfall at collection localities of specimens of *Riccia nigrella* in South Australia.

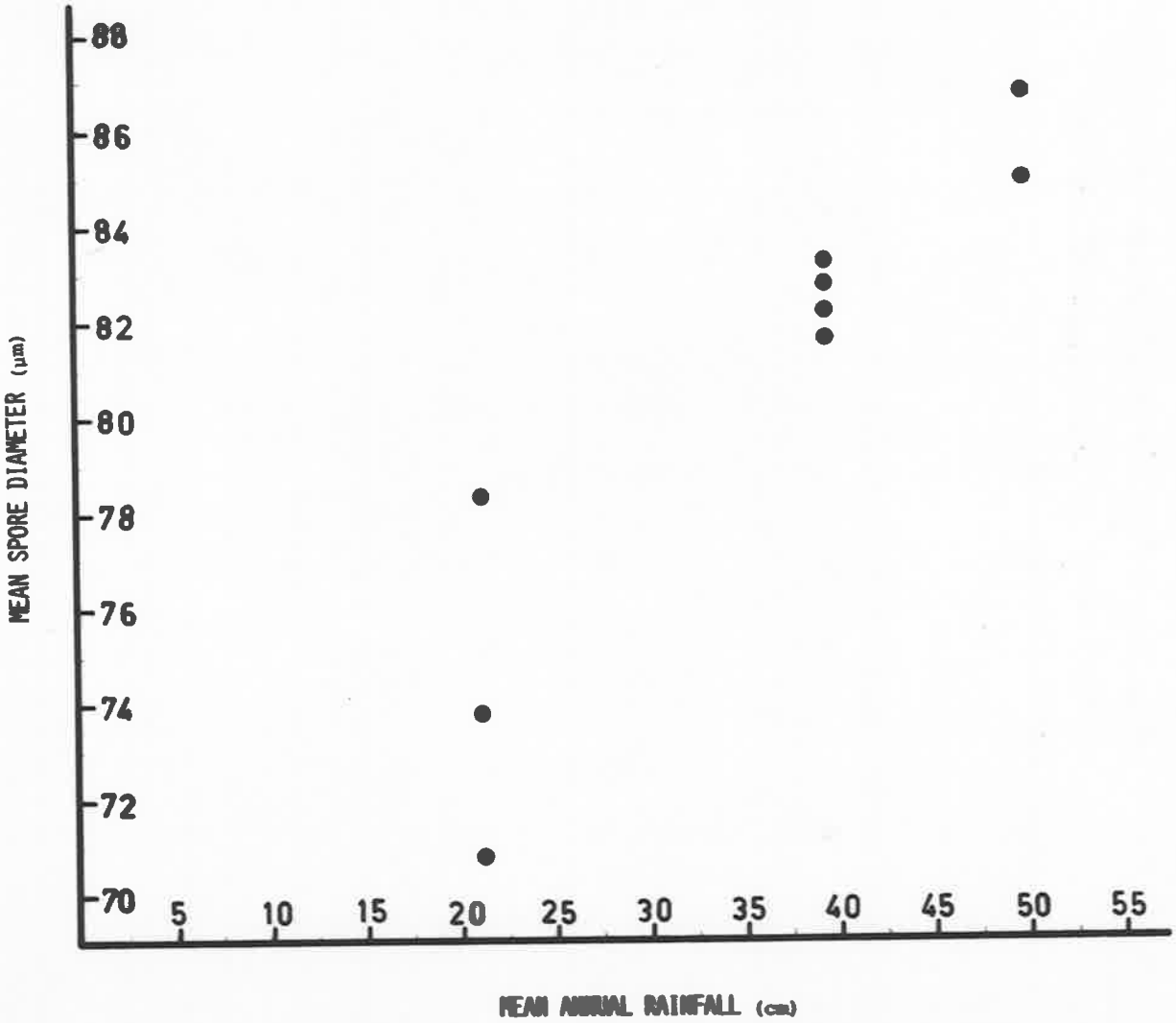

MEAN SPORE DIAMETER (µm)
88
86
84
82
80
78
76
74
72
70
5
10
15
20
25
30
35
40
45
50
55
MEAN ANNUAL RAINFALL (cm)

TABLE 6.7.

Spore characteristics of *R. nigrella*

Herbarium No.	Locality	Mean annual rainfall (cms)	Spore diam. µm	Mean diam µm	s.d.	Wing width µm
Seppelt 0477	Tassie Creek	21.32	62.5 - 77.5	70.76	3.97	1.25 - 3.75
0479	" "	21.32	62.5 - 87.5	73.71	4.26	2.5 - 3.75
0483	" "	21.32	70.0 - 87.5	78.30	3.93	3.75 - 6.25
0443	Warren Gorge	39.60	75.0 - 92.5	83.18	4.26	1.5 - 3.75
0443	" "	39.60	70.0 - 92.5	82.69	4.00	2.5 - 5.0
0443	" "	39.60	72.5 - 90.0	82.12	4.12	1.25 - 5.0
0446	" "	39.60	67.5 - 92.5	82.69	5.08	3.75 - 6.25
0454	" "	39.60	70.0 - 95.0	81.55	5.44	1.75 - 2.5
2567	Seppeltsfield	50.00	75.0 - 95.0	84.89	4.95	3.75 - 6.25
2567	" "	50.00	72.5 - 97.5	86.67	5.29	3.75 - 6.25
Na-Thalang 72	Jomah Creek, Barralier, NSW.		62.5 - 82.5	72.24	4.56	2.5 - 5.0
Na-Thalang 218	Tummallalee Ck., northern NSW.		62.5 - 82.5	71.44	4.47	2.5 - 3.75

Variability of *R. limbata* spores.

The largest spores for any species collected in South Australia have been found in *R. limbata*. A summary of the data obtained from a study of spores in South Australian specimens is given in Table 6.8.

Although this species has been collected from localities where the mean annual rainfall attains 50cm per annum, mature spores have as yet only been found in specimens collected from drier habitats. There is no apparent correlation between mean spore diameter and mean annual rainfall. Mean spore diameter has been found to vary considerably between specimens collected from the same locality.

The holotype specimen of *R. limbata* (G13163) lacks spores. Three species, *R. lata* Tayl., *R. punctata* Tayl., and *R. inflexa* Tayl., are now recognised as being conspecific with *R. limbata*. Whilst the holotype of *R. lata* (BM 45) lacks spores, *R. punctata* and *R. inflexa* have similar spore morphology. The synonymy of these species cannot be fully verified due to the lack of spores in the holotype specimen of *R. limbata*.

TABLE 6.8.

Spore characteristics of *R. limbata*.

Herbarium No.	Locality	Spore diam. µm	Mean diam. µm	s.d.	Wing width µm
Seppelt 0388	Wilpena	92.5 - 115.0	102.16	4.32	3.75 - 6.25
0398	"	100.0 - 132.5	116.02	6.61	5.0 - 10.0
3070	"	110.0 - 132.5	122.50	5.37	5.0 - 6.25
Na-Thalang 122	"	105.0 - 142.5	124.39	7.39	5.0 - 7.5
122	"	120.0 - 150.0	133.90	5.87	7.5 - 10.0
Seppelt 0461	Yourambulla	107.5 - 125.0	117.65	3.74	6.25 - 8.75
0447	Warren Gorge	102.5 - 127.5	114.39	5.58	3.75 - 6.25
0456	" "	102.5 - 127.5	117.20	5.42	5.0 - 8.75
0482	Tassie Creek	107.5 - 127.5	117.77	5.15	5.0 - 10.0
0484	" "	70.0 - 85.0	79.28	3.58	3.75 - 5.0
In AD	Gammon Range	112.5 - 135.0	122.12	4.81	5.0 - 7.5
In AD	" "	105.0 - 130.0	117.46	5.40	5.0 - 7.5

Spore Morphology and Synonymy of *Riccia macrospora*.

Whilst *R. macrospora* resembles *R. limbata* in thallus morphology, these two species have distinctly different spore morphology (compare Figs. 5.19, 5.23).

A summary of the features of spore morphology of *R. macrospora* is given in Table 6.9.

Na-Thalang (1969) considered *R. runssorensis* Steph., *R. rubrispora* Steph., and *R. sellingii* Arnell to be conspecific with *R. macrospora*. A re-examination of the holotype of *R. rubrispora* (G16116) confirmed that this species is conspecific with *R. macrospora*. However, the spores of the holotype of *R. runssorensis* (G13176) differ from those of *R. macrospora* in that they are smaller and that there are fewer areolae across the diameter of each spore. Although the holotype of *R. sellingii* was not seen, the spores of this species, from the type description and illustration, are also smaller and have fewer areolae across the diameter of each spore than those of *R. macrospora*.

The spores of *R. runssorensis* and *R. sellingii* are of similar morphology to the spores of *R. billardieri* Mont. et N., and *R. discolor* L. et L. However, *R. discolor* is reported to be dioicous (Stephani 1898; Na-Thalang 1969) whilst the other species are monoicous. Stephani (1898) reported 10 areolae across the diameter of each spore of *R. billardieri* whilst Na-Thalang (1969) reported 5-8 areolae across the diameter of each spore of this species. Based on these features *R. discolor* and *R. billardieri* should be regarded as separate species for the present.

A summary of the spore characteristics of *R. rubrispora* and *R. runssorensis* is given in Table 6.10.

Whilst the spores of *R. runssorensis* are significantly smaller than those of *R. rubrispora* and *R. macrospora*, the number of areolae across the diameter of each spore falls within the range observed for spores of *R. macrospora* (see Table 6.9). These observations confirm the conspecificity of *R. rubrispora*, *R. runssorensis* and *R. sellingii* with *R. macrospora*.

TABLE 6.9.

Spore characteristics of specimens of *R. macrospora* collected in South Australia and the Northern Territory.

Herbarium No.	Locality	Spore diam. µm	Mean diam. µm	s.d.	areolae distal face
South Australia					
Seppelt 0476	Tassie Creek	110.0 - 132.5	120.15	4.96	9 - 11
0476	" "	110.0 - 140.0	120.53	7.13	
Northern Territory.					
MEL 19768	Ayers Rock	95.0 - 112.5	103.30	4.97	
Carolin 5031	N-Dahla Gorge	112.5 - 137.5	126.33	4.89	10 - 12
Carolin 5398	Emily Gap	112.5 - 137.5	124.17	4.93	9 - 11
Na-Thalang 308	Maluka Cemetery	95.0 - 130.0	110.08	6.37	6 - 8
Na-Thalang 308	" "	100.0 - 132.5	114.51	6.81	

TABLE 6.10.

Holotype spore characteristics of *R. rubrispora* and *R. runssorensis*.

Species	Herbarium No.	Locality	Spore diam. µm	Mean diam µm	s.d.	areolae distal face
R. rubrispora	G16116	Arkaringa, S. Aust.	115.0 - 125.0	118.96	3.61	9 - 12
R. runssorensis	G13175	Marienthal, W. Africa	75.0 - 97.5	87.10	6.09	6 - 9

Spore Morphology of *Riccia albida*.

Mature spores of this species have been found in only one specimen from South Australia. A summary of the data obtained from a study of the morphology of spores of this species is given in Table 6.11.

The smooth-surfaced, rounded spores of this species are distinct.

Riccia crustata Trabut has been recently recorded by Jovet-Ast (1973) from near Mildura, Victoria. The spores of this species are reported to have only a few low, irregular ridges on the distal face and to be faintly triradiate on the proximal face (Jovet-Ast 1973). Both *R. crustata* and *R. albida* have similar thallus morphology. Although specimens of *R. crustata* have not been seen, the spores of this species, as illustrated by Jovet-Ast (1973), appear to be somewhat collapsed and distorted. It is therefore possible that the spores depicted were immature and that the shape and sculpturing of the exine may therefore be artifacts. Further study will be necessary in order to clarify the taxonomic status of these species. It is possible that *R. crustata* will prove to be conspecific with the earlier described species, *R. albida*.

TABLE 6.11.

Spore characteristics of *R. albida*.

Herb Herbarium No.	Locality	Spore diam. µm	Mean diam µm	s.d.
Seppelt 0632	Pondalowie Bay, Yorke Peninsula	87.5 - 115.0	102.20	5.45

Spore Characteristics of *Riccia marginata*.

Mature spores have been found in few specimens of this species collected in South Australia. However, the spore morphology of South Australian specimens closely resembles that of specimens from New South Wales and Queensland.

A summary of the features of spore morphology of this species is given in Table 6.12.

Spore Characteristics of *Riccia sorocarpa*.

Specimens of this species have been collected over a wide climatic range in South Australia. Within this range the specimens have been shown to exhibit considerable variation in thallus morphology and in some features of spore morphology, particularly mean spore diameter. A summary of the data obtained from a study of spore morphology of this species is given in Table 6.13.

A comparison of South Australian specimens with those from New South Wales showed a similarity of spore morphology although the collection localities were widely separated. No apparent relationship between mean spore diameter and mean annual rainfall has been shown for this species. However, the mean diameter of spores from South Australian specimens is larger than that for specimens from New South Wales.

TABLE 6.12

Spore Characteristics of *Riccia marginata*.

Herbarium No.	Locality	Spore diam. µm	Mean diam. µm	s.d.	Wing width µm	Areolae distal face
Seppelt 0480	Tassie Creek	80.0 - 97.5	87.96	4.02	2.5 - 6.25	8 - 10
0478	" "	67.5 - 85.0	77.24	3.40	2.5 - 3.75	
Na-Thalang 22	Cunnamulla, Qld.	80.0 - 92.5	86.82	3.09	3.75 - 6.25	10 - 12
Na-Thalang 146	Glen Davis, NSW.	62.5 - 92.5	81.63	6.76	2.5 - 6.25	

TABLE 6.13

Spore Characteristics of *Riccia sorocarpa*.

Herbarium No.	Locality	Spore diam. µm	Mean diam. µm	s.d.	Wing width µm	Areolae distal face
Seppelt 0418	Wilpena	77.5 - 102.5	92.54	5.05	3.75 - 7.5	9 - 13
0426	"	80.0 - 105.0	91.36	5.72	3.75 - 5.0	10 - 12
0445	Warren Gorge	95.0 - 117.5	109.43	4.25	3.75 - 6.25	9 - 10
0459	" "	82.5 - 105.0	93.64	4.71	3.75 - 5.0	10
2479	Caroline Forest	80.0 - 107.5	96.40	6.00	3.75 - 5.0	8 - 11
2479	" "	85.0 - 122.5	102.84	8.74	2.5 - 5.0	9 - 12
2520	" "	77.5 - 105.0	95.57	5.75	2.5 - 5.0	10 - 14
Na-Thalang 241	Luddenheim, NSW.	65.0 - 90.0	77.16	4.94	2.5 - 5.0	6 - 10
Na-Thalang 241	" " "	67.5 - 87.5	76.82	4.06	2.5 - 5.0	9

Spore Characteristics of *Riccia rorida*.

This species was proposed by Na-Thalang (1969) from specimens collected at Cotter River, Australian Capital Ter ritory. Specimens collected from Wilpena Pound in South Australia are similar in thallus and spore morphology to the holotype specimen.

A summary of the features of spore morphology of this species is given in Table 6.14.

Spore Characteristics of *Riccia lamellosa*.

Although *R. lamellosa* is probably the most widespread and abundant species of *Riccia* in South Australia, mature spores have been found in few of the collections made. From the studies which have been made of spore morphology of South Australian specimens there is no apparent relationship between mean spore diameter and mean annual rainfall.

A summary of the characteristics of the spores of *R. lamellosa* is given in Table 6.15.

Both *R. lamellosa* and *R. rorida* show some similarity in spore morphology. In the specimens examined the spores of the former species are significantly larger than those of the latter. The numbers of areolae across the diameter of individual spores of *R. lamellosa* and *R. rorida* are variable and can not be used as single features to distinguish the species.

Scanning electron micrographs reveal an even closer similarity in spore morphology of these two species than is apparent using conventional optical microscopy. The distal face of the spore of *R. lamellosa* appears to be irregularly ridged with only occasional areolae when viewed using conventional optical microscopy, whilst appearing more evidently areolate when viewed with the scanning electron microscope. It is thus apparent that *R. lamellosa* and *R. rorida* are closely similar in both thallus and spore morphology.

TABLE 6.14.

Spore Characteristics of *Riccia rorida*.

Herbarium No.	Locality	Spore diam. µm	Mean diam. µm	s.d.	Wing width µm	Areolae distal face
Seppelt 0411	Wilpena	62.5 - 85.0	76.21	5.16	2.5 - 5.0	8 - 12
3162	"	80.0 - 102.5			5.0 - 7.5	9 - 10
Na-Thalang 191 (Holotype)	Cotter River, A.C.T.	65.0 - 87.5	76.97	4.73	2.5 - 5.0	

TABLE 6.15

Spore Characteristics of *Riccia lamellosa*.

Herbarium No.	Locality	Spore diam. µm	Mean diam. µm	s.d.	Wing width µm	Areolae distal face
Seppelt 0386	Wilpena	92.5 - 110.0	102.25	4.80		
0390	"	100.0 - 112.5	106.50	3.32	5.0 - 7.5	
Na-Thalang 104	"	82.5 - 115.0	95.99	5.65	3.75 - 7.5	
Seppelt 0631	Tassie Creek	85.0 - 105.0	99.47	3.96	3.75 - 7.5	9 - 10
0431	Parachilna	105.0 - 127.5	117.54	4.97	7.5 - 11.25	12
0441	Chambers Gorge	97.5 - 122.5	111.74	5.82	5.0 - 8.75	
0449	Warren Gorge	95.0 - 127.5	112.57	6.99	5.0 - 10.0	9 - 12
0343	Seppeltsfield	90.0 - 107.5	101.55	4.04	3.75 - 6.25	
2549	Adelaide	75.0 - 122.5	95.53	7.84	5.0 - 8.75	11 - 14

Relationship between mean spore diameter and mean annual rainfall in *Riccia crystallina.*

Specimens of *R. crystallina* have been collected over a wide geographical range, extending from Cooper's Creek near Innaminka, in the far north-east of South Australia, to Glencoe, in the lower south-east of the State. Throughout this range the plants exhibit considerable variation in thallus morphology and in mean spore diameter. A detailed study has shown that spore morphology in this species is particularly constant and distinctive, and that there is a negative correlation between mean spore diameter and mean annual rainfall at collection sites (Seppelt 1974, in press).

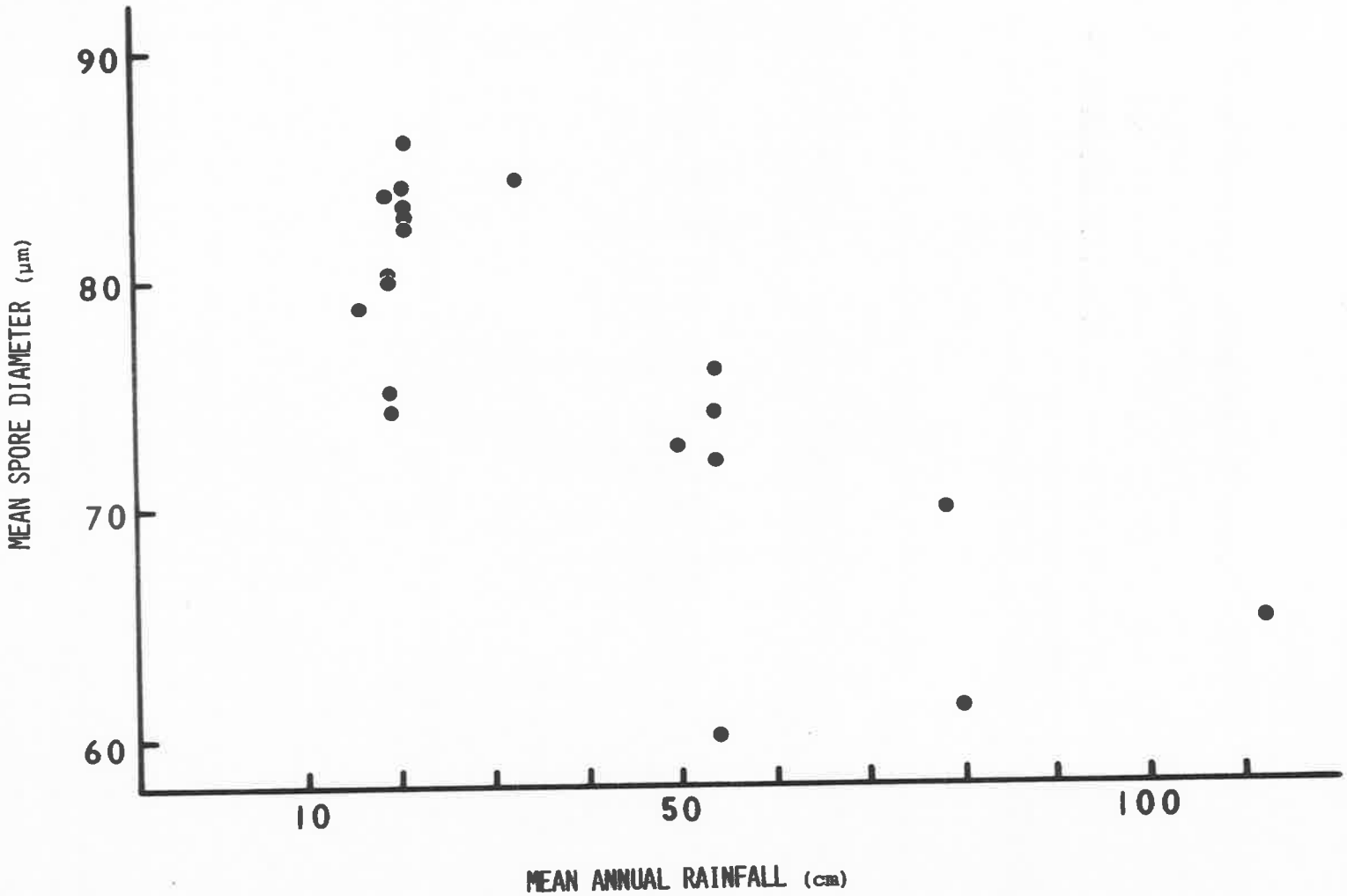
A summary of the features of spore morphology together with mean annual rainfall figures for the various collection sites is given in Table 6.16.

A regression analysis of the form $y = a + bx$ was undertaken on a plot (Fig. 6.2) of mean spore diameter against mean annual rainfall for each collection site. This analysis revealed a highly significant negative correlation between mean spore diameter and mean annual rainfall values with a value of $y = 85.38 - 0.23x$.

Jovet-Ast (1964-65) studied in detail spore morphology of European and Mediterranean specimens of *R. crystallina*, and undertook a biometrical analysis of spore morphology. It is apparent that the mean spore diameter for specimens examined from South Australia extends over a greater range of values than that for northern hemisphere specimens examined by Jovet-Ast. The specimens have similar sculpturing of the exine, however, thus verifying that

FIGURE 6.2

Mean spore diameter of spores from single capsules plotted against mean annual rainfall at collection localities of specimens of Riccia crystallina in South Australia.


90
80
70
60
MEAN SPORE DIAMETER (µm)
10
50
100
MEAN ANNUAL RAINFALL (cm)

the South Australian specimens of this species are conspecific with those specimens examined by Jovet-Ast. The range of spore diameter found in South Australian specimens varies between 52.5 and 92.5µm whilst the range of spore diameter reported by Jovet-Ast (1964-65) for European and Mediterranean specimens lies between 60.0 and 86.5µm.

TABLE 6.16

Spore Characteristics and mean annual rainfall data at collection sites of *Riccia crystallina*.

Herbarium No.	Locality	Mean annual rainfall cm	Spore Diam. µm	Mean Diam. µm	s.d.	Wing width µm	areolae distal face
Seppelt 3485	Coopers Creek	16.09	75.0 - 85.0	78.90	2.49	5.0 - 6.25	8 - 9
2402	Chambers Gorge	19.34	67.5 - 80.0	74.32	3.09	5.0 - 7.5	7 - 9
2403	" "	19.34	70.0 - 90.0	80.83	3.41	5.0 - 8.75	6 - 7
2494	" "	19.34	75.0 - 85.0	80.27	2.71	7.5 - 10.0	7 - 8
2407	" "	19.34	65.0 - 85.0	75.19	4.00	3.75 - 7.5	8 - 9
2408	" "	19.34	75.0 - 92.5	83.86	3.73	7.5 - 10.0	8 - 9
3292	Tassie Creek	21.32	80.0 - 92.5	86.14	3.32	5.0 - 7.5	6 - 7
3335	" "	21.32	75.0 - 90.0	83.37	2.96	6.25 - 8.75	6 - 7
3342	" "	21.32	77.5 - 90.0	82.99	3.29	6.25 - 8.75	6 - 8
3343	" "	21.32	77.5 - 87.5	84.02	2.59	5.0 - 7.5	6 - 7
3345	" "	21.32	77.5 - 87.5	82.35	2.84	6.25 - 7.5	6 - 7
3486	Terowie	33.72	77.5 - 92.5	84.43	3.25	5.0 -- 8.75	6 - 8
0255	Seppeltsfield	50.00	67.5 - 80.0	72.84	3.48	3.75 - 7.5	7 - 8
2706	Adelaide Univ.	54.11	65.0 - 80.0	72.20	2.93	2.5 - 7.5	7 - 8
2706	" "	54.11	70.0 - 82.5	76.14	2.67	5.0 - 7.5	7 - 9
2706	" "	54.11	67.5 - 82.5	74.21	3.32	5.0 - 7.5	6 - 8
3353	" "	54.11	52.5 - 70.0	60.04	3.91	3.75 - 5.0	9 - 10
3364	near Belair	78.60	60.0 - 75.0	69.36	3.17	3.75 - 6.25	9 - 10
2460	Glencoe	80.00	55.0 - 70.0	61.29	2.71	3.75 - 5.0	8 - 9
0346	Summertown	112.27	60.0 - 72.5	65.00	2.74	3.75 - 5.0	8 - 10

Spore Morphology of *Riccia cavernosa* and *Riccia multilamellata*.

Jovet-Ast (1964-65) in a study of thallus and spore morphology clarified the taxonomic status of *R. cavernosa* and included five previously recognised species as synonyms, based primarily on a comparison of spore morphology. An additional synonym, *R. multilamellata*, was proposed by Na-Thalang (1969). An examination of the thallus and a detailed study of the spore morphology of the holotype specimen (G12732) of *R. multilamellata* confirmed the conspecificity of this plant with that of *R. cavernosa*. The morphology of the spores of specimens of *R. cavernosa* collected in South Australia is similar to that of the specimens examined by Jovet-Ast (1964-65) and thus verifies that South Australian specimens agree in this feature with northern hemisphere specimens examined by Jovet-Ast.

A summary of spore characteristics of specimens of *R. cavernosa* from South Australia and the Northern Territory is given in Table 6.17.

The features of spore morphology of *R. multilamellata* are summarized in Table 6.18.

Jovet-Ast (1964-65) reported a range of spore diameter of 62.5 - 108.0µm for specimens of *R. cavernosa* from Europe, northern Africa and North America, which is similar to the range of diameter of specimens of this species collected in South Australia and the Northern Territory of 65.0 - 112.5µm.

TABLE 6.17.

Spore Characteristics of *Riccia cavernosa*.

Herbarium No.	Locality	Spore diam. µm	Mean diam. µm	s.d.	wing width µm
Seppelt 3544	Wilkinson Lakes	75.0 - 92.5	85.30	3.79	3.75 - 6.26
3544	" "	72.5 - 87.5	80.72	3.03	3.75 - 5.0
0485	Tassie Creek	90.0 - 110.0	101.19	3.98	2.5 - 7.5
2400	" "	87.5 - 107.5	99.43	4.27	5.0 - 7.5
0626	Chambers Gorge	75.0 - 95.0	81.25	4.79	3.75 - 7.5
0626	" "	70.0 - 102.5	79.51	6.02	3.75 - 5.0
0626	" "	85.0 - 100.0	91.43	4.22	5.0
2401	" "	80.0 - 92.5	85.95	3.06	5.0 - 7.5
2411	" "	72.5 - 92.5	81.71	4.48	5.0 - 7.5
2412	" "	87.5 - 112.5	98.03	5.47	5.0 - 7.5
Na-Thalang 88	Mt. Olga, NT.	80.0 - 100.0	88.71	5.16	3.75 - 6.25
Na-Thalang 98	Palm Valley, NT.	65.0 - 82.5	76.63	3.09	2.5 - 5.0
Na-Thalang 98	" " "	67.5 - 85.0	77.99	3.08	2.5 - 6.25
MEL 19802	" " "	70.0 - 87.5	79.92	4.18	2.5 - 5.0
MEL 19802	" " "	67.5 - 90.0	77.61	4.33	2.5 - 5.0

TABLE 6.18

Spore Characteristics of *Riccia multilamellata.*

Herbarium No.	Locality	Spore diam. µm	Mean diam. µm	s.d.	Wing width µm
in AD	Walkers Flat, S.A.	75.0 - 100.0	86.17	6.00	2.5 - 6.25
in AD	" "	75.0 - 102.5	93.71	5.65	3.75 - 6.25

Spore Characteristics of *Riccia spongiosa*, *Riccia crassa* and *Riccia deserticola*.

Studies of spore morphology have been made of three members of the subgenus *Ricciella* occurring in South Australia, namely *R. spongiosa*, *R. crassa*, and *R. deserticola*.

A summary of the features of spore morphology of specimens of *R. spongiosa* collected in South Australia and New South Wales is given in Table 6.19.

Although specimens of *R. crassa* have not been collected during the course of this study, spores from the holotype (G12729) and the isotype (MEL 19765) have been examined. A summary of the features of spore morphology of this species is given in Table 6.20.

Specimens of *R. deserticola* have similarly not been collected in South Australia during the course of this study. However, spores from the isotype (MEL 19766) and other specimens collected in the far northern regions of South Australia have been examined and the characteristics of the spores summarised in Table 6.21.

The spores of *R. crassa* and *R. deserticola* are very similar. It is here proposed that on the basis of spore morphology these two species are conspecific. The description of the spores of these two species given by Stephani (1898) are virtually identical and in addition the variation of the thallus fits well within the bounds of variability found in species of the subgenus *Ricciella*. Although both species names have equal priority, *R. crassa* is here proposed as a synonym of *R. deserticola*.

TABLE 6.19.

Spore Characteristics of *Riccia spongiosa*.

Herbarium No.	Locality	Spore diam. µm	Mean diam. µm	s.d.	Wing width µm	Areolae distal face
Seppelt 0391	Wilpena	82.5 - 102.5	93.60	4.02	2.5 - 5.0	
0458	Warren Gorge	90.0 - 110.0	103.90	4.00	5.0 - 8.75	10 - 12
2493	Christmas Rocks	97.5 - 117.5	106.71	4.85	5.0 - 7.5	9
Na-Thalang 31	Barralier, NSW.	75.0 - 90.0	82.16	4.36	2.75- 6.25	7 - 8
Na-Thalang 239	Prospect Res., NSW.	75.0 - 110.0	90.83	5.72	5.0 - 7.5	8 - 10

TABLE 6.20.

Spore Characteristics of *Riccia crassa*.

Herbarium No.	Locality	Spore diam. µm	Mean diam. µm	s.d.	Wing width µm	Areolae distal face
G 12729 TYPE	Arkaringa, S.A.	70.0 - 77.5	73.79	2.20	3.75 - 6.25	7 - 8
MEL 19765 Isotype	" "	65.0 - 80.0	73.41	3.06	2.75 - 5.0	8 - 10

TABLE 6.21.

Spore Characteristics of *Riccia desertícola*.

Herbarium=No.	Locality	Spore diam. µm	Mean diam. µm	s.d.	Wing width µm	Areolae distal face
MEL 19766 Isotype	Arco-eillina Well, S.A.	62.5 - 77.5	70.42	2.93	2.5 - 5.0	8 - 9
MEL 19766 Isotype.	" "	62.5 - 75.0	70.53	3.02	2.5 - 5.0	8 - 9
in AD.	Everard Range, S.A.	60.0 - 77.5	68.65	3.40	1.25- 3.75	
in AD	" "	57.5 - 77.5	67.92	4.01	1.25- 3.75	

Concluding Remarks.

As a result of this investigation spore morphology has been shown to be of considerable value in the taxonomic study of the genus *Riccia*. Two species, *R. longiciliata* and *R. areolata*, both proposed as new by Na-Thalang (1969), have been shown to be synonymous with *R. crinita* Tayl. *Riccia crozalsii* Levier and *R. bifurca* Hoffm., have been shown to be inseparable on the basis of spore morphology so that consequently some doubt concerning the taxonomic distinctness of these species has been raised. Two further species, *R. macrospora* Steph., and *R. limbata* Bisch., having similar thallus morphology, have been shown to possess quite different spore characteristics. Within the subgenus *Ricciella*, *R. multilamellata* Steph., has been confirmed as being conspecific with *R. cavernosa* Hoffm. emend Raddi, and *R. crassa* Steph., proposed as a synonym for *R. deserticola* Steph.

Whilst in most instances spore morphology needs to be used in association with thallus morphology for identification of species, the spores of some species, for example *R. crystallina* and *R. albida*, are characteristic.

Most species of *Riccia* found in South Australia possess spores which fall within both the large (50-100µm) and very large (100-200µm) spore diameter ranges of Erdtman (1965) (see Table 6.1). Seven species, *R. nigrella*, *R. bifurca*, *R. marginata*, *R. crystallina*, *R. multifida*, *R. muscicola* and *R. deserticola* (including *R. crassa*) possess spores which fall only within the large spore diameter category whilst three species, *R. macrospora*, *R. duplex* and *R. papulosa*, possess spores which fall only within the very large category. Spore diameter has been shown in this study to be an

unsatisfactory character on which to base species separation. Similarly, the numbers of areolae across the diameter of each spore has been found to be variable and thus unsatisfactory in delimiting species (see discussion on the synonymy of *R. crinita*).

Whilst individual features of spore morphology are of limited use in delimiting species, spore morphology as a whole has been shown to be of much value in clarifying the taxonomy of the species of *Riccia* found in South Australia, especially if used in association with other morphological features.

CHAPTER SEVEN

CONCLUSION.

With the exception of the subgenus *Ricciella*, for which much revisionary work still remains to be done, the genus *Riccia* in South Australia is now well known. Twenty-one species are recognized as a result of this study. Twelve of these species belong in the subgenus *Riccia* whilst the remaining nine species, of which only *R. crystallina* and *R. cavernosa* have been clarified taxonomically (Jovet-Ast 1964-65, 1967), belong in the subgenus *Ricciella*.

Unfortunately it has not been possible to collect species from the remote western and far northern districts of South Australia for detailed comparisons in this study. This situation is to be regretted particularly as the type localities of several species are found in the north western region of the State. For example, *R. crassa* has been included as a synonym of *R. deserticola* primarily on the basis of spore morphology, although clarification of the identity of these plants must await comparison with collections from the type localities in the far north-west of the State.

Spore morphology has been investigated in association with thallus morphology and it has been shown that in many instances spore morphology has facilitated the recognition of species of *Riccia* occurring in South Australia.

Additional species may be found as further collections are made and undoubtedly the distribution of the known species extended. The South Australian environment with its hot and dry interior in the north, subject to intermittent rains grading to the cooler, wetter southern districts, affords an excellent opportunity for the study of speciation and variation in taxa such as the genus *Riccia*.

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