

Distribution and ecology of ferns on dry rock outcrops in Tasmania, with special reference to Fingal Tier

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Abstract

*Ferns growing on dry rock outcrops are unusual in the Tasmanian flora but reach their best development in low rainfall areas. The distribution and ecology of eight species and one subspecies from this habitat are described. Possible strategies by the ferns to overcome their harsh environment are discussed, along with their conservation and reservation status, and threats to their survival. Two of the taxa described, *Asplenium trichomanes* subsp. *trichomanes* and *Cheilanthes distans*, are new records for Tasmania.*

Introduction

In Tasmania, most ferns grow in rainforest or wet sclerophyll forest in areas of high rainfall. A lesser number occurs in sheltered and permanently moist sites within low-rainfall areas, in moist and usually badly drained soils of exposed sites, and on rock outcrops in the cloud zone of high mountain summits. In addition, some are aquatics or semi-aquatics in still or moving waters (Duncan and Isaac 1986).

A small assemblage of ferns also occurs on dry, rocky sites in Tasmania. These ferns are virtually xerophytic in nature, and their habitat is found in low-rainfall areas of the State, such as the Derwent Valley, Midlands and east coast. This paper describes briefly the ecology as well as the Tasmanian distribution of these species, and attempts to explain some of the methods by which they have adapted to their relatively harsh environment.

Methods

State-wide observations on ferns in dry habitats were made between summer 1989 and autumn 1992 while conducting a distribution survey of all Tasmanian pteridophytes. A more intensive study of species inhabiting dry rock outcrops on Fingal Tier was undertaken from October to December 1992 inclusive. These data were supplemented with findings from occasional field trips at other times.

Previous fieldwork had indicated that late spring to early summer was the time of year when maturation would at least start to become apparent in most species. In addition, fieldwork done any later could have resulted in some species going unnoticed or being unidentifiable due to their state of desiccation. However, it should be noted that in mid November 1992, St Marys recorded 283 mm of rain (or almost four times the average for that whole month) over just four consecutive days. This may have resulted in atypically longer growing periods and certainly induced new growth among the ferns. These crozier and new growth characters are reliable and little recognised features for separating certain species of Tasmanian ferns, particularly in genera such as *Cheilanthes*, *Pellaea* and *Hypolepis* where there are species that are sometimes confusing.

Prospective habitats were ascertained from maps, and visually from roads and other vantage points. Fern species present, and their ecology and state of growth, were noted from each site.

Fingal study area

Fingal Tier runs approximately east-west between the St Pauls and South Esk Rivers, rising to 1027 m at St Pauls Dome. The Fingal Tier study area was limited to those lower slopes (300–700 m) which are deeply incised with permanent and ephemeral creeks draining into the South Esk River. The rock type is Jurassic dolerite, with frequent outcroppings of sandstone on the lower slopes.

Average monthly and annual rainfall figures for the nearest meteorological stations, Avoca, Ormley, Fingal, St Marys and Gray, are shown in Table 1. St Marys and Gray receive precipitation of predominantly easterly origin about the Mount Elephant massif, with their rainfall double that of more inland centres over equivalent rainy days. Fingal is the only meteorological centre in the Fingal Valley with temperature records (see Table 1).

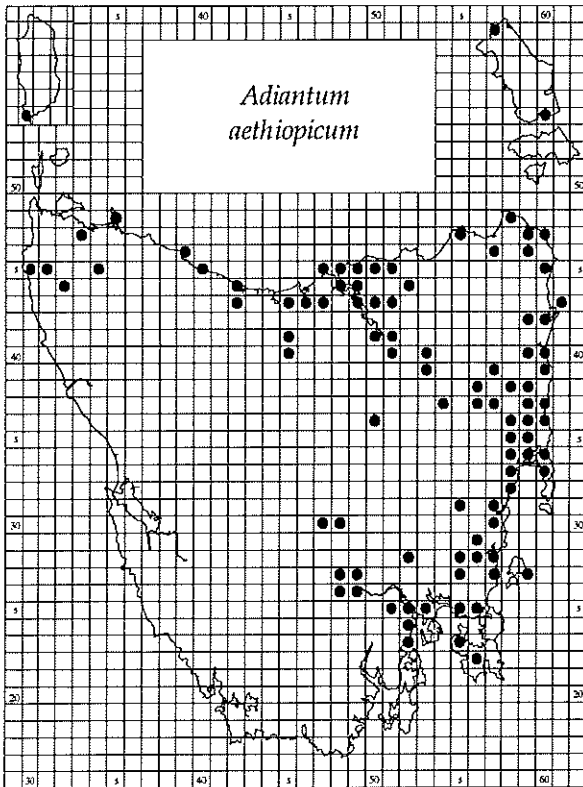


Figure 1. Distribution of *Adiantum aethiopicum*.

Results

Adiantum aethiopicum L. Maidenhair fern

This is a widespread species from lowland areas of low rainfall (Figure 1), where it is terrestrial on watercourse margins and grassy, rocky hillsides. On Fingal Tier, it occurs at places such as Bare Rock (Fingal) and Rostrevor Rivulet. Here it grows in soils surrounding rock outcrops, occasionally extending to soil pockets on outcrops proper. Plants in this habitat reach maturity in mid to late summer, with top growth on most plants drying and shrivelling irreversibly during late summer. Elsewhere in the State it can occur in more sheltered sites, such as on the banks of the Arthur River in the north-west, and in low light under tea-tree scrub beside the Apsley River near Bicheno. Under these conditions, plants are evergreen and produce spores year-round.

Anogramma leptophylla (L.) Link Annual fern

Anogramma leptophylla is a very small, annual fern, its fronds arising during late winter and early spring from a perennial gametophyte. In New Zealand, the species reaches maturity in August and September (Brownsey and Smith-Dodsworth 1989).

This species is very rare in Tasmania, and is known only from a few locations (Figure 2) where populations comprise just a small number of plants. It has not been recorded from Fingal Tier. Plants grow in the thin, mossy soil layer of ledges and crevices on rocky outcrops and cliff-faces. All Tasmanian plants have been observed growing on dolerite. The species often grows mixed with liverworts, grasses and small annual or perennial angiosperms. In New Zealand, Brownsey and Smith-Dodsworth (1989) report *Anogramma leptophylla*, *Asplenium flabellifolium*, *Cheilanthes distans*, *C. sieberi*, *Pellaea calidrupium* and *Pleurosorus rutifolius* as forming a characteristic

Table 1. Average monthly rainfall (mm) and rain days for Fingal Valley centres. Mean monthly maximum and minimum temperatures (°C) for Fingal are also given.

	J	F	M	A	M	J	J	A	S	O	N	D	Annual
Fingal													
rainfall	41	40	46	54	53	69	58	59	49	56	44	50	619
rain days	6	6	7	8	9	10	11	11	10	10	8	8	104
min. temp.	10.1	9.1	7.8	6.1	3.2	1.3	0.5	0.9	3.5	5.1	7.2	9.0	
max. temp.	23.8	23.0	22.2	19.0	15.4	13.0	12.1	13.0	15.8	17.5	19.8	21.3	
Avoca													
rainfall	38	33	38	46	48	52	48	53	50	55	46	49	556
rain days	6	6	7	8	9	11	11	12	11	11	9	8	109
Ormley													
rainfall	39	32	42	49	48	58	51	52	46	52	40	48	557
rain days	5	4	6	7	8	9	10	10	9	9	8	7	92
St Marys													
rainfall	56	83	96	89	99	106	99	92	69	88	75	83	1035
rain days	6	6	7	7	8	9	10	10	9	10	8	8	98
Gray													
rainfall	78	74	123	125	138	106	106	111	86	96	116	120	1279
rain days	9	8	11	9	10	10	10	12	10	10	11	11	121

assemblage of ferns which inhabit the dry, rocky areas of the eastern South Island. In Tasmania, *Adiantum aethiopicum*, *Asplenium flabellifolium*, *Cheilanthes austrotenuifolia*, *Pellaea calidurupium* and *Pleurosorus rutifolius* have been observed growing on the same outcrop as *Anogramma leptophylla*, although not together in the same microhabitat. While *Anogramma leptophylla* has the same habitat as xerophytic ferns, the species occurs on outcrops in those sites with some shelter; for example, on exposed southern slopes or on northern slopes in the protection of gullies.

Asplenium flabellifolium Cav.
Necklace fern

This is a widespread and abundant fern in Tasmania (Figure 3), occurring occasionally on rock or in soil in dark fern gullies, but is more common in exposed conditions. It is prolific as a lithophyte on the margins of ephemeral creeks and higher slopes of fern gullies, and is seldom absent from rock screes and outcrops. It is abundant on outcrops (particularly dolerite) at all

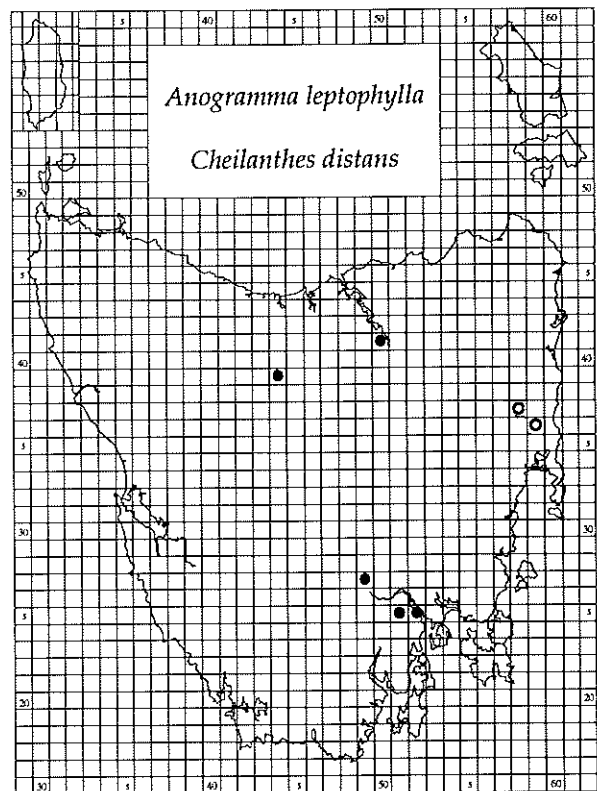


Figure 2. Distribution of *Anogramma leptophylla* (●) and *Cheilanthes distans* (○).

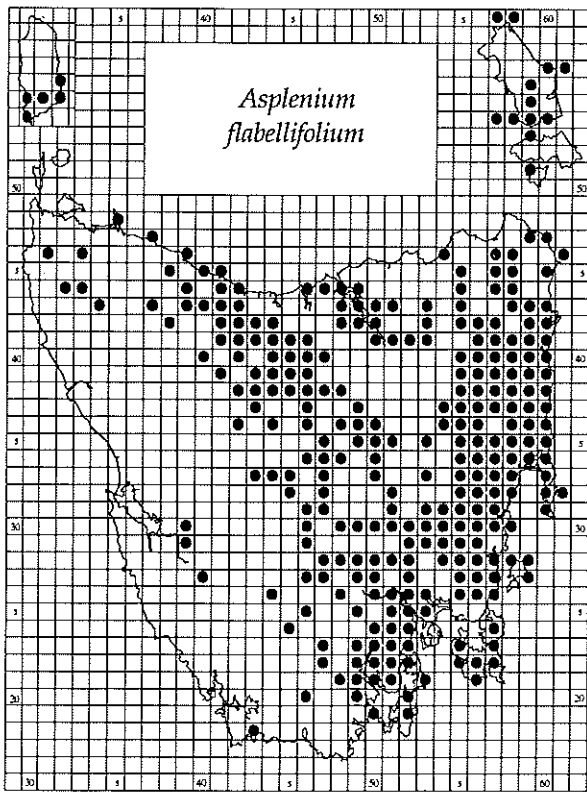


Figure 3. Distribution of *Asplenium flabellifolium*.

elevations and on all aspects on Fingal Tier. The species reaches maturity in mid to late summer, remains green year-round, and plants with withered fronds are rarely seen.

Asplenium trichomanes L. subsp. *trichomanes*
Maidenhair spleenwort (Photo 1)

This subspecies is very rare in Tasmania (Figure 4), being known with certainty from two locations only, at Valley Road below Spion Kop on Fingal Tier, and nearby on Mount Durham. Both populations are on north-east facing, weathered, sloping dolerite platforms that also contain numerous grasses, herbs and small shrubs growing in shallow soil pockets. These outcrops are distinguishable from neighbouring columnar dolerite outcrops which contain conspicuously less plant life. The Valley Road colony (500 m altitude) consists of only eight to ten plants, and shares the outcrop with *Asplenium flabellifolium*, *Cheilanthes*

austrotenuifolia, *C. sieberi* and *Pellaea caliduripium*. These species are not found elsewhere in the immediate vicinity. Two colonies exist at Mount Durham—well over 100 plants occur at the lower site (560 m altitude) where they grow with *Cheilanthes austrotenuifolia*, and approximately 30 plants occur with *C. austrotenuifolia* and *Pellaea caliduripium* at 680 m altitude.

In mid December, plants were green and growing vigorously but by mid February fronds had dried and shrivelled. As spores were not yet mature in February, and above average rainfall had been experienced during late spring (Table 2), it is suspected that plants were merely 'on hold' and that fronds would resurrect with the onset of suitable weather.

Asplenium trichomanes is a polytypic cosmopolitan species, with at least five European subspecies (A.C. Jermy, pers. comm.). Two of these, subsp. *trichomanes* and subsp. *quadrivalens* D. Meyer emend Lovis, occur in the British Isles (Jermy *et al.* 1978) and Australia (Duncan and

Isaac 1986). The two subspecies differ in chromosome number: subsp. *trichomanes* is diploid whereas subsp. *quadrivalens* is tetraploid. Morphological differentiation in the field is very difficult and, in both countries, habitat is used as a key character. For example, subsp. *quadrivalens* occurs on calcareous rock and subsp. *trichomanes* on non-calcareous rock types (Jermy *et al.* 1978; Duncan and Isaac 1986; T. Entwisle, pers. comm.). Dr John Lovis (University of Canterbury, Christchurch, New Zealand) has visited both the Valley Road and lower Mount Durham sites. He is a world authority on *A. trichomanes* and its subspecies, and his on-site observations, as well as later cytological analyses, have confirmed both populations as diploid subsp. *trichomanes* (J.D. Lovis, pers. comm.).

Subspecies *quadrivalens* is quite widespread on limestone in western Tasmania (Figure 4) where it occurs in wet forest in high-rainfall

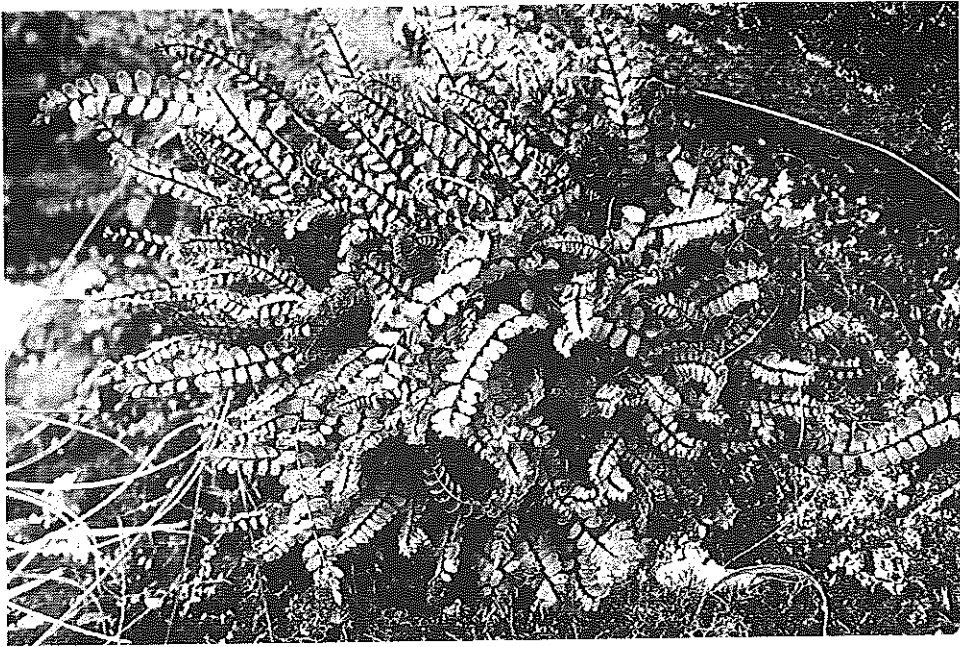


Photo 1. *Asplenium trichomanes* subsp. *trichomanes* on Mount Durham, where it grows on dolerite outcrops with *Cheilanthes austrotenuifolia*.

areas. In its overseas distribution, subsp. *quadrivalens* occurs in drier and more exposed habitats (J.D. Lovis, pers. comm.). Most Tasmanian rock types suitable for subsp. *quadrivalens* are in areas of high rainfall, although specimens of this subspecies still flourish on exposed limestone outcrops on Flinders Island and at Eugenana, south of Devonport. Both sites have been deforested since European settlement. No collections of *Asplenium trichomanes* have been made from limestone on mainland eastern Tasmania, including limestone formations near Gray. Outside the Fingal Valley, *A. trichomanes* has been observed growing on dolerite at Staircase Ford, east of Campbell Town; on Permian mudstone at Liffey Falls; on basalt near the Falls of Clyde at Bothwell; and a single specimen grows on dolerite beside a tributary of the West Swan River in eastern Tasmania. Plants from all these sites have been seen by Dr Lovis *in situ* or as herbarium specimens, and although none has been analysed cytologically as yet, preliminary investigations indicate they all belong to subspecies *quadrivalens*.

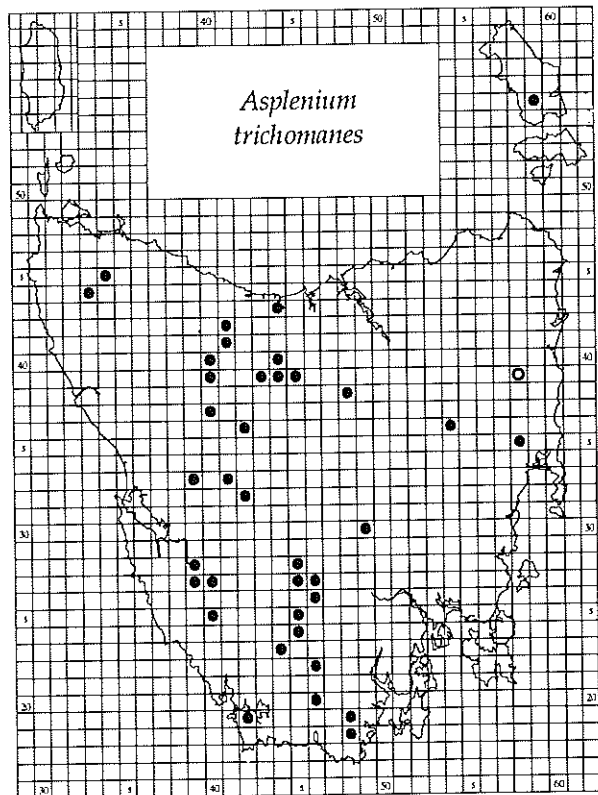


Figure 4. Distribution of *Asplenium trichomanes*. (● = subsp. *quadrivalens*, ○ = subsp. *trichomanes*)

Table 2. Monthly rainfall (mm) and number of rain days for Fingal Valley centres immediately preceding and during the study period. Average figures are in parentheses. Data are not available for some months.

	1992						1993	
	July	Aug	Sep	Oct	Nov	Dec	Jan	Feb
Avoca								
rainfall	88(48)	55(53)	58(50)	52(55)	44(46)	17(49)	46(38)	45(33)
rain days	-	14(12)	18(11)	-	-	-	11 (6)	13 (6)
Ormley								
rainfall	53(51)	38(52)	65(46)	75(52)	60(40)	10(48)	40(39)	43(32)
rain days	9(10)	6(10)	7 (9)	5 (9)	7 (8)	4 (7)	10 (5)	15 (4)
Fingal								
rainfall	43(58)	81(59)	49(49)	92(56)	62(44)	11(50)	41(41)	46(40)
rain days	15(11)	15(11)	13(10)	11(10)	19 (8)	13 (8)	8 (6)	17 (6)
St Marys								
rainfall	58(99)	100(92)	65(69)	83(88)	305(75)	51(83)	55(56)	80(83)
rain days	13(10)	10(10)	10 (9)	-	13 (8)	-	7 (6)	12 (6)
Gray								
rainfall	46(106)	65(111)	-	-	278(116)	93(120)	-	99(74)
rain days	-	-	-	-	-	-	-	-

Cheilanthes austrotenuifolia Quirk & Chambers
Rock fern (Photo 2)

This species is distributed widely across the eastern half of Tasmania, from sea-level to 680 m altitude. It is particularly common on the central east coast and along the Tamar estuary (Figure 5). It is common on Fingal Tier in suitable habitats.

Cheilanthes austrotenuifolia is terrestrial on sunny, rocky or grassy hillsides, or grows in the shallow soil of exposed rock outcrops. It would seem to favour sandstone substrates where this rock type is present but, overall, is more prolific on dolerite. The species also occurs on granite, in areas such as the Rossarden and Bicheno districts, but is often absent on seemingly suitable outcrops of this rock type. (See Figure 5 which shows it as largely absent from granite-rich, north-eastern Tasmania, and completely absent from islands of the Furneaux Group.)

As early as November, recently desiccated growth was observed on *C. austrotenuifolia*,

albeit from plants growing in shallow soils on very exposed sites. Lush specimens growing vigorously in semi-protected sites have been seen during mid to late summer. It is possible that such sites became sheltered after the ferns had become established (e.g. by trees falling and creating a relatively humid niche) but, in their present state, are not suitable for spore germination. Quirk and Chambers (1981) suggest that seasonal dying down of top growth in *C. austrotenuifolia* (and *C. sieberi*) may be partly a response to higher temperatures and longer day lengths—a theory they support by experimental glass-house plants dying down despite watering. However, in the present author's experience, plants in the wild from sheltered sites (as well as plants in cultivation) can remain green year-round. In mid December 1992 (close to the longest day, but following torrential rains in mid November), the majority of plants were still green with emerging new growth. This seems to indicate that 'dying down' is moisture related, with timing and duration of rainfall and site exposure, rather than temperature or daylength, determining dormancy.



Photo 2. *Cheilanthes austrotenuifolia*, a common fern in dry, rocky areas on Fingal Tier and in eastern Tasmania.

Cheilanthes distans (R. Br.) Mett.
Bristly cloak fern

This species represents a new discovery for Tasmania, having been found in 1993 on solitary outcrops near Royal George and near the Apsley River within the Douglas-Apsley National Park (Figure 2). It otherwise occurs in all mainland States and New Zealand.

As plants of *Cheilanthes distans* are only a few centimetres tall, it is possible that the species has been overlooked in the past, and may well occur in areas such as Fingal Tier. It has narrow, dark-green fronds that in the field may at first be confused with those of *C. sieberi*, but are much shorter than fronds of that species. They also have well-spaced lower pinnae and, most importantly, a dense covering of scales on the pinnule undersurfaces.

The Royal George population consists of three small colonies growing in close proximity on an exposed, north-facing,

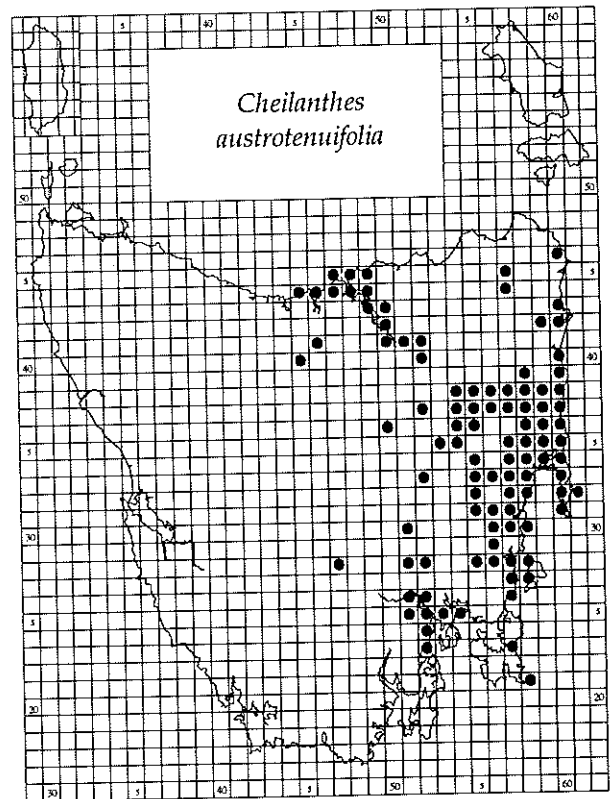


Figure 5. Distribution of *Cheilanthes austrotenuifolia*.



Photo 3. *Cheilanthes sieberi* growing in the crevice of an exposed rock outcrop near Rostrevor Rivulet on Fingal Tier.

sandstone outcrop at 340 m altitude. Each colony is less than 0.5 m² in extent and all occur in shallow soil on rock ledges. The plants are small and stunted and their fronds are sometimes barely visible above a carpet of fallen *Allocasuarina* 'leaves'. Only one colony of *Cheilanthes distans* is known from the Apsley River site, at 125 m altitude. The colony is approximately 1 m in diameter and occurs in a thin, lichen-covered soil layer on a shelf of a north-facing, sloping dolerite platform. In late November 1994 during drought conditions on the east coast, no green top-growth was visible. Very little fertile material from either site has been seen.

Asplenium flabellifolium, *Cheilanthes austrotenuifolia* and *Pellaea calidrupium* are associated with *Cheilanthes distans* at both sites, as well as *C. sieberi* and *Pleurosorus rutifolius* at the Royal George site.

Cheilanthes sieberi Kunze
Mulga fern (Photo 3)

This species is virtually co-extensive with *Cheilanthes austrotenuifolia* in Tasmania but is

less common. It has been recorded from sea-level to 450 m altitude, but there is one anomalous collection at 880 m altitude only a few kilometres south-east of Little Pine Lagoon on the Central Plateau (Figure 6). On Fingal Tier, *C. sieberi* is far less common than *C. austrotenuifolia*, preferring drier and more exposed sites, such as on high slopes and forward margins of shared outcrops. It was recorded from several sites on Fingal Tier, including Ormley Creek, Rostrevor Rivulet and Valley Road, whereas *C. austrotenuifolia* was almost ubiquitous on rocky, dry sites at lower altitudes. *Cheilanthes sieberi* appears to favour the same range of rock types as *C. austrotenuifolia*.

Commencement of new growth and subsequent desiccation is earlier in *C. sieberi* than in *C. austrotenuifolia*, and it would appear that due to the more xeric habit of *C. sieberi*, complete desiccation may be more frequent in this species. However, specimens from Valley Road in mid February 1993 were green and healthy with emerging new growth.

Cheilanthes sieberi superficially resembles *C. austrotenuifolia* but is distinguished by its darker green, narrower and more upright fronds with strongly recurved pinnules. Where top growth is desiccated beyond recognition, any emerging croziers of *C. sieberi* are almost glabrous, while those of *C. austrotenuifolia* have a medium to dense covering of white scales.

Pellaea calidirupium Brownsey & Lovis
Hot rock fern (Photo 4)

This species is uncommon in Tasmania, occurring on the east coast, in the Derwent Valley, and on O'Connors Peak in the Midlands (Figure 7). On Fingal Tier, *Pellaea calidirupium* grows at Ormley Creek, Rostrevor Rivulet, Barway Spur and Bare Rock (Fingal), as well as at Mount Durham. At these places, it grows on north and north-east facing sandstone and weathered dolerite formations between 310 and 700 m altitude. It typically occurs as isolated individuals or as small colonies of several plants. A colony of several contiguous plants appears often to have resulted from an original plant following a microseepage line and separating. Where it occurs near watercourses, *P. calidirupium* grows on higher, drier slopes, and is absent from outcrops and mossy boulders on southern slopes and from sheltered gullies. Such unsuitable sites are typified usually by the presence of kangaroo fern (*Phymatosorus pustulatus* (Forst.f.) Large emend Large) and, occasionally, *Hymenophyllum cupressiforme* Labill.

At least as early as November, and well before spore maturation, the fern's top growth was parched on the most exposed individuals. Spores matured over the period January to March, and it would appear that fronds shrivel during dry periods but have the ability to resurrect following rain. Plants which were both severely exposed and obviously old were commonly observed with juvenile growth only.

Pellaea calidirupium is very closely related to *P. falcata* (R. Br.) Fee, and morphologically the two (at least in Tasmania) are not easy to

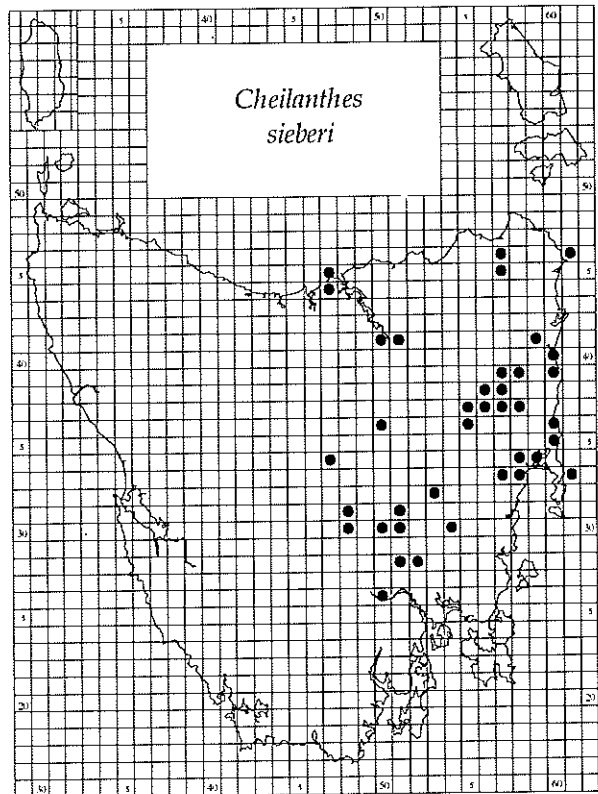


Figure 6. Distribution of *Cheilanthes sieberi*.

separate. Brownsey and Lovis (1990) use the continuous sori around pinnae apices and appressed stipe and rachis scales as key features distinguishing *P. calidirupium* from *P. falcata*. In the author's opinion, these, plus other features they list, could be interpreted as adaptations consistent with a more exposed habitat. A character not mentioned by these workers, but apparent in Tasmanian material of *P. calidirupium*, is the glaucous appearance of unfurling croziers and new growth due to a medium to dense covering of white, hair-like scales. Equivalent growth in *P. falcata* is bright pale-green, with conspicuous dark-brown scales perpendicular to the rachis.

Brownsey and Lovis (1990) also discuss the dry, rocky habitat of *P. calidirupium* in New Zealand. In Tasmania, it is this distinct habitat niche that more clearly separates *P. calidirupium* from *P. falcata*. As well as being terrestrial, *P. falcata* forms extensive colonies over mossy rock surfaces, typically

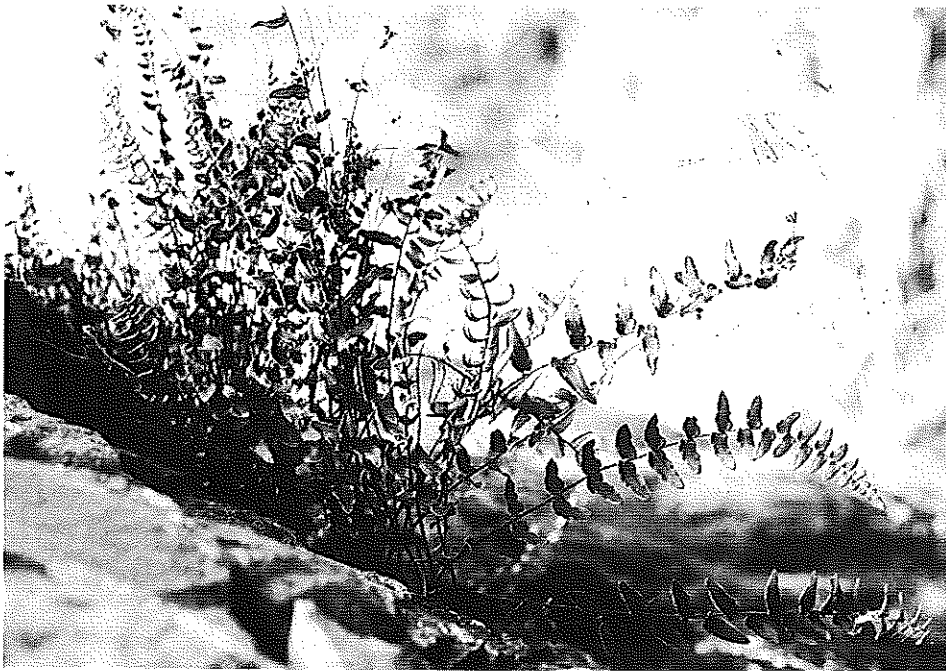


Photo 4. *Pellaea calidirupium* growing in a fissure of a dolerite outcrop near Barway Spur on Fingal Tier.

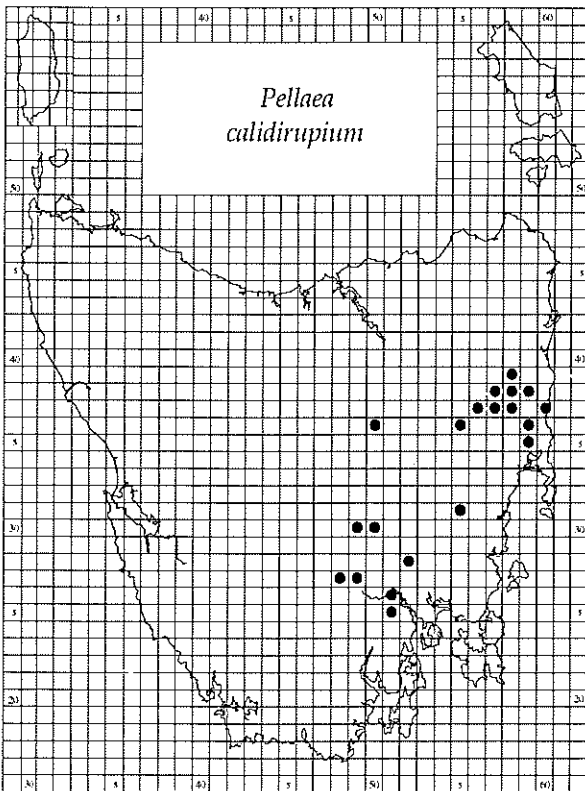


Figure 7. Distribution of *Pellaea calidirupium*.

under light to medium shade, such as on creek margins and higher slopes of fern gullies. *Pellaea calidirupium* occurs on exposed rock outcrops, growing on bare ledges and in crevices under full sun or light shade. Until one recent exception in Tasmania, populations of *P. calidirupium* in dry and exposed habitats had never been observed to extend into more sheltered sites close by as does *P. falcata*. However, on Twelve O'Clock Hill, south-west of Bicheno, the two species do co-exist. This habitat is typical of *P. falcata*—an easterly aspect, with the fern growing on dolerite boulders beneath *Callitris rhomboidea*. *Pellaea falcata* is abundant at this site, but the few colonies of *P. calidirupium* are visibly distinct with their larger and darker green fronds. This site was severely burnt in the bushfires of Christmas 1994.

Pleurosorus rutifolius (R. Br.) Fee
Blanket fern (Photo 5)

This species is uncommon in Tasmania, with populations centred in the Derwent

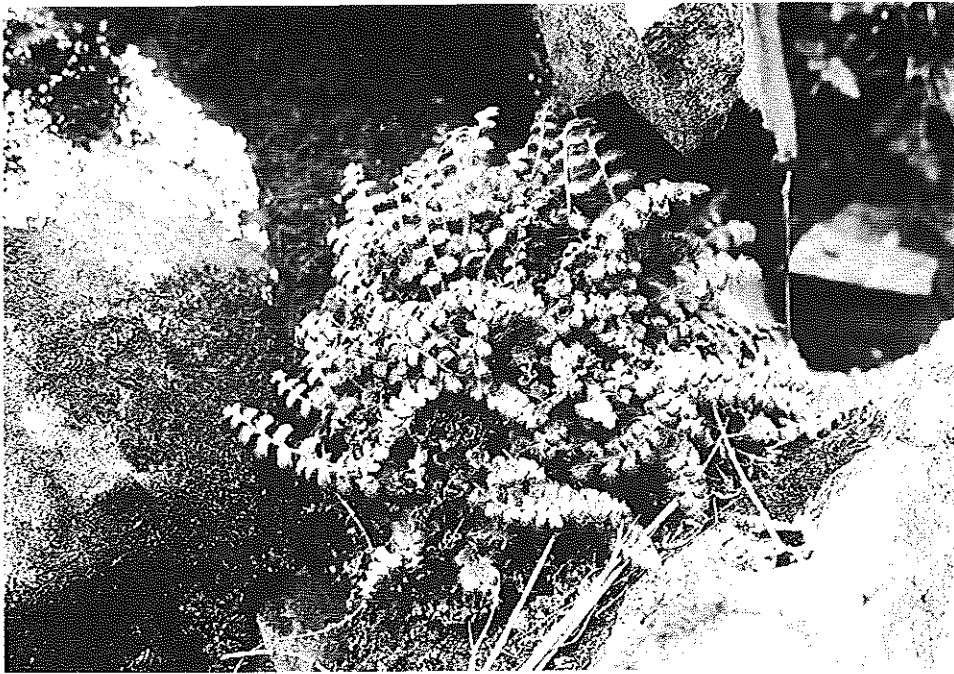


Photo 5. *Pleurosorus rutifolius* on Bare Rock (Fingal).

Valley (including the Wellington Range), Midlands and east coast, and with outliers at Table Cape (Willis 1991) and Flinders Island (Figure 8). *Pleurosorus rutifolius* is located at several sites on Fingal Tier; that is, Ormley Creek, Bare Rock (Fingal) and an unnamed creek draining Coachies Marsh. A very small population exists also on a sandstone outcrop above Lohreys Creek at St Marys Pass (where it grows with *Cheilanthes sieberi*), an area of much higher rainfall.

On Fingal Tier, *P. rutifolius* grows on exposed north to north-east facing outcrops between 400 and 600 m altitude. When occurring on gully slopes, it is rare at creek-level, more common on higher slopes, but absent at the very tops of surrounding ridges. The species grows in crevices and on ledges, in soil pockets usually devoid of other plant life except occasional mosses and liverworts. Nearly all microhabitats are protected from direct rainfall, the ferns appearing to rely solely on water seepage. At some sites, *P. rutifolius* grows on cliff

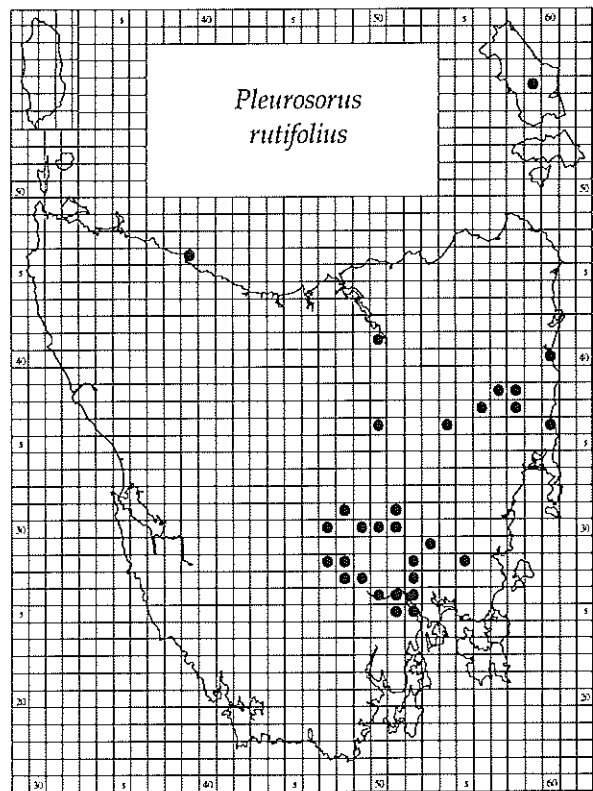


Figure 8. Distribution of *Pleurosorus rutifolius*.

tops in the bare soil at the junction of bare rock and vegetation. Although found on both sandstone and dolerite, the species is more common on the former substrate, possibly because of its greater capacity for water retention.

Desiccation of top growth was common amongst plants during early November, but spores had already matured and in most cases had been shed. By early summer, nearly all plants were desiccated so severely that they were difficult to locate.

Other fern species

Several other fern species on Fingal Tier and elsewhere in Tasmania are marginal to exposed rock outcrops. *Doodia media* R. Br. is common on a single steep drainage line in dolerite at 450 m altitude on Bare Rock (St Marys), occurring beside *Cheilanthes austrotenuifolia* and *Asplenium flabellifolium*. The same species grows also in the rock rubble surrounding the base of the outcrop containing *Cheilanthes distans* near the Apsley River. *Ophioglossum lusitanicum* L. (Photo 6) is abundant at the exposed and treeless summit of Bare Rock (Fingal), growing in bare soil amongst rock. Here, as at some other sites within the State, it grows with *Cheilanthes austrotenuifolia*. *Ophioglossum lusitanicum* was observed also at the summit of one of the Mount Durham outcrops discussed previously.

Pteridium esculentum (Forst.f.) Cockayne is terrestrial around the base of some outcrops but is absent at sites where *Pleurosorus rutifolius*, *Pellaea calidirupium* and *Cheilanthes sieberi* are more prevalent and where soils are possibly too rocky and impoverished. *Phymatosorus pustulatus* and *Hymenophyllum cupressiforme* are lithophytic on, and *Polystichum proliferum* (R. Br.) C. Presl terrestrial near, columnar doleritic outcrops too sheltered for xerophytic species (except *Asplenium flabellifolium*). This habitat is common on Fingal Tier, occurring on more protected east, through south, to south-west facing slopes, on creek margins, and above 600 m altitude on some north-facing outcrops.

Although this habitat and that of xerophytic ferns can virtually border each other, as on eastern slopes or steep, north-facing slopes above sheltered creeks, the two groups of ferns are never found growing together.

It is interesting to note that near the Falls of Clyde on the River Clyde, *Cystopteris tasmanica* Hook. grows on the same basalt cliff-face as *Pleurosorus rutifolius*, *Pellaea calidirupium* and *Asplenium trichomanes*. *Cystopteris tasmanica* is an uncommon fern in Tasmania and is usually associated with more sheltered habitats at higher altitudes.

Discussion

The distribution of xerophytic fern species in areas of low to moderate rainfall (Fingal Tier) to areas of moderate to high rainfall (St Marys Pass) indicates a preferred microhabitat of sunny and exposed north-facing rock-faces. The length of time the plants are evergreen appears to be determined by moisture availability (i.e. it is related to length and regularity of rainfall and to site exposure).

Asplenium trichomanes subsp. *trichomanes*, *Cheilanthes distans*, *C. sieberi*, *Pellaea calidirupium* and *Pleurosorus rutifolius* are restricted to northern and north-eastern aspects. *Anogramma leptophylla* and *Cheilanthes austrotenuifolia* extend to more sheltered slopes, while *Adiantum aethiopicum* and especially *Asplenium flabellifolium* occur on a wide range of aspects.

Anogramma leptophylla, *Asplenium trichomanes* subsp. *trichomanes*, *Cheilanthes distans*, *Pellaea calidirupium* and *Pleurosorus rutifolius* were observed growing only on ledges and in crevices of rock outcrops. *Adiantum aethiopicum*, *Asplenium flabellifolium*, *Cheilanthes austrotenuifolia* and *C. sieberi* grow in rocky soils as well as on outcrops.

Rock-type preference is summarised in Table 4. *Anogramma leptophylla* was observed only on dolerite during the study, but an 1840 collection from Macquarie Plains held in the



Photo 6. *Ophioglossum lusitanicum* growing in bare soil amongst rocks at the summit of Bare Rock (Fingal).

Tasmanian Herbarium may represent plants that grew on basalt. Note that the relatively common species, *Cheilanthes austrotenuifolia* and *C. sieberi*, have not been recorded as growing on basalt. Where *Asplenium trichomanes* subsp. *trichomanes*, *Cheilanthes distans*, *Pellaea calidrupium* and *Pleurosorus rutifolius* occur on dolerite, they are restricted to weathered and often sloping formations. These species are absent from smooth, columnar doleritic outcrops.

Differences in the length of time plants are evergreen are displayed by all species. For example, *Anogramma leptophylla*, *Cheilanthes distans* and *Pleurosorus rutifolius* are totally deciduous over summer, while *Adiantum aethiopicum*, *Cheilanthes austrotenuifolia* and *C. sieberi* are almost completely so. *Asplenium flabellifolium* is evergreen while *A. trichomanes* subsp. *trichomanes* and *Pellaea calidrupium* differ from other species susceptible to dehydration in that withered fronds appear able to resurrect with the addition of water. Some epiphytic ferns from Tasmanian rainforest and rainforest margins also display

a similar ability to resurrect. They include several filmy ferns (especially *Hymenophyllum cupressiforme* but also *H. marginatum* Hook. and Grev. and *H. rarum* R.Br.), as well as *Ctenopteris heterophylla* (Labill.) Tind., *Grammitis magellanica* Desv. subsp. *nothofagei* Parris and *G. pseudociliata* Parris.

Survival strategies

The xerophytic ferns display varying degrees of adaptations to cope with their harsh environment. Species of *Cheilanthes* have small dissected leaves as an aid to reduce overall water loss through evaporation; the leaves of *Pleurosorus rutifolius* have a dense covering of hairs for the same purpose; *Anogramma leptophylla* survives during summer months as a prothallus only; and the rhizomes of some other species are densely scaly to prevent drying out over summer. Nearly all species have fronds arising close together on short- to medium-creeping rhizomes, the dense covering of old stipe bases and current season's frond growth helping to protect the growing point of the plant.

Table 4. Rock-type preference of fern species occurring on dry rock outcrops in Tasmania.

	Rock type			
	Dolerite	Sandstone	Granite	Basalt
<i>Adiantum aethiopicum</i>	+	+	+	+
<i>Anogramma leptophylla</i>	+			(+)
<i>Asplenium flabellifolium</i>	+	+	+	+
<i>Asplenium trichomanes</i> subsp. <i>trichomanes</i>	+			
<i>Cheilanthes austrotenuifolia</i>	+	+	+	
<i>Cheilanthes distans</i>	+	+		
<i>Cheilanthes sieberi</i>	+	+	+	
<i>Pellaea calidirupium</i>	+	+		+
<i>Pleurosorus rutifolius</i>	+	+		+

Prothalli from only a few days old to sporophyte production are able to resurrect in Australian species of *Cheilanthes* (Quirk and Chambers 1981), and are far more tolerant of extremes of dryness than gametophytes of ferns from more 'normal' habitats.

The more extensive creeping rhizomes in old plants of *Adiantum aethiopicum* and *Pellaea calidirupium*, and to a lesser degree *Cheilanthes austrotenuifolia*, may aid in the dispersal of these species. *Asplenium flabellifolium* can spread from bulbils produced at frond tips, and all species are capable of reproducing from spores.

Apogamy is advantageous amongst xerophytic ferns, and has been reported for *Asplenium flabellifolium* (Brownsey 1977) and *Cheilanthes sieberi* (Quirk *et al.* 1983). In this short-cut reproductive mechanism, the sporophyte is produced from the gametophyte without the usual sexual phase of the plant's life cycle. This is advantageous for xerophytic ferns because free water is not required for fertilisation, allowing plants to mature more quickly (Camus *et al.* 1991). For example, spores of *Cheilanthes sieberi* sown by the present author visibly germinated within two weeks. The first sporophytes appeared after a further six to eight weeks, and fertile fronds were produced six to seven months after the initial sowing (under glasshouse conditions). This compares with the sexually reproducing, rare (in Tasmania) wet-forest treefern, *Cyathea cunninghamii* Hook.f., which

preliminary investigations indicate may not reach maturity till 20 to 25 years of age (M. Garrett, unpublished data).

While Quirk *et al.* (1983) claim *Cheilanthes austrotenuifolia* to be sexually reproductive, gametophytes of this species raised by the present author appeared to indicate an apomictic nature, by virtue of the speed and evenness of sporophyte production (comparable with *Asplenium flabellifolium*, *Cheilanthes sieberi* and commercially grown and recognised exotic apomictic species). Raised gametophytes of *Adiantum aethiopicum* displayed a more typical sexual mode, sporophytes being produced at different times in older gametophytes. The author has no personal knowledge of spore reproductive modes for other species, although Brownsey and Lovis (1990) suggest that *Pellaea calidirupium* may be sexually reproductive.

Threats

On extremely exposed outcrops, sporelings or weak plants of all species may conceivably perish during severe drought. However, populations overall are not affected. Xerophytic ferns would appear resistant to fire, by virtue of their sparsely vegetated and isolated habitat, and their protected rhizome or growing point that is preconditioned to survive desiccation of top growth. In nearly all cases, the topography surrounding rock outcrops renders the sites unsuitable for

agriculture or forestry. However, stunted plants have been observed from lone outcrops amidst pasture, and terrestrial *Cheilanthes sieberi* and *C. austrotenuifolia* can occur in grazed grasslands. No outcrops were observed within logged areas.

No instances of grazed plants have been observed that could be attributable to either native mammals or feral animals. Outcrops are mostly inaccessible to livestock, but no grazing damage to xerophytic species from outcrop perimeters has been observed. Furthermore, some species are toxic to stock. *Cheilanthes sieberi* has been identified as poisoning sheep and cattle (Everist 1974) and *C. distans* has been suspected of poisoning although there is no conclusive evidence. *Cheilanthes austrotenuifolia* is similarly suspect but past taxonomic uncertainty between this species and *C. sieberi* confuses the matter. Stock has been known to feed on *Cheilanthes* species only during periods of severe food shortage. *Asplenium flabellifolium* is also under suspicion as it yields the toxin prussic acid (Everist 1974).

Disturbance of the more usual fern habitats by controlled burns, clearing or grazing on their perimeters may bring harmful consequences such as over-exposure and invasion by weeds. However, rock outcrops appear little affected by such actions because the environment is already exposed and too hostile for most weeds. Nevertheless, quarrying may pose a threat. For instance, *Asplenium trichomanes* subsp. *trichomanes* and other xerophytic fern species occur only several metres above the worked face of a disused quarry at the Valley Road site.

Conservation status

Anogramma leptophylla, *Asplenium trichomanes* subsp. *trichomanes* and *Cheilanthes distans* are very rare in Tasmania, *Pellaea calidrupium* and *Pleurosorus rutifolius* are uncommon, and *Adiantum aethiopicum*, *Asplenium flabellifolium*, *Cheilanthes austrotenuifolia* and *C. sieberi* are all common. But statewide observations made during the larger pteridophyte survey would indicate that of all the habitats occupied by

ferns, dry and exposed rock outcrops are the least threatened, either by natural or man-made agencies.

Only two extant populations of *Anogramma leptophylla* are presently known in Tasmania. The species grows on several of the higher rock ledges of a cliff-face at Sensation Gorge near Mole Creek, and on rock outcrops near Glenorchy at the foothills of Mount Wellington. *Asplenium trichomanes* subsp. *trichomanes* is known only from Valley Road and from the two outcrops on Mount Durham and *Cheilanthes distans* is known only from Royal George and near the Aspley River. Of these three very rare taxa, *Anogramma leptophylla* is the only one known to be in apparent decline. The two others were not discovered, or at least not recognised, until this survey. All collections in Australian herbaria of Tasmanian *A. leptophylla* were collected last century (from Cataract Gorge and Macquarie Plains) or very early this century (Glenorchy). Although the species is still extant on an outcrop near Glenorchy, recent repeated searching has failed to re-locate the species at Cataract Gorge (B. Robinson, pers. comm.) or at Macquarie Plains. Ledges on seemingly suitable outcrops at Macquarie Plains are now heavily infested with weeds, and *Rosa rubiginosa* (briar) is naturalised in surrounding soil pockets.

Reservation status

Anogramma leptophylla and *Asplenium trichomanes* subsp. *trichomanes* are not known from within any secure Tasmanian reserve. *Cheilanthes distans*, *Pellaea calidrupium* and *Pleurosorus rutifolius* are each known only as a few plants within single reserves, while larger populations of these species occur outside existing reserves. *Adiantum aethiopicum*, *Asplenium flabellifolium*, *Cheilanthes austrotenuifolia* and *C. sieberi* are adequately reserved in Tasmania.

Cheilanthes distans and *Pellaea calidrupium* are reserved only within the Douglas-Apsley National Park where they both occur on the same solitary outcrop. *Cheilanthes distans* is otherwise known as several small colonies on

one outcrop on privately owned land near Royal George. Populations of *Pellaea calidirupium* worthy of consideration for reservation exist at Mount Durham, Bare Rock (Fingal) and near the Falls of Clyde on the River Clyde. Several plants only of *Pleurosorus rutifolius* are known from the species' sole Tasmanian reserve, St Marys Pass State Reserve. Larger populations exist on Fingal Tier, such as at Bare Rock (Fingal), and in the Derwent Valley. A population at Parramore Creek, below Mount Faulkner, is notable for its luxuriance in both number and state of growth of its plants. Sporelings of *Pleurosorus rutifolius* were also abundant at this site, and were not observed elsewhere during the survey.

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