The Rare Grass *Simplicia laxa*

Field Status, Ecology, and Conservation

SCIENCE FOR CONSERVATION: 15

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Published by
Department of Conservation
P.O. Box 10-420
Wellington, New Zealand

Science for Conservation presents the results of investigations contracted to science providers outside the Department of Conservation. Reports are subject to peer review within the Department and, in some instances, to a review from outside both the Department and the science providers.

March 1995, Department of Conservation

ISSN 1173-2946
ISBN 0-478-01688-3

This publication originated from work done under Department of Conservation contract No. 1587, carried out by: P. N. Johnson, Manaaki Whenua-Landcare Research, Private Bag 1930, Dunedin. It was approved for publication by the Director, Science and Research Division, Department of Conservation, Wellington.

This paper, produced by Landcare in 1993, has also appeared under the same title as Landcare Research Contract Report LC 9394/42.

Cataloguing-in-Publication data

Johnson, P. N. (Peter Nevill), 1946-
The rare grass Simplicia laxa : field status, ecology, and conservation / P.N. Johnson. Wellington, N.Z. : Dept. of Conservation, 1995.
1 v. ; 30 cm. (Science for conservation, 1173-2946; 15.)
Includes bibliographical references.
ISBN 0478016883
1. Grasses-New Zealand. I. Title. 11. Series: Science for conservation; 15.
584.90993 20
zbn95-017205

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1. Introduction

Simplicia laxa is classified in the DoC Priority Ranking System (Molloy & Davis 1992) in category I (species about which little information exists, but which are considered threatened).

The endemic grass genus *Simplicia* comprises 2 species: *S. buchananii* (classified as Local) and *S. laxa* (classified as Endangered (Cameron et al. 1993). *Simplicia laxa* is the type of the genus; it was described from a composite of specimens gathered from the Ruamahanga Valley, eastern Wairarapa, Waikouaiti and Deep Stream, Otago, by Kirk and Petrie (Kirk, 1897).

The species was not seen again for over 90 years, until its accidental rediscovery by I.M. Ritchie in 1969 at Castle Rock, Old Man Range, Central Otago (Zotov 1971). The plant collected by Ritchie was cultivated for a time at Lincoln, as noted by Zotov (1971), but its fate is unknown. Over the next two decades it seems no botanist revisited the Castle Rock site, and *Simplicla laxa* again faded into the realm of being unfamiliar to botanical and conservation workers. In the process of scoring threatened species for conservation priority, carried out by DoC in 1991 (Molloy & Davis 1992), *Simplicia laxa* was the most highly rated of plants.

In June 1991, Dr B.P.J. Molloy chanced upon a small population of S. laxa in a disturbed and vulnerable habitat, while botanically fossicking in limestone country in North Otago. Cuttings were brought into cultivation at Landcare Research, Lincoln. His discovery gave immediate direction to further studies.

The aims of the present investigation were to understand the ecology, habitat requirements, population sizes, and conservation requirements of *Simplicia laxa*. The study has been funded by Science and Research Division, Department of Conservation.

2. Objectives

1 Conduct field studies to establish population size and ascertain habitat requirements.

2 Increase numbers of plants in cultivation and distribute live material to additional rare plant cultivators.

3 Produce illustrated document enabling DOC staff and other field workers to recognise *S. laxa.*

4 Assemble information towards a draft recovery plan.

5 Add to descriptive knowledge on morphology, habit, and phenology from observations of cultivated plants.

3. Methods

The North Otago *Simplicia laxa* site was visited on 7 May 1992, with Brian Molloy (Landcare Research) and Peter de Lange (DoC Wellington), and we searched other limestone country nearby, and in the Awahokomo Valley south of Lake Waitaki. On 23 January 1993 limestone outcrops in the Ngapara area, North Otago, were searched, the *Simplicia* site revisited, and seedling plants added to the population there. Initial progress of these was monitored on 25 September 1993.

On the Old Man Range, searches were made at Prophets Rock on 19 April 1991 and again more thoroughly on 21 May 1993. Rock tors in the Conroys Creek catchment were examined on 2 January 1993, and a few *Simplicia plants* discovered at Castle Rock just as the weather turned foul at the end of the day. Castle Rock was studied in more detail on 30 March 1993, in the company of Bruce McKinlay, Graeme Loh (both DoC, Dunedin), Don Bruce, Ian Southey, and Anita Middlemiss.

Simplicia laxa was found near Nenthorn, North Otago, by Graeme Loh on 17 July 1993. 1 studied this site in more detail on 20 July 1993 with Graeme Loh, Brian Patrick, and Neill Simpson (all DoC, Otago).

Other potential *Simplicia laxa* habitats in Otago and Southland were examined, partly in the course of other studies, as follows:

Deep Stream, Rocklands, Otago, 7 June 1992.

Trotters Gorge, North Otago, 1 October 1992.

Deep Stream confluence, Taieri River, Otago, 21 February 1993

Borland Valley Limestone Cavern, East Fiordland, 9 March 1993

Taieri Gorge above Outram, East Otago, 14 March 1993

Remarkables Range, Wye Creek gorge, Central Otago, 27 March 1993

Waipori Gorge, East Otago, 10 April 1993

N. Waikouaiti River, North Otago, 12 April 1993

Gorge Creek, Old Man Range, Central Otago, 24 May 1993

Waikouaiti coast, Cornish Head, East Otago, 27 June 1993

Plants of *Simplicia laxa* were brought into cultivation from the Ngapara site (by Brian Molloy, Landcare Research, Lincoln), from Castle Rock, and from Nenthorn. Other grass species from similar habitats and of similar growth habit were also brought into cultivation, to assist with morphological comparison, and for future experimental work.

A report describing *Simplicia laxa*, and illustrating also nine other species with which it might be confused, was prepared and distributed to DoC staff and botanists, in order to encourage more pairs of eyes to look out for this rare grass.

Discussions were held with Ian Williamson, QE II National Trust representative, towards securing protection of the Ngapara site, and the adjacent landowner,

Brent Harvey of The Knolls, was shown the plant and site. The landowners of Earnscleugh Station, Mr and Mrs A. Campbell were made aware of the presence of *Simplicia* at Castle Rock.

4. Results

4.1 *SIMPLICIA*, A BRIEF HISTORY

The genus *Simplicia* was founded by Thomas Kirk in 1897, with *S. laxa* based on two collections from Otago and one from the Wairarapa (Zotov, 1971). The species was not collected again until Ian Ritchie found it 1969 on the Old Man Range, Otago. In 1991 Brian Molloy found it north-west of Ngapara in North Otago.

The only other species was described by John Buchanan in 1880, originally under the name *Poa uniflora,* from a collection by Alexander Mackay from Mt Arthur, NW Nelson. This too went undiscovered again until 1965, when Ian Ritchie was again the finder. Victor Zotov re-classified and renamed the plant *Simplicia buchananii,* and it has since been more widely collected in NW Nelson.

The genus *Simplicia is* endemic to New Zealand, and has no close relatives here. Zotov (1971) considered it to be most similar to the western Pacific *Aulacolepis,* a genus now known as *Aniselytron* (Korthof & Veldkamp, 1984), but this relationship is unlikely.

4.2 HABITATS OF *SIMPLICIA BUCHANANII*

The habitats of *Simplicia buchananii,* the only other species in the genus, might give us clues as to the type of habitats where *S. laxa* might be expected. S. *buchananii is* known only from NW Nelson, from a wide altitudinal range (270 - c.1400 m), mainly in forest, and often on limestone or marble. Specimens in Landcare Research Herbarium at Lincoln (CHR) indicate the following specific habitats: cave mouth, stony valley floor, cliff, marble rock face, bluff, limestone face, steep side of sink-hole, and under sloping rock (in open grassland).

4.3 THE HISTORICAL SITES OF *SIMPLICIA LAXA*

From the three collection sites of last century we can build up a limited picture of distribution and habitats, as follows.

Deep Stream, Otago

Collections by D. Petrie form the basis of this record: "Deep Stream Hotel, Old Dunstan Road, Feb 1877", CHR 408.3. The CHR specimen is vegetative only.

Zotov (1971) notes specimens also at AK and WELT. The WELT specimen (43018) states "in shade of a rock not far from road side (Peter de Lange, pers. comm.).

Donald Petrie used his travels as an inspector of schools to botanise on the way. The Dunstan Trail was the route to the Otago goldfields, and there were two hotels on either side of the Deep Stream crossing (George Griffiths, Otago Heritage Books; Rodney Russ, Southern Heritage Expeditions: personal communications). This site is near the present Rocklands Station homestead (map reference 144/ 752 995, altitude 360 m, mean annual rainfall c. 600 mm.). It is gently rolling hill country, on schist, still with some narrow-leaved snow tussock (Chionochloa rigida) grassland, though much of it now developed to pasture.

It is likely Petrie would have collected his grass from beneath schist outcrops either along the slightly incised stream courses or from tors on the hill crests. I examined a few of the larger tors on the road west of Deep Stream crossing in June 1992, but failed to find *Simplicia laxa*, nor any very likely habitat.

The more deeply gorged schist country of the lower Deep Stream, 17 km to the east, and near its confluence with the Taieri (144/ 999 972) was visited in February 1993. The narrow gorge bed is dense with willows and the steep lower slopes choked with elder, broom, blackberry and brier, growing among bracken and native bush remnants of broadleaf, kohuhu, cabbage trees, coprosma, and creepers. A preliminary search, limited by my struggle with this vegetation and its prickly precarious nature, failed to reveal any *S. laxa*, but there are numerous bluffs with clefts, crevices, and occasional caves where the rare grass might still persist.

Ruamahanga Valley, Wairarapa

The following collection, from the Wairarapa, is the only North Island record: "Lower Ruamahanga Valley, Dry River Station. T. Kirk, Jan 1880", CHR 6279. (Zotov, 1971 notes a specimen also at WELT).

Peter de Lange notes (pers. comm.): "Kirk's material is beautiful but location is unhelpful. The Dry River is a tributary to the Ruamahanga River (c. S.27/ 095855). His plants are etiolated, suggesting they grew in very low light levels. The area he most probably gathered *Simplicia laxa* is from a long wide valley with numerous calcareous sandstone and limestone outcrops and several caves. The soils are standard yellow-brown earths and yellow-grey earths, and the climate dry (c. 900 mm rain/year)." Over the last year, Peter de Lange (pers. comm.) has begun a systematic search of rock overhangs of the Dry River/ Blue Creek limestones, but without yet finding *S.laxa.*

Waikouaiti, Otago

D. Petrie made his second collection from Waikouaiti, c.1880, (AK 1370). Zotov (1971) notes specimens also at CHR and WELT. The lectotype (WELT 43021) states "near sea". Waikouaiti is on the Otago coast, north of Dunedin. The coast here has rolling low hills (to c. 150 m high), now mostly pasture, overlying

Miocene Caversham Sandstone and Goodwood. Limestone. Annual rainfall is c. 600 m.

I visited the portion of this coast that is closest to Waikouaiti, namely Cornish Head in June 1993. The south face of this headland has scarps, slumps, and tumbled blocks of the sedimentary rocks, with very small pockets of remnant coastal forest, mainly ngaio. A few shady clefts and slight overhangs were encountered, and though no *Simplicia* was seen, the site would warrant further searching.

4.4 *SIMPLICIA LAXA* ON THE OLD MAN RANGE

I. M. Ritchie made the following collection: "Old Man Range, Castle Rock, c. 1000 m., in shade of rocks. 25.10.1969." (CHR 202752). This site is in Central Otago, about halfway up the north-east flank of the Obelisk Range (north end of Old Man Range).

There are two particularly massive schist tors in this area to which the name Castle Rock has been applied, leading to some difficulty in determining which had been Ritchie's collection site. On the one-mile map (NZMS 1) Castle Rock was shown at S.143/ 067407, the higher altitude of the two tors. From a recent notice of a New Zealand Geographic Board decision, and since publication of the metric map (NZMS 260, sheet G42) the following situation has become apparent:

Prophets Rock is the name now given to the higher altitude for (G42/155 400, 1020 m altitude, in the Omeo Creek catchment). I failed to find any S. *laxa* at this site in April 1991, nor in May 1993 (by which time I was more familiar with the grass I was searching for).

Castle Rock is located some 2.5 km to the south-east of the above, at G42/175 389, 700 m altitude, in the head of Conroys Creek. Having confirmed in January 1993 that S. *laxa* still occurs beneath shaded overhangs at this tor, I conclude that this also was the site of Ritchie's 1969 collection, and that his use then of the name Castle Rock was based either on local knowledge, or else he cited the only named rock feature (and its higher altitude) as they appeared on the topographic map then available.

Castle Rock is a massive schist for about 150 x 60 m, the long axis aligned north-west, and some 40 m high. It sits on an undulating hill slope of north-east aspect, among short tussock grassland of hard tussock (*Festuca novae -zelandiae*) and silver tussock (*Poa cita*), and scattered scrub of matagouri (*Discaria toumatou*). Like most schist tors, Castle Rock has ledges with speargrass, blue tussock, woodrushes and lichens, and crevices containing shrubs such as *Coprosma propinqua*, *Corokia cotoneaster*, and *Melicytus alpinus*. But Castle Rock is also rent by deep clefts (Fig 3) with cool shaded floors.

The four cleft and ledge sites where *Simplicia laxa* grows are shown in Fig. 1, and the vegetation composition of two of these sites is shown in Tables 1 and 2. Site A is a cleft some 9 m long, 1 m wide and 6 m deep, with a gently sloping floor of fine dusty soil. Vegetation cover was estimated within 1 m sections of the floor. Thirteen *Simplicia* plants were present, accounting for just 4% mean

cover, the more common plants being the grass *Poa matthewsii* and etiolated shrubs of *Coprosma propinqua*. To enter this cleft requires a scramble up a rock step and past an elder tree at the entrance: these features probably preclude sheep and rabbits entering.

Site B is the major cleft visible in Fig. 3. Table 2 shows estimated percent cover of plant species along nine sections of the cleft edges (Fig. 1), and within 0.5 m of the rock wall base, i.e. the zone where *Simplicia laxa* occurs. At least 35 *Simplicia* plants grow here (3% mean cover), both along the line where vertical rock meets the low grass sward of the cleft floor, and beneath small basal overhangs. The most common associated plants along the rock wall base are the native grasses *Poa matthewsii* and *Poa breviglumis*, and the naturalised chickweed *Stellaria media*. This habitat contains a diverse flora of 23 native and 14 naturalised species. Away from the rock walls the main floor of the cleft has a sward of naturalised grasses (*Hordeum murinum*, *Bromus hordeaceus*, *Testuca rubra*) and weedy herbs (especially *Stellaria media*, *Conium maculatum*, *Urtica urens*, and *Rumex acetosella*). It is of interest that *Simplicia laxa* survives in this cleft despite ready access by grazing animals.

Site C, the ledge visible in centre left of Fig. 3, contained seven *Simplicia* plants in somewhat different habitat conditions. They grow as scattered individuals among otherwise mostly unvegetated gritty ground, littered with fallen rocks, dry because of the overhang above, but well-lit and probably catching some afternoon sun in contrast to the more usual, deeply shaded habitat.

Site D is a cleft 2 m wide with a steep, well-lit grassy floor and at least 21 *Simplicia laxa* plants at the cleft edges and beneath fallen blocks of rock.

The total of 76 *Simplicia laxa* plants at Castle Rock is a conservative figure, representing numbers of discrete patches, mostly 10 - 20 cm in diameter, any one of which might contain more than one individual. Most plants had at least some inflorescences of the current season. Seedlings were not immediately apparent, but nor were they specifically searched for. Their recognition would take an identification effort additional to that required to separate mature *Simplicia laxa* plants from other grass species at the site. However, all plants seen were healthy and vigorous, with a range of mat sizes, suggesting that the population is reproducing and maintaining itself.

4.5 *SIMPLICIA LAXA* NEAR NGAPARA, NORTH OTAGO

In June 1991 Brian Molloy discovered *Simplicia laxa* near Ngapara, in the shaded rear of a shallow cave-like overhang in limestone, on a roadside site which would have escaped attention from livestock. The site is at 141/ 263849, at 300 m altitude (Fig. 7), in limestone country, of low rolling hills, with limestone escarpments outcropping along the flanks of stream valleys. Simplicia grows beneath a 3 m high overhanging escarpment of southerly aspect which runs parallel to and some 6-8 m back from a tarsealed road. Above the escarpment is grazed pasture on almost level ground. There is no fenceline here.

FIG. 1 CASTLE ROCK, OLD MAN RANGE NZMS 260 G42/175 700 M ALT. SKETCH MAP BASED ON AIR PHOTOS 2886/5-6 SHOWING LOCATIONS OF THE RARE GRASS *SIMPLICIA LAXA*, 30.3.1993 IN ROCK CLEFTS A-D. NUMBERED SECTIONS OF CLEFT B ARE VEGETATION DESCRIPTION SITES. NUMBERS OF *SIMPLICIA LAXA* PLANTS: A - 13, B - 35, C - 7, D - 21. AT LEAST 76 TOTAL.

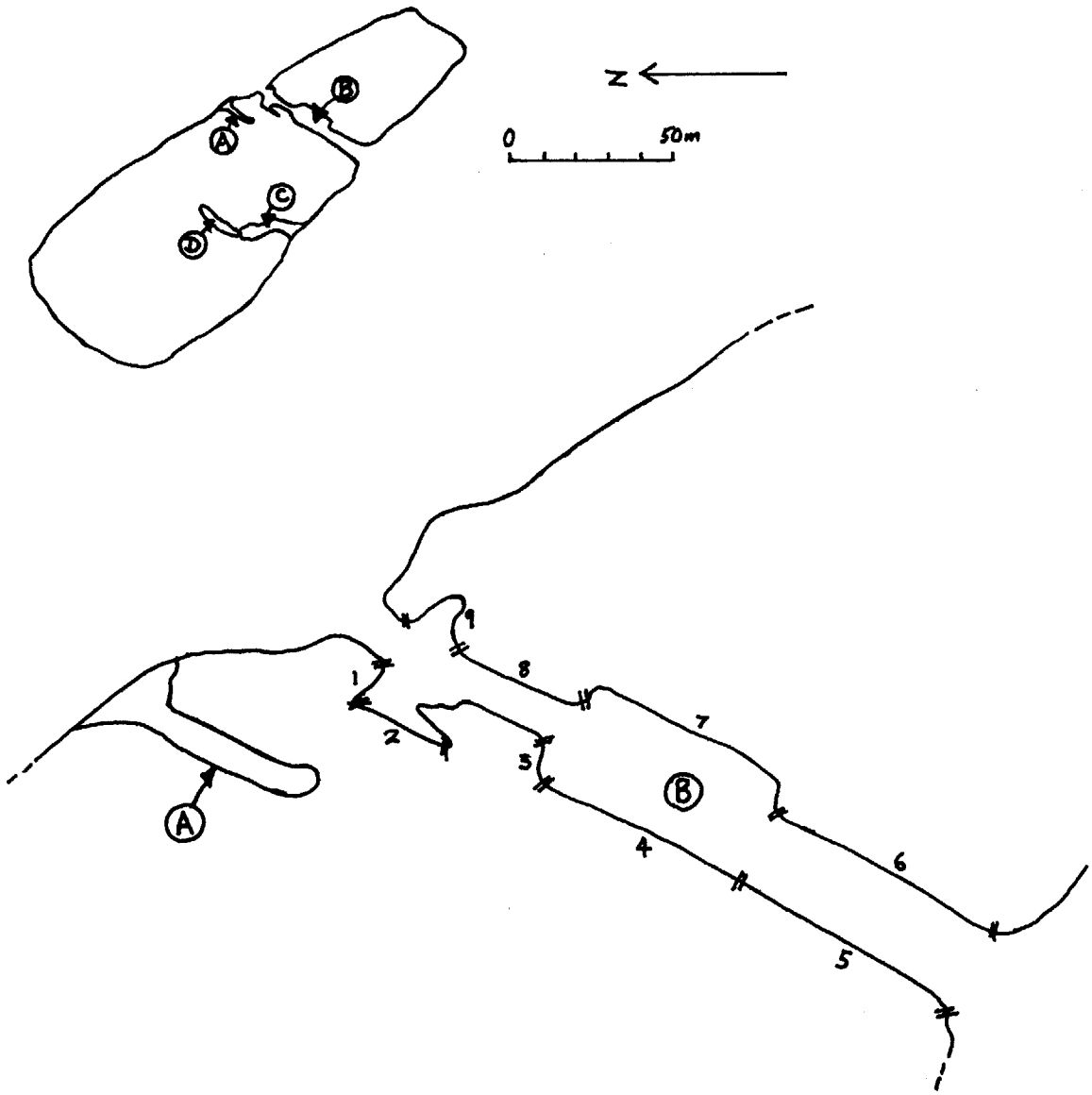
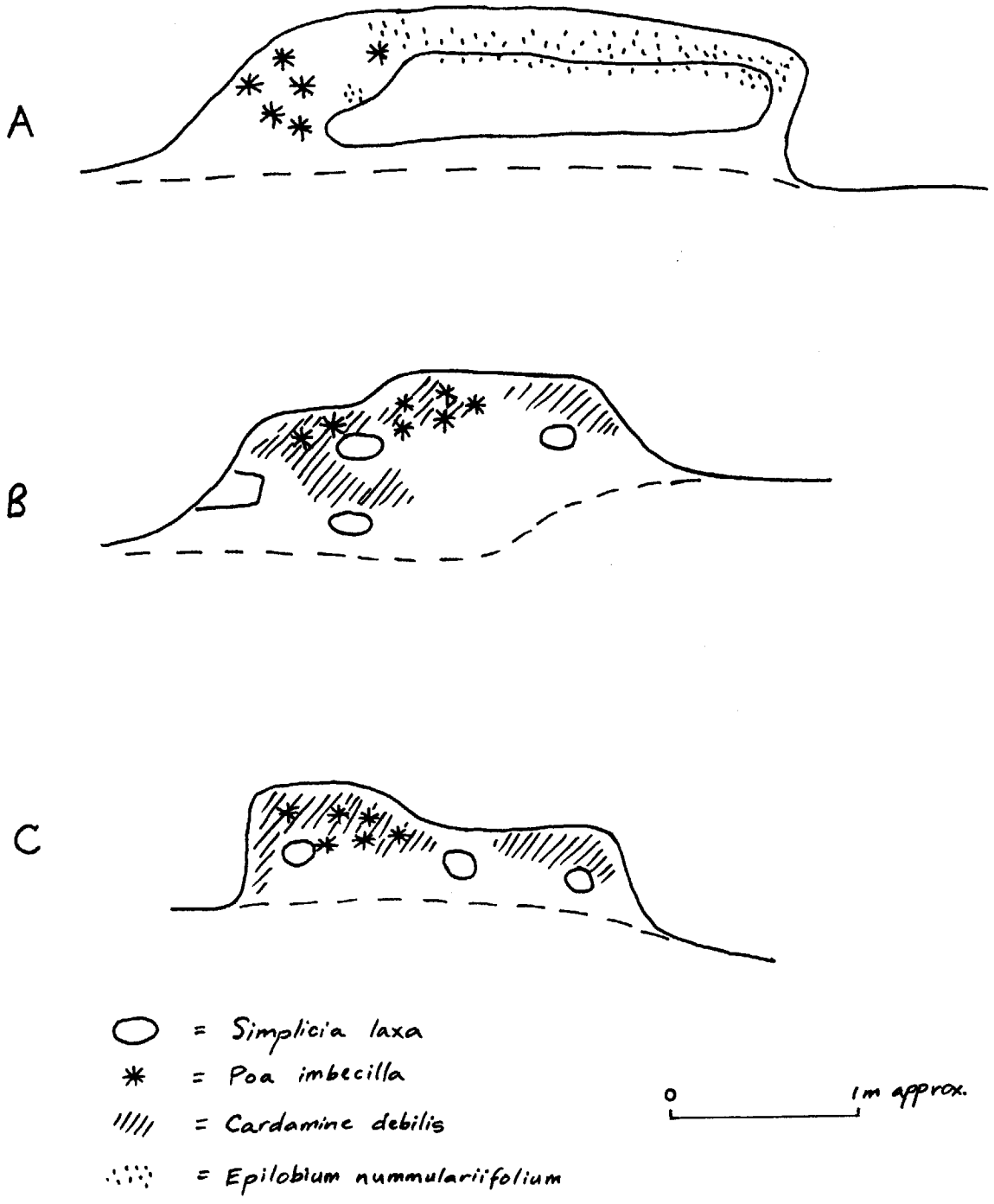


FIG. 2 NORTH OTAGO, SIMPLICIA LAXA SITE NEAR NGAPARA SHOWING VEGETATION IN SHALLOW CAVES. A = CAVE WITH WILD POPULATION OF S. LAXA, B = CAVE 18 M TO WEST OF A WITH NEW PLANTINGS OF S. LAXA, C = CAVE 12 M TO WEST OF A WITH NEW PLANTINGS OF S. LAXA.



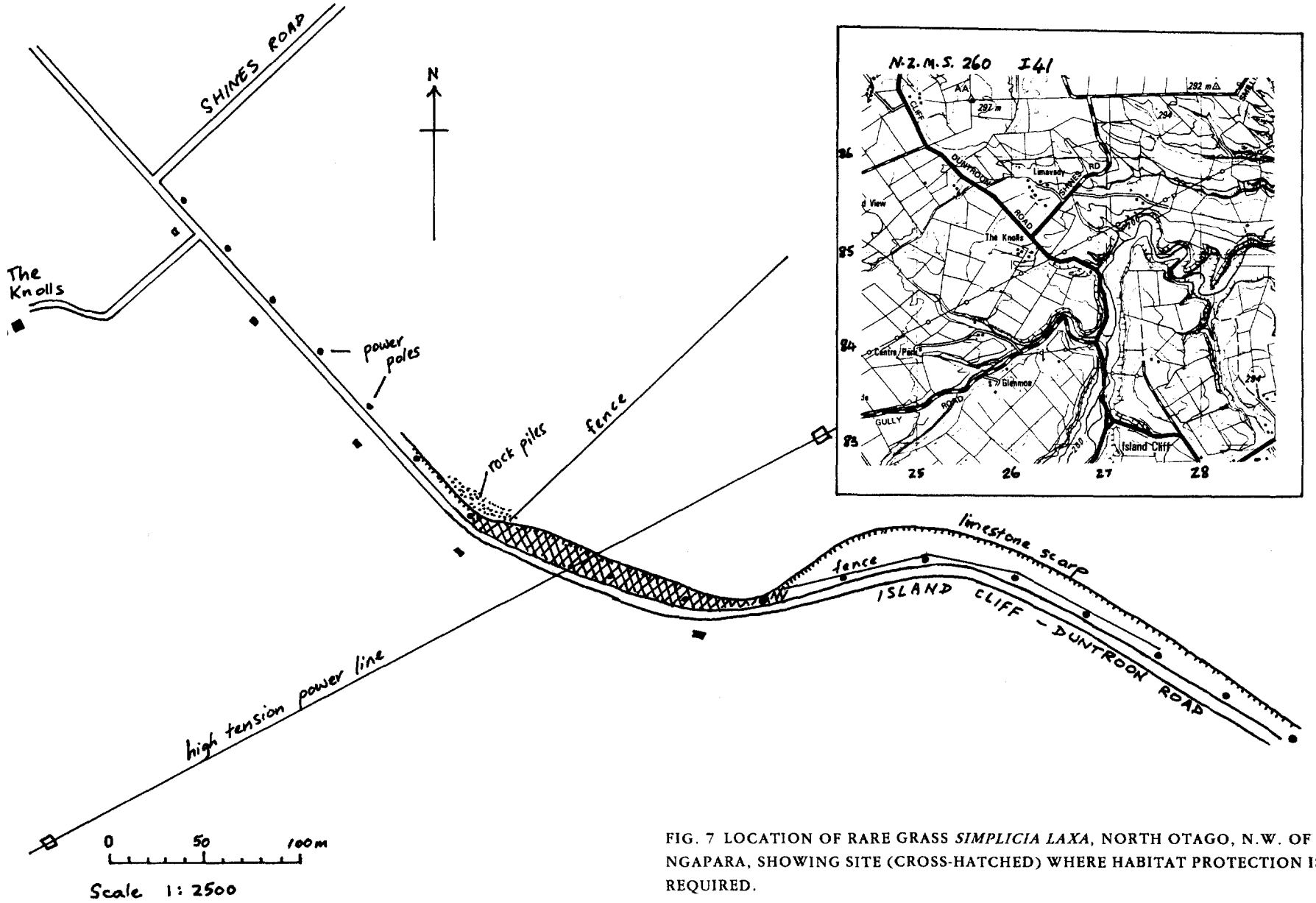


FIG. 7 LOCATION OF RARE GRASS *SIMPLICIA LAXA*, NORTH OTAGO, N.W. OF NGAPARA, SHOWING SITE (CROSS-HATCHED) WHERE HABITAT PROTECTION IS REQUIRED.

Long rank grass runs from the road edge on slightly rising ground, back to and under the escarpment. The grassland is of Chewings fescue (*Festuca rubra*), tall fescue (*F. arundinacea*), cocksfoot (*Dactylis glomerata*), couch (*Elymus repens*), meadow grass (*Poa pratensis*), Californian thistle (*Cirsium arvense*), parsnip (*Pastinaca sativa*), curled dock (*Rumex crispus*), and dandelion (*Taraxacum officinale*). Of these species, all naturalised, it is Chewings fescue and meadow grass which extend furthest under the overhangs.

Simplicia laxa grows at the rear of a shallow cave some 5 m within an overhang having a roof 1.5 m high at its entrance and 0.6 m high at the rear. A mat of S. laxa, some 10 cm tall and 1.5 x 0.5 m in extent, grows on a pad of soil that slopes forward from the cave rear (Fig. 4). This soil has accumulated from weathering limestone chips and dust that have fallen from the roof. It is doubtful that rain would ever penetrate to the rear of the cave where the *Simplicia* grows. Instead the slight moistness of the soil must come as seepage through the porous rock behind, or from the substrate below. The *Simplicia* mat had scattered inflorescences, mainly at the forward margin of the mat.

The creeping willowherb *Epilobium nummulariifolium* grows among the rear of the *Simplicia* mat and clings onto the rear wall. Wispy tufts of the fine-leaved native grass *Poa imbecilla* grow alongside the *Simplicia*. The lichen *Lepraria incana* forms a greenish grey powdery felt on parts of the cave roof.

The site is shown in Fig. 7. A sketch map (Fig 2) shows the vegetation of this and of two other caves of similar dimension 12 m and 18 m to the west. These other caves (B and C) also contained *Poa imbecilla*, along with the native bitter cress (*Cardamine debilis*). *Simplicia* was not initially present in caves B and C, but three young plants were introduced to each cave on 23 January 1993. These were seedlings, glasshouse-grown, derived from the nearby plants in cave A. When re-examined in September 1993, four of the six introduced plants were growing vigorously; the easternmost individuals in caves B and C were just surviving.

4.6 *SIMPLICIA LAXA* NEAR NENTHORN, NORTH OTAGO

The discovery of *Simplicia laxa* plants here by Graeme Loh (DoC) in July 1993 was the result of informed botanical fossicking in an area of prime interest for conservation of rare lizards. The country comprise the north-eastern edge of the Otago schists, with low block faulted ridges, gently rolling wide basins, meandering streams in shallow gorges, and a general cover of narrow-leaved snow tussock (*Chionochloa rigida*) grassland.

The *Simplicia laxa* site is in Emerald Creek, in a winding gorge some 40 m deep below the surrounding country, among bluffy rocks, tussock and scattered scrub (Fig. 5). Kanuka (*Kunzea ericoides*) forms patches on sunny sites, with Corokia cotoneaster, *Melicytus alpinus*, and *Dracophyllum uniflorum* more common on thin soils near rock outcrops. Shady sites have scrub patches with *Olearia bullata*, *Coprosma propinqua*, *Polystichum vestitum*, and *Phormium cookianum*. Altitude is 440 m, and mean annual rainfall c. 700 mm.

Simplicia laxa was found beneath two rock overhangs. The first, at 143/ 065225 (Fig. 5) is a south-aspect cave some 20 m in lateral extent, 1-2 m deep, and 0.1 - 0.3 m high at the rear. At least 19 *Simplicia* were recorded beneath the overhang, in friable soil of moderate moisture content because of seepage coming downslope in the bedrock. Some of the *Simplicia* plants grow in the partly bare soil at the cave rear. Others extend forward, and comprise about 10% cover among *Poa breviglumis* (20%), *Oreomyrrhis ramosa* (20%), *Stellaria parviflora* (10%), *Hypolepis rugosula* (10%), *Viola fifcaulis* (10%), *Schizeilema trifoliolata* (10%), and *Asplenium richardii* (10%).

The second site, 200 m to the east, at 143/ 067225, with a similar habitat, had about 20 *Simplicia* plants.

Simplicia laxa plants at the Nenthorn locality were healthy, and mostly loose tufts 5 - 15 cm across. At July 1993 many had old inflorescences from the previous season, but only a few seeds remained on the plants. The area is subject to pastoral use, with grazing at least by sheep, and the *Simplicia* sites, although accessible to sheep, hares, and rabbits, are probably too dank and shaded to attract animal use and disturbance.

4.7 SOILS AT *SIMPLICIA LAXA SITES*

Soil samples from the surface horizon were collected from these sites:

A Castle Rock, Old Man Range, (rock cleft A on Fig 1).

B Nenthorn, Emerald Creek.

C North Otago, Simplicia habitat (cave A on Fig 2).

D North Otago, near Simplicia site (cave B on Fig 2).

Analyses of pH and conductivity (milli Siemens/cm.):

Site A	pH 4.5	conductivity 0.05 mS/cm
Site B	pH 4.7	
Site C	pH 8.1	conductivity 1.48 mS/cm
Site D	pH 8.3	conductivity 0.24 mS/cm

Soil sample descriptions:

Site A, Castle Rock: a Raw Soil derived from schist; sandy loam with pale grey colour indicating probably <2% organic content; structureless, single grain.

Site B, Nenthorn: a Recent Soil derived from schist; silt loam, well humified with very dark brown colour indicating >2% organic matter, polyhedral and spheroidal peds.

Sites C and D: a Raw Soil derived from limestone; very pale, whitish-grey sandy loam, structureless, single grain, with a partial crust of animal (possibly worm) casts.

These samples indicate that *Simplicia laxa* can grow on soils of greatly differing pH and conductivity. The Ngapara samples are alkaline while those from Castle

Rock and Nenthorn have an acidity in the same order as that which would occur in schist-derived soils under tussock grassland in the surrounding country, away from rock tors. Conductivity is an estimate of salinity and it is noteworthy that these measurements have a range of values, from the low of 0.05 mS at Castle Rock, to 1.4 mS at Ngapara, the latter falling within the 0.8 - 2.0 mS class regarded as moderately saline, and possibly a result of high gypsum content in the limestone.

4.8 *SIMPLICIA LAXA* IN CULTIVATION: ITS MORPHOLOGY AND PHENOLOGY

Plants from the Ngapara site have been brought into cultivation at Landcare Research, Lincoln, and thence to Percy Reserve, Lower Hutt (in the care of Tony Silbery and Peter de Lange), to Otari Native Botanic Garden, to Victoria University, and to Geoff Rogers in Rotorua. Ngapara plants of seedling origin are in cultivation at Landcare Research, Dunedin, along with cutting-grown plants from Castle Rock, and young cuttings from Nenthorn. Dunedin Botanic Garden has plants from Ngapara and Castle Rock.

My observations and measurements tally with the morphological description of *Simplicia laxa* in Zotov (1971). Leaves are of matt pale green appearance, tending towards bluish green, in contrast to the brighter green of say *Poa matthewsii* or *Poa breviglumis* which often grow alongside *Simplicia laxa.* A distinctive feature of *S. laxa* foliage is the common tendency for pale brown dead leaves to remain visible, more-or-less erect, slightly curled but not inrolled in the dry state. In cultivated plants that are more than a year or so old this brown foliage can be quite conspicuous. Lower leaves on each stem get browned off as they age, but also whole stems can die at once, an event which has been observed to occur in three situations: in pot-bound and under-watered plants, in overwatered pots, and in plants subject to dry air in full light. This partial death may be a strategy to cope rapidly with periodic adverse conditions, especially of soil wetness and dryness.

The pot-grown plant in Fig. 6 and the mat of *Simplicia* in the Ngapara cave (Fig. 4), both illustrate this browning of foliage in old plants, but also the vigorous subsequent growth of new stems to give the typical loose mat habit. Young stems near the centre of an established clump tend to be short and erect. Those at the perimeter grow prostrate, to 40 cm long with internodes 25 mm long, the angling stem lying loosely on the soil surface. It is usual to find these prostrate vegetative stems taking root from a low proportion of the nodes which make contact with the ground.

In the wild most individual S. laxa plants of 10-20 cm diameter have some inflorescences, while larger mats, such as that at Ngapara produce a few inflorescences mainly around the mat perimeter. A similar situation was observed in cultivation. One-year old vigorous plants in pots produced inflorescences, but after two years plants which had become mats 40-50 cm across, such as that in Fig. 6 ceased to flower.

In both wild and cultivated plants, inflorescences are angled out from the plant, and may even lie upon the ground when ripe. Flowering has been observed from

spring through to autumn in cultivated plants. Seed falls gradually, leaving the old inflorescence naked and still attached to the plant. Most seed is probably deposited by gravity just beyond the perimeter of the parent. This pattern was evident in a glasshouse-grown plant at Lincoln, where seedlings appeared in fine gravel around the potted parent.

Glasshouse seedlings grew slowly at first, but proved amenable to pricking out and later potting on. *Simplicia laxa* has also proved easy to propagate from cuttings, using short young stems having 3-4 leaves, broken off the stems from which they had appeared as basal branches, inserted into either sand or potting soil, and kept moist but not too wet in partial shade.

Slight differences were noted between the three known populations of *S. laxa,* in hairiness of the leaf sheath, lamina, and ligule, but not in any other characters. The differences between populations, shown in illustration 1 in the appendix, are as follows. Ngapara plants have 0.2 mm long hairs densely on the ligule, and 0.1 mm hairs sparsely on the upper surface of the leaf blade, and on the sheath, mainly on its membranous margin. Castle Rock plants are more hairy, with 0.2 mm hairs on the ligule and moderately densely on the sheath, and sparse 0.1 mm hairs on the veins of the upper leaf blade surface. Nenthorn plants have even longer and more dense hairs: 0.3 mm long and moderately dense on the ligule and scattered on both surfaces of the leaf blade, and dense 0.4 mm long hairs on the sheath.

4.9 HABITAT STUDIES IN OTAGO AND SOUTHLAND

Part of what was learned during this study came not from sites where *Simplicia laxa* was found, but from likely habitats where it did not turn up, but which had many of the associated plant species.

Table 3 lists the non-woody flora at the three *Simplicia laxa* sites and at seven other Otago and Southland localities having rocky shaded topography with overhangs. Only three native plant species are common to all three *Simplicia* sites: *Poa imbecilla, Cardamine debilis,* and *Epilobium nummulariifolium*. Another 24 native species (including 8 grasses) are common to two of the three *Simplicia* sites.

Floristic linkages between the 10 localities are illustrated by the fact that of the 27 species that associate with *Simplicia laxa* at two or more of its three sites, 12 species on average occur at the other seven localities. Those species which show the greatest constancy (present at 6 or more localities) are *Arthropodium candidum, Asplenium flabellifolium, A. terrestre, Cardamine debilis, Epilobium nummulariifolium, Poa colensoi, P. imbecilla, P. matthewsii,* Polystichum *richardii, Rytidosperma gracile, Schizellema trifoliolata,* and *Stellaria parviflora*. Despite these linkages there is considerable variability in the floras between localities. This partly reflects the broad geographic and altitudinal distribution of the localities. To a slight degree it is influenced by local rarities, e.g., *Celmisia hookeri.* There is a considerable element of widespread yet uncommon (though not necessarily threatened) species, e.g., *Anemanthele lessomana, Austrafna pusilla, Elymus narduroides, Ischnocarpus novae -zelandiae, Microlaena polynoda, M. stipoides, Myosotis*

forsterl, M. goyenii, and *Parietaria debilis.* But even the bulk of this flora, being species that would be considered common and characteristic of dry shade, do not occur regularly at every locality.

The preferred habitats of the plant species of Table 3 are illustrated in Figures 8-11. Each group of herbaceous species (grasses, ferns, native dicots, naturalised dicots) has been arrayed as they were perceived to occur along a gradient from dry shade to moister, more open sites.

The species groups on the right of each diagram are those which are generally typical of well-lit sites such as grasslands or sunny bluffs, but which extend into shade to a greater or lesser extent. In the centre of each diagram are the groups of a considerable number of species considered as characteristic of dry forest floors.

On the left of Figures 3-6 are the species groups of caves, the habitat to which *Simplicia laxa is* restricted. Among the ferns (Fig. 9) a distinction is made between those which grow typically in cave ceiling crevices (group A: *Adiantum cunninghamii, Blechnum vulcanicum, Asplenium lyallii, A. richardii),* and those of cave floors (group B). In small caves the ferns *Cystopteris tasmanica* and *Asplenium flabellifolium* are the best indicators of potential *Simplicia laxa* habitat.

Native herbs which most often grow alongside *Simplicia laxa* in the rear of small caves are *Epilobium nummulariifolium, Cardamine debilis, Stellaria parviflora,* and *ArtAropodium candidum.* The native grasses (Fig. 8) which most often accompany *S. laxa* are *Poa imbecilla, Poa matthewsii,* and *Poa breviglumis* (in that order as they are to be found from cave rear towards cave mouth). Although *Simplicia laxa* associates with only a limited flora in the rear of its shallow cave sites, it merges with many more native and naturalised species towards cave entrances or just out from a vertical rock wall base, as illustrated in Table 2 for the Castle Rock population.

Naturalised herbs of shaded rocky habitats are shown in Fig. 11, and naturalised grasses as group D in Fig. 8. The naturalised species recorded alongside *Simplicia laxa* within caves, usually as scattered or etiolated individuals, were *Stellaria media, Cerastium fontanum, Euphorbia peplus, Holcus lanatus,* and *Hordeum murinum.* At other localities, additional naturalised species demonstrating an ability to grow in the part shade of caves were *Cardamine flexuosa, C. hlrsuta, Mycefs muralis, Lapsana communis, Galium aparine,* and *Sonchus oleraceus.*

5. Discussion

Most grasses are found in open, well-lit habitats and achieve their greatest importance - as grasslands - in environments that are too cold, dry, or exposed for taller forest or scrub vegetation. But certain grasses are shade-tolerant, and New Zealand examples include representatives of diverse genera such as *Anemanthele, Elymus, Echinopogon, Micvolaena, Poa,* and of course

Simplicia. Whereas the understorey of forests in wet climates will be dominated by ferns, the ground in dry climate forests typically has a greater cover and diversity of *herbaceous dicotyledons* , of sedges such as *Uncinia,* and of grasses.

Three species of *Poa* are probably the most widespread and common grasses of dry forest and shaded rocky places in New Zealand, and they offer an interesting comparison with *Simplicia laxa.* They are *Poa breviglumis, Poa imbecilla,* and *Poa matthewsii,* each of which can associate with *Simplicia laxa,* and look remarkably similar to it. But while each of these *Poa* species has the ability to grow in dry shade beneath rock overhangs, as well as in a diversity of other environments, *Simplicia laxa* demonstrates a much greater specificity to habitat by occurring only in shallow caves, and always extending that bit further back into the shade.

The common factors at the three currently known *Simplicia laxa* sites make it clear that this is a species of relatively sheltered, mainly east- or south-aspect rock outcrops where the specific micro-site is the immediate base of the rock outcrop or the floor of small caves. It grows on well-drained skeletal soils derived directly from the rock material, rather than from loess which has blown in. These soils are sheltered from direct rain and consequent leaching. *Simplicia laxa* is able to benefit from the relatively high fertility by being a stress-tolerant plant, able to tolerate low light intensity and soil which permanently or seasonally is in a relatively dry state. In its cave habitats *Simplicia laxa* must tolerate dank cool air for most of the time. In cultivation it demonstrates an ability for renewed vegetative growth after being set back by excessive drying of foliage, or drying or waterlogging of soil.

Notwithstanding these very specific site requirements, the distribution of *Simplicia laxa* spans a range of altitude and of soil parent materials. It may associate with limestone, not because it is a calcicole in the accepted sense of a species which specifically tolerates calcium, but because limestone offers high fertility soil, especially a high level of calcium-bound phosphate, good aeration and drainage, and minimal competition. At *Ngapara Simplicia laxa* grows in soil of pH 8.1, in contrast to the acid soils, schist-derived, of pH 4.7 at Nenthorn and 4.5 at Castle Rock. Other parent materials with similar physical characteristics which should produce similar soils, and where *Simplicia laxa* might not be unexpected, are basic volcanics such as basalt, and alluvium.

Although *Simplicia laxa* appears to be a stress-tolerant plant, it nevertheless grows only in places where it lacks competition from other plants.

The rarity of *Simplicia laxa* is likely to be partly a natural phenomenon. Rocky shaded places - bluffs, gorges, tors - are very much "island" habitats, separated from each other by often large tracts of very different landforms and vegetation. Even the common and characteristic plant species of dry shaded habitats illustrate a patchy occurrence at the ten sites listed in Table 3. In other words, rarity or lack of constancy within this type of habitat is shown not only by *Simplicia laxa* but by a large proportion of the native flora. Not every rocky shaded place provides the same mix of micro-habitats, whether caves, ledges, overhangs, crevices, extreme dryness or dank shade. Even when a particular species is favoured by the availability of its specific micro-habitat, the extent of this might be insufficient to sustain a population at any one locality.

Simplicia laxa is not a local endemic. Its historical distribution from the Wairarapa to scattered Otago sites indicates that it has been around for a long time. It would appear to be a species of relictual status (Brian Molloy, pers. comm.), like *Carex inopinata*, a rare sedge found on similar parent materials, and recently known from three widely separated sites in inland Marlborough, Canterbury, and Otago (Morgan & Norton, 1992). *Australopyrum calcis* is another example, recently described from small populations on limestone (Connor et al., 1993). Differences in the distribution and length of hairs and prickle teeth have been considered by these authors as sufficient to warrant recognition of subspecies optatum from two Canterbury sites, as distinct from subspecies calcis from one site in Marlborough. It is of interest that the three known populations of *Simplicia laxa* also show consistent minor differences in hairiness of leaf blade and sheath, not necessarily sufficient to warrant recognition of subspecies, but illustrating a degree of genetic isolation between the populations, presumably of long standing.

What natural (pre-human) factors might have led to the localised distribution of *Simplicia laxa*? Maybe it was once a plant also of dry forest floors in eastern North and South Islands, which has suffered during the long history of periodic fires in these regions. But from its present known locations there is no evidence to suggest that it has much ability to grow other than beneath rock overhangs. In one sense, this habitat may be a relatively stable one, capable of retaining a characteristic flora regardless of climate changes and the consequent comings and goings of forest, scrub, or tussock grassland on a grand scale in the surrounding landscape. Small caves can also be a very stable habitat, as is evident from the way in which sub-fossil remains of animals or cave ceiling drawings are preserved in these places, provided they are not physically disturbed.

What relationship might *Simplicia laxa* once have had with New Zealand's once larger bird fauna, including many flightless ground dwellers for whom small dry caves must have been premium real estate? Did *Simplicia laxa* once rely on the assistance of the shuffling kakapo or the laughing owl to carry its seeds from one rock "island" to another. The seeds themselves are smooth, but the enclosing glumes, with which they fall, are pubescent enough to suggest they would lodge among feathers for short-distance dispersal. A more likely bird-dispersal mechanism might be within the entanglement of spider webs which accumulate around maturing *Simplicia* seed heads in the shelter of their shallow cave habitats.

The sensitivity of cave features to physical disturbance is well known to cavers, but extends beyond the obvious and spectacular features such as stalactites, moa mummies, and ancient dust accumulations. Two examples of the fragility of small vegetated caves became evident during my field studies. When small potted *Simplicia laxa* plants were newly planted beneath overhangs adjacent to the Ngapara site it became obvious how easy it is to disturb the soil profile of a cave floor by excavating even small holes. Secondly the Limestone Cavern of the Borland Valley illustrates how cave entrance plants are delicately rooted in the thinnest of topsoil veneers, a humid powdery layer that is readily shaved off by footprints. This site also illustrates an example of good management in the form of a barrier fence to restrain visitors from entering the cavern entrance.

Introduced mammals have a marked physical impact on small caves. *Simplicia* searches in the schist for country of Central Otago showed that almost every small cave and overhang holds the evidence of being used as a bedroom, latrine, or final resting place by sheep or rabbits. Higher ledges and crevices are seldom inaccessible to goats and possums. The reason why *Simplicia laxa* has persisted at Castle Rock, yet was not found at other rock outcrops in the area might be because of the massive size of this tor. It offers many favourable roosting and loafing sites for the local animals, such as to reduce animal pressure on the more dank and shaded clefts and ledges where the *Simplicia* grows. The Nenthorn site is similar in having numerous caves more attractive to animals than the ones having *Simplicia*. At the Ngapara site, the overhang on a roadside has given Simplicia laxa a freedom from the physical disturbance by livestock which regularly occurs beneath limestone scarps elsewhere in the district.

Grazing by livestock and feral mammals may well have contributed to a decline in *Simplicia laxa,* though it is significant to note that at Castle Rock the rare grass does grow in some sites to which livestock have access.

It is difficult to judge the extent to which weeds might have reduced the extent of *Simplicia laxa.* Castle Rock has a fair complement of naturalised herbs and grasses which extend some distance into shallow cave shade, but which currently leave *Simplicia* and other native grasses without competition in the most shaded sites. The Nenthorn site is relatively free of naturalised species. The Ngapara site is wholly surrounded by a bevy of pasture plants and weeds, though none of them extend quite in to the *Simplicia* stronghold at the cave rear. But this site, along with many others in North Otago, illustrates the invasive powers especially of Chewings fescue *(Festuca rubra)* and meadow grass (*Poa pratensis*) which now threaten the native flora of many limestone outcrops in Canterbury (Brian Molloy, pers. comm.).

Woody weeds do not pose an immediate threat to any of the three known *Simplicia laxa* sites. Elder (*Sambucus nigra*) and sweet brier (*Rosa rubiginosa*) are present in low numbers at Castle Rock. Scattered shrubs, whether naturalised or native species, would not be expected to greatly alter the micro-sites of small caves which are shaded anyway. But woody weeds, in combination with other influences can have a major impact on the integrity of rock outcrop ecosystems. As an example, take Bucklands Crossing in the Waikouaiti catchment of eastern Otago. Rocky bluff systems which were considered as potential search sites for *Simplicia laxa* were discounted, having become grossly modified by the invasion of gorse, broom, and pines, and by an obvious history of repeated fires. Many other parts of New Zealand would display something similar.

Although the focus of this study has been on one rare plant species and its habitat, it has become clear from field observations, that the habitat types that might loosely be termed "dry forest" and "rock outcrops" are both in need of further study and conservation assessment on several fronts. By the ill-defined term "dry forest" I mean the mixtures of say kanuka, kowhai, totara, broadleaf, matai or mountain beech perhaps, which are widespread for example in eastern South Island, especially in slightly inland valleys. Within "rock outcrop" habitat I include gorges, bluffs, scarps, and tors. The "dry forest" and "rock outcrop" habitats often go together. They contain diverse and very distinctive elements of

New Zealand's flora, and probably fauna. They are the sorts of places that are dry enough to suffer from fire, at least on their edges. They are habitats that are open enough to suffer invasion by woody weeds yet often too steep and rugged for any control strategies once wilding trees or shrubs are established. Taken together, these habitats would provide a useful working framework for the assessment of conservation needs of quite a suite of threatened and uncommon plants, including *Simplicia laxa, Teucridium parvifolium, Ischnocarpus novae-zelandiae, Parietaria debilis,* and *Anemanthele lessoniana.*

Simplicia laxa is classified in the threat category Endangered (Cameron et al., 1993). From current knowledge of the plant at its now three known sites, this classification remains the appropriate one.

When Connor et al.(1993) described the grass *Australopyrum calcis* they named one of its subspecies *optatum,* the epithet referring figuratively to the long-wished-for diploid endemic New Zealand grass. In its own way, *Simplicia laxa* has also been a wished-for and a sought-after grass. Three years ago nobody would have been sure where to find it for certain, or whether it still existed. The name Holy Grail grass might be appropriate for *Simplicia laxa,* the more so for being, like the Holy Grail of Monty Python, hidden in a cave.

6. Conclusions

6.1 MANAGEMENT NEEDS

All three known *Simplicia laxa* sites should be managed in such a way that the populations and habitats can be maintained, and the sites given appropriate recognition in planning documents or formal conservation protection.

The Ngapara site has only limited habitat available for *Simplicia laxa,* but is of particular interest as the only known limestone habitat for the species. On the initiative of Brian Molloy, Landcare Research, Lincoln, steps are well underway towards a Management Agreement between the QE II National Trust and the Waitaki District Council. A Protected Habitat Management Statement is in its final stages of preparation. The land to be protected comprises 0.1 ha of Crown Road Reserve. Provision will be sought to control any unwanted encroaching weeds preferably by non-chemical means, to prevent disturbance from road maintenance activity, to exclude browsing animals by fencing and control animal pests as necessary.

The precise locality of the Ngapara *Simplicia* site has been kept confidential until the preparation of this report. The issue has become less critical now that *Simplicia laxa* is known at three sites. Nevertheless it is an intention of the management statement to avoid general publicity of the exact location of the Ngapara site.

Consideration has been given to erecting a grill across the limestone cave entrance to prevent access by people, but current consensus is that this would only draw attention to the site.

Given the interest shown in the site and its rare grass by the Waitaki District Council, it is to be hoped that council staff might play an active role in the monitoring and management of this small but important site. There is a need to identify other suitable limestone outcrop sites in this vicinity where *Simplicia laxa* plants derived from the Ngapara population can be planted and given protection against livestock. I envisage this is an activity in which DoC staff would play a principal role, but where council staff and local interest groups could also assist.

The Nenthorn *Simplicia laxa* site is in country where DoC is already active in negotiating protection of habitat for lizards. The presence of *Simplicia* adds another high conservation value to the Emerald Creek area. The full extent of *Simplicia* habitat and presence in the gorges of Emerald Creek is not yet known, and needs to be assessed by DoC staff in order to determine what area(s) warrant protection. Botanically valuable features of this area are more than just the presence of this rare grass. There is great diversity of scrub, rock outcrop, and tussock grassland communities here, in relatively good condition so far as impacts of weeds, fire, and pastoral farming are concerned. The landforms and vegetation types would furthermore appear to be fairly representative of this central part of the Macraes Ecological District, a district having few protected natural areas and for which PNA survey has not yet been done.

Castle Rock on the Old Man Range has the largest known population of *Simplicia laxa*. The population has survived, at least on this one tor, despite a history of non-intensive pastoral farming, though the question arises as to whether grazing and burning practices might have contributed to the seeming absence of *Simplicia* from other large tors and schist bluff systems in the vicinity. There are no apparent immediate threats to the Castle Rock population, though this needs to be assessed over time by monitoring of plant numbers, animal influences, and weed encroachment. Protection should nevertheless be sought for the site with the aim of preserving not only the *Simplicia* population, but also its other rock habitats and communities, and its landscape and vegetation setting of montane hard tussock grassland and matagouri scrubland. This site was not included in any of the Recommended Areas for Protection by the PNA survey, probably because other areas were considered as being more representative of the Old Man Ecological District (Brumley et al., 1986). However, Castle Rock and its surroundings warrant recognition and management as a special site, being perhaps the most massive of Central Otago schist tors.

Simplicia laxa should also be conserved in cultivation. Plants from the Ngapara population are already in cultivation in the hands of several agencies and people, as detailed earlier. Plants of Castle Rock and Nenthorn origin are in cultivation to a more limited extent. One aim of ex situ cultivation is to maintain the genotypes over a long time scale in the event that wild populations crash. This is a function appropriate to a botanic garden. A second aim is to produce seedling stocks available for replanting, and boosting wild populations and their extent. This function should be undertaken by one of the DoC nurseries.

6.2 FURTHER RESEARCH, MONITORING, AND SURVEY

Conclusions so far on the ecology of *Simplicia laxa* have been based on field interpretation at a preliminary level and on qualitative observations of cultivated plants. In order to better understand the ecology and conservation needs of the species, further field and experimental studies are needed. Field studies should concentrate on understanding demography and phenology: the life cycle, relative ages, and longevity of plants; flowering and fruiting behaviour, the processes of seed dispersal and seedling establishment. Experiments on cultivated plants should seek to quantify the light requirements, shade tolerance, soil moisture and soil fertility needs of *Simplicia laxa,* in comparison with other grass species, growth response in relation to competition, and response to impacts such as foliage removal such as would occur with grazing.

All three known populations should be monitored by DoC staff, by recording plant numbers and distribution, and using photo points to assist with providing a record of weed encroachment. This report provides the comparative baseline for future observations on the Ngapara and Castle Rock populations. The Nenthorn population has yet to be recorded in enough detail to act as a reference point for future possible changes.

It is likely that *Simplicia laxa* will turn up in additional localities. It is hoped that this report will provide sufficient identification features for this and similar grasses to be recognised. DoC staff should continue to be encouraged to report suspected finds and to contribute site record information for this and other threatened plants to the Landcare Research Threatened Plant Database, which underpins the DoC database as well as conservation strategies for rare taxa in general.

Finally I believe that there is a need for inventory, survey, and research on rock outcrop and dry forest habitats as outlined in the discussion above. These are the habitats, and often the refugia, for a distinctive and diverse assemblage of native organisms, both common and uncommon. They are habitats which tend to be of limited and patchy geographical extent, which often have particular vulnerability to fire and weed infestation, and which have tended to be overlooked while nature appreciation and conservation effort have been concentrated on the more lush, scenic, and accessible aspects of our landscape and biota.

7. Acknowledgements

Brian Molloy, Landcare Research, Lincoln has helped with many aspects of understanding the habitat requirements of *Simplicia laxa*, with field studies and cultivation. Peter de Lange, (DoC, Wellington) has keenly supported the project throughout, provided historical material, and undertaken field searches in the Wairarapa. Bruce McKinlay, Graeme Loh, and Brian Patrick (DoC, Dunedin)

have helped with field work, transport, and discussions on conservation requirements. Don Bruce, Ian Southey, and Anita Middlemiss assisted with field work at Castle Rock. Pru Johnson spent many hours hunting for *Simplicia* among scratchy vegetation and slippery bluffs at several sites. Ian Williamson, QE 11 National Trust Representative, Twizel, has been involved with conservation management needs at the North Otago site. Karin Jehn and Peter McIntosh did soil pH measurements, and Allan Hewitt provided descriptions of soil samples. Geoff Rogers and Henry Connor provided helpful comments on grass identification. David Purcell (Landcare Research, Lincoln), and Tony Silbery (Percy Reserve, Lower Hutt) have propagated plants and cared for them in cultivation.

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