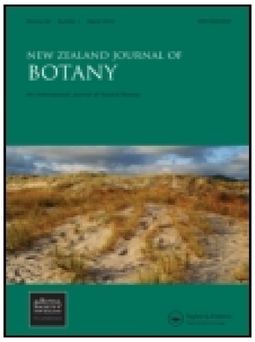

New Zealand Journal of Botany

ISSN: 0028-825X (Print) 1175-8643 (Online) Journal homepage: http://www.tandfonline.com/loi/tnzb20

Breeding systems in New Zealand grasses X. Species at risk for conservation

H. E. Connor

To cite this article: H. E. Connor (1988) Breeding systems in New Zealand grasses X. Species at risk for conservation, New Zealand Journal of Botany, 26:1, 163-167, DOI: 10.1080/0028825X.1988.10410108

To link to this article: http://dx.doi.org/10.1080/0028825X.1988.10410108

New Zealand Journal of Botany, 1988, Vol. 26: 163–167
0028–825X/88/2601–163$2.50/0

Breeding systems in New Zealand grasses X. Species at risk for conservation*

H. E. CONNOR
Centre for Resource Management
University of Canterbury
Christchurch
New Zealand

Abstract Fifteen species of indigenous grasses are considered to be at some conservation risk. One species of *Poa* is dioecious; all other taxa bear perfect flowers. Self-compatibility is common and expressed as cleistogamy in *Bromus arenarius*. *Rytidosperma tenue* appears to be sterile; no other species is at particular risk because of its breeding system.

Keywords grasses; reproductive biology; rare species; endangered species; conservation

INTRODUCTION

National and international concern for the future of plant species which are rare, and for those species whose futures which through habitat destruction or mismanagement are imperilled, calls for, *inter alia*, precise information on their reproductive biology. The grasses because of modest appearance and apparent ubiquity may seem of lesser concern but similar, perhaps even greater, pressures are exerted on them as on flamboyant taxa.

Given (1981) listed a dozen grass species either as of local distribution, or as rare, and cited *Chionochloa spiralis* as endangered. Given and Williams (1985) listed two endemic grasses of Chatham Islands as of endangered or vulnerable conservation status. This paper discusses the breeding systems of all those grasses and comments on the genetic consequences for conservation or preservation. There is no discussion on germination, its extent, and any special characteristics associated with successful rates or failure because such data are generally unavailable.

OBSERVATIONS AND DISCUSSION

For simplicity, genera are arranged alphabetically. The status of plants at risk is listed in Given (1981: 141–145)

Bromus: The annual coastal *B. arenarius*, primarily of Australia, is regarded by Given (op.cit. p. 53) as of local enough distribution to warrant threatened status. Given logically asks whether or not it is truly endemic or possibly a recent arrival; that question remains unanswered but, based on its behaviour in Australia, I would support the latter view.

In all specimens at CHR flowers are cleistogamous. Anthers are typically 0.8–1.2 mm long, purple, and sometimes carried up on the apex of the caryopsis and appearing as if chasmogamous. Seed setting is abundant and the breeding system should not derogate from the reproductive efficiency of this species. Cleistogamy in species of *Bromus* is well established (Beddows 1931, Smith 1944, McKone 1985).

Chionochloa: Given (1981) regards *C. spiralis* as an endangered species; it is of exceedingly restricted distribution and occurs on marble and limestone in Fiordland. Nothing is known of its reproduction biology other than the flowering is chasmogamous. I showed earlier that several species of *Chionochloa* were self-compatible (Connor 1967); *C. spiralis* is likely to be of similar behaviour. Periodic flowering is characteristic of species of *Chionochloa* (Connor 1966); to whatever extent this is disadvantageous to the genus as a whole will apply to *C. spiralis*.

Cortaderia: No mainland species of *Cortaderia* is thought to be at risk, but Given and Williams (1985) list the local Chatham Islands *Cortaderia* – which I have since described as *C. turbaria* Connor (in Connor & Edgar 1987)–as endangered in

---

*For part IX see Connor, H. E. *New Zealand journal of botany 22*: 569–574, 1984, on sex ratios in *Spinifex sericeus*.

Received 5 January 1987; accepted 22 January 1987

conservation status. Further, they described those insular plants as "probably dioecious" (table 6, p. 25). No species of *Cortaderia* Section Bifida in New Zealand is strictly dioecious, but all are gynodioecious (Connor 1963, 1973) consisting of plants with perfect (hermaphrodite) flowers only and of other plants with pistillate flowers. Seeds are set in both sex-forms; in the former from both self- and cross-pollination, and in the latter exclusively from cross-pollination. One exception in *C. richardii* was a large population comprising plants with perfect flowers only growing at Mackenzie Pass (Connor 1963).

Cortaderia turbaria from the Chatham Islands was known to occur in the seed-bearing perfect form only (Connor 1971); the one plant raised from seed (G9305) bore perfect flowers. All subsequent collections in CHR bear polliniferous anthers 1.7–2.6 mm long, and stigma-styles from 1 mm to 2.3 mm. These measurements are consonant with those reported earlier, and the stigma-styles are clearly longer than is customary in the perfect sex-form in species on mainland New Zealand. Chasmogamy occurs in *C. turbaria*; seeds were found on recent collections.

It is very probable, though untested, that *C. turbaria* will be self-compatible like those species on the mainland. As such, seed set of itself is unlikely to be a constraint for the survival of Chatham Island *C. turbaria* and the breeding system should not affect its conservation status. The conditions for experimental germination of seeds of *Cortaderia* are listed in Connor & Brown (1972); what applies in nature is unknown.

Deschampsia: The grass *D. pusilla* is of small stature and is known only from high altitudes in southern South Island. Anthers are small, 0.3–0.5 mm long, and rarely seem exserted; those which reach to the apex of lemma and palea seem already to have discharged pollen. Anthers may be included within the floret and lying above a developed or developing caryopsis. *Deschampsia pusilla* appears to be self-compatible and cleistogamous to an appreciable extent. Hemichasmogamy (Auquier & Stace 1980) may obtain in the third (apical) florets.

Cleistogamy is well established in subantarctic species of *Deschampsia* (Werth 1911, Parodi 1949) and in arctic species (Levkovsky et al. 1981); its presence in high alpine species could perhaps be expected. Nothing in the breeding system of *D. pusilla* should adversely affect its conservation status.

Festuca: Given and Williams (1985) listed *F. coxii*, a Chatham Island endemic, as of vulnerable conservation status, and described it as monoecious (table 6, p.25).

Festuca coxii is not monoecious; all flowers are perfect with orange, polliniferous anthers 3–4 mm long, and stigma-styles 2–3 mm long. Flowers are chasmogamous. Monoecism is unknown in *Festuca* as a whole (Connor 1979, 1981). Experimental self-pollination of two plants of *F. coxii* grown in the garden of Botany Division, Lincoln, resulted in an average seed-set of 50% relative to 65% seed set under open-pollination. In families grown from both, the average height of inflorescences was 38.07 ± 1.07 cm (n = 30) in open-pollinated plants and in S_1 was 30.88 ± 0.93 cm (n = 24); the average number of inflorescences per plant was 54.17 ± 8.69 in the family from open-pollination and 15.21 ± 2.47 in S_1 family; differences are significant at 0.1% level, with inbreeding depression (δ) $\approx$ 0.75. This result conforms to those reported earlier for *F. novae-zelandiae* and *F. matthewsii* (Connor 1957, 1960) and to the generalisation that out-crossing predominates in *Festuca* (Auquier 1977). I assume that the deleterious effects of inbreeding will be corrected by one generation of outcrossing as was detected in *F. novae-zelandiae* (Connor 1960).

The breeding system of octoploid *F. coxii* will not affect its conservation status; it will ensure seed set from self-pollination. The breeding system is not disadvantageous to the survival of the taxon.

Poa: Four species of *Poa* were listed by Given 1981: 39, 115) and based on Zotov's data (1965), but Edgar (1986), in a complete revision of *Poa* in New Zealand, indicated that four taxa are of concern viz. *P. pygmaea, P. senex, P. sudicola,* and *P. aucklandica* ssp. *rakiura.*

Two species are from Central Otago.

Poa pygmaea ($2n = 4x = 28$) is found on the Pisa Range and Mt St Bathans. Its distribution is still local. Seed is set in chasmogamous flowers which bear large anthers (1.2–1.6 mm long).

Poa senex is known from four alpine collections on the Old Man Range. Seed is set in chasmogamous flowers. Anthers are small (0.3–0.4 mm) and may be found on the apex of fully developed caryopses. Self-pollination may be possible.

An extremely slender, fine-leaved, mat-forming, form of *P. pusilla* ($2n = 4x = 28$) had been collected from sand dunes and sand flats on western coast, North Island near Himatangi. Its habitat has been reduced and it may now no longer be present. Flowering as seen in herbarium material is chasmogamous; anthers are 1–2 mm long; seed is set.

Among three dioecious species, *P. sudicola* is found on subalpine limestone and mudstone scree on Matiri and Allen Ranges in north-west Nelson. The distribution of staminate and pistillate plants is imperfectly known. All specimens from Matiri Range are pistillate, and two of them are seminiferous; the presence of staminate plants is inferred unless some form of autonomous apospory occurs here.

Poa aucklandica ssp. *rakiura* is endemic to Mt Anglem, Stewart Island, where it occurs in *Chionochloa pungens* grassland. Anthers are small (0.7 mm); flowering is chasmogamic; seed is set.

Of these species of *Poa*, reproductive biology may possibly be of importance in *P. sudicola* where the distribution of the sex-forms is so far imperfectly known. In the other species, the breeding system as inferred from herbarium material is not such that it will impair the conservation status of the taxa.

Two New Zealand species of *Poa* are self-incompatible, *P. cita* and *P. colensoi*, and *P. breviglumis* is self-compatible (Connor 1957). Versatility in reproductive systems is a feature of *Poa*; the species discussed here are simple in their systems.

Puccinellia: One species of this maritime genus is included in Given's list of rare species – *P. antipoda* of Auckland and Antipodes Is, together with an as yet unnamed unit from Campbell I. thought to be close to *P. macquariensis*.

Flowers in both are chasmogamous; seed is set. Little else can be determined from herbarium specimens, but *P. fasciculata* var. *novae-zelandiae* is self-fertile and there was no significant inbreeding depression (Connor 1957); *P. fasciculata* var. *caespitosa* is also self-compatible.

It seems improbable that the system of reproduction in *Puccinellia* spp. will affect their future conservation status.

Rytidosperma: Two species, *R petrosum* and *R. tenue* are listed by Given (1981: 53,89) as rare; the former is known from coastal rocks around Cook Strait, and the latter from four sites in Otago. Self-compatibility and cleistogamy are well known in *Rytidosperma* (Connor 1979).

Connor and Edgar (1979) in their revision of *Rytidosperma* reported anther lengths in *R. tenue* consistent with cleistogamy, but no caryopses were seen. Caryopses are found in *R. petrosum*; anthers corresponding to those typical of cleistogamous florets and those typically of chasmogamous florets were also described. Self-compatibility should ensure that *R. petrosum* is not at any conservation risk.

The specimens of *R. tenue* being devoid of seeds may indicate possible sterility or some other state; anthers on CHR 362712 contained sterile pollen, but in two other specimens no anthers could be found. On the evidence to date the reproductive behaviour of the taxon does not inspire confidence for its future, vegetation extension excluded.

Simplicia: This endemic genus of two species was reconsidered by Zotov (1971). Self-compatibility was clearly indicated. Given (1981: 89) considers both *S. laxa* and *S. buchananii* as endangered.

A single plant of *S. buchananii* (2n = 28) grown in a glasshouse "...set seed freely" (Zotov op. cit.). Flowers are chasmogamous in specimens at CHR (e.g., CHR 394262, CHR 277684) with three purple anthers 1 mm long, and exserted stigmata; the gynoecium is about the same length as the anthers. Dehisced anthers may be caught between the lemma and palea.

A single glasshouse-grown plant of *S. laxa* (CHR 202752) also bears seeds. Chasmogamic flowers are present. Three purple anthers 1 mm long were found in one floret with a developing caryopsis; in a second floret anthers of the same size were present together with a developed caryopsis. For the same reasons which Zotov gave, I am unable to comment on the possibility of cleistogamy; but the flowers are triandrous, and not diandrous as he reported.

Both species of *Simplicia* are self-compatible, and judged solely from the florets, self-fertilisation is not infrequent. The breeding system in *Simplicia* should not in any special way affect the conservation status of the genus. Germination, as mentioned by Zotov (op. cit.) may be a much greater constraint.

Stipa: The single endemic species *S. petriei*, is known from the inland basis of Central Otago, and the Waitaki River; it may be found up to 1000 m above sea level. Given (1981, p. 89) rated it threatened.

Many species of *Stipa* are cleistogamous (Rosengurtt 1984, Vickery et al. 1986) and many also produce clandestine spikelets (cleistogenes). Flowers in *S. petriei* are excluvely chasmogamous with barbellate, caudate anthers 2.5 mm long.

Anthers, neither in size nor in position relative to caryopses, suggest the possibility of cleistogamy. The only other indigenous species of *Stipa*, *S. stipoides*, is also chasmogamous.

Nothing in the reproductive biology of *S. petriei* guarantees abundant seed setting save that, in *Stipa* as a whole, self-compatibility is well established (Connor 1979).

CONCLUSIONS

None of the grasses in New Zealand which could be considered at varying levels of conservation risk will be constrained by their breeding system except *Rytidosperma tenue*, which seems sterile. There is some uncertainty about the distribution of the sexual morphs in dioecious *Poa sudicola* but seed setting occurs where staminate plants have not as yet been collected; this issue is readily solved.

Chasmogamic flowering predominates, but cleistogamy occurs in *Bromus arenarius* and in *Deschampsia pusilla*. Self-compatibility is more frequent than verifiable self-incompatibility.

REFERENCES

Auquier, P. 1977: Biologie de la reproduction dans le genre Festuca L. (Poaceae) I. Systeme de Pollinisation. *Bulletin de la société Royale botanique de Belqique 110*: 129–150.

Auquier, P.; Stace, C. A. 1980: Variation in flowering behaviour in *Vulpia* (Poaceae). *Plant systematics and evolution 136*: 47–56.

Beddows, A. R. 1931: Seed setting and flowering in various grasses. *University College of Wales. Series H. 12*: 5–99

Connor, H. E. 1957: Breeding systems in some New Zealand grasses. *New Zealand journal of science and technology 38A*: 742–751.

———1960: Breeding systems in New Zealand grasses. III. Festuceae, Aveneae and Agrostideae. *New Zealand journal of agricultural research 3*: 728–733.

———1963: Breeding systems in New Zealand grasses. IV. Gynodioecism in *Cortaderia*. *New Zealand journal of botany 1*: 258–264.

———1966: Breeding systems in New Zealand grasses. VII. Periodic flowering of snow tussock, *Chionochloa rigida*. *New Zealand journal of botany 4*: 392–397.

———1967: Interspecific hybrids in *Chionochloa* (Gramineae). *New Zealand journal of botany 5*: 3–16.

———1971: *Cortaderia splendens* Connor sp. nov. (Gramineae). *New Zealand journal of botany 9*: 519–525.

———1973: Breeding systems in *Cortaderia* (Gramineae). *Evolution 27*: 663–678.

———1979: Breeding systems in the grasses: a survey. *New Zealand journal of botany 17*: 547–574.

———1981: Evolution of reproductive systems in the Gramineae. *Annals of the Missouri Botanical Garden 68*: 48–74.

Connor, H. E.; Brown, I. C. 1972: Pampas grass. *Gardeners chronicle April 14*. p. 11.

Connor, H. E.; Edgar, E. 1979: *Rytidosperma* Steudel (*Notodanthonia* Zotov) in New Zealand. *New Zealand journal of botany 17*: 311–337.

———1987: Name changes in the indigenous New Zealand Flora, 1960–1986 and Nomina Nova IV, 1983–1986. *New Zealand journal of botany 25*: 115–170.

Edgar, E. 1986: *Poa* L. in New Zealand. *New Zealand journal of botany 24*: 425–503.

Given, D. R. 1981: Rare and endangered plants in New Zealand. Wellington, A. H. & A. W. Reed.

Given, D. R.; Williams, P. A. 1985: Conservation of Chatham Island flora and vegetation. Reprint with amendments. Botany Division, Department of Scientific and Industrial Research, Christchurch.

Levkovsky, V. P.; Tikhmenev, E. A.; Levkovsky, E. P. 1981: Cleistogamy in arctic grasses. *Botanicheski zhurnal 66*: 116–120.

McKone, M. J. 1985: Reproductive biology of several brome grasses (*Bromus*): breeding system, pattern of fruit maturation and seed set. *American journal of botany* 72: 1334–1339

Parodi, L. R. 1949: Las gramíneas sudamericanas del género *Deschampsia*. *Darwiniana 8*: 415–475.

Rosengurtt, B. 1984: Gramíneas cleistogamas del Uruguay. *Boletín no.134*, Facultad de Agronomia Universidad de la Republica Montevideo.

Smith, D. C. 1944: Pollination and seed formation in grasses. *Journal of agricultural research 68*: 79–95.

Vickery, J. W.; Jacobs, S. W. L.; Everett, J. 1986: Taxonomic studies in *Stipa* (Poaceae) in Australia. *Telopea 3*: 1–132.

Werth, E. 1911: Die Vegetation der subantarktischen Inseln: Kerguelen, Possession – und Heard – Eiland. Deutsche Südpolar – Expedition 1901 – 1903. viii. *Band Botanik Heft 3*: 223–371.

Zotov, V. D. 1965: Grasses of the subantarctic islands of the New Zealand region. *Records of the Dominion Museum 5(15)*: 101–146.

Zotov, V. D. 1971: *Simplicia* T. Kirk (Gramineae). *New Zealand journal of botany 9*: 539–544.

Note added in Proof:

Amphibromus: Ogle (1987) regards the future in New Zealand for aquatic *A. fluitans* as "...generally bleak". Although noting that it was a rather late discovery in New Zealand (T. Kirk in 1873), he did not present the view of Jacobs and Lapinpuro (1986) that *A. fluitans* "...would seem to be a recent introduction from Australia", but accepted it as indigenous.

Regardless of its nativity, *A. fluitans* will not be disadvantaged because of its breeding system as every specimen at CHR bears cleistogamously set seeds. Chasmogamic florets with typically longer anthers (1.5 mm) are present in some specimens. Autogamy together with occasional allogamy is well recognised as a competent system of reproduction.

Nicora and Rúgolo de Agrasar (1987) refer to cleistogenes on subterranean nodes in *Amphibromus*; none occurs in the specimens of *A. fluitans* I have seen.

REFERENCES

Jacobs, S. W. L.; Lapinpuro, L. 1986: The Australian species of *Amphibromus* (Poaceae). *Telopea 2*: 715–729.

Nicora, E. G.; Rúgolo de Agrasar, Z. E. 1987: Los géneros de gramíneas de America Austral. Buenos Aires. Editorial Hemispherio Sur S.A.

Ogle, C. 1987: A rarely seen native grass, *Amphibromus fluitans*. *Wellington Botanical Society bulletin 43*: 29–32.