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Passiflora (Passifloraceae) in New Zealand: a revised key with notes on distribution

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Abstract A revised key to New Zealand indigenous and naturalised species of *Passiflora* is presented, and this resolves previous difficulties with the identification of *P. mixta* and *P. mollissima* of subgenus *Tacsonia.* Particular attention is given to this subgenus as there have been recent taxonomic changes to naturalised species that originate from South America and most are serious pest plants in New Zealand. The names *P. tarminiana* and *P. tripartita* var. *azuayensis* are applied to New Zealand plants for the first time, and *P. tripartita* var. *mollissima* is a new rank for plants previously known as *P. mollissima*. These taxa occur throughout New Zealand. *P. mixta* sens. str. is considered to be restricted to the Waitakere Ranges, North Auckland, and Kenepuru Sound, Marlborough, and many of the plants hitherto assigned to that species are treated as *P. tarminiana*.

Keywords Passifloraceae; *Passiflora*; *Passiflora* subg. *Tacsonia*; *P. mixta*; *P. mixta* hybrid; *P. tarminiana*; *P. tripartita* var. *azuayensis*; *P. tripartita* var. *mollissima*; naturalised plants; New Zealand flora

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INTRODUCTION

The most recent treatment of *Passiflora* in New Zealand includes a single endemic species *P. tetrandra* DC. (*Passiflora* subg. *Tetrapathaea* (DC) P.S.Green), six naturalised species, and a naturalised hybrid (Webb et al. 1988). The naturalisation of *Passiflora* in New Zealand has occurred relatively recently, with no species being listed by Allan (1940). The first species of *Passiflora* subg. *Tacsonia* (Juss.) Triana & Planch. to be recorded as naturalised in New Zealand was *P. mollissima* (Kunth) L.Bailey from collections made in Nelson in 1947 and Wellington in 1949 and 1952 (Healy 1958). This was followed by the naturalisation of *Passiflora mixta* L.f. (Young 1970), *P. pinnatistipula* Cav. (Sykes 1982), and *P. antioquiensis* H.Karst. and *P.* ×*rosea* (H.Karst.) Killip (Webb et al. 1988). Despite this recent naturalisation, banana passionfruits, as several of these species are commonly called, are now serious weeds in parts of New Zealand with the status of National Surveillance Pests, and are subject to Pest Management Strategies in several regions of New Zealand (Webb et al. 1988; Vervoort & Hennessy 1997; Roy et al. 1998; Winks & Fowler 2000). Furthermore, biological control is now also being considered for their management in New Zealand (Fowler 1999; Fröhlich & Gianotti 2001).

Difficulties with the classification and identification of species of subgenus *Tacsonia* in New Zealand were indicated by reference to the "*P. mixta* L.f. agg." (Sykes 1982), followed by the comment that "The correct taxonomic placement of the northern banana passionfruit is somewhat problematic ... [and] ... is therefore treated here as a form of *P. mixta*" (Sykes in Webb et al. 1988, p. 937). Recently, critical assessment of morphological (Villacis et al. 1998) and genetic (Fajardo et al. 1998; Sanchez et al. 1999) variation of banana passionfruits indigenous to South America has resulted in a new understanding of relationships, with species' boundaries being reconsidered and a new species described (Holm-Nielsen et al. 1988;

Coppens d'Eeckenbrugge et al. 2001). These actions significantly affect the nomenclature and identification of species of *Passiflora* subg. *Tacsonia* that are naturalised in New Zealand, and in particular they address the uncertainties of Sykes (1982; in Webb et al. 1988). Because of the pest plant status of banana passionfruit, possible research into biological control agents, and general needs for accurate identification, we apply the most recent taxonomic treatments to New Zealand plants, revise the key to the genus *Passiflora* in New Zealand provided by Webb et al. (1988), and present additional notes on distributions.

TAXONOMIC OVERVIEW AND NEW ZEALAND DISTRIBUTIONS

Many of the New Zealand naturalised plants previously referred to *P. mixta* are here treated as the recently recognised *P. tarminiana* Coppens & V.E.Barney (Coppens d'Eeckenbrugge et al. 2001). Plants now placed in *P. tarminiana* undoubtedly contributed to the difficulties Sykes (1982; in Webb et al. 1988) had in identification and his concerns about the application of the name *P. mixta* in New Zealand. *P. tarminiana* is most readily distinguished from other New Zealand species of *Passiflora* by a combination of characters, including its small (see Webb et al. 1988, fig. 93, as *P. mixta*) and deciduous stipules, shorter hypanthium (floral tube), prominent nectary chamber, and fusiform fruit. In New Zealand, *P. mixta* differs from *P. tarminiana* in having densely hairy elongated bracts, a hairy hypanthium, a narrow nectary chamber, and salmon-pink flowers. There are three named varieties of *P. mixta* in Ecuador (Holm-Nielsen et al. 1988), but it is difficult to confidently and consistently apply this treatment to New Zealand plants. In New Zealand plants the hypanthium is 7–12 cm long (cf. var. *mixta*), the bracts are elongate, forming a deeply cup-shaped involucre (cf. var. *pilaloensis*), and the outer surface of the hypanthium is pubescent (cf. var. *eriantha*). As the morphological characters of New Zealand plants of *P. mixta* are not unique to any one of these varieties we do not apply the infraspecific classification of Holm-Nielsen et al. (1988) and simply refer to them as *P. mixta* sens. lat. It is also difficult to apply the treatment of Holm-Nielsen et al. (1988) to *P. mixta* in South America as polymorphism is extensive and all the intermediate forms exist (G. Coppens d'Eeckenbrugge pers. comm.).

Passiflora mollissima, as treated by Webb at al. (1988), has been shown with morphological and molecular data to be part of the natural variation of *P. tripartita* Juss. sens. lat. (Fajardo et al. 1998; Villacis et al. 1998; Sanchez et al. 1999) and is currently treated as *P. tripartita* var. *mollissima* (Kunth) Holm-Niels. & P.Jørg. (Holm-Nielsen et al. 1988). We adopt this classification here. There are three varieties of *P. tripartita* and they have similar flower and fruit morphology (Holm-Nielsen et al. 1988). Another of these, *P. tripartita* var. *azuayensis* Holm-Niels. & P.Jørg., also occurs in New Zealand. The two varieties in New Zealand are consistently distinguished by a glabrous to glabrate (var. *azuayensis*) or moderately to densely pubescent (var. *mollissima*) upper leaf surface. Plants now referred to var. *azuayensis* were previously confused with *P. mixta*, most probably because of their glabrous or glabrate leaves. Some New Zealand specimens of *P. tripartita* var. *azuayensis* (e.g., CHR 400718, CHR 473968) have their corona with short (2–6 mm long) filaments, but these specimens are easily distinguished from *P. pinnatistipula* and *P. ×rosea* by other morphological characters (see key). A collection from near Momorangi Bay, Queen Charlotte Sound, Marlborough (CHR 765490), is unusual in that it has a hypanthium/sepal length ratio of about 2, a slightly swollen nectary chamber, and apparently deciduous stipules. This collection is referred with some caution to *P. tripartitia* var. *azuayensis*, but it may represent a hybrid between *P. tarminiana* and *P. tripartita* var. *azuayensis.*

Passiflora mixta was previously considered to be one of the most common species in New Zealand, but it is now only known in the wild from the Waitakere Ranges, Auckland, and a recent collection from roadside bush near Portage, Kenepuru Sound, Marlborough (CHR 560135). The current distribution of *P. mixta* in the Waitakere Ranges is unknown. The three most common passionfruits in New Zealand are *P. tarminiana*, *P. tripartita* var. *azuayensis*, and *P. tripartita* var. *mollissima*. Unfortunately, it is difficult to be sure of the full extent of their distributions due to the few herbarium collections, particularly the lack of them in recent years, and the past confusion with the application of names. The limited information available indicates that while these three taxa occur throughout New Zealand, there are some distribution patterns that most probably reflect their cultivation history. *P. tarminiana* appears to be most common in the northern North Island, *P. tripartita* var. *mollissima* in Wellington, Nelson, and Marlborough, and *P.*

tripartita var. *azuayensis* in Wellington, Canterbury, and Otago. Recent collections of *P. pinnatistipula* indicate that this species is more common in Canterbury and Otago than was previously thought (Webb et al. 1988), whereas *P.* ×*rosea* appears to be still restricted to Banks Peninsula (Webb et al. 1988). In some areas a number of these taxa are known to occur together. For example, in the vicinity of Diamond Harbour, Banks Peninsula, are found *P. tarminiana*, *P. tripartita* var. *azuayensis*, *P. tripartita* var. *mollissima*, *P. pinnatistipula*, and *P.* ×*rosea*. *P. antioquiensis* is now known from additional sites in North Auckland (Heenan et al. 2002) and was recently seen, but not collected, by PBH naturalised in coastal forest at Camp Bay, Endeavour Inlet, Queen Charlotte Sound, Marlborough. The species of *Passiflora* subg. *Tacsonia* naturalised in New Zealand usually occur in disturbed indigenous or naturalised vegetation, forest gaps and margins, on bluffs, and along roadsides and waterways, and usually in moist, frost-free, lowland and coastal areas.

For full descriptions and detailed illustrations of *P. mixta*, *P. pinnatistipula*, *P. tarminiana*, *P. tripartita* var. *azuayensis*, and *P. tripartita* var. *mollissima* referred to in the key below consult Holm-Nielsen et al. (1988) and Coppens d'Eeckenbrugge et al. (2001), and for illustrations of *P. antioquiensis* and *P.* ×*rosea* see Young (1970). Nomenclature, author and place of publication, first record, and representative specimens of *Passiflora* subg. *Tacsonia* in New Zealand are provided in the Appendix.

Key to *Passiflora* in New Zealand

1 Hypanthium (floral tube) cylindric and strongly elongated *2*
Hypanthium (floral tube) absent or saucer-shaped and inconspicuous *7*

2 Corolla bright crimson; hypanthium 2–3 cm long; peduncle 14–40 cm long, < 1.5 mm diam.; ovary glabrous ..... ***antioquiensis***
Corolla pink or shades of pink, to salmon-pink; hypanthium > 4 cm long; peduncle 2–7 cm long, > 2 mm diam.; ovary white villous *3*

3 Bracts free or occasionally connate < ¼ of their length; stipules pinnate and with filiform segments; corona filamentous, filaments > 7 mm long; fruit length < 1.7 × fruit width *4*
Bracts connate > ⅓ of their length; stipules simple, ovate and toothed, often deciduous; corona reduced to teeth, rarely filamentous and then filaments < 6 mm long; fruit length > (1.8–)2× fruit width *5*

4 Stipules pinnatisect, pinnae filiform to narrow-linear, dark red; stamens normally developed; corona filaments 14–20 mm long; androgynophore extending to ovary base; bracts free, margins irregularly serrate and with prominent filamentous apices; fruit globose to depressed globose, abundantly produced ..... ***pinnatistipula***
Stipules lanceolate, pinnae of small marginal teeth, green; stamens usually abnormal and ± petaloid; corona filaments 5–12 mm long; androgynophore terminating > 4 mm below ovary base; bracts free or occasionally connate < ¼ of their length, margins uniformly serrulate and with subacute apices; fruit broad ellipsoid, rarely produced ..... ×***rosea***

5 Leaves glabrous to glabrate on upper surface; stipules 4–7 × 2–3 mm, early deciduous; nectary chamber 1.4–2.0 cm wide; hypanthium/sepal length ratio 1.3–1.6; fruit fusiform ..... ***tarminiana***
Leaves glabrous to densely pubescent on upper surface; stipules 6–20 × 12–30 mm, persistent; nectary chamber < 1.4 cm wide; hypanthium/sepal length ratio > 1.6; fruit obovoid to oblong *6*

6 Leaves glabrous to glabrate or moderately to densely pubescent on upper surface; petiole with 6–14 glands; bracts connate for ⅓–⅔ length, sparsely to moderately pubescent, with the hairs inconspicuous; flowers pink; hypanthium glabrous, hypanthium/sepal length ratio (c. 2.0–)2.4–3.2 ..... ***tripartita***
Leaves glabrous to glabrate on upper surface ..... var. ***azuayensis***
Leaves moderately to densely pubescent on upper surface ..... var. ***mollissima***
Leaves glabrous to glabrate on upper surface; petiole with 4–10 glands; bracts usually connate for > ¾ length, densely pubescent with the hairs conspicuous; flowers salmon-pink; hypanthium moderately to densely pubescent, hypanthium/sepal length ratio 1.6–2.6 ..... ***mixta***

(*continued over page*)

7 Plants dioecious; leaves entire, coriaceous; perianth, 4-merous, < 2 cm diam. when fresh; fruit < 3 cm diam., orange…….. ..... ***tetrandra***
Plants with hermaphroditic flowers; leaves 3- or 5-lobed on adult shoots, membranous or submembranous; perianth 5-merous, > 4 cm diam. when fresh; fruit > 3 cm diam., yellow or purple *8*

8 Leaves dull above, 5-lobed on adult shoots; stipules broad and subreniform; bracts entire; fruit yellow when ripe, 3.0–4.5 cm diam. ..... ***caerulea***
Leaves shining above, 3-lobed on adult shoots; stipules linear-subulate; bracts serrate; fruit dull or dark purple when ripe, > 4.5 cm diam. ..... ***edulis* f. *edulis***

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Appendix Name and place of publication, first record, and representative herbarium specimens of species of *Passiflora* subg. *Tacsonia* in New Zealand.

P. antioquiensis H.Karst., *Linnaea 30*, 162 (1859–60)
FIRST RECORD: Sykes, W. R., in *Flora of New Zealand IV*, 935 (1988).
VOUCHER: (*fide* Webb et al. 1989): AKU 18515, *M. Large*, 24 Jun 1985, east of Kawakawa, North Auckland.
ADDITIONAL SPECIMENS: (*fide* Heenan et al. 2002): AK 213681, *R. O. Gardner 6931*, 4 Mar 1993, Hauraki Gulf, Kawau Island, Two House Bay; AK 213682, *R. O. Gardner 6935*, 6 Mar 1993, Hauraki Islands, Kawau Island, Schoolhouse Bay.
NOTES: Also known in New Zealand as *P. van-volxemii* Triana & Planchon.

P. mixta L.f., *Suppl. Pl.*, 408 (1781)
FIRST RECORD: Young, B. R., *Rec. Auckland Inst. Mus. 7*, 159–163 (1970).
VOUCHER: AK 116169, *R. R. McNab*, Mar 1966, Auckland Ecological Region, Titirangi, Godley Road.
ADDITIONAL SPECIMENS: AK 117576, *S. Davidson*, 6 Jan 1967, Auckland Ecological Region, Titirangi, Bishop Park Scenic Reserve; CHR 227510, *A. E. Esler*, 12 Jan 1972, Scenic Drive, Waitakere Ranges, Auckland; CHR 560135, *P. B. Heenan*, 16 Jan 2002, near Portage, Kenepuru Sound, Marlborough.

P. pinnatistipula Cav., *Icon. Pl.* 428 (1799)
FIRST RECORD: Sykes, W. R., *New Zealand J. Bot. 20*, 77 (1982).
VOUCHER: (*fide* Sykes 1982): CHR 201211, *B. P. J. Molloy*, 15 Apr 1970, Akaroa Domain, Canterbury.
ADDITIONAL SPECIMENS: CHR 404806, *J. West*, 10 Aug 1983, Goodwood Scenic Reserve, Otago; CHR 510674, *D. Rossiter*, 22 May 1996, Ashley River, Canterbury.

P.* ×*rosea (H.Karst.) Killip, *Publ. Field Mus. Nat. Hist. Bot. Ser. 19*, 278 (1938)
FIRST RECORD: Sykes, W. R., in *Flora of New Zealand IV*, 935 (1988).
VOUCHER (*fide* Webb et al. 1989): CHR 400637, *W. R. Sykes 212/82*, 10 Apr 1982, Diamond Harbour, Banks Peninsula, Canterbury.
ADDITIONAL SPECIMEN: CHR 181444, *W. R. Sykes 7/68*, 6 Jan 1968, Redcliffs, Christchurch, Canterbury.
NOTES: Plants in New Zealand rarely produce fruit. When fruits are formed the seeds appear to contain endosperm and embryo, although we have not tried to germinate them. We are uncertain whether these fruits have formed by self pollination from pollen that occasionally occurs in the malformed and petaloid stamens, or whether hybridisation with another species is involved. On Banks Peninsula, *P.* ×*rosea* produces occasional fruit and grows near *P. pinnatistipula*. At this site *P. pinnatistipula* may be the parent involved in pollination and fertilisation if outcrossing has occurred. A cultivated collection (CHR 194655, Dannevirke, Wellington) of *P.* ×*rosea* lacks the obvious petaloid stamens but the androgynophore and stipules are like *P.* ×*rosea*, and thus may represent a backcross or an F_2 hybrid of *P.* ×*rosea*. Twenty-one percent (n = 510) of pollen grains of this plant have normal cytoplasm when stained with Alexanders Differential Stain, and this suggests at least some of the pollen is viable. The presence of pollen grains that lack cytoplasm or have abnormal cytoplasm is consistent with a hybrid origin. Other cultivated specimens of *P.* ×*rosea* from Auckland also differ from naturalised South Island plants in their shorter hypanthium (2.5–3.0 cm) as well as having normal stamens (AK 117573).

P. tarminiana Coppens & V.E.Barney, *Novon 11*, 9 (2001)
NEW RECORD: e.g., CHR 228763, *W. R. Sykes 233/72*, 12 Feb 1972, Aubrey's Hill, Whangarei Heads, Northland.
ADDITIONAL SPECIMENS: AK 219107, *A. E. Esler*, 17 Nov 1970, Kerikeri, Northland; AK 138965, *A. E. Wright 912*, 1 Jan 1976, Auckland City, Auckland; CHR 400766, *W. R. Sykes 394/81*, 1 Dec 1981, Kerikeri, Northland; CHR 418008, *W. R. Sykes 10/85*, 1 Feb 1985, Buller, Karamea, Nelson.

P. tripartita* var. *azuayensis Holm-Niels. & P.Jørg., *Flora of Ecuador 126. Passifloraceae*, 79 (1988)
NEW RECORD: e.g., AK 173113, *A. E. Esler & R. M. Greenwood*, 12 Nov 1985, Palmerston North, Linton Military Camp.
ADDITIONAL SPECIMENS: AK 145544, *B. G. Hamlin*, 16 Mar 1955, Paturau River, Nelson; AK 219105, *A. E. Esler*, 24 Mar 1971, Kahuterawa Valley, Manawatu; CHR 285427, *E. J. Godley*, 15 Oct 1976, Mt Baldie, north of Waikouaiti, Otago; CHR 468161, *R. Mason 13359*, 2 Feb 1978, Gore Bay district, Canterbury; CHR 473968, *W. R. Sykes 388/91*, 22 Sep 1991, Macandrew Bay, Otago.

P. tripartita* var. *mollissima (Kunth) Holm-Niels. & P.Jørg., *Flora of Ecuador 126 Passifloraceae*, 80 (1988)
≡*P. mollissima* (Kunth) L.Bailey, *Rhodora 18*, 156 (1916) (For a full synonymy see Holm-Nielsen et al. (1988)).
FIRST RECORD: Healy, A. J., *Trans. Roy. Soc. New Zealand 85*, 544 (1958).
VOUCHER: CHR 82820, *A. J. Healy*, 28 Feb 1947, Ruby Bay, near Motueka, Nelson.
ADDITIONAL SPECIMENS: CHR 82819, *A. J. Healy*, 9 Apr 1952, Raumati; CHR 115291, *E. J. Godley*, 13 Oct 1960, east of Collingwood, Nelson; AK 181989, *D. J. Court*, 20 Feb 1975, Titirangi, Auckland.
NOTES: Also known in New Zealand as "*P. tomentosa* Triana & Planchon".