

Supplementary Materials

Appendix S1: Woody epiphytes and hemiepiphytes of tree fern trunks as identified by a literature review. Epiphyte type is as described by Zotz (2013), and epiphytic strategy is as Burns (2010).

Species	Epiphyte Type	Epiphytic strategy	Article author
<i>Ackama nubicola</i>	Hemi-epiphyte	Facultative	de Lange et al. 2002
<i>Ackama rosifolia</i>	Hemi-epiphyte	Facultative	Pope 1926; Dawson & Sneddon 1969; Dawson 1986; Page & Brownsey 1986; Dawson 1988
<i>Beilschmiedia tawa</i>	Epiphyte	Accidental	Dawes & Burns 2020
<i>Brachyglottis kirkii</i> var. <i>kirkii</i>	Epiphyte	Facultative	Clarkson 1985
<i>Brachyglottis repanda</i>	Epiphyte	Accidental	Pope 1926; Oliver 1930; Dawes & Burns 2020
<i>Coprosma foetidissima</i>	Epiphyte	Accidental	Oliver 1930; Veblen & Stewart 1980
<i>Coprosma grandifolia</i>	Epiphyte	Facultative	Dawes & Burns 2020
		Accidental	Pope 1926; Dawson 1988
	Hemi-epiphyte	Accidental	Dawson 1986
		Facultative	Oliver 1930; Dawson & Sneddon 1969; Clarkson 1985
<i>Coprosma rhamnoides</i>	Epiphyte	Accidental	Pope 1926
<i>Coprosma robusta</i>	Hemi-epiphyte	Accidental	Pope 1926
		Facultative	Oliver 1930
	Epiphyte	Accidental	Oliver 1930
<i>Coprosma tenuifolia</i>	Epiphyte	Accidental	Oliver 1930
<i>Dacrydium cupressinum</i>	Epiphyte	Accidental	Pope 1926; Oliver 1930
<i>Dracophyllum arboreum</i>	Hemi-epiphyte	Facultative	Oliver 1930
<i>Elaeocarpus dentatus</i>	Epiphyte	Accidental	Dawes & Burns 2020
<i>Geniostoma ligustrifolium</i>	Epiphyte	Accidental	Pope 1926; Oliver 1930
		Facultative	Campbell 1984; Ogle et al. 2000; Dawes & Burns 2020
<i>Griselinia littoralis</i>	Hemi-epiphyte	Facultative	Oliver 1930
	Epiphyte		Veblen & Stewart 1980; Campbell 1984; Smale & Smale 2003; Bryan 2011
<i>Griselinia lucida</i>	Epiphyte	Facultative	Heginbotham & Esler 1985; Duguid 1990
	Hemi-epiphyte	Facultative	Dawson 1966
<i>Hedyocarya arborea</i>	Epiphyte	Accidental	Dawes & Burns 2020
<i>Ixerba brexioides</i>	Epiphyte	Accidental	Nepia & Clarkson 2018
<i>Knightia excelsa</i>	Epiphyte	Accidental	Dawes & Burns 2020
<i>Kunzea</i> sp. ¹	Epiphyte	Accidental	Pope 1926; Oliver 1930
<i>Laurelia novae-zelandiae</i>	Epiphyte	Accidental	Dawes & Burns 2020
<i>Leptospermum scoparium</i>	Epiphyte	Accidental	Oliver 1930
	Epiphyte	Accidental	Pope 1926
<i>Leucopogon fasciculatus</i>	Epiphyte	Accidental	Pope 1926; Oliver 1930
<i>Melicytus ramiflorus</i>	Epiphyte	Accidental	Oliver 1930
	Hemi-epiphyte	Facultative	Ogle et al. 2000; Dawes & Burns 2020
<i>Metrosideros bartlettii</i>	Hemi-epiphyte	Facultative	Dawson 1985
<i>Metrosideros robusta</i>	Hemi-epiphyte	Facultative	Oliver 1930; Page & Brownsey 1986; Knightbridge & Ogden 1988; Duguid 1990
<i>Metrosideros umbellata</i>	Hemi-epiphyte	Facultative	Oliver 1930
<i>Myrsine australis</i>	Epiphyte	Accidental	Pope 1926; Oliver 1930; Veblen & Stewart 1980
<i>Myrsine chathamica</i>	Hemi-epiphyte	Facultative	Wardle 1991
<i>Nestegis lanceolata</i>	Epiphyte	Accidental	Oliver 1930
<i>Nestegis</i> sp.	Epiphyte	Accidental	Dawes & Burns 2020
<i>Olearia rani</i>	Epiphyte	Accidental	Pope 1926; Oliver 1930; Dawes & Burns 2020
<i>Pectinopitys ferruginea</i>	Epiphyte	Accidental	Pope 1926; Oliver 1930
<i>Phyllocladus alpinus</i>	Epiphyte	Accidental	Oliver 1930
<i>Piper excelsum</i>	Epiphyte	Accidental	Pope 1926; Oliver 1930; Ogle et al. 2000
<i>Pittosporum cornifolium</i>	Epiphyte	Obligate	Clarkson et al. 2012
<i>Pittosporum kirkii</i>	Epiphyte	Obligate	Myron 2012
<i>Pseudopanax arboreus</i>	Hemi-epiphyte	Facultative	Dawes & Burns 2020
			Pope 1926; Oliver 1930; Dawson & Sneddon 1969; Cockayne 1971; Dawson 1986; Page & Brownsey 1986; Dawson 1988
<i>Pseudopanax colensoi</i>	Hemi-epiphyte	Accidental	Veblen & Stewart 1980
	Epiphyte		Oliver 1930
<i>Pseudopanax crassifolius</i>	Epiphyte	Accidental	Oliver 1930
			Ogle et al. 2000
<i>Quintinia acutifolia</i>	Hemi-epiphyte	Facultative	Bellingham & Richardson 2006
<i>Raukaua edgerleyi</i>	Hemi-epiphyte	Accidental	Pope 1926
		Facultative	Oliver 1930; Dawson & Sneddon 1969; Barton 1972; Campbell 1984; Heginbotham & Esler 1985; Dawson 1986; Page & Brownsey 1986; Dawson 1988

¹This species was recorded as *Kunzea ericoides* prior to the revision and splitting of this species complex (de Lange 2014); it is not known which of the newly described species of *Kunzea* that resulted was recorded as an epiphyte.

Appendix S1: Continued.

Species	Epiphyte Type	Epiphytic strategy	Article author
<i>Raukaua simplex</i>	Hemi-epiphyte	Facultative Accidental	Campbell 1984 Veblen & Stewart 1980
<i>Weinmannia racemosa</i>	Epiphyte Hemi-epiphyte	Facultative	Oliver 1930 Pope 1926; Oliver 1930; Wardle & MacRae 1966; Dawson & Sneddon 1969; Cockayne 1971; Beveridge 1973; Dobson 1977; Veblen & Stewart 1980; Campbell 1984; Dawson 1986; Page & Brownsey 1986; Dawson 1988; Duguid 1990; Blaschke 1992; Lusk & Ogden 1992; Smale et al. 1997; Burrows 1999; Ogle et al. 2000; Smale & Smale 2003; Bellingham & Richardson 2006; Gaxiola et al. 2008; Dawes & Burns 2020
<i>Weinmannia sylvicola</i>	Hemi-epiphyte	Facultative	Oliver 1930; Wardle & MacRae 1966; Dawson & Sneddon 1969; Page & Brownsey 1986

Appendix S2a: Percentage occurrence of saplings (> 135 cm tall, but not reproductive) and reproductive individual woody epiphytes across tree fern stems by species (*Ackama to Laurelia*) and survey area (Survey areas north to south: 1 = Northland, 2 = Waikato, 3 = Bay of Plenty, 4 = Manawatu, 5 = Nelson, 6 = Westland, 7 = Southland). For a key to the six-letter codes in the column headers, refer to: <https://nvs.landcareresearch.co.nz/Resources/NVSNAMES>. Percentage occurrence calculated from frequency of epiphyte occurrence per site × frequency of sapling or reproductive individuals' occurrence per site.

Site	% occurrence on tree ferns	ACKros	ALSmac	BRArep	COPfoe	COPgra	COPluc	DRAlat	ELAden	GENlig	GRlit	LAUnov
1	sapling and larger % occurrence (0.15 * 0.284)	1 0.0426	1 0.0426	0	0	5 0.213	0	1 0.0426	2 0.0852	1 0.0426	1 0.0426	1 0.0426
	reproductive % occurrence (0.05 * 0.284)	1 0.0142	0	0	0	2 0.0284	0	0	0	0	1 0.0142	0
2	sapling and larger % occurrence (0.18 * 0.575)	0	1 0.1035	0	0	0	1 0.1035	0	1 0.1035	3 0.3105	0	0
	reproductive % occurrence (0.00 * 0.575)	0	0	0	0	0	0	0	0	0	0	0
3	sapling and larger % occurrence (0.18 * 0.603)	0	0	0	0	2 0.21708	0	0	0	2 0.21708	0	0
	reproductive % occurrence (0.03 * 0.603)	0	1 0.01809	0	0	0	0	0	0	2 0.03618	0	0
4	sapling and larger % occurrence (0.04 * 0.530)	0	0	1 0.0212	0	1 0.0212	0	0	0	1 0.0212	0	0
	reproductive % occurrence (0.03 * 0.530)	0	0	1 0.0159	0	0	0	0	0	1 0.0159	0	0
5	sapling and larger % occurrence (0.08 * 0.710)	0	0	0	0	4 0.2272	0	0	0	0	0	0
	reproductive % occurrence (0.01 * 0.710)	0	0	0	0	1 0.0071	0	0	0	0	0	0
6	sapling and larger % occurrence (0.22 * 0.911)	0	0	0	0	1 0.20042	0	0	0	0	0	0
	reproductive % occurrence (0.01 * 0.911)	0	0	0	0	0	0	0	0	0	0	0
7	sapling and larger % occurrence (0.10 * 0.569)	0	0	0	3 0.1707	1 0.0569	2 0.1138	0	0	0	1 0.0569	0
	reproductive % occurrence (0.01 * 0.569)	0	0	0	0	0	1 0.00569	0	0	0	0	0
	Mean % sapling and larger occurrence on TFs	0.0426	0.1461	0.0212	0.1707	0.9358	0.2173	0.0426	0.1887	0.59138	0.0995	0.0426
	Mean % reproductive on TFs	0.0142	0.01809	0.0159	0	0.0355	0.00569	0	0	0.05208	0.0142	0
	Total seedlings	331	9	30	27	126	29	3	15	157	38	56
	Total saplings and larger	1	2	1	3	14	3	1	3	7	2	1
	Total reproductive	1	1	1	0	3	1	0	0	3	1	0
	% of epiphytes as sapling and larger	0.30%	22.22%	3.33%	11.11%	11.11%	10.34%	33.33%	20.00%	4.46%	5.26%	1.79%
	% of epiphytes as reproductive	0.30%	11.11%	3.33%	0.00%	2.38%	3.45%	0.00%	0.00%	1.91%	2.63%	0.00%

Appendix S2b: Percentage occurrence of saplings (> 135 cm tall, but not reproductive) and reproductive individual woody epiphytes by species (*Meliccytus* to *Weinmannia*) and survey area (Survey areas north to south: 1 = Northland, 2 = Waikato, 3 = Bay of Plenty, 4 = Manawatu, 5 = Nelson, 6 = Westland, 7 = Southland). For a key to the six-letter codes in the column headers, refer to: <https://nvs.landcareresearch.co.nz/Resources/NVSNames>. Percentage occurrence calculated from frequency of epiphyte occurrence per site \times frequency of sapling or reproductive individuals' occurrence per site.

Site	% occurrence on tree ferns	MELmac	MELram	OLEran	PODtot	PSEarb	PSEcra	RAUedg	SCHdig	STRhet	WEIrac	WEIsil
1	sapling and larger (<i>n</i>)	5			1			3	2			2
	% occurrence (0.15 * 0.284)	0.213	0	0	0.0426	0	0	0.1278	0.0852	0	0	0.0852
	reproductive epiphytes (<i>n</i>)	1										2
	% occurrence (0.05 * 0.284)	0.0142	0	0	0	0	0	0	0	0	0	0.0284
2	sapling and larger (<i>n</i>)		2	1		1	1					12
	% occurrence (0.18 * 0.575)	0	0.207	0.1035	0	0.1035	0.1035	0	0	0	0	1.242
	reproductive epiphytes (<i>n</i>)											
	% occurrence (0.00 * 0.575)	0	0	0	0	0	0	0	0	0	0	0
3	sapling and larger (<i>n</i>)		1	1		9			1		6	
	% occurrence (0.18 * 0.603)	0	0.10854	0.10854	0	0.97686	0	0	0.10854	0	0.65124	0
	reproductive epiphytes (<i>n</i>)					1						
	% occurrence (0.03 * 0.603)	0	0	0	0	0.01809	0	0	0	0	0	0
4	sapling and larger (<i>n</i>)		1		1					1		
	% occurrence (0.04 * 0.530)	0	0.0212	0	0.0212	0	0	0	0	0.0212	0	0
	reproductive epiphytes (<i>n</i>)		1									
	% occurrence (0.03 * 0.530)	0	0.0159	0	0	0	0	0	0	0	0	0
5	sapling and larger (<i>n</i>)			1		2					1	
	% occurrence (0.08 * 0.710)	0	0	0.0568	0	0.1136	0	0	0	0	0.0568	0
	reproductive epiphytes (<i>n</i>)											
	% occurrence (0.01 * 0.710)	0	0	0	0	0	0	0	0	0	0	0
6	sapling and larger (<i>n</i>)							3	9		21	
	% occurrence (0.22 * 0.911)	0	0	0	0	0	0	0.60126	1.80378	0	4.20882	0
	reproductive epiphytes (<i>n</i>)								1			
	% occurrence (0.01 * 0.911)	0	0	0	0	0	0	0	0.00911	0	0	0
7	sapling and larger (<i>n</i>)						1	1			3	
	% occurrence (0.10 * 0.569)	0	0	0	0	0	0.0569	0.0569	0	0	0.1707	0
	reproductive epiphytes (<i>n</i>)							1			1	
	% occurrence (0.01 * 0.569)	0	0	0	0	0	0	0.00569	0	0	0.00569	0
	Mean % sapling and larger	0.213	0.33674	0.26884	0.0638	1.19396	0.1604	0.78596	1.99752	0.0212	5.08756	1.3272
	Mean % reproductive	0.0142	0.0159	0	0	0.01809	0	0.00569	0.00911	0	0.00569	0.0284
	Total seedlings	36	333	14	6	76	52	42	182	1	1179	236
	Total saplings and larger	5	4	3	2	12	2	7	12	1	31	14
	Total reproductive	1	1	0	0	1	0	1	1	0	1	2
	% sapling and larger	13.89%	1.20%	21.43%	33.33%	15.79%	3.85%	16.67%	6.59%	100.00%	2.63%	5.93%
	% reproductive epiphytes	2.78%	0.30%	0.00%	0.00%	1.32%	0.00%	2.38%	0.55%	0.00%	0.08%	0.85%

Appendix S3: Model parameters for linear mixed models of woody epiphyte and hemiepiphyte diversity, richness, and abundance using DBH and tree fern height as fixed effects, with tree fern species and survey area as random effects. All *p*-values have been corrected for family-wise error using the Hochberg method.

	Estimate	Std Error	df	t value	<i>P</i>
Diversity ~ DBH					
(Intercept)	0.03377	1.23696	10.07255	0.027	0.979
DBH	0.33749	0.052	384.79071	6.49	< 0.0001
Diversity ~ height					
(Intercept)	1.7222	0.908	14.8983	1.897	0.0774
TF_Height	0.7498	0.1321	698.4978	5.678	< 0.0001
Richness ~ DBH					
(Intercept)	1.675	0.19031	6.68716	8.801	6.45E-05
TF_Height	0.07811	0.02952	683.22564	2.646	0.0112
Richness ~ height					
(Intercept)	1.52917	0.19725	16.23254	7.752	7.57E-07
DBH	0.03305	0.01099	65.53835	3.007	0.0003
Abundance ~ DBH					
(Intercept)	3.67E-01	8.76E-02	1.08E+01	4.184	0.0016
DBH	7.95E-03	4.60E-03	2.39E+02	1.729	0.0851
Abundance ~ height					
(Intercept)	0.37883	0.08204	5.60405	4.618	0.00431
TF_Height	0.02422	0.01199	690.20741	2.021	0.0851

References

- Barton IL 1972. On the vegetation of the Hunua Ranges, Auckland. *New Zealand Journal of Botany* 10(1): 8–26.
- Blaschke PM, Trustrum NA, DeRose RC 1992. Ecosystem processes and sustainable land use in New Zealand steeplands. *Agriculture, Ecosystems and Environment* 41(2): 153–178.
- Bellingham PJ, Richardson SJ 2006. Tree seedling growth and survival over 6 years across different microsites in a temperate rain forest. *Canadian Journal of Forest Research* 36(4): 910–918.
- Bryan CL 2011. Ecology of vascular epiphytes in urban forests with special reference to the shrub epiphyte *Griselinia lucida*. Unpublished MSc thesis. The University of Waikato, Hamilton, New Zealand.
- Burns KC 2010. How arboreal are epiphytes? A null model for Benzing's classifications. *New Zealand Journal of Botany* 48(3–4): 185–191.
- Burrows CJ 1999. Germination behaviour of seeds of the New Zealand woody species *Alseuosmia macrophylla*, *A. pusilla*, *Cordyline banksii*, *Geniostoma rupestre*, *Myrtus bullata*, and *Solanum aviculare*. *New Zealand Journal of Botany* 37(2): 277–287.
- Campbell DJ 1984. The vascular flora of the DSIR study area lower Orongorongo Valley, Wellington, New Zealand. *New Zealand Journal of Botany* 22(2): 223–270.
- Clarkson BD 1985. The vegetation of the Kaitake Range Egmont National Park, New Zealand. *New Zealand Journal of Botany* 23(1): 15–31.
- Cockayne L 1971. The subtropical and subantarctic rain forests of New Zealand. In: Eyre SR ed. *World vegetation types*. London, Palgrave Macmillan UK. Pp. 109–136.
- Dawes TN, Burns KC 2020. Facultative hemiepiphytism as a recruitment strategy in small-seeded tree species. *Journal of Vegetation Science* 31: 1102–1113.
- Dawson JW 1966. Vegetative features of *Griselinia lucida* - a New Zealand shrub epiphyte. *Tuatara* 14(3): 121–129.
- Dawson JW 1985. *Metrosideros bartlettii* (Myrtaceae) a new species from North Cape, New Zealand. *New Zealand Journal of Botany* 23(4): 607–610.
- Dawson JW 1986. The vines, epiphytes and parasites of New Zealand forests. *Tuatara* 28(2): 44–70.
- Dawson JW 1988. *Forest vines to snow tussocks: the story of New Zealand plants*. Wellington, Victoria University Press. 87 p.
- Dawson JW, Sneddon BV 1969. The New Zealand rain forest: A comparison with tropical rain forest. *Pacific Science* 23: 131–147.
- de Lange PJ 2014. A revision of the New Zealand *Kunzea ericoides* (Myrtaceae) complex. *PhytoKeys* 2014(40): 1–185.
- Dobson AT 1977. Stand structure in a kamahi (*Weinmannia racemosa*) forest at Waimangaroa, Buller County. *Mauri Ora* 5: 9–20.
- Duguid PC 1990. Botany of northern Horowhenua lowlands, North Island, New Zealand. *New Zealand Journal of Botany* 28(4): 381–437.
- Heginbotham M, Esler AE 1985. Wild vascular plants of the Opotiki — East Cape region North Island, New Zealand. *New Zealand Journal of Botany* 23(3): 379–406.
- Knightbridge PI, Ogden J 1998. Establishment patterns and host tree preferences of the emergent hemi-epiphytic tree *Metrosideros robusta* in northern New Zealand. *New Zealand Journal of Botany* 36(2): 203–212.
- Lusk C, Ogden J 1992. Age structure and dynamics of a podocarp-broadleaf forest in Tongariro National Park, New Zealand. *Journal of Ecology* 80(3): 379–393.
- Myron KJ 2012. *Pittosporum kirkii*: autecology of an endemic shrub epiphyte. Unpublished MSc thesis. The University of Waikato, Hamilton, New Zealand. 182 p.
- Nepia RE, Clarkson BD 2018. Biological flora of New Zealand

- (15): *Ixerba brexioides*, tāwari. New Zealand Journal of Botany 56(1): 2–25.
- Ogle C, La Cock G, Halsey B 2000. What use are dead tree ferns? Ecological Management 8: 95–103.
- Oliver WRB 1930. New Zealand epiphytes. Journal of Ecology 18: 1–50.
- Page CN, Brownsey PJ 1986. Tree-fern skirts: a defence against climbers and large epiphytes. Journal of Ecology 74(3): 787–796.
- Smale MC, Smale PN 2003. Dynamics of upland conifer/broadleaved forest at Waihaha, central North Island, New Zealand. Journal of the Royal Society of New Zealand 33(2): 509–528.
- Smale MC, McLeod M, Smale PN 1997. Vegetation and soil recovery on shallow landslide scars in tertiary hill country, East Cape Region, New Zealand. New Zealand Journal of Ecology 21(1): 31–41.
- Wardle P 1991. Vegetation of New Zealand. Cambridge, UK, Cambridge University Press. 672 p.
- Wardle P, MacRae AH 1966. Biological flora of New Zealand. 1. *Weinmannia racemosa* Linn. F. (Cunoniaceae). Kamahi. New Zealand Journal of Botany 4(1): 114–131.
- Zotz G 2013. Hemiepiphyte: A confusing term and its history. Annals of Botany 111(6): 1015–1020.