Taxon: Cyrtomium falcatum (L. f.) C. Presl

Family: Dryopteridaceae

Common Name(s): holly fern
house holly fern
Japanese holly fern

Synonym(s): Aspidium falcatum (L. f.) Sw.
Cyrtomium yiangshanense Ching &
Dryopteris falcata (L. f.) Kuntze
Phanerophlebia falcata (L. f.) Copel.
Polypodium falcatum L. f.
Polystichum falcatum (L. f.) Diels

Assessor: Chuck Chimera **Status:** Assessor Approved **End Date:** 17 Sep 2018

WRA Score: 14.0 **Designation:** H(Hawai'i) **Rating:** High Risk

Keywords: Naturalized Fern, Environmental Weed, Ornamental, Shade-Tolerant, Apogamous

Qsn #	Question	Answer Option	Answer
101	Is the species highly domesticated?	y=-3, n=0	n
102	Has the species become naturalized where grown?		
103	Does the species have weedy races?		
201	Species suited to tropical or subtropical climate(s) - If island is primarily wet habitat, then substitute "wet tropical" for "tropical or subtropical"	(0-low; 1-intermediate; 2-high) (See Appendix 2)	High
202	Quality of climate match data	(0-low; 1-intermediate; 2-high) (See Appendix 2)	High
203	Broad climate suitability (environmental versatility)	y=1, n=0	y
204	Native or naturalized in regions with tropical or subtropical climates	y=1, n=0	y
205	Does the species have a history of repeated introductions outside its natural range?	y=-2, ?=-1, n=0	y
301	Naturalized beyond native range	y = 1*multiplier (see Appendix 2), n= question 205	y
302	Garden/amenity/disturbance weed	n=0, y = 1*multiplier (see Appendix 2)	n
303	Agricultural/forestry/horticultural weed	n=0, y = 2*multiplier (see Appendix 2)	n
304	Environmental weed	n=0, y = 2*multiplier (see Appendix 2)	y
305	Congeneric weed		
401	Produces spines, thorns or burrs	y=1, n=0	n
402	Allelopathic		
403	Parasitic	y=1, n=0	n
404	Unpalatable to grazing animals	y=1, n=-1	y
405	Toxic to animals	y=1, n=0	n
406	Host for recognized pests and pathogens		

Qsn #	Question	Answer Option	Answer
407	Causes allergies or is otherwise toxic to humans	y=1, n=0	n
408	Creates a fire hazard in natural ecosystems	y=1, n=0	n
409	Is a shade tolerant plant at some stage of its life cycle	y=1, n=0	y
410	Tolerates a wide range of soil conditions (or limestone conditions if not a volcanic island)	y=1, n=0	y
411	Climbing or smothering growth habit	y=1, n=0	n
412	Forms dense thickets		
501	Aquatic	y=5, n=0	n
502	Grass	y=1, n=0	n
503	Nitrogen fixing woody plant	y=1, n=0	n
504	Geophyte (herbaceous with underground storage organs -- bulbs, corms, or tubers)	y=1, n=0	n
601	Evidence of substantial reproductive failure in native habitat	y=1, n=0	n
602	Produces viable seed	y=1, n=-1	y
603	Hybridizes naturally		
604	Self-compatible or apomictic	y=1, n=-1	y
605	Requires specialist pollinators	y=-1, n=0	n
606	Reproduction by vegetative fragmentation	y=1, n=-1	y
607	Minimum generative time (years)	1 year = 1, 2 or 3 years = 0, 4+ years = -1	>3
701	Propagules likely to be dispersed unintentionally (plants growing in heavily trafficked areas)		
702	Propagules dispersed intentionally by people	y=1, n=-1	y
703	Propagules likely to disperse as a produce contaminant		
704	Propagules adapted to wind dispersal	y=1, n=-1	y
705	Propagules water dispersed	y=1, n=-1	y
706	Propagules bird dispersed	y=1, n=-1	n
707	Propagules dispersed by other animals (externally)		
708	Propagules survive passage through the gut	y=1, n=-1	n
801	Prolific seed production (>1000/m2)	y=1, n=-1	y
802	Evidence that a persistent propagule bank is formed (>1 yr)		
803	Well controlled by herbicides	y=-1, n=1	y
804	Tolerates, or benefits from, mutilation, cultivation, or fire		
805	Effective natural enemies present locally (e.g. introduced biocontrol agents)		

Supporting Data:

Qsn #	Question	Answer
101	**Is the species highly domesticated?**	**n**
	Source(s)	**Notes**
	Wu, Z.Y., Raven,P.H. & Hong, D.Y. (eds.). 2013. Flora of China. Vol. 2-3 (Lycopodiaceae through Polypodiaceae). Science Press, Beijing, and Missouri Botanical Garden Press, St. Louis	[No evidence of domestication] "Coastal and lowland forests; sea level to 500 m. Fujian, Guangdong, Jiangsu, Liaoning, Shandong, Taiwan, Zhejiang [Indochina, Japan, Korea; Pacific islands (Polynesia); introduced and locally naturalized in Europe, Hawaii, North America, Réunion, South Africa]."

102	**Has the species become naturalized where grown?**	
	Source(s)	**Notes**
	WRA Specialist. 2018. Personal Communication	NA

103	**Does the species have weedy races?**	
	Source(s)	**Notes**
	WRA Specialist. 2018. Personal Communication	NA

201	**Species suited to tropical or subtropical climate(s) - If island is primarily wet habitat, then substitute "wet tropical" for "tropical or subtropical"**	**High**
	Source(s)	**Notes**
	USDA, ARS, Germplasm Resources Information Network. 2018. National Plant Germplasm System [Online Database]. http://www.ars-grin.gov/npgs/index.html. [Accessed 16 Sep 2018]	"Native Asia-Temperate CHINA: China EASTERN ASIA: Japan, [Hokkaido, Honshu, Ryukyu Islands, Shikoku] Taiwan Asia-Tropical INDIAN SUBCONTINENT: India INDO-CHINA: Vietnam"

202	**Quality of climate match data**	**High**
	Source(s)	**Notes**
	USDA, ARS, Germplasm Resources Information Network. 2018. National Plant Germplasm System [Online Database]. http://www.ars-grin.gov/npgs/index.html. [Accessed]	

Qsn #	Question	Answer
203	**Broad climate suitability (environmental versatility)**	**y**
	Source(s)	**Notes**
	Palmer, D.D. 2003. Hawaii's Ferns and Fern Allies. University of Hawaii Press, Honolulu, HI	"Escaped in dry, mesic, to wet forest floors and valleys, near sea level to 1,525 m, all major islands." [Elevation range exceeds 1500 m, demonstrating environmental versatility]
	Missouri Botanical Garden. (2018). Cyrtomium falcatum. http://www.missouribotanicalgarden.org. [Accessed 17 Sep 2018]	"Zone: 6 to 10" [5 hardiness zones]

204	**Native or naturalized in regions with tropical or subtropical climates**	**y**
	Source(s)	**Notes**
	USDA, ARS, Germplasm Resources Information Network. 2018. National Plant Germplasm System [Online Database]. http://www.ars-grin.gov/npgs/index.html. [Accessed 16 Sep 2018]	"Native Asia-Temperate CHINA: China EASTERN ASIA: Japan, [Hokkaido, Honshu, Ryukyu Islands, Shikoku] Taiwan Asia-Tropical INDIAN SUBCONTINENT: India INDO-CHINA: Vietnam Cultivated (also cult.) Naturalized Australasia AUSTRALIA: Australia [New South Wales, Queensland, South Australia] NEW ZEALAND: New Zealand"

205	**Does the species have a history of repeated introductions outside its natural range?**	**y**
	Source(s)	**Notes**
	USDA, ARS, Germplasm Resources Information Network. 2018. National Plant Germplasm System [Online Database]. http://www.ars-grin.gov/npgs/index.html. [Accessed 16 Sep 2018]	"Cultivated (also cult.) Naturalized Australasia AUSTRALIA: Australia [New South Wales, Queensland, South Australia] NEW ZEALAND: New Zealand"
	Palmer, D.D. 2003. Hawaii's Ferns and Fern Allies. University of Hawaii Press, Honolulu, HI	"Cyrtomium falcatum is native to eastern Asia. including China. South Korea, Japan, the Ryukyus, and Taiwan and is very popular in cultivation because of its glossy, dark green fronds."
	Robinson, R.C. 2009. Invasive and Problem Ferns: A European Perspective. International Urban Ecology Review 4: 83-91	"It is commonly grown as a house plant and also as a garden plant in warmer areas of Europe."

301	**Naturalized beyond native range**	**y**

Qsn #	Question	Answer
	Source(s)	**Notes**
	Robinson, R.C. 2009. Invasive and Problem Ferns: A European Perspective. International Urban Ecology Review 4: 83-91	"Cyrtomium falcatum is an ornamental species, native to southeastern Africa, China and Japan, that is popular in horticulture and has naturalised in many parts of the world including Europe. In Macaronesia, where winter temperatures are not limiting, C. falcatum is known to be displacing Asplenium marinum (Sea Spleenwort) from its traditional niches close to the sea (3) but its ecological impact in other parts of Europe appear little studied." … "Besides naturalising in Europe, C. falcatum is also known to be invasive in New Zealand (15), a country with a climate similar to many parts of Europe and where the behaviour of this, and other invasive alien ferns, may anticipate future responses of such species to be expected within Europe."
	Palmer, D.D. 2003. Hawaii's Ferns and Fern Allies. University of Hawaii Press, Honolulu, HI	"Escaped in dry, mesic, to wet forest floors and valleys, near sea level to 1,525 m, all major islands. It prefers windward sea cliffs."
	USDA, ARS, Germplasm Resources Information Network. 2018. National Plant Germplasm System [Online Database]. http://www.ars-grin.gov/npgs/index.html. [Accessed 16 Sep 2018]	"Naturalized Australasia AUSTRALIA: Australia [New South Wales, Queensland, South Australia] NEW ZEALAND: New Zealand"
	Wagner Jr, W. H. (1950). Ferns Naturalized in Hawaii. Bishop Museum Occasional Papers 20(8): 95-121	"The fol-lowing list shows the evidently naturalized plants, over twice as many brought from the Old World as from the New, and their first collec-tion dates." … "Cyrtomium falcatum, 1928, local, Molokai and Hawaii. "

302	Garden/amenity/disturbance weed	n
	Source(s)	**Notes**
	Flora of North America Editorial Committee. 1993. Flora of North America: Volume 2: Pteridophytes and Gymnosperms. Oxford University Press, Oxford, UK	"Brick or stone walls, rocky areas, mesic forests, and coastal bluffs; 0--100 m; introduced; Calif., Fla., Ga., La., Miss., S.C.; Europe; Asia. Cyrtomium falcatum is native to east Asia and widely escaped from cultivation."
	Palmer, D.D. 2003. Hawaii's Ferns and Fern Allies. University of Hawaii Press, Honolulu, HI	"Escaped in dry, mesic, to wet forest floors and valleys, near sea level to 1,525 m, all major islands. It prefers windward sea cliffs." [No evidence]

303	Agricultural/forestry/horticultural weed	n
	Source(s)	**Notes**
	Palmer, D.D. 2003. Hawaii's Ferns and Fern Allies. University of Hawaii Press, Honolulu, HI	"Escaped in dry, mesic, to wet forest floors and valleys, near sea level to 1,525 m, all major islands. It prefers windward sea cliffs." [No evidence from Hawaiian Islands]
	Randall, R.P. (2017). A Global Compendium of Weeds. 3rd Edition. Perth, Western Australia. R.P. Randall	No evidence
	CABI. 2018. Invasive Species Compendium. Wallingford , UK: CAB International. www.cabi.org/isc	No evidence

304	Environmental weed	y

Qsn #	Question	Answer
	Source(s)	**Notes**
	CABI. 2018. Invasive Species Compendium. Wallingford , UK: CAB International. www.cabi.org/isc	"C. falcatum can colonize sparsely vegetated rocks, often in moist and humid conditions. It therefore has the potential to displace co-occurring rare ferns and bryophytes that often grow in such habitats at low population sizes. In Hawaii, USA, it has been reported to displace the endangered Stenogyne bifida, a herbaceous vine in the mint family (Lamiaceae) (US Fish and Wildlife Service, 2010). In Bermuda, it is reported to compete with the endangered Bermuda shield fern (Thelypteris bermudiana) (Copeland and Malcolm, 2014) and the endangered epiphyte, wild Bermuda pepper (Peperomia septentrionalis) (Bárrios et al., 2015). In Macaronesia, C. falcatum is displacing the fern, sea spleenwort (Asplenium marinum) (Robinson, 2009). It has the potential in Florida to displace rare, native fern species such as Trichomanes punctatum subsp. floridanum, but it has not been observed to displace rare native ferns in the southeastern USA (Alan Cressler, Atlanta, GA, USA, personal communication, 2015; Jennifer Possley, Fairchild Tropical Botanic Garden, Florida, USA, personal communication"n, 2015).
	Robinson, R.C. 2009. Invasive and Problem Ferns: A European Perspective. International Urban Ecology Review 4: 83-91	"In Macaronesia, where winter temperatures are not limiting, C. falcatum is known to be displacing Asplenium marinum (Sea Spleenwort) from its traditional niches close to the sea (3) but its ecological impact in other parts of Europe appear little studied."
	Queensland Government. (2018). Weeds of Australia. Cyrtomium falcatum. http://keyserver.lucidcentral.org. [Accessed 17 Sep 2018]	"This species is regarded as an environmental weed in some parts of New South Wales (i.e. the wider Sydney and Blue Mountains region) and Western Australia, and is a "sleeper weed" in other parts of the country. This shade-tolerant fern is widely cultivated as a garden ornamental and indoor plant. Japanese holly fern (Cyrtomium falcatum) has escaped cultivation and become established in the crevices of coastal cliffs, in rock crevices, in coastal heathlands, on shaded riverbanks and near small natural springs (as well as on walls in urban areas). For example, it is occasionally found growing on cliffs along the Swan River estuary in south-western Western Australia. Naturalised plants in Australia can generally be ascribed to Cyrtomium falcatum 'Rochfordii', a cultivar with irregularly and sharply toothed leaf margins."

305	**Congeneric weed**	
	Source(s)	**Notes**
	Randall, R.P. (2017). A Global Compendium of Weeds. 3rd Edition. Perth, Western Australia. R.P. Randall	Cyrtomium fortune cited as a weed. Impacts unverified

401	**Produces spines, thorns or burrs**	**n**
	Source(s)	**Notes**

Qsn #	Question	Answer
	Wu, Z.Y., Raven,P.H. & Hong, D.Y. (eds.). 2013. Flora of China. Vol. 2-3 (Lycopodiaceae through Polypodiaceae). Science Press, Beijing, and Missouri Botanical Garden Press, St. Louis	[No evidence] "Plants 30–40 cm tall. Rhizome erect, densely covered with lanceolate brown scales. Stipe stramineous, 15–27 cm, 3–4 mm in diam. at base, lower portion densely scaly; scales pale brown, sometimes blackish brown at middle, ovate, lower portion fimbriate. Lamina broadly lanceolate, 22–35 × 12–15 cm, base contracted, 1-imparipinnate, apex acute; rachis with lanceolate brown dentate scales or glabrous. Lateral pinnae 5–14 pairs, alternate, spreading or ascendant, shortly stalked, lanceolate or ovate-lanceolate, often curved acroscopically; middle pinnae 6– 10 × 2.5–3 cm, base obliquely rounded-cuneate, margins entire or repand, sometimes dentate, apex long acuminate or caudate; terminal pinna ovate-lanceolate, forked or trifurcate, 4.5–8 × 2–4 cm; leathery, glabrous on both surfaces; venation pinnate, slightly raised abaxially, indistinct adaxially, veinlets anastomosing to form 3 or 4 rows of areoles. Sori throughout abaxial surface of pinnae; indusia margins slightly incised."

402	Allelopathic	
	Source(s)	**Notes**
	WRA Specialist. 2018. Personal Communication	Unknown. No evidence found

403	Parasitic	n
	Source(s)	**Notes**
	Wu, Z.Y., Raven,P.H. & Hong, D.Y. (eds.). 2013. Flora of China. Vol. 2-3 (Lycopodiaceae through Polypodiaceae). Science Press, Beijing, and Missouri Botanical Garden Press, St. Louis	"Plants 30–40 cm tall. Rhizome erect, densely covered with lanceolate brown scales." [Dryopteridaceae. No evidence]

404	Unpalatable to grazing animals	y
	Source(s)	**Notes**
	Missouri Botanical Garden. (2018). Cyrtomium falcatum. http://www.missouribotanicalgarden.org. [Accessed 17 Sep 2018]	"Tolerate: Rabbit, Heavy Shade"
	Rutgers New Jersey Agricultural Experiment Station. (2018). Landscape Plants Rated by Deer Resistance. https://njaes.rutgers.edu/deer-resistant-plants/. [Accessed 17 Sep 2018]	Cyrtomium falcatum - A = Rarely Damaged

Qsn #	Question	Answer
405	**Toxic to animals**	**n**
	Source(s)	**Notes**
	ASPCA. 2018. Toxic and Non-Toxic Plants - Holly Fern. https://www.aspca.org/pet-care/animal-poison-control/toxic-and-non-toxic-plants/holly-fern. [Accessed 17 Sep 2018]	"Toxicity: Non-Toxic to Dogs, Non-Toxic to Cats"
	Quattrocchi, U. 2012. CRC World Dictionary of Medicinal and Poisonous Plants: Common Names, Scientific Names, Eponyms, Synonyms, and Etymology. CRC Press, Boca Raton, FL	[No evidence] "Anthelmintic, against tapeworms"

406	**Host for recognized pests and pathogens**	
	Source(s)	**Notes**
	Golan, K., & Górska-Drabik, E. (2006). The scale insects (Hemiptera, Coccinea) of ornamental plants in a greenhouse of the Maria Curie Skłodowska University botanical garden in Lublin. Journal of Plant Protection Research, 46(4), 347-352	"Abstract: The aim of presented investigation was to determine the composition of scale insects species and intensity of their occurrence on some greenhouse's ornamental plants. The investigations were carried out in the greenhouse of Maria Curie Skłodowska Botanical Garden in Lublin in years 200 –2004. Eight species belonging to seven botanical families were observed: Abutilon striatum cv. Thomsoni, Cyrtomium falcatum Presl., Dizygotheca elegantissima (Veitch), Hedera helix L., Hypoestes phyllostachya Presl., Nerium oleander L., Passiflora guadrangularia L., Ruscus aculeatus L. The quantitative analysis of the studied material was performed making use of the following ecological indicators: number and density. Identification of the scale insects species was performed on the basis of microscope slides. Three species of the scale insects belonging to three families were observed on ornamental plants: Pseudococcidae [Pseudococcus maritimus (Ehrh.)], Coccidae [Saissetia coffeae (Walker)] and Diaspididae (Aspidiotus nerii Bouchè). The scale insects were noted on all species of studied plants. Observed scale insects are typical polyphagous and all of them are considered as harmful pests in greenhouses. Among scale insects inhabiting this group of plants distinctly numerous on particular host plants were S. coffea and A. nerii. On the studied plants scale insects were stated at four degree of density."
	Missouri Botanical Garden. (2018). Cyrtomium falcatum. http://www.missouribotanicalgarden.org. [Accessed 17 Sep 2018]	"No serious insect or disease problems. Susceptible to root rot, fungal spots and scale. Winter hardiness in the St. Louis area is a concern."

Qsn #	Question	Answer
	Grasso, S., Pane, A., & Cacciola, S. O. (2000). First Report of Armillaria mellea on a fern from Italy. Plant Disease, 84 (5), 592	"Several perennial species of rhizomatous herbaceous ferns are cultivated as ornamental foliage plants. During late summer 1999, in a garden at the foot of Mount Etna, eastern Sicily (Italy), we noted a fern hedge showing patches of withered or stunted plants. The fern was identified as Cyrtomium falcatum (L.f.) C. Presl. (=Polystichum falcatum (L.f.) Diels), a house holly fern or Japanese holly fern, which is an ornamental fern native to East and South Asia. Other woody plants in the immediate vicinity had died over the last few years, including apricot and cedar trees whose stumps had not been removed. A close examination of uprooted ferns revealed the presence of creamy white fan-shaped mycelial mats with an odor typical of Armillaria species that were intermixed with the felt-like tangle formed by the rhizomes and roots of the ferns." … " This pathogen, very common and widespread on wooded or previously wooded sites, has an extremely wide host range, encompassing both woody and herbaceous plants (2,4). However, this is the first report of A. mellea on a fern in Italy."

407	Causes allergies or is otherwise toxic to humans	n
	Source(s)	**Notes**
	Plants for a Future. (2018). Cyrtomium falcatum. https://pfaf.org/user/Plant.aspx?LatinName=Cyrtomium+falcatum. [Accessed 17 Sep 2018]	"Known Hazards: None known"
	Quattrocchi, U. 2012. CRC World Dictionary of Medicinal and Poisonous Plants: Common Names, Scientific Names, Eponyms, Synonyms, and Etymology. CRC Press, Boca Raton, FL	[No evidence] "Anthelmintic, against tapeworms"

408	Creates a fire hazard in natural ecosystems	n
	Source(s)	**Notes**
	Palmer, D.D. 2003. Hawaii's Ferns and Fern Allies. University of Hawaii Press, Honolulu, HI	"Escaped in dry, mesic, to wet forest floors and valleys" [Unlikely. Generally not found in fire prone habitats]
	CABI. 2018. Invasive Species Compendium. Wallingford , UK: CAB International. www.cabi.org/isc	Not listed among impacts

Qsn #	Question	Answer
409	**Is a shade tolerant plant at some stage of its life cycle**	**y**
	Source(s)	**Notes**
	Robinson, R.C. 2009. Invasive and Problem Ferns: A European Perspective. International Urban Ecology Review 4: 83-91	"It grows from crevices in walls, on coastal cliffs, among maritime rocks, rocky slopes, streambanks, and other moist, stable areas– often in shady places where the effects of frost are limited."
	Missouri Botanical Garden. (2018). Cyrtomium falcatum. http://www.missouribotanicalgarden.org. [Accessed 17 Sep 2018]	"Sun: Part shade to full shade" … "Tolerate: Rabbit, Heavy Shade" … "Grow in moist, humusy, well-drained soils in part shade to full shade."
	Bezona, N. (2018). Tropical Gardening: Fall ideal for planting shade lovers such as ferns. Hawaii Tribune-Herald. Sunday, Sept. 16, 2018. http://www.hawaiitribune-herald.com. [Accessed 16 Sep 2018]	"The holly ferns, Cyrtomium, are a good choice for groundcover use. They can get as tall as 2 feet if conditions are to their liking. They are called holly ferns because the individual leaflets are shaped like large holly leaves. They are tough and leathery. They do best in loose organic soil with sufficient moisture. Plants will stand some sun during cooler weather, but only a little in the summer."

410	**Tolerates a wide range of soil conditions (or limestone conditions if not a volcanic island)**	**y**
	Source(s)	**Notes**
	Shoot Gardening. (2018). Cyrtomium falcatum (Holly fern). https://www.shootgardening.co.uk/plant/cyrtomium-falcatum. [Accessed 17 Sep 2018]	"Soil type -Chalky, Clay, Loamy, Sandy (will tolerate most soil types) Soil drainage -Moist but well-drained, Well-drained Soil pH - Acid, Alkaline, Neutral"
	Palmer, D.D. 2003. Hawaii's Ferns and Fern Allies. University of Hawaii Press, Honolulu, HI	[Widely distributed & presumably not substrate limited] "Escaped in dry, mesic, to wet forest floors and valleys, near sea level to 1,525 m, all major islands."

411	**Climbing or smothering growth habit**	**n**
	Source(s)	**Notes**
	Wu, Z.Y., Raven,P.H. & Hong, D.Y. (eds.). 2013. Flora of China. Vol. 2-3 (Lycopodiaceae through Polypodiaceae). Science Press, Beijing, and Missouri Botanical Garden Press, St. Louis	"Plants 30–40 cm tall. Rhizome erect, densely covered with lanceolate brown scales."

412	**Forms dense thickets**	
	Source(s)	**Notes**
	CABI. 2018. Invasive Species Compendium. Wallingford , UK: CAB International. www.cabi.org/isc	"Where there are denser populations of C. falcatum, or where plants occur on sensitive substrates such as historical masonry structures, control can be achieved with foliar glyphosate application." [Possibly yes. Denser populations could potentially exclude other vegetation. impacts unspecified]

Qsn #	Question	Answer
	Wilson, K.A. 1996. Alien Ferns in Hawaii. Pacific Science 50 (2): 127-141	[No evidence or description from the Hawaiian Islands] "Cyrtomium falcatum (L. f.) Presl, Holly Fem, from eastern Asia, is a popular fern in cultivation and has been known from the wild in Hawai'i since it was first collected in 1928 on the cliffs and gulches above Kalau-papa, Moloka'i (Degener 1946b). It has been found naturalized on each of the major is-lands except Kaua'i. Hobdy (pers. comm) informed me that it shows a marked prefer-ence for damp windward sea cliffs and is now fairly common on such sites on Maui and Moloka'i; elsewhere it is rare and widely scattered. Cyrtomium falcatum has escaped from cultivation in widely scattered warmer areas of the United States, New Zealand, Australia, and South America. It is appa-rently an apogamous species, reproducing without sexual reproduction. "

501	Aquatic	n
	Source(s)	**Notes**
	Palmer, D.D. 2003. Hawaii's Ferns and Fern Allies. University of Hawaii Press, Honolulu, HI	[Terrestrial] "Escaped in dry, mesic, to wet forest floors and valleys, near sea level to 1,525 m, all major islands. It prefers windward sea cliffs."

502	Grass	n
	Source(s)	**Notes**
	USDA, ARS, Germplasm Resources Information Network. 2018. National Plant Germplasm System [Online Database]. http://www.ars-grin.gov/npgs/index.html. [Accessed 17 Sep 2018]	Dryopteridaceae

503	Nitrogen fixing woody plant	n
	Source(s)	**Notes**
	USDA, ARS, Germplasm Resources Information Network. 2018. National Plant Germplasm System [Online Database]. http://www.ars-grin.gov/npgs/index.html. [Accessed 17 Sep 2018]	Dryopteridaceae

504	Geophyte (herbaceous with underground storage organs -- bulbs, corms, or tubers)	n
	Source(s)	**Notes**
	Palmer, D.D. 2003. Hawaii's Ferns and Fern Allies. University of Hawaii Press, Honolulu, HI	"Rhizomes erect, short, densely scaly. Fronds 30-60 cm long."

601	Evidence of substantial reproductive failure in native habitat	n
	Source(s)	**Notes**

Qsn #	Question	Answer
	Wu, Z.Y., Raven,P.H. & Hong, D.Y. (eds.). 2013. Flora of China. Vol. 2-3 (Lycopodiaceae through Polypodiaceae). Science Press, Beijing, and Missouri Botanical Garden Press, St. Louis	[No evidence. Widespread native & naturalized range] "Coastal and lowland forests; sea level to 500 m. Fujian, Guangdong, Jiangsu, Liaoning, Shandong, Taiwan, Zhejiang [Indochina, Japan, Korea; Pacific islands (Polynesia); introduced and locally naturalized in Europe, Hawaii, North America, Réunion, South Africa]."

602	Produces viable seed	y
	Source(s)	**Notes**
	Lloyd, R. M., & Davis, M. L. (1994). Spore germination and isozyme patterns in the apomictic fern Cyrtomium falcatum. Botanical Journal of the Linnean Society, 115(1), 1-8	"Progeny from a plant of the apomictic species Cyrtomium falcatum were examined by protein electrophoresis. These progeny were produced from spores originating in sporangia with differing spore numbers. Analysis of zymograms indicates that variant banding patterns were exhibited in 16.1% of the progeny sampled. These anomalous phenotypes suggest that some apomictically reproducing plants can produce genetically variable progeny."
	Benson, D., & McDougall, L. (1993). Ecology of Sydney plant species: part 1. Ferns, fern-allies, cycads, conifers and dicotyledon families Acanthaceae to Asclepiadaceae. Cunninghamia, 3(2): 257-422	"Reproduction: Spores produced in sori on lower surface of frond (inadequate material). Spore size 29-39 µm (Large & Braggins 1991)."
	Palmer, D.D. 2003. Hawaii's Ferns and Fern Allies. University of Hawaii Press, Honolulu, HI	"Sori plentiful, round, small, about 1 nun diam., borne on veins in areoles. Indusia peltate"
	Staples, G.W. & Herbst, D.R. 2005. A Tropical Garden Flora - Plants Cultivated in the Hawaiian Islands and Other Tropical Places. Bishop Museum Press, Honolulu, HI	"The species is propagated by spores."

603	Hybridizes naturally	
	Source(s)	**Notes**
	Palmer, D.D. 2003. Hawaii's Ferns and Fern Allies. University of Hawaii Press, Honolulu, HI	""A hybrid between C. caryotideum and C. falcatum exists in horticulture, but has not been seen in the wild in Hawai 'i."
	Chandra, S. & Srivastava, M. (eds.). (2003). Pteridology in the New Millennium. Springer Science+Business Media, Dordrecht	"It is believed that apogamous ferns are mostly triploids (Lovis, 1977; Walker, 1979; Masuyama, 1984; Wagner and Wanger, 1980) and this is true in the case of Cyrtomium also, but the hybrid C. caryotideum × C. falcatum which is a pentaploid, is also apogamous."

Qsn #	Question	Answer
604	**Self-compatible or apomictic**	**y**
	Source(s)	**Notes**
	Mehltreter, K., Walker, L.R. & Sharpe, J.M. 2010. Fern Ecology. Cambridge University Press, Cambridge, UK	"Apogamy is the development of a sporophyte from a gametophyte cell without benefit of fertilization (Sheffield, 2008) and occurs in approximately 10% of fern species (Walker, 1985)."… "Apogamous juvenile sporophytes mature faster than sporelings that develop following fertilization. This rapid development is a particularly important characteristic of those apogamous species that are used in horticulture (e.g., Cyrtomium falcatum, C. fortunei, Dryopteris cycadina and Pteris cretica, Hoshizaki and Moran, 2001). Because an apogamous gametophyte grows rapidly and does not require water for fertilization, apogamy can be advantageous in dry regions with a short growing season"

605	**Requires specialist pollinators**	**n**
	Source(s)	**Notes**
	Palmer, D.D. 2003. Hawaii's Ferns and Fern Allies. University of Hawaii Press, Honolulu, HI	[No water required] "Apogamous juvenile sporophytes mature faster than sporelings that develop following fertilization. This rapid development is a particularly important characteristic of those apogamous species that are used in horticulture (e.g., Cyrtomium falcatum, C. fortunei, Dryopteris cycadina and Pteris cretica, Hoshizaki and Moran, 2001). Because an apogamous gametophyte grows rapidly and does not require water for fertilization, apogamy can be advantageous in dry regions with a short growing season"

606	**Reproduction by vegetative fragmentation**	**y**
	Source(s)	**Notes**
	Benson, D., & McDougall, L. (1993). Ecology of Sydney plant species: part 1. Ferns, fern-allies, cycads, conifers and dicotyledon families Acanthaceae to Asclepiadaceae. Cunninghamia, 3(2): 257-422	"Creeping rhizome. Can reproduce from large pieces of old withered rhizome - dormant vegetative buds become active when rhizome is detached from plant (Jones 1987)."
	Wu, Z.Y., Raven,P.H. & Hong, D.Y. (eds.). 2013. Flora of China. Vol. 2-3 (Lycopodiaceae through Polypodiaceae). Science Press, Beijing, and Missouri Botanical Garden Press, St. Louis	"Plants 30–40 cm tall. Rhizome erect, densely covered with lanceolate brown scales."

607	**Minimum generative time (years)**	**>3**
	Source(s)	**Notes**
	Sato, T. (1984). Life history characteristic of Cyrtomium falcatum around the natural northern boundary in Hokkaido, with reference to the alternation of generations. The botanical magazine= Shokubutsu-gaku-zasshi, 97(1), 1-12	"The fertility of the sporophyte seems to be achieved more than five years after the germination." [May be at a younger age in tropical climates]

701	**Propagules likely to be dispersed unintentionally (plants growing in heavily trafficked areas)**	

Qsn #	Question	Answer
	Source(s)	**Notes**
	Benson, D., & McDougall, L. (1993). Ecology of Sydney plant species: part 1. Ferns, fern-allies, cycads, conifers and dicotyledon families Acanthaceae to Asclepiadaceae. Cunninghamia, 3(2): 257-422	"Dispersal, establishment & growth: Diaspore: spores dispersed by wind, probably no dormancy mechanism."
	WRA Specialist. 2018. Personal Communication	Unknown. Possible that spores may be dispersed in soil stuck to footwear, equipment or vehicles

702	**Propagules dispersed intentionally by people**	**y**
	Source(s)	**Notes**
	Palmer, D.D. 2003. Hawaii's Ferns and Fern Allies. University of Hawaii Press, Honolulu, HI	"Cyrtomium falcatum is native to eastern Asia. including China. South Korea, Japan, the Ryukyus, and Taiwan and is very popular in cultivation because of its glossy, dark green fronds."
	Robinson, R.C. 2009. Invasive and Problem Ferns: A European Perspective. International Urban Ecology Review 4: 83-91	"It is commonly grown as a house plant and also as a garden plant in warmer areas of Europe."
	Missouri Botanical Garden. (2018). Cyrtomium falcatum. http://www.missouribotanicalgarden.org. [Accessed 17 Sep 2018]	"Woodland areas and shaded areas of borders or rock gardens. Border for tree or shrub areas. May be grown as a houseplant."

703	**Propagules likely to disperse as a produce contaminant**	
	Source(s)	**Notes**
	Benson, D., & McDougall, L. (1993). Ecology of Sydney plant species: part 1. Ferns, fern-allies, cycads, conifers and dicotyledon families Acanthaceae to Asclepiadaceae. Cunninghamia, 3(2): 257-422	"Dispersal, establishment & growth: Diaspore: spores dispersed by wind, probably no dormancy mechanism." [Unknown. Possible that spores could contaminant soil of potted plants or other ornamental plants grown in proximity]

704	**Propagules adapted to wind dispersal**	**y**
	Source(s)	**Notes**
	Benson, D., & McDougall, L. (1993). Ecology of Sydney plant species: part 1. Ferns, fern-allies, cycads, conifers and dicotyledon families Acanthaceae to Asclepiadaceae. Cunninghamia, 3(2): 257-422	"Dispersal, establishment & growth: Diaspore: spores dispersed by wind, probably no dormancy mechanism."
	Missouri Botanical Garden. (2018). Cyrtomium falcatum. http://www.missouribotanicalgarden.org. [Accessed 17 Sep 2018]	"Spores are easily carried by wind, and species plants have escaped gardens and naturalized in certain areas of the southeastern U.S."

705	**Propagules water dispersed**	**y**
	Source(s)	**Notes**

Qsn #	Question	Answer
	CABI. 2018. Invasive Species Compendium. Wallingford , UK: CAB International. www.cabi.org/isc	[Plants in drainage ditches, near waterfalls & in stream banks probably dispersed by water as well as wind] "In the eastern USA it is associated with stream banks, limestone outcrops, bluffs, drainage ditches, wooded ravines and waterfalls (Faircloth, 1975; Hill, 1992; Woods and Diamond, 2008; Peck, 2011; Weakley, 2015). Unlike its native range and some parts of its naturalized range, it has not been reported for coastal habitats in this region. In California, USA, it has been found associated with a waterfall in a canyon (Tracy, 1940). In Hawaii it has been found in “bare, windswept precipice and in the wooded gullies” (Degener and Hawkes, 1951)."

706	Propagules bird dispersed	n
	Source(s)	**Notes**
	Benson, D., & McDougall, L. (1993). Ecology of Sydney plant species: part 1. Ferns, fern-allies, cycads, conifers and dicotyledon families Acanthaceae to Asclepiadaceae. Cunninghamia, 3(2): 257-422	"Dispersal, establishment & growth: Diaspore: spores dispersed by wind, probably no dormancy mechanism."

707	Propagules dispersed by other animals (externally)	
	Source(s)	**Notes**
	Benson, D., & McDougall, L. (1993). Ecology of Sydney plant species: part 1. Ferns, fern-allies, cycads, conifers and dicotyledon families Acanthaceae to Asclepiadaceae. Cunninghamia, 3(2): 257-422	"Dispersal, establishment & growth: Diaspore: spores dispersed by wind, probably no dormancy mechanism." [Spores could potentially be dispersed in soil stuck to terrestrial animals]

708	Propagules survive passage through the gut	n
	Source(s)	**Notes**
	Benson, D., & McDougall, L. (1993). Ecology of Sydney plant species: part 1. Ferns, fern-allies, cycads, conifers and dicotyledon families Acanthaceae to Asclepiadaceae. Cunninghamia, 3(2): 257-422	"Dispersal, establishment & growth: Diaspore: spores dispersed by wind, probably no dormancy mechanism." [No evidence that this fern is consumed or that spores would survive gut passage]

801	Prolific seed production (>1000/m2)	y
	Source(s)	**Notes**
	Gordon, D. R., Mitterdorfer, B., Pheloung, P. C., Ansari, S., Buddenhagen, C., Chimera, C., ... & Williams, P. A. 2010). Guidance for addressing the Australian Weed Risk Assessment questions. Plant Protection Quarterly, 25(2): 56-74	"Assume ‘yes’ for fern taxa unless contradictory evidence exists."
	Benson, D., & McDougall, L. (1993). Ecology of Sydney plant species: part 1. Ferns, fern-allies, cycads, conifers and dicotyledon families Acanthaceae to Asclepiadaceae. Cunninghamia, 3(2): 257-422	"Reproduction: Spores produced in sori on lower surface of frond" [Presumably yes]

802	Evidence that a persistent propagule bank is formed (>1 yr)	

Qsn #	Question	Answer
	Source(s)	**Notes**
	Benson, D., & McDougall, L. (1993). Ecology of Sydney plant species: part 1. Ferns, fern-allies, cycads, conifers and dicotyledon families Acanthaceae to Asclepiadaceae. Cunninghamia, 3(2): 257-422	"Dispersal, establishment & growth: Diaspore: spores dispersed by wind, probably no dormancy mechanism."

803	Well controlled by herbicides	y
	Source(s)	**Notes**
	CABI. 2018. Invasive Species Compendium. Wallingford , UK: CAB International. www.cabi.org/isc	"Chemical Control - Where there are denser populations of C. falcatum, or where plants occur on sensitive substrates such as historical masonry structures, control can be achieved with foliar glyphosate application."

804	Tolerates, or benefits from, mutilation, cultivation, or fire	
	Source(s)	**Notes**
	CABI. 2018. Invasive Species Compendium. Wallingford , UK: CAB International. www.cabi.org/isc	"Control of C. falcatum is primarily accomplished by hand pulling. Pulled plants should be removed from the site to prevent the spread of spores." [Unknown, but removal of leaves probably would not control plant without elimination of rhizomes]

805	Effective natural enemies present locally (e.g. introduced biocontrol agents)	
	Source(s)	**Notes**
	Palmer, D.D. 2003. Hawaii's Ferns and Fern Allies. University of Hawaii Press, Honolulu, HI	"Escaped in dry, mesic, to wet forest floors and valleys, near sea level to 1,525 m, all major islands. It prefers windward sea cliffs." [Unlikely. No evidence of natural enemies or limiting biotic factors]

Summary of Risk Traits:

High Risk / Undesirable Traits
• Elevation range exceeds 1000 m, demonstrating environmental versatility
• Grows in tropical climates
• Naturalized on all the main Hawaiian Islands & widely naturalized elsewhere
• Regarded as an environmental weed in Hawaii, (where it threatens Stenogyne bifida), Bermuda, Macaronesia, Florida & Australia
• Unpalatable to deer, rabbits & probably other animals
• Shade tolerant (capable of invading forest understory)
• Tolerates many soil types
• Reproduces by spores & vegetatively by rhizomes
• May hybridize with native C. caryotideum)
• Apogamous (able to develop a sporophyte from a gametophyte cell without fertilization)
• Spores dispersed by wind, water & intentionally cultivated by people
• Prolific spore production

Low Risk Traits
• Unarmed (no spines, thorns, or burrs)
• Non-toxic
• Despite weediness, valued for ornamental uses
• May take 5 years for to reach maturity
• Herbicides may provide effective control