



WATER-TRUMPET (*Cryptocoryne*) Conservation Action Plan 2023-2033



IUCN SSC Freshwater Plant Specialist Group

Citation: Lansdown, R.V., Jacobsen, N., Kasselmann, C., Naive, M.A.K., Velautham, E., Watve, A., Wongso, S. and Yakandawala, D. 2023 Water-trumpet (*Cryptocoryne*): Conservation Action Plan 2023-2033. IUCN SSC Freshwater Plant Specialist Group. Ardeola, Stroud, UK.

Cover photographs:

Above: *Cryptocoryne* × *timahensis* flowering at its type locality in Bukit Timah Nature Reserve, Singapore (photo R.V. Lansdown).

Below: Left to right: Richard Lansdown, Elango Velautham, Dennis Sng Kah Hseng and Suwidji Wongso with the first batch of plants for the Singapore Botanic Gardens *ex-situ* collection (photo David Chen, YKBLB).



WATER-TRUMPET (*Cryptocoryne*) Conservation Action Plan 2023-2033

R.V. Lansdown¹, N. Jacobsen², C. Kasselman³, M.A.K. Naive⁴, E. Velautham⁵, A. Watve⁶, S. Wongso⁷ and D. Yakandawala⁸

1. IUCN SSC Freshwater Plant Specialist Group, 45 The Bridle, Stroud, Glos. GL5 4SQ, UK
2. Section of Organismal Biology, Dept of Plant and Environmental Sciences, University of Copenhagen, Thorvaldsensvej 40, DK-1871 Frederiksberg C, Denmark.
3. Alfred-Fritz-Str. 19, 14513 Teltow, Germany.
4. Jose Rizal Memorial State University, Tampilisan Campus, Znac, Tampilisan 7116, Zamboanga del Norte, Philippines. Center for Integrative Conservation, Xishuangbanna Tropical Botanical Garden, Chinese Academy of Sciences, Mengla, Yunnan 666303, China. University of Chinese Academy of Sciences, Beijing 100049, China
5. Deputy Director, Arboriculture, Plant Records, Plant Resource Centre & Curator (Trees) Singapore Botanic Gardens, 259569 Singapore.
6. 34/6, Gulawani Maharaj Road, Pune, Maharashtra 411004, India
7. Yayasan Konservasi Biota Lahan Basah, Raya Sawo Gg. III/33, Surabaya 60218, Indonesia
8. Department of Botany, University of Peradeniya, Peradeniya, Sri Lanka

About IUCN

IUCN, International Union for Conservation of Nature, helps the world find pragmatic solutions to our most pressing environment and development challenges.

IUCN's work focuses on valuing and conserving nature, ensuring effective and equitable governance of its use and deploying nature-based solutions to global challenges in climate, food and development. IUCN supports scientific research, manages field projects all over the world and brings governments, NGOs, the UN and companies together to develop policy, laws and best practice.

IUCN is the world's oldest and largest global environmental organization, with more than 1,200 government and NGO Members and almost 11,000 volunteer experts in some 160 countries. IUCN's work is supported by over 1,000 staff in 45 offices and hundreds of partners in public, NGO and private sectors around the world.

IUCN Species Survival Commission

The Species Survival Commission (SSC) is the largest of IUCN's six volunteer commissions with a global membership of 8,000 experts. SSC advises IUCN and its members on the wide range of technical and scientific aspects of species conservation and is dedicated to securing a future for biodiversity. SSC has significant input into the international agreements dealing with biodiversity conservation.

IUCN Species Programme

The IUCN Species Programme supports the activities of the IUCN Species Survival Commission and individual Specialist Groups, as well as implementing global species conservation initiatives. It is an integral part of the IUCN Secretariat and is managed from IUCN's international headquarters in Gland, Switzerland. The Species Programme includes a number of technical units covering Wildlife Trade, the Red List, Freshwater Biodiversity Assessments (all located in Cambridge, UK) and the Global Biodiversity Assessment Initiative (located in Washington DC, USA).

IUCN SSC Freshwater Plant Specialist Group

The IUCN SSC Freshwater Plant Specialist Group (FPSG) is a network of scientists and researchers with an interest in the conservation of wetland plants. The FPSG exists to promote and further the conservation of plant species which are dependent upon wetlands and the habitats upon which they depend. The main focus of the work of the FPSG is to assess the extinction risk to wetland-dependent plants using the IUCN criteria, use the information in these assessments to prepare conservation action plans and to support field conservation action.

WATER-TRUMPET (*Cryptocoryne*): Conservation Action Plan 2022-2032
April 2023

Contents

EXECUTIVE SUMMARY	I
1 INTRODUCTION	1
Acknowledgements	2
2 THE GENUS <i>CRYPTOCORYNE</i>	3
3 STATUS OF POPULATIONS	5
3.1 Introduction	5
3.2 Regional Overview	6
3.2.1 Introduction	6
3.2.2 Borneo (Brunei Darussalam, Indonesia, East Malaysia)	9
3.2.3 Sri Lanka	10
3.2.4 Indonesia (Sumatra, Bangka, Belitung, Singkep and Lingga)	11
3.2.5 Philippines	12
3.2.6 Indochina – Mekong (Cambodia, China, Laos, Myanmar, Thailand, Vietnam)	13
3.2.7 Peninsular (West) Malaysia, Southern Thailand, Singapore and parts of Indonesia	14
3.2.8 India (India including Andaman and Bangladesh)	15
3.2.9 New Guinea (Papua New Guinea and Papua - Indonesia)	16
4 THREAT ANALYSIS	17
5 STRATEGIC ACTION PLAN	21
5.1 Context	21
5.2 Vision (30 years, global)	21
5.3 Goals (30 years, range-wide)	22
5.4 Actions (5 years)	22
5.4.1 Introduction	22
5.4.2 <i>Ex-situ</i> cultivation	23
5.4.3 Conservation of <i>Cryptocoryne</i> taxa in Borneo	23
5.4.4 Conservation of <i>Cryptocoryne</i> in South-west Sri Lanka	24
5.4.5 Conservation of <i>Cryptocoryne</i> in the Mahaweli-Ganga System in central Sri Lanka	25
5.4.6 Conservation of <i>Cryptocoryne</i> in Central Sumatra (Indonesia)	25
5.4.7 Conservation of <i>Cryptocoryne</i> in North-west Sumatra (Indonesia)	26
5.4.8 Conservation of <i>Cryptocoryne</i> in the Philippines	27
5.4.9 Conservation of <i>Cryptocoryne</i> on the River Mekong	27
5.4.10 Conservation of <i>Cryptocoryne</i> in Vietnam	28
5.4.11 Conservation of <i>Cryptocoryne</i> in Peninsular Malaysia	28
5.4.12 Conservation of <i>Cryptocoryne</i> in the Western Ghats (India)	29
5.4.13 Conservation of <i>Cryptocoryne</i> in New Guinea (Papua New Guinea, West Papua)	29
5.4.14 Conservation of <i>Cryptocoryne crispatula</i> var. <i>planifolia</i>	29
5.4.15 Conservation of <i>Cryptocoryne</i> × <i>griffithioides</i>	30
5.4.16 Conservation of <i>Cryptocoryne noritai</i>	30
5.4.17 Conservation of <i>Cryptocoryne uenoi</i>	30
5.4.18 Conservation of <i>Cryptocoryne zaidiana</i>	31
5.4.19 Conservation of <i>Cryptocoryne bogneri</i>	31
5.4.20 Conservation of <i>Cryptocoryne</i> × <i>hendrae</i>	32
5.4.21 Conservation of <i>Cryptocoryne nevillei</i>	32
5.5 Monitoring	32
BIBLIOGRAPHY	35
APPENDIX A THREAT CATEGORIES ASSIGNED	41
APPENDIX B SPECIES ACCOUNTS	45
1. <i>Cryptocoryne affinis</i> N.E.Br. ex. J.D.Hooker 1893	45
2. <i>Cryptocoryne alba</i> de Wit 1975	46
3. <i>Cryptocoryne annamica</i> Serebryanyi 1991	47

4.	<i>Cryptocoryne aponogetifolia</i> Merr. 1919	48
5.	<i>Cryptocoryne aura</i> Wongso & Ipor 2016	49
6.	<i>Cryptocoryne auriculata</i> Engl. 1879	50
7.	<i>Cryptocoryne bangkaensis</i> Bastm. 2007	51
8.	<i>Cryptocoryne bastmeijeri</i> Wongso 2017	52
9.	<i>Cryptocoryne beckettii</i> Thw. ex Trim. 1885	53
10.	<i>Cryptocoryne bogneri</i> Rataj 1975	54
11.	<i>Cryptocoryne bullosa</i> Becc. ex Engl. 1879	55
12.	<i>Cryptocoryne ciliata</i> (Roxb.) Schott in H.W.Schott & S.L.Endlicher 1832	56
12a.	<i>Cryptocoryne ciliata</i> var. <i>bogneri</i> N.Jacobsen 2018	56
12b.	<i>Cryptocoryne ciliata</i> var. <i>ciliata</i>	57
12c.	<i>Cryptocoryne ciliata</i> var. <i>latifolia</i> Rataj 1975	58
13.	<i>Cryptocoryne cognata</i> Schott 1857	59
14.	<i>Cryptocoryne consobrina</i> Schott 1857	60
15.	<i>Cryptocoryne cordata</i> Griff. 1851	61
15a.	<i>Cryptocoryne cordata</i> var. <i>cordata</i>	61
15b.	<i>Cryptocoryne cordata</i> var. <i>diderici</i> (de Wit) N.Jacobsen 2002	62
15c.	<i>Cryptocoryne cordata</i> var. <i>grabowskii</i> (Engl.) N.Jacobsen 2002	63
15d.	<i>Cryptocoryne cordata</i> var. <i>siamensis</i> (Gagnep.) N.Jacobsen & Sookch. 2010	63
15e.	<i>Cryptocoryne cordata</i> var. <i>wellyi</i> Wongso 2019	64
16.	<i>Cryptocoryne coronata</i> Bastm. & Wijng. 1999	66
17.	<i>Cryptocoryne crispatula</i> Engl. 1920	67
17a.	<i>Cryptocoryne crispatula</i> var. <i>albida</i> (Parker) N.Jacobsen, Maneean & T.Idei 2022	68
17b.	<i>Cryptocoryne crispatula</i> var. <i>balansae</i> (Gagnep.) N.Jacobsen 1991	68
17c.	<i>Cryptocoryne crispatula</i> var. <i>crispatula</i>	69
17d.	<i>Cryptocoryne crispatula</i> var. <i>decus-mekongensis</i> T.Idei, Bastm. & N.Jacobsen 2010	70
17e.	<i>Cryptocoryne crispatula</i> var. <i>flaccidifolia</i> N.Jacobsen 1991	71
17f.	<i>Cryptocoryne crispatula</i> var. <i>kubotae</i> N.Jacobsen & Bastm. 2015	71
17g.	<i>Cryptocoryne crispatula</i> var. <i>planifolia</i> Hang Zhou, H.W.He & N.Jacobsen 2010	72
17h.	<i>Cryptocoryne crispatula</i> var. <i>tonkinensis</i> (Gagnep.) N.Jacobsen 1991	73
17i.	<i>Cryptocoryne crispatula</i> var. <i>yunnanensis</i> (H.Li) H.Li & N.Jacobsen 2010	73
18.	<i>Cryptocoryne cruddasiana</i> Prain 1900	75
19.	<i>Cryptocoryne dewittii</i> N.Jacobsen 1977	76
20.	<i>Cryptocoryne elliptica</i> N.E.Br. ex. Hook.f. 1893	77
21.	<i>Cryptocoryne erwinii</i> Wongso & Ipor 2017	78
22.	<i>Cryptocoryne ferruginea</i> Engl. 1879	79
22a.	<i>Cryptocoryne ferruginea</i> var. <i>ferruginea</i>	79
22b.	<i>Cryptocoryne ferruginea</i> var. <i>sekadauensis</i> Bastm., Kishi, Takah., Wongso & N. Jacobsen 2013	80
23.	<i>Cryptocoryne fusca</i> de Wit 1970	82
24.	<i>Cryptocoryne griffithii</i> Schott 1856	83
25.	<i>Cryptocoryne hutoroi</i> Bogner & N.Jacobsen 1985	84
26.	<i>Cryptocoryne ideii</i> Budianto 2004	85
27.	<i>Cryptocoryne isae</i> Wongso 2017	86
28.	<i>Cryptocoryne joshanii</i> Naive & R.J.T.Villanueva 2018	87
29.	<i>Cryptocoryne keei</i> N.Jacobsen 1982	88
30.	<i>Cryptocoryne lingua</i> Becc. ex Engl. 1879	89
31.	<i>Cryptocoryne loeiensis</i> Bastm., T.Idei & N.Jacobsen 2010	90
32.	<i>Cryptocoryne longicauda</i> Becc. ex Engl. 1879	91
33.	<i>Cryptocoryne matakensis</i> Bastm., K. Nakamoto & N. Jacobsen 2014	92
34.	<i>Cryptocoryne mekongensis</i> T.Idei, Bastm. & N.Jacobsen 2010	93
35.	<i>Cryptocoryne minima</i> Ridl. 1910	94
36.	<i>Cryptocoryne moehlmannii</i> de Wit 1983	95
37.	<i>Cryptocoryne nevillii</i> Trim. ex. Hook.f. 1898	96
38.	<i>Cryptocoryne noritoi</i> Wongso 2005	97
39.	<i>Cryptocoryne nurii</i> Furtado 1935	98
39a.	<i>Cryptocoryne nurii</i> var. <i>nurii</i>	98
39b.	<i>Cryptocoryne nurii</i> var. <i>raubensis</i> Ganapathy & Siow 2013	99
40.	<i>Cryptocoryne paglaterasiana</i> Naive & N.Jacobsen 2022	101
41.	<i>Cryptocoryne palawanensis</i> Bastm., N.Jacobsen & Naive 2022	102

42.	<i>Cryptocoryne pallidinervia</i> Engl. 1879	103
43.	<i>Cryptocoryne parva</i> de Wit 1970	104
44.	<i>Cryptocoryne pontederiifolia</i> Schott 1863	105
45.	<i>Cryptocoryne pygmaea</i> Merr. 1919	106
46.	<i>Cryptocoryne regina</i> Wongso & Ipor 2017	107
47.	<i>Cryptocoryne retrospiralis</i> (Roxb.) Kunth 1841	108
48.	<i>Cryptocoryne sahalii</i> Wongso & Ipor 2017	109
49.	<i>Cryptocoryne schulzei</i> de Wit 1971	110
50.	<i>Cryptocoryne scurrilis</i> de Wit 1962	111
51.	<i>Cryptocoryne sivadasanii</i> Bogner 2004	112
52.	<i>Cryptocoryne spiralis</i> (Retz.) Fisch. ex Wydler 1830	113
52a.	<i>Cryptocoryne spiralis</i> var. <i>caudigera</i> Bogner 2013	113
52b.	<i>Cryptocoryne spiralis</i> var. <i>cognatoides</i> (Blatt. & McCann) S.R.Yadav, K.S.Patil & Bogner 1993	114
52c.	<i>Cryptocoryne spiralis</i> var. <i>huegelii</i> (Schott) Bogner 2013	115
52d.	<i>Cryptocoryne spiralis</i> var. <i>spiralis</i>	115
53.	<i>Cryptocoryne striolata</i> Engl. 1879	116
54.	<i>Cryptocoryne thwaitesii</i> Schott 1857	117
55.	<i>Cryptocoryne tirtadinatae</i> Wongso 2020	118
56.	<i>Cryptocoryne uenoi</i> Yuji Sasaki 2002	119
57.	<i>Cryptocoryne undulata</i> Wendt 1954	120
58.	<i>Cryptocoryne usteriana</i> Engl. in A.Usteri 1905	121
59.	<i>Cryptocoryne verrucosa</i> Wongso & Asih 2022	122
60.	<i>Cryptocoryne versteegii</i> Engl. 1910	123
60a.	<i>Cryptocoryne versteegii</i> var. <i>jayaensis</i> N.Jacobsen, Bastm., P.J.Edwards, R.J.Johns, N.Takah. & Wongso 2014	123
60b.	<i>Cryptocoryne versteegii</i> var. <i>versteegii</i>	124
61.	<i>Cryptocoryne vietnamensis</i> I.Hertel & H.Mühlberg 1994	126
62.	<i>Cryptocoryne villosa</i> N.Jacobsen 1980	127
63.	<i>Cryptocoryne walkeri</i> Schott 1857	128
64.	<i>Cryptocoryne waseri</i> Kettner 2012	129
65.	<i>Cryptocoryne wendtii</i> de Wit 1958	130
66.	<i>Cryptocoryne wongsoi</i> Ipor 2016	131
67.	<i>Cryptocoryne yujii</i> Bastm. 2002	132
67a.	<i>Cryptocoryne yujii</i> var. <i>hendrikii</i> Wongso 2017	132
67b.	<i>Cryptocoryne yujii</i> var. <i>yujii</i>	133
68.	<i>Cryptocoryne zaidiana</i> Ipor & Tawan 2005	134
69.	<i>Cryptocoryne</i> × <i>agusii</i> Takah. 2020	135
70.	<i>Cryptocoryne</i> × <i>ardyi</i> Wongso 2019	136
71.	<i>Cryptocoryne</i> × <i>batangkayanensis</i> Ipor, Ørgaard & N.Jacobsen 2015	137
72.	<i>Cryptocoryne</i> × <i>decus-silvae</i> de Wit 1976	138
73.	<i>Cryptocoryne</i> × <i>griffithioides</i> N.Jacobsen 2020	139
74.	<i>Cryptocoryne</i> × <i>hendrae</i> Wongso 2020	140
75.	<i>Cryptocoryne</i> × <i>ikezewaldiae</i> Bast. 2020	141
76.	<i>Cryptocoryne</i> × <i>jambiensis</i> Bastm. 2019	142
77.	<i>Cryptocoryne</i> × <i>nakamotoi</i> Bastm. 2022	143
78.	<i>Cryptocoryne</i> × <i>purpurea</i> Ridl. 1904	144
78a.	<i>Cryptocoryne</i> × <i>purpurea</i> nothovar. <i>borneoensis</i> N.Jacobsen, Bastm. & Yuji Sasaki 2002	145
78b.	<i>Cryptocoryne</i> × <i>purpurea</i> nothovar. <i>purpurea</i>	145
79.	<i>Cryptocoryne</i> × <i>schulzeioides</i> N.Jacobsen 2020	147
80.	<i>Cryptocoryne</i> × <i>timahensis</i> Bastm. 2001	148
81.	<i>Cryptocoryne</i> × <i>willisii</i> Reitz 1908	149
82.	<i>Cryptocoryne</i> × <i>zukaii</i> Rataj 1974	150
82a.	<i>Cryptocoryne</i> × <i>zukaii</i> nothovar. <i>sumateraensis</i> W.Reichert	150
82b.	<i>Cryptocoryne</i> × <i>zukaii</i> nothovar. <i>zukaii</i>	151

EXECUTIVE SUMMARY

Water-trumpets (the genus *Cryptocoryne*), include a total of 115 currently recognised taxa, represented by 68 species, 29 varieties, 14 hybrids or hybrid complexes and 4 nothovarieties. However, surveys, field recording and painstaking *ex-situ* research are constantly finding new taxa and so these figures will have changed even as this action plan is published. *Cryptocoryne* taxa occur from western India east to southern China and south through South-east Asia and the Philippines to New Guinea. Many taxa are known from single locations or even single collections, while two are known only from horticulture with their native range unknown.

Most of the species in the genus are restricted to rainforest rivers, from small headwater streams to a few which occur in large rivers such as the Irrawaddy, the Mekong and their tributaries. While rainforest and its destruction has received much publicity, there has been relatively little focus on forest rivers. These are typically more threatened than the forest itself, being vulnerable to issues such as nutrient enrichment and increased turbidity as a result of selective logging, mineral extraction and mining, whilst often being devastated by secondary impacts of human use of forest habitats. Other species are dependent upon habitats such as freshwater swamp forest which is threatened throughout the region. Species which occur only in a single watercourse are highly vulnerable to even quite local changes in hydrology, water quality and even riparian habitat modification.

The distribution of *Cryptocoryne* taxa is not uniform in the region and a small number of areas support particularly high genetic diversity. The greatest species diversity occurs in Borneo, mainly in western Kalimantan and Sarawak where 26 species, six varieties and six natural hybrid combinations are known followed by Sumatra (Sumatera) with 16 species, three varieties and four natural hybrid combinations and Sri Lanka with ten species and one natural hybrid combination. This contrasts with Indochina with only seven species, but nine varieties, as well as with New Guinea with two species and two varieties, however taxonomic work is showing that there are new taxa to be described in a number of areas. This diversity is reflected in the distribution of widespread taxa, as compared to local endemics. Areas such as western India and Indochina support a higher proportion of widespread taxa, whereas Borneo and Sumatra support high proportions of local endemics.

Throughout their range, *Cryptocoryne* taxa are mainly threatened by six types of action: clearance of natural habitats, agricultural intensification (often gradually following on from selective logging of natural forest and then small-scale clearance), development, uncontrolled and/or illegal collection, hydrological modification and water use (abstraction). The most significant threat to *Cryptocoryne* populations throughout their range is the degradation of habitats within which wetlands supporting *Cryptocoryne* populations occur and their conversion to industrial-scale plantations. However the relationship between habitat degradation and the survival of some *Cryptocoryne* populations is not simple. Many *Cryptocoryne* populations appear able to survive some aspects of the conversion of forest to industrial-scale plantations, small-holder farming and even urbanisation, with populations persisting in drainage ditches in highly modified landscapes, such as in northern Kerala in western India. However, these are likely to be sparse remnants of formerly larger and more extensive populations.

This Conservation Action Plan is based on preparation of Red List assessments, employing the IUCN Criteria, for all species, varieties and hybrid combinations known at the time of preparation. Assessments of species and varieties were submitted for publication in 2022. The information included in these assessments was then compiled to enable analysis of threats, leading to development of a suite of proposals for conservation action for species or regional populations. The action plan is presented in the following sections:

- An introduction to the Conservation Action Plan.
- A summary characterisation of the genus *Cryptocoryne*.
- An overview of the conservation status of all known taxa, based on Red List assessments.
- Analysis of the threats affecting *Cryptocoryne* populations.
- A strategic plan presenting an overview of potential action at a range of levels down to individual regions and taxa.
- A list of references used in putting together the Action Plan.
- An appendix presenting the threat status assigned to each taxon assessed.

- Detailed information on each taxon assessed, including the information used to prepare the Red List assessment. Some information in this section differs from that in the main body of the report, as new information became available and new taxa were described during preparation of the report.

This Conservation Action Plan must, by its nature, be dynamic. Not only are taxonomic issues constantly being clarified and new taxa described, but conservation action is being undertaken all the time. At the same time, surveys have failed to find previously known populations of two taxa (*C. crispatula* var. *planifolia* and *C. ×hendrae*) and it is highly likely that they have become extinct in the wild during the lifetime of this project. This Conservation Action Plan needs to be revised at regular intervals to ensure that it continues to be relevant. At the same time, updating the Red list assessments every ten years will enable a more objective assessment of progress in conservation of taxa in the genus *Cryptocoryne*.

1 INTRODUCTION

Cryptocoryne is a genus of plants which occurs in rivers, streams, swamp forest and a small range of other wetland habitats in South and South-east Asia, from western India east to southern China and Vietnam and south to New Guinea. They are among the most popular plants in aquaria and some taxa are much sought after for horticulture.

Many taxa are known only from one or a small number of sites and most occur in areas threatened by habitat loss and degradation. Consequently, a very high proportion of taxa are considered to be threatened. This Conservation Action Plan is a first step toward global conservation of the genus. In combination with publication of IUCN Red List assessments for all species and varieties, this Conservation Action Plan is designed to establish a foundation for regional, local and site-specific conservation action. The taxonomy of *Cryptocoryne* is still highly dynamic; between submission of the Red List assessments for publication and finalisation of this Action Plan, three new species were described and the taxonomy of other species clarified.

This Conservation Action Plan is a first attempt to summarise available information on all currently recognised taxa within the genus *Cryptocoryne* to inform a global approach to their conservation. Preparation of this Action Plan involved the following steps:

1. Compilation of data from published sources, the grey literature and personal contributions from specialists to form the basis of Red List assessments applying the IUCN criteria (IUCN 2019).
2. Use of point data to develop distribution maps and to calculate the Extent of Occurrence (EOO) and Area of Occupancy (AOO) of all taxa.
3. Review of the draft Red List assessments by specialists.
4. Compilation of all comments and corrections, followed by submission of Red List assessments of species and varieties for publication by IUCN.
5. Extraction of information from the Red List assessments to inform this Conservation Action Plan.

Throughout this project, efforts have been made to avoid providing information which could enable unscrupulous collectors to find populations of threatened *Cryptocoryne* taxa. Inevitably, this has meant a degree of loss of detail which might be useful for conservation purposes. Where necessary, such information can be made available by the authors to those working on conservation of *Cryptocoryne*.

One major constraint on potential to implement the proposals presented in this Action Plan is the limited number of botanists capable of field, or even lab-based identification of *Cryptocoryne* taxa. The opportunities to resolve this constraint are limited and will take time, but the following may be of use:

- In many cases, particularly in Indonesia, local individuals have been identified who can recognise local taxa and projects have been initiated involving these people in keeping track of populations. This approach can be extended to other areas and should be enhanced by providing training for these local individuals in population monitoring methods.
- Students in Asian universities, particularly at PhD and post-doctorate levels, should be encouraged to carry out research into aquatic plant taxa such as *Barclaya*, *Bucephalandra*, *Cryptocoryne*, *Eriocaulon*, *Rotala* and *Utricularia* both to help resolve outstanding taxonomic questions and to improve training of botanists in identification of these genera.
- The possibility must be considered simply to document *Cryptocoryne* populations without critical identification, including photography of all parts represented. This will enable the best chance of accurate identification without relying on critical determination in the field. This approach is particularly appropriate for documentation/monitoring of existing known populations, but is not ideal when searching for new populations.

Conservation of *Cryptocoryne* will require long-term monitoring of populations of all threatened taxa, in addition to specific conservation projects. Such monitoring will need to depend on local people. Initiatives to involve local people in conservation of *Cryptocoryne* need to be extended throughout the region. However, the extremely high prices offered for material of some taxa will always be an understandable temptation for local people to collect plants for sale. The only way to eliminate this temptation is to flood the market with cheap plants of all taxa. The establishment of an *ex-situ* living

collection of all available taxa at Singapore Botanic Gardens may provide an opportunity for legitimate enterprises to initiate *ex-situ* propagation and tissue-culture of all taxa.

This Conservation Action Plan must, by its nature, be dynamic. Not only are taxonomic issues constantly being clarified and new taxa described, but conservation action is being undertaken all the time. At the same time, surveys have failed to find previously known populations of two taxa (*C. crispatula* var. *planifolia* and *C. ×hendrae*) and it is highly likely that they have become extinct in the wild during the lifetime of this project. This Conservation Action Plan needs to be revised at regular intervals to ensure that it continues to be relevant. At the same time, updating the Red list assessments every ten years will enable a more objective assessment of progress in conservation of taxa in the genus *Cryptocoryne*.

Acknowledgements

The authors would like to thank all the people who have made this project possible, in particular IUCN SSC for the grant No. 5350-0189 which has enabled much of the work to happen. We are also grateful to Melanie Bilz and David Allen for their help with the Red List assessment process, Kirsty Shaw of Botanic Gardens Conservation International for help with the steps leading to establishment of the *ex-situ* collection and staff of Singapore Botanic Garden, particularly Dennis Sng Kah Hseng and Nura Abdul Karim, for their help with logistics and practicalities. The data files prepared by the late Jan D. Bastmeijer have been fundamental to this work.

2 THE GENUS *CRYPTOCORYNE*

The genus *Cryptocoryne* involves a total of 115 currently recognised taxa, represented by 68 species, 29 varieties, 14 hybrids or hybrid complexes and 4 nothovarieties. All of these taxa occur in tropical forest streams and rivers or occasionally standing waters, including seasonal habitats, with some taxa extending into the intertidal zone of rivers. They occur from western India east to southern China and south through South-east Asia and the Philippines to New Guinea (Figure 2.1). Many taxa are known from single locations or even single collections, while two species are known only from horticulture with their native range unknown. *Cryptocoryne* taxa are extremely popular in aquatic horticulture, which brings a risk of destruction of populations through uncontrolled and/or illegal collection by unscrupulous individuals. At the same time, “hobbyist” organisations such as the European *Cryptocoryne* Society and their members have been vital in helping to preserve genetic diversity in the genus through establishment of *ex-situ* collections such as in the Munich Botanical Gardens and the University of Copenhagen.

The distribution of *Cryptocoryne* taxa is not uniform in the region and a small number of areas support particularly high genetic diversity. The greatest species diversity occurs in Borneo, mainly in western Kalimantan and Sarawak where 26 species, six varieties and six natural hybrid combinations are known (Asih *et al.* 2022) followed by Sumatra (Sumatera) with 16 species, three varieties and four natural hybrid combinations and Sri Lanka with ten species and one natural hybrid combination. This contrasts with Indochina with only seven species, but nine varieties, as well as with New Guinea with two species and two varieties, however taxonomic work is showing that there are new taxa to be described in a number of areas. This diversity is reflected in the distribution of widespread taxa, as compared to local endemics. Areas such as western India and Indochina support a higher proportion of widespread taxa, whereas Borneo and Sumatra support high proportions of local endemics.

Cryptocoryne plants are rhizomatous perennials and all but a few species, such as *C. cognata*, are stoloniferous, often forming extensive stands through vegetative spread in which all plants may be genetically identical. Some populations or individual plants may be completely submerged for much of the year, but all populations must be emergent or fully exposed for periods to flower, as the flowers are pollinated by airborne flies (Jacobsen and Ørgaard 2018). It appears likely that pollination in many species is dependent on particular insect species such that disruption of invertebrate communities could compromise sexual reproduction in some *Cryptocoryne* populations.

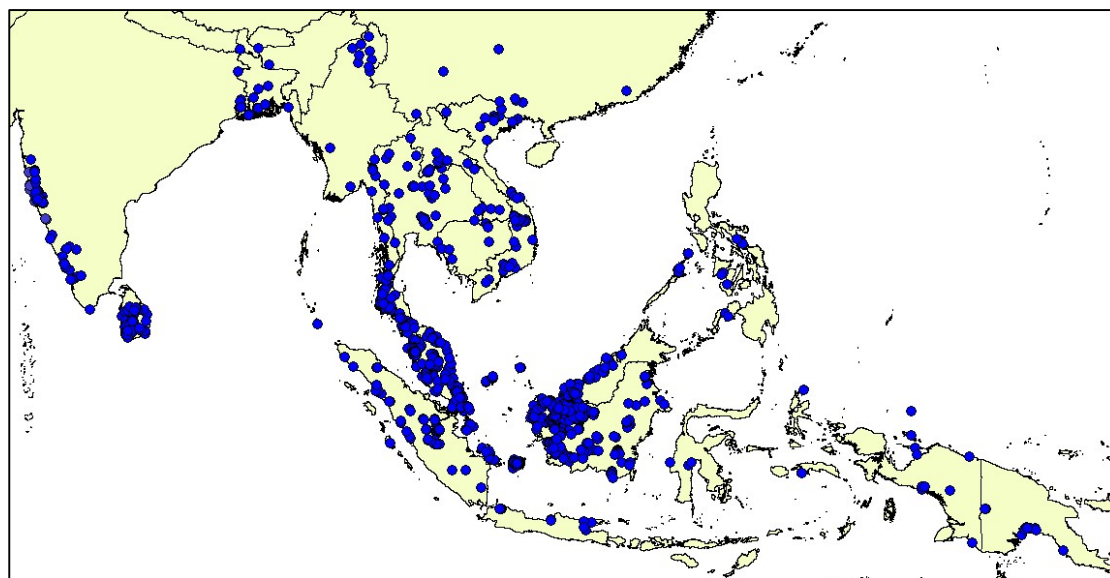


Figure 2.1 The global distribution of *Cryptocoryne* taxa

Cryptocoryne taxa only flower when the spathe opening can be held above water levels or in seasonally dry conditions, to allow access by pollinators. Therefore stabilisation of water levels (which are typically then higher than before stabilisation) will preclude flowering unless plants are able to colonise new

habitat as it becomes available. The extent to which *Cryptocoryne* taxa are dependent upon sexual reproduction is not clear. Certainly much reproduction is asexual, through development of daughter plants on stolons, however it is possible that sexual reproduction allows dispersal by animal vectors and may increase genetic resilience, although inbreeding depression does not appear to be a constraint on most aquatic plant species. Aquatic horticulture has shown that a number of *Cryptocoryne* taxa can be maintained totally submerged for extended periods of up to a number of years. It is not known whether wild populations subject to permanent submergence by hydrological modification could also survive for extended periods. Populations growing in seasonal habitats, such as rice fields in India are dormant during the dry season, while in contrast, species which grow in the channel of the Mekong River in Laos and northern Thailand are dormant during the rainy season when they may be submerged to a depth of up to 10m when the river rises.

Most of the taxa in the genus are restricted to rainforest rivers, from small headwater streams to a few which occur in large rivers such as the Irrawaddy, the Mekong and their tributaries. While rainforest and its destruction has received much publicity, there has been relatively little focus on forest rivers. These are typically more threatened than the forest itself, being vulnerable to issues such as nutrient enrichment and increased turbidity as a result of selective logging, mineral extraction and mining, whilst often being devastated by secondary impacts of human use of forest habitats. Other species are dependent upon habitats such as freshwater swamp forest which is threatened throughout the region. Species which occur only in a single watercourse are highly vulnerable to even quite local changes in hydrology, water quality and even riparian habitat modification.

3 STATUS OF POPULATIONS

3.1 Introduction

The threatened status of all *Cryptocoryne* species and varieties has been assessed following the IUCN Criteria (IUCN 2019) and these assessments submitted for publication by IUCN (<https://www.iucnredlist.org/>). Red list assessments have also been prepared for all currently recognised hybrid combinations but these will not yet be published by IUCN as the organisation does not yet include hybrids in the Red List. A summary of each Red List assessment is appended to this Conservation Action Plan.

Table 3.1 The number of taxa assigned to each threat category

	species	variety	hybrid	Total
CR(PE)	1	1	2	4
CR	11	2	5	18
EN	13	5	5	24
VU	11	5		17
NT	13	3	1	17
DD	3	4	2	9
LC	13	8	3	24
Total	65	28	17	113
% threatened	55.4	46.4	64.7	55.8

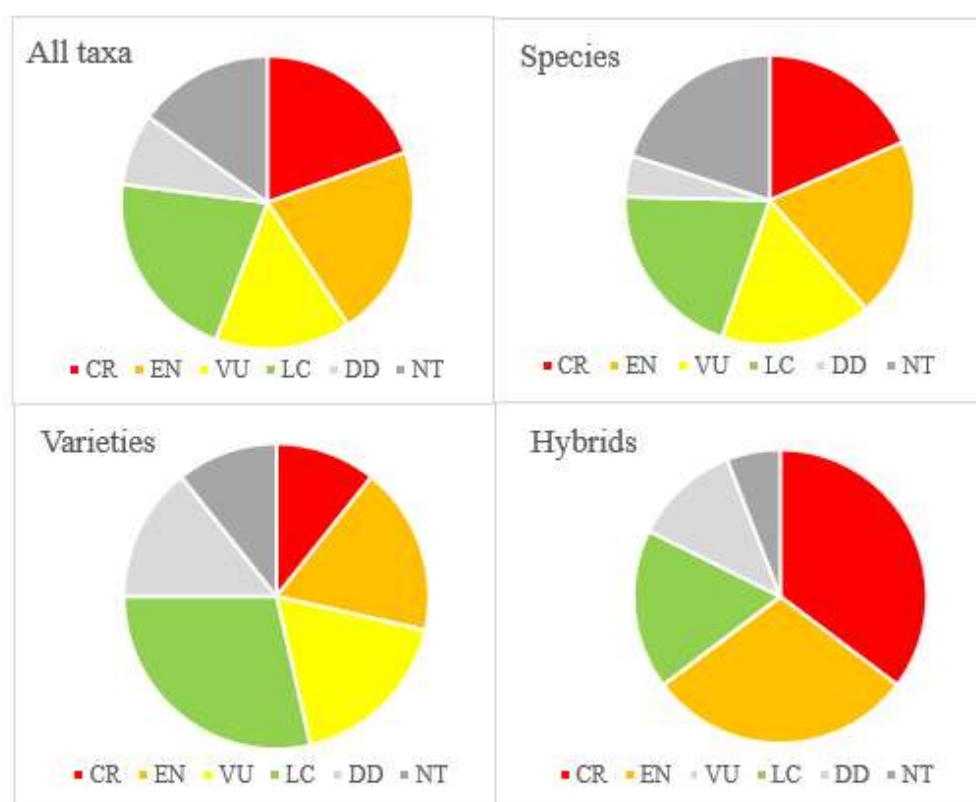


Figure 3.1 The proportion of taxa assigned to each threat category

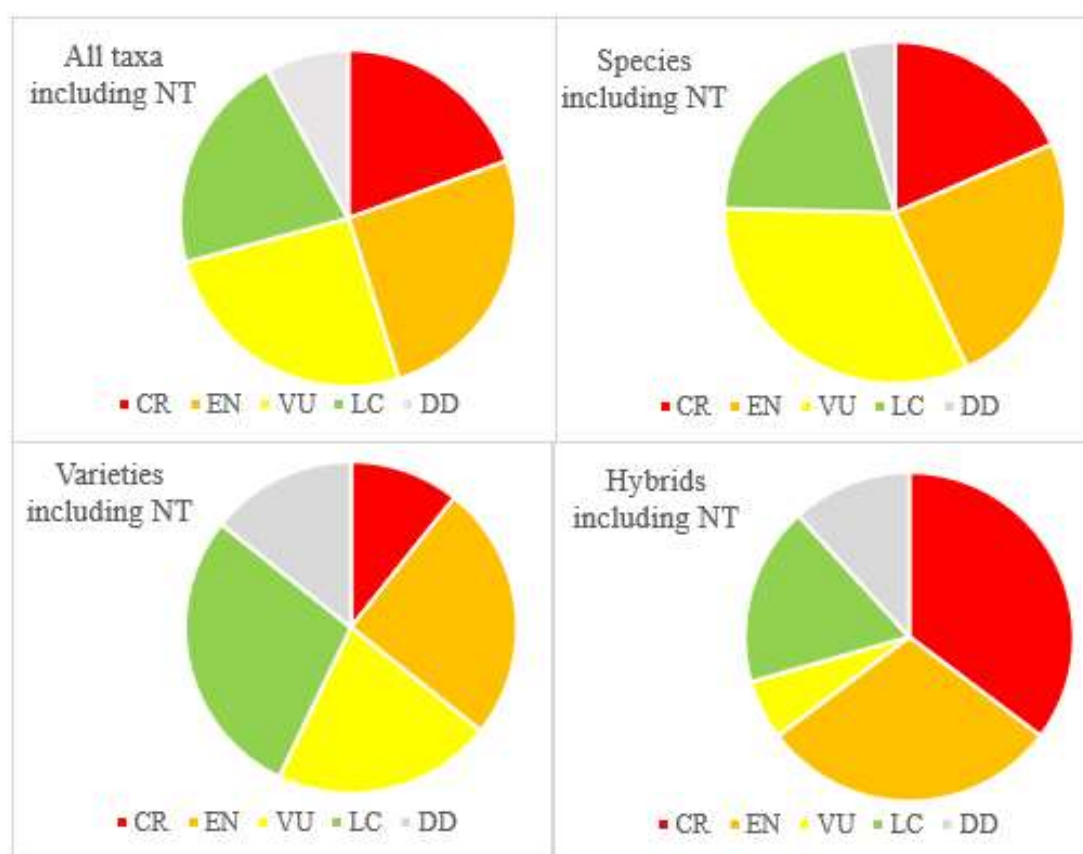


Figure 3.2 The proportion of taxa assigned to each threat category where taxa classed as Near Threatened are included within the threat category into which they are expected to fall if predicted declines continue

Table 3.1 and Figures 3.1-3.2 show the number of *Cryptocoryne* taxa assigned to each threat class, while the threat class assigned to each taxon is given in Appendix A. This shows that a remarkably high proportion of taxa (53.6) is classed as threatened (classed as Critically Endangered [CR], Endangered [EN] or Vulnerable [VU]). In general, most assessments of groups or genera of aquatic and wetland plant result in fewer than 30% being classed as threatened. The main reason for the high proportion of *Cryptocoryne* species classed as threatened is the number of species which have extremely limited distribution, combined with the ongoing destruction of forest habitats in South and South-east Asia.

3.2 Regional Overview

3.2.1 Introduction

For the purposes of conservation assessment, the global range of the genus *Cryptocoryne* can be divided into eight regions. The regions listed here are based on the distribution of *Cryptocoryne* taxa, some such as Sri Lanka and Vietnam are countries, other such as Borneo and New Guinea are single islands which involve parts of different countries, while Sri Lanka is a single island representing one country. Table 3.2 shows the regional distribution of taxa in each threat class. It is important to recognise that the regions are not of comparable scale, for example “Indochina” as employed here is a massive region involving five countries, while Sumatra is a single island representing part of a single country.

Eleven species and nine varieties may be considered reasonably widespread and all of these except *C. ciliata* var. *latifolia* are classed as Least Concern. *C. ciliata* var. *latifolia* is poorly understood because of poor recording of the variety, however the evidence suggests that it is widespread and reasonably

abundant, such that additional data will show it to be of Least Concern. To some extent, the classification of some species as Least Concern is inevitable because one or more varieties is classed as Least Concern. Thus, var. *ciliata* of *C. ciliata* is of Least Concern and inevitably, the species itself will be of Least Concern (Table 3.3), the status of *C. cordata*, *C. crispatula* and *C. spiralis* is similar.

Table 3.2 Regional breakdown of taxa by threat category. This table excludes widespread taxa (see table 3.4). The number of threatened taxa in each region is given in brackets under Total.

REGION	CR(PE)	CR	EN	VU	NT	DD	LC	Total
Borneo (Brunei Darussalam, Indonesia, East Malaysia)	1	7	7	5	11	1	7	39 (20)
Indonesia (Sumatra, Bangka, Belitung, Singkep and Lingga)		5	4	3	2	1	8	23 (12)
Sri Lanka	1	2	5	1	2	0		11 (9)
Indochina – Mekong (Cambodia, China, Laos, Myanmar, Thailand, Vietnam)	1	1	1	4	2	2	8	19 (7)
Peninsular (West) Malaysia, Southern Thailand, Singapore and parts of Indonesia	1		1	3	2	3	11	21 (5)
Philippines		2	3			3		8 (5)
New Guinea (Papua New Guinea and Papua - Indonesia)		1	3				2	6 (4)
India (India including Andaman and Bangladesh)				3	1	2	5	11 (3)

Table 3.3 Taxa classed as Least Concern because their distribution alone makes extinction unlikely in the short-term (*Cryptocoryne ciliata* var. *latifolia* is included here because in spite of being classed as Data Deficient, it is known to be widespread)

<i>Cryptocoryne affinis</i>	<i>Cryptocoryne crispatula</i>
<i>Cryptocoryne bangkaensis</i>	<i>Cryptocoryne crispatula</i> var. <i>albida</i>
<i>Cryptocoryne ciliata</i>	<i>Cryptocoryne crispatula</i> var. <i>balansae</i>
<i>Cryptocoryne ciliata</i> var. <i>ciliata</i>	<i>Cryptocoryne crispatula</i> var. <i>crispatula</i>
<i>Cryptocoryne ciliata</i> var. <i>latifolia</i> (DD)	<i>Cryptocoryne crispatula</i> var. <i>tonkinensis</i>
<i>Cryptocoryne cordata</i>	<i>Cryptocoryne griffithii</i>
<i>Cryptocoryne cordata</i> var. <i>cordata</i>	<i>Cryptocoryne minima</i>
<i>Cryptocoryne cordata</i> var. <i>grabowskii</i>	<i>Cryptocoryne retrospiralis</i>
<i>Cryptocoryne cordata</i> var. <i>siamensis</i>	<i>Cryptocoryne spiralis</i>
	<i>Cryptocoryne spiralis</i> var. <i>spiralis</i>

Figures 3.3-3.5 show the distribution of threatened *Cryptocoryne* taxa. Just as in the case with the relative distribution of genetic diversity in the genus, these figures clearly show concentrations of threatened taxa. Thus areas which can be described as conservation hotspots for the genus are Borneo, Sumatra and Sri Lanka, with a concentration of Endangered taxa in western India. These concentrations of threatened taxa are a consequence of the combination of high numbers of locally endemic taxa and areas with a particularly high level of threat to wetland habitats.

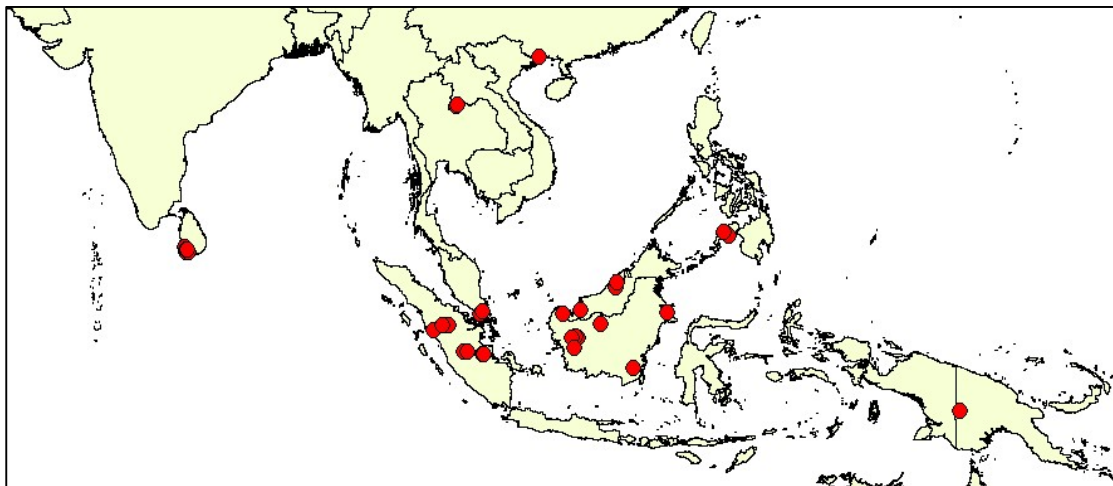


Figure 3.3 The distribution of Critically Endangered *Cryptocoryne* taxa

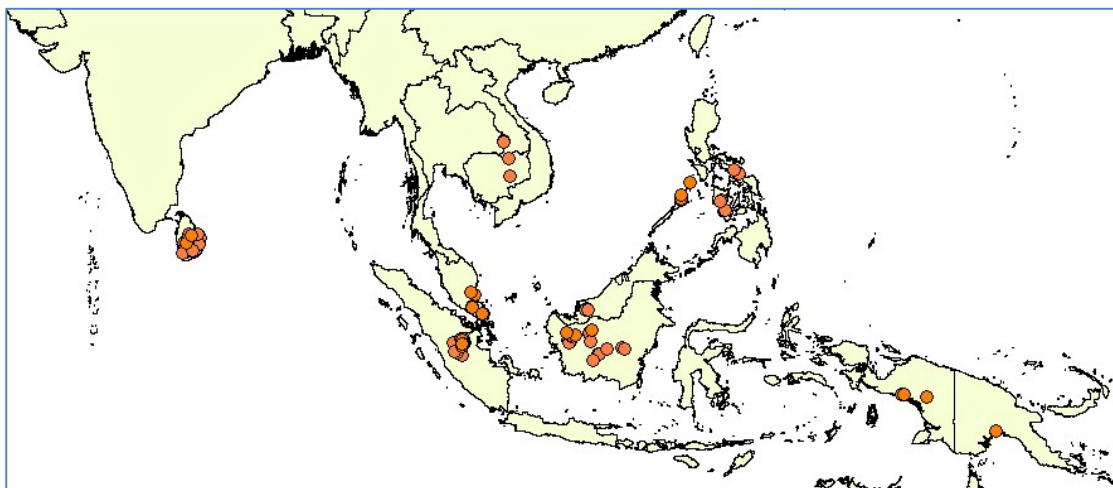


Figure 3.4 The distribution of Endangered *Cryptocoryne* taxa

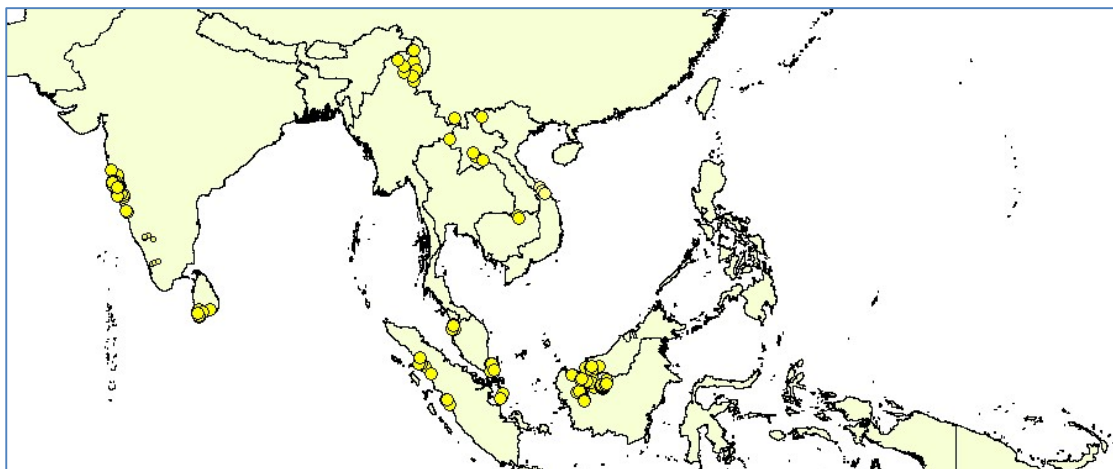


Figure 3.5 The distribution of Vulnerable *Cryptocoryne* taxa

3.2.2 Borneo (Brunei Darussalam, Indonesia, East Malaysia)

The area covered by this heading includes Brunei Darussalam, Indonesia (Kalimantan, Natuna, Anambas) and Malaysia (Sabah, Sarawak).

Table 3.3 The threat categories assigned to *Cryptocoryne* taxa occurring in Borneo (excluding LC)

Name	Status
<i>Cryptocoryne</i> × <i>hendrae</i>	CR(PE) B1ab(iii)+2ab(iii)
<i>Cryptocoryne</i> <i>noritoi</i>	CR B1ab(i, ii, iii, iv, v)+2ab(i, ii, iii, iv, v)
<i>Cryptocoryne</i> <i>isae</i>	CR B1ab(i, ii, iii, iv)+2ab(i, ii, iii, iv).
<i>Cryptocoryne</i> <i>tirtadinatae</i>	CR B1ab(iii)+2ab(iii)
<i>Cryptocoryne</i> × <i>batangkayanensis</i>	CR B1ab(iii)+2ab(iii)
<i>Cryptocoryne</i> × <i>ikezewaldiae</i>	CR B1ab(iii)+2ab(iii).
<i>Cryptocoryne</i> <i>erwinii</i>	CR B1ab(iii, iv)+2ab(iii, iv).
<i>Cryptocoryne</i> <i>zaidiana</i>	CR B1ab(iii, v)
<i>Cryptocoryne</i> <i>ciliata</i> var. <i>bogneri</i>	CR B1ab(iii, v)+B2ab(iii, v)
<i>Cryptocoryne</i> <i>aura</i>	EN B1ab(ii, iii)+2ab(ii, iii).
<i>Cryptocoryne</i> × <i>nakamotoi</i>	EN B1ab(iii)+2ab(iii)
<i>Cryptocoryne</i> <i>sahalii</i>	EN B1ab(iii)+2ab(iii).
<i>Cryptocoryne</i> <i>yujii</i> var. <i>hendrikii</i>	EN B1ab(iii)+2ab(iii).
<i>Cryptocoryne</i> <i>yujii</i> var. <i>yujii</i>	EN B1ab(iii)+2ab(iii).
<i>Cryptocoryne</i> × <i>agusii</i>	EN B1ab(iii, v)
<i>Cryptocoryne</i> <i>ideii</i>	EN B2ab(iii)
<i>Cryptocoryne</i> <i>verrucosa</i>	VU B1ab(iii)+2ab(iii)
<i>Cryptocoryne</i> <i>auriculata</i>	VU B1ab(iii)+2ab(iii).
<i>Cryptocoryne</i> <i>ferruginea</i> var. <i>sekadauensis</i>	VU B1ab(iii, v)+2ab(iii, v).
<i>Cryptocoryne</i> <i>uenoi</i>	VU B1b(iii)+2b(iii)
<i>Cryptocoryne</i> <i>bastmeijeri</i>	VU D2.
<i>Cryptocoryne</i> <i>bullosa</i>	NT EN B1ab(i, ii, iii, iv, v)+B2ab(i, ii, iii, iv, v)
<i>Cryptocoryne</i> <i>ferruginea</i> var. <i>ferruginea</i>	NT EN B1b(i, ii, iii)+2b(i, ii, iii).
<i>Cryptocoryne</i> <i>keei</i>	NT VU B1ab(iii)+2ab(iii).
<i>Cryptocoryne</i> <i>yujii</i>	NT VU B1ab(iii)+2ab(iii).
<i>Cryptocoryne</i> <i>hudoroi</i>	NT VU B1ab(iii, v)+ (iii, v); D2
<i>Cryptocoryne</i> <i>regina</i>	NT VU B1ab(iii, v)+2ab(iii, v)
<i>Cryptocoryne</i> <i>ferruginea</i>	NT VU B1b(i, ii, iii)+2b(i, ii, iii).
<i>Cryptocoryne</i> × <i>purpurea</i> nothovar. <i>borneoensis</i>	NT VU B2ab(i, ii, iii)
<i>Cryptocoryne</i> <i>longicauda</i>	NT VU B2ab(i, ii, iii, v)
<i>Cryptocoryne</i> <i>lingua</i>	NT VU B2b(i, ii, iii, v)
<i>Cryptocoryne</i> <i>pallidinervia</i>	NT VU B2b(iii, v).

As noted previously, Borneo supports the greatest taxonomic diversity in the genus, including nearly 35% of all currently recognised taxa and 25% of currently recognised species. Most known populations are in western Kalimantan and Sarawak (Figure 2.1) and this is reflected in the distribution of threatened species and varieties, all but two of which also occur in the west, although there are two threatened hybrids and Near Threatened species elsewhere (Figure 3.2-3.4).

In western Kalimantan there are two areas which support concentrations of threatened taxa (Figure 3.6):

- The Schwaner Mountains which support all or most of the global populations of *C. bastmeijeri*, *C. erwinii*, *C. ferruginea* var. *sekadauensis*, *C. isae*, *C. tirtadinatae*, *C. yujii* var. *hendrikii* and *C. ×agusii*.
- Kapuas Hulu Regency which supports all or most of the global populations of *C. regina*, *C. sahalii*, *C. verrucosa*, *C. ×ikezewaldiae* and *C. ×nakamotoi*.

Remaining wetland habitats in both of these areas are highly threatened and much has already been degraded or lost to industrial-scale plantations, urban development, selective logging or clearance for small-scale agriculture.

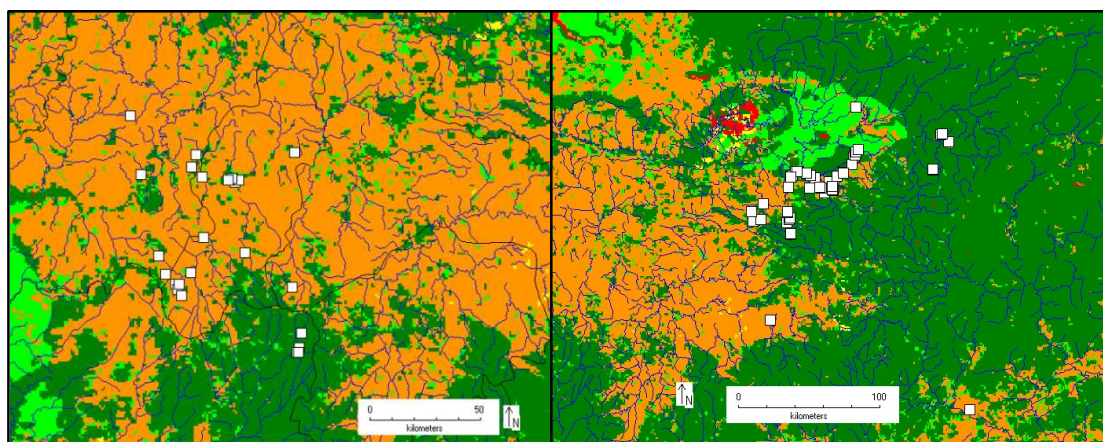


Figure 3.6 Left: The distribution of populations of *Cryptocoryne* taxa in the Schwaner Mountains in Kalimantan: *C. bastmeijeri*, *C. erwinii*, *C. ferruginea* var. *sekadauensis*, *C. isae*, *C. tirtadinatae*, *C. yujii* var. *hendrikii* and *C. ×agusii*. Right: The distribution of *Cryptocoryne* taxa in Kapuas Hulu Regency in Kalimantan: *C. regina*, *C. sahalii*, *C. verrucosa*, *C. ×ikezewaldiae* and *C. ×nakamotoi*

These two areas include some of the highest priorities for *Cryptocoryne* conservation. In the short-term, initiatives such as the acquisition and conservation management of land at Nanga Pari and Nanga Mahap by Yayasan Konservasi Biota Lahan Basah may be critical for the conservation of some *Cryptocoryne* taxa. However in the long-term, it is vital that institutional and legislative protection is given both to sites supporting threatened taxa and to the hydrological systems on which they depend. Such protection must also be applied at a scale where core populations of groups of threatened taxa can be covered, such as throughout the Schwaner Mountains and Kapuas Hulu Regency.

3.2.3 Sri Lanka

Table 3.4 The threat categories assigned to *Cryptocoryne* taxa occurring in Sri Lanka

Name	Status
<i>Cryptocoryne waseri</i>	CR(PE) 2ab(iii)+2ab(iii).
<i>Cryptocoryne alba</i>	CR B1ab(iii)+2ab(iii)
<i>Cryptocoryne bogneri</i>	CR B1ab(iii)+2ab(iii)
<i>Cryptocoryne nevillii</i>	EN B1ab(iii)+2ab(iii).
<i>Cryptocoryne parva</i>	EN B1ab(iii)+2ab(iii).
<i>Cryptocoryne undulata</i>	EN B1ab(iii)+2ab(iii).
<i>Cryptocoryne walkeri</i>	EN B2ab(iii).
<i>Cryptocoryne ×willisii</i>	EN B1ab(iii)+2ab(iii)
<i>Cryptocoryne thwaitesii</i>	VU B1ab(i, ii, iii, v)+2 ab(i, ii, iii, v)
<i>Cryptocoryne beckettii</i>	NT EN B2ab(i, iii)
<i>Cryptocoryne wendtii</i>	NT B2ab(i, iii)

Sri Lanka is globally one of the most important areas for *Cryptocoryne* conservation, including both poorly-known species and some which are relatively well-known but highly threatened. In Sri Lanka, threatened *Cryptocoryne* taxa mainly occur in three areas:

- The south-west, where most records are from streams and rivers in lowland forest. This area has been relatively poorly documented by botanists interested in the genus. Most available information

involves descriptive accounts of new populations and little information is available to inform conservation. There is an urgent need for detailed surveys in the area both to collect information to inform conservation action and to attempt to locate additional populations of known taxa. This should be combined with detailed taxonomic research.

- The centre, where extensive populations occur in the Mahaweli-Ganga system. In this area, the Mahaweli-Ganga is a very large river system flowing mainly through heavily populated areas and *Cryptocoryne* populations form extensive stands in the margins and backwaters. Whilst some taxa appear to be abundant, others have been adversely affected by hydrological modification of the rivers and by over-collection. There is a need for detailed surveys of the rivers to document the distribution and abundance of the different species, combined with identification of areas which could be designated to protect specific populations.
- An area of coastal lagoons and freshwater wetlands in Eastern Province which supports populations of *C. nevillii*. *C. nevillii* is an unusual species, both because it occurs in coastal lagoons and marshes and because it may have benefitted from a measure of protection due to the presence of unexploded land-mines in the coastal zone. Whilst the continued existence of land-mines will impose quite severe restrictions on surveys, it is important to document the distribution and status of *C. nevillii* populations before the current peace allows increased access to the coastal zone with the risk of proposals for tourist development. It is likely that the most effective means of protecting *C. nevillii* will be through designation of at least part of the coastal zone as a strictly protected area.

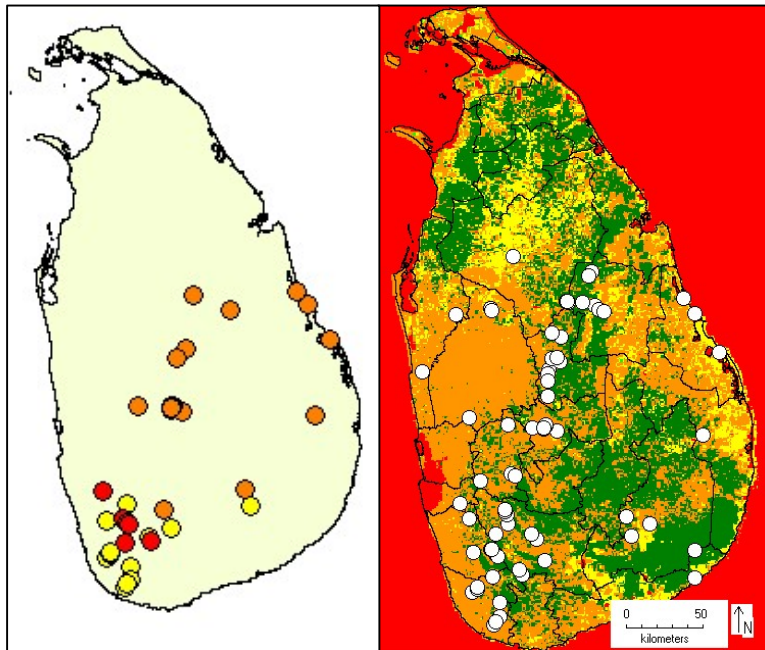


Figure 3.7 Left: The distribution of threatened *Cryptocoryne* taxa in Sri Lanka. Right: The distribution of *Cryptocoryne* taxa in Sri Lanka in relation to forest cover

3.2.4 Indonesia (Sumatra, Bangka, Belitung, Singkep and Lingga)

The island of Sumatra still retains extensive lowland forest, although much of this has already been degraded through settlement, selective logging and exploitation of other natural resources, while other remnant forest is potentially allocated for conversion to industrial-scale plantations. Many of the remaining lowland forest areas have been protected due to the importance of Sumatra for other species such as orang-utan (*Pongo abelii*), Sumatran tiger (*Panthera tigris* ssp. *sumatrae*) and Sumatran Rhinoceros (*Dicerorhinus sumatrensis*), with fortuitous protection of some *Cryptocoryne* populations. However protection of habitat for large vertebrates does not necessarily provide adequate protection for other taxa such as plants, which could still be subject to over-collection.

Most *Cryptocoryne* taxa in Sumatra are threatened mainly by a combination of their intrinsic rarity (many are known from one site or location) and the extent of habitat degradation. The highest priorities for these taxa are thorough documentation of populations, combined with an assessment of the extent to which the existing protected areas network can currently and potentially protect populations. If the

existing protected areas network is shown to be inadequate to protect these species then new protected areas should be proposed.

Table 3.5 The threat categories assigned to *Cryptocoryne* taxa occurring in Sumatra (excluding Least Concern)

Name	Status
<i>Cryptocoryne cordata</i> var. <i>diderici</i>	CR B1ab(iii, v)+2ab(iii, v)
<i>Cryptocoryne moehlmannii</i>	CR B1ab(iii, v)+2ab(iii, v)
<i>Cryptocoryne</i> × <i>jambiensis</i>	CR B1ab(i, iii)+2ab(i, iii)
<i>Cryptocoryne</i> × <i>zukaii</i> nothovar. <i>sumateraensis</i>	CR B1ab(iii)+2ab(iii)
<i>Cryptocoryne cordata</i> var. <i>wellyi</i>	EN B1ab(i, ii, iii, v)+2ab(i, ii, iii, v)
<i>Cryptocoryne scurris</i>	EN B1ab(iii)+2ab(iii).
<i>Cryptocoryne villosa</i>	EN B1ab(iii, v)+2ab(iii, v).
<i>Cryptocoryne wongsoi</i>	EN B1ab(iii)+2ab(iii)
<i>Cryptocoryne</i> × <i>ardyi</i>	EN B1ab(iii, iv)+2ab(iii, iv)
<i>Cryptocoryne pontedericiifolia</i>	VU B1ab(iii)+2ab(iii); D2
<i>Cryptocoryne schulzei</i>	VU B1ab(iii)+2ab(iii)
<i>Cryptocoryne longicauda</i>	NT VU B2ab(i, ii, iii, v)
<i>Cryptocoryne nurii</i> var. <i>nurii</i>	NT VU B2b(iii, v); D2
<i>Cryptocoryne</i> × <i>zukaii</i>	DD

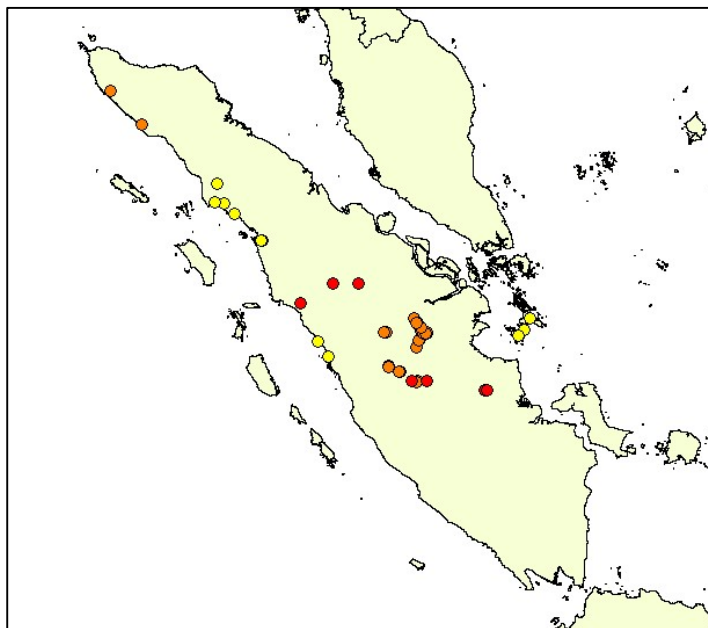


Figure 3.8 The distribution of threatened *Cryptocoryne* taxa in Sumatra

There is also an urgent need to survey potentially suitable habitat throughout the island to locate additional populations. Mapping additional populations might both reduce the level of threat assigned to taxa and enable measures to address the conservation needs of more than one species with a single action, such as purchase of land along water courses or designation of a single protected area.

3.2.5 Philippines

Table 3.6 The threat categories assigned to *Cryptocoryne* taxa occurring in the Philippines (excluding Least Concern)

Name	Status
<i>Cryptocoryne paglaterasiana</i>	CR B1ab(ii, iii, v)+2ab(ii, iii, v)
<i>Cryptocoryne pygmaea</i>	CR B1ab(ii, iii, v)+2ab(ii, iii, v); D
<i>Cryptocoryne aponogetifolia</i>	EN B1ab(i, ii, iii, iv, v)+B2ab(i, ii, iii, iv, v).
<i>Cryptocoryne palawanensis</i>	EN B1ab(ii, iii, v)+2ab(ii, iii, v)
<i>Cryptocoryne usteriana</i>	EN B1ab(iii)+2ab(iii).

<i>Cryptocoryne coronata</i>	DD
<i>Cryptocoryne joshanii</i>	DD

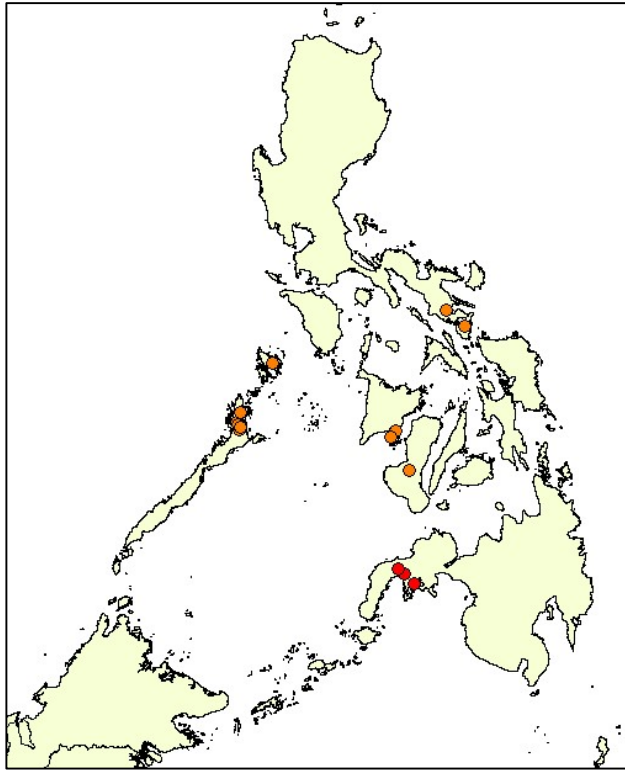


Figure 3.9 The distribution of threatened *Cryptocoryne* taxa in The Philippines

The Philippines have been relatively poorly surveyed for *Cryptocoryne* species, although this is now changing. There is no information on the location from which *C. coronata* was recorded and it is not clear whether *C. aponogetifolia* still occurs on Negros and Panay. Recent surveys of the Zamboanga Peninsula in western Mindanao have led to the recognition of two new species (*C. paglaterasiana* and *C. palawanensis*), as well as clarification of the taxonomic status of *C. pygmaea* (Naive, Bastmeijer and Jacobsen 2022, Naive, Yhebron and Jacobsen 2022). It is highly likely that further surveys will lead to recognition of other new taxa.

Most *Cryptocoryne* populations in The Philippines are threatened by the secondary effects of habitat destruction and degradation, as well as by illegal collection and trade. The most urgent conservation

actions needed involves a combination of surveys to inform site and habitat protection, as well as formal protection of critical sites.

3.2.6 Indochina – Mekong (Cambodia, China, Laos, Myanmar, Thailand, Vietnam)

Table 3.7 The threat categories assigned to *Cryptocoryne* taxa occurring in Indochina (excluding Least Concern)

Name	Status
<i>Cryptocoryne crispatula</i> var. <i>planifolia</i>	CR B1ab(iii)+2ab(iii).
<i>Cryptocoryne loeiensis</i>	CR B1ab(iii, v)
<i>Cryptocoryne mekongensis</i>	EN B1ab(iii, iv, v)+2ab(iii, iv, v)
<i>Cryptocoryne vietnamensis</i>	VU B1ab(iii)+2ab(iii)
<i>Cryptocoryne crispatula</i> var. <i>yunnanensis</i>	VU B2ab(i, ii, iii); D2
<i>Cryptocoryne cruddasiana</i>	VU B2ab(iii).
<i>Cryptocoryne crispatula</i> var. <i>decus-mekongensis</i>	VU D2
<i>Cryptocoryne annamica</i>	NT EN B1ab(iii, iv)+2ab(iii, iv).
<i>Cryptocoryne crispatula</i> var. <i>flaccidifolia</i>	NT VU B1ab(iii)+2ab(iii).

The term “Indochina” used here is a very loose designation, covering the region from Myanmar east to Guangxi Province in southern China and south to include Laos, Cambodia, Vietnam and parts of Thailand excluding the peninsular region. Within this region, many *Cryptocoryne* populations involve varieties of the widespread species *C. cordata* and *C. crispatula* and are classed as Least Concern. There are two main exceptions to this rule, four taxa which occur in the channel of the River Mekong and which are severely threatened by actions such as construction of dams on the river and four scattered taxa with very disparate and restricted ranges.

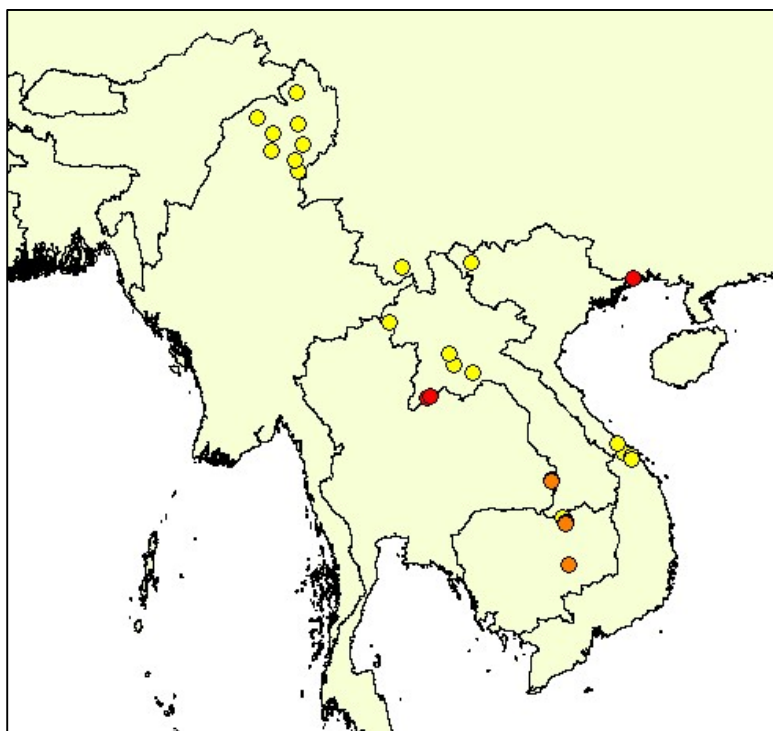


Figure 3.10 The distribution of threatened *Cryptocoryne* taxa in Indochina

The single greatest threat to *Cryptocoryne* taxa in the region involves hydrological modification of the River Mekong. In many cases, construction of a single dam could risk the extinction of a species; while most of the currently proposed dams are likely to eliminate many populations of threatened taxa and compromise the resilience of remaining populations. The potential environmental and biodiversity implications of the proposed hydrological modifications to the Mekong are well known and widely publicised. The most

effective use of the information available here on the relationship between these plans and *Cryptocoryne* populations is to combine this information with other actions designed to reduce or mitigate the potential impacts of these hydrological modifications on the biodiversity and ecological function of the Mekong.

Cryptocoryne populations on the Mekong are also affected by a range of other factors including over-grazing by cattle and habitat degradation during the dry season, over-exploitation of natural resources and development of the banks and adjacent habitats. These threats are best dealt with through local, often site-specific actions, although any opportunities to link such action to other related initiatives should be exploited.

Cryptocoryne populations in the region away from the Mekong typically occur on small to medium-sized forest streams. Whilst many are threatened by a range of factors such as habitat loss and degradation, available information is generally inadequate to enable design of appropriate conservation action. The highest priorities for these taxa are thorough documentation of populations, combined with an assessment of the extent to which the existing protected areas network can currently and could potentially protect populations. If the existing protected areas network is shown to be inadequate to protect these species then new protected areas should be proposed.

3.2.7 Peninsular (West) Malaysia, Southern Thailand, Singapore and parts of Indonesia

Table 3.8 The threat categories assigned to *Cryptocoryne* taxa occurring in Peninsular Malaysia (excluding Least Concern)

Name	Status
<i>Cryptocoryne</i> × <i>griffithioides</i>	CR(PE) B1b(i, ii, iii)+2ab(iii)
<i>Cryptocoryne</i> × <i>decus-silvae</i>	EN B1ab(i, ii, iii, iv)+2ab(i, ii, iii, iv)
<i>Cryptocoryne elliptica</i>	VU B1ab(i, ii, iii, v)+2ab(i, ii, iii, v).
<i>Cryptocoryne schulzei</i>	VU B1ab(iii)+2ab(iii).
<i>Cryptocoryne nurii</i> var. <i>nurii</i>	NT EN B2b(iii, v).
<i>Cryptocoryne</i> × <i>schulzeioides</i>	DD

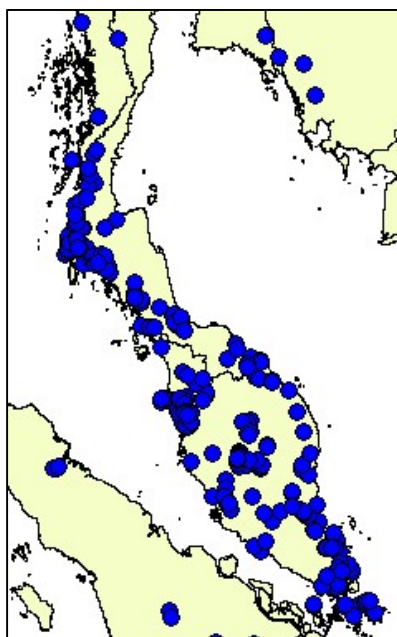


Figure 3.11 The distribution of *Cryptocoryne* taxa in Peninsular Malaysia and Thailand, Singapore and parts of Indonesia

The area covered by this heading includes Peninsular Malaysia and Thailand, Singapore and parts of Indonesia (Bintan, Batam and Karimun).

Few *Cryptocoryne* taxa in the region are highly threatened, those which have mainly been subject to documented population losses. It is highly likely that both of these factors are a consequence of Peninsular Malaysian *Cryptocoryne* populations being much better documented than elsewhere as Malaysia has been more thoroughly surveyed for these species. Most populations have been recorded from small to medium-sized forest streams or water courses flowing through swamp forest.

Peninsular Malaysia has an extensive network of protected lowland forest areas, however there is evidence to suggest these are inadequately protected and many are becoming degraded. These may therefore not confer adequate protection on populations threatened by factors such as over-collection, habitat destruction and habitat degradation. Panti Forest Reserve in Johor

State appears to be particularly important for *Cryptocoryne* species, however there are anecdotal accounts of parts of this reserve being clear-felled in recent years and there is a need to ensure that the protection of these areas is enforced.

3.2.8 India (India including Andaman and Bangladesh)

India supports only a relatively small number of threatened *Cryptocoryne* taxa, all of which occur in a relatively small area in the Western Ghats or coastal areas in the west. In this area, most populations occur in areas with fairly high human population levels, while others appear to have survived only by virtue of the remoteness of their populations.

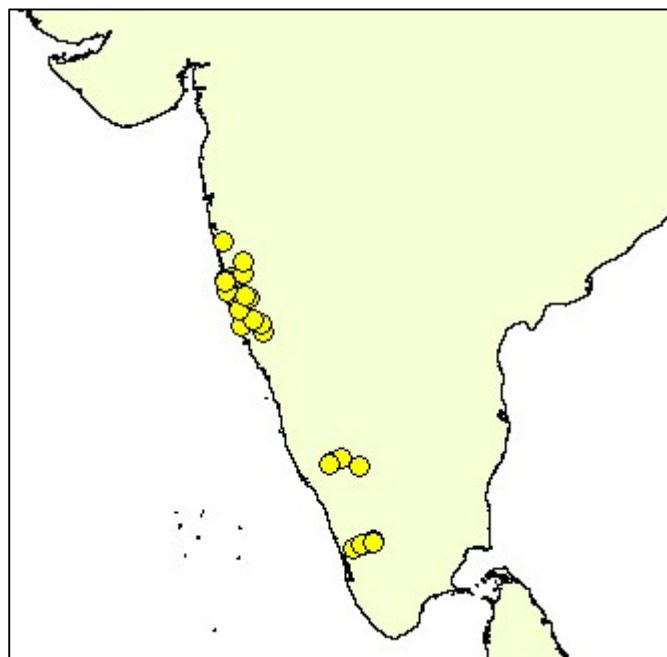


Figure 3.12 The distribution of Endangered *Cryptocoryne* taxa in India

Two varieties of *C. spiralis* (var. *caudigera* and var. *huegelii*) are not well enough known to allow development of action for their conservation. The other Vulnerable and Near Threatened taxa are most vulnerable to factors such as modification of hydrological systems (particularly construction of dams and realignment or canalisation of water courses) and pollution, particularly the secondary effects of nutrient enrichment derived from urban or agricultural sources.

Initiatives such as work to protect laterite hill outcrops by the IUCN SSC Western Ghats Plant Specialist Group and the conservation work of Zoos

Outreach Organisation may help to secure the future of some populations. However there is a need for a targeted programme of surveys to inform protection of sites and hydrological systems supporting these

species in the region. It is also likely that there is greater taxonomic diversity in the region than currently recognised. There is therefore a need for further research.

Table 3.9 The threat categories assigned to *Cryptocoryne* taxa occurring in India (excluding Least Concern)

Name	Status
<i>Cryptocoryne cognata</i>	VU B1ab(ii, iii)+B2ab(ii, iii): D2
<i>Cryptocoryne spiralis</i> var. <i>cognatoides</i>	VU B1ab(iii)+2ab(iii).
<i>Cryptocoryne consobrina</i>	VU B1ab(iii)+2ab(iii)
<i>Cryptocoryne sivadasanii</i>	VU B1ab(iii)+2ab(iii)
<i>Cryptocoryne spiralis</i> var. <i>caudigera</i>	DD
<i>Cryptocoryne spiralis</i> var. <i>huegelii</i>	DD

3.2.9 New Guinea (Papua New Guinea and Papua - Indonesia)

Table 3.10 The threat categories assigned to *Cryptocoryne* taxa occurring in New Guinea (excluding Least Concern)

Name	Status
<i>Cryptocoryne dewittii</i>	CR B1ab(i, ii, iii, iv, v)+2ab(i, ii, iii, iv, v).
<i>Cryptocoryne versteegii</i> var. <i>jayaensis</i>	EN B1ab(iii)+2ab(iii)
<i>Cryptocoryne versteegii</i>	EN B2ab(iii)
<i>Cryptocoryne versteegii</i> var. <i>versteegii</i>	EN B1ab(iii)+2ab(iii)

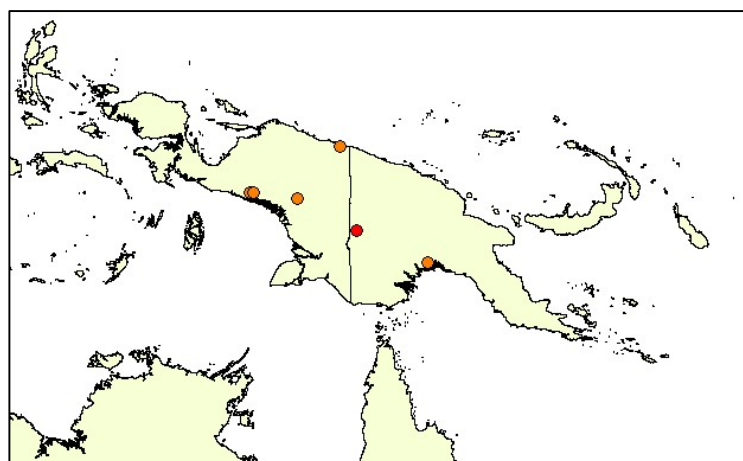


Figure 3.13 The distribution of threatened *Cryptocoryne* taxa in New Guinea

Only two threatened species of *Cryptocoryne* are known from New Guinea, however two varieties are recognised within one of these; *C. versteegii*. All lowland forest in New Guinea is threatened by clearance and most wetlands are threatened by factors associated with mining, mainly of heavy metals. The main effects to-date have

involved increased sedimentation in rivers and this could dramatically affect *Cryptocoryne* populations, covering plants or coating the leaves and preventing photosynthesis. New Guinea has been subject only to very little survey for *Cryptocoryne* species and there is a need both for extensive surveys to search for new populations and to document the known populations of threatened species to provide a basis for population monitoring.

4 THREAT ANALYSIS

Table 4.1 Characterisation of the main threats to *Cryptocoryne* populations

Action	Effect
<u>Clearance of natural habitats*</u> (the initial phase, typically for smallholder agriculture but often leading to further destruction)	Release of sediment into water courses Direct habitat loss Hydrological modification Increased insolation Increased turbidity
<u>Agricultural intensification*</u> (Typically following initial clearance for smallholder agriculture. Usually involving industrial-scale operations, such as oil-palm plantations)	Habitat destruction Habitat degradation Chemical pollution Sediment release and deposition Increased nutrient loading
<u>Development*</u> - expansion of rural settlements - Urban development - Industrial development - Tourism-related development - Aquaculture - Transport and communication	Habitat destruction Habitat degradation Pollution Sediment release (wash-out)
<u>Uncontrolled and/or illegal collection</u>	Removal of all or part of populations Disruption of metapopulation function
<u>Hydrological modification</u> - construction of dams/weirs - modification of springs - culverting and diversion of streams - Canalisation of water courses	Stabilisation of water levels Erosion Loss of substrate Habitat destruction
<u>Water use</u> (abstraction)	Drying springs Hydrological modification
Mining*, gravel extraction and quarrying	Habitat destruction Disruption of hydrology Increased turbidity Deposition of mine tailings
Industrial and domestic waste (water and solids)	Habitat degradation Deposition on plants
<u>Recreation*</u> (tourism)	Habitat degradation
Over-grazing	Death of plants Grazing of flowers
Secondary effects of natural resource exploitation* (such as rattan, “mansai”)	Increased insolation Hydrological modification
Natural disasters (increase in rainfall intensity due to climate change causing flash flooding)	Loss of populations due to bank erosion

* these actions primarily remove tree cover, which adversely affect leaf litter retention, temperature, humidity, evapotranspiration, precipitation/runoff, light intensity etc.

The most significant threat to *Cryptocoryne* populations throughout their range is the degradation of habitats within which wetlands supporting *Cryptocoryne* populations occur and their conversion to industrial-scale plantations. However the relationship between habitat degradation and the survival of some *Cryptocoryne* populations is not simple. Many *Cryptocoryne* populations appear able to survive some aspects of the conversion of forest to industrial-scale plantations, small-holder farming and even urbanisation, with populations persisting in drainage ditches in highly modified landscapes, such as in northern Kerala in western India. However, these are likely to be sparse remnants of formerly larger and more extensive populations.

Equally, it is clear that even minor degradation of forest can sometimes adversely affect *Cryptocoryne* populations. It is highly likely that this variation in response of populations to habitat degradation depends at least partly on the methods used to modify forest habitats. The effects of habitat degradation on *Cryptocoryne* populations may be relatively minor as a result of selective logging and even clear-felling but further survival will depend on subsequent land-use (Figure 4.1). Selective logging is an initial stage in the loss of semi-natural habitats and may not have a significant effect on *Cryptocoryne* species, with some species clearly able to persist following selective logging and even clear-felling followed by conversion to agriculture. However, erosion and subsequent sediment deposition can have significant effects on *Cryptocoryne* populations. Many impacts are linked, thus for example construction of routes into rainforest for the purpose of selective logging will cause quite localised release of disturbed sediments into rivers and streams and can disrupt hydrology. This effect will increase significantly with clear-felling, often with catastrophic effects on local hydrological systems.

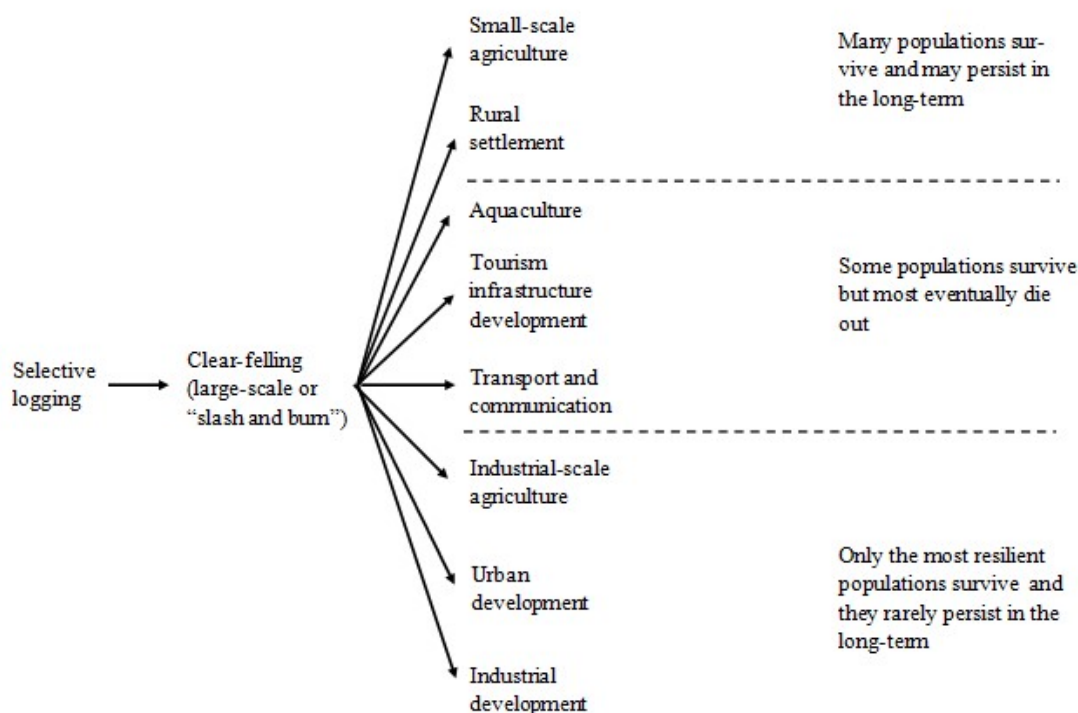


Figure 4.1 Simplified illustration of the effects of logging on *Cryptocoryne* populations

The other most widespread and frequent threat to *Cryptocoryne* populations is modification of the water courses in which they grow. The most significant threat in the north of the region is construction of dams to create large reservoirs, usually for hydroelectric power and water supply. This is a particular threat on the River Mekong in Indochina and on the Mahaweli-Ganga system in central Sri Lanka. However, even in India where many *Cryptocoryne* populations occur in historic cultural landscapes which have been modified for thousands of years and plants have often been able to adapt to the relatively subtle modification in the past, recent industrial-scale intervention is causing local extinctions. As noted previously, stabilisation of water levels will prevent sexual reproduction in *Cryptocoryne*, even if the populations are able to persist.

Development and hydrological modification associated with urbanisation, mining and quarrying also represent significant threats to *Cryptocoryne* populations throughout the region. These range from diversion and culverting of water courses for transport networks, to the complete loss of natural and semi-natural habitats through urban development. Conversion of natural stream and river channels to concrete-lined, steep-sided straightened channels which are trapezoid in cross-section, to carry storm water flow through urban areas, usually results in the loss of *Cryptocoryne* populations. Other hydrological modifications can have more subtle but equally devastating effects. Over-extraction of

water from aquifers often for irrigation or public water supply, can disrupt the hydroperiod (the duration of wet and dry periods) in seasonal streams, to the extent that *Cryptocoryne* populations are unable to complete their life-cycle before water bodies dry out. This is a particular concern in areas around the Kalu Ganga in south-western Sri Lanka but may also be an overlooked problem elsewhere, such as around *C. noritai* populations in eastern Kalimantan.

Linked to hydrological modification in many cases, pollution in its various forms is also a significant threat to *Cryptocoryne* populations. The most extreme example is where mine tailings are allowed to flow untreated into natural water courses, leading to deposition of fine and often deep layers of sediment on plants, preventing photosynthesis and eventually killing them. Similar effects may occur where poorly controlled roads and tracks cross water courses or as a consequence of clear-felling forest. Other forms of pollution appear to pose a less significant threat to aquatic plants, apart from eutrophication. Although most aquatic plants can tolerate and may even benefit from elevated nutrient levels, it is the secondary effects of these which are more significant. Elevated nutrient levels typically lead to increased growth of plants. This typically means that the species best adapted to exploit high nutrient levels, often including the larger, more aggressive aquatic species, grow larger and faster than other plants and therefore have a competitive advantage over smaller, more specialised taxa. The other most frequent effect of nutrient enrichment is excessive growth of algae which can occupy the water column and develop into “blooms” with consequent dramatic effects on dissolved oxygen levels and other chemical characteristics of the water as they die and break down. Such secondary effects of hyper-eutrophication are a common threat to aquatic plants throughout the world.

In many areas, unregulated exploitation of river sediments, particularly sand and gravel, can have dramatic effects on *Cryptocoryne* populations. In such cases, casual removal of riverine sediments can not only lead to direct loss of populations but can disrupt erosion-deposition sequences along rivers with the erosion of sediment banks happening too fast for *Cryptocoryne* populations to adapt.

Another threat to *Cryptocoryne* populations which does not affect all wetland-dependent plants species is over-collection. Some populations are exploited for food, but the popularity of *Cryptocoryne* in aquatic horticulture means that some populations are targeted not only by collectors themselves, but by local people who see harvest of these species as a means of making a living. Unfortunately not only are populations simply over-harvested, particularly in areas such as the lowland wet zone and central Sri Lanka, but rare species are often particularly sought after, simply due to their rarity. Many populations are so small that they have no capacity to tolerate such exploitation.

In the 1960-70ies large scale bulk exports and imports of *Cryptocoryne* species were common within the aquarium trade, many involving species which did not survive well in aquaria. This bulk gradually declined due to lack of interest from the import side. More recently, there has been an increase in internet trade with many new species being offered. It is to be expected that this new trend, mainly targeting more advanced aquarium keeping or collectors, will have a negative influence some species, particularly the more threatened *Cryptocoryne* populations.

5 STRATEGIC ACTION PLAN

5.1 Context

It has been possible to derive informed Red List assessments for almost all *Cryptocoryne* taxa based on available data, as can be seen from the fact that only eight taxa are classed as Data Deficient. However as is the case for many wetland-dependent plants, particularly in Asia and much of the southern hemisphere, only for a few taxa is available information adequate to prepare detailed conservation action plans and no data on *Cryptocoryne* populations are adequate to serve as a baseline for population monitoring. Therefore, alongside all recommendations for intervention or site and habitat protection must be seen an underlying need for quantified and replicable data to inform monitoring of population trends. There is also a need to identify areas which have potential to support previously unknown *Cryptocoryne* populations but have yet to be surveyed and to organise surveys of these.

In addition to collection of data suitable to serve as a baseline for monitoring population trends, the highest priority for *Cryptocoryne* conservation is protection of sites and habitats to prevent further habitat destruction and degradation. Effective protection of *Cryptocoryne* populations needs to involve:

1. Protection of specific sites and habitats where populations occur. These should serve as core areas to ensure that the populations themselves survive and ideally they should include extensive zones of natural habitat surrounding populations to serve as a buffer. It is important that such protected sites also enable prevention of collection of *Cryptocoryne* plants, i.e. enforcement of protection.
2. Watershed protection and reforestation. Ideally, protection of *Cryptocoryne* populations should include protection of the sources of water feeding water bodies in which the populations actually grow. In particular, where watersheds have been subject to logging, work should be undertaken to restore forest cover to the upper reaches of river catchments and to the watersheds. This can be linked to erosion control and measures to reduce risk of landslides.
3. Protection of buffer zones for water courses. Effective protection of water courses should include delineation of buffer zones within which logging and exploitation of natural resources should be prohibited or rigorously controlled. Such buffer zones need to be wide enough to enable natural ecosystem functioning and therefore 0.5-1 km wide. Such buffer zones will prevent factors such as release of sediment, nutrient and other pollutants into channels, increase of insolation of channels reducing the competitive ability of *Cryptocoryne* populations and enabling continuation of natural dynamism in forest wetlands.

Steps toward practical *in-situ* protection of *Cryptocoryne* populations have already been taken by Yayasan Konservasi Biota Lahan Basah at Nanga Pari and Nanga Mahap in Kalimantan. At these sites, critical core areas including populations of threatened *Cryptocoryne* taxa have been purchased and rangers employed both to enforce protection of the sites and to manage sustainable exploitation of forest products. This initiative has potential to ensure the long-term survival of threatened *Cryptocoryne* taxa whilst work can be undertaken to enable legal protection of surrounding buffer zones, as well as the sources of the water on which the populations depend.

There is a fundamental need for a change to approaches to land-use and management throughout the region. This must include legal definition of minimum working distances from water courses and water bodies, accompanied by realistic penalties for infringement.

Whilst there is a need for more information, particularly details of population size and status, for all *Cryptocoryne* species, it is clearly not possible to carry out all tasks for all taxa and it has been necessary therefore to identify priorities for conservation action. No action is proposed for the following species which are classed as Least Concern: *C. affinis*, *C. ciliata*, *C. ciliata* var. *ciliata*, *C. cordata*, *C. cordata* var. *cordata*, *C. cordata* var. *grabowskii*, *C. cordata* var. *siamensis*, *C. crispatula*, *C. crispatula* var. *albida*, *C. crispatula* var. *crispatula*, *C. crispatula* var. *tonkinensis*, *C. crispatula* var. *balansae*, *C. fusca*, *C. griffithii*, *C. matakensis*, *C. minima*, *C. nurii*, *C. nurii* var. *raubensis*, *C. retrospiralis*, *C. spiralis*, *C. spiralis* var. *spiralis*, *C. striolata*, *C. ×purpurea* nothovar. *purpurea* and *C. ×timahensis*.

5.2 Vision (30 years, global)

The overall vision of this Conservation Action Plan is that within the next thirty years, the following steps will have been achieved:

1. Protection will have been assured of:
 - All populations of *Cryptocoryne* taxa classed as Critically Endangered.
 - More than 50% of all populations of *Cryptocoryne* taxa classed as Endangered.
 - More than 30% of all populations of *Cryptocoryne* taxa classed as Vulnerable.
2. Populations will have been protected *in-situ* or where necessary, work will have been undertaken to assess potential for habitat restoration, combined with reintroduction.
3. Surveys will have been carried out to document all taxa, such that none are classed as Data Deficient.
4. A list will be available of all *Cryptocoryne* taxa available for sale, forming a market master list which can be compared to the list of wild populations.
5. The *ex-situ* material at Singapore Botanic Gardens, via the in-house facilities for *in vitro* propagation will have been made available for other *ex situ* sites, or reintroduction into *in-situ* facilities if necessary. With *ex-situ* and *in situ* conservation widely implemented, surplus material will have been made available for commercial exploits *pro bono* (or at low cost) to hinder wild collections.
6. *Cryptocoryne* taxa will only be considered to be threatened because of their intrinsic rarity and not because of direct threats to populations.

5.3 Goals (30 years, range-wide)

1. Funding will have been found to enable surveys of all threatened, Near Threatened and Data Deficient taxa either through specific project applications or through collaboration with other initiatives.
2. Funding will have been found to protect areas supporting concentrations of threatened *Cryptocoryne* taxa in central Sumatra, Sri Lanka, the Western Ghats, New Guinea and Kalimantan (the Schwaner Mountains and Kapuas Hulu Regency).
3. The ecology and conservation of *Cryptocoryne* species, as well as other little-known wetland-dependent plant species, will be more widely understood and recognised throughout the botanical and conservation communities.
4. Monitoring protocols will have been developed for threatened *Cryptocoryne* and will be implemented within ongoing botanical survey and reporting protocols.

5.4 Actions (5 years)

5.4.1 Introduction

The approach taken here is to try to identify a suite of projects which, if carried out, could significantly reduce the overall threat status of the genus by addressing the conservation needs of most Critically Endangered taxa within five years. The main emphasis is on consolidating the existing information baseline and moving it from a taxonomic and descriptive nature to the type of information needed to undertake conservation action on the ground.

One high priority in all regions is to assess the extent to which the existing protected area network could serve to protect threatened *Cryptocoryne* taxa, what modifications might be needed for the protection to be effective for *Cryptocoryne* taxa and whether there are cases where relatively minor adjustments to existing protected areas could address the conservation needs of threatened *Cryptocoryne* taxa. Specific protected areas supporting known populations include Khao Sok NP in Thailand

(*C. crispatula* var. *flaccidifolia*, Kubah National Park in Kalimantan (*C. ferruginea* var. *ferruginea*), Lanjak Entimau Wildlife Sanctuary in Sarawak (*C. auriculata*), Betung Kerihun National Park in Kapuas Hulu (*C. auriculata*), Leuser National Park in Sumatra (*C. wongsoi*), Bukit Timah Nature Reserve in Singapore (*C. ×timahensis*), Panti Recreational Forest in Peninsular Malaysia (*C. cordata* var. *cordata*, *C. nurii* var. *nurii*, *C. schulzei* and *C. ×decus-silvae*), Pondok-Tanjung, Gunung Bongsu and Bukit Panchor Forest Reserves in Peninsular Malaysia (*C. elliptica*), Taman Negara in Peninsular Malaysia (*C. affinis*, *C. nurii* var. *raubensis*) and Yod Dome Wildlife Sanctuary in Vietnam (*C. crispatula* var. *kubotae*). There are also protected sites in the vicinity of populations of threatened taxa such as Bodhingala Forest Reserve and Walauwewaththa Wathurana freshwater swamp forest, Bulathsinghala in Sri Lanka (*C. alba* and *C. waseri*) and a site in Eastern Province in Sri Lanka (*C. nevillei*) which need to be surveyed in case threatened taxa occur within the protected area boundaries. There is a need to ensure that the small Gunong Bongsu area, Forest Growth Trial Center, Kampung Pegawai, Pahau in Kedah State, Malaysia will continue to be protected.

5.4.2 Ex-situ cultivation

Since at least the 1970s, specialists carrying out research into the genus such as Jan Bastmeijer, Josef Bogner, Niels Jacobsen and Suwidji Wongso, have gathered together collections of representatives of all known species, varieties and hybrids. This material has been used to study the morphology and genetics of different taxa to enable clarification of the taxonomy of the genus, but has to-date been mainly held in private collections. In 2020 Singapore Botanic Gardens expressed an interest in hosting a living *ex-situ* collection of *Cryptocoryne* taxa and work is currently in place to establish this collection.

The aim of the collection is three-fold:

1. To provide a resource for re-introduction and augmentation of wild populations.
2. To provide a resource for cultivation and sale of material.
3. To provide material for research.

Many *Cryptocoryne* taxa are widely available in cultivation, however some are rare and difficult to obtain such that there is still heavy pressure on wild populations from over-collection for horticulture. One possible benefit of an *ex-situ* collection is to provide material for work to enable gel-tissue culture such that large quantities of the rare taxa can be made available to horticultural trade, in the hope of relieving this collection pressure.

Another possible use of material from the *ex-situ* collection is to restore or augment wild populations if this is considered to be a useful conservation tool. However, it is important to recognise that *ex-situ* conservation is only of value, from a conservation perspective, if there is a prospect, however remote, of restoration of habitats to a stage where re-introduction is a plausible option. Thus, *ex-situ* conservation should only ever run in tandem with *in-situ* conservation action. The highest priority should be to focus on preservation of populations in their natural habitat, however degraded that may be.

Where populations have been destroyed and *in-situ* conservation is not possible, at known localities, restoration from *ex-situ* collections should be explored. The key is to engage stakeholders to take responsibility, whatever the land use, in allocating a percentage of land to restoration of the conservation potential of the site and implementing reintroduction. For example, urban development, pepper and palm oil industries are regulated for sustainability for certification/quality assurance/risk management purposes. Under Corporate Social Responsibility the stakeholders can be engaged in conservation work for funding, site allocation and management, monitoring and also to participate in the carbon economy for climate change mitigation. Working in tandem with governments, NGOs, landscape designers /architects, universities, botanic gardens and many other like-minded institutions, stakeholders, who are often seen as damaging habitat, can contribute instead in many ways. Such collaborations could benefit *ex/in-situ* conservation and reintroductions alike. Where possible, these collaborations shall be explored.

5.4.3 Conservation of *Cryptocoryne* taxa in Borneo

This proposal is for a regional project to address the conservation needs of *Cryptocoryne* taxa in Borneo: (Brunei Darussalam, Indonesia [Kalimantan] and Malaysia [Sabah, Sarawak]). The first action required

is a desk study, ideally to be carried out in collaboration with the relevant government departments, as follows:

1. Review of land-use cover and land-ownership in relation to the precise distribution of all known populations of threatened taxa.
2. Review of protected areas in relation to the precise distribution of all known populations of threatened taxa. Assessment of the degree and nature of protection afforded to *Cryptocoryne* populations by the designation and the proportion of the global population of each threatened taxon in relation to the threat class assigned. Also assessment of the capacity of the existing protected areas network for protection or even restoration of the hydrological systems on which the taxa depend.
3. Review of information available on existing and proposed concessions for industrial use, urban development, industrial-scale plantations etc.
4. Review of other existing and proposed conservation initiatives (such as for other plant and animal taxa), as well as the known distribution of other threatened or potentially threatened taxa (e.g. *Bucephalandra* species in the Sekadau area).
5. Identification of small areas which could be purchased to serve as keystone sites for protection of species, groups of species or the hydrological resource on which populations of threatened taxa depend.

This series of reviews needs to produce a considered account of potential threats to all known populations, potential for the existing protected areas network to protect populations and potential to extend the existing protected areas network to cover sites and the water sources on which they depend. This desk study should also enable identification of areas for watershed protection or re-afforestation. The highest priorities for this work are the groups of taxa occurring in the Schwaner Mountains and in Kapuas Hulu Regency.

At the same time, surveys are needed to map and document known populations to collect the information necessary for preparation of credible site and area-specific conservation action plans. These surveys should also ensure that information available provides a credible overview of the distribution and extent of populations of each taxon as follows:

1. Map the extent of the population and identify the source of water for the wetland supporting the population.
2. Establish who owns the land supporting the species, the water source and any hydrological systems in-between, as well as any organisations/individuals with direct influence over the water courses identified.
3. Assess potential for legislative or practical protection of the area supporting populations and associated water bodies outlined in 2. Protection must include potential to control collection and must apply to existing, as well as proposed protected areas.

The data obtained through desk study and field surveys needs to be used to develop a plan for conservation of *Cryptocoryne* taxa in the area covered. This plan should involve relevant governmental organisations and detail specific actions to enable protection of known *Cryptocoryne* populations.

5.4.4 Conservation of *Cryptocoryne* in South-west Sri Lanka

This proposal is for a regional project to address the conservation needs of *Cryptocoryne* taxa in south-western Sri Lanka. This includes: *C. alba*, *C. beckettii*, *C. bogneri*, *C. parva*, *C. thwaitesii*, *C. undulata*, *C. walkeri*, *C. waseri* and *C. ×willisii*. This proposal should be considered in tandem with the proposal for *Cryptocoryne bogneri* (Chapter 5.4.19).

The first action required is a desk study, ideally to be carried out in collaboration with the relevant government departments, as follows:

1. Review of land-use cover in relation to the precise distribution of all known populations of threatened taxa.
2. Review of protected areas in relation to the precise distribution of all known populations of threatened taxa. Assessment of the degree and nature of protection afforded to *Cryptocoryne* populations by the

- designation and the proportion of the global population of each threatened taxon affected in relation to the threat class assigned. Also assessment of the capacity of the existing protected areas network for protection or even restoration of the hydrological systems on which the taxa depend.
3. Identification of small areas which could be purchased to serve as keystone sites for protection of species, groups of species or the hydrological resource on which populations of threatened taxa depend.

This series of reviews needs to produce a considered account of potential threats to all known populations, potential for the existing protected areas network to protect populations and potential to extend the existing protected areas network to cover sites and the water sources on which they depend. There is also a need to identify areas for watershed protection or re-forestation.

At the same time, surveys are needed to map and document known populations to collect the information necessary for preparation of credible site and area-specific conservation actions plans and to ensure that available information provides a credible overview of the distribution and extent of populations of each taxon.

1. Map the extent of the population and identify the source of water.
2. Establish who owns the land supporting the species, water source and any hydrological systems in-between, as well as any organisations/individuals with direct influence over the water courses identified.
3. Assess potential for legislative or practical protection of the area supporting populations and associated water bodies outlined in 2. Protection must include potential to control collection and must apply to existing, as well as proposed protected areas.
4. Work with government to enable legal commercial propagation of plants for sale, to undermine illegal markets in threatened species.

The data obtained through desk study and field surveys needs to be used to develop a plan for conservation of *Cryptocoryne* taxa in the area covered. This plan should involve relevant governmental organisations and detail specific actions to enable protection of known *Cryptocoryne* populations.

5.4.5 Conservation of *Cryptocoryne* in the Mahaweli-Ganga System in central Sri Lanka

At least five *Cryptocoryne* taxa are known from the main channel of the Mahaweli-Ganga system near Kandy: *C. beckettii*, *C. parva*, *C. undulata*, *C. walkeri* and *C. ×willisii*. Whilst there are anecdotal reports of some of these taxa forming extensive stands, populations of all of these taxa are severely threatened by works related to hydrological modification of the river system, illegal encroachment on river banks and uncontrolled waste disposal (Moonasingha 1991, Yakandawala 2012). The potentially clonal nature of many taxa, combined with relatively local distribution, means that even relatively minor interventions, such as weirs and dams, can have a significant effect on even quite large stands. Whilst there do not appear to be any data to demonstrate direct loss of populations due to construction along the river channel, it is likely that existing dams will already have led to the loss of some populations.

There is an urgent need to carry out surveys of major channels of the Mahaweli-Ganga system, at least from Getambe to the upstream limits of influence of the Victoria Reservoir and throughout much of the length of the Amban Ganga, to map all *Cryptocoryne* populations. This should enable development of a map of priority river sections for protection of *Cryptocoryne* populations. Ideally, surveys should map all potentially threatened aquatic and wetland plants along these channels to maximise data availability. This work should be carried out in collaboration with the relevant government departments.

5.4.6 Conservation of *Cryptocoryne* in Central Sumatra (Indonesia)

This proposal is for a regional project to address the conservation needs of *Cryptocoryne* taxa in central Sumatra, Indonesia. This includes: *C. cordata* var. *diderici*, *C. cordata* var. *wellyi*, *C. nurii* var. *nurii*, *C. scurilis*, *C. villosa*, *C. ×ardyi*, *C. ×jambiensis* and *C. ×zukalii* nothovar. *sumateraensis*.

The first action required is a desk study, ideally to be carried out in collaboration with the relevant government departments, as follows:

1. Review of land-use cover in relation to the precise distribution of populations of all known populations of threatened taxa.
2. Review of protected areas in relation to the precise distribution of populations of all known populations of threatened taxa. Assessment of the degree and nature of protection afforded to *Cryptocoryne* populations by the designation and the proportion of the global population of each threatened taxon in relation to the threat class assigned. Also assessment of the capacity of the existing protected areas network for protection or even restoration of the hydrological systems on which the taxa depend.
3. Identify small areas which could be purchased to serve as keystone sites for protection of species, groups of species or the hydrological resource on which populations of threatened taxa depend.

This series of reviews needs to produce a considered account of potential threats to all known populations, potential for the existing protected areas network to protect populations and potential to extend the existing protected areas network to cover sites and the water sources on which they depend. There is also a need to identify areas for watershed protection or re-afforestation.

At the same time, surveys are needed to map and document known populations to collect the information necessary for preparation of credible site and area-specific conservation action plans and to ensure that information available provides a credible overview of the distribution and extent of populations of each taxon as follows;

1. Map the extent of the population and identify the source of water.
2. Establish who owns the land supporting the species, water source and any hydrological systems in-between, as well as any organisations/individuals with direct influence over the water courses identified.
3. Assess potential for legislative or practical protection of the area supporting populations and associated water bodies outlined in 2. Protection must include potential to control collection and must apply to existing, as well as proposed protected areas.

There is also a need for further surveys to try to locate previously undescribed taxa.

The data obtained through desk study and field surveys needs to be used to develop a plan for conservation of *Cryptocoryne* taxa in the area covered. This plan should involve relevant governmental organisations and detail specific actions to enable protection of known *Cryptocoryne* populations.

5.4.7 Conservation of *Cryptocoryne* in North-west Sumatra (Indonesia)

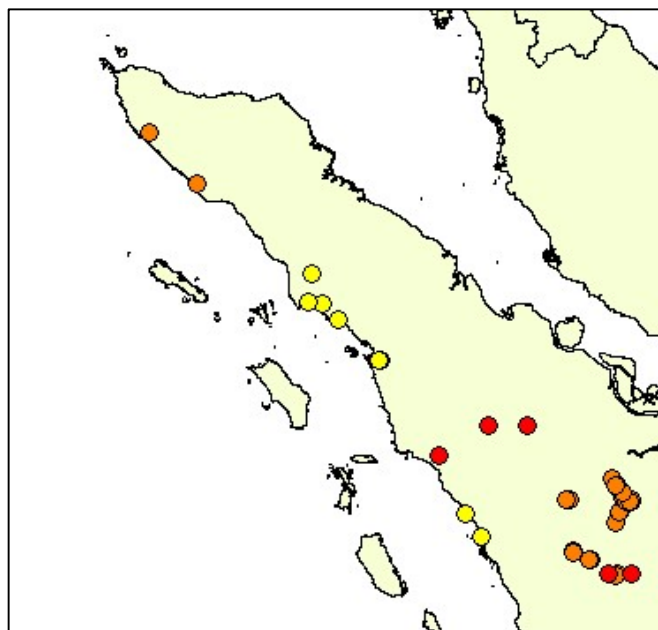


Figure 5.1 The distribution of threatened *Cryptocoryne* taxa in north-western Sumatra

Three threatened *Cryptocoryne* species are known only from north-west Sumatra: *C. moehlmannii*, *C. pontederiifolia* and *C. wongsoi* (Figure 5.1). There is limited overlap between the distribution of these species and no two species are known from precisely the same sites. However, there is a logic to addressing the conservation needs of these species together. As is the case with most *Cryptocoryne* taxa, there is also a need for thorough surveys of potentially suitable habitat in lowland areas of north-west Sumatra to try to establish a comprehensive account of

the distribution of these species, together with an assessment of the conservation condition of each population.

Once a reasonable overview of the distribution of these three taxa has been acquired, there is a need for a desk study to review protected areas (such as Gunung Leuser National Park) in relation to the precise distribution of populations of all known populations of these three species. This must include an assessment of the degree and nature of protection afforded to *Cryptocoryne* populations by the designation and the proportion of the global population of each threatened taxon in relation to the threat class assigned. There is also a need for an assessment of the capacity of the existing protected areas network for protection or even restoration of the hydrological systems on which the taxa depend.

There is also a need for further surveys to attempt to locate previously undescribed taxa.

The data obtained through desk study and field surveys needs to be used to develop a plan for conservation of *Cryptocoryne* taxa in the area covered. This plan should involve relevant governmental organisations and detail specific actions to enable protection of known *Cryptocoryne* populations.

5.4.8 Conservation of *Cryptocoryne* in the Philippines

Recent surveys have shown that there is a need for further taxonomic work on the genus in the Philippines. For each of the known populations, there is a need to:

1. Map the extent of the population and identify the source of water.
2. Establish who owns the land supporting the species, water source and any hydrological systems in-between, as well as any organisations/individuals with direct influence over the water courses identified.
3. Assess potential for legislative or practical protection of the area supporting populations and associated water bodies outlined in 2. Protection must include potential to control collection and must apply to existing, as well as proposed protected areas.

The data obtained through desk study and field surveys needs to be used to develop a plan for conservation of *Cryptocoryne* taxa in the area covered. This plan should involve relevant governmental organisations and detail specific actions to enable protection of known *Cryptocoryne* populations.

5.4.9 Conservation of *Cryptocoryne* on the River Mekong

The River Mekong flows for nearly 5,000 km, from the Tibetan plateau in China to the South China Sea, passing through China, Cambodia, Laos, Myanmar, Thailand and Vietnam. In areas where the river flows through Laos, Cambodia, Thailand and Vietnam it supports four threatened *Cryptocoryne* taxa: *C. crispatula* var. *decus-mekongensis*, *Cryptocoryne crispatula* var. *yunnanensis*, *C. loeensis* and *C. mekongensis*. The main threat to these species is the proposed construction of large-scale hydroelectric dams on the main stem and tributaries of the river (Figure 5.2).

Many organisations are working to try to reduce the impact of dams and other hydrological modifications on the River Mekong. The aim of this project is to obtain precise data on specific threats to *Cryptocoryne* taxa to help inform work by other organisations, as well as to address other specific threats to *Cryptocoryne* taxa such as over-grazing. Actions required are:

1. Document the precise range and distribution of *Cryptocoryne* taxa on the Mekong and its tributaries, in a way which will enable other conservation organisations to take the threats to *Cryptocoryne* taxa into account in their work. Initially this should involve a desk study, but the desk study should be carried out in combination with surveys to consolidate the existing baseline of distribution data for these taxa.
2. Review the distribution of populations of threatened *Cryptocoryne* taxa and compare with the distribution and predicted extent of impact of proposals for dam construction.
3. Publicise the information either through popular articles or by production of report which can be distributed to relevant conservation organisations. This should contribute to the designation of high profile conservation areas such as Key Biodiversity Areas.

There is also a need to address the threat to some taxa of over-grazing by cattle during the dry season when water levels are low. It may be that the best approach to this is to work with local people to try to establish exclusion zones to protect specific populations.

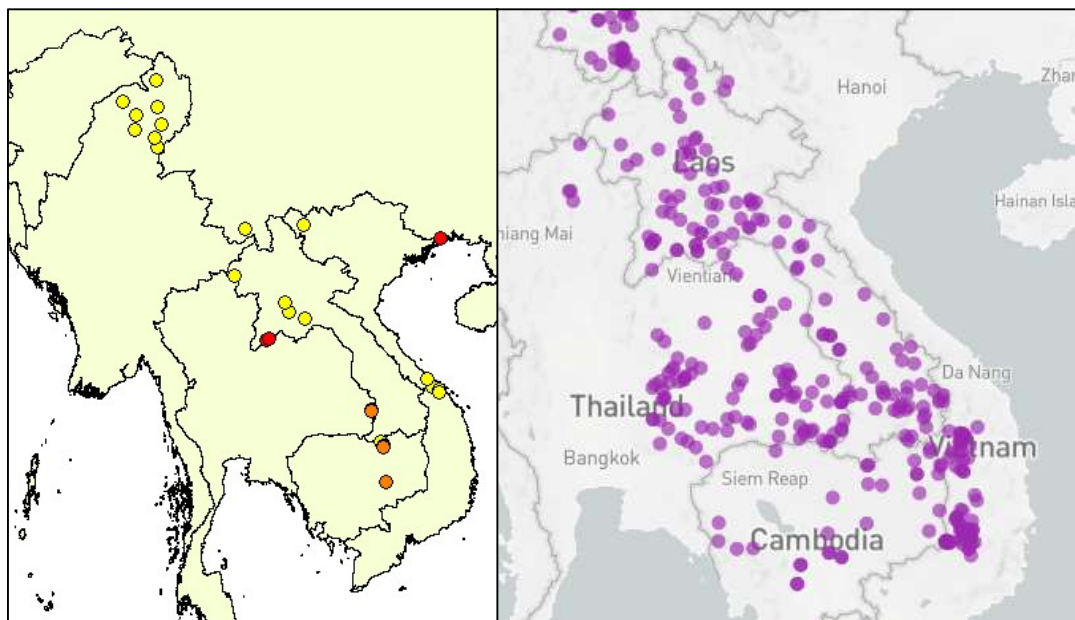


Figure 5.2 Left: the distribution of threatened *Cryptocoryne* taxa in the region; Right: the distribution of hydropower dams in the Greater Mekong Subregion (courtesy of Map for Environment)

The data obtained through desk study and field surveys needs to be used to develop a plan for conservation of *Cryptocoryne* taxa in the area covered. This plan should involve relevant governmental organisations and detail specific actions to enable protection of known *Cryptocoryne* populations.

5.4.10 Conservation of *Cryptocoryne* in Vietnam

Two *Cryptocoryne* species occur in Vietnam away from the Mekong and its tributaries. *C. annamica* has been reported from a number of sites, but some reports are unconfirmed and the true status of the species is unclear. *C. vietnamensis* has been reported from two sites in the centre of the country in streams and rivers in lowland forest.

There is a need for surveys to visit known populations to document their current conservation condition and collect data to form a baseline for population trend monitoring. These surveys should be combined with surveys of potentially suitable habitat in the area to locate previously unknown populations.

Data collected through surveys should be compared with information on the distribution and extent of protected areas to enable an assessment of the extent to which the existing protected area network may include these two species.

The data obtained through desk study and field surveys needs to be used to develop a plan for conservation of *Cryptocoryne* taxa in the area covered. This plan should involve relevant governmental organisations and detail specific actions to enable protection of known *Cryptocoryne* populations.

5.4.11 Conservation of *Cryptocoryne* in Peninsular Malaysia

Three *Cryptocoryne* taxa are found within the boundaries of Panti Recreational Forest in Johor State in West (Peninsular) Malaysia. Whilst the protection afforded by the status of the site should ensure the survival of *Cryptocoryne* populations, there are anecdotal accounts of both illegal logging and extraction of river sand from the reserve. There is an urgent need to survey the site to establish whether the reports

of natural resource exploitation are accurate and if so, whether *Cryptocoryne* populations are being affected. If they are, then comprehensive documentation is needed to inform the relevant government departments and support efforts to control or stop the exploitation. There is also an urgent need for surveys to attempt to locate extant populations of *C. × griffithioides* (see also 5.4.15), *C. × schulzeioides* and *C. × zukalii* nothovar. *zukalii*.

5.4.12 Conservation of *Cryptocoryne* in the Western Ghats (India)

Four threatened *Cryptocoryne* taxa and two varieties of *C. spiralis* which are classed as Data Deficient occur on the west coast of India (Figure 3.12). Most populations occur in ancient cultural landscapes which have been subject to varying degrees of modification for centuries. At least initially, the main action needed for conservation of these taxa is to survey and document populations, including an assessment of potential threats. It will also be important to assess the extent to which the existing protected areas network can serve to protect populations, as well as whether there is a need to modify existing protected areas or potentially designate new sites.

5.4.13 Conservation of *Cryptocoryne* in New Guinea (Papua New Guinea, West Papua)

Three threatened *Cryptocoryne* taxa are known from the island of new Guinea: *C. dewitii*, *C. versteegii* var. *jayaensis* and *C. versteegii* var. *versteegii*. All three are threatened both by the effects of mining and clearance of lowland forest; none are particularly well-known.

The most urgent actions for these three taxa are:

1. Collaboration with the relevant government departments to protect known populations, including assessment of past and ongoing effects of mining and potential measures to control these.
2. Surveys to locate additional populations of these taxa throughout the areas in which populations have been found, to assess the extent to which populations are under threat

The results of surveys should be used to inform designation of protected areas for these taxa, as well as measures to control the effects of mining, such as establishment of effective settling and treatment basins before discharge to natural water courses.

5.4.14 Conservation of *Cryptocoryne crispatula* var. *planifolia*

C. crispatula var. *planifolia* was known from a single site on a tributary of the Beilun River in the extreme south of Guangxi Province in southern China, close to the border with Vietnam. However, recent surveys have failed to find any plants and this variety is now considered to be extinct in the wild. Two populations were known from a small stream in secondary forest consisting of artificially planted pine trees and bamboos growing along the stream. Whilst there is fairly extensive remnant forest in the area, forest and wetland habitats in southern China are highly threatened both by direct destruction, such as deforestation and development, as well as to the secondary effects of these actions and to urbanisation. It is not clear whether there has been much survey in the area which would be likely to locate populations of this variety.

The overall aim of the project is to establish protection for the area where populations were known, combined with surveys to search for populations. The success of this project may depend upon support from the relevant government departments.

1. Survey the area formerly supporting the known population, as well as areas of potentially suitable habitat in the area.
2. Map the extent of any populations found, identify the source of water to the stream(s) where it grows. If no populations can be found, the following needs to be applied to areas where it formerly grew.
3. Establish whether there are existing plans or permits for development of the area supporting *C. crispatula* var. *planifolia* or the catchment of the stream where it grows. Contact local people to assess the likelihood of development of this area without increasing the risk of over-collection by drawing attention to the variety and its rarity.

4. Establish who owns land supporting or formerly supporting *C. crispatula* var. *planifolia*, the water source and any hydrological systems in-between, as well as any organisations/individuals with direct influence over the water courses identified.
5. Assess potential for legislative or practical protection of the area supporting populations and associated water bodies outlined in 4. Protection must include potential to control collection and must apply to existing, as well as proposed protected areas.

The overall aim is to establish a protected area including the area formerly supporting *C. crispatula* var. *planifolia* and the catchment of the stream in which it grew, with the aim of reintroduction if appropriate. It would be beneficial to identify local conservation organisations which might be in a position to purchase the immediate area supporting remaining populations to ensure the survival of the species while work to establish a protected area continues.

5.4.15 Conservation of *Cryptocoryne ×griffithioides*

Cryptocoryne ×griffithioides has been recorded from three accessions in southern Peninsular Malaysia. It has not been confirmed at any of the sites in recent years and the areas from which it was recorded have mainly been converted to industrial plantations. The main action needed for this hybrid is to survey potentially suitable habitat in an attempt to locate surviving populations. If any populations are found there is a need to try to establish formal protection of the sites and water sources, either through legislation or by land purchase.

5.4.16 Conservation of *Cryptocoryne noritoui*

Cryptocoryne noritoui is currently known from a single site in Berau District in East Kalimantan, with two former populations having been lost to development of settlements. It grows in springs and the upstream reaches of forested streams arising from karstic limestone, in an area with numerous springs and underground rivers. It is threatened by a number of factors, including modification of springs for water supply, commercial collection, illegal logging and lime quarrying. Habitats in the area were also damaged in the fires of 1982-83 and 1997-98. Much of the remaining forest in the area has been allocated for industrial plantation.

The main aim of the project is to protect the site, habitat and water source for the remaining population, combined with surveys to attempt to locate other populations. The success of this project may depend upon support from the relevant government departments.

1. Map the extent of the population, identify the source of water to the stream or river where it grows.
2. Identify any concessions allocated to the area supporting *C. noritoui* or the catchment of the stream where it grows and establish whether there is capacity for these to be revised to reduce potential adverse effects on *C. noritoui*.
3. Establish who owns the land supporting the species, water source and any hydrological systems in-between, as well as any organisations/individuals with direct influence over the water courses identified.
4. Assess potential for legislative or practical protection of the area supporting populations and associated water bodies outlined in 3. Protection must include potential to control collection and must apply to existing, as well as proposed protected areas.

The overall aim is to establish a protected area including the area supporting *C. noritoui* and the catchment of the stream or river in which it grows. It may be necessary for an organisation such as Yayasan Konservasi Biota Lahan Basah to attempt to purchase the immediate area supporting remaining populations to ensure the survival of the species while work to establish wider protected areas continues.

5.4.17 Conservation of *Cryptocoryne uenoi*

Cryptocoryne uenoi is known only from the river system at Sabal Keruing in Sarawak (east Malaysia), where it occurs at the upstream limits of tidal influence and in the Kapuas Hulu Regency, in the eastern part of West Kalimantan. All the sites in Sarawak supporting known populations of this species have

been badly disturbed by human activities including logging and forest clearance for oil palm plantations, as well as cutting trees for a power line. There is an urgent need for surveys to establish a current assessment of the conservation status of this species combined with work to establish protection for all extant populations. This project should be linked to the proposal in Chapter 5.4.3.

5.4.18 Conservation of *Cryptocoryne zaidiana*

Cryptocoryne zaidiana is known only from Sungai Mering near Tinjar in Miri Division, Sarawak (East Malaysia) where it occurs in slow-flowing forest rivers. The northern population is in reasonably intact forest; however the southern population is in an area where the forest was cleared in the 1980s and converted to rice fields, but in 2005 was described as “earmarked for oil palm plantation” (Ipor *et al.* 2005). In the past (and possibly to this day), the river was fished by “mansai”, a method using a round net to scoop up fish from the shallows. This apparently disturbed the substrate, with a potentially damaging effect on this species.

There is an urgent need to survey all known populations to derive an up-to-date assessment of their conservation status, combined with surveys to try to locate additional populations in the region from which it has already been recorded and over a wider area. There is also a need for a review of protected areas in relation to the precise distribution of all known populations of *C. zaidiana*. This needs to be combined with an assessment of the degree and nature of protection afforded to this species by existing designations, together with assessment of the capacity of the existing protected areas network for protection or even restoration of the hydrological systems on which the taxa depend.

5.4.19 Conservation of *Cryptocoryne bogneri*

Assessment of the conservation condition of existing populations of *C. bogneri*, to identify its conservation needs and to initiate action for its conservation. This project should be linked to the project No. 5.4.4.

1. To document the size and conservation condition of known populations of *C. bogneri*, with particular regard to existing and potential threats.
2. To survey potentially suitable habitat within the known range of *C. bogneri* to search for additional populations and to provide the first global conservation assessment of the species and the habitat on which it depends.
3. Using the results of 1 and 2 (above), prepare a conservation plan both for individual populations and for the global population, including consideration of:
 - Formal site protection.
 - Site management, such as establishment of buffer zones between agriculture and streams.
 - Ex-situ conservation, through establishment of tissue culture by a Sri Lankan organisation.

Each of the known populations of *C. bogneri* will be visited and a conservation assessment will be prepared, documenting:

- The size and distribution of the known population, including recording a baseline for population monitoring.
- Botanical, hydrological and physical characterisation of the habitat in which the population occurs.
- The condition of the habitat in the area supporting the population, including the wider area.
- Existing and potential threats, including their potential to act on the population.

Once data have been collected on known populations, the results will be used to identify sites and areas of potentially suitable habitat within the known range of the species. These will then be surveyed to search for additional populations. If more populations are found, then a similar data-set will be collected from each of these as will be collected from the known populations.

Other actions will depend on the results of the field surveys and conservation assessment. The possibility of involving local people, in collaboration with government and non-governmental organisations in protection of populations will be investigated. However, this possibility must be approached with caution due to the risk of commercial collection of this species.

5.4.20 Conservation of *Cryptocoryne ×hendrae*

Cryptocoryne ×hendrae is endemic to southern Kalimantan, where it is known only from the type locality. There is an urgent need for surveys to establish a current assessment of the conservation status of this hybrid as it is believed now to be extinct in the wild. If any populations are found there is a need to try to establish formal protection of the sites and water sources, either through legislation or by land purchase.

The data obtained through desk study and field surveys needs to be used to develop a plan for conservation of *Cryptocoryne* taxa in the area covered. This plan should involve relevant governmental organisations and detail specific actions to enable protection of known *Cryptocoryne* populations. If no extant populations are found, consideration should be given to potential for reintroduction.

5.4.21 Conservation of *Cryptocoryne nevillei*

Cryptocoryne nevillei is endemic to a small area in Eastern Province on the east coast of Sri Lanka. It is known from four scattered sites in seasonally inundated marshes and lagoons. It is threatened by factors such as development of tourist facilities and by conversion of coastal wetlands to aquaculture, as well as the secondary effects of these factors, such as hyper-eutrophication of coastal wetlands and casual habitat degradation of coastal habitats due to recreational use. Ironically, some populations of *C. nevillei* may have been afforded some degree of protection by the fear of unexploded land mines in the coastal fringe.

There is an urgent need for surveys to assess the conservation condition of all known populations, combined with surveys of potentially suitable habitat to locate additional populations. Parts of the coastal fringe, including parts of some lagoons are already protected as nature reserves. One of the first elements of this project is to compare the distribution of known populations of *C. nevillei* and those discovered through surveys outlined here with these protected areas and assess a) the extent to which known populations may already have some degree of protection and b) whether existing protected areas could be modified slightly to cover known populations.

Once these surveys and review have been completed, conservation organisations need to work together with government departments to establish protection for areas which support *C. nevillei*. This protection must include measures to prevent over-collection.

5.5 Monitoring

The degree to which most populations appear to be composed of genetically identical individuals due to clonal spread by stolons (except for a few taxa which are not stoloniferous) suggests that counts of plants are unlikely to be useful and it is likely that some degree of taxon-specific design of monitoring protocols will be needed. However, if the aim is to measure the resilience of a taxon to a diverse range of threats, then it is clear that a measure of the number of stands occurring on water courses which derive from different sources or even catchments, combined with a measure of the number of stands occurring on land in different management or ownership will provide at least a basic measure of population resilience.

In most cases, monitoring protocols need to be species-specific, designed to record data which provide a meaningful indication of the condition of populations in a particular species. However, there are a number of fundamental principles which should apply to monitoring of all *Cryptocoryne* populations:

- A. Population size. As most, if not all, species form clonal stands, it is unlikely that counts of individual plants or area occupied will be meaningful. Two measures of population size are likely to provide the best indication of the condition and resilience of populations:
 1. The number of populations occurring on water bodies which could not be affected by a single action. This measure correlates with the definition of “locations” by IUCN (IUCN 2012) and is intended as a measure of the risk that a single action could eliminate different combinations of what might otherwise be considered to be different populations.
 2. The number of discrete stands. This too should provide a measure of the resilience of populations, although it is likely that only a difference in the order of magnitude of number of stands would confer any real advantage.

- B. Reproductive capacity. There is no information on the relative importance of sexual reproduction, as opposed to vegetative reproduction for *Cryptocoryne* species, varieties or hybrids, but this is likely to vary between taxa. It is also a difficult character for which to collect replicable data, as the number of flowers at any given time is strongly influenced by factors such as water levels. While it is often easy to count flowers, it is more difficult to establish the proportion of flowers which result in development of viable seed. However, for species and varieties, it may be useful to at least record the presence of flowers.

There is therefore a need to record the following data for all populations visited:

- Location (using a GPS).
- Water body type.
- Number of discrete stands (separated from each other by an area of wetland with no plants).
- Whether different stands are on the same water body/water course as other populations.
- Whether flowers are present.
- Salinity/pH/temperature etc
- Presence/absence/extent of canopy cover

Photographs should also be taken of each stand to assist in comparison between recording visits.

Additional information such as on substrate-type, habitat character etc. will always be useful but are less important for monitoring purposes. Any additional information, such as evident threats to the population, should also be recorded.

BIBLIOGRAPHY

- Ara, H. 2001 An Annotated Checklist of Aroids of Bangladesh. Bangladesh Journal of Plant Taxonomy 8(2): 19-34.
- Ara, H. 2016 Taxonomic studies in the family Araceae from Bangladesh. PhD thesis, University of Dhaka.
- Asih, N.P.S., Wongso, S., Hendrik, J.D., Bastmeijer, J.D., Reitel, S., Jensen, K.R., Ørgaard, M. and Jacobsen, N. 2022. New *Cryptocoryne* (Araceae) from West Kalimantan, Indonesia. Aroideana 45(1): 296-312.
- Babics, P. 2011 *Cryptocoryne nevillii* Trimen ex Hook.f., eine (fast) vergessene Rarität aus Sri Lanka. Aqua Planta 36 (3): 90-95.
- Bastmeijer, J.D. 2000. Looking for *Cryptocoryne aponogetifolia* in the Philippines. Planted Aquaria, Summer 2000 edition
- Bastmeijer, J.D. 2002 *Cryptocoryne yujii* Bastmeijer (Araceae), eine neue Art aus Sarawak. Aqua Planta 27(4): 145-146.
- Bastmeijer, J.D. and Duyfjes, B.E.E. 1997 Zwei *Cryptocorynen* aus dem Gunung-Leuser-Nationalpark (Sumatra, Indonesien). Aqua-Planta 2(2): 43-50.
- Bastmeijer, J.D. and Morco, H. 2000 *Cryptocoryne pygmaea* Merrill (Araceae) von Busuanga und Palawan (Philippinen). Aqua Planta 25(3): 99-107.
- Bastmeijer, J.D. and Kiew, R. 2001 A New *Cryptocoryne* Hybrid (Araceae) from the Bukit Timah Nature Reserve, Singapore. Garden's Bulletin Singapore 53: 9–17.
- Bastmeijer, J.D. and Jacobsen, N. 2007 *Cryptocoryne bangkaensis* Bastmeijer, ein neuer Name für eine gut bekannte *Cryptocoryne* von Sumatra (Indonesien). Aqua-Planta 32(2): 41, 44-55.
- Bastmeijer, J.D. and van Wijngaarden, P. 1999. *Cryptocoryne coronata* Bastmeijer and van Wijngaarden spec. nov. (Araceae), eine neue Art von den Philippinen. Aqua Planta 24(1): 23-28.
- Bastmeijer, J.D., Budianto, H., Ipor, I.B., Ørgaard, M. and Jacobsen, N. 2016 *Cryptocoryne wongsoi* (Araceae), a new species from Sumatera, Indonesia. Aroideana 39(2): 4-14.
- Bastmeijer, J.D., Idei, T., Jacobsen, N., Ramsdal, A.M. and Sookchaloem, D. 2010 Notes on *Cryptocoryne* (Araceae) of Thailand, including a new species from Loei Province. Thai Forest Bulletin (Botany) 38: 170-183.
- Bastmeijer, J.D., Kishi, H., Takahashi, N., Wongso, S. and Jacobsen, N. 2013 Eine neue varietät der *Cryptocoryne ferruginea* Engl. von Sekadau, West Kalimantan, Indonesien. Aqua-Planta 38(3): 84-93.
- Bastmeijer, J.D., P. Babics and C. Kettner, 2012. Eine neue *Cryptocoryne*-Art (Araceae) aus Sri Lanka (Ceylon). Aqua Planta 37(2): 50-59.
- te Beest, M. 1998 A Taxonomic Study of the Genus *Cryptocoryne* (Araceae) of South India. University of Calicut.
- Blatter, E. and McCann, C. 1931 Revision of the flora of the Bombay Presidency, Part 15: Araceae. Journal of the Bombay Natural History Society 35 13–31.
- Bogner, J. 1984 *Cryptocoryne usteriana* Engler und *Cryptocoryne aponogetifolia* Merrill. Aqua-Planta 9 (4): 7-13.
- Bogner, J. 2004 *Cryptocoryne sivadasanii* (Araceae), a new species from India. Willdenowia 34(1): 195-201.
- Bogner, J. 2009 *Cryptocoryne cruddasiana* Prain, eine endemische Art aus Myanmar (Burma). Aqua Planta 34(1): 4-13.
- Bogner, J. 2013 Eine neue Varietät der *Cryptocoryne spiralis* (Retzius) Fischer ex Wydler (Araceae) aus Indien. Aqua Planta 38(4): 141-148.
- Budianto, H. and Bastmeijer J.D. 2004 Eine neue *Cryptocoryne*-Art (Araceae) aus Kalimantan (Indonesien). Aqua Planta 29(4): 124-130.
- Chandore A. 2010 Floristic studies on monocotyledons of Belgaum district PhD Thesis, Shivaji University, Kolhapur, India: <http://hdl.handle.net/10603/4289>.
- Cook, C. D. K. 1996 Aquatic and Wetland Plants of India: A reference book and identification manual for the vascular plants found in permanent or seasonal fresh water in the Subcontinent of India south of the Himalayas. Oxford University Press, Oxford.
- Duke, J.A. 2010 Phytochemical and Ethnobotanical Databases. Available at: <http://www.ars-grin.gov/cgi-bin/duke/ethnobot.pl>. (Accessed: 20 January).

- Gaikwad, S., Gore, R., Garad, K. and Gaikwad, S. 2014 Endemic flowering plants of northern Western Ghats (Sahyadri Ranges) of India: A checklist. *Check List* 10(3): 461-472.
- Gaveau, D.L., Wich, S., Epting, J., Juhn, D., Kanninen, M. and Leader-Williams, N. 2009 The future of forests and orangutans (*Pongo abelii*) in Sumatera: Predicting impacts of oil palm plantations, road construction, and mechanisms for reducing carbon emissions from deforestation. *Environmental Research Letters* 4(3): 1-11. <http://dx.doi.org/10.1088/1748-9326/4/3/034013>.
- Gonzales, B.J. and Matillano, J.D. 2014 Wetland Study of Lake Manguao as Special Co-management Area for Eco-tourism in the Province of Palawan. Unpublished report to Palawan Council for Sustainable Development Staff, Puerto Princessa City.
- De Graaf, A. and Arends, J. C. 1986 The occurrence of *Cryptocoryne* and *Lagenandra* (Araceae) on Sri Lanka. *Nordic Journal of Botany* 6: 757-764.
- Hertel, I. and Mühlberg, H. 1994. *Cryptocoryne vietnamensis* spec. nov. (Araceae). *Aqua-Planta* 19 (2): 76-81.
- Wilstermann-Hildebrand 2000–2021 Heimbiotop - Aquaristik, Wirbellose und Garten <http://repository.library.du.ac.bd:8080/xmlui/bitstream/handle/123456789/942/Hosne.pdf?sequence=1&disAllowed=yhttp://www.heimbiotop.de/>
- Bastmeijer, J.D. Crypts pages. <https://crypts.home.xs4all.nl/>
- Idei T. 2010 Der natürliche Standort von *Cryptocoryne dewittii* N. Jacobsen (Araceae) in Papua Neuguinea. *Aqua Planta* 35(1): 23–28.
- Idei, T. 2006 Die natürlichen Standorte der *Cryptocoryne hutoroi* Bogner and Jacobsen. *Aqua Planta* 31(4): 151-161.
- Idei, T., Bastmeijer, J.D. and Jacobsen, N. 2010 Geschichten vom Mekong: Zwei neue *Cryptocorynen* (Araceae). *Aqua-Planta* 35(4): 139-146.
- Idei, T., Bastmeijer, J.D. and Jacobsen, N. 2017 Stories from the Mekong, part 2. The *Cryptocoryne* (Araceae) of Chiang Khan District, Loei Province, Thailand. *Thai Forest Bulletin* 45(1): 58–78.
- Idei, T., S. Maneeanakekul and N. Jacobsen. 2021 Stories from the Mekong, part 3. *Cryptocoryne* (Araceae) habitats in the Kok River, Chiang Rai Province, Northern Thailand. *Aroideana* 44 (1): 281-295.
- Ipor, I.B., Ho, W.S., Tawan, C.S., Salmizana, M.S. and Noryatimah, M. 2007 Ecology and DNA fingerprinting of *Cryptocoryne pallidinervia* Engler (Araceae) accessions using polymerase chain reaction M13 Universal Primer. *Malaysian Applied Biology* 36(2): 21-31.
- Ipor, I.B., Ørgaard, M. and Jacobsen, N. 2015 *Cryptocoryne* × *batangkayanensis* (Araceae), a new hybrid from Sarawak. *Willdenowia* 45: 183–187.
- Ipor, I.B., Tawan, C.S. and Jacobsen, N. 2005 A new species of *Cryptocoryne* (Araceae) from Borneo. *Gardens' Bulletin Singapore* 57: 1-6.
- Ipor, I.B., Tawan, C.S. and Meekiong, K. 2010 Notes on occurrence of *Cryptocoryne auriculata* Engler in Lanjak Entimau Wildlife Sanctuary. In: Mohamed, A.M., I.B. Ipor, Meekiong K., Ampeng, A., Sapuan A. and Latiff, A. (eds.) *Proceeding on Seminar of Biodiversity of Eastern Lanjak Entimau Wildlife Sanctuary*. Akademi Sains Malaysia, Kuala Lumpur: 111–114.
- Ipor, I.B., Tawan, C.S., Abai, J., Saupi, N. and Meekiong, K. 2007 Ökologie und Verbreitung der *Cryptocorynen*-Arten auf Sarawak (Malaysia). Teil 1. *Aqua Planta* 3: 101-106.
- Ipor, I.B., Tawan, C.S., Abai, J., Saupi, N. and Meekiong, K. 2008 Ecology and Distribution of *Cryptocoryne* Species in Sarawak (Malaysia). Part 3. *Aqua Planta* 1-2008: 22-27
- Ipor, I.B., Tawan, C.S., Abai, J., Saupi, N. and Meekiong, K. 2009 Notes on occurrence and distribution of *Cryptocoryne* species in Sarawak. Malaysia. *Folia Malaysiana* 10(2): 115–138.
- Ipor, I.B., Yahya, M.D. and Tawan, C. 2017 Response of *Cryptocoryne pallidinervia* Engler (Araceae) on light intensity and water depth. *Journal of Tropical Biology and Conservation* 14:1–19.
- IUCN Standards and Petitions Committee 2019 Guidelines for Using the IUCN Red List Categories and Criteria. Version 14. Prepared by the Standards and petitions committee. Available from: <https://www.iucnredlist.org/resources/redlistguidelines> (accessed 26 October 2022).
- Jacobsen, N. 1976 Notes on *Cryptocoryne* of Sri Lanka (Ceylon). *Botaniska Notiser* 129: 179-190.
- Jacobsen, N. 1977 *Cryptocoryne dewittii* N. Jacobsen sp. nov. (Araceae). *Botaniska Notiser* 130: 381-382.
- Jacobsen, N. 1980 Does *Cryptocoryne ferruginea* flower at full moon? *Aroideana* 3-4: 111-116.
- Jacobsen, N. 1980 The *Cryptocoryne albida* group of Mainland Asia. *Mededelingen Landbouwhogeschool Wageningen* 19: 183 – 204.

- Jacobsen, N. 1982 *Cryptocoryne* from Borneo. Mededelingen Werkgroep Aquariumplanten 6: 61-76.
- Jacobsen, N. 1985 The *Cryptocoryne* (Araceae) of Borneo. Nordic Journal of Botany 5: 31-50.
- Jacobsen, N. 1986 Deterioration of the habitats of the *Cryptocoryne* species. Symposium Bedreiging van het aquatisch milieu, *Ludwigia*, Wageningen: 33 (1-6 printout).
- Jacobsen, N. 1987 *Cryptocoryne*, p. 85-99. In Dassanyake, M.D. & Forsberg, F.R. (eds.). A revised Handbook to the Flora of Ceylon. VI. A Balkema, Rotterdam, Netherlands.
- Jacobsen, N. 1990 Blüht *Cryptocoryne ferruginea* Engler bei Vollmond? Aqua-Planta 15(2): 55-62.
- Jacobsen, N. and Bogner, J. 1986. Die *Cryptocorynen* der Malaiischen Halbinsel (1. Teil). Aqua Planta 11(4): 135-139.
- Jacobsen, N. and Bogner, J. 1987 Die *Cryptocorynen* der Malaiischen Halbinsel (2. Teil), Aqua-Planta 12(1): 13-20.
- Jacobsen, N. and Bogner, J. 1987 Die *Cryptocorynen* der Malaiischen Halbinsel (3. Teil). Aqua-Planta 12(2): 56-60.
- Jacobsen, N. and Ørgaard, M. 2018 On the Diptera pollinators of *Cryptocoryne* (Araceae). Aroideana 41(2-3): 218 – 236.
- Jacobsen, N. and Sookchaloem, D. 2006 *Cryptocoryne crispatula* Engler var. *flaccidifolia* N. Jacobsen im Südlichen Thailand. Aqua Planta 31(1): 16-23.
- Jacobsen, N., Bastmeijer J. D., Bogner J., Nguyen V. D., Quang B. H. and Ørgaard M. 2015 The identity of *Cryptocoryne crispatula* var. *tonkinensis* (Araceae). Willdenowia 45: 177–182.
- Jacobsen, N., Bastmeijer J. D., Edwards P. J., Johns R. J., Takahashi N. and Wongso S. 2014 A new variety of *Cryptocoryne versteegii* (Araceae) from Irian Jaya Tengah, Indonesia. Willdenowia 44: 385–391.
- Jacobsen, N., Bastmeijer J. D., Jensen K. R. and Ørgaard M. 2018 A new tetraploid variety of *Cryptocoryne ciliata* (Araceae) from Sarawak. Willdenowia 48: 425–431. doi: <https://doi.org/10.3372/wi.48.48312>
- Jacobsen, N., Bastmeijer, J.D., Bongcheewin, B., Idei, T., Sookchaloem, D. and Ørgaard, M. 2015 A new variety of *Cryptocoryne crispatula* Engl. (Araceae) from Thailand. Thai Forest Bull. (Botany) 43: 104-110.
- Jacobsen, N., Bastmeijer, J.D., Bogner, J., Budianto, H., Ganapathy, H.B., Idei, T., Ipor, I.B., Thirumalai, K., Othman, A.S., Rosazlina, R., Siow, J., Wongso, S. and Ørgaard, M. 2016 Hybrids and the Flora of Thailand 2: Hybridization in the Southeast Asian genus *Cryptocoryne* (Araceae). Thai Forest Bulletin (Botany) 44(1): 53–73.
- Jacobsen, N., Bastmeijer, J.D., Ganapathy, H.B., Ipor, I., Jensen, K.R., Komala, T., Mangsor, K.N.A., Othman, A.S., Rosazlina, R., Siow, J. and Ørgaard, M. 2020 *Cryptocoryne* hybrids (Araceae) 3: Hybrids between *Cryptocoryne cordata* and *Cryptocoryne nurii* from southern Peninsular Malaysia. Aroideana 43(1): 255-284.
- Jacobsen, N., Bastmeijer, J.D., Ganapathy, H.B., Mangsor, K.N.A., Mansor, M., Othman, A.S., Rahman, S.N.A., Rusly, R. and Siow, J. 2015 A new calcicolous variety of *Cryptocoryne nurii* Furtado (Araceae) from Pahang, Peninsular Malaysia. Malayan Nature Journal 65(4): 230-239.
- Jacobsen, N., Bastmeijer, J.D., Othman, A.S., Sookchaloem, D. and Ørgaard, M. 2019 Artificial hybrids in *Cryptocoryne* (Araceae) 2: Hybridization between species of the Malay Peninsula. Aroideana 42(1): 107–137
- Jacobsen, N., Bastmeijer, J.D., Wongso, S. and Ørgaard, M. 2016 New Guinea - Rätsel um *Cryptocoryne versteegii* und *Cryptocoryne dewitii*. Aqua Planta 41(4): 130-141.
- Jacobsen, N., Bastmeijer, J.D. and Sasaki, Y. 2002 *Cryptocoryne* × *purpurea* Ridley nothovar. *borneoensis* Aqua-Planta 27(4): 152–154
- Jacobsen, N., Bogner, J. and Christensen, C. 1998 Weitere Aufsammlungen von *Cryptocoryne usteriana* Engler auf den Philippinen. Aqua Planta 23(3): 113-115.
- Jacobsen, N., Ganapathy, H.B., Mangsor, K.N.A., Othman, A.S., Rahman, S.N.A., Rosazlina R. and Siow, J. 2020 Sungai Sedili Kechil, Johor, Peninsular Malaysia. Aquatic plants in a river with a tidal zone. Aqua Planta 45(4): 128-139.
- Jacobsen, N., T. Idei and D. Sookchaloem. 2012 11. *Cryptocoryne* in Boyce, P.C., D. Sookchaloem, W.D.A. Hettterscheid, G. Gusman, N. Jacobsen, T. Idei and N.V. Du. 2012. Flora of Thailand, Acoraceae and Araceae, 11(2): 218-232 and Plates XLV-LVIII.
- Jayasingham, T. 2008 Eastern Province Biodiversity Profile and Conservation Action Plan. The Biodiversity Secretariat, Ministry of Environment and Natural Resources, Sri Lanka.

- Joshi, V. C. and Janarthanam, M. K. 2004 The diversity of life-form type, habitat preference and phenology of the endemics in the Goa region of the Western Ghats, India. *Journal of Biogeography*, 31(8), 1227-1237.
- Kambhar, S.V., Bhise, M.R., Naik, M.M., Parab, A.L., Patil, K.H., Tawade, A.P., Patil, V.K., Rane, A.D., Narkhede, S.S. and Bhawe, S.G. 2015 Additional information on the threatened *Cryptocoryne cognata* Schott (Araceae): A need for reassessment of the IUCN Red List status. *Journal of Threatened Taxa* 7(15): 8302–8304; <http://dx.doi.org/10.11609/jott.2471.7.15.8302-8304>
- Kasselmann, C. 2003 *Cryptocoryne bogneri*. Bogner's Wasserkelch - neue oekologische Erkenntnisse. *Die Aquarien und Terrarien Zeitschrift* 56(11): 26-31.
- Kasselmann, C. 2007 *Cryptocoryne parva*. Zur Ökologie und Kultur des Kleinen Wasserkelches. *Die Aquarien und Terrarien Zeitschrift* 60(6): 16-20.
- Kasselmann, C. 2014 *Cryptocoryne spiralis* var. *caudigera*. Wasser- und Sumpfpflanzen aus Indien (1). *Die Aquarien und Terrarien Zeitschrift* 67(4): 50-55.
- Kasselmann, C. 2015 *Cryptocoryne consobrina*. Ein lange verschollener Wasserkelch aus Südindien. *Die Aquarien und Terrarien Zeitschrift* 68(4): 38-43.
- Kasselmann, C. 2015 *Cryptocoryne sivasadanii*. Ein Wasserkelch mit Potenzial für eine gute Aquariumpflanze. *Die Aquarien und Terrarien Zeitschrift* 68(6): 44-49.
- Kasselmann, C. 2016 *Cryptocoryne cognata* Schott – zur Verbreitung und Ökologie einer indischen *Cryptocoryne*. *Aqua Planta* 41(3): 90–103.
- Kasselmann, C. 2020 *Aquarium Plants*. Aquarium Plants Publisher, Teltow
- Komala, T. 2019 Phylogenetic and molecular divergent analysis of three forest canopy dependent plant families (Araceae, Hanguanaceae and Nymphaeaceae) in Riau Pocket. PhD Thesis, Universiti Sains Malaysia, Penang, Malaysia.
- Kulkarni, B. G. 1988 *Flora of Sindhudurg*. Botanical Survey of India, Department of Environment, Pune, India.
- Lansdown, R.V. and Molur, S. 2017 Development of a conservation plan for Malabar river-lily (*Crinum malabaricum*). Unpublished report to the IUCN SSC Freshwater Plant Specialist Group.
- Leach, G.J. and Osborne, P.L. 1985 *Freshwater plants of New Guinea*. University of Papua New Guinea Press, Port Moresby.
- Li, H. and Jacobsen, N. 2010 *Cryptocoryne*. In Li, H., Zhu, G., Boyce, P.C., Murata, J., Hettterscheid, W.L.A., Bogner, J. and Jacobsen, N. (Eds) *Araceae. Flora of China* 23: 20-22.
- Lopez, A. and Prentice, C. 1988 Tasek Bera. Ramsar Sites Information Service. Retrieved 9th May 2022.
- Manawaduge, C.G., Yakandawala, D. and Yakandawala, K. (2020). Does the IUCN Red Data 'Criteria B' do justice for smaller aquatic plants: A case study from Sri Lankan Aponogetons. *Biodiversity and Conservation* 29: 115-127. <https://doi.org/10.1007/s10531-019-01873-x>
- Mansor, M. and Masnadi, M. 1994 *Cryptocoryne elliptica*, an endangered amphibious plant in Pondok-Tanjung Forest Reserve, Peninsular Malaysia. *Aquatic Botany* 47(1): 91-96.
- Mansor, M., Boyce, P.C., Othman, A.S. and Sulaiman, B. 2012. *The Araceae of Peninsular Malaysia*. Glugor, Pulau Pinang, Penerbit Universiti Sains Malaysia.
- Masrol, M. 2004 Ecology of *Cryptocoryne ferruginea* Engler in Sarawak. BSc. thesis, UNIMas Sarawak.
- Ministry of Agriculture 2017 Western Province Biodiversity Profile and Conservation Action Plan. Ministry of Agriculture, Land, Irrigation, Fisheries, Animal Production and Health and Agrarian Development, Government of Sri Lanka, Ministry of Agriculture, Battaramulla, Sri Lanka.
- Mishra, D. K. and Singh, N. P. 2001 Endemic and threatened flowering plants of Maharashtra. Botanical Survey of India, Kolkata.
- Mohidin, J. 2004 Ecology of *Cryptocoryne auriculata* Engler in Pakan, Sibul, Sarawak. PhD thesis, University Sains Malaysia, Sarawak.
- Moonasingha, A.D. 1991 The environmental impacts of Mahaweli River engineering and reservoir construction project. Institute of Water and Environmental Management conference, Birmingham, UK.
- Morco, H. 2010. Die *Cryptocoryne*-Arten der Philippinen. *Aqua Planta* 35(3): 81, 84-93.
- Naive, M.A. and Villanueva, R.G.T. 2018 *Cryptocoryne joshanii* (Araceae), a new species serendipitously discovered in Sulu archipelago, Philippines. *Taiwania* 63(3): 248-250.
- Narasimha, S., Ipor, I.B., Tawan, C.S., Ho, W.S. and Meekiong, K. 2009 The biomass partitioning allocation in vegetative parts of *Cryptocoryne cordata* var. *zonata* (De Wit) Jacobsen from various

- localities in Sarawak, Malaysia. Proceedings of the 3rd Regional Conference on Natural Resources in the Tropics, Hilton Kuching, Sarawak.
- National Red List 2020 Conservation Status of the Flora of Sri Lanka (2020) Sri Lanka: Biodiversity Secretariat, Ministry of Environment and the National Herbarium, Department of National Botanic Gardens.
- Nguyen, T.V., Nguyen, K.H. and Vu, X.P. 2005. *Checklist of plant species in Vietnam*. Agriculture Publishing House, Hanoi.
- Nguyen, V.D., Bui, H.Q. and Bogner, J. 2014 The status of *Cryptocoryne annamica* (Araceae: Aroideae: Cryptocoryneae) in Vietnam. *Gardens' Bulletin Singapore* 66(1): 67–72.
- Othman, A., S., Jacobsen, N. and Mansor, M. 2009 *Cryptocoryne* of Peninsular Malaysia. Penerbit University Sains Malaysia. 1-102.
- Patil, K.S., Yadav, S.R., Dixit, G.B. and Bogner, J. 1992 Eine lang verschollene *Cryptocoryne* aus Indien: *Cryptocoryne cognata* Schott (Araceae). *Aqua-Planta* 17(2)-92: 59-65.
- RBG Kew. 2011 World Checklist of Selected Plant Families. London Available at: <http://www.kew.org/wcsp/>.
- Reitel, S., Nakamoto, K. and Bastmeijer, J.D. 2012 Die echte *Cryptocoryne scurrilis* de Wit (Araceae), *Aqua-Planta* 37(4): 135-142.
- Rusly, R., Jacobsen, N., Ørgaard, M. and Othman, A.S. 2021 Molecular evidence of the hybrid origin of *Cryptocoryne* × *purpurea* Ridl. nothovar. *purpurea* (Araceae). *PLOS ONE* 16(1) e0239499. <https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0239499>
- Sasaki, Y. 2002 *Cryptocoryne uenoi* Y. Sasaki (Araceae), eine neue Art aus Sarawak. *Aqua Planta* 27(4): 147-149.
- Sasikala, K., E. Vajravelu and P. Daniel. 2019 Fascicles of Flora of India, Fascicle 29, Araceae, Botanical Survey of India. p. 1-358; I-X, Plate 1-33.
- Serebryanyi, M. 1991 Eine neue *Cryptocoryne*-Art (Araceae) aus Vietnam. *Aqua-planta* 98: 101.
- Sunil, C.N. and Sivadasan, M. 2009 Rediscovery of *Cryptocoryne consobrina*, a little-known and suspected-to-be-extinct species of Araceae of India. *Aroideana* 32: 142-146.
- Tanaka, N., Tanaka, N., Ohi-Toma, T. and Murata, J. 2007 New and noteworthy plant collections from Myanmar (2): *Aponogeton lakhonensis*, *Cryptocoryne cruddasiana*, *C. crispata* var. *balansae* and *Stichoneuron membranaceum*. *The Journal of Japanese Botany* 82(5): 266 - 273 (with four plates).
- Wongso S., Bastmeijer J. D., Budianto H., Ipor I. B., Rysbjerg Munk K., Ørgaard M. and Jacobsen N. 2017 Six new *Cryptocoryne* taxa (Araceae) from Kalimantan, Borneo. *Willdenowia* 47: 325–339. doi: <https://doi.org/10.3372/wi.47.47314>
- Wongso S., Ipor I. B., Tawan C. S., Budianto H., Bastmeijer J. D. and Jacobsen N. 2016 *Cryptocoryne aura* (Araceae), a new species from West Kalimantan, Indonesia. *Willdenowia* 46: 275–282. doi: <http://dx.doi.org/10.3372/wi.46.46209>.
- Wongso, S. and J.D. Bastmeijer, 2005 *Cryptocoryne noritoui* Wongso (Araceae), eine neue Art aus Ost-Kalimantan (Indonesien). *Aqua-Planta* 30(3): 92-100.
- Wongso, S., Asih, N.P.S, Bastmeijer, J.D., Jensen, K.R., Reichert, W., Ørgaard, M. and Jacobsen, N. 2019 Four new *Cryptocoryne* (Araceae) from Sumatera, Indonesia: A new variety and three interspecific natural hybrids. *Taiwania* 64(3): 326-338.
- Wongso, S., Bastmeijer, J.D., Hendrik, Jensen, K.R. Kishi, H., Ørgaard, M., Takahashi, N. & Jacobsen, N. 2020 *Cryptocoryne*-hybriden (Araceae): *Cryptocoryne* × *ikezewaldiae* und *C.* × *agusii*, zwei neue Hybriden aus West-Kalimantan, Indonesien. *Aqua Planta* 45(2): 44-57.
- Wongso, S., Bastmeijer, J.D., Idei, T., Jensen, K.R., Ørgaard, M. and Jacobsen, N. 2020 *Cryptocoryne* hybrids (Araceae) 4: A *Cryptocoryne* hybrid from the Meratus mountains, South Kalimantan, Indonesia. *Aroideana* 43(1–2): 285– 298.
- Wongso, S., Hendrik, Jensen, K.R., Ørgaard, M. and Jacobsen, N. 2020 A new *Cryptocoryne* species (Araceae) from the Schwaner mountains, West Kalimantan, Indonesia. *Nordic Journal of Botany* 38(4): 1-5. <https://doi.org/10.1111/njb.02716>
- Yakandawala, D. 2012 Present status of fresh water aquatic flora in Sri Lanka. In Weerakoon, D.K. and Wijesundara, S. (Eds.) *The National Red List 2012 of Sri Lanka; Conservation Status of the Fauna and Flora*. Ministry of Environment, Colombo, Sri Lanka: 186-196.
- Zhou, H., H.W. He and N. Jacobsen. 2010. Eine neue Varietät der *Cryptocoryne crispata* Engler (Araceae) aus der Provinz Guangxi, China. *Aqua Planta* 35(4): 134-138.

APPENDIX A THREAT CATEGORIES ASSIGNED

The categories recorded here reflect those on the Red List assessments submitted for publication, except for those taxa described since submission (*C. paglaterasiana*, *C. palawanensis* and *C. verrucosa*) and taxa for which new information suggests that a different category would be appropriate (e.g. *C. bogneri*, *C. crispatula* var. *planifolia* and *C. ×hendrae*) and hybrids which are not yet included in publications by IUCN. An explanation of these differences is given under the taxonomic accounts for the relevant taxa.

Taxa are listed in alphabetic order by category.

Name	Status
<i>Cryptocoryne isae</i>	CR B1ab(i, ii, iii, iv)+2ab(i, ii, iii, iv)
<i>Cryptocoryne dewittii</i>	CR B1ab(i, ii, iii, iv, v)+2ab(i, ii, iii, iv, v)
<i>Cryptocoryne noritoui</i>	CR B1ab(i, ii, iii, iv, v)+2ab(i, ii, iii, iv, v)
<i>Cryptocoryne ×jambiensis</i>	CR B1ab(i, iii)+2ab(i, iii)
<i>Cryptocoryne pygmaea</i>	CR B1ab(ii, iii, v)+ (ii, iii, v)
<i>Cryptocoryne paglaterasiana</i>	CR B1ab(ii, iii, v)+2ab(ii, iii, v)
<i>Cryptocoryne alba</i>	CR B1ab(iii)+2ab(iii)
<i>Cryptocoryne bogneri</i>	CR B1ab(iii)+2ab(iii)
<i>Cryptocoryne ×batangkayanensis</i>	CR B1ab(iii)+2ab(iii)
<i>Cryptocoryne ×ikezewaldiae</i>	CR B1ab(iii)+2ab(iii)
<i>Cryptocoryne ×zukalii</i> nothovar. <i>sumateraensis</i>	CR B1ab(iii)+2ab(iii)
<i>Cryptocoryne erwinii</i>	CR B1ab(iii, iv)+2ab(iii, iv)
<i>Cryptocoryne loeiensis</i>	CR B1ab(iii, v)
<i>Cryptocoryne zaidiana</i>	CR B1ab(iii, v)
<i>Cryptocoryne cordata</i> var. <i>diderici</i>	CR B1ab(iii, v)+2ab(iii, v)
<i>Cryptocoryne moehlmannii</i>	CR B1ab(iii, v)+2ab(iii, v)
<i>Cryptocoryne ciliata</i> var. <i>bogneri</i>	CR B1ab(iii, v)+B2ab(iii, v)
<i>Cryptocoryne waseri</i>	CR(PE) 2ab(iii)+2ab(iii)
<i>Cryptocoryne crispatula</i> var. <i>planifolia</i>	CR(PE) B1ab(iii)+2ab(iii)
<i>Cryptocoryne ×hendrae</i>	CR(PE) B1ab(iii)+2ab(iii)
<i>Cryptocoryne ×griffithioides</i>	CR(PE) B1b(i, ii, iii)+2ab(iii)
<i>Cryptocoryne ×decus-silvae</i>	EN B1ab(i, ii, iii, iv)+2ab(i, ii, iii, iv)
<i>Cryptocoryne aponogetifolia</i>	EN B1ab(i, ii, iii, iv, v)+B2ab(i, ii, iii, iv, v)
<i>Cryptocoryne cordata</i> var. <i>wellyi</i>	EN B1ab(i, ii, iii, v)+2ab(i, ii, iii, v)
<i>Cryptocoryne aura</i>	EN B1ab(ii, iii)+2ab(ii, iii)
<i>Cryptocoryne palawanensis</i>	EN B1ab(ii, iii, v)+B2ab(ii, iii, v)
<i>Cryptocoryne nevillei</i>	EN B1ab(iii)+2ab(iii)
<i>Cryptocoryne parva</i>	EN B1ab(iii)+2ab(iii)
<i>Cryptocoryne sahalii</i>	EN B1ab(iii)+2ab(iii)
<i>Cryptocoryne scurrielis</i>	EN B1ab(iii)+2ab(iii)
<i>Cryptocoryne undulata</i>	EN B1ab(iii)+2ab(iii)
<i>Cryptocoryne usteriana</i>	EN B1ab(iii)+2ab(iii)
<i>Cryptocoryne versteegii</i> var. <i>versteegii</i>	EN B1ab(iii)+2ab(iii)
<i>Cryptocoryne versteegii</i> var. <i>jayaensis</i>	EN B1ab(iii)+2ab(iii)
<i>Cryptocoryne wongsoi</i>	EN B1ab(iii)+2ab(iii)
<i>Cryptocoryne yujii</i> var. <i>hendrikii</i>	EN B1ab(iii)+2ab(iii)
<i>Cryptocoryne yujii</i> var. <i>yujii</i>	EN B1ab(iii)+2ab(iii)
<i>Cryptocoryne ×nakamotoi</i>	EN B1ab(iii)+2ab(iii)
<i>Cryptocoryne ×willisii</i>	EN B1ab(iii)+2ab(iii)
<i>Cryptocoryne ×ardyi</i>	EN B1ab(iii, iv)+2ab(iii, iv)
<i>Cryptocoryne mekongensis</i>	EN B1ab(iii, iv, v)+2ab(iii, iv, v)
<i>Cryptocoryne ×agusii</i>	EN B1ab(iii, v)
<i>Cryptocoryne villosa</i>	EN B1ab(iii, v)+2ab(iii, v)

<i>Cryptocoryne ideii</i>	EN B2ab(iii)
<i>Cryptocoryne versteegii</i>	EN B2ab(iii)
<i>Cryptocoryne walkeri</i>	EN B2ab(iii)
<i>Cryptocoryne tirtadinatae</i>	VU B1ab(i, ii, iii, v)+2 ab(i, ii, iii, v)
<i>Cryptocoryne elliptica</i>	VU B1ab(i, ii, iii, v)+2ab(i, ii, iii, v)
<i>Cryptocoryne thwaitesii</i>	VU B1ab(i, ii, iii, v)+B2ab(i, ii, iii, v)
<i>Cryptocoryne cognata</i>	VU B1ab(ii, iii)+B2ab(ii, iii); D2
<i>Cryptocoryne auriculata</i>	VU B1ab(iii)+2ab(iii)
<i>Cryptocoryne consobrina</i>	VU B1ab(iii)+2ab(iii)
<i>Cryptocoryne schulzei</i>	VU B1ab(iii)+2ab(iii)
<i>Cryptocoryne sivasadanii</i>	VU B1ab(iii)+2ab(iii)
<i>Cryptocoryne spiralis</i> var. <i>cognatoides</i>	VU B1ab(iii)+2ab(iii)
<i>Cryptocoryne vietnamensis</i>	VU B1ab(iii)+2ab(iii)
<i>Cryptocoryne verrucosa</i>	VU B1ab(iii)+2ab(iii)
<i>Cryptocoryne pontederiifolia</i>	VU B1ab(iii)+2ab(iii); D2
<i>Cryptocoryne ferruginea</i> var. <i>sekadauensis</i>	VU B1ab(iii, v)+2ab(iii, v)
<i>Cryptocoryne uenoi</i>	VU B1b(iii)+2b(iii)
<i>Cryptocoryne crispatula</i> var. <i>yunnanensis</i>	VU B2ab(i, ii, iii); D2
<i>Cryptocoryne cruddasiana</i>	VU B2ab(iii)
<i>Cryptocoryne bastmeijeri</i>	VU D2
<i>Cryptocoryne crispatula</i> var. <i>decus-mekongensis</i>	VU D2
<i>Cryptocoryne bullosa</i>	NT EN B1ab(i, ii, iii, iv, v)+B2ab(i, ii, iii, iv, v)
<i>Cryptocoryne nurii</i> var. <i>raubensis</i>	NT EN B1ab(iii)+2ab(iii)
<i>Cryptocoryne annamica</i>	NT EN B1ab(iii, iv)+2ab(iii, iv)
<i>Cryptocoryne beckettii</i>	NT EN B2ab(i, iii)
<i>Cryptocoryne wendtii</i>	NT VU B1ab(iii)
<i>Cryptocoryne crispatula</i> var. <i>flaccidifolia</i>	NT VU B1ab(iii)+2ab(iii)
<i>Cryptocoryne keei</i>	NT VU B1ab(iii)+2ab(iii)
<i>Cryptocoryne yujii</i>	NT VU B1ab(iii)+2ab(iii)
<i>Cryptocoryne hudoroi</i>	NT VU B1ab(iii, v)+ (iii, v); D2
<i>Cryptocoryne regina</i>	NT VU B1ab(iii, v)+2ab(iii, v)
<i>Cryptocoryne ferruginea</i>	NT VU B1b(i, ii, iii)+2b(i, ii, iii)
<i>Cryptocoryne</i> × <i>purpurea</i> nothovar. <i>borneoensis</i>	NT VU B2ab(i, ii, iii)
<i>Cryptocoryne longicauda</i>	NT VU B2ab(i, ii, iii, v)
<i>Cryptocoryne lingua</i>	NT VU B2b(i, ii, iii, v)
<i>Cryptocoryne pallidinervia</i>	NT VU B2b(iii, v)
<i>Cryptocoryne nurii</i> var. <i>nurii</i>	NT VU B2b(iii, v); D2
<i>Cryptocoryne ciliata</i> var. <i>latifolia</i>	DD
<i>Cryptocoryne coronata</i>	DD
<i>Cryptocoryne crispatula</i> var. <i>kubotae</i>	DD
<i>Cryptocoryne joshanii</i>	DD
<i>Cryptocoryne spiralis</i> var. <i>caudigera</i>	DD
<i>Cryptocoryne spiralis</i> var. <i>huegelii</i>	DD
<i>Cryptocoryne</i> × <i>schulzeioides</i>	DD
<i>Cryptocoryne</i> × <i>zukaii</i>	DD
<i>Cryptocoryne</i> × <i>zukaii</i> nothovar. <i>zukaii</i>	DD
<i>Cryptocoryne affinis</i>	LC
<i>Cryptocoryne bangkaensis</i>	LC
<i>Cryptocoryne ciliata</i>	LC
<i>Cryptocoryne ciliata</i> var. <i>ciliata</i>	LC
<i>Cryptocoryne cordata</i>	LC
<i>Cryptocoryne cordata</i> var. <i>cordata</i>	LC
<i>Cryptocoryne cordata</i> var. <i>grabowskii</i>	LC
<i>Cryptocoryne cordata</i> var. <i>siamensis</i>	LC

<i>Cryptocoryne crispatula</i>	LC
<i>Cryptocoryne crispatula</i> var. <i>albida</i>	LC
<i>Cryptocoryne crispatula</i> var. <i>crispatula</i>	LC
<i>Cryptocoryne crispatula</i> var. <i>tonkinensis</i>	LC
<i>Cryptocoryne crispatula</i> var. <i>balansae</i>	LC
<i>Cryptocoryne fusca</i>	LC
<i>Cryptocoryne griffithii</i>	LC
<i>Cryptocoryne matakensis</i>	LC
<i>Cryptocoryne minima</i>	LC
<i>Cryptocoryne nurii</i>	LC
<i>Cryptocoryne retrospiralis</i>	LC
<i>Cryptocoryne spiralis</i>	LC
<i>Cryptocoryne spiralis</i> var. <i>spiralis</i>	LC
<i>Cryptocoryne striolata</i>	LC
<i>Cryptocoryne</i> × <i>purpurea</i>	LC
<i>Cryptocoryne</i> × <i>purpurea</i> nothovar. <i>purpurea</i>	LC
<i>Cryptocoryne</i> × <i>timahensis</i>	LC

APPENDIX B SPECIES ACCOUNTS

1. *Cryptocoryne affinis* N.E.Br. ex. J.D.Hooker 1893

Distribution: *C. affinis* is endemic to the Malay Peninsula, it is widespread in Peninsular Malaysia and a single population is known from the Bettong area of southern Peninsular Thailand.

EOO: 37,196 km²

AOO: 108 km²

Countries of Occurrence: West Malaysia (Selangor, Pahang, Kelantan, Perak and Kedah), Thailand

Population: Although few populations are known, many individual populations are large. There is no information on population trends in *C. affinis*.

Habitats and Ecology: This species grows on sandy, stony or silt substrates in relatively fast-flowing streams and rivers flowing off limestone hills. It often grows in deeper channels between sand bars which are exposed during low flows and large populations may themselves create sandbars. It generally grows in forested streams but can tolerate direct sunlight, and has been recorded persisting in streams flowing through oil palm plantations. 30-180 m.

General Use and Trade Information: This species is one of the classic aquarium plants and is apparently easy to cultivate.

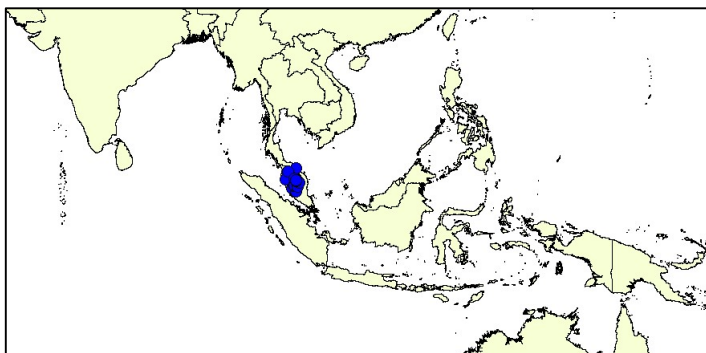
Threats: *C. affinis* is threatened by destruction and degradation of rainforest, as well as by pollution and modification of forest streams. In 2007, a population of this species in Terengganu State, Peninsular Malaysia was destroyed when a road widening and bridge replacement project resulted in wash-out of soil into the river, covering the entire population. It may also be threatened by uncontrolled and/or illegal collection.

Conservation status: *C. affinis* occurs in Taman Negara, Peninsular Malaysia, but there are no conservation measures in place specifically for this species and none needed.

Red List Assessment: LC

Assessment Rationale: *C. affinis* has a wide distribution and is known from a number of disparate locations. Although most of the areas of habitat in which it occurs are threatened by forest clearance or degradation, it is considered unlikely to become extinct in the near future. It is therefore classed as Least Concern, however more detailed information on the most recent record of each population and the condition of habitats at each site could lead to a revision of this classification.

Reviewers: N. Jacobsen, S. Wongso.



2. *Cryptocoryne alba* de Wit 1975

Distribution: *C. alba* is endemic to Sri Lanka, where it has been recorded twice near the Kalu Ganga, near Yahalawatta. There is also a report from east of Colombo but this is probably an error. In 1975 it was found to the south of the river and then in 1981 to the north of the river (80°9'4"E, 6°43'33' N) (Graaf and Arends 1986), A. de Graaf pers. comm., 06° 43' 24" N, 80° 08' 56" E given on the isotype of *C. waseri*). A population has recently been found in Kaluthara District and there are unconfirmed reports of a few other populations (D. Yakandawala pers. comm.).

EOO: 4 km² (an under-estimate based on occurrence of a single known population)

AOO: 4 km² (an under-estimate based on occurrence of a single known population)

Countries of Occurrence: Sri Lanka

Population: Populations are described as tiny.

Habitats and Ecology: This species occurs on sandy, stony or silt substrates, in or beside seasonal streams in dense lowland forest. It typically forms small stands in the margins in a layer of organic material.

General Use and Trade Information: This species had been in cultivation since 1990, it is apparently easy to cultivate emersed, but difficult submerged (*C. Kasselmann* pers. comm.). It is very vulnerable to over-collection.

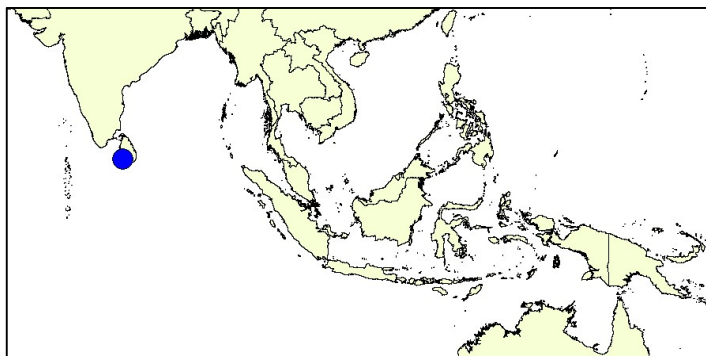
Threats: Most natural habitat in areas from which *C. alba* has been found has been converted to cultivation or plantations. Remaining potentially suitable habitat in the area has some degree of protection as a Forest Reserve but the springs are described as drying out, possibly due to over-exploitation of ground water or climate change.

Conservation: *C. alba* is classed as Critically Endangered CRB1ab(i, ii, iii)+B2ab(i, ii, iii) in the Red Data Book of Sri Lanka (National Red List 2020). There are no conservation measures in place specifically for this species and it is not known to occur in any protected areas. See detailed proposal chapter 5.4.7.

Red List Assessment: CR B1ab(iii)+2ab(iii)

Assessment Rationale: *C. alba* is endemic to Sri Lanka. It was described as occurring at Yahalawatta in the south west, where it was collected from a stream also supporting *C. waseri* in 1990 (Bastmeijer *et al.* 2012). In the same article, the type locality is described as having been destroyed by conversion to cultivation. The location at the coordinates given on the type material of *Cryptocoryne waseri* (see <https://plants.jstor.org/stable/history/10.5555/al.ap.specimen.m0234355>) has clearly been cleared of much of the lowland forest which would have occurred and now apparently supports cultivated trees in an open habitat. In 1986 *C. alba* was found north of the Kalu Ganga in the same area (Bastmeijer *et al.* 2012). As is the case with the type locality, the area of this second record now also appears to have been converted to pasture or cultivation. There are areas in the vicinity which still support relatively intact lowland forest with streams, such as Bodhingala Forest Reserve/Hermitage, although various anecdotal accounts suggest that the springs are drying out, while the site is surrounded by settlements, rice fields or rubber plantations and therefore very vulnerable. Potentially suitable habitat appears to exist in the area and detailed surveys could locate extant populations. This species is classed as Critically Endangered. Recent reports of additional populations are unconfirmed.

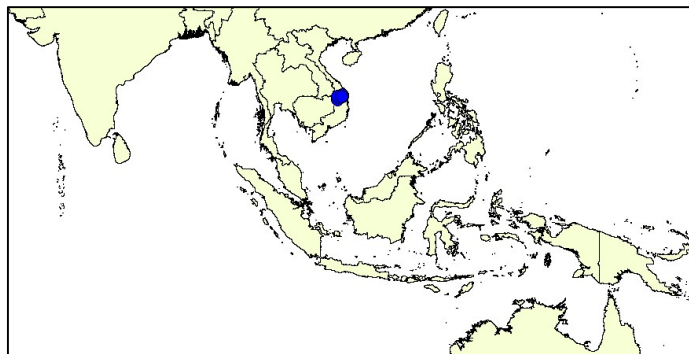
Reviewers: N. Jacobsen, D. Yakandawala.



3. *Cryptocoryne annamica* Serebryanyi 1991

Common Names: Mai dam trung bo (Vietnamese)

Distribution: *C. annamica* is endemic to Vietnam. It has been the subject of a number of unconfirmed reports and anecdotal accounts by hobbyists. A record from Mt. Bana in 1927 was re-determined as *C. vietnamensis* (Serebryanyi 1991). It was reported from near Pleiku in Gia Lai province (Serebryanyi 1991) but it is not clear whether this report is reliable. It has been confirmed from three sites in K'Bang (formerly Buoenloy [Buon Luoi]), Gia Lai Province: Kon Ha Nung, Kon Ka King National Park; and Ankhe. Searches at its type locality near Buon Luoi (Buoenloy) in 1996 were unsuccessful and it is likely to have been lost from the site. Three new sites in more lowland areas have recently been added (S. Wongso pers. comm.). However, the amount of anecdotal information suggests that it may be at least occasional within suitable habitat on the Ha Nung Plateau. There is also a credible photograph taken from an undisclosed location (Nguyen *et al.* 2005). A few more localities have been “documented” by photographs, but the exact localities have not been disclosed. 900 m.



EOO: 1,927 km² (this is a parsimonious estimate based on confirmed records).

AOO: 24 km² (this is a parsimonious estimate based on confirmed records).

Countries of Occurrence: Vietnam

Population: No information is available on population size or trends in this species.

Habitats and Ecology: *C. annamica* grows in or along small streams and in swampy areas of tropical, partly deciduous forests. 200–900 m.

General Use and Trade Information: *C. annamica* is found in the aquarium trade, cultivated from the original collection and from a few subsequent accessions. It is apparently easy to grow emersed but slow to propagate and is at risk of over-collection.

Threats: The species is likely to be extremely vulnerable to local and even very small-scale actions which affect the water bodies in which it grows, such as logging of catchments, development or pollution. Recently it has become apparent that two of the sites from which it has been recorded are much disturbed (Nguyen *et al.*, 2014). It may also be threatened by commercial collecting, as known populations appear to be small.

Conservation: There are no conservation measures in place specifically for this species. Remaining populations occur in protected areas, to one of which access is only permitted for scientific research. However, it is not clear whether this protection is enough to prevent collection for commercial sale. There is an urgent need for surveys to locate and document extant populations and to assess the extent to which existing protected areas are likely to protect this species. It is possible that linking projects to *C. vietnamensis* could make them more effective. It was classed as Vulnerable VU A2a; B2ab(ii, iii); C1 by Nguyen *et al.* (2014).

Red List Assessment: NT VU B1ab(iii, iv)+2ab(iii, iv).

Assessment Rationale: There is evidence that the habitat in which *C. annamica* formerly occurred at some sites has been destroyed or severely degraded. Remaining populations occur in protected areas which are (in the foreseeable future) unlikely to be damaged but there is a risk that populations could be compromised by illegal collection. This species is therefore classed as Near Threatened but this should be elevated to VU B1ab(iii, iv)+2ab(iii, iv) if any evidence becomes available that populations continue to decline.

Reviewers: Jacobsen, N., Wongso, S.

4. *Cryptocoryne aponogetifolia* Merr. 1919

Distribution: *C. aponogetifolia* is endemic to the Philippines. It was formerly reported from the island Panay but has recently only been recorded from south-eastern Luzon where it is known from Sorsogon and Albay Provinces and from Negros. Populations on Luzon were well surveyed and documented in the past by

Herson Morco, but this has ceased with his death. It is currently known from fewer than ten locations.

EOO: 8,548 km² (8 on SIS using current populations)

AOO: 12 km² (8 on SIS using current populations)

Countries of Occurrence: Philippines.

Population: It is described as abundant where it occurs.

Habitats and Ecology: *C. aponogetifolia* grows in fast-flowing gravel-bed streams and small rivers flowing over basalt and limestone with highly variable water levels. It typically grows submerged in the channel but may also occur on the margins when water is turbid. The streams where it occurs typically flow through forest but it tends to occur where breaks in the canopy allow sunlight to reach the channel.

General Use and Trade Information: This species is widespread in aquaria and is easy to propagate. It is vulnerable to uncontrolled and/or illegal collection.

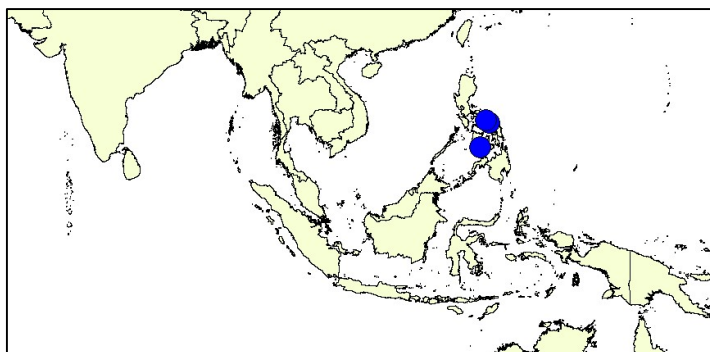
Threats: When forest is cleared and particularly when the substrate adjacent to the forest is disturbed, resulting in increased sediments and turbidity, this species appears to decline in the channel and grow on the margins, where it is more vulnerable to erosion and other impacts.

Conservation: There are no conservation measures in place specifically for this species. There is a need to survey and document remaining populations of this species, as well as for surveys to attempt to locate populations on Panay to inform design of site protection. There is potential to link projects to conservation of *C. usteriana* (Panay).

Red List Assessment: EN B1ab(i, ii, iii, iv, v)+B2ab(i, ii, iii, iv, v).

Assessment Rationale: *C. aponogetifolia* has undergone a significant decline in the past. There is no evidence that populations are protected and it is now known from three sites, each of which is considered to represent a single location. The maximum realistic AOO is estimated to be 12 km² and the EOO has been set to agree with this. The historic loss from Negros, combined with habitat degradation in its remaining range mean that populations are threatened and it is therefore classed as Endangered. It is likely that an increase in data on the remaining populations would show that it is more threatened than can be demonstrated with available data.

Reviewers: N. Jacobsen, A. Naive.



5. *Cryptocoryne aura* Wongso & Ipor 2016

Distribution: *C. aura* is endemic to Kalimantan in Borneo.

EOO: 186 km²

AOO: 16 km²

Countries of Occurrence: Indonesia (Kalimantan)

Population: The population comprises several patches of various sizes in a few streams in a very small area.

Habitats and Ecology: This species grows in small, shallow streams in rainforest over peaty soils, flowing through shallow valleys between small hills in undulating terrain. Surrounding vegetation mainly involves rubber farms and degraded secondary forest dominated by *Dillenia suffruticosa* Griff., *Miscanthus floridulus* (Labill.) Warb. and *Scleria sumatrensis* Retz. (Wongso *et al.* 2016). 60-130 m,

General Use and Trade Information: This species is in cultivation and commercially available, however it is likely to be vulnerable to collection for sale.

Threats: Most forest in the areas in which this species occurs has been cleared for small-scale agriculture, although some remains on higher ground. Remaining habitat is threatened by ongoing degradation of habitats through intensive logging, transformation to large-scale agriculture, indiscriminate discharge of industrial waste and domestic sewage as well as illegal gold extraction in most rivers.

Conservation: There are no conservation measures in place specifically for this species. The area in which this species occurs has no protection. It is possible that other populations occur in the area but to-date surveys have failed to find any. See detailed proposal, Chapter 5.4.3.

Red List Assessment: EN B1ab(ii, iii)+2ab(ii, iii).

Assessment Rationale: *C. aura* is currently known from a small number of sites in an area where habitats are already degraded and are threatened with further degradation or destruction. It is therefore classed as Endangered.

Reviewers: N. Jacobsen, S. Wongso.



6. *Cryptocoryne auriculata* Engl. 1879

Distribution: *C. auriculata* is endemic to Sarawak, East Malaysia, where it is known from five areas: Gamalat, Tajuk and Kaki Wong in Julau and Mador and Empran in Meradong District. In total, populations have been found in twelve sites, treated as ten locations as some sites are on the same river systems or separated by less than five kilometres.

EOO: 15,446 km²

AOO: 48 km²

Countries of Occurrence: Malaysia (Sarawak).

Population: In areas where *C. auriculata* occurs, populations tend to occur as separate patches, all of which are small and involve few plants. Extensive surveys of streams in Lanjak Entimau Wildlife Sanctuary resulted in location of populations in three streams (Sungai Datai, Sg. Belawak and Sg. Latong.), two of which supported only small, scattered populations, with abundant plants in the third. It occurred as one or two scattered plants at Sungai (river) Tajuk, single patches in each of Kaki Wong, Mador and Empra and 3 patches in Sungai Gamalat.

Habitats and Ecology: This species occurs in fast-flowing streams and rivers in rainforest, where it typically grows in the zone between high and low water levels, such that it is inundated only during periods of high flow. It typically occurs in sandy or sandy-alluvial substrates, as well as on the root boles of emergent *Saraca declinata* trees. 10-150 m.

General Use and Trade Information: *C. auriculata* is apparently difficult to maintain in cultivation. As a result, it is unlikely to be vulnerable to collection.

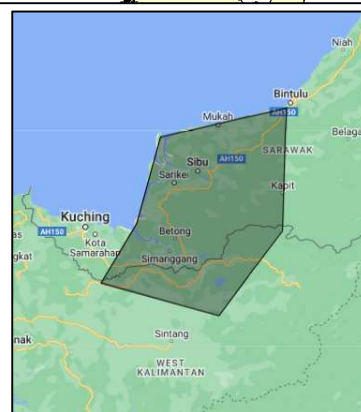
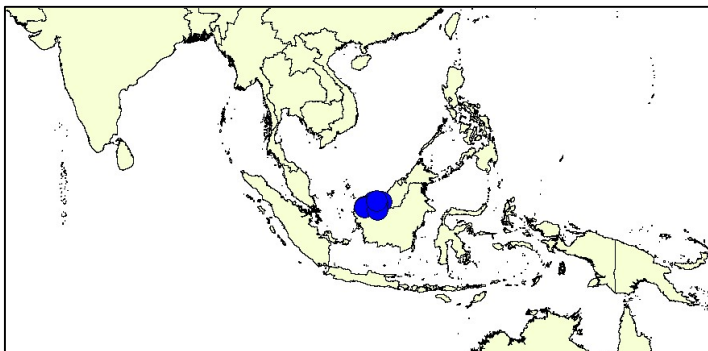
Threats: Most of the sites where this species occurs are not protected and are therefore already suffering from or threatened by the factors affecting all lowland river systems in Borneo. These include the primary and secondary effects of forest degradation and clearance, direct habitat destruction and pollution. It occurs in one strictly protected area, however even here it is vulnerable to illegal collection.

Conservation: There are no conservation measures in place specifically for this species. It occurs in Lanjak Entimau Wildlife Sanctuary which is strictly protected and where the risk of habitat destruction should be limited. There is an urgent need to visit known populations to assess the current level threat to the species and habitat, as well as to assess potential for protection of more populations. There is also a need to assess the level of protection within Lanjak Entimau Wildlife Sanctuary, if this represents more than 30% of populations, then no more action is needed but there is a need to ensure that the Sanctuary will protect the species.

Red List Assessment: VU B1ab(iii)+2ab(iii).

Assessment Rationale: *C. auriculata* is known only from ten locations in habitat which is severely threatened throughout the region. It occurs in a strictly protected area, where it should be relatively secure, however in spite of this protection, it remains vulnerable to illegal collection. It is therefore classed as Vulnerable.

Reviewers: N. Jacobsen, S. Wongso.



7. *Cryptocoryne bangkaensis* Bastm. 2007

Distribution: *C. bangkaensis* is endemic to Indonesia, where it is known from the islands of Sumatra, Bangka and Belitung, where it is widespread and at least locally abundant. The distribution of *Cryptocoryne* species has not been thoroughly investigated in South Sumatra Province and it is possible that more populations of this species will be found by further surveys.

EOO: 88,876 km²

AOO: 136 km²

Countries of Occurrence: Indonesia (Sumatra).

Population: There is no information on population size in this species.

Habitats and Ecology: *C. bangkaensis* grows on mud or sand on the beds of slow-flowing streams and small rivers in primary or secondary forest. It has been recorded with *Cryptocoryne longicauda* on Bangka, *C. fusca* on Belitung and *C. cordata* var. *diderici* on Sumatra. 0-65 m.

General Use and Trade Information: This species is considered unsuitable for cultivation in typical aquarium conditions. It is therefore unlikely to be threatened by collection.

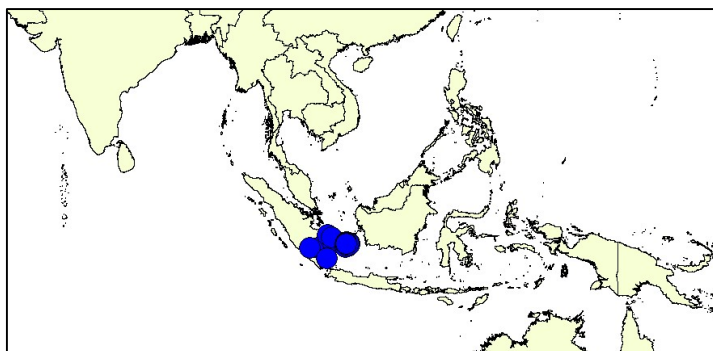
Threats: *C. bangkaensis* is threatened by the factors which affect flowing water systems in the region. These include destruction and clearance of forest with consequent changes to hydrology, sediment load and water quality. However, its occurrence on three separate islands and the likelihood of more populations being found in South Sumatra mean that it may be considered reasonably secure.

Conservation: There are no conservation measures in place specifically for this species and no urgent need for conservation action.

Red List Assessment: LC

Assessment Rationale: The occurrence of *C. bangkaensis* on three separate islands and the likelihood of more populations being found in South Sumatra mean that it may be considered reasonably secure. It is therefore classed as Least Concern.

Reviewers: N. Jacobsen, S. Wongso.



8. *Cryptocoryne bastmeijeri* Wongso 2017

Distribution: *C. bastmeijeri* is endemic to the Schwaner Mountains in West Kalimantan, where it has been recorded from four sites south-west of Sintang.

EOO: 3,742 km²

AOO: 16 km²

Countries of Occurrence:
Indonesia (Kalimantan).

Population: Each of the known populations includes a few hundred individuals.

Habitats and Ecology: *C. bastmeijeri* has been recorded from a stream in swamp forest, where it grew in mud and sand in clear, slow-flowing water. 175 – 200 m.

General Use and Trade Information: This species is available in cultivation and is apparently easily cultivate. It is therefore vulnerable to uncontrolled and/or illegal collection.

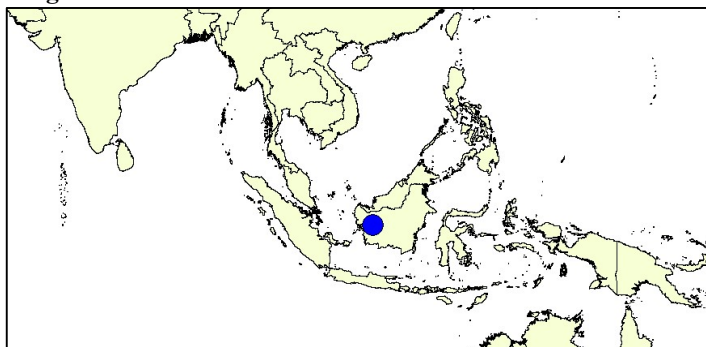
Threats: *C. bastmeijeri* occurs in hilly areas which remain relatively inaccessible, which may provide some security. However, the area has no formal protection and is vulnerable to the factors which affect flowing water systems in the region. These include destruction and clearance of forest with the consequent changes to hydrology, sediment load and water quality.

Conservation: There are no conservation measures in place specifically for this species. Whilst this species does not occur in a formally protected area, it occurs in an area which is relatively inaccessible, which may afford it some protection, although lowland habitats within a few kilometres have been cleared for agriculture. See detailed proposal Chapter 5.4.3.

Red List Assessment: VU D2.

Assessment Rationale: *C. bastmeijeri* is known from four populations in a region where the habitat in which it occurs is threatened by habitat destruction and degradation, while the species itself is extremely vulnerable to illegal collection. The level of threat to forest and flowing water systems in the region, combined with the extremely small known populations mean that this species must be considered highly threatened. One of the known populations is adjacent to an area cleared for cultivation and while the habitats supporting the species and the immediate area in which the other three populations occur appear to be relatively intact, any loss of populations or extension of this cultivated area could be potentially catastrophic. It is classed as Vulnerable due to the extremely small population size and level of threat, recognising that if any actions adversely affect the area in which it occurs, this classification will be revised to Critically Endangered.

Reviewers: N. Jacobsen, S. Wongso.



9. *Cryptocoryne beckettii* Thw. ex Trim. 1885

Distribution: *C. beckettii* is endemic to central and southern Sri Lanka.

EOO: 13,931 km²

AOO: 68 km²

Countries of Occurrence: Sri Lanka

Population: There is no information on population size or trends in this species.

Habitats and Ecology: This species grows in springs and in sheltered places along fast-flowing rivers, submerged in the channel or on the margins under light tree and scrub cover. It can tolerate direct sunlight, although more luxuriant stands occur in shade. It will persist in secondary habitats, such as secondary forest, in ditches in rubber plantations, in a river regulated upstream by a reservoir and at one site in rice fields, where it occurred with *C. wendtii* (Kasselmann 2020). It has been recorded growing with dense populations of *Cryptocoryne parva*. 0-530 m.

General Use and Trade Information: This species has been in cultivation for a long time, it apparently grows well, but as it is a good species for normal aquarium cultivation, it is vulnerable to uncontrolled and/or illegal collection.

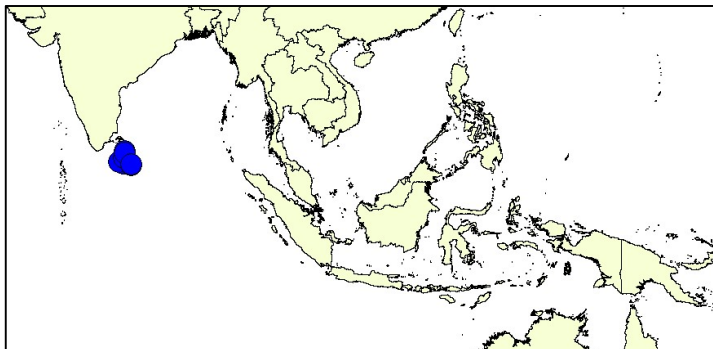
Threats: *C. beckettii* is threatened throughout its range by forest clearance and degradation, as well as the secondary effects of soil disturbance such as increased turbidity of rivers. It may also be threatened by uncontrolled and/or illegal collection.

Conservation: There are no conservation measures in place specifically for this species. It is classed as VU B1ab(i, ii, iii) (National Red List 2020). See detailed proposal Chapter 5.4.7

Red List Assessment: NT EN B2ab(i, iii)

Assessment Rationale: The habitats on which *C. beckettii* depends are threatened both directly by deforestation and development as well as by the secondary effects of these activities, such as increased turbidity of flowing waters. However, it occurs in a range of widely separated sites, involving a large number of river systems, as well as in springs and sources. It is therefore classed as Near Threatened, recognising that if data can be obtained on the conservation condition of each population, it may well become evident that it is undergoing a population decline and qualify as Endangered.

Reviewers: N. Jacobsen, D. Yakandawala.



10. *Cryptocoryne bogneri* Rataj 1975

Distribution: *C. bogneri* is endemic to south-western Sri Lanka, where it is known from a small number of scattered sites.

EOO: 193 km²

AOO: 20 km²

Countries of Occurrence: Sri Lanka

Population: Most available evidence is anecdotal and there have been no coordinated surveys of the known populations, nor searches for potential additional populations within the area. *C. bogneri* is currently known from four populations, all of which involve very small numbers of plants and none of which have been recorded since 2005. This is considered to be one of the most threatened *Cryptocoryne* species in Sri Lanka.

Habitats and Ecology: *C. bogneri* grows in narrow, shallow, nutrient-poor streams with a rocky bed interspersed with gravel, sand and some clay under a layer of decaying organic material, occasionally up to 1 m deep, in dense forest. It has also been recorded from a ditch, approximately 3 m wide growing with *Lagenandra bogneri*. 60-270 m.

General Use and Trade Information: This species is considered very difficult to cultivate and is not suited for typical aquaria. It is unlikely to be threatened by collection.

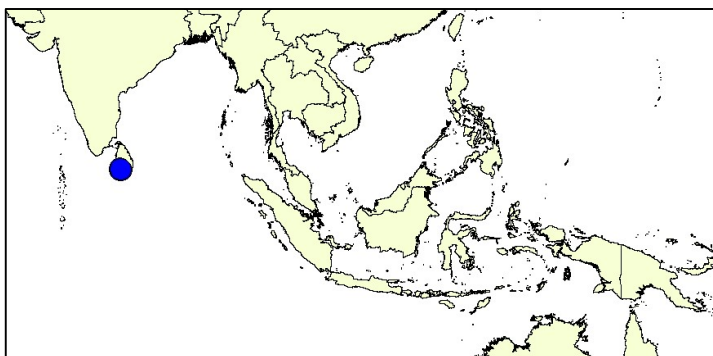
Threats: While some of the sites from which *C. bogneri* is known are in well-forested, upland areas, others are in lowland areas which have little remaining natural habitat. All of the sites where it occurs are threatened by deforestation and the secondary effects of forest degradation, such as increased turbidity in flowing waters. The type locality near Atweltotoa was visited in 2003 and considered to be unchanged from the original visit in 1973 (Kasselmann 2020).

Conservation: There are no conservation measures in place specifically for this species. It is not known to occur in any protected areas. It is classed as CR B1ab(i, ii, iii)+2ab(i, ii, iii) (National Red List 2020). See detailed proposal Chapter 5.4.18.

Red List Assessment: CR B1ab(iii)+2ab(iii)

Assessment Rationale: *C. bogneri* occurs in a limited range of habitats in a very restricted area. The habitats on which it depends are threatened by destruction and degradation and it is therefore classed as Critically Endangered. The assessment submitted was classed as EN B1ab(ii, iii, v)+2 ab(ii, iii, v) but this should be modified.

Reviewers: N. Jacobsen, D. Yakandawala.



11. *Cryptocoryne bullosa* Becc. ex Engl. 1879

Distribution: *C. bullosa* is endemic to Borneo, where it has been found at seventeen sites in Sarawak in the Krian, Sibiak and Kanowit River systems. Reports from other localities are erroneous.

EOO: 7,721 km²

AOO: 88 km²

Countries of Occurrence:

Malaysia (Sarawak).

Population: Most populations consist of many thousands of plants (N. Jacobsen pers. comm.), however these population may consist of small numbers of clones.

Habitats and Ecology: *C. bullosa* grows on sandy or gravel substrates in large, fast-flowing, forest rivers where plants are normally submerged and occur in larger, denser patches in fast flow. Stands will persist in secondary forest and it thrives on some degree of increased sediment deposition resulting from forest clearance. 5-135 m.

General Use and Trade Information: This species is available in cultivation, but must be considered to be at risk from uncontrolled and/or illegal collection.

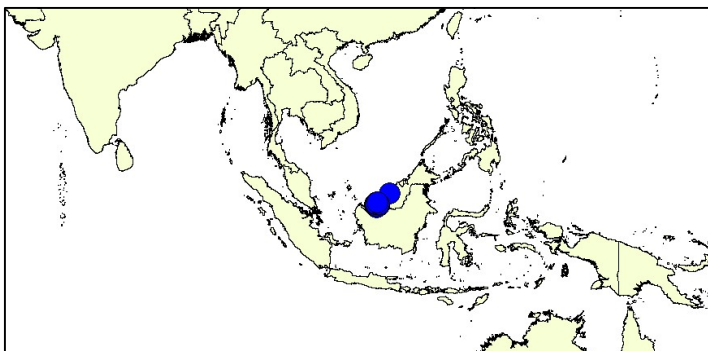
Threats: All known populations are threatened by logging (Ipor *et al.* 2007). The population at Bintulu is unlikely to survive more than a few years as it is surrounded by urban development. This would reduce the EOO from 7,700 km² to 2,288 km². It may also be threatened by uncontrolled and/or illegal collection.

Conservation: There are no conservation measures in place specifically for *C. bullosa*. None of the known populations are in protected areas, many are close to or even surrounded by clear-felled areas and some may already have been lost. There is a need for surveys to confirm the current conservation status of the different populations and the level of threat to these, as well as to define areas for protection, including catchment/watershed protection. Conservation action could be linked to conservation of *C. ciliata* var. *bogneri*.

Red List Assessment: NT EN B1ab(i, ii, iii, iv, v)+2 ab(i, ii, iii, iv, v)

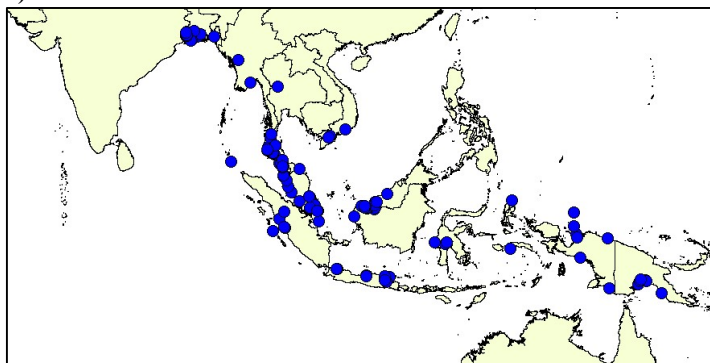
Assessment Rationale: *C. bullosa* is relatively widespread and occurs on a number of scattered river systems in Sarawak. However, most populations are heavily threatened by logging or urban development, while others may be vulnerable to illegal collection. The small AOO and high level of threat to this species justify its classification as Near Threatened with the expectation that surveys will show an ongoing decline which then meets the criteria for Endangered.

Reviewers: N. Jacobsen, S. Wongso



12. *Cryptocoryne ciliata* (Roxb.) Schott in H.W.Schott & S.L.Endlicher 1832

Taxonomic note: Three varieties are recognised within *C. ciliata*, var. *bogneri* which is endemic to Sarawak, var. *ciliata* which occurs throughout the range of the species, var. *latifolia* which is known from a number of localities throughout SE Asia and sometimes occurs in mixed populations with var. *ciliata*.



Distribution: *C. ciliata* occurs from eastern India, south and east through South-east Asia to New Guinea and New Caledonia. It was reported from the Andaman and Nicobar Islands by Cook (1996). A recent record from Palawan is considered likely to involve plants introduced by an aquarist.

EOO: 12,459,084 km²

AOO: 492 km²

Countries of Occurrence: Bangladesh, India, Indonesia, Malaysia, Myanmar, New Guinea, Thailand, Vietnam.



Population: This species is widespread and locally abundant. There is no information on population trends but no reason to consider that they are declining.

Habitats and Ecology: *C. ciliata* typically grows in the muddy margins of rivers, streams and ditches in coastal areas where stands are inundated twice daily, but not necessarily by brackish water. It often occurs with mangroves such as *Brugiera* and *Rhizophora* species, as well as *Nypa fruticans*. It will occur in direct sunlight, although the leaves are usually covered with a fine layer of silt, deposited by high water. It also occasionally occurs in freshwater swamps and rivers and has been recorded from a canal in a fruit plantation, but always near the coast. It has been recorded with other species such as *Agladodorum griffithii*, *Cryptocoryne ferruginea*, *C. lingua* and *Eichhornia crassipes*. 0-100 m

General Use and Trade Information: This species is widely available in cultivation and easily propagated. It is consequently likely to be threatened by uncontrolled and/or illegal collection.

Threats: Many sites supporting this species are threatened by destruction and degradation of forest habitat, the secondary effects of these actions and other factors typically affecting lowland wetlands in the region. It may also be threatened by uncontrolled and/or illegal collection.

Conservation: There are no conservation measures in place specifically for this species and none needed. Populations of this species occur in a number of protected areas, such as Hutan Pantim Timor Nature Reserve.

Red List Assessment: LC

Assessment Rationale: *C. ciliata* has a very wide range and is locally frequent in suitable habitat. No threats are known which could affect all populations and it is therefore classed as Least Concern.

Reviewer: N. Jacobsen

12a. *Cryptocoryne ciliata* var. *bogneri* N.Jacobsen 2018

Distribution: *C. ciliata* var. *bogneri* is known from a single site on the Seblak River at Saratok, Betong Division in Sarawak.

Countries of Occurrence: Malaysia (Sarawak).

EOO: 4 km²

AOO: 4 km²

Population: There is no information on population size in this species.

Habitats and Ecology: There is no information on the habitats in which *C. ciliata* var. *bogneri* was found but it is likely to be within the tidal reaches of the river.

General Use and Trade Information: *C. ciliata* var. *bogneri* is not widely cultivated and could be significantly threatened by collection.

Threats: The majority of the forest cover in the downstream 30 km of the Sungai Seblak has been cleared and converted to agriculture. It is very likely that even the riparian fringe is threatened by clearance and development. This variety is threatened by ongoing habitat degradation, pollution, the secondary impacts of upstream deforestation and over-collection.

Conservation: There are no conservation measures in place specifically for *C. ciliata* var. *bogneri*. The site where it was found has no formal protection. There is a need for surveys to confirm the current conservation status of the population and the level of threat, as well as to map the extent of the population, combined with measures to protect the river channel and margins and to define areas for protection, including catchment/watershed protection. Conservation action could be linked to conservation of *C. bullosa*.

Red List Assessment: CR B1ab(iii, v)+B2ab(iii, v).

Assessment Rationale: *C. ciliata* var. *bogneri* is threatened by ongoing habitat degradation, pollution, the secondary impacts of upstream deforestation and over-collection. It is known from a single site and is therefore classed as Critically Endangered.

Reviewer: N. Jacobsen



12b. *Cryptocoryne ciliata* var. *ciliata*

Distribution: *C. ciliata* var. *ciliata* occurs from eastern India, south and east through South-east Asia to New Guinea and New Caledonia. It was reported from the Andaman and Nicobar Islands by Cook (1996).

EOO: 12,459,084 km²

AOO: 476 km²

Countries of Occurrence:

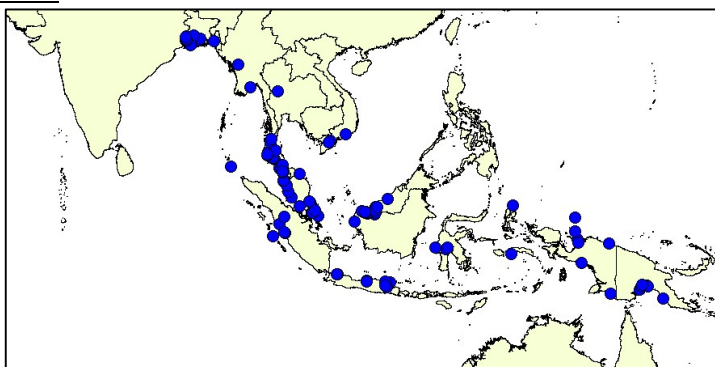
Bangladesh, India, Indonesia, Malaysia, Myanmar, New Caledonia, New Guinea, Thailand, Vietnam.

Population: This variety is widespread and locally abundant. There is no information on population trends but no reason to consider that they are declining.

Habitats and Ecology: *C. ciliata* var. *ciliata* typically grows in the muddy margins of rivers, streams and ditches in coastal areas where stands are inundated twice daily, but not necessarily by brackish water. It often occurs with mangroves such as *Brugiera* and *Rhizophora* species, as well as *Nypa fruticans*. It will occur in direct sunlight, although the leaves are usually covered with a fine layer of silt, deposited by high water. It also occasionally occurs in freshwater swamps or rivers and has been recorded from a canal in a fruit plantation, but always near the coast. It has been recorded with other species such as *Aglaodorum griffithii*, *Cryptocoryne ferruginea*, *C. lingua* and *Eichhornia crassipes*. 0-100 m

General Use and Trade Information: *C. ciliata* var. *ciliata* is widely available in cultivation and easily propagated. It is consequently likely to be threatened by uncontrolled and/or illegal collection.

Threats: Many sites supporting this variety are threatened by destruction and degradation of forest habitat, the secondary effects of these actions and other factors typically affecting lowland wetlands in the region. It may also be threatened by uncontrolled and/or illegal collection.



Conservation: There are no conservation measures in place specifically for *C. ciliata* var. *ciliata* and none needed. Populations of this variety occur in a number of protected areas, such as Hutan Panti Timor Nature Reserve.

Red List Assessment: LC

Assessment Rationale: This variety has a very wide range and is locally frequent in suitable habitat. No threats are known which could affect all populations and it is therefore classed as Least Concern.

Reviewer: N. Jacobsen

12c. *Cryptocoryne ciliata* var. *latifolia* Rataj 1975

Taxonomic Note: Few populations have been confirmed as *C. ciliata* var. *latifolia* and as it sometimes grows mixed with var. *ciliata*, it is difficult to define its precise status.

Distribution: *C. ciliata* var. *latifolia* is known to occur in Thailand (Bangkok), Cambodia, Malaysia (Peninsular, Sabah and Sarawak), Indonesia (Bintan, Anambas, Moluccas - Morotai, Ambon) and the Philippines (Palawan). The population in Palawan was probably introduced by an aquarist

EOO: ?

AOO: ?

Countries of Occurrence: Thailand, Malaysia, Cambodia, Indonesia, Philippines.

Population: Known populations contain thousands of individuals but there is no information on the genetic diversity of populations.

Habitats and Ecology: *C. ciliata* var. *latifolia* typically grows in the muddy margins of rivers, streams and ditches in coastal areas where stands are inundated twice daily, but not necessarily by brackish water. It often occurs with mangroves such as *Brugiera* and *Rhizophora* species, as well as *Nypa fruticans*. It often occurs in direct sunlight, although the leaves are usually covered with a fine layer of silt, deposited by high water. 0-100 m.

General Use and Trade Information: *C. ciliata* var. *latifolia* is widespread in cultivation and is easily propagated. It is therefore threatened by uncontrolled and/or illegal collection.

Threats: Many sites supporting *C. ciliata* var. *latifolia* are threatened by destruction and degradation of forest habitat, the secondary effects of these actions and other factors typically affecting lowland wetlands in the region. It may also be threatened by uncontrolled and/or illegal collection.

Conservation: There are no conservation measures in place specifically for this variety and none needed. Populations of this species occur in a number of protected areas. This variety is classed as Data Deficient mainly due to a lack of critical review of the identity of populations of *C. ciliata* throughout its range. It is unlikely to be threatened but it is important that efforts are made to confirm the identity of populations at varietal level whenever the opportunity arises.

Red List Assessment: DD

Assessment Rationale: The limited number of populations which have been distinguished from var. *ciliata* mean that available information is inadequate to derive an informed assessment of the extinction risk to *C. ciliata* var. *latifolia*. It is therefore classed as Data Deficient.

Reviewer: N. Jacobsen

13. *Cryptocoryne cognata* Schott 1857

Distribution: *C. cognata* is endemic to India, where there are confirmed populations from five areas on the west coast: Pimpalwadi in Sindhudurg (near Mumbai); near Kudavale in Dapoli Taluka; between Phansop and Pali; as well as in Holi Village in Ratnagiri Taluka, all in Maharashtra State. Reports from Goa and Karnataka are unconfirmed.

EOO: 4,862 km²

AOO: 32 km²

Countries of Occurrence: India

Population: There is little information on the condition of populations, except at Holi Village, where a healthy population was found along 500 m of the stream.

Habitats and Ecology: *C. cognata* occurs in fast-flowing acid streams in partial shade, where it grows rooted in sand, gravel or stony (laterite) substrate and in the margins in shallow water. 0-200 m.

General Use and Trade Information: *C. cognata* is uncommon in cultivation because it does not develop stolons and is therefore difficult to propagate. It has proved difficult, if not impossible to maintain it for extended periods in cultivation. However, due to its “rarity” it could be of interest as a collector’s item and it could be vulnerable to over-collection from the wild.

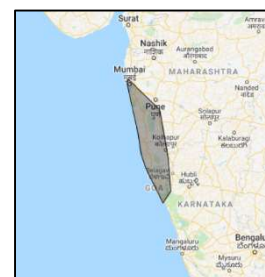
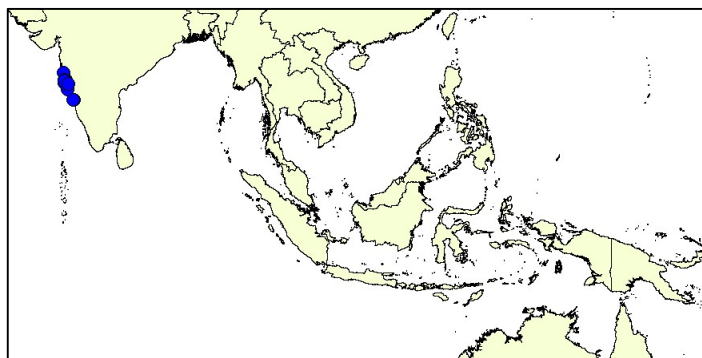
Threats: Populations of *C. cognata* are threatened by industrial development, construction of power plants, mining and tourist development, as well as by factors which affect all flowing water systems in the region, such as increasing turbidity and water pollution. Some water bodies supporting this species show high phosphate levels due to detergent and fertiliser run-off, leading to dense algal growth. Any collection from the wild could have a significant adverse effect on populations.

Conservation: There are no conservation actions in place for *C. cognata*. See detailed proposal Chapter 5.4.12.

Red List Assessment: VU B1ab(ii, iii)+B2ab(ii, iii).

Assessment Rationale: *C. cognata* is known from few sites, all of which are threatened by actions such as industrial development, construction of power plants, mining and tourism. Without detailed information, all populations must be treated as separate locations and it is therefore classed as Vulnerable.

Reviewers: N. Jacobsen, A. Watve, S. Wongso



14. *Cryptocoryne consobrina* Schott 1857

Distribution: *C. consobrina* is endemic to India, where it is known from the Western Ghats in southern Karnataka, Kerala (Palakkad, Malappuram and Calicut Districts) and Tamil Nadu (Coimbatore, Nilgiris).

EOO: 15,868 km²

AOO: 36 km²

Countries of Occurrence: India.

Population: There is no information on population size in this species.

However, it is described as occurring in dense stands at intervals along rivers (C. Kasselman pers. comm.).

Habitats and Ecology: *C. consobrina* occurs on stream and river banks in dry deciduous forest, in marshy areas in evergreen forests and on the margins of canals and dams, on clayey substrates (Sunil and Sivadasan 2009). 120-850 m.

General Use and Trade Information: *C. consobrina* is rare or virtually unknown in cultivation. It may be extremely vulnerable to collection for cultivation and sale, however it is very likely to be overlooked due to its growth form.

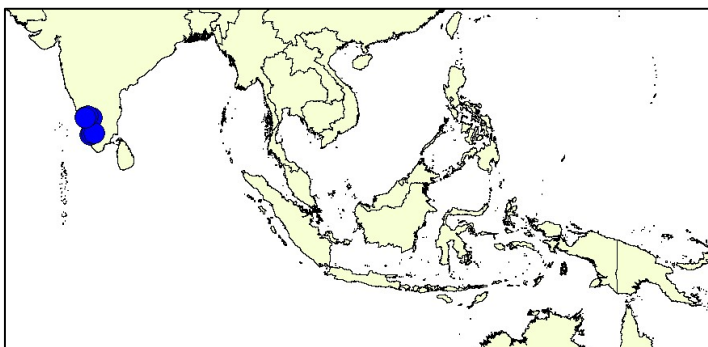
Threats: *C. consobrina* is declining due to habitat destruction, including construction of dams and canals. Remaining population are threatened by the same factors, as well as by increased turbidity and pollution of flowing water courses.

Conservation: There are no conservation actions in place for *C. consobrina*. It is known to occur in the Nigiri Biosphere Reserve, B.R. Hills Wildlife Sanctuary and Rajiv Gandhi National Park. See detailed proposal Chapter 5.4.12.

Red List Assessment: VU B1ab(iii)+2ab(iii).

Assessment Rationale: *C. consobrina* is known from fewer than ten locations and is undergoing a continuing decline in the quality of habitat as well as a decrease in the area of occupancy and extent of occurrence. However, its occurrence in two widely separated areas means that it is relatively resilient to local actions. It is therefore classed as Vulnerable.

Reviewers: N. Jacobsen, S. Wongso



15. *Cryptocoryne cordata* Griff. 1851

Taxonomic Note: Five varieties are currently recognised within *C. cordata*: var. *cordata* from Peninsular Malaysia and southern Peninsular Thailand, var. *diderici* from Sumatra, var. *grabowskii* from Borneo, var. *siamensis* from peninsula Thailand and. var. *wellyi* from south-eastern Sumatra.

EOO: 907,160 km²

AOO: 320 km²

Geographic Range: *C. cordata* occurs from Peninsular Thailand south through Peninsular Malaysia to the islands of Borneo and Sumatra.

Countries of Occurrence: Thailand, Malaysia (Peninsular Malaysia, Sarawak), Indonesia (Kalimantan, Sumatra).

Population: Known populations typically consist of thousands of individuals but there is no information on genetic diversity in populations.

Habitats and Ecology: *C. cordata* occurs in forest streams and small rivers, peat and *Pandanus*-dominated swamps and forest pools, as well as in springs arising from limestone. It occurs in both still and fast-flowing water over peat, gravel and limestone with organic matter, as well as with the zone of tidal influence. It will persist in secondary habitats such as rubber and oil-palm plantations. It has been recorded with *Azolla* sp., *Barclaya longifolia*, *B. motleyi*, *Blyxa* sp., *Crinum thaianum*, *Cryptocoryne longicauda*, *Hydrilla verticillata*, *Leptochilus pteropus*, *Nitella* sp. and *Riccia* sp., also with an introduced population of *Echinodorus grisebachii* in a pond and its outlet river. 0-125 m.

General Use and Trade Information: *C. cordata* is widespread in the aquarium trade. It may therefore be threatened by uncontrolled and/or illegal collection.

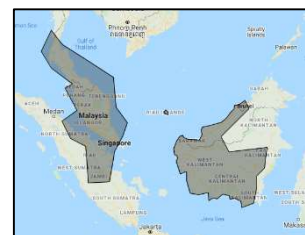
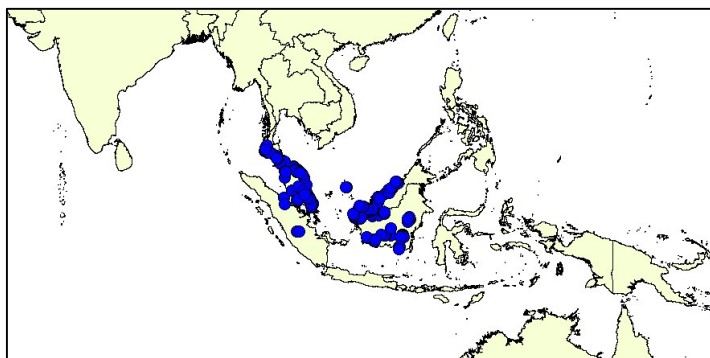
Threats: Habitats and sites in which *C. cordata* occurs are threatened by the factors which affect all wetlands in the region, including deforestation and the secondary effects of this, as well as urbanisation and habitat degradation. It is also threatened by uncontrolled and/or illegal collection.

Conservation: There are no conservation actions specifically in place for *C. cordata* and none needed. It is known to occur in three protected areas: Endau Rompin National Park, Gunung Arong Recreational Forest and Panti Recreational Forest.

Red List Status: LC

Assessment Rationale: This species is widespread and certainly locally abundant over a fairly large area with no evidence of a decline beyond that caused by forest clearance. It is therefore classed as Least Concern.

Reviewers: Maxwell, J., Jacobsen, N. and Allen, D.J.

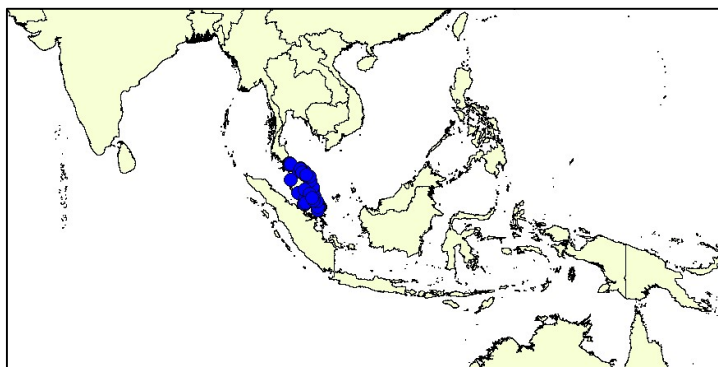


15a. *Cryptocoryne cordata* var. *cordata*

Distribution: *C. cordata* var. *cordata* occurs throughout Peninsular Malaysia, as well as in Narathiwat and Songkhla Provinces in southern Peninsular Thailand.

Countries of Occurrence: Malaysia, Thailand.

Population: Populations often consist of thousands of



individuals but there is no information on genetic diversity within populations.

Habitats and Ecology: *C. cordata* var. *cordata* occurs in streams and small rivers flowing over acid peat in lowland forest, including in peat swamp forest and fresh water tidal zones. 0-125 m.

EOO: 169,988 km²

AOO: 232 km²

General Use and Trade Information: *C. cordata* var. *cordata* is considered to be unsuitable for normal aquaria and is therefore unlikely to be threatened by over-collecting.

Threats: Habitats and sites in which *C. cordata* var. *cordata* occurs are threatened by the factors which affect all wetlands in the region, including deforestation and the secondary effects of this, as well as urbanisation and habitat degradation.

Conservation: There are no conservation actions specifically in place for *C. cordata* var. *cordata* and none needed. It is known to occur in three protected areas: Princess Sindrihorn Swamp Forest Research Centre, Endau Rompin National Park, Gunung Arong Recreational Forest and Panti Recreational Forest.

Red List Assessment: LC

Assessment Rationale: *C. cordata* var. *cordata* is widespread and known from a large number of sites. Whilst some populations may be threatened by a range of factors, overall the variety is considered to be secure and is classed as Least Concern.

Reviewer: N. Jacobsen



15b. *Cryptocoryne cordata* var. *diderici* (de Wit) N.Jacobsen 2002

Distribution: *C. cordata* var. *diderici* is known from central Sumatra, where it has been recorded from near Tanjung, between Kotabaru and Muaratebo in Jambi Province. There is also a literature reference to material from “north of Malacca” in Peninsular Malaysia, however there is no evidence to support the suggestion that this variety occurs in Peninsular Malaysia and the record is dismissed unless confirmation can be made.

EOO: -

AOO: 8 km²

Countries of Occurrence: Indonesia (Sumatra).

Population: There is no information on population size in this variety.

Habitats and Ecology: The habitat of *C. cordata* var. *diderici* is poorly known. It has been recorded from a muddy stream, probably associated with peat swamp forest. 40-50 m.

General Use and Trade Information: *C. cordata* var. *diderici* is considered to be reasonably easy to cultivate and propagate, it is therefore likely to be at high risk of uncontrolled and/or illegal collection.

Threats: Both areas from which *C. cordata* var. *diderici* have been recorded are highly modified, by deforestation and conversion to agriculture or urbanisation. Whilst it is possible that there are other populations in the area, the degree of deforestation and habitat modification in the areas where it is known are such that all populations must be considered severely threatened. It is also highly threatened by uncontrolled and/or illegal collection.

Conservation: There are no conservation measures in place for *C. cordata* var. *diderici* and it is not known from any protected areas. See detailed proposal Chapter 5.4.6.



Red List Assessment: CR B1ab(iii, v)+B2ab(iii, v).

Assessment Rationale: Although there has been relatively little survey effort in the area which would be likely to locate populations of this variety, it is clear that any additional populations in the area would also be severely threatened. Given the small number of known locations and the level of habitat destruction in the area, *C. cordata* var. *diderici* is classed as Critically Endangered.

Reviewers: N. Jacobsen, S. Wongso

15c. *Cryptocoryne cordata* var. *grabowskii* (Engl.) N.Jacobsen 2002

Distribution: *C. cordata* var. *grabowskii* is widespread in coastal areas of Kalimantan and Sarawak, it has also been reported from Subi-besar Island.

EOO: 555,143 km²

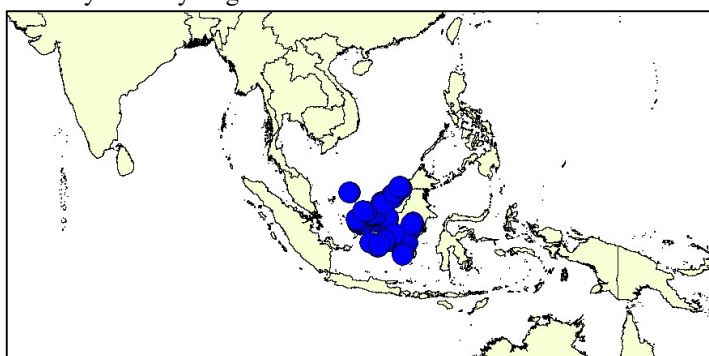
AOO: 312 km²

Countries of Occurrence: Malaysia (Sarawak), Indonesia (Kalimantan), Natuna

Population: Some populations of this variety are very large.

Habitats and Ecology:

C. cordata var. *grabowskii* grows on sand, gravel, silt and organic debris in slow-flowing streams and rivers in lowland forest, in peat swamps and forest pools, as well as in reaches influenced by tidal fluctuations in depth. It can tolerate direct sunlight but is most often recorded in shade. It often occurs with *Barclaya motleyi* and has been recorded with other species such as *Cryptocoryne longicauda* and *Blyxa* sp.



General Use and Trade Information: *C. cordata* var. *grabowskii* is not suitable for normal aquaria as it does not grow well in hard water, although it is considered easy to cultivate emerged. It is unlikely to be highly threatened by collection.

Threats: Many populations are threatened by the secondary effects of deforestation and land-clearance, such as mobilisation of sediment. Many populations now persist in oil palm plantations, urban or industrial areas but it is not clear how long they will survive.

Conservation: There are no specific conservation measures in place for *C. cordata* var. *grabowskii* and none needed. It is known to occur in some protected areas in Sarawak and Brunei.

Red List Assessment: LC

Assessment Rationale: *C. cordata* var. *grabowskii* is widespread throughout much of Borneo, however many areas where it occurs are threatened by deforestation and land-clearance, as well as by the secondary effects of these activities. Many populations are now within urban and industrial areas and may not persist. It is classed as Least Concern, however, this is with the expectation that it will be classed as Endangered if surveys demonstrate loss of significant numbers of populations.

Reviewers: N. Jacobsen, S. Wongso



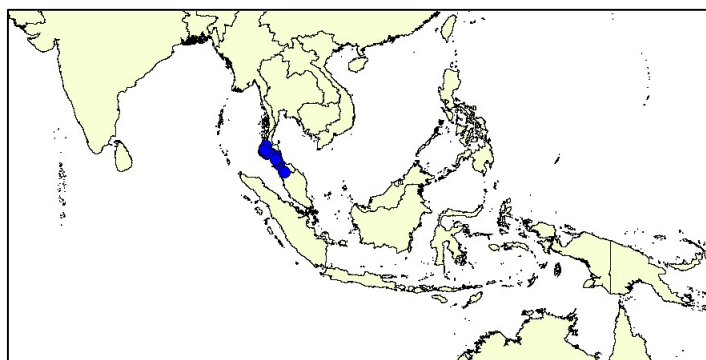
15d. *Cryptocoryne cordata* var. *siamensis* (Gagnep.) N.Jacobsen & Sookch. 2010

Distribution: *C. cordata* var. *siamensis* occurs in southern Peninsular Thailand, with a possible occurrence in north-west Peninsular Malaysia.

Countries of Occurrence: Thailand (Phangnga, Phuket, Krabi, Trang, Satun), Malaysia

Population: Populations often consist of thousands of individuals but there is no information on genetic diversity within populations.

Habitats and Ecology: *C. cordata* var. *siamensis* typically occurs in streams and small rivers with fast-flowing water, often arising on limestone, so the water is less acid than is typical for other varieties of *C. cordata*. It has also been recorded from a small stream with sandy substrate in a rubber plantation, from a *Pandanus*-dominated swamp and from a deep lime-rich pond associated with a spring. It has been recorded with *Azolla* sp., *Barclaya longifolia*, *Blyxa* sp., *Crinum thaianum*, *Hydrilla verticillata*, *Leptochilus pteropus*, *Nitella* sp. and *Riccia* sp., as well as with an introduced population of *Echinodorus grisebachii* in a river and a pond. 0-50 m.



General Use and Trade Information: *C. cordata* var. *siamensis* is considered easy to cultivate and propagate under normal aquarium conditions. It may be threatened by uncontrolled and/or illegal collection.

Threats: Many sites supporting *C. cordata* var. *siamensis* are threatened by destruction and degradation of forest habitat, the secondary effects of these actions and other factors typically affecting lowland wetlands in the region. It may also be threatened by uncontrolled and/or illegal collection.



Conservation: There are no conservation measures in place specifically for *C. cordata* var. *siamensis* and none needed.

Red List Assessment: LC

Assessment Rationale: *C. cordata* var. *siamensis* has a fairly wide distribution and is fairly frequent throughout its range. There are no threats considered likely to affect a significant proportion of populations and it is therefore classed as Least Concern.

Reviewer: N. Jacobsen

15e. *Cryptocoryne cordata* var. *wellyi* Wongso 2019

Distribution: *C. cordata* var. *wellyi* is endemic to the island of Sumatra in Indonesia, where it was recorded from three sites in Riau Province in 2015-2016.

EOO: 12 km²

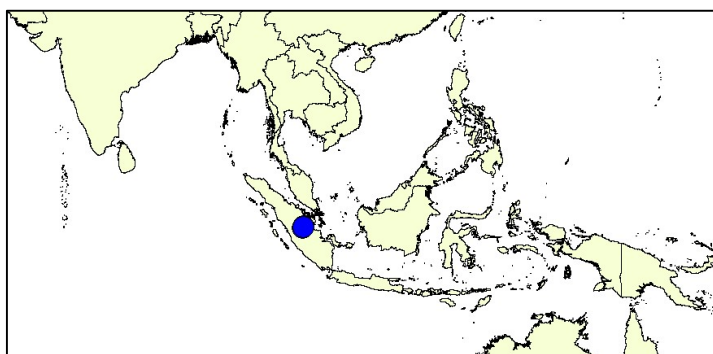
AOO: 12 km²

Countries of Occurrence: Indonesia (Sumatra).

Population: There is no information on population size in *C. cordata* var. *wellyi*.

Habitats and Ecology: *C. cordata* var. *wellyi* is known only from drainage canals in oil palm plantations, growing in silt with organic debris. This is a secondary habitat likely to be derived from small forest streams which were present before the forest was cleared. 50 – 100 m.

General Use and Trade Information: *C. cordata* var. *wellyi* is easily cultivated and propagated. It is considered to be extremely vulnerable to uncontrolled and/or illegal collection.



Threats: The only known populations of *C. cordata* var. *wellyi* have persisted after forest clearance in oil palm plantations. This is a secondary, highly managed habitat and it is likely that these populations will be lost through ongoing management of the plantations. Any remaining populations of this variety in natural habitats are likely to be highly threatened by forest clearance and the secondary effects of this action. It may also be threatened by uncontrolled and/or illegal collection.

Conservation: There are no conservation actions in place for *C. cordata* var. *wellyi* and no evidence that it occurs in protected areas. See detailed proposal Chapter 5.4.6.

Red List Assessment: EN B1ab(i, ii, iii, v)+2ab(i, ii, iii, v)

Assessment Rationale: This variety is known only from three sites in oil palm plantations in a very small area (EOO estimated to be less than 100 km²), where it is unlikely to persist in the long-term. Even if other populations remain in semi-natural habitats in the area, they are likely to be very vulnerable to forest clearance and the secondary effects of this action. This variety is therefore classed as Endangered.

Reviewers: N. Jacobsen, S. Wongso

16. *Cryptocoryne coronata* Bastm. & Wijng. 1999

Distribution: *C. coronata* is known only from Zamboanga on the western tip of Mindanao Island in the Philippines. It was identified from material exported for cultivation.

Countries of Occurrence: Philippines.

Population: There is no information on population size or trends in *C. coronata*.

Habitats and Ecology: There is no information on the habitat in which this species grows.

General Use and Trade Information: *C. coronata* is today unknown in cultivation and has been difficult to propagate, it is very likely to be vulnerable to over-collection if the site is rediscovered.

Threats: The lack of information on the sites and habitats where *C. coronata* occurs makes it impossible to assess threats.

Conservation: There are no conservation measures in place for *C. coronata* and no evidence that it occurs in protected areas. There is an urgent need to survey areas from which this species may have originated to try to find extant populations in the wild.

Red List Assessment: DD

Assessment Rationale: Available information is inadequate to derive an informed assessment of the extinction risk to *C. coronata* and it is therefore classed as Data Deficient.

Reviewers: N. Jacobsen, A. Naive.

17. *Cryptocoryne crispatula* Engl. 1920

Taxonomic Note: Eight varieties are currently recognised within *Cryptocoryne crispatula*:

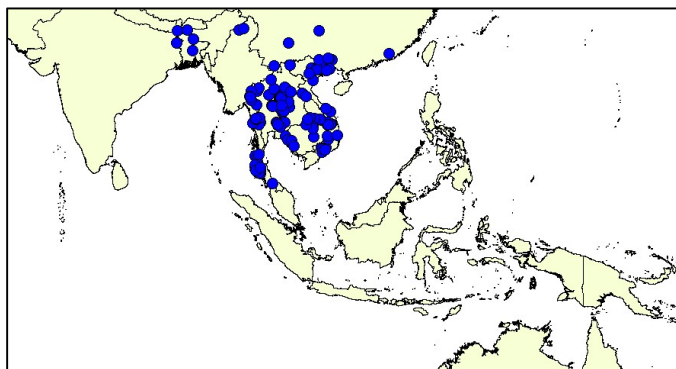
Cryptocoryne crispatula var. *albida*
Cryptocoryne crispatula var. *balansae*
Cryptocoryne crispatula var. *crispatula*
Cryptocoryne crispatula var. *decus-mekongensis*
Cryptocoryne crispatula var. *flaccidifolia*
Cryptocoryne crispatula var. *kubotae*
Cryptocoryne crispatula var. *planifolia*
Cryptocoryne crispatula var. *tonkinensis*
Cryptocoryne crispatula var. *yunnanensis*

Distribution: *C. crispatula* occurs from eastern India east to southern China and south to southern Peninsular Thailand.

Countries of Occurrence:

Bangladesh, Cambodia, China (Guangdong, Guangxi, Guizhou, Yunnan), India (Assam, Bihar, Meghalaya, West Bengal), Laos, Myanmar, Thailand

Population: Population sizes are different for the different varieties, but it often occurs in large populations.



Habitats and Ecology: The different varieties of this species occur in different habitats or, when they occur together, they generally occupy different elements of the same system. *C. crispatula* typically grows in fast-flowing water systems, from small, fast-flowing forest tributaries of the Mekong River to the main channel of the Mekong. It will occupy a range of substrate types from silt or mud banks through sand, gravel and cobble deposits to crevices and hollows in bedrock exposures. It will grow in crystal-clear, lime-rich forest streams, but is also capable of tolerating the densely turbid reaches of the Mekong where it typically forms only narrow leaves until exposed by falling water levels, some populations also tolerate brackish conditions in the tidal reaches of rivers. In Thailand it has been recorded growing with a range of other aquatic plant species including *Barclaya longifolia*, *Ceratopteris thalictroides*, *Crinum thianum*, *Hydrilla verticillata*, *Hygrophila polysperma*, *Ottelia alismoides*, *Nymphaea pubescens*, *Potamogeton* sp. and *Vallisneria* sp. 0-500 m.

General Use and Trade Information: In general, *C. crispatula* is not particularly well-suited to aquaria, except vars. *balansae*, *flaccidifolia*, *kubotae* and *tonkinensis* because of seasonal growth or difficulty of cultivation. Overall, it is likely to be at low risk of over-collecting, although some populations and some of the varieties may be at higher risk.

Threats: Habitats and sites in which *C. crispatula* occurs are threatened by the factors which affect all wetlands in the region, including deforestation and the secondary effects of this, as well as urbanisation and habitat degradation.

Conservation: There are no conservation measures in place specifically for *C. crispatula* and none needed at a species level. It is known to occur in a number of protected areas: Khao Yai National Park, Khlong Naka Game Sanctuary, Phou-Khao-Kuay National Park, Phu Khieo Wildlife Sanctuary and Umphang Wildlife Sanctuary in Thailand; and in Yod Dome Wildlife Sanctuary in Vietnam.

Red List Assessment: LC

Assessment Rationale: *C. crispatula* is widespread and certainly locally abundant over a fairly large area with no evidence of a decline beyond that caused by forest clearance. It is therefore classed as Least Concern.

Reviewer: N. Jacobsen

17a. *Cryptocoryne crispata* var. *albida* (Parker) N.Jacobsen, Maneean & T.Idei 2022

Distribution: *C. crispata* var. *albida* occurs in southern Myanmar, western and north-western Thailand and throughout much of Peninsular Thailand.

Countries of Occurrence: Myanmar, Thailand

Population: Populations are generally large, there is no information on population trends but there is no evidence of an overall decline.

Habitats and Ecology: *C. crispata* var. *albida* occurs in forested streams and small rivers flowing over sand, gravel and cobbles. It will occur with other *Cryptocoryne crispata* varieties, including var. *balansae* and var. *flaccidifolia*, in which situations it typically occurs at higher levels, usually developing leaves only when water levels fall. It has been recorded in diverse plant associations with *Barclaya longifolia*, *Blyxa aubertii*, *Ceratopteris thalictroides*, *Crinum thaianum*, *Cyperus helferi*, *Hydrilla verticillata*, *Limnophila rugosa*, *Leptochilus pteropus* and *Nitella* sp.

General Use and Trade Information: *C. crispata* var. *albida* is considered to be easy to grow and propagate, it is therefore vulnerable to commercial collection.

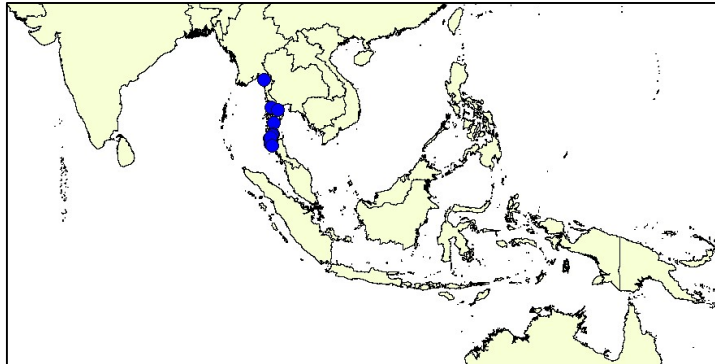
Threats: Some populations are threatened by factors which affect all water bodies in the region such as forest clearance and its secondary effects, urbanisation and pollution, however there is no evidence of a significant threat to *C. crispata* var. *albida* as a whole.

Conservation: There are no conservation measures in place specifically for *C. crispata* var. *albida* and none needed. This variety occurs in Khlong Naka Wildlife Sanctuary, Khao Sok N.P. and Phou-Khao-Kuay National Park in Thailand and populations occurring with *Crinum thaianum* will benefit from measures to protect that species.

Red List Assessment: LC

Assessment Rationale: This species is widespread and certainly locally abundant over a fairly large area with no evidence of a decline beyond that caused by forest clearance. It is therefore classed as Least Concern. This taxon is documented on the Red List as *C. albida*.

Reviewer: N. Jacobsen



17b. *Cryptocoryne crispata* var. *balansae* (Gagnep.) N.Jacobsen 1991

Distribution: *C. crispata* var. *balansae* occurs from Kachin State in northern Myanmar east to southern China and south to southern Peninsular Thailand.

Countries of Occurrence: China (Guangxi), Laos, Myanmar, Thailand, Vietnam.

Population: Populations are generally large. There is no information on population trends but there is no evidence of an overall decline.

Habitats and Ecology: *C. crispata* var. *balansae* grows in forested rivers and streams, typically in shallow reaches with some flow, over gravel or bedrock and often in situations where it is deeply submerged in the rainy season but more or less emerged in the dry season. It has been recorded growing with *Ceratopteris thalictroides*, *Crinum thaianum*, *Cryptocoryne crispata* var. *crispata*, *C. crispata* var. *flaccidifolia*, *C. crispata* var. *tonkinensis*, *Cyperus helferi*, *Hydrilla verticillata*, *Hygrophila polysperma*, *Limnophila indica* and *Nymphaea* cf. *rubra*. 0-700 m.

General Use and Trade

Information: *C. crispatula* var. *balansae* is considered easy to cultivate and propagate and is therefore unlikely to be severely threatened by over-collection for horticulture. In Thailand it is used as medicine for “kidney illness”, coughing and strength in men and is fed to pigs to improve the flavour of the meat. The pressure of collection for this purpose is unknown.

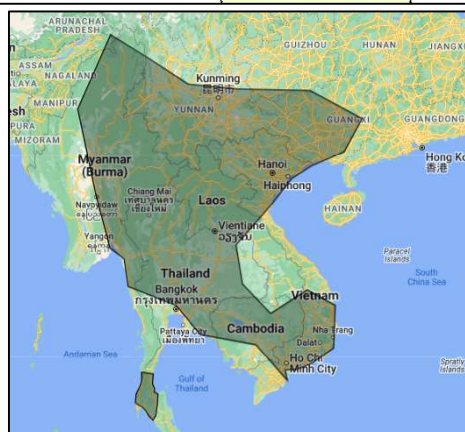
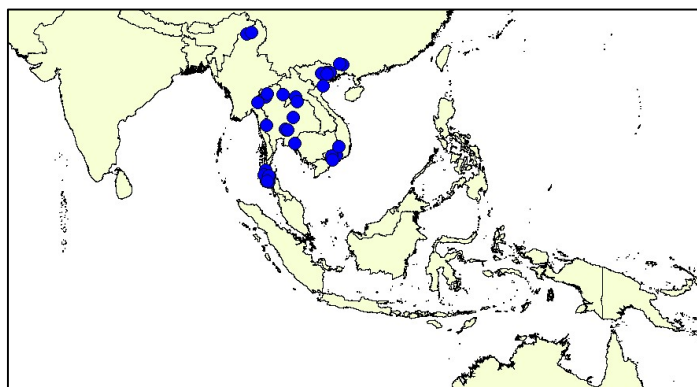
Threats: Habitats and sites in which *C. crispatula* var. *balansae* occurs are threatened by the factors which affect all wetlands in the region, including deforestation and the secondary effects of this, as well as urbanisation and habitat degradation.

Conservation: There are no conservation actions specifically in place for *C. crispatula* var. *balansae* and none needed. It is known to occur in three protected areas: Khao Yai National Park, Phu Khieo Wildlife Sanctuary and Umphang Wildlife Sanctuary in Thailand.

Red List Assessment: LC

Assessment Rationale: *C. crispatula* var. *balansae* is widespread and certainly locally abundant over a fairly large area with no evidence of a decline beyond that caused by forest clearance. It is therefore classed as Least Concern.

Reviewer: N. Jacobsen



17c. *Cryptocoryne crispatula* var. *crispatula*

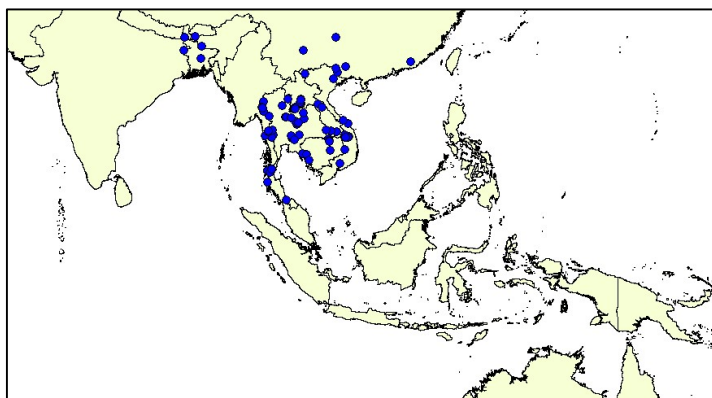
Distribution: *C. crispatula* var. *crispatula* occurs from eastern India and Bangladesh east to southern China and south to southern Peninsular Thailand.

Countries of Occurrence: Bangladesh, Cambodia, China (Guangdong, Guangxi, Guizhou), India (Assam, Bihar, Meghalaya, West Bengal), Laos, Myanmar, Thailand

Population: Populations of this variety are generally large. There is no information on population size or trends in *C. crispatula* var. *crispatula*, however there is no evidence to suggest that it is declining and it is therefore considered to be stable.

Habitats and Ecology:

C. crispatula var. *crispatula* grows in slow to fast-flowing forested streams and rivers, including the River Mekong, where it may occur in direct sunlight. It will grow on a range of substrates including calcareous habitats, from silt, sand, gravel or cobbles to boulders and bedrock. It will also grow in the lower reaches of rivers which may be influenced by tidal fluctuations. It has been recorded growing with *Cryptocoryne crispatula* var. *balansae*, *C. crispatula* var. *flaccidifolia* and a *Vallisneria* species. 100-500 m.



General Use and Trade Information: *C. crispatula* var. *crispatula* is not considered particularly suitable for cultivation in typical aquaria and is therefore unlikely to be severely threatened by over-collection.

Threats: Habitats and sites in which *C. crispatula* var. *crispatula* occurs are threatened by the factors which affect all wetlands in the region, including deforestation and the secondary effects of this, as well as urbanisation and habitat degradation.

Conservation: There are no conservation actions specifically in place for *C. crispatula* var. *crispatula* and none needed. It is known to occur in Khao Yai National Park in Thailand and other national parks.

Red List Assessment: LC

Assessment Rationale: *C. crispatula* var. *crispatula* is widespread and certainly locally abundant over a fairly large area with no evidence of a decline beyond that caused by forest clearance. It is therefore classed as Least Concern.

Reviewer: N. Jacobsen



17d. *Cryptocoryne crispatula* var. *decus-mekongensis* T.Idei, Bastm. & N.Jacobsen 2010

Distribution: *C. crispatula* var. *decus-mekongensis* is known only from a short section of the River Mekong in Champasak Province of Laos, but may be expected to occur elsewhere in the system.

EOO: 23 km²

AOO: 16 km²

Countries of Occurrence: Laos, Thailand (presence uncertain)

Population: *C. crispatula* var.

decus-mekongensis may form large populations where conditions are suitable. There is no information on population trends.

Habitats and Ecology: *C. crispatula* var. *decus-mekongensis* grows in areas which are deeply-submerged in the rainy season but exposed in the dry season. It occurs in situations with some shelter from the current, such as in sand and gravel or silt deposits between boulders or bedrock exposures, often in direct sunlight. It has been recorded growing with *C. crispatula* var. *crispatula*. 100 m.

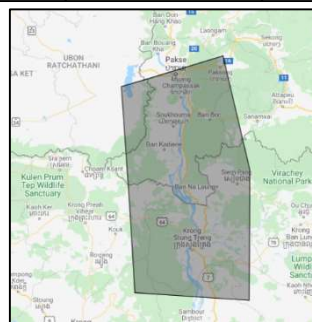
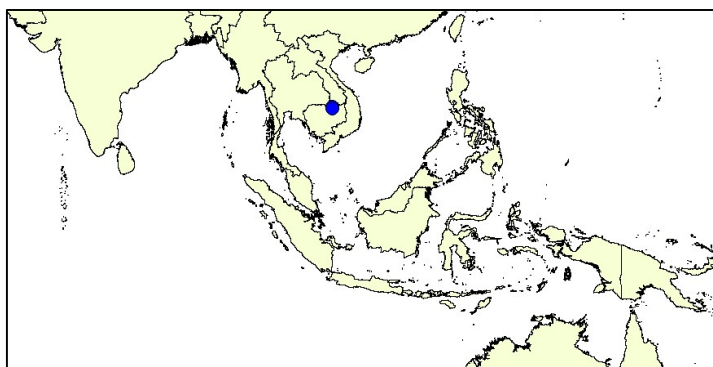
General Use and Trade Information: *C. crispatula* var. *decus-mekongensis* is not considered to be particularly suited to aquaria and is therefore unlikely to be severely threatened by over-collection.

Threats: *C. crispatula* var. *decus-mekongensis* is severely threatened by proposed dams on the River Mekong, even a small number of which could eradicate populations by stabilising water levels at a depth which would preclude flowering because *Cryptocoryne* species only flower when emersed.

Conservation: There are no conservation actions specific to *C. crispatula* var. *decus-mekongensis* and it is not known from any protected areas. See detailed proposal Chapter 5.4.9.

Red List Assessment: VU D2

Assessment Rationale: *C. crispatula* var. *decus-mekongensis* appears to be a small-scale endemic, occurring on a very short section of the River Mekong, where it is severely threatened by proposals to construct dams. It is feasible that construction of a single dam could destroy the entire population, which is therefore treated as a single location. It is classed as Vulnerable because it occurs only as a very small population which is threatened by dam construction



Reviewer: N. Jacobsen

17e. *Cryptocoryne crispatula* var. *flaccidifolia* N.Jacobsen 1991

Distribution: *C. crispatula* var. *flaccidifolia* is known only from Phangnga and Surat Thani Provinces in southern Peninsula Thailand.

EOO: 2,606 km²

AOO: 44 km²

Countries of Occurrence:
Thailand

Population: There is no information on population size or trends in *C. crispatula* var. *flaccidifolia*.

Habitats and Ecology: *C. crispatula* var. *flaccidifolia* typically grows in slow- or fast-flowing forest streams and small rivers on silt, gravel or stony substrates and generally in the deeper areas with a longer hydroperiod. It has been recorded with a wide range of aquatic plants species, including *Barclaya longifolia*, *Ceratopteris thalictroides*, *Crinum thaianum*, *Cryptocoryne crispatula* var. *balansae*, *Cyperus helferi*, *Hydrilla verticillata*, *Hygrophila polysperma*, *Limnophila indica*, *Nymphaea* cf. *rubra*, *N. pubescens* and *Potamogeton* sp.

General Use and Trade Information: *C. crispatula* var. *flaccidifolia* is considered easy to grow and easy to propagate. It is likely to be threatened by uncontrolled and/or illegal collection.

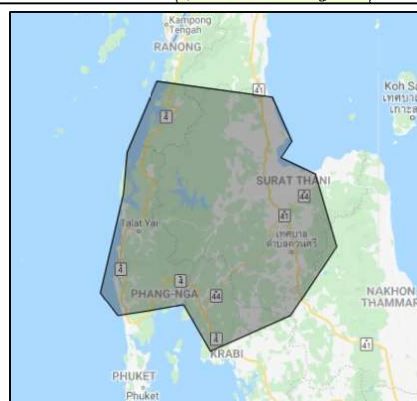
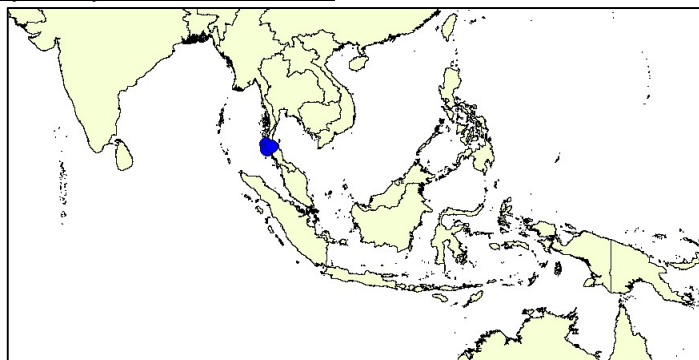
Threats: Forest and wetland habitats in southern Peninsular Thailand are highly threatened both by direct destruction, such as deforestation and development as well as by the secondary effects of these actions. *C. crispatula* var. *flaccidifolia* may also be threatened by uncontrolled and/or illegal collection.

Conservation: There are no conservation actions being undertaken specifically for *C. crispatula* var. *flaccidifolia*. It occurs in a river flowing out of Khao Sok NP, but it is not known whether it also occurs within the park boundary. There is an urgent need for information on the current conservation status of all known populations of this variety, including within Khao Sok NP, to establish whether this variety occurs inside the park boundaries, if so there is a need to assess what proportion of the population is protected by the park, as well as the degree and nature of the protection provided.

Red List Assessment: NT VU B1ab(iii)+2ab(iii).

Assessment Rationale: Populations of *C. crispatula* var. *flaccidifolia* are threatened by direct and indirect habitat destruction and degradation. The conservation condition of individual populations of this variety is unknown but it is feasible that all populations are threatened. For this reason, it is classed as Near Threatened, with the expectation that it will be classed as Vulnerable should surveys show that there is an ongoing loss of populations or decline in the size of populations.

Reviewer: N. Jacobsen



17f. *Cryptocoryne crispatula* var. *kubotae* N.Jacobsen & Bastm. 2015

Distribution: *C. crispatula* var. *kubotae* is known only from a small area in Ubon Ratchathani Province in eastern Thailand, in streams flowing from the mountains bordering Lao P.D.R. and in the south towards Cambodia. It has not been mapped as there is no detailed information on the precise distribution of populations.

Countries of Occurrence: Thailand.

Population: There is no information on population size or trends in *C. crispatula* var. *kubotae*.

Extinct) (the submitted assessment does not recognise that it is Potentially Extinct as this information became available only post-submission).

Reviewer: N. Jacobsen

17h. *Cryptocoryne crispatula* var. *tonkinensis* (Gagnep.) N.Jacobsen 1991

Taxonomic note: All reports of var. “*tonkinensis*” outside the confirmed range of this variety in south-eastern China and Vietnam refer to other varieties of *C. crispatula*.

Distribution: *C. crispatula* var. *tonkinensis* is known from south-eastern China and northern Vietnam.

EOO: 8 km² (adjusted to fit AOO)

AOO: 8 km²

Countries of Occurrence: China (Guangxi), Vietnam, Thailand.

Population: There is no information on population size or trends in *C. crispatula* var. *tonkinensis*.

Habitats and Ecology: *C. crispatula* var. *tonkinensis* grows in fast-flowing streams and small rivers in forest, with a granite and quartz sand substrate, as well as occasionally among bedrock outcrops. It has been recorded in rivers with *Cryptocoryne crispatula* var. *balansae* and *C. crispatula* var. *crispatula* in situations where it is deeply submerged during the rainy season but more or less emerged in the dry season. 20-1265 m.

General Use and Trade Information: *C. crispatula* var. *tonkinensis* appears to be relatively poorly known in cultivation, it is stocked by only a very small number of suppliers and it is not clear whether plants are sourced from nature or propagated *ex-situ*. This variety may be threatened by uncontrolled and/or illegal collection.

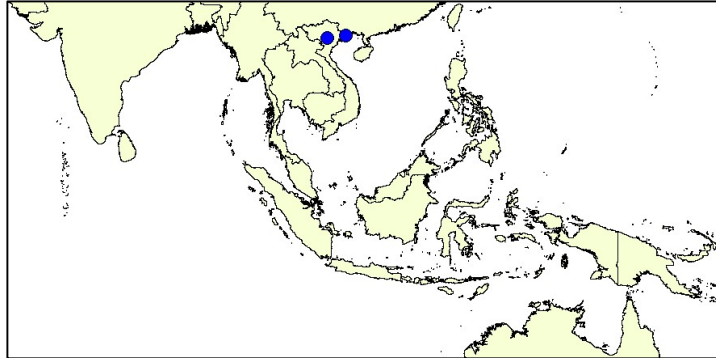
Threats: Forest and wetland habitats throughout the region are threatened both by direct destruction, such as deforestation and development as well as by the secondary effects of these actions and by urbanisation. It may also be threatened by uncontrolled and/or illegal collection.

Conservation: There are no conservation actions being undertaken specifically for *C. crispatula* var. *tonkinensis* and none needed. It has been recorded from Phou Khao-Koay National Park in Vietnam.

Red List Assessment: LC.

Assessment Rationale: When the Red List assessment was submitted, *C. crispatula* var. *tonkinensis* was thought to be known from a reasonably large area and was therefore classed as Least Concern. However, clarification of the identity of material suggests that it has a restricted distribution and should be considered to be threatened. The Red List assessment therefore needs to be revised.

Reviewer: N. Jacobsen



17i. *Cryptocoryne crispatula* var. *yunnanensis* (H.Li) H.Li & N.Jacobsen 2010

Distribution: *C. crispatula* var. *yunnanensis* is known from the River Mekong in China, Laos, Thailand and Vietnam.

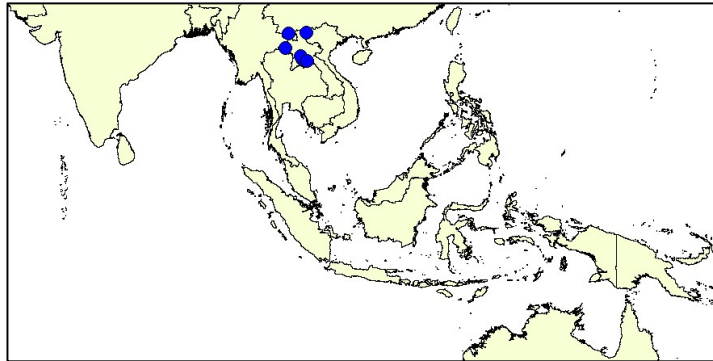
Countries of Occurrence: China (Yunnan), Laos, Thailand, Vietnam.

Population: Known populations are typically large but there is no information on population trends in *C. crispatula* var. *yunnanensis*.

Habitats and Ecology: *C. crispatula* var. *yunnanensis* occurs along the River Mekong and tributaries in areas which become silt, gravel or cobble bars and backwaters during the dry season. 230-620 m.

General Use and Trade Information: *C. crispatula* var. *yunnanensis* is considered to be unsuited to aquaria and is not likely to be very threatened by over-collection.

Threats: *C. crispatula* var. *yunnanensis* is threatened by some proposed dams on the River Mekong, only a small number of which could eradicate populations by stabilising water levels at a depth which would preclude flowering.



Conservation: There are no conservation actions specific to *C. crispatula* var. *yunnanensis* and it is not known from any protected areas. See detailed proposal Chapter 5.4.9.

Red List Assessment: VU B2ab(i, ii, iii).

Assessment Rationale: *C. crispatula* var. *yunnanensis* is known from a small area and a single river system which is severely threatened by a series of proposed dam projects as well as ongoing destruction and degradation of wetland habitats. It is therefore classed as Vulnerable.

Reviewer: N. Jacobsen



18. *Cryptocoryne cruddasiana* Prain 1900

Distribution: *C. cruddasiana* is endemic to Myanmar (Burma) where most known populations are in Kachin State in the north-east, although it may also occur in Shan State in China. It is likely that this species is under-recorded, with the known populations associated with areas surveyed, rather than necessarily the true distribution of the species.

EOO: 22, 392 km².

AOO: 32 km².

Countries of Occurrence: Myanmar and possibly also China (Shan State).

Population: *C. cruddasiana* apparently occurs in large, extensive populations where it grows. There is no information on population trends, but ongoing habitat destruction and degradation in Myanmar would suggest that it is likely to be declining.

Habitats and Ecology: *C. cruddasiana* was described as forming small, dense grass-like stands on silt, gravel or sand in slow-flowing reaches and in ponded sections in rivers in tropical evergreen and deciduous *Dipterocarpus* forest. It was recorded growing where sunlight could reach the channel, with rhizomes making a solid mat below the surface of the substrate, in areas where stands would be exposed and flower in periods of low flow. It has been recorded in a range of flowing water habitats, from small forest rivers to the margins of the Irrawaddy. 230-660 m.

General Use and Trade Information: *C. cruddasiana* is not widely cultivated and is considered unsuitable for typical aquaria.

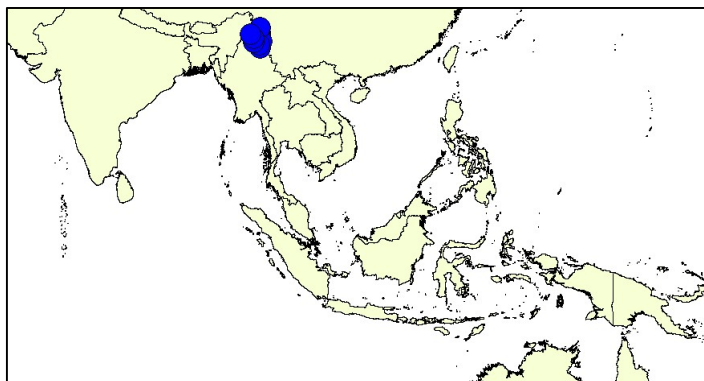
Threats: None of the known populations are known to be directly threatened, however most are likely to be threatened by forest clearance or by the secondary effects of this activity, such as increased turbidity and water pollution. Some populations are also threatened by urbanisation and development.

Conservation: There is no conservation action specifically in place for this species. None of the populations in Kachin State are in protected areas.

Red List Assessment: VU B2ab(iii).

Assessment Rationale: *C. cruddasiana* appears to be widespread throughout a reasonably large area. However, some populations are in areas which have already been cleared, while most or all populations are likely to be threatened by forest clearance and associated activities, as well as by the secondary effects of these activities and by development. Fewer than ten populations are known and it is therefore classed as Vulnerable.

Reviewer: N. Jacobsen



19. *Cryptocoryne dewitii* N.Jacobsen 1977

Distribution: *C. dewitii* is endemic to New Guinea, where it has been recorded from a single site, near the Kiunga Airstrip where it was re-found in 2009.

EOO: -

AOO: 8 km²

Countries of Occurrence: Papua
New Guinea

Population: There is no information on population size in this species, but from the available information the population is large.

Habitats and Ecology: *C. dewitii* occurs in a small marsh adjacent to an area of swamp forest over laterite soil. Vegetation in the area is characterised by sago palms (*Metroxylon sagu*) over wet leaf debris and peat. 40 m.

General Use and Trade Information: This species is not considered suitable for aquaria and is slow to propagate, it is therefore unlikely to be threatened by over-collection.

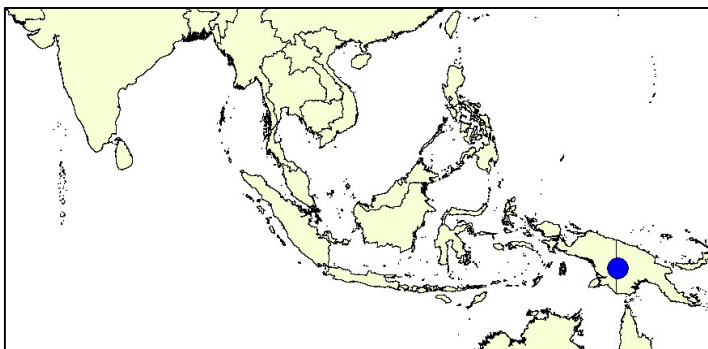
Threats: Lowland forest throughout New Guinea is heavily threatened by clearance, the secondary effects of clearance and urbanisation. The area supporting *C. dewitii* is also threatened by ongoing forest clearance and expansion of mining operations.

Conservation: There are no conservation measures in place for *C. dewitii*. See detailed proposal Chapter 5.4.13.

Red List Assessment: CR B1ab(i, ii, iii, iv, v)+2ab(i, ii, iii, iv, v).

Assessment Rationale: *C. dewitii* is known from a single site. The habitat on which it depends is threatened by forest clearance and secondary effects of this action. It is therefore classed as Critically Endangered.

Reviewer: N. Jacobsen



20. *Cryptocoryne elliptica* N.E.Br. ex. Hook.f. 1893

Distribution: *C. elliptica* is endemic to western Peninsular Malaysia, where it is known from three areas in Penang and Kedah States. Two new localities to the north and south have been reported, but not officially documented.

EOO: 629 km²

AOO: 32 km²

Countries of Occurrence:

Peninsular Malaysia

Population: This species is described as abundant in the Pondok-Tanjung, Gunung Bongsu and Bukit Panchor Forest Reserves, otherwise there is no information on population size or trends in this species.

Habitats and Ecology: *C. dewitii* grows on silt in swampy areas, pools and streams in dense, wet rainforest habitats. Wild boar (*Sus scrofa*) were very active in one of the sites and it is possible that these animals are important for dispersal. It has been recorded growing with *Barclaya kunstleri*, *Cryptocoryne minima*, *Homalomena nutans*, *Asplenium* spp. and *Zingiber* spp. 5-550 m.

General Use and Trade Information: *C. dewitii* is considered reasonably easy to propagate and to maintain in cultivation. It may be threatened by over-collection due to the small number of known populations and their accessibility.

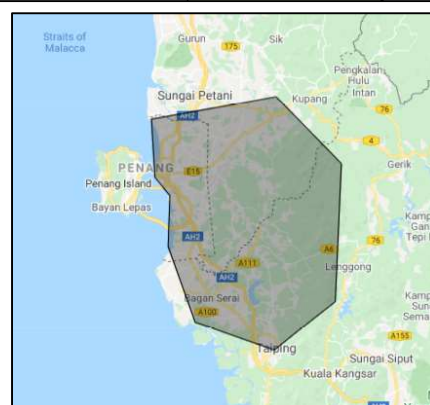
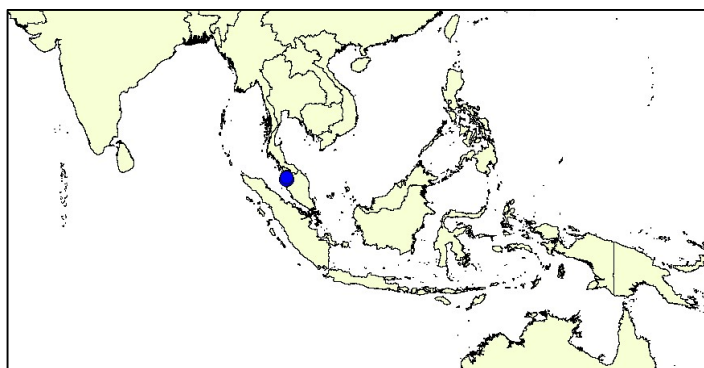
Threats: This species is threatened by clearance of forest and some of the areas where it occurs have already been converted to oil palm plantations. Populations are known from three Forest Reserves, which means that they should be secure, however it is not certain that the protection provided by Forest Reserves will be sufficient. It is also threatened by logging, highway construction or widening projects and urban expansion.

Conservation: There are no conservation measures in place specifically for *C. dewitii*. Some populations have already been lost to development and forest clearance, but it is known to occur in three Forest Reserves: Pondok-Tanjung FR in Penang State, as well as Gunung Bongsu FR and Bukit Panchor FR in Kedah State. There is a need for surveys to establish a current assessment of the conservation condition of populations outside Forest Reserves, combined with monitoring of all populations. There is also a need to assess the degree and nature of protection provided by the Pondok-Tanjung, Gunung Bongsu and Bukit Panchor Forest Reserves.

Red List Assessment: VU B1ab(i, ii, iii, v)+2ab(i, ii, iii, v).

Assessment Rationale: *C. dewitii* has a very limited range, some populations have already been lost and others are threatened by actions such as forest clearance and urban expansion. However, it occurs in three Forest Reserves, where populations should be secure, although they are still vulnerable to actions such as illegal collection. It is therefore classed as Vulnerable.

Reviewer: N. Jacobsen.



21. *Cryptocoryne erwinii* Wongso & Ipor 2017

Distribution: *C. erwinii* is endemic to the Schwaner Mountains in western Kalimantan, where it is known from a single site.

EOO: 4 km²

AOO: 4 km²

Countries of Occurrence: Indonesia (Kalimantan).

Population: Since it was discovered in 2015, the population has declined dramatically and is now estimated to number only 500 individuals.

Habitats and Ecology: The type specimen was collected in a small humus-rich, stream flowing over silt and peat in swamp forest, where the population was growing among tree roots. 60 m.

General Use and Trade Information: There is not much information on cultivation of *C. erwinii*, but it is considered difficult to grow and not suited for normal aquarium use. It is offered for sale and may be vulnerable to uncontrolled and/or illegal collection.

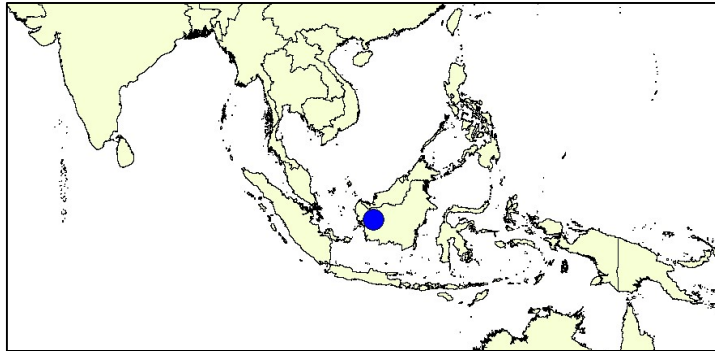
Threats: Most of the natural habitat in the area in which *C. erwinii* was found is privately owned by indigenous people and involves a combination of *Shorea* forest and small scale agriculture. Remaining patches of semi-natural habitat in the area are extremely vulnerable to damage and degradation, the secondary effects of forest clearance such as increased turbidity and pollution, as well as intensification of land-use. There is also a risk to this species from over-collection.

Conservation: Yayasan Konservasi Biota Lahan Basah has acquired 2 ha of *Shorea* forest at Nanga Pari, West Kalimantan toward conservation of *C. erwinii*. See detailed proposal Chapter 5.4.3.

Red List Assessment: CR B1ab(iii, iv)+2ab(iii, iv).

Assessment Rationale: *C. erwinii* is known from a single site in a remnant stand of semi-natural habitat surrounded by agriculture and oil palm plantations. It is highly vulnerable to small-scale, local actions and may be severely threatened by over-collection. It is therefore classed as Critically Endangered, although this does not take into account any security offered by the site at Nanga Pari.

Reviewers: N. Jacobsen, S. Wongso.



22. *Cryptocoryne ferruginea* Engl. 1879

Taxonomic note: Two varieties are recognised within *C. ferruginea*: var. *ferruginea* occurring mainly within the zone of tidal influence of large lowland rivers in western Sarawak, with some populations inland and var. *sekadauensis*, known from a few small streams in the Sekadau area in western Kalimantan.

EOO: 10,843 km²

AOO: 88 km²

Distribution: *C. ferruginea* is endemic to Borneo where it is known from a number of populations in western Sarawak and in the area around Sekadau in western Kalimantan.

Countries of Occurrence: Malaysia (Sarawak), Indonesia (Kalimantan).

Population: There is no information on population size or trends in *C. ferruginea*. However, the population at Balai Ringin was described as involving millions of plants in 2004.

Habitats and Ecology: *C. ferruginea* typically grows in soft silt and gravel along shallow, slow-flowing streams and rivers flowing off limestone in dense forest, where freshwater is backed up by the tide, as well as in forested rivers above the influence of the tide, in acid waters of freshwater swamp forest and in a seasonally inundated ditch. It has been recorded growing with *Barclaya motleyi*, *Cryptocoryne fusca*, *C. keei* and *C. lingua*.

General Use and Trade Information: *C. ferruginea* is considered fairly easy to grow and is available in horticultural trade, it may be vulnerable to uncontrolled and/or illegal collection.

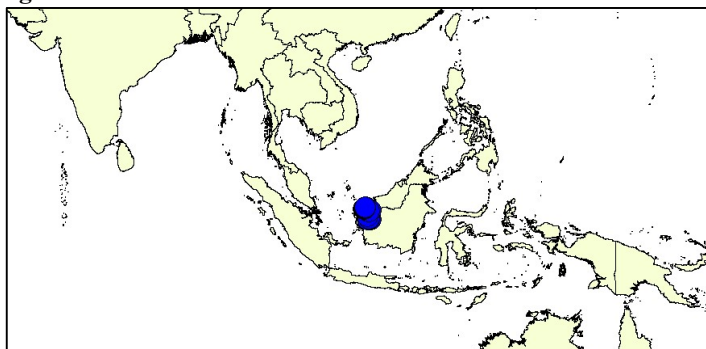
Threats: None of the sites where *C. ferruginea* occurs are protected and most are therefore already suffering from or threatened by the factors affecting all lowland river systems in Borneo. The primary and secondary effects of forest degradation and clearance, direct habitat destruction and pollution. Most of the sites from which it is known are in areas which have been cleared for some time and within which it is threatened by intensification of agriculture and expansion of settlements.

Conservation: There are no conservation actions specifically in place for *C. ferruginea*. See detailed proposal Chapter 5.4.3.

Red List Assessment: NT VU B1b(i, ii, iii)+2b(i, ii, iii).

Assessment Rationale: *C. ferruginea* is known from a fairly limited area, in habitats and sites which are severely threatened by forest clearance and the secondary effects of this action, as well as by urbanisation and pollution. However, information on individual populations is inadequate both to derive an informed number of locations and to assess the degree of threat to which they are exposed. This species is therefore classed as Near Threatened, with the expectation that collection of more data will show that it should be classed as Vulnerable.

Reviewer: N. Jacobsen



22a. *Cryptocoryne ferruginea* var. *ferruginea*

Distribution: *C. ferruginea* var. *ferruginea* is endemic to Sarawak where it is known from a few sites near Bau and Simunjan,

EOO: 2,356 km²

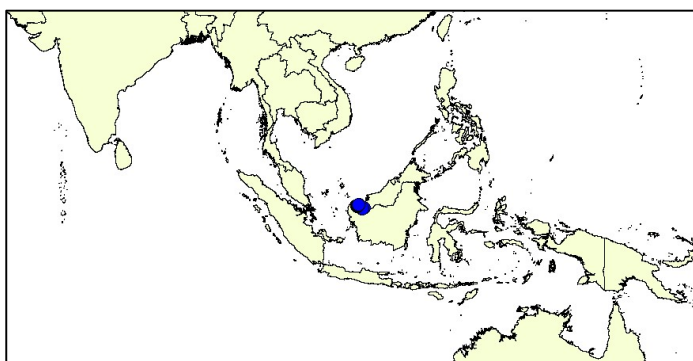
AOO: 60 km²

Countries of Occurrence: Malaysia (Sarawak).

Population: There is no information on population size or trends in this variety.

Habitats and Ecology:

C. ferruginea var. *ferruginea* typically grows along streams and rivers flowing off limestone, where freshwater is backed up by the tide, as well as in forested rivers above the influence of the tide. It has also been recorded in acid waters of freshwater swamp forest and in a seasonally inundated ditch. It has been recorded growing



with *Barclaya motleyi*, *Cryptocoryne keei* and *C. lingua*.

General Use and Trade Information: *C. ferruginea* var. *ferruginea* is considered fairly easy to grow and is available in horticultural trade, it may be vulnerable to over-collection.

Threats: One population is within Kubah National Park, Matang, otherwise none of the sites where *C. ferruginea* var. *ferruginea* occurs are protected and most are therefore already suffering from or threatened by the factors affecting all lowland river systems in Borneo. This includes the primary and secondary effects of forest degradation and clearance, direct habitat destruction and pollution. Most of the sites from which it is known are in areas which have been cleared for some time and within which it is threatened by intensification of agriculture and expansion of settlements. It may also be threatened by uncontrolled and/or illegal collection.



Conservation: There are no conservation actions specifically in place for *C. ferruginea* var. *ferruginea*. It would be useful to have up-to-date information on the conservation status of populations throughout its range to assess the impacts of threats such as forest clearance. This should be combined with an assessment the level and nature of protection provided by the Kubah National Park and a review of potential for watershed, catchment and water course protection.

Red List Assessment: NT EN B1b(i, ii, iii)+2b(i, ii, iii).

Assessment Rationale: *C. ferruginea* var. *ferruginea* is known from a fairly limited area, in habitats and sites which are severely threatened by forest clearance and the secondary effects of this action, as well as by urbanisation and pollution. However, information on individual populations is inadequate both to derive an informed number of locations and to assess the degree of threat to which they are exposed. This variety is therefore classed as Near Threatened, with the expectation that collection of more data will show that it should be classed as Endangered.

Reviewer: N. Jacobsen

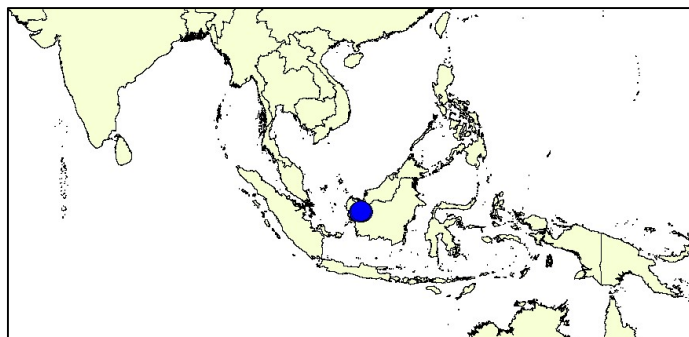
22b. *Cryptocoryne ferruginea* var. *sekadauensis* Bastm., Kishi, Takah., Wongso & N. Jacobsen 2013

Distribution: *C. ferruginea* var. *sekadauensis* is endemic to the Sekadau area of western Kalimantan in Indonesian Borneo, where it is known only from small tributaries of the Kapuas River.

EOO: 248 km²

AOO: 24 km²

Countries of Occurrence: Indonesia (Kalimantan).



Population: There is no information on population size or trends in this variety.

Habitats and Ecology: *C. ferruginea* var. *sekadauensis* grows in silt and gravel in shallow, slow-flowing streams in dense forest. It has been recorded with *C. fusca*. 15-30 m.

General Use and Trade Information: *C. ferruginea* var. *sekadauensis* is not widely available in cultivation; it is extremely vulnerable to any collection from the wild due to the small number of known populations.

Threats: Three known populations are within the boundaries of the town of Sekadau and are extremely vulnerable to casual habitat destruction or degradation. The fourth known population is in a small remnant stand of forest in an area where forest is being cleared for agriculture. All four populations are severely threatened by unwitting destruction. It is also very vulnerable to over-collection.

Conservation: There are no conservation measures in place for this variety. See detailed proposal Chapter 5.4.3.

Red List Assessment: VU B1ab(iii, v)+2ab(iii, v).

Assessment Rationale: *C. ferruginea* var. *sekadauensis* is known from four populations in three locations, three of which are within the boundary of the town of Sekadau. All known populations are severely threatened and it is therefore classed as Vulnerable.

Reviewers: N. Jacobsen. S. Wongso.



23. *Cryptocoryne fusca* de Wit 1970

Distribution: *C. fusca* is widespread in south-western Kalimantan, as well as in a few locations in Sarawak and on the island of Belitung, off Sumatra.

EOO: 173,838 km²

AOO: 264 km²

Countries of Occurrence:
Indonesia (Kalimantan, Sumatra), Malaysia (Sarawak).

Population: There is no information on population size or trends in this species.

Habitats and Ecology: *C. fusca* occurs in slow-flowing streams and small rivers in lowland forest, where it grows in areas which are exposed during the dry season. It has been recorded growing with species such as *C. cordata* var. *grabowskii*, *C. ferruginea* var. *sekadauensis*, *C. griffithii*, *C. ideii* and *C. striolata*. 0-75 m.

General Use and Trade Information: This species is considered not to be difficult to cultivate and may be severely threatened by over-collection.

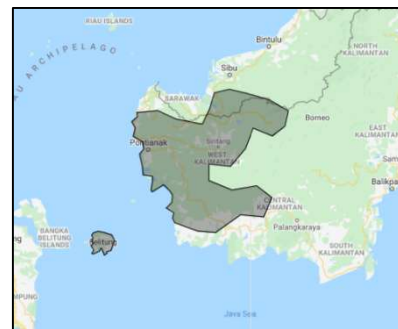
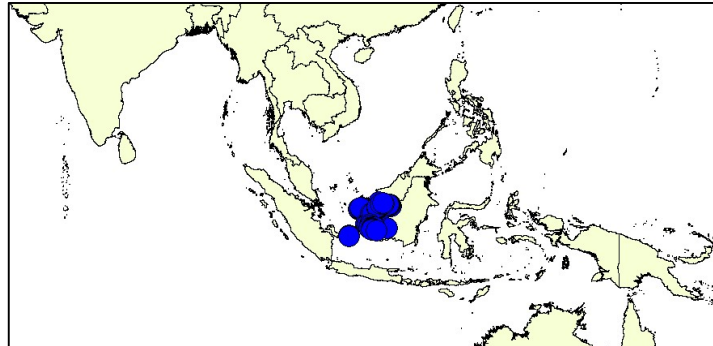
Threats: The habitats and sites where *C. fusca* occurs are threatened by factors which affect all plants occurring in flowing water bodies in the region. These include forest clearance, urbanisation, agricultural intensification and the secondary effects of these factors, particularly increased turbidity, pollution and casual habitat degradation. It may also be threatened by uncontrolled and/or illegal collection.

Conservation: There are no conservation actions in place specifically for *C. fusca* and none needed. It is not known from any protected areas.

Red List Assessment: LC

Assessment Rationale: *C. fusca* is widespread and known from a large number of locations. Therefore, in spite of the threats to the habitat and sites where it occurs, it is considered unlikely to go extinct in the near future and is classed as Least Concern.

Reviewers: N. Jacobsen, S. Wongso.



24. *Cryptocoryne griffithii* Schott 1856

Distribution: *C. griffithii* occurs in southern Peninsular Malaysia, Singapore and Southern Kalimantan, as well as on the islands of Bintan, Karimun, Batam and Rempang in Indonesia.

EOO: 88,591 km²

AOO: 64 km²

Countries of Occurrence: Indonesia (Kalimantan), Malaysia, Singapore.

Population: This species may be abundant where it occurs, but there is no information on population trends.

Habitats and Ecology: *C. griffithii* occurs in small forest streams and can survive habitat modification, persisting in reservoirs and ditches in rubber plantations. In cultivation it only grows in acid water. 0–40 m.

General Use and Trade Information: *C. griffithii* is considered difficult to cultivate and not well suited to normal aquaria. It is unlikely to be threatened by over-collection.

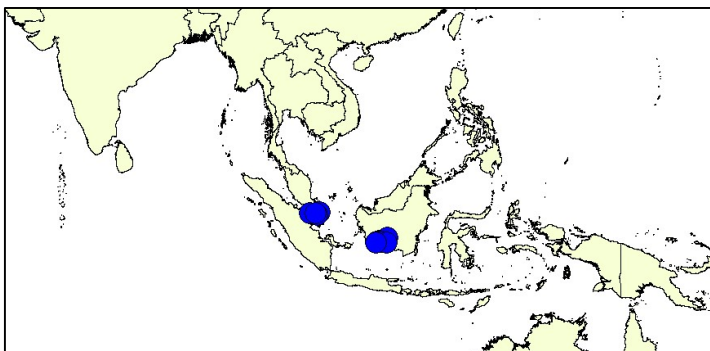
Threats: The habitats and sites where *C. griffithii* occurs are threatened by factors which affect all plants occurring in flowing water bodies in the region. These include forest clearance, urbanisation, agricultural intensification and the secondary effects of these factors, particularly increased turbidity, pollution and casual habitat degradation. The locations known in southern Peninsular Malaysia have greatly declined during the last 50 years due to development.

Conservation: There are no conservation actions in place specifically for *C. griffithii* and none needed. It is not known from any protected areas except in Singapore. As with all members of the genus, it would be useful to have an up-to-date assessment of the conservation status of known populations.

Red List Assessment: LC

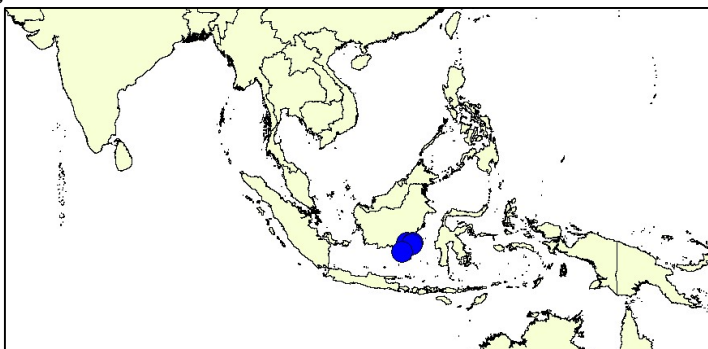
Assessment Rationale: *C. griffithii* is widespread and known from a number of locations. Therefore, in spite of the threats to the habitat and sites where it occurs, it is considered unlikely to go extinct in the near future and is classed as Least Concern.

Reviewers: N. Jacobsen, S. Wongso.



25. *Cryptocoryne hutoroi* Bogner & N.Jacobsen 1985

Distribution: *C. hutoroi* is endemic to Kalimantan, where it is known from the Barito, Jorong and Kahajan River systems, as well as the Kuson and Meratus Mountain ranges. Its limited distribution is considered likely to be a product of limited habitat suitability, rather than evidence of a decline.



EOO: 5,259 km²

AOO: 24 km²

Countries of Occurrence: Indonesia (Kalimantan).

Population: This species typically forms dense stands, but there is no information on population size or trends.

Habitats and Ecology: *C. hutoroi* typically grows in medium-sized to large gravel and bedrock streams in lowland forest and shrub-heath, in areas where the river is wide enough that gaps in the canopy allow sunlight to reach the channel. Most of the rivers in which it occurs flow off karstic limestone hills and so are high in calcium. It has been recorded growing with other aquatic plants, such as *Ceratopteris thalictroides*, *Hydrilla verticillata* and *Leptochilus pteropus*. 0-125 m.



General Use and Trade Information: *C. hutoroi* is considered to be easy to grow in aquaria and easy to propagate. It may therefore be severely threatened by over-collection.

Threats: The habitats and sites where *C. hutoroi* occurs are threatened by factors which affect all plants occurring in flowing water bodies in the region. These include forest clearance, urbanisation, agricultural intensification and the secondary effects of these factors, particularly increased turbidity, pollution and casual habitat degradation. All known populations occur within or adjacent to areas which have been cleared for cultivation and all of the southern sites are very vulnerable to expansion of existing settlements. It is also likely to be threatened by uncontrolled and/or illegal collection.

Conservation: There are no conservation actions in place specifically for *C. hutoroi*. It is not known from any protected areas. There is a need to establish an up-to-date assessment of the conservation status of known populations, as well as to survey other potentially suitable habitat in the area to try to find more populations and to review potential for protection of existing sites, combined with water course protection.

Red List Assessment: NT VU B1ab(iii, v)+ (iii, v); D2.

Assessment Rationale: There is no evidence that *C. hutoroi* is currently declining, however all known populations are within areas which are either already cleared for cultivation or adjacent to such areas and many are threatened by expansion of existing developments. It is therefore classed as Near Threatened, with the expectation that this class will be revised to Vulnerable if surveys show that populations are being lost.

Reviewers: N. Jacobsen, S. Wongso

26. *Cryptocoryne ideii* Budianto 2004

Distribution: *C. ideii* has been confirmed from three areas in central Kalimantan.

EOO: 6,943 km²

AOO: 28 km²

Countries of Occurrence: Indonesia (Kalimantan).

Population: There is no information on populations size or trends in *C. ideii*.

Habitats and Ecology: *C. ideii* grows in streams and small rivers in lowland forest, typically growing in silt or gravel with abundant organic debris. 35-65 m.

General Use and Trade Information: *C. ideii* is considered easy to grow and propagate, however, given the low number of known populations, it is probably vulnerable to over-collection.

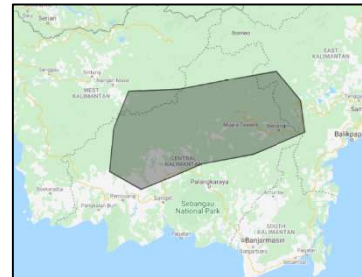
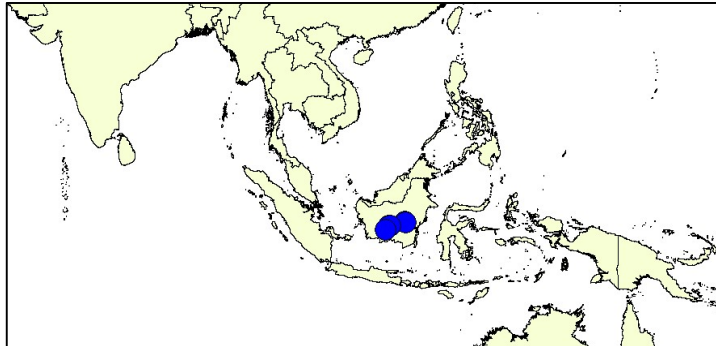
Threats: *C. ideii* and sites where this species occurs are threatened by factors which affect all plants occurring in flowing water bodies in the region. These include forest clearance, urbanisation, agricultural intensification and the secondary effects of these factors, particularly increased turbidity, pollution and casual habitat degradation. It is also threatened by coal mining and oil palm plantation and appears to suffer from incidental damage from rattan collection.

Conservation: There are no specific conservation measures in place for *C. ideii* and it is not known to occur in any protected areas. There is a need to document known populations of *C. ideii*, as well as to survey potentially suitable habitat in the area to seek additional populations, this should be supported by review of existing protected areas in Kalimantan and potential for protection of *C. ideii*.

Red List Assessment: EN B2ab(iii).

Assessment Rationale: This species is known from very few sites, all of which are threatened by habitat destruction and degradation. It is also vulnerable to over-collecting. It is therefore classed as Endangered.

Reviewers: N. Jacobsen, S. Wongso.



27. *Cryptocoryne isae* Wongso 2017

Distribution: *C. isae* is endemic to the Schwaner Mountain range in Western Kalimantan, where it is known from two sites near Sekadau. Since its discovery in 2015 one of the sites has been cleared for agriculture and no suitable habitat remains.

EOO: 8 km²

AOO: 8 km²

Countries of Occurrence: Indonesia (Kalimantan).

Population: There is no information on population size in this species.

Habitats and Ecology: *C. isae* is known from a muddy stream flowing through secondary forest which may be dry for part of the year. 90-135 m.

General Use and Trade Information: *C. isae* is not widely available in cultivation, but it is offered for sale. It is suited for normal aquarium use and it is likely that it is severely threatened by uncontrolled and/or illegal collection.

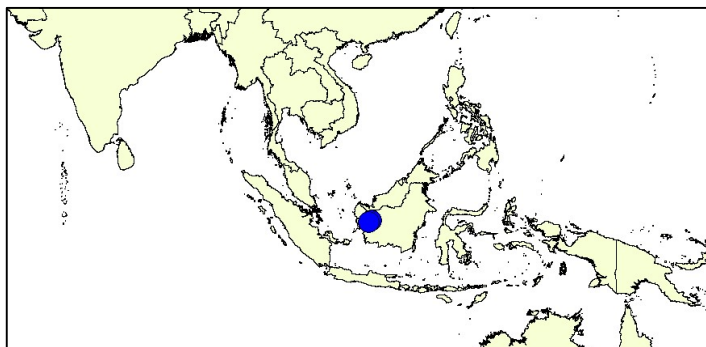
Threats: The habitats and sites where *C. isae* occurs are threatened by factors which affect all plants occurring in flowing water bodies in the region. These include forest clearance, urbanisation, agricultural intensification and the secondary effects of these factors, particularly increased turbidity, pollution and casual habitat degradation. It is also severely threatened by uncontrolled and/or illegal collection.

Conservation: There are no conservation actions in place specifically for this species. It is not known from any protected areas. See detailed proposal Chapter 5.4.3.

Red List Assessment: CR B1ab(i, ii, iii, iv)+2ab(i, ii, iii, iv).

Assessment Rationale: *C. isae* is known from a single site in an area where all flowing water bodies are under severe threat from forest clearance, urbanisation and the secondary effects of such actions. One of the populations found in 2015 has already been lost. It is also likely to be threatened by over-collecting. It is therefore classed as Critically Endangered.

Reviewers: N. Jacobsen, S. Wongso



28. *Cryptocoryne joshanii* Naive & R.J.T.Villanueva 2018

Distribution: *C. joshanii* is endemic to the Philippines, where it is known only from two sites on the island of Basilan in the Sulu Archipelago. Extensive surveys have failed to find additional populations. No point data are available and so a regional map is not provided.

Countries of Occurrence: Philippines

Population: There is no information on population size or trends for *C. joshanii*.

Habitats and Ecology: *C. joshanii* is known from sandy substrate in a slow-flowing montane forest stream, with patchy sunlight reaching the channel. 800-1000 m.

General Use and Trade Information: *C. joshanii* is either rare or unknown in cultivation and has been considered difficult to cultivate under normal aquarium conditions. Therefore, whilst it may not be threatened by over-collection for commercial purposes, any collection will have severe implications for conservation of the species.

Threats: This species is threatened both by habitat destruction and by over-collection.

Conservation: There are no specific conservation actions in place for *C. joshanii* and it does not occur in any protected areas. There is an urgent need for work to try to protect the type locality, combined with work to establish populations ex-situ for sale, to reduce pressure on wild populations.

Red List Assessment: CR B1ab(iii)+2ab(iii).

Assessment Rationale: *C. joshanii* is known from two sites where it is threatened by habitat destruction and over-collection. It was classed as Data Deficient on the submitted assessment, but this should be revised to Critically Endangered.

Reviewers: N. Jacobsen, M.A.K. Naive.



29. *Cryptocoryne keei* N.Jacobsen 1982

Distribution: *C. keei* is endemic to Borneo, where it is known from two areas in western Kalimantan and near Bau in Sarawak.

EOO: 6,468 km²

AOO: 56 km²

Countries of Occurrence: Malaysia (Sarawak) and Indonesia (Kalimantan).

Population: There is no information on population size or trends in *C. keei*.

Habitats and Ecology: *C. keei* forms dense stands rooted in sand and gravel bars in shallow, fast-flowing, highly flashy lowland rivers arising on limestone. 20-120 m.

General Use and Trade Information: *C. keei* is considered to be easy to grow in aquaria and easy to propagate. It may therefore be highly threatened by uncontrolled and/or illegal collection.

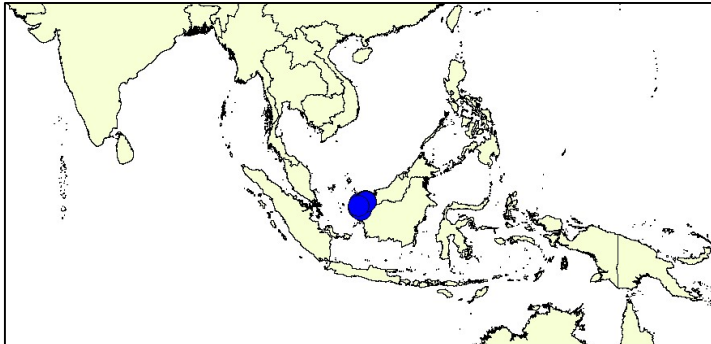
Threats: The habitats and sites where *C. keei* occurs are threatened by factors which affect all plants occurring in flowing water bodies in the region. These include forest clearance, urbanisation, agricultural intensification and the secondary effects of these factors, particularly increased turbidity, pollution and casual habitat degradation. Forest clearance for agriculture and oil palm plantations increases the flow rate and sediment movements in rivers and as a result, populations of this species are covered by sediment deposits leading to their decline and loss (Ipor *et al.* 2007). It may also be threatened by uncontrolled and/or illegal collection.

Conservation: There are no conservation actions in place specifically for *C. keei*. It is not known from any protected areas. As with all members of the genus, it would be useful to have an up-to-date assessment of the conservation status of known populations. There is potential to link conservation action for this species to conservation of *C. lingua* and *C. pallidinervia*.

Red List Assessment: NT VU B1ab(iii)+2ab(iii).

Assessment Rationale: There is evidence that this species is currently declining and all known populations are within areas which are either already cleared for cultivation or adjacent to such areas, many are threatened by expansion of existing developments. It is therefore classed as Near Threatened, with the expectation that this class will be revised to Vulnerable if surveys show that populations are being lost

Reviewers: N. Jacobsen, S. Wongso.



30. *Cryptocoryne lingua* Becc. ex Engl. 1879

Distribution: *C. lingua* occurs at a single site in Kalimantan and in Sarawak, where it is known from twelve sites in four separate areas.

EOO: 45,008 km²

AOO: 52 km²

Countries of Occurrence:

Malaysia (Sarawak),

Indonesia (Kalimantan).

Population: *C. lingua* has been

reported to occur in large stands. Populations are decreasing due to forest clearance, conversion to oil palm plantations and mining.

Habitats and Ecology: *C. lingua* forms large, dense stands on mud on the inland margin of mangrove vegetation in lowland rivers in the zone where freshwater is backed up by 2-3 m twice per day by the tide. It may also occur far enough downstream that it is exposed to elevated salt concentrations. 0-40 m.

General Use and Trade Information: *C. lingua* is not considered suitable for normal aquaria and is therefore likely to be at low risk of over-collection.

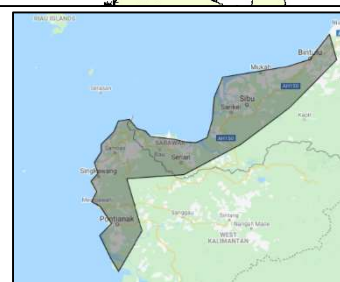
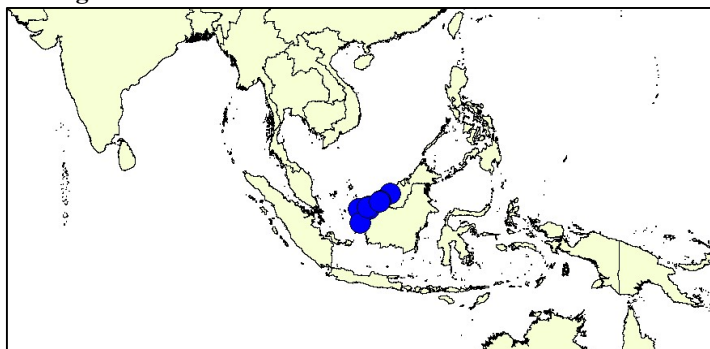
Threats: The habitats and sites where *C. lingua* occurs are threatened by factors which affect all plants occurring in flowing water bodies in the region. These include forest clearance, urbanisation, agricultural intensification and the secondary effects of these factors, particularly increased turbidity, pollution and casual habitat degradation. All known populations occur within or adjacent to areas which have been cleared for cultivation and a number of sites are very vulnerable to expansion of existing settlements. Installation of a weir at one site has stabilised water levels with the result that the population has become covered with a layer of sediment and is rapidly declining. At least two of the populations are in dense urban areas and unlikely to survive, if these populations are lost then the EOO would be reduced to 8,263 km².

Conservation: There are no conservation actions in place specifically for *C. lingua*. It is not known from any protected areas. There is a need to establish an up-to-date assessment of the conservation status of known populations, as well as to survey other potentially suitable habitat in the area to try to find more populations. There is potential to link conservation action for this species to conservation of *C. keei* and *C. pallidinervia*.

Red List Assessment: NT VU B2ab(i, ii, iii, iv, v).

Assessment Rationale: *C. lingua* is known from only a few areas, all of which are threatened by the primary and secondary effects of forest clearance, urbanisation and the consolidation of existing settlements. There is evidence to suggest that some populations are declining and may already have been lost. This species is therefore classed as Near Threatened with the expectation that surveys will show that it qualifies for Vulnerable.

Reviewer: N. Jacobsen



31. *Cryptocoryne loeimensis* Bastm., T.Idei & N.Jacobsen 2010

Distribution: *C. loeimensis* is currently only known from the margins of the River Mekong along a 20 km section in Chiang Khan, Loei Province, north-eastern Thailand.

EOO: 12 km².

AOO: 12 km²

Countries of occurrence:

Thailand

Population: There is no information on population size or trends in *C. loeimensis*.

Ecology: *C. loeimensis* grows on sand and gravel bars and in silt beds among bedrock exposures and boulders along the River Mekong, that are exposed during the dry season. During the rainy season plants may be under 10 m of water. 200-210 m.

General Use and Trade Information: There is no information to suggest that *C. loeimensis* is available for trade and it is not particularly suited for aquaria. It is therefore unlikely to be threatened by over-collection.

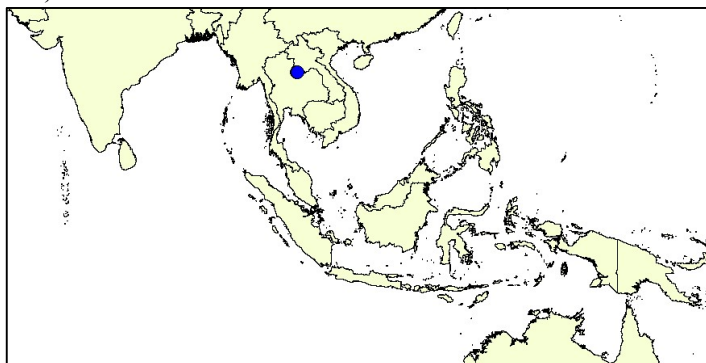
Threats: *C. loeimensis* is threatened by dam construction and other actions which modify the flow character of the Mekong River. It is also likely to be threatened by logging or clear-felling on the banks or floodplain of the river, as well as over-grazing during the dry season.

Conservation: There are no conservation actions in place specifically for *C. loeimensis*. It is not known from any protected areas. See detailed proposal Chapter 5.4.9.

Red List Assessment: CR B1ab(iii, v)

Rationale; *C. loeimensis* is known from a small number of collections along 20 km of the margins of the River Mekong river in north-eastern Thailand. All of these populations are extremely vulnerable to modification of the margins of the river and all are threatened by proposals for constructions of dams on the river. The latter threat means that known populations must be considered as a single location. This species is therefore classified as Critically Endangered.

Reviewer: N. Jacobsen.



32. *Cryptocoryne longicauda* Becc. ex Engl. 1879

Distribution: *C. longicauda* has been recorded from southern Peninsular Malaysia, Borneo, Sumatra and the islands of Bangka, Bintan, Singkep. However the populations on Bintan and in the Riau Archipelago have been destroyed, as has at least one site in Sumatra.

EOO: 358,362 km²

AOO: 88 km²

Countries of Occurrence: Indonesia (Kalimantan, Sumatra), Malaysia (Johor, Sarawak)

Population: There is no information on population size or trends in *C. longicauda*. A number of populations in Sarawak are large.

Habitats and Ecology: *C. longicauda* typically grows in slow-flowing streams and small rivers, from the upper reaches of the upstream influence of the tide to inland areas, as well as in swamp forest. It will also occur in forest pools and is able to persist through conversion of forest to oil palm, rubber and durian plantations or orchards, where it grows in drainage ditches. It will grow in a range of geological conditions, including rivers flowing off limestone. 0-65 m.

General Use and Trade Information: *C. longicauda* is difficult to maintain in cultivation, it does not transport well and is unlikely to be threatened by over collection.

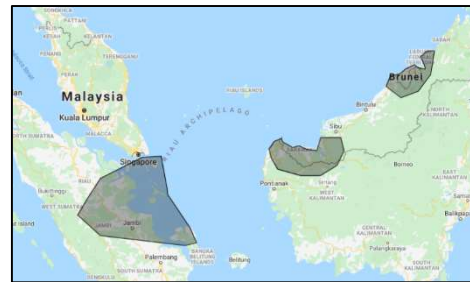
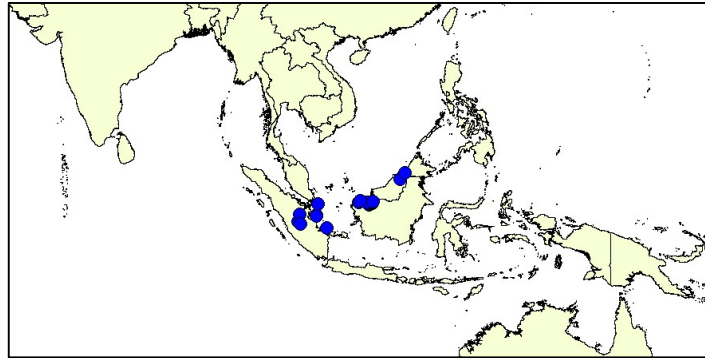
Threats: The habitats and sites where *C. longicauda* occurs are threatened by factors which affect all plants occurring in flowing water bodies in the region. These include forest clearance, urbanisation, agricultural intensification and the secondary effects of these factors, particularly increased turbidity, pollution and casual habitat degradation.

Conservation: There are no conservation actions in place specifically for this species and apparently none needed. It is known to occur in Gunung Mulu National Park in Sarawak.

Red List Assessment: NT VU B2ab(i, ii, iii, v).

Assessment Rationale: *C. longicauda* is widespread over a large area, with populations on a number of islands and administrative regions. Therefore, although many populations are directly threatened by and some have been lost due forest clearance and urbanisation, as well as the secondary effects of these actions, it is unlikely to become extinct in the near future. However the loss of all known populations on Bintan and in the Riau Archipelago is of significant concern. There is an urgent need to establish a monitoring programme for remaining populations. It is therefore classed as Near Threatened, on the understanding that better information would show that it should be classed as Vulnerable.

Reviewers: N. Jacobsen, S. Wongso.



33. *Cryptocoryne matakensis* Bastm., K. Nakamoto & N. Jacobsen 2014

Distribution: *C. matakensis* is endemic to the Anambas Islands in Indonesia, part of the Riau Archipelago, where it is known from the islands of Matak, Semanja and Siantan.

EOO: 731 km²

AOO: 48 km²

Countries of Occurrence:
Indonesia

Population: *C. matakensis* is considered to be common on two islands where it occurs.

Habitats and Ecology: *C. matakensis* occurs in fast-flowing but shallow streams, flowing through forest or through grasslands, bordered by forest. 0-250 m.

General Use and Trade Information: *C. matakensis* is considered easy to cultivate. It is likely to be severely threatened by uncontrolled and/or illegal collection.

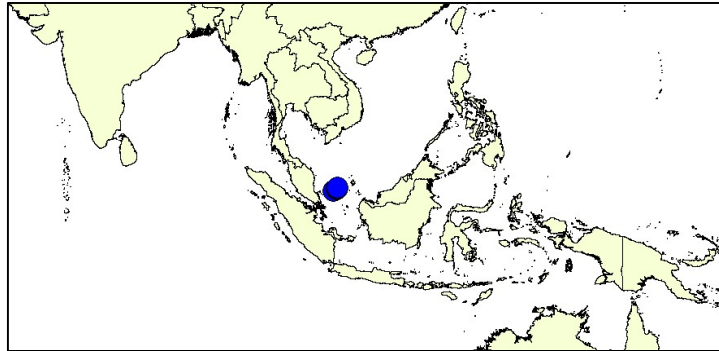
Threats: The islands where *C. matakensis* occurs have retained much of their forest cover by virtue of their location. While there is a risk that they will become subject to clearance in time, there are no obvious threats to populations of this species, apart from the threat of uncontrolled and/or illegal collection.

Conservation: There are no specific conservation measures in place for *C. matakensis* and none needed.

Red List Assessment: LC

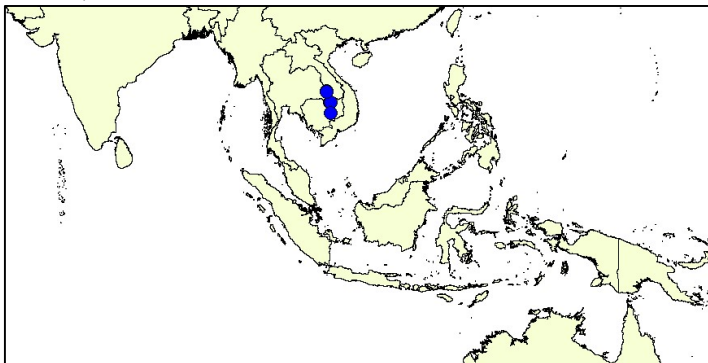
Assessment Rationale: *C. matakensis* has a narrow range, but it is common within this area and no subject to any known threats. It is therefore classed as Least Concern.

Reviewer: N. Jacobsen



34. *Cryptocoryne mekongensis* T.Idei, Bastm. & N.Jacobsen 2010

Distribution: *C. mekongensis* has been recorded from three areas along the River Mekong: Don Khon, Champasak Province, Lao PDR; Kratie Province in Cambodia and from Ubon Ratchathani Province in Thailand. It is possible that it is under-recorded and populations may occur along the river between the known sites.



EOO: 3,205 km²

AOO: 24 km²

Countries of Occurrence: Cambodia, Laos, Thailand.

Population: *C. mekongensis* can form large population where it occurs. There is no information on overall population trends, however losses due to dam construction mean that it is almost certainly declining.

Habitats and Ecology: *C. mekongensis* grows on marginal areas of the River Mekong which are exposed during the dry season, but submerged to a depth of up to 10 m throughout most of the year. It usually grows in backwaters, or in the lee of large boulders and bedrock outcrops as well as downstream of sand and gravel banks and bars. 15-160 m.



General Use and Trade Information: *C. mekongensis* is not widely grown in the aquarium trade and is not considered suited for aquaria. It is unlikely to be severely threatened by over collection.

Threats: Dam construction upstream in Yunnan and Tibet affects the flow regime in the Mekong, which will have an adverse effect on populations throughout the river system. Existing dam construction and the dams proposed for the main channel of the Mekong will cause local extinction of populations. This species is also threatened by the direct and secondary effects of logging and clear-felling on the banks or floodplain of the river. It is also likely to be threatened by over-grazing during the dry season.

Conservation: There are no specific conservation measures in place for this species. It is not known to occur in any protected areas. See detailed proposal Chapter 5.4.9.

Red List Assessment: EN B1ab(iii, iv, v)+2ab(iii, iv, v).

Assessment Rationale: *C. mekongensis* is known only from three locations and is severely threatened at all three by proposals for major dams on the Mekong, both upstream in Yunnan Province of China and Tibet and on the main stem in Cambodia, Laos and Thailand. Given that a single dam could compromise the survival of all known populations, all populations could be considered to represent a single location, however it is more practical to treat the areas supporting populations as separate locations. It is already declining due to dam construction and over-grazing and is vulnerable to the direct and secondary effects of forest clearance. It is therefore classed as Endangered.

Reviewer: N. Jacobsen.

35. *Cryptocoryne minima* Ridl. 1910

Distribution: *C. minima* occurs throughout much of western Peninsular Malaysia in Perak, Kedah and Selangor States, as well as in Sumatra where it is known from North Sumatra and near the border with Aceh Province and Riau Province.

Countries of Occurrence: Indonesia (Sumatra), Malaysia (Peninsular).

Population: There is no information on population size in *C. minima*. There anecdotal evidence to suggest that it is declining in the peninsular localities where some known populations have disappeared during the last 25 years.

Habitats and Ecology: *C. minima* grows in slow-flowing acid streams, rivers and pools in lowland forest, often with *Barclaya motleyi*. It will also persist in drainage ditches in rubber plantations after forest clearance. 10-1060 m.

General Use and Trade Information: *C. minima* is fairly widely available in cultivation, where Malaysian plants are considered easy to cultivate but Sumatran plants less so. Malaysian populations may be severely threatened by uncontrolled and/or illegal collection, Sumatran populations may be less threatened.

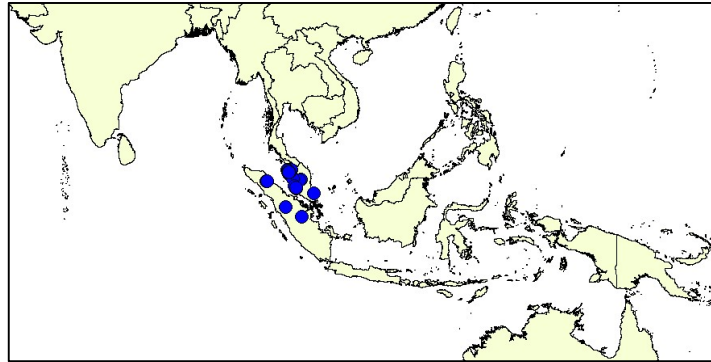
Threats: The habitats and sites where *C. minima* occurs are threatened by factors which affect all plants occurring in flowing water bodies in the region. These include forest clearance, urbanisation, agricultural intensification and the secondary effects of these factors, particularly increased turbidity, pollution and casual habitat degradation. Malaysian populations may also be threatened by uncontrolled and/or illegal collection.

Conservation: There are no conservation actions in place specifically for this species and none needed. It is known to occur in Sungei Buloh Forest Reserve and Pondok Tanjong Forest Reserve in Malaysia, as well as in Gunung Leuser Forest Reserve in Sumatra.

Red List Assessment: LC.

Assessment Rationale: Although it occurs in a habitat which is threatened, *C. minima* is widespread and reasonably abundant where it occurs. It is therefore classed as Least Concern.

Reviewers: N. Jacobsen, S. Wongso.



36. *Cryptocoryne moehlmannii* de Wit 1983

Taxonomic notes: The taxonomic status of *C. moehlmannii* is uncertain and it may ultimately be included within *C. pontederiifolia*.

Distribution: *C. moehlmannii* is endemic to the island of Sumatra in Indonesia, where it is known from a single area near Bukittinggi in West Sumatra Province.

EOO: 6,295 km²

AOO: 16 km²

Countries of Occurrence: Indonesia (Sumatra).

Population: There is no information on population size or trends in *C. moehlmannii*.

Habitats and Ecology: *C. moehlmannii* has been recorded from rivers on silt or peat substrates and in swamp forest at the upstream limits of the tidal zone, as well as along the inland margins of mangrove forest. It often occurs in association with *Nypa fruticans*. 0-20 m.

General Use and Trade Information: *C. moehlmannii* is considered to be easy to grow but is not common in cultivation. Populations are likely to be threatened by uncontrolled and/or illegal collection.

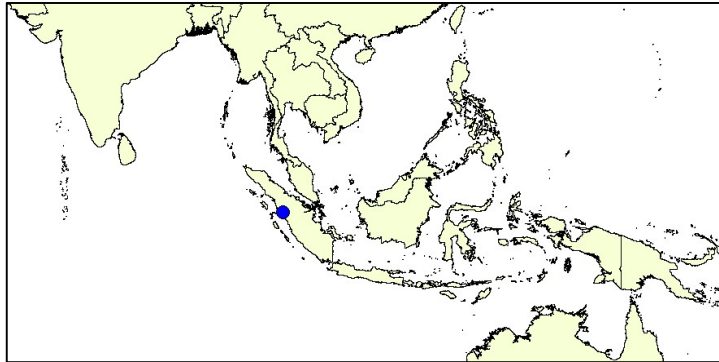
Threats: The known populations appear to be in an area cleared of forest. It is threatened by the direct and secondary effects of forest clearance, while two populations are also at risk from other factors such as urbanisation and pollution. It may also be threatened by uncontrolled and/or illegal collection.

Conservation: There are no specific conservation measures in place for this species. See detailed proposal Chapter 5.4.7.

Red List Assessment: CR B1ab(iii, v)+2ab(iii, v).

Assessment Rationale: This species is known from a single site on the west coast of Sumatra. All populations are threatened by the direct or secondary effects of forest clearance. It is therefore classed as Critically Endangered.

Reviewers: N. Jacobsen, S. Wongso.



37. *Cryptocoryne nevillei* Trim. ex. Hook.f. 1898

Distribution: *C. nevillei* is endemic to Sri Lanka, where it is known from four scattered sites on the east coast in Batticaloa District.

EOO: 891 km²

AOO: 16 km²

Countries of Occurrence: Sri Lanka

Population: There is no information on population size or trends in *C. nevillei*. However, it is scarce, even within known sites as surveys have often failed to find plants. There is information (around 1980) that it was not uncommon on the margin of the lagoon at Batticaloa.

Habitats and Ecology: *C. nevillei* grows on clay and sandy substrates in seasonally inundated marshes and swamps in dry savannah habitat. It is described as occurring on white sand with open grassy vegetation, in pools on the inland side of a lagoon and in the shade of swamp forest. All sites are within 40 km of the coast. It has been recorded growing with *Ceratophyllum*, *Potamogeton* and *Vallisneria* species. 0-50 m.

General Use and Trade Information: *C. nevillei* is not considered suitable for normal aquaria; however, it remains vulnerable to uncontrolled and/or illegal collection due to the small number of known populations. Most populations are very easily accessible, although access may be limited due to unexploded ordnance.

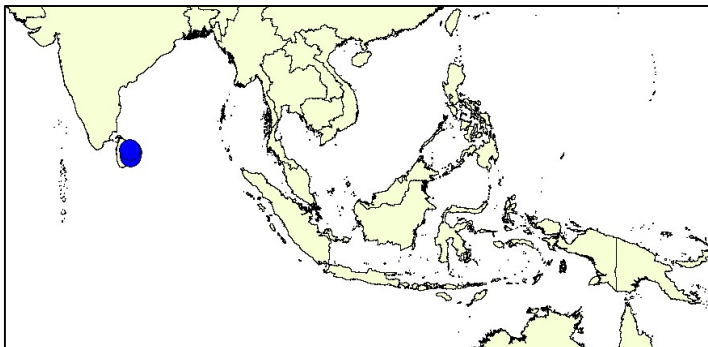
Threats: *C. nevillei* is threatened by factors which affect coastal habitat throughout much of the world. It is directly threatened by the effects of development of tourist facilities and by conversion of coastal wetlands to aquaculture. It is also threatened by the secondary effects of these factors, such as hyper-eutrophication of coastal wetlands and casual habitat degradation of coastal habitats due to recreational use.

Conservation: There are no direct conservation measures in place for *C. nevillei* and it is not known from any protected areas. Some degree of protection may be provided by the potential for unexploded ordnance to still occur in some of the areas from which it has been recorded. It was classed as EN B2ab(i, ii, iii) (National Red List 2020). See detailed proposal Chapter 5.4.21.

Red List Assessment: EN B1ab(iii)+2ab(iii).

Assessment Rationale: *C. nevillei* has a very restricted distribution in highly threatened habitats and may be declining as some surveys have failed to find it. It is therefore classed as Endangered.

Reviewers: N. Jacobsen, D. Yakandawala.



38. *Cryptocoryne noritoi* Wongso 2005

Distribution: *C. noritoi* is endemic to Borneo, where it was formerly known from three sites in Berau District of East Kalimantan, in Indonesia. However, two sites were converted to settlement in 2019. It is now only known from one site where conditions are rapidly degrading.

EOO: 4 km²

AOO: 4 km²

Countries of Occurrence: Indonesia (Kalimantan)

Population: There is no information on population size or trends in *C. noritoi*.

Habitats and Ecology: *C. noritoi* grows in springs and the upstream reaches of forested streams arising from karstic limestone, in an area with numerous springs and underground rivers. The water is often cloudy due to dissolved lime and flows over loam substrates. 0-20 m.

General Use and Trade Information: *C. noritoi* is considered likely to be suitable for cultivation in aquaria but is not yet readily available. It is likely to be very vulnerable to uncontrolled and/or illegal collection.

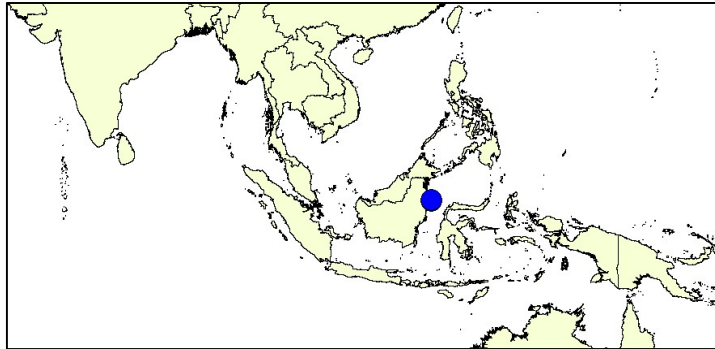
Threats: *C. noritoi* is threatened by a number of factors, including modification of springs for water supply, commercial collection, illegal logging and lime quarrying. Habitats in the area were also damaged in the fires of 1982-83 and 1997-98. Much of the remaining forest in the area has been allocated for industrial plantation. It may also be threatened by uncontrolled and/or illegal collection.

Conservation: There are no specific conservation measures in place for *C. noritoi*. It does not occur in any protected areas. See detailed proposal Chapter 5.4.6.

Red List Assessment: CR B1ab(i, ii, iii, iv, v)+2ab(i, ii, iii, iv, v).

Assessment Rationale: *C. noritoi* has the smallest AOO and EOO possible and it is severely threatened by a range of factors, including commercial collection, it is therefore classed as Critically Endangered.

Reviewers: N. Jacobsen, S. Wongso.



39. *Cryptocoryne nurii* Furtado 1935

Taxonomic note: Two varieties are recognised within *C. nurii*: var. *nurii* occurs in south-eastern Peninsular Malaysia, Sumatra and the Riau Archipelago and var. *raubensis* occurs in a limited area in central Peninsular Malaysia.

Distribution: *C. nurii* occurs in central and south-eastern Peninsular Malaysia, southern Sumatra and the islands of Bintan, Lingga and Singkep in the Riau Archipelago in Indonesia.

EOO: 129,500 km²

AOO: 100 km²

Countries of Occurrence: Indonesia (Sumatra, Riau), Malaysia (Peninsula).

Population: There is no information on population size or trends in *C. nurii*, it can occur in large populations.

Habitats and Ecology: *C. nurii* occurs in fast-flowing forest streams and rivers in shade or where reaches are broad enough, the channel may be in direct sunlight. It has been recorded in limestone systems and typically occurs on sand, gravel or rocky substrates. In some areas it persists beyond forest clearance and it has been recorded in a recently planted oil plantation. 0-500 m.

General Use and Trade Information: Var. *nurii* is considered to be difficult to maintain in cultivation and has previously been reported to be extensively collected from the wild. In contrast var. *raubensis* is easy to grow and likely to be threatened by uncontrolled and/or illegal collection.

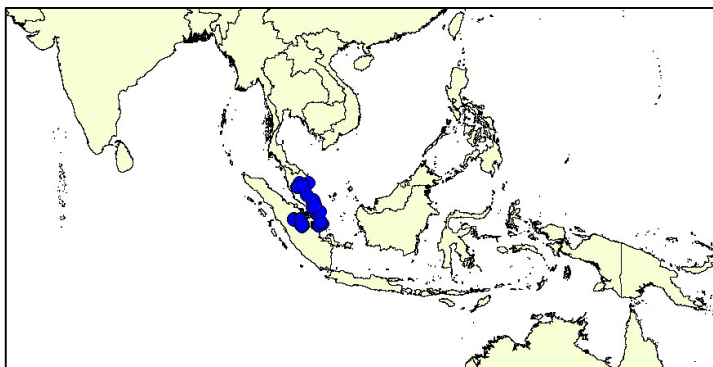
Threats: The habitats and sites where *C. nurii* occurs are threatened by factors which affect all plants occurring in flowing water bodies in the region. These include forest clearance, urbanisation, agricultural intensification and the secondary effects of these factors, particularly increased turbidity, pollution and casual habitat degradation.

Conservation: There are no conservation actions in place specifically for *C. nurii* and none needed. It is known to occur in Panty Recreational Forest and the Malay Nature Society Endau Rompin Education and Research Centre in Malaysia.

Red List Assessment: LC.

Assessment Rationale: *C. nurii* is widespread and occurs in a number of administrative regions. Var. *nurii* is considered to be Near Threatened because of the threat of commercial collection, however var. *raubensis* is considered to be Least Concern and therefore the species as a whole is classed as Least Concern.

Reviewer: N. Jacobsen



39a. *Cryptocoryne nurii* var. *nurii*

Distribution: *C. nurii* var. *nurii* is known from south-eastern of Peninsular Malaysia in Johore, Pahang and Trengganu States, Riau Province in Sumatra and the islands of Bintan, Lingga and Singkep in the Riau Archipelago.

EOO: 85,682 km²

AOO: 80 km²

Countries of Occurrence: Malaysia (Peninsula), Indonesia (Sumatra, Riau).

Population: There is no information on population size or trends in *C. nurii* var. *nurii*.

Habitats and Ecology: *C. nurii* var. *nurii* grows in slow- or fast-flowing streams and rivers on gravel in lowland forest. 10-500 m.

General Use and Trade

Information: *C. nurii* var. *nurii* is considered to be difficult to cultivate but has previously been collected from the wild in large quantities.

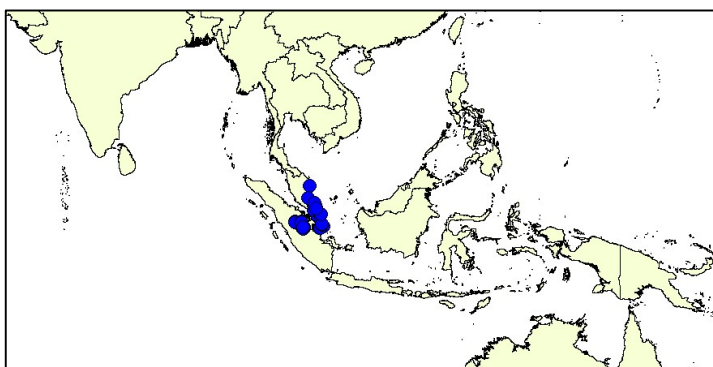
Threats: The habitats and sites where *C. nurii* var. *nurii* occurs are threatened by factors which affect all plants occurring in flowing water bodies in the region. These include forest clearance, urbanisation, agricultural intensification and the secondary effects of these factors, particularly increased turbidity, pollution and casual habitat degradation. It is also described as often collected and exported in large quantities.

Conservation: There are no conservation measures in place specifically for *C. nurii* var. *nurii*. It is known to occur in Panti Recreational Forest and the Malay Nature Society Endau Rompin Education and Research Centre both in Peninsular Malaysia. There is a need to assess the conservation condition of known populations to enable monitoring of the effects of commercial collection, combined with a comparison of the distribution of development, industrial plantation and logging concessions with the distribution of this variety.

Red List Assessment: NT VU B2b(iii, v); D2.

Assessment Rationale: *C. nurii* var. *nurii* is quite widespread and occurs not only in different administrative regions, but on a number of different islands. However, it appears to be threatened by commercial collection throughout its range. It is therefore classed as Near Threatened, with the expectation that if surveys show that populations are being lost, it would be re-classed as Vulnerable.

Reviewer: N. Jacobsen



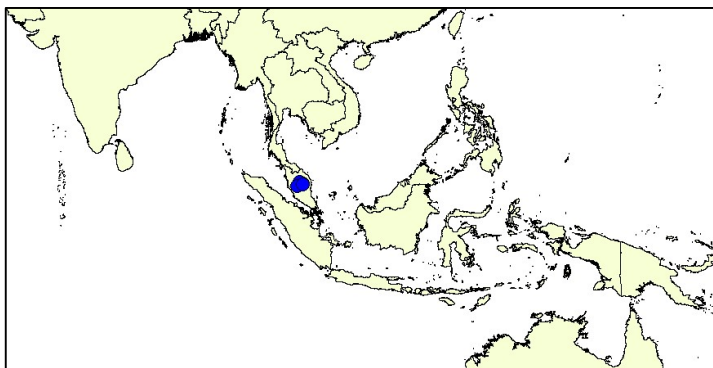
39b. *Cryptocoryne nurii* var. *raubensis* Ganapathy & Siow 2013

Distribution: *C. nurii* var. *raubensis* is known from a small area in central Peninsular Malaysia, north of Raub and Jerantut in tributaries of the Pahang River, as well as in rivers in Taman Negara.

EOO: 1,626 km²

AOO: 20 km²

Countries of Occurrence:
Malaysia



Population: Known populations are large but there is no quantified information on population size or trends in *C. nurii* var. *raubensis*.

Habitats and Ecology: *C. nurii* var. *raubensis* grows in streams and rivers in lowland rainforest, flowing over clay or sandy substrates. It is capable of persisting after forest clearance and has been recorded in direct sunlight in streams flowing through oil palm plantations. In Taman Negara it has been found growing together with *Cryptocoryne affinis*. 100-150 m.

General Use and Trade Information: *C. nurii* var. *raubensis* is considered easy to cultivate and may be severely threatened by uncontrolled and/or illegal collection.

Threats: The habitats and sites where *C. nurii* var. *raubensis* occurs are threatened by factors which affect all plants occurring in flowing water bodies in the region. These include forest clearance, urbanisation, agricultural intensification and the secondary effects of these factors, particularly increased turbidity, pollution and casual habitat degradation. It may also be threatened by uncontrolled and/or illegal collection.

Conservation: There are no conservation actions in place specifically for this species and none needed. It is known to occur in the National Park - Taman Negara.

Red List Assessment: NT EN B1ab(iii)+2ab(iii).

Assessment Rationale: Populations outside the National Park are in areas either already cleared of forest or vulnerable to such clearance. Whilst populations have been found which persisted in plantations after forest clearance, it is not clear how long they may be able to survive in these conditions. The occurrence of healthy populations in Taman Negara, as well as outside the park boundary suggest that *C. nurii* var. *raubensis* is not immediately threatened. Ongoing threats to populations and the small number of known populations mean that it is classed as Near Threatened with the understanding that it is likely to be classed as Endangered if more detailed information becomes available.

Reviewer: N. Jacobsen

40. *Cryptocoryne paglaterasiana* Naive & N.Jacobsen 2022

Distribution: This species is endemic to the Zamboanga Peninsula, Western Mindanao in the Philippines.

EOO: 4 km²

AOO: 4 km²

Countries of Occurrence: Philippines.

Population: This species is known from a single site with an estimated population of fewer than 100 individuals. There is no information on populations trends in this species.

Habitats and Ecology: *C. paglaterasiana* has been recorded growing partly or completely submerged in rock crevices and on sandy substrate in a stream in forest, both in shade and in sunlight. 140-150 m.

General Use and Trade Information: The species is not yet available in horticultural trade. Preliminary tests suggest that it is easy to cultivate and it is therefore likely to be highly threatened by uncontrolled and/or illegal collection.

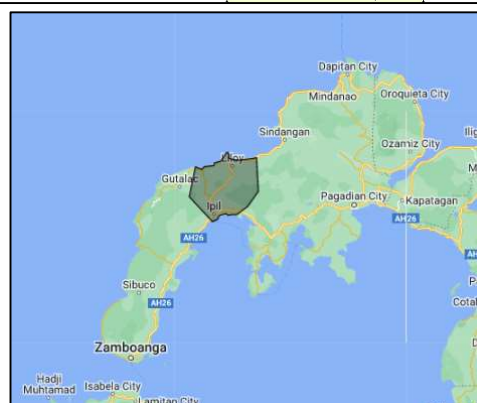
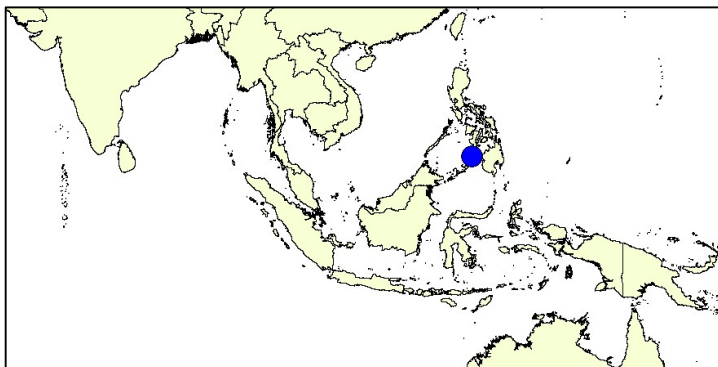
Threats: This species is threatened by ongoing habitat degradation and destruction by quarrying, forest clearance for agriculture and expansion of settlements. It is also likely to be threatened by uncontrolled and/or illegal collection.

Conservation: There are no conservation measures in place for this species. There is an urgent need to protect the known population, which could also protect known populations of *C. pygmaea*.

Red List Assessment: CR B1ab(ii, iii, v)+2ab(ii, iii, v)

Assessment Rationale: *C. paglaterasiana* is known from a single population involving fewer than 100 mature individuals. It is threatened by issues such as expansion of agriculture and settlements, as well as quarrying and uncontrolled and/or illegal collection. It is therefore classed as Critically Endangered. The description of *C. paglaterasiana* as a new species was published after the Red List assessments were submitted and so this assessment was not included.

Reviewers: N. Jacobsen, M.A.K. Naive



41. *Cryptocoryne palawanensis* Bastm., N.Jacobsen & Naive 2022

Distribution: This species is endemic to the Philippines, where it is known from Palawan and Busuanga.

EOO: 1,333 km²

AOO: 48 km²

Countries of Occurrence: Philippines.

Population: There is no information on population size or trends in this species.

Habitats and Ecology: *C. palawanensis* is known from small streams and rivers flowing over sandy or stony substrates. There is no information on the altitude of known populations.

General Use and Trade Information: This species is likely to be easy to cultivate and therefore vulnerable to uncontrolled and/or illegal collection.

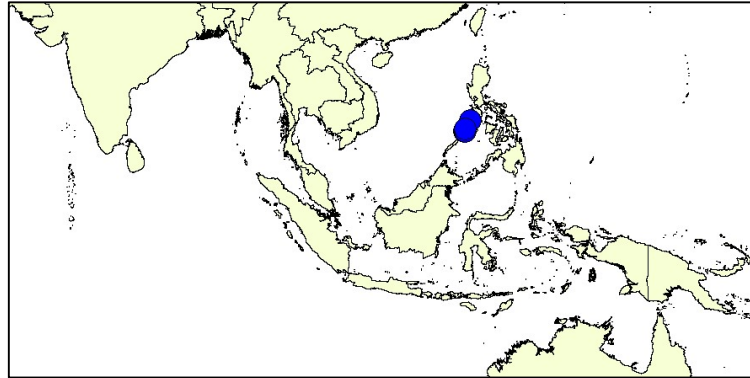
Threats: *C. palawanensis* is threatened by ongoing habitat destruction and degradation. It is also likely to be threatened by uncontrolled and/or illegal collection.

Conservation: There are no conservation measures in place for this species. There is an urgent need to protect the known populations.

Red List Assessment: EN B1ab(ii, iii, v)+2ab(ii, iii, v).

Assessment Rationale: *C. palawanensis* is known from ten collections, each of which is currently treated as a separate location, although more detailed information is likely to show that some sites should be combined. It is threatened by ongoing habitat destruction and degradation and likely to be vulnerable to uncontrolled and/or illegal collection. It is therefore classed as Endangered. The description of *C. palawanensis* as a new species was published after the Red List assessments were submitted and so this assessment was not included.

Reviewers: N. Jacobsen, M.A.K. Naive



42. *Cryptocoryne pallidinervia* Engl. 1879

Distribution: *C. pallidinervia* is endemic to Borneo, where it is known from western Kalimantan (Indonesia) and Sarawak (Malaysia).

EOO: 76,061 km²

AOO: 76 km²

Countries of Occurrence:
Indonesia (Kalimantan),
Malaysia (Sarawak)

Population: There is no information on population size or trends in *C. pallidinervia*.

Habitats and Ecology: *C. pallidinervia* occurs on deep humus in slow-flowing rivers and streams, as well as in seasonally inundated pools in lowland forest and often in association with peat swamp forest, occurring both inland and close to the tidal limit. It has been recorded growing through forest dominated by *Kibessia gracilis*, *Shorea macrophylla*, *S. myrionerva* and *Sandoricum borneense*, as well as in *Hevea brasiliensis* plantations. It is also able to persist after forest clearance and has been recorded growing in a rubber farm intercropped with local fruit trees and nuts such as *Durio zibethinus* and *Shorea macrophylla*.

General Use and Trade Information: *C. pallidinervia* is considered to be difficult to cultivate and not suitable for normal aquaria. It is unlikely to be severely threatened by over collection.

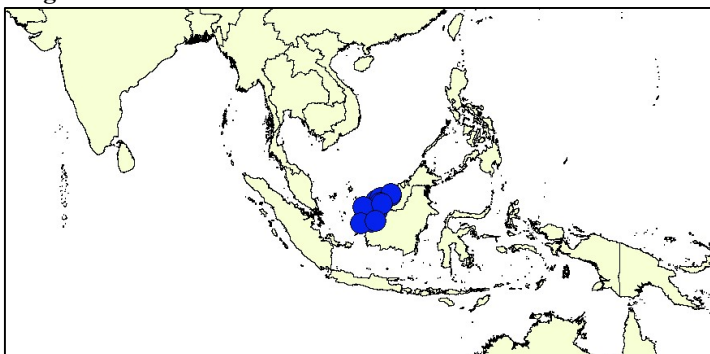
Threats: The habitats and sites where *C. pallidinervia* occurs are threatened by factors which affect all plants occurring in flowing water bodies in the region. These include forest clearance, urbanisation, agricultural intensification and the secondary effects of these factors, particularly increased turbidity, pollution and casual habitat degradation. It is often associated with peat swamp forest which is a habitat that has been substantially destroyed and transformed to agriculture throughout much of the region.

Conservation: There are no conservation actions in place specifically for *C. pallidinervia* and it is not known from any protected areas. There is a need to establish an up-to-date assessment of the conservation status of known populations, as well as to survey other potentially suitable habitat in the area to try to find more populations. Conservation action for this species could be linked to conservation of *C. keei* and *C. lingua*.

Red List Assessment: NT VU B2b(iii, v).

Assessment Rationale: *C. pallidinervia* is found over a wide area, in two administrative regions. However, all known populations are in areas of secondary forest, plantations or around settlements. All are extremely vulnerable to the secondary effects of habitat conversion, as well as intensification of land-use and urbanisation. It is therefore classed as Near Threatened and expected to be re-classed as Vulnerable if surveys show that populations are being lost.

Reviewers: N. Jacobsen, S. Wongso



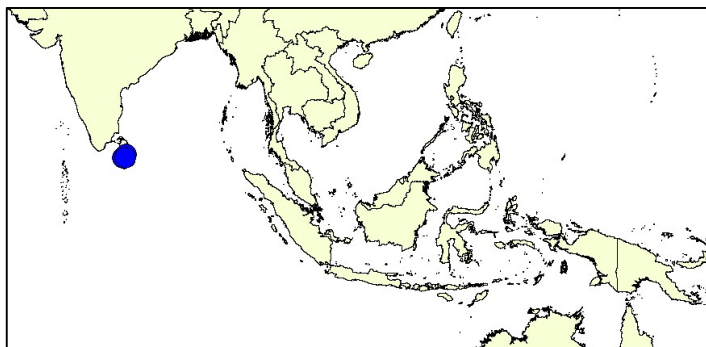
43. *Cryptocoryne parva* de Wit 1970

Distribution: *C. parva* grows in the central highlands of Sri Lanka near Kandy, where it is known from three documented sites. It probably occurs in other sites in the surrounding areas.

EOO: 551 km²

AOO: 12 km²

Countries of Occurrence: Sri Lanka



Population: *C. parva* is known from very few sites but it may occur in large populations.

Habitats and Ecology: *C. parva* forms dense stands on coarse sand and pebble substrates in fast-flowing forest streams and rivers, including canalised sections. It has been recorded with *Cryptocoryne beckettii*, *C. walkeri* and *Lagenandra praetermissa*. 80-560 m.

General Use and Trade Information: *C. parva* is easy to cultivate but is scarce in aquaria, it may be threatened by commercial collection.

Threats: The habitat in most of the sites where *C. parva* occurs has been heavily degraded by forest clearance for agriculture and plantations. All populations are threatened by factors which affect all plants occurring in flowing water bodies in the region. These include forest clearance, urbanisation, agricultural intensification and the secondary effects of these factors, particularly increased turbidity, pollution and casual habitat degradation. It may also be threatened by uncontrolled and/or illegal collection.

Conservation: There are no conservation actions in place specifically for *C. parva* and it is not known to occur in any protected areas. It was classed as EN B1ab(i, ii, iii)+2ab(i, ii, iii) (National Red List 2020). See detailed proposal Chapter 5.4.5.

Red List Assessment: EN B1ab(iii)+2ab(iii).

Assessment Rationale: *C. parva* is known from a very small number of sites in heavily modified habitats. All populations are threatened by direct and secondary effects of habitat degradation and urbanisation. It is therefore classed as Endangered.

Reviewers: N. Jacobsen, D. Yakandawala.



44. *Cryptocoryne pontederiifolia* Schott 1863

Distribution: *C. pontederiifolia* is endemic to Indonesia, where it is known from a small number of sites along the north-west coast of Sumatra. It is reported to occur as a non-native in Singapore. Only seven populations have been recorded since 2000; the southernmost population was in an urban stream and has not been seen since 1985.

EOO: 10,961 km²

AOO: 28 km²

Countries of Occurrence: Indonesia (Sumatra)

Population: There is no information on population size or trends in *C. pontederiifolia*.

Habitats and Ecology: *C. pontederiifolia* grows in slow-flowing rivers in dense forest in freshwater areas at the upstream limit of mangroves, often in association with *Nypa fruticans*. It will grow in silt and on the root plates and boles of emergent trees. 0-30 m.

General Use and Trade Information: *C. pontederiifolia* is considered to be an excellent species for cultivation in aquaria, so it is widely farmed and cultivated. Consequently it may be severely threatened by uncontrolled and/or illegal collection.

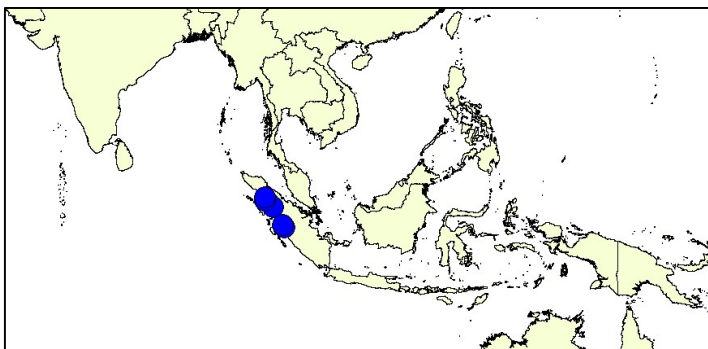
Threats: All known populations are from areas in which the forest has largely been cleared. They are under severe threat from factors which affect all plants occurring in flowing water bodies in the region. These include forest clearance, urbanisation, agricultural intensification and the secondary effects of these factors, particularly increased turbidity, pollution and casual habitat degradation. Some populations appear to have been lost in recent years. All populations are also likely to be threatened by uncontrolled and/or illegal collection.

Conservation: There are no conservation actions in place specifically for *C. pontederiifolia* and it is not known to occur in any protected areas. See detailed proposal Chapter 5.4.7.

Red List Assessment: VU B1ab(iii)+2ab(iii); D2.

Assessment Rationale: *C. pontederiifolia* is known from a small number of sites in the coastal region of western Sumatra in areas in which most natural habitats have been cleared for agriculture and plantations. Remaining habitats in these areas are under pressure from the secondary effects of forest clearance, as well as from urbanisation. Only seven populations have been recorded since 2000. The southernmost population was in an urban stream and has not been seen since 1985, if it has been lost then the EOO would be reduced to 2,727 km². This species is therefore classed as Vulnerable.

Reviewers: N. Jacobsen, S. Wongso.



45. *Cryptocoryne pygmaea* Merr. 1919

Distribution: *C. pygmaea* is endemic to the Philippines, where it is known from the Zamboanga Peninsula in Western Mindanao, with historic records from Zamboanga del Sur and Zamboanga Sibugay, but there are recent records only from Zamboanga del Norte (Naive, Bastmeijer and Jacobsen 2022).

EOO: 50 km²

AOO: 12 km²

Countries of Occurrence: Philippines

Population: There is no information on population size or trends in *C. pygmaea*.

Habitats and Ecology: *C. pygmaea* has been recorded from a crevice in rock in a shaded stream with clear water. 150 m.

General Use and Trade Information: *C. pygmaea* is considered to be easy to cultivate. Given its distribution and small number of known populations, it is likely to be threatened by uncontrolled and/or illegal collection.

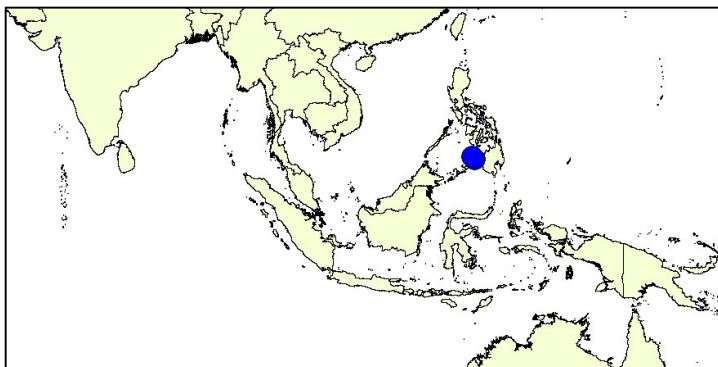
Threats: This species is threatened by ongoing conversion of semi-natural habitat to rubber plantations and by quarrying. It may also be vulnerable to uncontrolled and/or illegal collection.

Conservation: There are no conservation measures in place specifically for *C. pygmaea* and it is not known from any protected areas. There is an urgent need to derive an assessment for the conservation condition of all known populations, combined with an assessment of the likelihood of finding other extant populations. This should be combined with an assessment of current habitat condition and development in relation to the populations of this species.

Red List Assessment: CR B1ab(ii, iii, v)+2b(ii, iii, v).

Assessment Rationale: Following taxonomic revision, this species is now confirmed only to occur at a single site in an area which is degraded due to quarrying and conversion of forest to rubber plantations. It is therefore classed as Critically Endangered. It was previously classed as Vulnerable B2ab(i, ii, iii).

Reviewers: N. Jacobsen, M.A.K. Naive.



46. *Cryptocoryne regina* Wongso & Ipor 2017

Distribution: *C. regina* is endemic to Borneo, where it is known from two areas in West Kalimantan.

EOO: 3,076 km²

AOO: 64 km²

Countries of Occurrence: Indonesia (Kalimantan)

Population: There is no information on population size or trends in *C. regina*.

However, it is known from a number of sites in Kapuas Hulu Regency, where it can occur in very large populations.

Habitats and Ecology: *C. regina* grows on sand banks and bars in large streams and rivers. 50–75 m.

General Use and Trade Information: There is no information on *C. regina* in trade or cultivation.

Threats: The habitats and sites where *C. regina* occurs are threatened by factors which affect all plants occurring in flowing water bodies in the region. These include forest clearance, urbanisation, agricultural intensification and the secondary effects of these factors, particularly increased turbidity, pollution and casual habitat degradation.

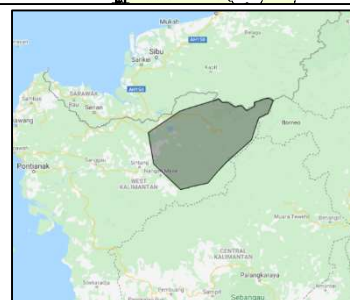
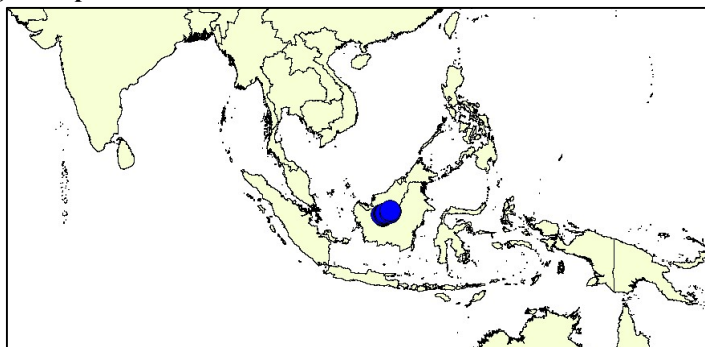
Conservation: There are no conservation actions in place specifically for *C. regina* and it is not known from any protected areas. See detailed proposal Chapter 5.4.3.

Red List Assessment: NT VU B1ab(iii, v)+2ab(iii, v).

Assessment Rationale: *C. regina* is known from a number of locations in two areas of Kalimantan.

Approximately half of the locations are in high forest and currently appear to be secure, however the other half are in areas where forest has either been cleared or is being cleared and are highly threatened. Actions such as forest clearance on the upper reaches of water courses supporting this species could cause rapid declines. However, there is only limited information available on the current conservation condition of populations and there is a need for an assessment of the status of known populations and threats to the habitat on which they depend. This species is classed as Near Threatened in the understanding that if forest clearance continues in the area it is likely to be revised to Vulnerable.

Reviewers: N. Jacobsen, S. Wongso.



47. *Cryptocoryne retrospiralis* (Roxb.) Kunth 1841

Distribution: *C. retrospiralis* is known from Bangladesh and India (see Sasikala *et al.* 2019), where it is known from coastal areas in the south, as well as scattered localities inland in the east, including Assam.

Countries of Occurrence: Bangladesh, India (Assam, Gujarat, Karnataka, Kerala, Maharashtra, Tamil Nadu).

Map: No point data are available from throughout the range of *C. retrospiralis*, therefore only an approximate map is possible.

Population: There is no information available on population size or trends in *C. retrospiralis*, however it is reasonable to assume that it is stable.

Habitats and Ecology: *C. retrospiralis* grows in the sand, gravel, pebble or cobble substrate of slow to fast-flowing streams and rivers in lowland forest, as well as on the banks of rivers which are only inundated at high water, often in full sunlight. It has been recorded in quite diverse aquatic plant associations including *Blyxa aubertii*, *Ceratopteris thalictroides*, *Eleocharis* sp., *Eriocaulon cinereum*, *Fissidens* sp., *Hydrilla verticillata*, *Indotristicha ramosissima*, *Lagenandra toxicaria*, *Limnophila indica*, *Utricularia gibba* and *U. graminifolia*. 0-1110 m.

General Use and Trade Information: *C. retrospiralis* is reported to have some medicinal properties. For example, the rhizome possesses anti-emetic values and acts as a sedative in dyspeptic disorders particularly in vomiting during pregnancy. It is considered unsuitable for aquaria due to its seasonality and is not considered likely to be threatened by over-collection.

Threats: Habitats in which *C. retrospiralis* occurs are threatened by the direct and secondary effects of forest clearance as well as urbanisation. As far as known it seems to be able to tolerate at least some of the changing conditions.

Conservation: There are no conservation measures in place specifically for *C. retrospiralis* and none needed; it is not known to occur in any protected areas.

Red List Assessment: LC

Assessment Rationale: *C. retrospiralis* is widespread and reasonably abundant over a very wide area and it is therefore classed as Least Concern.

Review: N. Jacobsen, A. Watve, S. Wongso.



48. *Cryptocoryne sahalii* Wongso & Ipor 2017

Distribution: *C. sahalii* is endemic to Indonesia, where it is known from two areas: A single site in Gunung Mas Regency and three areas in Kapuas Hulu Regency in West Kalimantan.

EOO: 5,079 km²

AOO: 20 km²

Countries of Occurrence:

Indonesia (Kalimantan)

Population: There is no information available on population size or trends in *C. sahalii*.

Habitats and Ecology: *C. sahalii* grows in small, slow-flowing streams over clay. It has been recorded with *Cryptocoryne striolata*, *Barclaya rotundifolia* and *Bucephalandra* sp. 75 – 225 m.

General Use and Trade Information: *C. sahalii* is not readily available in commerce and not widely cultivated. It is likely to be heavily threatened by uncontrolled and/or illegal collection.

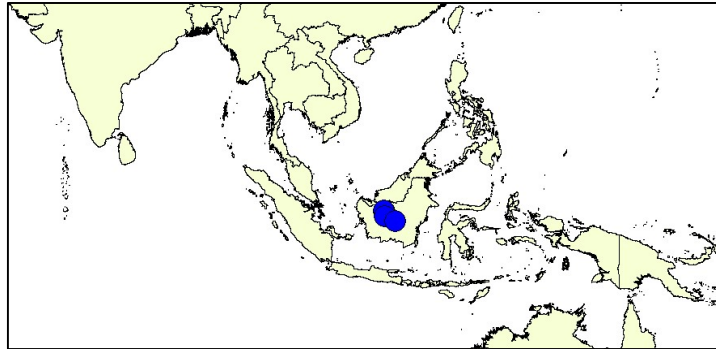
Threats: The habitats and sites where *C. sahalii* occurs are threatened by factors which affect all plants occurring in flowing water bodies in the region. These include forest clearance, urbanisation, agricultural intensification and the secondary effects of these factors, particularly increased turbidity, pollution and casual habitat degradation. It may also be threatened by uncontrolled and/or illegal collection.

Conservation: There are no conservation actions in place specifically for *C. sahalii* and it is not known from any protected areas. See detailed proposal Chapter 5.4.3.

Red List Assessment: EN B1ab(iii)+2ab(iii).

Assessment Rationale: *C. sahalii* is known from a total of four sites in two areas. All known populations of this species are threatened by the direct and secondary effects of forest clearance. It is also likely to be vulnerable to uncontrolled and/or illegal collection. It is therefore classed as Endangered.

Reviewers: N. Jacobsen, S. Wongso.



49. *Cryptocoryne schulzei* de Wit 1971

Distribution: *C. schulzei* is known from Johore State in southern Peninsular Malaysia, between Mersing and Kota Tinggi, as well as from the islands of Singkep and Lingga off eastern Sumatra.

EOO: 6,475 km²

AOO: 28 km²

Countries of Occurrence:

Malaysia (Peninsular),

Indonesia (Riau Islands).

Population: There is no information on population size or trends in *C. schulzei*.

Habitats and Ecology: *C. schulzei* grows in slow-flowing forest streams and small rivers on organic silt. It may persist after forest clearance and has been recorded from small streams and a drainage ditch in rubber plantations. It has been recorded growing with *Cryptocoryne nurii* var. *nurii*, *C. ×timahensis* and *Barclaya motleyi*. 5-50 m.

General Use and Trade Information: *C. schulzei* is not considered easy to cultivate but is often exported, suggesting that it may be at risk of uncontrolled and/or illegal collection.

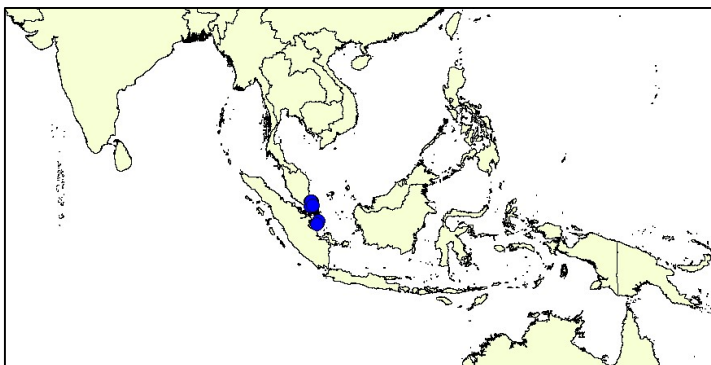
Threats: The habitats and sites where *C. schulzei* occurs are threatened by factors which affect all plants occurring in flowing water bodies in the region. These include forest clearance, urbanisation, agricultural intensification and the secondary effects of these factors, particularly increased turbidity, pollution and casual habitat degradation. It may also be threatened by uncontrolled and/or illegal collection.

Conservation: There are no conservation actions in place specifically for *C. schulzei*. In Pantí Recreational Forest the population is large. Populations on the Riau and Lingga Islands may be secure. See detailed proposal Chapter 5.4.11.

Red List Assessment: VU B1ab(iii)+2ab(iii).

Assessment Rationale: *C. schulzei* occurs in two very widely separated areas, however all populations are at risk from a number of significant threats, particularly the direct and secondary effects of forest clearance and urbanisation, while others are adversely affected by large industry such as oil palm plantations and mining. In spite of a population occurring in a protected area, this does not guarantee protection from over-collection. It is therefore classed as Vulnerable.

Reviewers: N. Jacobsen, S. Wongso.



50. *Cryptocoryne scurrilis* de Wit 1962

Distribution: *C. scurrilis* is endemic to the Indonesian island of Sumatra, where it is known from two sites on the upper reaches of the Indragiri (Kuantan) River in Riau Province.

EOO: 280 km²

AOO: 24 km²

Countries of Occurrence:

Indonesia (Sumatra)

Population: There is no information on population size or trends in *C. scurrilis*.

Habitats and Ecology: *C. scurrilis* occurs in a shallow, shaded, seasonal, 1-2 m wide stream flowing through remnant forest in an area in which most of the forest has been cleared. 100 m.

General Use and Trade Information: *C. scurrilis* is considered relatively difficult to grow in aquaria and it may not be threatened by over-collection.

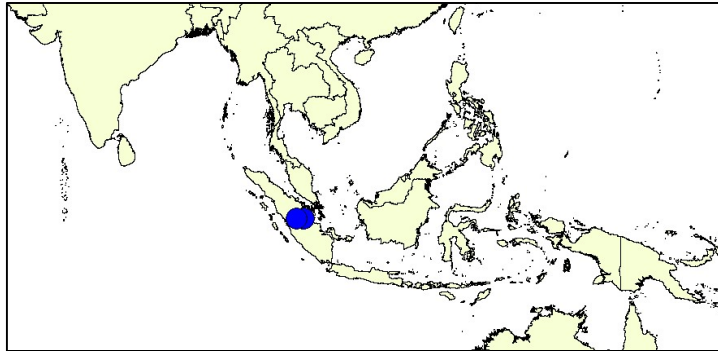
Threats: The habitat and sites where *C. scurrilis* occurs are threatened by factors which affect all plants occurring in flowing water bodies in the region. These include forest clearance, urbanisation, agricultural intensification and the secondary effects of these factors, particularly increased turbidity, pollution and casual habitat degradation.

Conservation: There are no conservation actions in place specifically for *C. scurrilis* and it is not known from any protected areas. See detailed proposal Chapter 5.4.6.

Red List Assessment: EN B1ab(iii)+2ab(iii).

Assessment Rationale: This species is known from two sites on a single river which are considered to represent a single location. The area in which it occurs has largely been cleared of forest, or the forest is degraded and being cleared. It is therefore classed as Endangered.

Reviewers: N. Jacobsen, S. Wongso.



51. *Cryptocoryne sivadasanii* Bogner 2004

Distribution: *C. sivadasanii* is endemic to south-western India, where it is known from only a few sites including Malappuran and Khozikode States in Kerala, as well as in Uttara Kannada and South Kanara Districts in Karnataka.

EOO: 4,131 km²

AOO: 28 km²

Countries of Occurrence: India (Kerala, Karnataka).

Population: There is no information on population size or trends in *C. sivadasanii*.

Habitats and Ecology: *C. sivadasanii* occurs in fast-flowing seasonal streams on laterite, with gravel, sand or bedrock substrate. It has been recorded with *Schoenoplectus articulatus* and *Blyxa aubertii*. 20-45 m.

General Use and Trade Information: *C. sivadasanii* is considered to be relatively easy to cultivate and it is likely to be highly threatened by over-collection.

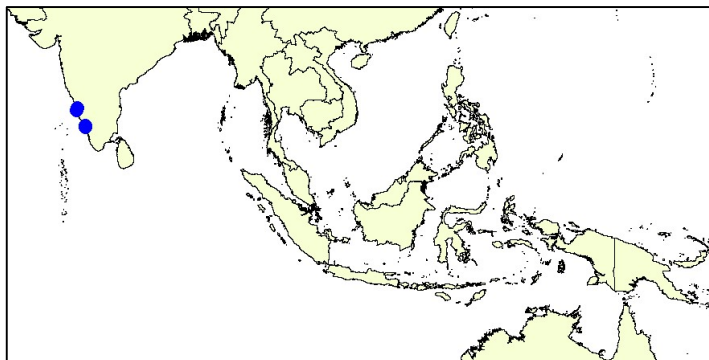
Threats: All of the known populations are in fairly densely populated areas, in which streams flow through villages and settlements. They are all vulnerable to casual modification of water courses, such as hydrological modification, channel realignment or extraction of gravel from the bed. It may also be threatened by uncontrolled and/or illegal collection.

Conservation: There are no conservation actions in place specifically for *C. sivadasanii* and it is not known from any protected areas (although one population is within a university campus). See detailed proposal Chapter 5.4.12.

Red List Assessment: VU B1ab(iii)+2ab(iii).

Assessment Rationale: *C. sivadasanii* is known from a total of eight locations in two main areas, where all populations are in settled areas and extremely vulnerable to stochastic events. It is therefore classed as Vulnerable.

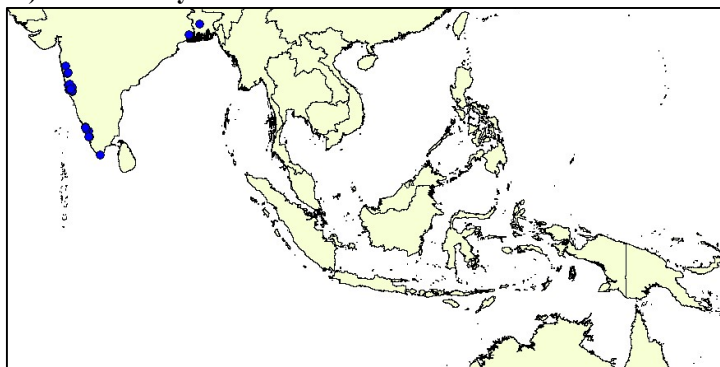
Reviewers: N. Jacobsen, A. Watve, S. Wongso.



52. *Cryptocoryne spiralis* (Retz.) Fisch. ex Wydler 1830

Taxonomic note: Four varieties are recognised within *C. spiralis*, all occurring on the west coast of India: var. *caudigera*, var. *cognatoides*, var. *huegeli* and var. *spiralis*.

Distribution: *C. spiralis* is endemic to India where it is widespread on the west coast from Maharashtra State south through the Western Ghats to Tamil Nadu.

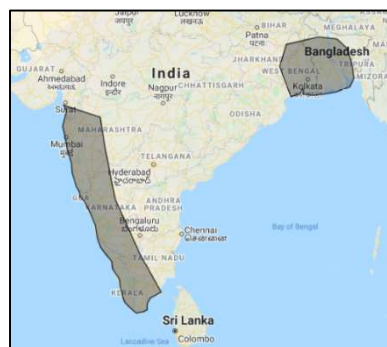


Population: *C. spiralis* is common throughout much of its range.

There is no information on populations trends.

Habitats and Ecology: *C. spiralis* occurs in a wide range of wetland habitats, from streams, rivers, pools, swamps and marshy hollows in the floodplains of small streams in pasture to anthropogenic habitats such as rice fields and roadside ditches. 45-1300 m.

General Use and Trade Information: *C. spiralis* is considered relatively easy to grow in aquaria. The rhizome is reported to possess anti-emetic properties and to act as a sedative in dyspeptic disorders particularly in vomiting during pregnancy. It is not considered likely to be severely threatened by uncontrolled and/or illegal collection.



Threats: Although some varieties are threatened, the species as a whole is not.

Conservation: There are no conservation measures in place for this species and none needed.

Red List Assessment: LC

Assessment Rationale: *C. spiralis* is widespread and reasonably abundant throughout much of its range. It is therefore classed as Least Concern.

Reviewer: N. Jacobsen

52a. *Cryptocoryne spiralis* var. *caudigera* Bogner 2013

Distribution: *C. spiralis* var. *caudigera* is endemic to south-western India, where it has been recorded from sites in Kerala and Tamil Nadu States on the west coast.

Countries of Occurrence: India (Kerala, Tamil Nadu).

Map: No point data are available from throughout the range of *C. spiralis* var. *caudigera*.

Population: There is no information on population size or trends in *C. spiralis* var. *caudigera*.

Habitats and Ecology: *C. spiralis* var. *caudigera* has been collected from a Shola Forest, which is a subtropical or tropical, moist deciduous forest that occurs in valleys between grassland areas (at higher elevations) in the mountainous regions of Karnataka, Kerala and Tamil Nadu at higher elevations in the Western Ghats in southern India. It also occurs with *Crinum malabaricum* on laterite bedrock exposures and on gravel beds in shaded medium-sized seasonal streams flowing through tree plantations (including areca, cashew and coconut, rubber and banana) and riparian forest in Aravanchal and Periya, northern Kerala. 100-1300 m

General Use and Trade Information: *C. spiralis* var. *caudigera* is considered relatively easy to cultivate, it is therefore at risk of uncontrolled and/or illegal collection.

Threats: There is no detailed information available on the sites from which *C. spiralis* var. *caudigera* was collected and it is therefore not possible to assess threats to populations. The populations at Aravanchal and Periya are relatively secure, although they are very small and could easily be lost to relatively minor changes in use of the water bodies or adjacent habitat. Some populations may also be threatened by uncontrolled and/or illegal collection.

Conservation: There are no conservation measures in place specifically for *C. spiralis* var. *caudigera*. There is an urgent need to document extant populations and survey to find additional populations. See detailed proposal Chapter 5.1.15

Red List Assessment: DD.

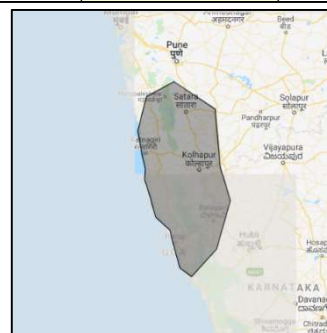
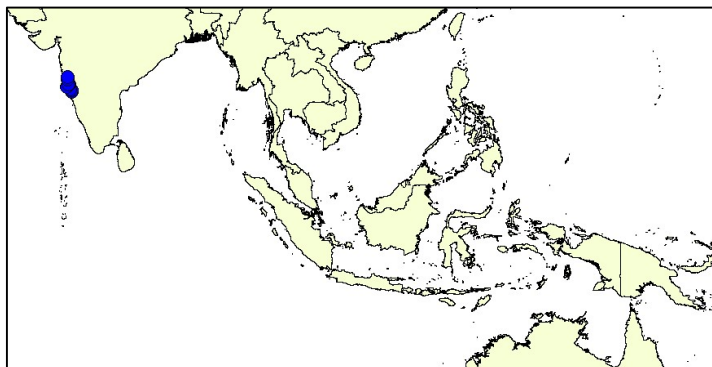
Assessment Rationale: Available information is inadequate to derive an informed assessment of the extinction risk to *C. spiralis* var. *caudigera* and it is therefore classed as Data Deficient.

Reviewers: A. Watve, N. Jacobsen, S. Wongso

52b. *Cryptocoryne spiralis* var. *cognatoides* (Blatt. & McCann) S.R.Yadav, K.S.Patil & Bogner 1993

Distribution: *C. spiralis* var. *cognatoides* is endemic to the Western Ghats in Western India, where it is known from eight sites in Karnataka and Maharashtra States.

- Gaganbavda (Kolhapur district) (te Beest 1998, Mishra and Singh 2001)
- Borbet (Kolhapur district) (te Beest 1998)
- Koynanagar (Satara district) (te Beest 1998, Mishra and Singh 2001)
- Gothane (Sangli district previously Ratnagiri district) - Part of Chandoli National Park (Mishra and Singh 2001)
- Amboli ghat (Sindhudurg district) (te Beest 1998, Mishra and Singh 2001)
- Tillari ghat (Kolhapur district) (Mishra and Singh 2001)
- Amgaon (Chikhle) Belgaum dt (Karnataka state) (Chandore 2010).
- Osargaon (nr Kanakavali, Sindhudurg dt) (Kulkarni 1988) (all other records are on high altitude plateaus and this one is on a low altitude plateau, thus whilst included here, it needs confirmation)



EOO: 3,458 km²

AOO: 24 km²

Countries of Occurrence: India (Karnataka, Maharashtra).

Population: There is no information on population size or trends in *C. spiralis* var. *cognatoides*.

Habitats and Ecology: *C. spiralis* var. *cognatoides* occurs on silt, gravel and sand in standing or flowing water in swamps, as well as in seasonally inundated hollows in the floodplains of small streams. It is also capable of growing in anthropic habitats such as rice fields and roadside ditches. It has been recorded with var. *spiralis* in Sindhudurg District. 650-900 m.

General Use and Trade Information: *C. spiralis* var. *cognatoides* is considered to be relatively easy to cultivate, but seems to be at low risk from commercial collection.

Threats: Populations have been found both in agricultural areas and within intact forest. Individual populations may be vulnerable to casual modification of water courses, such as hydrological modification, channel realignment or extraction of gravel from the bed, but some populations are able to survive in anthropogenic habitats.

Conservation: There are no specific conservation measures in place for *C. spiralis* var. *cognatoides*. One of the populations may be within the boundary of Radhanagari Wildlife Sanctuary but otherwise it is not known from any protected areas. See detailed proposal Chapter 5.1.12.

Red List Assessment: VU B1ab(iii)+2ab(iii).

Assessment Rationale: *C. spiralis* var. *cognatoides* is known from eight sites and some populations are quite isolated. It may be able to exploit anthropogenic habitats but most populations occur in areas which have been only slightly modified and many persist mainly due to their remoteness. Any improvement in access or increase in habitat modification could cause loss of populations. It is therefore classed as Vulnerable.

Reviewers: A. Watve, N. Jacobsen, S. Wongso

52c. *Cryptocoryne spiralis* var. *huegelii* (Schott) Bogner 2013

Distribution: *C. spiralis* var. *huegelii* is endemic to Maharashtra State on the west coast of India, where it is known from a small number of sites in the Western Ghats.

Countries of Occurrence: India (Maharashtra).

Map: No point data available from throughout the range of the variety.

Population: There is no information on population size or trends in *C. spiralis* var. *huegelii*.

Habitats and Ecology: *C. spiralis* var. *huegelii* is known from rivers, ditches, rice fields and seasonal hollows in pasture. 1200 m.

General Use and Trade Information: *C. spiralis* var. *huegelii* is not widely available in cultivation, it may be at a high risk from commercial collection.

Threats: There is no detailed information available on the sites from which *C. spiralis* var. *huegelii* was collected and it is therefore not possible to assess the risk to populations.

Conservation: There are no conservation measures in place specifically for *C. spiralis* var. *huegelii*. See detailed proposal Chapter 5.4.1.12.

Red List Assessment: DD.

Assessment Rationale: Available information is inadequate to derive an informed assessment of the extinction risk to *C. spiralis* var. *huegelii* and it is therefore classed as Data Deficient.

Reviewers: A. Watve, N. Jacobsen, S. Wongso

52d. *Cryptocoryne spiralis* var. *spiralis*

Distribution: *C. spiralis* var. *spiralis* occurs on the west coast of India, where it is widespread in the lowlands from Maharashtra State south to Tamil Nadu. There are also recent reports from Bangladesh

Countries of Occurrence: India (Karnataka, Kerala, Maharashtra, Tamil Nadu), Bangladesh

Population: *C. spiralis* var. *spiralis* is common many areas, including as a weed in rice fields.

Habitats and Ecology: *C. spiralis* var. *spiralis* occurs in a wide range of seasonal and permanent wetland habitats, including streams, ditches, rivers, pools, rice fields and marshy pasture. 0-900 m.

General Use and Trade Information: *C. spiralis* var. *spiralis* is widely available and considered easy to cultivate, it is considered to be at low risk from over collection.

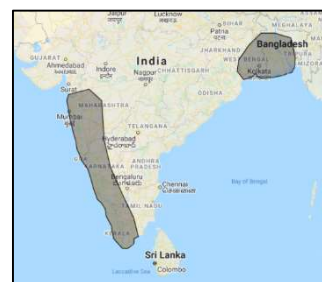
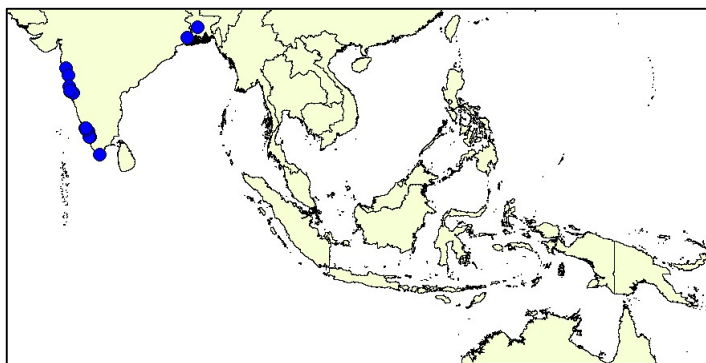
Threats: There are no known threats likely to cause the extinction of *C. spiralis* var. *spiralis*.

Conservation: There are no specific conservation actions in place for *C. spiralis* var. *spiralis* and none needed. It is not known to occur in any protected areas.

Red List Assessment: LC

Assessment Rationale: *C. spiralis* var. *spiralis* is widespread and reasonably abundant throughout much of its range. It is therefore classed as Least Concern.

Reviewers: N. Jacobsen, S. Wongso



53. *Cryptocoryne striolata* Engl. 1879

Distribution: *C. striolata* is endemic to Borneo, where it is widespread from Brunei Darussalam in the north, more or less throughout Kalimantan.

EOO: 337,880 km²

AOO: 308 km²

Countries of Occurrence: Brunei Darussalam, Indonesia (Kalimantan), Malaysia (Sarawak) (point data unavailable for some of the range and so not mapped)

Population: There is no information on population size in *C. striolata*, although some populations will be threatened by factors such as forest clearance, the overall population trend is likely to be stable.

Habitats and Ecology: *C. striolata* grows in slow to fast-flowing forest streams and rivers, usually in heavily shaded areas and often in deep water. It is found on a range of substrates, from silt and sand to gravel, stones and bedrock, as well as on the root boles of emergent *Saraca indica* trees. It has been recorded growing with *Barclaya* species, *Bucephalandra* species and *Cryptocoryne auriculata*. 0-600 m.

General Use and Trade Information: *C. striolata* is considered to be difficult to cultivate and is not much sought after, it is therefore unlikely to be threatened by commercial collection.

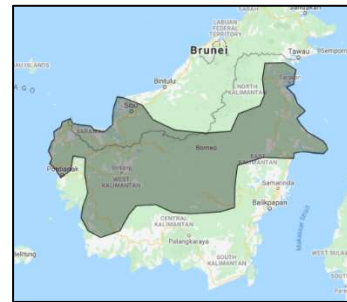
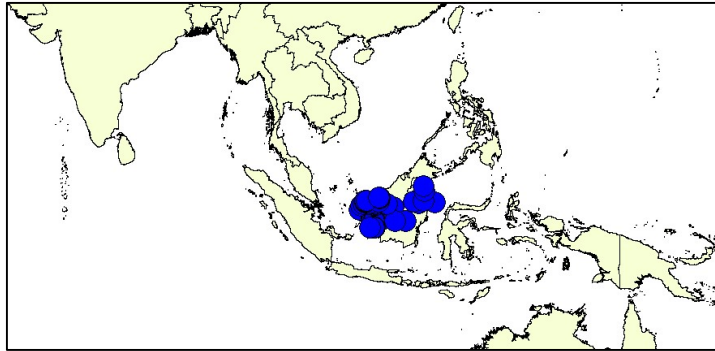
Threats: The habitats and sites where *C. striolata* occurs are threatened by factors which affect all plants occurring in flowing water bodies in the region. These include forest clearance, urbanisation, agricultural intensification and the secondary effects of these factors, particularly increased turbidity, pollution and casual habitat degradation. However, none of these threats is considered likely to result in the extinction of this species in the near future.

Conservation: There are no conservation actions in place specifically for *C. striolata* and none needed. It is not known from any protected areas.

Red List Assessment: LC.

Assessment Rationale: *C. striolata* is widespread and locally abundant throughout much of southern Borneo and although some populations are threatened by a range of factors such as forest clearance, these are not considered likely to cause the extinction of the species. It is therefore classed as Least Concern.

Reviewers: N. Jacobsen, S. Wongso.



54. *Cryptocoryne thwaitesii* Schott 1857

Distribution: *C. thwaitesii* is endemic to south-western Sri Lanka.

EOO: 3,447 km²

AOO: 48 km²

Countries of Occurrence: Sri Lanka

Population: *C. thwaitesii* appears to have declined over the last 40 years (C. Kasselman pers. comm.) due to over-collection and there are river sections where this has caused the loss of populations.

Habitats and Ecology: *C. thwaitesii* occurs in small forest streams flowing over gravel, often with a layer of organic debris and typically under a closed canopy, in dense shade.

General Use and Trade Information: *C. thwaitesii* is considered difficult to cultivate but is threatened by commercial collection.

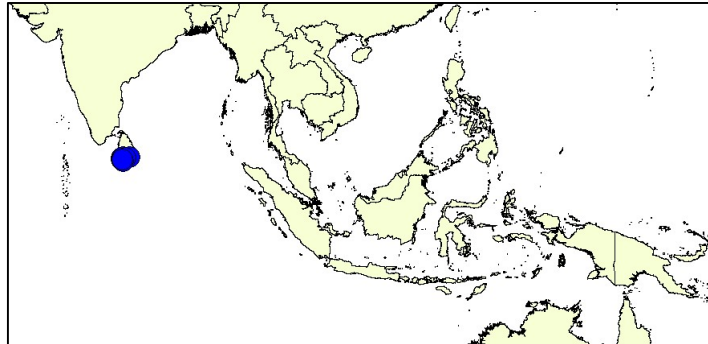
Threats: The habitat where *C. thwaitesii* occurs is declining in area and becoming degraded because of logging and conversion to agricultural land. It is also threatened by over-collection.

Conservation: There are no specific conservation actions in place for *C. thwaitesii*. It is known to occur in the Kottawa Forest Reserve and Sinharaja Forest Reserve, it was classed as EN Bab(i, ii, iii)+2ab(i, ii, iii) (National Red List 2020). See detailed proposal Chapter 5.4.7.

Red List Assessment: VU B1ab(i, ii, iii, v)+B2ab(i, ii, iii, v).

Assessment Rationale: *C. thwaitesii* is restricted to a small area of south-western Sri Lanka, where apart from the Kottawa and Sinharaja Forest Reserves, all the sites from which it has been recorded are in remnant forest patches among areas converted to settlements, agriculture or plantations. It is also severely threatened by illegal collection. It has declined in recent years and all remaining sites are under serious threat. It is therefore classed as Vulnerable.

Reviewers: N. Jacobsen, D. Yakandawala.



55. *Cryptocoryne tirtadinatae* Wongso 2020

Distribution: *C. tirtadinatae* is known from a single site about 100km north-east from Ketapang in Ketapang Regency, in the Schwaner mountain area, West Kalimantan.

EOO: 4 km²

AOO: 4 km²

Countries of Occurrence:
Indonesia (Kalimantan)

Population: There is no information on population size in *C. tirtadinatae*.

Habitats and Ecology: *C. tirtadinatae* grows on mixed mineral soil and plant debris between tree roots on the banks of a small, 10–15m wide, river with water seeping from the adjacent forest. It was found emergent on a riverbank below the high-water mark, while *C. striolata* occupied deeper parts of the river. The habitat is influenced by water level fluctuations during the dry and wet seasons. 58 m.

General Use and Trade Information: *C. tirtadinatae* is not represented in trade. It is likely to be very vulnerable to collection for sale.

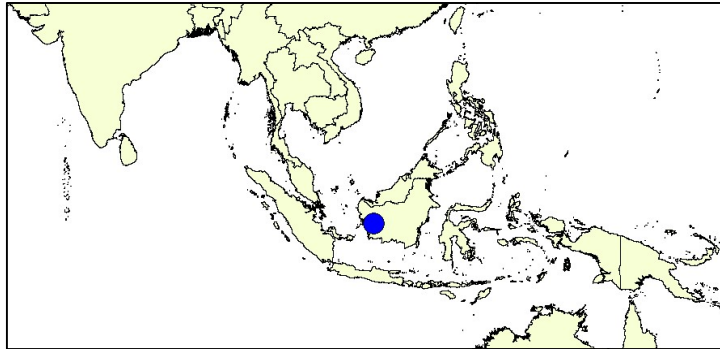
Threats: The habitat in which it occurs is threatened by clear-felling of forest, habitat degradation as a secondary effect of logging of adjacent areas and it is highly vulnerable to over-collection.

Conservation: There are no conservation measures in place for *C. tirtadinatae*. See detailed proposal Chapter 5.4.3.

Red List Assessment: CR B1ab(iii)+2ab(iii)

Assessment Rationale: *C. tirtadinatae* is known from a single site where it is threatened by conversion of forest to agriculture, secondary effects of upstream logging and over-collection. It is therefore classed as Critically Endangered.

Reviewers: N. Jacobsen, S. Wongso



56. *Cryptocoryne uenoi* Yuji Sasaki 2002

Distribution: *C. uenoi* is endemic to Borneo, where it is known from the river system at Sabal Keruing in Sarawak and to the south in Indonesia, W Kalimantan.

EOO: 15,316 km²

AOO: 48 km²

Countries of Occurrence:
Malaysia (Sarawak),
Indonesia (Kalimantan).

Population: There is no information on population size or trends in *C. uenoi*.

Habitats and Ecology: *C. uenoi* occurs in a lowland forest river at the upstream limit of tidal influence, growing in silt, sand and gravel. It occurs with *Cryptocoryne striolata*, *Barclaya motleyi* and *Schismatoglottis jelandii*.

General Use and Trade Information: *C. uenoi* is considered to be difficult to cultivate and is unlikely to be threatened by commercial collection.

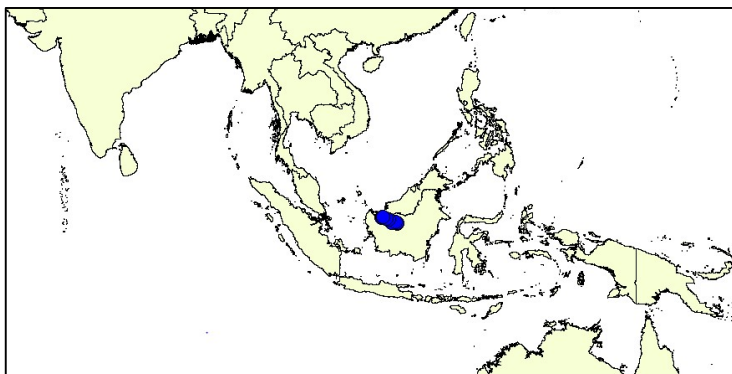
Threats: The sites in Sarawak supporting known populations of this species have been badly disturbed by human activities including logging, forest clearance for oil palm plantations and cutting of trees for a power line.

Conservation: There are no conservation measures in place and *C. uenoi* is not known from any protected areas. See detailed proposals Chapters 5.4.3 and 5.4.7.

Red List Assessment: VU B1ab(iii)+2ab(iii).

Assessment Rationale: *C. uenoi* is known from eleven areas, each treated as a separate location, although one includes a number of sub-populations in a small area and some populations may already have been lost. Populations are declining due to habitat destruction, including forest clearance for oil palm plantations. It is therefore classed as Vulnerable.

Reviewers: N. Jacobsen, S. Wongso.



57. *Cryptocoryne undulata* Wendt 1954

Distribution: *C. undulata* is endemic to Sri Lanka where it is known from Kandehene, Udamulle and at Halloluwa.

EOO: 12km² (increased to agree with AOO)

AOO: 12km²

Countries of Occurrence: Sri Lanka

Population: There is no information on population size or trends in *C. undulata*.

Habitats and Ecology: *C. undulata* is found in small to large, fast-flowing rivers in forested areas, growing in silt and other sediment deposited between boulders. 450-520 m.

General Use and Trade Information: *C. undulata* is considered to be easy to cultivate and may be under severe threat from uncontrolled and/or illegal collection.

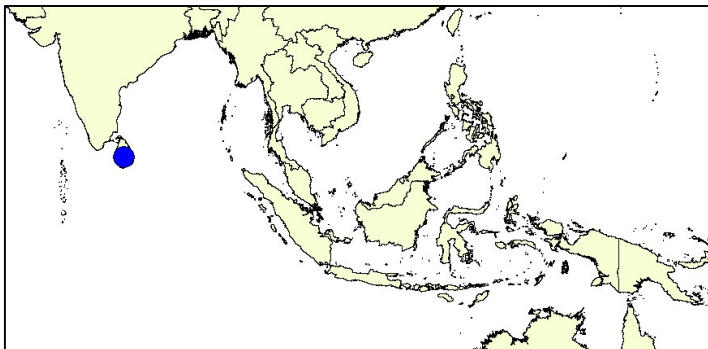
Threats: All the sites where *C. undulata* has been recorded are heavily modified and affected by human activity. Some populations have also been affected by hydrological modification of the Mahaweli Ganga system. It is also threatened by uncontrolled and/or illegal collection.

Conservation: There are no specific conservation actions in place for *C. undulata* and it is not known to occur in any protected areas. It is classed as CR B1ab(i, ii, iii) (National Red List 2020). See detailed proposal Chapter 5.4.5.

Red List Assessment: EN B1ab(iii)+2ab(iii).

Assessment Rationale: *C. undulata* is known from only four sites, all of which are treated as separate locations, all are threatened by habitat destruction and degradation. It is therefore classed as Endangered. There is no evidence of a decline, however if surveys show any decline, it is likely that it would qualify for Critically Endangered.

Reviewers: N. Jacobsen, D. Yakandawala.



58. *Cryptocoryne usteriana* Engl. in A.Usteri 1905

Distribution: *C. usteriana* is endemic to the Philippines, where it is known only from the island of Guimaras, south-west of Panay.

EOO: 12 km² (increased to agree with AOO)

AOO: 12 km²

Countries of Occurrence:
Philippines

Population: There is no information on population size or trends in *C. usteriana*.

Habitats and Ecology: *C. usteriana* occurs in slow-flowing or standing water bodies on gravel or sand substrate in the lowlands, typically in forested areas, although most areas where it occurs are severely modified. 5-75 m.

General Use and Trade Information: *C. usteriana* is considered easy to cultivate and is therefore probably at risk of uncontrolled and/or illegal collection.

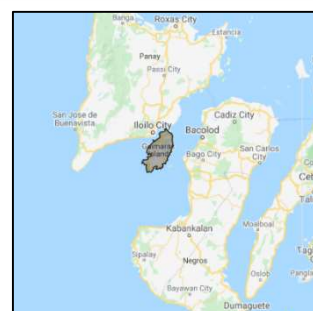
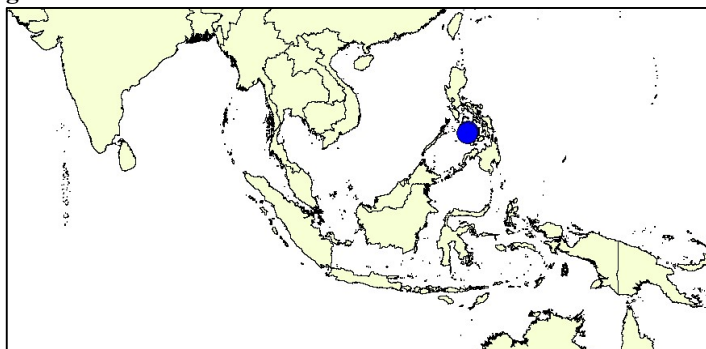
Threats: The habitats and sites where *C. usteriana* occurs are threatened by factors which affect all plants occurring in flowing water bodies in the region. These include forest clearance, urbanisation, agricultural intensification and the secondary effects of these factors, particularly increased turbidity, pollution and casual habitat degradation. It may also be threatened by uncontrolled and/or illegal collection.

Conservation: There are no conservation actions in place specifically for *C. usteriana* and it is not known from any protected areas. There is an urgent need to survey all known populations to derive an up-to-date assessment of the conservation status of known populations, combined with investigation of the possibility of protecting sites and hydrological systems supporting this species.

Red List Assessment: EN B1ab(iii)+2ab(iii).

Assessment Rationale: *C. usteriana* is known from only seven sites, one of which may already have been lost. All of the sites where it occurs have been highly modified by man and it is threatened by commercial collection. It is therefore classed as Endangered.

Reviewer: N. Jacobsen, M.A.K. Naive



59. *Cryptocoryne verrucosa* Wongso & Asih 2022

Distribution: *C. verrucosa* is endemic to a small area in central Kalimantan, mainly to the south-west of the town of Putussibau in Kapuas Hulu Regency.

EOO: 1,117 km²

AOO: 60 km²

Countries of Occurrence:
Indonesia (Kalimantan).

Population: *C. verrucosa* forms large stands on the margins of rivers. There is no information on population trends in this species.

Habitats and Ecology: *C. verrucosa* occurs on the banks of small rivers and streams with muddy substrate, mainly in secondary forest. The pH of water at the site was 4.1, conductivity 35 µS/cm. 40-60 m.

General Use and Trade Information: *C. verrucosa* is easy to cultivate and may be vulnerable to uncontrolled and/or illegal collection.

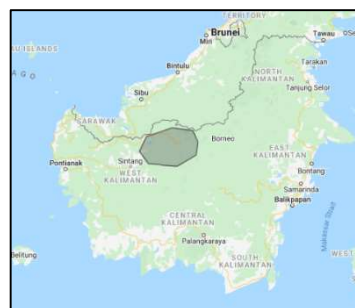
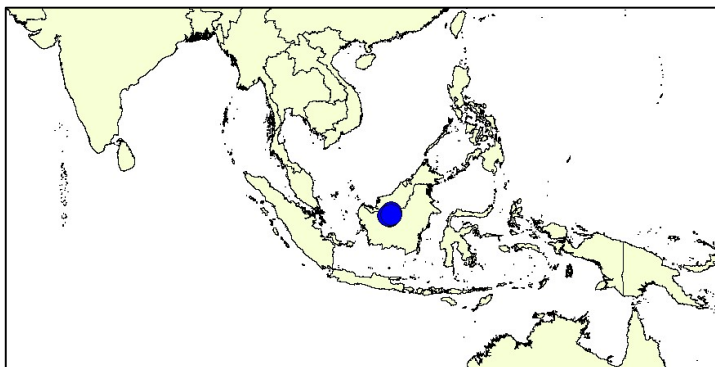
Threats: The area in which *C. verrucosa* occurs has mainly been logged, particularly along water courses but there is remnant forest in the area. The habitats and sites where this species occurs are threatened by factors which affect all plants occurring in flowing water bodies in the region. These include forest clearance, urbanisation, agricultural intensification and the secondary effects of these factors, particularly increased turbidity, pollution and casual habitat degradation. Most populations appear to be linked to a single main water course and as such may be vulnerable to small-scale land-use change or infrastructure development. It may also be threatened by uncontrolled and/or illegal collection.

Conservation: There are no conservation actions in place specifically for *C. verrucosa* and it is not known from any protected areas. See detailed proposal Chapter 5.4.3.

Red List Assessment: VU B1ab(iii)+2ab(iii)

Assessment Rationale: *C. verrucosa* occurs at scattered localities in a small area. Most populations occur along a single major water course, with one outlier to the north. Whilst it is unlikely that a single action could threaten all populations, any major infrastructure project or conversion of habitat to intensive agriculture could threaten a significant proportion of the known populations. The populations are interpreted as nine locations, based on their distribution and proximity to one another. This species is therefore classed as Vulnerable.

Reviewers: N. Jacobsen, S. Wongso.



60. *Cryptocoryne versteegii* Engl. 1910

Taxonomic note: Two varieties are recognised within *C. versteegii*, both endemic to New Guinea (a record from Lake Sentani is considered to be an error).

Distribution: *C. versteegii* is endemic to New Guinea, where it is known from three areas, two in West Papua (Indonesia) and one in New Guinea.

EOO: 25,288 km²

AOO: 20 km²

Countries of Occurrence: Indonesia (West Papua), New Guinea

Population: There is no information available on population size in *C. versteegii*, but it is likely to be declining.

Habitats and Ecology: *C. versteegii* grows in peat-stained lowland, spring-fed streams in swamp forest above the limits of tidal influence. It forms large, dense mats in sand and gravel (some lateritic) between boulders. At one site it has persisted beyond forest clearance and now grows in an open area, in another it grows in dappled sunlight beneath the forest canopy. It has been recorded growing with *Cryptocoryne ciliata* var. *latifolia*, *Leptochilus pteropus* and *Barclaya motleyi*. 15-70 m.

General Use and Trade Information: *C. versteegii* var. *versteegii* is not considered suitable for aquaria and it is therefore unlikely to be threatened by commercial collection, however var. *jayaensis* is easy to cultivate and may therefore be threatened by uncontrolled and/or illegal collection.

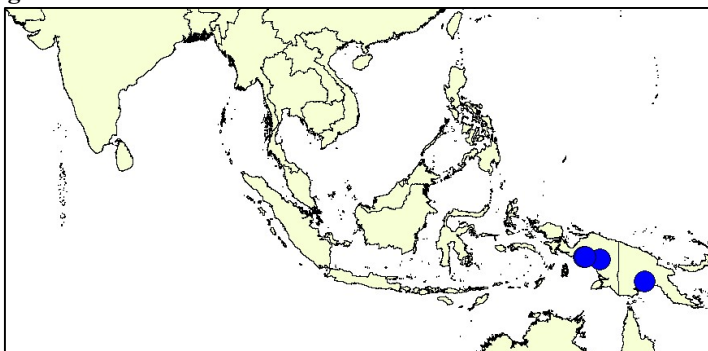
Threats: The habitats and sites where *C. versteegii* occurs are threatened by factors which affect all plants occurring in flowing water bodies in the region. These include forest clearance, urbanisation, agricultural intensification and the secondary effects of these factors, particularly increased turbidity, pollution and casual habitat degradation. This species is also specifically threatened by deposition of mine tailings and some populations may already have been lost. Populations of *C. versteegii* var. *jayaensis* may also be threatened by uncontrolled and/or illegal collection.

Conservation: There are no conservation actions in place specifically for *C. versteegii* and it is not known from any protected areas. See detailed proposal Chapter 5.4.13.

Red List Assessment: EN B2ab(iii).

Assessment Rationale: *C. versteegii* is known from five sites, probably representing four locations. All populations are threatened by the direct and secondary effects of forest clearance, but two are more specifically threatened by the impacts of mining activities. It is therefore classed as Endangered.

Reviewer: N. Jacobsen



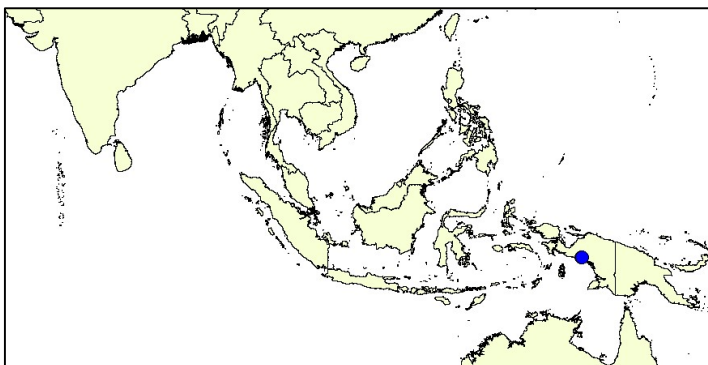
60a. *Cryptocoryne versteegii* var. *jayaensis* N.Jacobsen, Bastm., P.J.Edwards, R.J.Johns, N.Takah. & Wongso 2014

Distribution: *C. versteegii* var. *jayaensis* is endemic to West Papua, where it is known from two sites in the area around Timika, on the Kopi and Ajkwa Rivers.

EOO: 12 km² (increased to agree with AOO)

AOO: 12 km²

Countries of Occurrence: West Papua



Population: There is no information on population size in *C. versteegii* var. *jayaensis*, but the known populations are likely to be declining.

Habitats and Ecology: *C. versteegii* var. *jayaensis* grows in peat-stained lowland, spring-fed streams in swamp forest above the limits of tidal influence. It forms large, dense mats in sand and gravel (some lateritic) between boulders. At one site it has persisted beyond forest clearance and now grows in an open area, in another it grows in dappled sunlight beneath the forest canopy. It has been recorded growing with *Barclaya motleyi*. 15-70 m.

General Use and Trade Information: *C. versteegii* var. *jayaensis* is considered easy to cultivate and is likely to be highly threatened by commercial collection.



Threats: The habitats and sites where *C. versteegii* var. *jayaensis* occurs are threatened by factors which affect all plants occurring in flowing water bodies in the region. These include forest clearance, urbanisation, agricultural intensification and the secondary effects of these factors, particularly increased turbidity, pollution and casual habitat degradation. This species is also specifically threatened by deposition of mine tailings and some populations may already have been lost. It is also threatened by uncontrolled and/or illegal collection.

Conservation: There are no conservation actions in place specifically for *C. versteegii* var. *jayaensis* and it is not known from any protected areas. See detailed proposal Chapter 5.4.13.

Red List Assessment: EN B1ab(iii)+2ab(iii).

Assessment Rationale: *C. versteegii* var. *jayaensis* is known from two sites, probably representing two locations. Both populations are threatened by direct and secondary effects of forest clearance and specifically threatened by the impacts of mining activities. The small number of populations and level of threat make this variety highly vulnerable to ongoing activities. It is therefore classed as Endangered.

Reviewers: N. Jacobsen, S. Wongso.

60b. *Cryptocoryne versteegii* var. *versteegii*

Distribution: *C. versteegii* var. *versteegii* is endemic to New Guinea, where it is known from two sites, one near Kikori in Papua New Guinea and the second on the Lorentz River system in West Papua (Indonesia).

EOO: 8 km²

AOO: 8 km².

Countries of Occurrence:

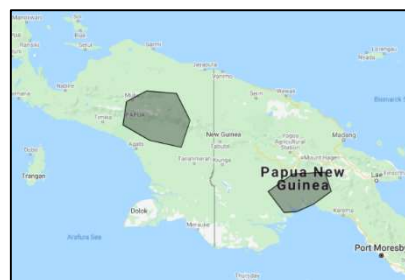
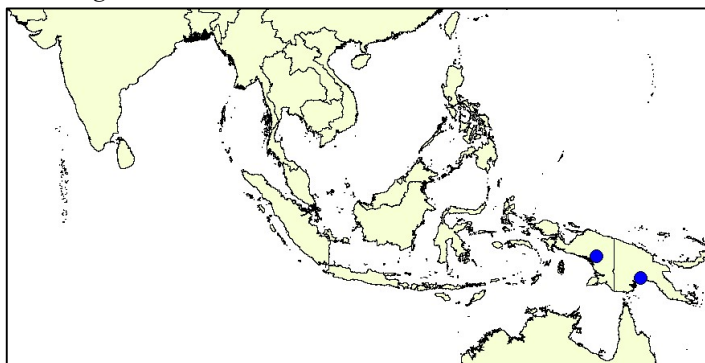
Indonesia (West Papua), Papua New Guinea.

Population: There is no information on population size or trends in *C. versteegii* var. *versteegii*.

Habitats and Ecology: *C. versteegii* var. *versteegii* is known from lowland swamp forest streams growing in laterite gravel in dappled shade. It has been recorded growing with *Cryptocoryne ciliata* var. *ciliata*, *Leptochilus pteropus* and *Barclaya motleyi*. 20-25 m.

General Use and Trade Information: *C. versteegii* var. *versteegii* is rare in cultivation for which it is not considered particularly suitable. It is therefore not considered likely to be threatened by commercial collection.

Threats: The habitats and sites where *C. versteegii* var. *versteegii* occurs are threatened by factors which affect all plants occurring in flowing water bodies in the region. These include forest clearance, urbanisation, agricultural intensification and the secondary effects of these factors, particularly increased turbidity, pollution



and casual habitat degradation. This species is also specifically threatened by deposition of mine tailings and some populations may already have been lost.

Conservation: There are no conservation actions in place specifically for *C. versteegii* var. *versteegii* and it is not known from any protected areas. See detailed proposal Chapter 5.4.13.

Red List Assessment: EN B1ab(iii)+2ab(iii)

Assessment Rationale: *C. versteegii* var. *versteegii* is known from two widely separated sites, both of which are threatened by direct and secondary effects of forest clearance and by the impacts of mining activities. It is therefore classed as Endangered.

Reviewers: N. Jacobsen, S. Wongso.

61. *Cryptocoryne vietnamensis* I.Hertel & H.Mühlberg 1994

Distribution: *C. vietnamensis* is endemic to coastal areas of Vietnam, where it has been reported from sites near Hue, Da Nang, with a recent report from Thua Thien in Hue Province.

EOO: 439 km²

AOO: 16 km²

Population: There is no information available on population size or trends in *C. vietnamensis*.

Habitats and Ecology: *C. vietnamensis* has been recorded from small forested streams. The population in Hue Province occurred on wet mossy rocks along the water line of a small stream flowing through remnants of primary evergreen broadleaved forest on very steep hill slopes composed of stratified shale and sandstone. 25-475 m.

General Use and Trade Information: *C. vietnamensis* is considered slow-growing but easy to propagate. It may be severely threatened by commercial collection.

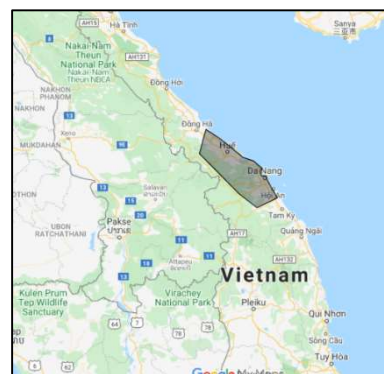
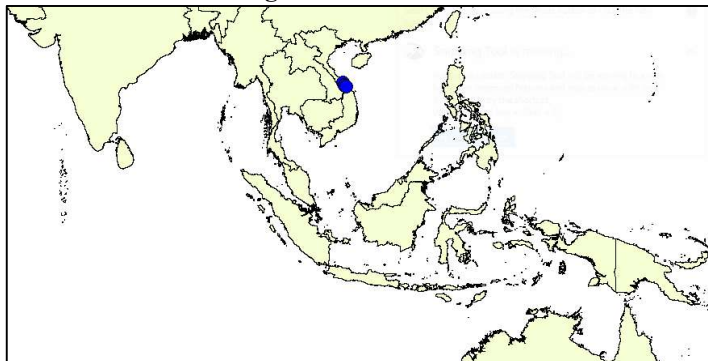
Threats: *C. vietnamensis* is likely to be extremely vulnerable to local and even very small-scale actions which affect the water bodies in which it grows, such as logging of catchments, development or pollution. It is also likely to be threatened by commercial collection.

Conservation: There are no specific conservation actions in place for *C. vietnamensis* and it is not known to occur in any protected areas. There is an urgent need for compilation of an up-to-date assessment of the conservation condition of all known populations, combined with surveys of potentially suitable habitat in the region to locate additional populations and an assessment of potential to protect the site and hydrological systems supporting at least half of known populations. See detailed proposal 5.4.10.

Red List Status: VU B1ab(iii)+2ab(iii).

Assessment Rationale: *C. vietnamensis* is known from approximately ten sites in a small region. It is threatened by a range of actions, from forest clearance to commercial collection. It is therefore classed as Vulnerable.

Reviewers: N. Jacobsen, S. Wongso.



62. *Cryptocoryne villosa* N.Jacobsen 1980

Distribution: *C. villosa* is endemic to central Sumatra in Indonesia.

EOO: 161 km²

AOO: 24 km²

Countries of Occurrence: Indonesia (Sumatra)

Population: There is no information on population size for *C. villosa*, the population is considered likely to be declining due to habitat destruction.

Habitats and Ecology: *C. villosa* has been recorded from slow-flowing streams and small rivers in rainforest. It grows in sandy gravel covered by a layer of organic matter. 65-115 m.

General Use and Trade Information: *C. villosa* is considered to survive poorly in cultivation, it is therefore probably not very threatened by commercial collection.

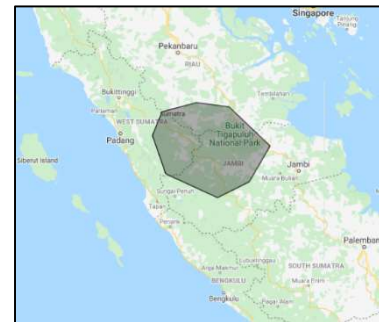
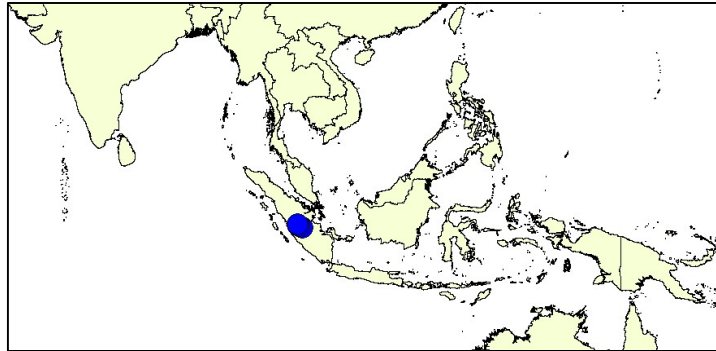
Threats: The habitats and sites where *C. villosa* occurs are threatened by factors which affect all plants occurring in flowing water bodies in the region. These include forest clearance, urbanisation, agricultural intensification and the secondary effects of these factors, particularly increased turbidity, pollution and casual habitat degradation.

Conservation: There are no conservation actions in place specifically for *C. villosa* and it is not known from any protected areas. See detailed proposal Chapter 5.4.6.

Red List Assessment: EN B1ab(iii, v)+2ab(iii, v).

Assessment Rationale: *C. villosa* is known from a very small number of sites, one of which has been lost in the last 40 years and all remaining populations are severely threatened by the direct and secondary effects of forest clearance. It is therefore classed as Endangered.

Reviewers: N. Jacobsen, S. Wongso.



63. *Cryptocoryne walkeri* Schott 1857

Distribution: *C. walkeri* is endemic to Sri Lanka, where it has been reported from a few very scattered sites mainly in the south of the centre, with one site further north.

EOO: 7,024 km²

AOO: 20 km²

Countries of Occurrence: Sri Lanka

Population: There is no information on population size or trends in *C. walkeri*. There have been no confirmed records in recent years and the status of the previously known populations is not certain, however it is likely to persist along the Mahaweli-Ganga system.

Habitats and Ecology: *C. walkeri* occurs in springs and on the banks of fast-flowing rivers on clay and gravel. It will persist when springs are converted to brick-walled basins and after clearance of forest along rivers. It has been recorded with *Cryptocoryne parva* and *Lagenandra praetermissa*. 155-460 m.

General Use and Trade Information: *C. walkeri* is very popular in cultivation and it is therefore likely to be threatened by uncontrolled and/or illegal collection.

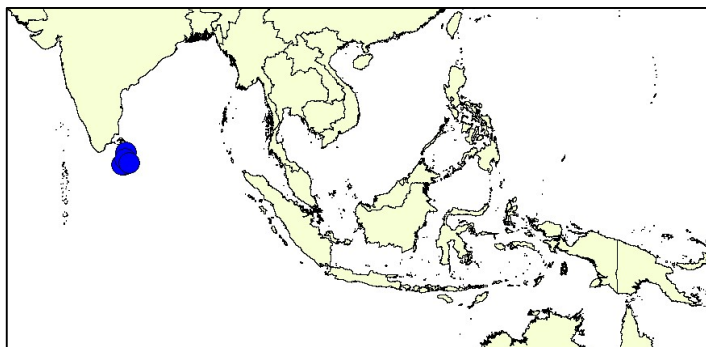
Threats: The habitats and sites where *C. walkeri* occurs are threatened by factors which affect all plants occurring in flowing water bodies in the region. These include forest clearance, urbanisation, agricultural intensification and the secondary effects of these factors, particularly increased turbidity, pollution and casual habitat degradation. Although this species may survive conversion of springs into brick-walled basins and clearance of forest, it will always be vulnerable to intensification of these systems. It is also likely to be threatened by uncontrolled and/or illegal collection.

Conservation: There are no conservation actions in place specifically for *C. walkeri* and it is not known from any protected areas. It is classed as CR B1ab(i,ii,iii) (National Red List 2020). See detailed proposal Chapter 5.4.4.

Red List Assessment: EN B2ab(iii).

Assessment Rationale: *C. walkeri* has occurred over a wide area in central Sri Lanka and appears to be able to tolerate some level of habitat modification and degradation. However the small number of populations, with no recent records and degree of habitat destruction in the region mean that it is classed as Endangered. It is very likely that survey would show further loss of populations and lead to an increased threat level.

Reviewers: N. Jacobsen, D. Yakandawala.



64. *Cryptocoryne waseri* Kettner 2012

Distribution: *C. waseri* is endemic to Sri Lanka, where it was known from a single site near Yahawalatta. This population was destroyed when surrounding forest was cleared.

Countries of Occurrence: Sri Lanka

Population: The only known population of *C. waseri* was destroyed.

Habitats and Ecology: *C. waseri* was recorded in a small, shaded forest stream, growing in full sunlight with *Lagenandra praetermissa*.

General Use and Trade Information: *C. waseri* is considered easy to cultivate, if it still survives then it is very vulnerable to commercial collection.

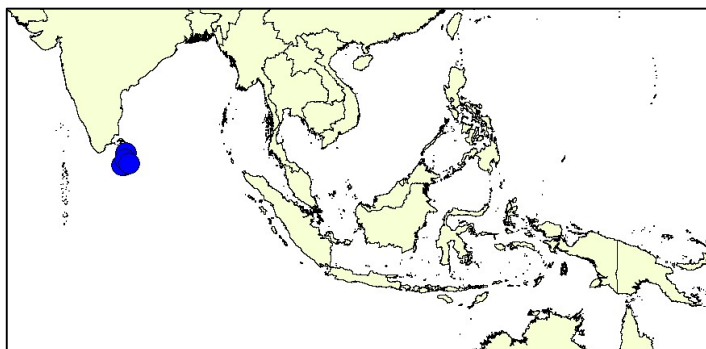
Threats: The habitats and sites where *C. waseri* occurred are threatened by factors which affect all plants occurring in flowing water bodies in the region. These include forest clearance, urbanisation, agricultural intensification and the secondary effects of these factors, particularly increased turbidity, pollution and casual habitat degradation. If it survives, it will also be threatened by uncontrolled and/or illegal collection.

Conservation: This species has not been found in the wild since its discovery in 1990. It was classed as CR B2ab(i,ii,iii) (National Red List 2020). See detailed proposal Chapter 5.4.4.

Red List Assessment: CR(PE) 2ab(iii)+2ab(iii).

Assessment Rationale: *C. waseri* is endemic to Sri Lanka. It was described as occurring at Yahalawatta in the south west, where it was collected from a stream also supporting *C. alba* in 1990 (Bastmeijer *et al.* 2012). In the same article, the type locality is described as having been destroyed by conversion to cultivation. The location at the coordinates given as the type material of *Cryptocoryne waseri* (see <https://plants.jstor.org/stable/history/10.5555/al.ap.specimen.m0234355>) has clearly been cleared of much of the lowland forest which would have occurred and now apparently supports cultivated trees in an open habitat. There are areas in the vicinity which still support relatively intact lowland forest with streams, such as Bodhingala Forest Reserve/Hermitage, although various anecdotal accounts suggest that the springs within the forest reserve are drying out, while the site is surrounded by settlements, rice fields or rubber plantations and therefore very vulnerable. It appears possible that *C. waseri* is extinct due to destruction of the only sites in which it occurred. However, potentially suitable habitat appears to exist in the area and detailed surveys could locate extant populations. For this reason, this species is classed as Critically Endangered (Possibly Extinct).

Reviewers: N. Jacobsen, D. Yakandawala.



65. *Cryptocoryne wendtii* de Wit 1958

Distribution: *C. wendtii* is endemic to Sri Lanka, where there are historic records scattered over much of the western part of the centre of the island.

EOO: 18,240 km²

AOO: 88 km²

Countries of Occurrence: Sri Lanka

Population: There is no information on population levels or trends in *C. wendtii*. It has previously occurred in large numbers but there is no information on the present status.

Habitats and Ecology: *C. wendtii* occurs in and on the margin of fast-flowing forest streams and rivers, as well as ditches in the lowlands. It has been recorded once from rice fields, where it occurred with *C. beckettii* (Kasselmann 2020). 10-350 m.

General Use and Trade Information: *C. wendtii* is considered suitable for cultivation in aquaria, it is likely to be vulnerable to commercial collection.

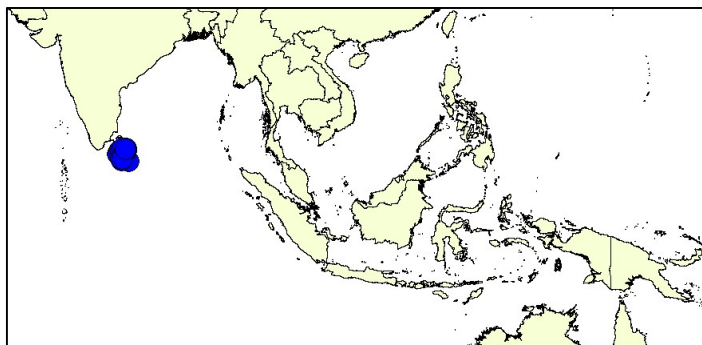
Threats: The habitats and sites where *C. wendtii* occurs are threatened by factors which affect all plants occurring in flowing water bodies in the region. These include forest clearance, urbanisation, agricultural intensification and the secondary effects of these factors, particularly increased turbidity, pollution and casual habitat degradation.

Conservation: There are no conservation actions in place specifically for *C. wendtii* and it is not known from any protected areas. It is classed as VU B1ab(i,ii,iii) (National Red List 2020). See detailed proposal Chapter 5.4.7.

Red List Assessment: NT VU B1ab(iii).

Assessment Rationale: *C. wendtii* has been reported from a wide area within Sri Lanka, however there are very few recent records. Without updated information, it cannot be demonstrated that this species is threatened, however it is considered highly likely that field surveys would show that it is and that it is declining. It is therefore classed as Near Threatened, with the expectation that this classification would be revised to Vulnerable if data on its current status become available.

Reviewers: N. Jacobsen, D. Yakandawala.



66. *Cryptocoryne wongsoi* Ipor 2016

Distribution: *C. wongsoi* is endemic to Sumatra, where it is known only from the type locality in Aceh, SE of Meulaboh and a second site to the south, north of the boundary of Gunung Leuser National Park. It may occur along a number of river systems in the area.

EOO: 8 km²

AOO: 8 km²

Countries of Occurrence: Indonesia (Sumatra).

Population: There is no information on population size or trends in *C. wongsoi*.

Habitats and Ecology: *C. wongsoi* was recorded from seasonally dry areas of lowland swamp forest near the main river in shade or dappled sunlight.

General Use and Trade Information: *C. wongsoi* is apparently easy to propagate and cultivate. It is vulnerable to uncontrolled and/or illegal collection.

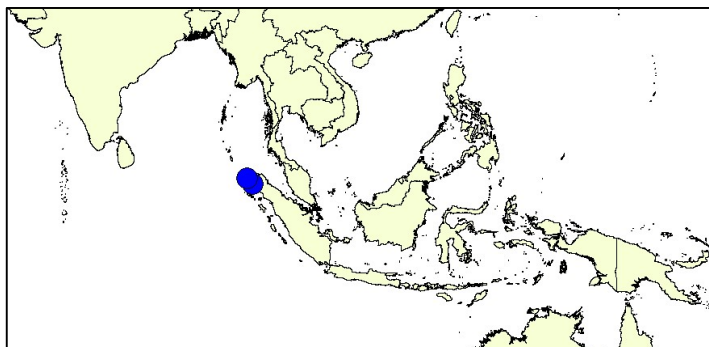
Threats: The habitats and sites where *C. wongsoi* occurs are threatened by factors which affect all plants occurring in flowing water bodies in the region. These include forest clearance, urbanisation, agricultural intensification and the secondary effects of these factors, particularly increased turbidity, pollution and casual habitat degradation. Available information suggests that both known populations are in areas already affected by industrial deforestation (Gaveau *et al.* 2009). It may also be threatened by uncontrolled and/or illegal collection.

Conservation: There are no conservation actions in place specifically for *C. wongsoi* and it is not known from any protected areas. See detailed proposal Chapter 5.4.7.

Red List Assessment: EN B1ab(iii)+2ab(iii)

Assessment Rationale: *C. wongsoi* is known from two sites, both of which appear to be suffering from forest clearance and the secondary effects of this. It is therefore classed as Endangered.

Reviewers: N. Jacobsen, S. Wongso



67. *Cryptocoryne yujii* Bastm. 2002

Taxonomic note: Two varieties are recognised within *C. yujii*, var. *hendrikii* and var. *yujii*.

Distribution: *C. yujii* is endemic to Borneo, where it is known from four areas in the Schwaner Mountains in West Kalimantan, as well as from Sungai Nibong in Durin and Sungai Rajang in Sibul Division in Sarawak.

EOO: 3,667 km²

AOO: 40 km²

Countries of Occurrence: Indonesia (Kalimantan), Malaysia (Sarawak).

Population: There is no information on population size or trends in *C. yujii*.

Habitats and Ecology: *C. yujii* grows in slow-flowing streams and small rivers in forest over clay or sandy substrates. It will persist in areas where the primary forest has been replaced by secondary. 0-185 m.

General Use and Trade Information: *C. yujii* is not generally considered to be suitable for normal aquaria but is easy to grow emersed. It is unlikely to be vulnerable to commercial collection.

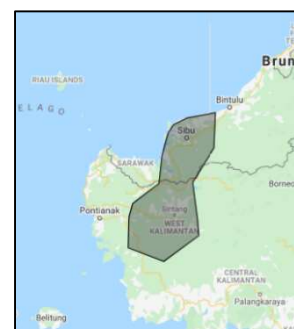
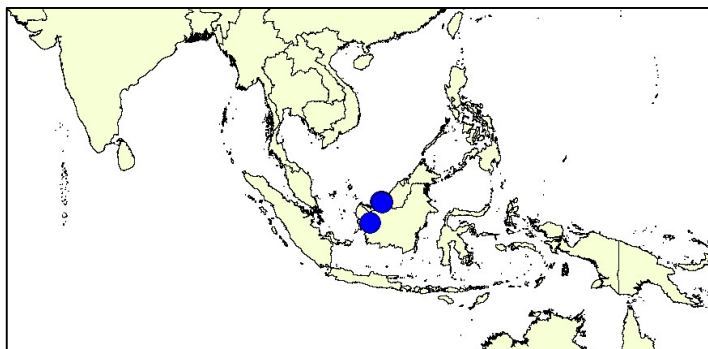
Threats: The habitats and sites where *C. yujii* occurs are threatened by factors which affect all plants occurring in flowing water bodies in the region. These include forest clearance, urbanisation, agricultural intensification and the secondary effects of these factors, particularly increased turbidity, pollution and casual habitat degradation.

Conservation: There are no conservation actions in place specifically for *C. yujii* and it is not known from any protected areas. See detailed proposal Chapter 5.4.3.

Red List Assessment: NT VU B1ab(iii)+2ab(iii).

Assessment Rationale: *C. yujii* is known from four sites on three river systems in two regions. All known populations of this species are threatened by the direct and secondary effects of forest clearance. It is also likely to be vulnerable to uncontrolled and/or illegal collection. It is therefore classed as Near Threatened with the expectation that survey data will show it to have declined more than is currently evident.

Reviewer: N. Jacobsen



67a. *Cryptocoryne yujii* var. *hendrikii* Wongso 2017

Distribution: *C. yujii* var. *hendrikii* is endemic to the Schwaner Mountains in West Kalimantan, where it is known from three sites.

EOO: - km²

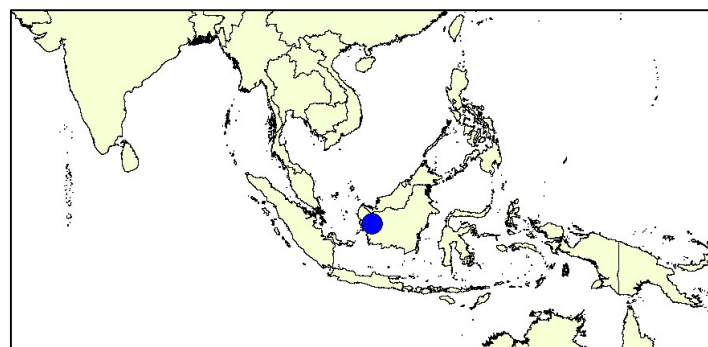
AOO: 12 km²

Countries of Occurrence: Indonesia (Kalimantan)

Population: There is no information on population size or trends in *C. yujii* var. *hendrikii*.

Habitats and Ecology: *C. yujii* var. *hendrikii* occurs in small muddy streams and creeks with slow-flowing water seeping over the surface of clayey sandy soil. 95 –185 m.

General Use and Trade Information: *C. yujii* var. *hendrikii* is rare in cultivation and may be vulnerable to commercial collection.



Threats: The habitats and sites where *C. yujii* var. *hendrikii* occurs are threatened by factors which affect all plants occurring in flowing water bodies in the region. These include forest clearance, urbanisation, agricultural intensification and the secondary effects of these factors, particularly increased turbidity, pollution and casual habitat degradation.

Conservation: Yayasan Konservasi Biota Lahan Basah has acquired a 3 ha former rubber plantation at Nanga Mahap, West Kalimantan to support conservation of *C. yujii* var. *hendrikii*. The area is being replanted with native fruiting trees with the aim of sustainable production of Illipe (*Shorea* sp.) butter, stingless bee (*Trigona* sp.) honey and Gandaria (*Bouea macrophylla*) syrup by local rangers. *C. yujii* var. *hendrikii* is not known from any protected areas. See detailed proposal Chapter 5.4.3.



Red List Assessment: EN B1ab(iii)+2ab(iii).

Assessment Rationale: *C. yujii* var. *hendrikii* is known from three sites in a very small area. All known populations of this species are threatened by the direct and secondary effects of forest clearance. It is also likely to be vulnerable to uncontrolled and/or illegal collection. It is therefore classed as Endangered.

Reviewers: N. Jacobsen, S. Wongso.

67b. *Cryptocoryne yujii* var. *yujii*

Distribution: *C. yujii* var. *yujii* is endemic to Borneo, where it is found in several streams, both south and north of the main Batang Rajang river near Sibu in Sarawak.

EOO: 85 km²

AOO: 28 km²

Countries of Occurrence: Malaysia (Sarawak).

Population: There is no information available on population size or trends in *C. yujii* var. *yujii*.

Habitats and Ecology: *C. yujii* var. *yujii* grows on silt on the banks and in the channel of forested streams. 0-20 m.

General Use and Trade Information: *C. yujii* var. *yujii* is not considered suitable for normal aquaria but is easy to cultivate emersed and may be vulnerable to commercial collection.

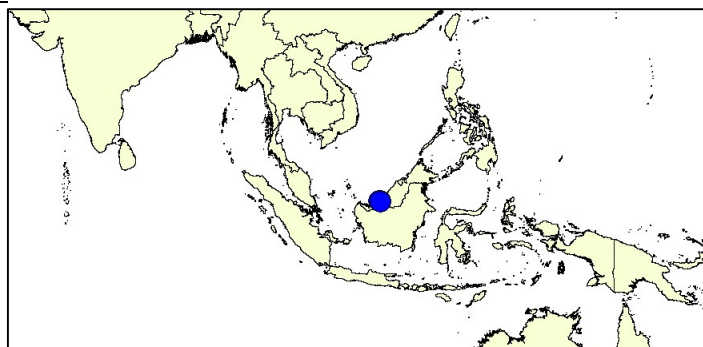
Threats: The habitats and sites where *C. yujii* var. *yujii* occurs are threatened by factors which affect all plants occurring in flowing water bodies in the region. These include forest clearance, urbanisation, agricultural intensification and the secondary effects of these factors, particularly increased turbidity, pollution and casual habitat degradation. All known populations of this variety occur in areas where much of the forest has been or is being cleared for agriculture. It may also be threatened by uncontrolled and/or illegal collection.

Conservation: There are no conservation actions in place specifically for *C. yujii* var. *yujii* and it is not known from any protected areas. See detailed proposal Chapter 5.4.3.

Red List Assessment: EN B1ab(iii)+2ab(iii).

Assessment Rationale: *C. yujii* var. *yujii* is known from a small number of sites in a small area. All known populations of this species are threatened by the direct and secondary effects of forest clearance. It is also likely to be vulnerable to uncontrolled and/or illegal collection. It is therefore classed as Endangered.

Reviewers: N. Jacobsen, S. Wongso.



68. *Cryptocoryne zaidiana* Ipor & Tawan 2005

Distribution: *C. zaidiana* is endemic to Borneo, where it is known only from Sungai Mering, near Tinjar in Miri Division, Sarawak.

EOO: 42 km²

AOO: 12 km²

Countries of Occurrence: Malaysia (Sarawak).

Population: There is no information on population size or trends in *C. zaidiana*. All known populations of *C. zaidiana* are on a single river system and could be affected by a single action. All are therefore treated as a single location.

Habitats and Ecology: *C. zaidiana* grows in slow-flowing lowland forest rivers over clay and sand, with abundant organic litter. Southern populations are in a seasonal river flowing through a band of secondary forest along the river in which the undergrowth is dominated by *Donax grandis*. 15-25 m.

General Use and Trade Information: *C. zaidiana* is not considered suitable for normal aquaria, it is easy to cultivate emersed, but slow to propagate. It is unlikely to be vulnerable to commercial collection.

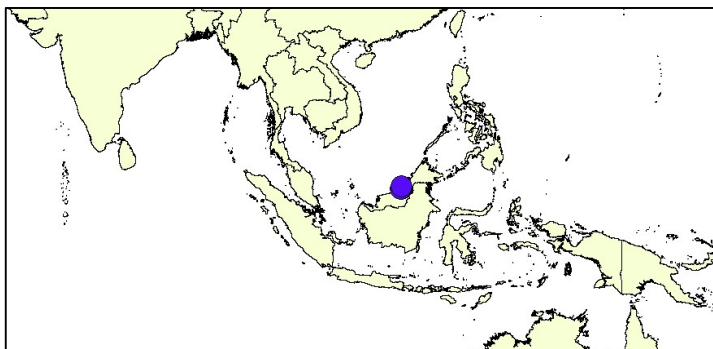
Threats: The northern population is in reasonably intact forest, however the southern population is in an area where the forest was cleared in the 1980s and converted to rice fields, but in 2005 was described as “earmarked for oil palm plantation” (Ipor *et al.* 2005). In the past (and possibly to this day), the river was fished by “mansai”, a method using a round net to scoop up fish from shallow water. This apparently disturbed the substrate, with a potentially damaging effect on *C. zaidiana*. The habitats and sites where this species occurs are threatened by factors which affect all plants occurring in flowing water bodies in the region. These include forest clearance, urbanisation, agricultural intensification and the secondary effects of these factors, particularly increased turbidity, pollution and casual habitat degradation.

Conservation: There are no conservation actions in place specifically for this species and it is not known from any protected areas. There is an urgent need to survey all known populations to derive an up-to-date assessment of their conservation status, together with surveys to try to locate additional populations in the region from which it has already been recorded and over a wider area, as well as an assessment of potential to protect areas where it occurs.

Red List Assessment: EN B1ab(iii, v).

Assessment Rationale: *C. zaidiana* is known from a single river system which is treated as a single location. All known populations of this species are threatened by the direct and secondary effects of forest clearance. It is also likely to be vulnerable to uncontrolled and/or illegal collection. It is therefore classed as Endangered.

Reviewers: N. Jacobsen, S. Wongso.



69. ***Cryptocoryne ×agusii* Takah. 2020**
(*C. ferruginea* var. *sekadauensis* × *C. fusca*)

Distribution: *C. ×agusii* is endemic to West Kalimantan in Indonesia. It has been recorded from a total of four locations around the Kapuas River in Sekadau Regency, West Kalimantan, however the type locality was confirmed to have been lost to settlement in 2015.

EOO: 820 km²

AOO: 16 km²

Countries of Occurrence: Indonesia (Kalimantan)

Population: Populations of *C. ×agusii* may be quite extensive but these are almost certainly clonal.

Habitats and Ecology: *C. ×agusii* occurs in and on the margins of forest streams, approximately 3 m wide, with a substrate of sand and leaf litter. 20-50 m.

General Use and Trade Information: *C. ×agusii* is easily cultivated on leaf peat. There is no information on commercial availability of *C. ×agusii* and as with all very rare hybrids, it may be vulnerable to over-collection.

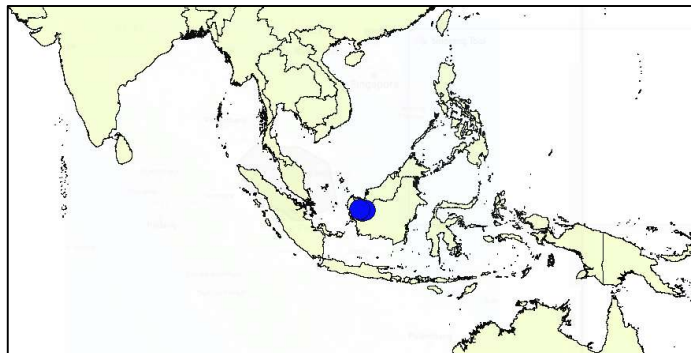
Threats: The habitats and sites where *C. ×agusii* occurs are threatened by factors which affect all plants occurring in flowing water bodies in the region. These include forest clearance, urbanisation, agricultural intensification and the secondary effects of these factors, particularly increased turbidity, pollution, and casual habitat degradation. All known populations of this hybrid occur in areas where much of the forest has been or is being cleared for agriculture. It may also be threatened by uncontrolled and/or illegal collection.

Conservation: There are no conservation actions in place specifically for *C. ×agusii* and it is not known from any protected areas. See detailed proposal Chapter 5.4.3.

Red List Assessment: EN B1ab(iii, v)

Assessment Rationale: *C. ×agusii* is known from four sites along a single river system, one of which has already been destroyed. The habitats in which it occurs have all been modified and there is no protection in place. All sites are threatened by agricultural intensification and expansion of settlements. It is therefore classed as Endangered.

Reviewers: N. Jacobsen, S. Wongso.



70. ***Cryptocoryne* ×*ardyi* Wongso 2019**
(*C. cordata* var. *wellyi* × *C. scurrielis*)

Distribution: *C. ×ardyi* is endemic to Sumatra, Indonesia, where it has been recorded from six sites in Indragiri Hulu and Pelalawan Regencies in Riau Province, one of which has been destroyed.

EOO: 51 km²

AOO: 24 km²

Countries of Occurrence:

Indonesia (Sumatra)

Population: There is no information on population size in *C. ×ardyi*.

Habitats and Ecology: *C. ×ardyi* occurs in slow-flowing streams several metres wide and in pools on muddy substrate of mixed minerals and plant debris in areas characterised by oil palm plantations and settlements. The conductivity of the water at one site was 48 µS/cm. 0-50 m.

General Use and Trade Information: *C. ×ardyi* is easily cultivated. There is no information on commercial availability of *C. ×ardyi* and as with all very rare hybrids, it may be vulnerable to over-collection.

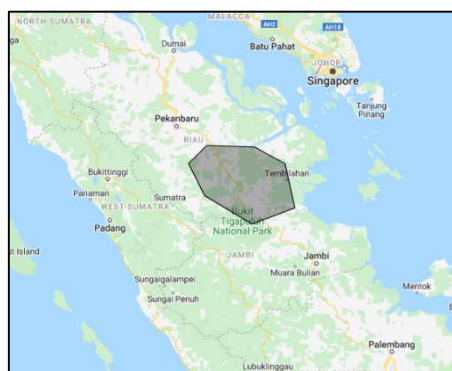
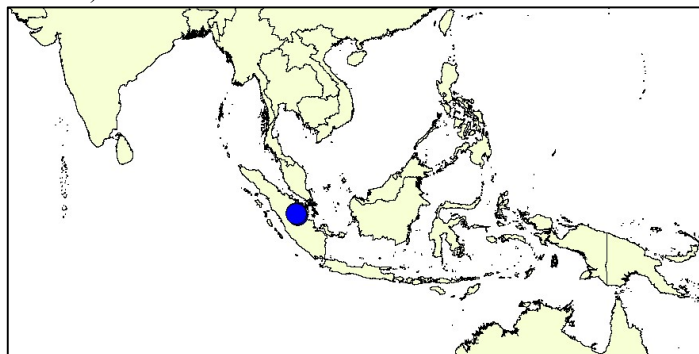
Threats: *C. ×ardyi* is threatened throughout its known range by agricultural intensification, expansion of settlements and the ongoing management of oil palm plantations. It is also threatened by factors which affect all plants occurring in flowing water bodies in the region. These include forest clearance, urbanisation, agricultural intensification and the secondary effects of these factors, particularly increased turbidity, pollution and casual habitat degradation. It may also be threatened by uncontrolled and/or illegal collection.

Conservation: There are no conservation actions in place specifically for *C. ×ardyi* and it is not known from any protected areas. See detailed proposal Chapter 5.4.6.

Red List Assessment: EN B1ab(iii, iv)+2ab(iii, iv)

Assessment Rationale: *C. ×ardyi* occurs in a very limited area, all of which has already been converted to oil palm plantations or is directly affected by settlements and has been recorded from a total of six sites (all of which are treated as separate locations, although further information could show that some could be affected by a single threat), one of which has been destroyed. It is therefore classed as Endangered.

Reviewers: N. Jacobsen, S. Wongso.



71. ***Cryptocoryne* ×*batangkayanensis* Ipor, Ørgaard & N.Jacobsen 2015**
(*C. cordata* var. *grabowskii* × *C. ferruginea* var. *ferruginea*)

Distribution: *C. ×batangkayanensis* is endemic to Malaysia (Sarawak) where it is known from the type locality near Kampong Stungkor Baru, Batang Kayan Basin, Kuching Division, and has also been reported from adjacent areas.

EOO: 4 km²

AOO: 4 km²

Countries of Occurrence: Malaysia (Sarawak).

Population: *C. ×batangkayanensis* was originally known only from a small population but has recently been reported a few more sites.

Habitats and Ecology: *C. ×batangkayanensis* is known from a small ditch created by diversion of water from a stream and in pools in secondary forest and a partly abandoned rubber plantation, as well as in streams in adjacent forest. There is no information available on the altitude of the site.

General Use and Trade Information: *C. ×batangkayanensis* is easily cultivated. There is no information on commercial availability of *C. ×batangkayanensis* and as with all very rare hybrids, it may be vulnerable to over-collection.

Threats: The area where *C. ×batangkayanensis* was first found is within a partly abandoned rubber plantation in secondary forest, where most of the surrounding forest has already been cleared for oil palm plantations. It is possible that the area will be cleared in the near future and restored to agricultural use. It may also be threatened by uncontrolled and/or illegal collection.

Conservation: There are no conservation actions in place specifically for *C. ×batangkayanensis* and it is not known from any protected areas. There is a need to work with government departments to try to establish protection for the water courses supporting this hybrid.

Red List Assessment: CR B1ab(iii)+2ab(iii)

Assessment Rationale: *C. ×batangkayanensis* is known from a few locations, the area in which it occurs has already been logged and much of it cleared for oil palm plantation. It is very unlikely that natural habitats in the area will persist for any length of time. It is therefore classed as Critically Endangered.

Reviewers: N. Jacobsen, S. Wongso.



72. *Cryptocoryne* \times *decus-silvae* de Wit 1976
(*C. cordata* var. *cordata* \times *C. nurii* var. *nurii*)

Distribution: The *C. \times decus-silvae* complex is known from five sites in southern Peninsular Malaysia: Two in Pahang (Sg. Bebar and Tasik Cini) and three in Johor (Kota Tinggi, Panti Recreational Forest and Labis. It was formerly reported from one other site (the type locality) but searches have failed to find populations of *C. \times decus-silvae* and the area where it occurred is now under oil palm plantation.

EOO: 8,620 km²

AOO: 24 km²

Countries of Occurrence: Peninsular Malaysia (Johor, Pahang).

Population: No information.

Habitats and Ecology: *C. \times decus-silvae* has been recorded from small streams and rivers in primary and secondary forest, and in ditches in oil-palm plantations. There is no information available on the altitude of the known sites.

General Use and Trade Information: *C. \times decus-silvae* complex is easily cultivated. There is no information on commercial availability of *C. \times decus-silvae* and as with all very rare hybrids, it may be vulnerable to over-collection.

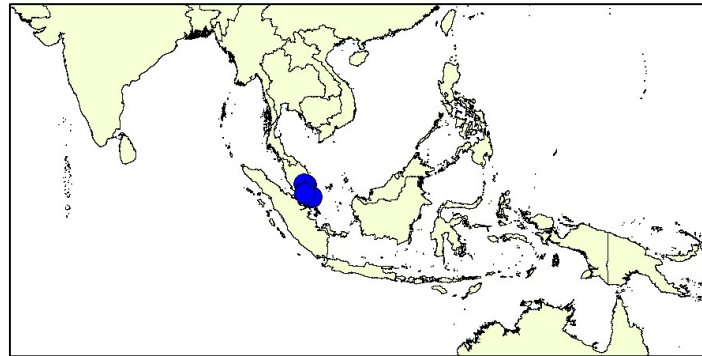
Threats: There is no detailed information on threats to *C. \times decus-silvae* complex or the sites where it occurs. However, it appears highly likely that the type population has been lost to forest clearance for oil-palm plantations and other sites will be vulnerable to the same process. It may also be threatened by uncontrolled and/or illegal collection.

Conservation: There are no conservation actions in place specifically for *C. \times decus-silvae*. It occurs in Panti Forest Reserve and other populations are not far from Endau Rompin National Park. See detailed proposal Chapter 5.4.6.

Red List Assessment: EN B1ab(i, ii, iii, iv)+2ab(i, ii, iii, iv)

Assessment Rationale: *C. \times decus-silvae* is currently known from five sites and at least one former population appears to have been destroyed. Remaining sites are threatened by conversion of habitat to oil-palm plantation and other uses. It is therefore classed as Endangered.

Reviewers: N. Jacobsen, S. Wongso.



73. ***Cryptocoryne ×griffithioides* N.Jacobsen 2020**
(*C. griffithii* × *C. nurii* var. *nurii*)

Distribution: *C. ×griffithioides* is endemic to Johor State in southern Peninsular Malaysia. It has been collected at least three times but only two of the sites, one near Pontian Kecil, 36 miles from Johor Baru and the second north-east of Kulai, have been reported and neither is precisely known.

EOO: 8 km² (set at 8 km² to agree with AOO)

AOO: 8 km²

Countries of Occurrence: Malaysia (Johor).

Population: There is no information on populations of *C. ×griffithioides*.

Habitats and Ecology: *C. ×griffithioides* was recorded from a temporary ditch in a cacao plantation. The original habitat of *C. ×griffithioides* is unknown but is likely to have occurred in forest streams. It is now most likely to persist in oil palm, rubber or cacao plantations with mixed mineral soil and plant debris. 0-50 mm.

General Use and Trade Information: *C. ×griffithioides* is easily cultivated. There is no information on commercial availability of *C. ×griffithioides* and as with all very rare hybrids, it may be vulnerable to over-collection.

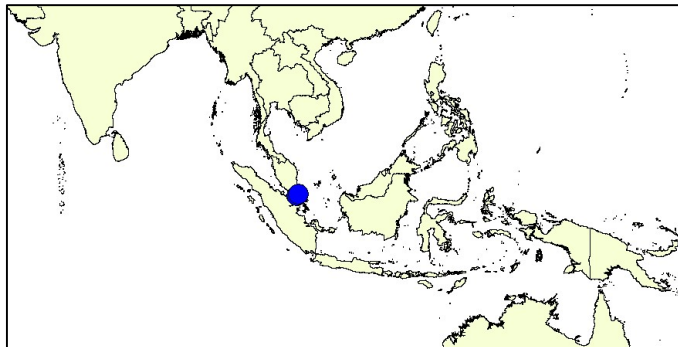
Threats: Much of the habitat in the area from which *C. ×griffithioides* has been collected has already been lost through forest clearance for intensive agriculture such as oil palm, cacao and rubber plantations. It is possible that some populations persist, but none have been recorded in recent years and the rate of loss of natural habitats in the region means that it may be extinct. If it survives, populations will be vulnerable to uncontrolled and/or illegal collection.

Conservation: There are no conservation actions in place specifically for *C. ×griffithioides* and it is not known from any protected areas. There is an urgent needs for surveys to try to locate remaining populations of *C. ×griffithioides*, together with work with government departments to try to establish protection for the water courses supporting this hybrid if it survives.

Red List Assessment: CR(PE) B1b(i, ii, iii)+2ab(iii)

Assessment Rationale: *C. ×griffithioides* has been known from a total of at least three sites, however only two of these sites are known and neither precisely. Surveys in the area have failed to find extant populations and the degree of destruction of natural habitats in the region means that all populations may have been lost. The lack of recent records in spite of searches is inferred to indicate an ongoing loss of populations and therefore an ongoing decline in EOO and AOO. This hybrid is therefore classed as Critically Endangered (Potentially Extinct).

Reviewers: N. Jacobsen, S. Wongso.



74. *Cryptocoryne ×hendrae* Wongso 2020
(*C. hudoroi* × *C. striolata*)

Distribution: *C. ×hendrae* is endemic to South Kalimantan, Indonesia where it is known only from the type locality near Kampong Loksado in South Hulu Sungai Regency in the Meratus mountains. However, recent surveys have failed to find plants and it may now be extinct.

EOO: 4 km²

AOO: 4 km²

Countries of Occurrence Indonesia (Kalimantan)

Population: There is no information on population size or trends in *C. ×hendrae*.

Habitats and Ecology: *C. ×hendrae* was recorded along a small river, 2 m wide with a sandy substrate with mixed gravel, silt and soil; moderate flow rate and clear water. The water had a pH of 7.50; total dissolved solids 91ppm; Conductivity 200µS/cm; water temperature 26.0 °C (15:15).

General Use and Trade Information: *C. ×hendrae* is easily cultivated.

There is no information on commercial availability of *C. ×hendrae* and as with all very rare hybrids, it may be vulnerable to over-collection.

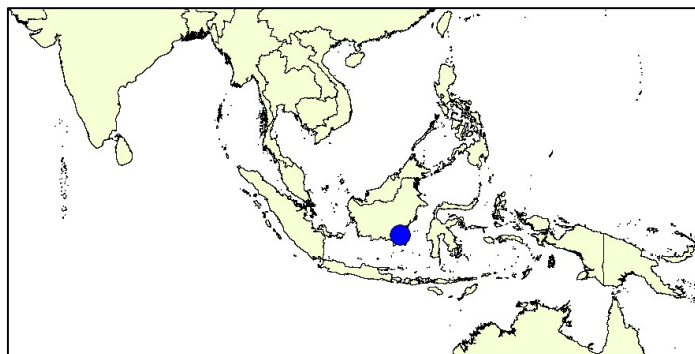
Threats: Much of the area in which *C. ×hendrae* occurs has been logged and many areas clear-felled for small-scale agriculture. It is threatened throughout its known range by agricultural intensification, expansion of settlements and the ongoing management of oil palm plantations, as well as factors which affect all plants occurring in flowing water bodies in the region. These include forest clearance, urbanisation, agricultural intensification and the secondary effects of these factors, particularly increased turbidity, pollution and casual habitat degradation. It may also be threatened by uncontrolled and/or illegal collection.

Conservation: There are no conservation actions in place specifically for *C. ×hendrae* and it is not known from any protected areas. See detailed proposal Chapter 5.4.20.

Red List Assessment: CR(PE) B1ab(iii)+2ab(iii)

Assessment Rationale: *C. ×hendrae* is known from a single location, the area in which it occurs has already been logged and much of it cleared. It is very unlikely that natural habitats in the area will persist for any length of time and recent surveys have failed to find any plants. It is therefore classed as Critically Endangered (Potentially Extinct).

Reviewers: N. Jacobsen, S. Wongso.



75. ***Cryptocoryne ×ikezewaldiae* Bast. 2020**
(*C. cordata* var. *grabowskii* × *C. pallidinervia*)

Distribution: *C. ×ikezewaldiae* is endemic to Kapuas Hulu Regency in West Kalimantan, where it is known only from the type locality near Nanga Kalis, south of Putussibau. However, both parents occur together elsewhere, and it is likely that there will be other populations of this hybrid.

EOO: 4 km²

AOO: 4 km²

Countries of Occurrence: Indonesia (Kalimantan)

Population: There is no information on population size or trends in *C. ×ikezewaldiae*.

Habitats and Ecology: *C. ×ikezewaldiae* was recorded in small, still to slow-flowing streams over laterite mixed with peat from plant debris in secondary habitats derived from rainforest. In 2019 at the type locality, the pH of the water was 5.1 and conductivity 19 µS/cm. 50 m.

General Use and Trade Information: *C. ×ikezewaldiae* is easy to cultivate. There is no information on commercial availability of *C. ×ikezewaldiae* and as with all very rare hybrids, it may be vulnerable to over-collection.

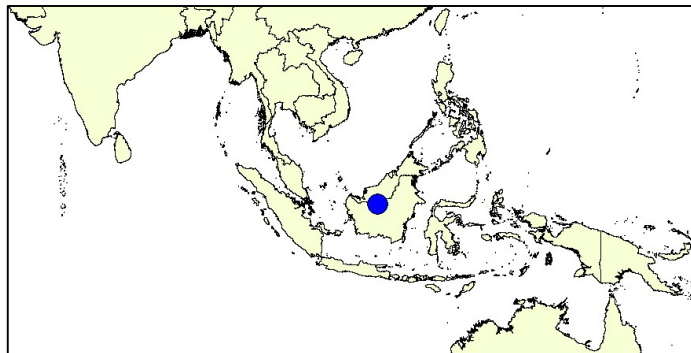
Threats: The area in which *C. ×ikezewaldiae* occurs has been logged and partly clear-felled for agriculture. It is highly likely that it will be under pressure from large- or industrial-scale agriculture, such as oil-palm plantation. It is also threatened by factors which affect all plants occurring in flowing water bodies in the region. These include forest clearance, urbanisation, agricultural intensification and the secondary effects of these factors, particularly increased turbidity, pollution and casual habitat degradation.

Conservation: There are no conservation actions in place specifically for *C. ×ikezewaldiae* and it is not known from any protected areas. See detailed proposal Chapter 5.4.3.

Red List Assessment: CR B1ab(iii)+2ab(iii).

Assessment Rationale: Whilst it is possible that other populations will have arisen in areas where the parents occur together. Until such populations are found *C. ×ikezewaldiae* must be treated as known from a single location where most of the natural habitats have been cleared for agriculture and remaining semi-natural habitats are threatened by agricultural intensification. It is therefore classed as Critically Endangered.

Reviewers: N. Jacobsen, S. Wongso.



76. *Cryptocoryne ×jambiensis* Bastm. 2019
(*C. bangkaensis* × *C. nurii* var. *nurii*)

Distribution: *C. ×jambiensis* is endemic to Batang Hari Regency in Jambi Province in Sumatra, Indonesia. It is known only from the type locality on the Pijoan River, west of Jambi City. It was formerly known from two other sites, but these have been destroyed. A possible second extant population has been found at Tangkit Sungai Gelam, also near Jambi.

EOO: 4 km²

AOO: 4 km²

Countries of Occurrence: Indonesia (Sumatra)

Population: There is no information on population size or trends in *C. ×jambiensis*.

Habitats and Ecology: *C. ×jambiensis* is known only from a slow-flowing, polluted ditch with a bed of mixed mud and plant debris behind a food factory. The water had a pH of 6.0 and conductivity of 50 µS/cm. 20-30 m.

General Use and Trade Information: *C. ×jambiensis* is easy to cultivate in leaf peat. There is no information on commercial availability of *C. ×jambiensis* and as with all very rare hybrids, it may be vulnerable to over-collection.

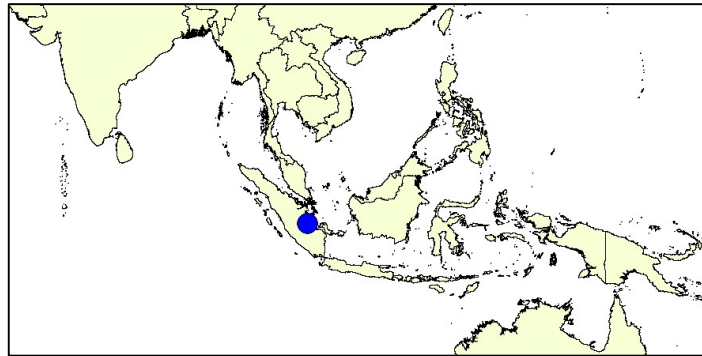
Threats: Two sites supporting *C. ×jambiensis* are known to have been destroyed, one by expansion of a settlement. The remaining site is in a cleared and settled area, where it is threatened by urban expansion and agricultural intensification, including industrial-scale agriculture. It may also be threatened by uncontrolled and/or illegal collection.

Conservation: There are no conservation actions in place specifically for *C. ×jambiensis* and it is not known from any protected areas. See detailed proposal Chapter 5.4.6.

Red List Assessment: CR B1ab(i, iii)+2ab(i, iii)

Assessment Rationale: *C. ×jambiensis* has been known from a total of at least three sites, however only one of these sites survives. The loss of two populations is inferred to indicate an ongoing loss of populations and therefore an ongoing decline in EOO. This hybrid is therefore classed as Critically Endangered.

Reviewers: N. Jacobsen, S. Wongso.



77. ***Cryptocoryne* ×*nakamotoi* Bastm. 2022**
(*C. uenoi* × *C. verrucosa*)

Distribution: *C. ×nakamotoi* is endemic to West Kalimantan in Indonesia, where it is known from two sites west of Temuyuk in Kapuas Hulu Regency.

EOO: 8 km²

AOO: 8 km²

Countries of Occurrence:
Indonesia (Kalimantan)

Population: There is no information on population size or trends in *C. ×nakamotoi*.

Habitats and Ecology: *C. ×nakamotoi* has been recorded on the banks of small rivers and streams with a muddy bed in secondary forest. At one of the sites, the pH of the water was 5.5-5.7 and conductivity 21-28 µS/cm. 40-60 m.

General Use and Trade Information: *C. ×nakamotoi* is easily cultivated. There is no information on commercial availability of *C. ×nakamotoi* and as with all very rare hybrids, it may be vulnerable to over-collection.

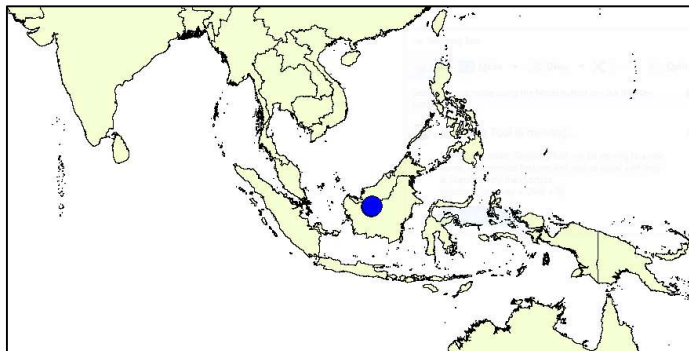
Threats: Both areas from which *C. ×nakamotoi* has been recorded have been logged and partly clear-felled for agriculture. It is highly likely that it will be under pressure from large- or industrial-scale agriculture, such as oil-palm plantation. It is also threatened by factors which affect all plants occurring in flowing water bodies in the region. These include forest clearance, urbanisation, agricultural intensification and the secondary effects of these factors, particularly increased turbidity, pollution and casual habitat degradation. It may also be threatened by uncontrolled and/or illegal collection.

Conservation: There are no conservation actions in place specifically for *C. ×nakamotoi* and it is not known from any protected areas. See detailed proposal Chapter 5.4.3.

Red List Assessment: EN B1ab(iii)+2ab(iii)

Assessment Rationale: *C. ×nakamotoi* has been recorded from two sites, both of which are in secondary habitats which have already been degraded through logging and clear-felling. Both areas are threatened by agricultural intensification and this hybrid is therefore classed as Endangered.

Reviewers: N. Jacobsen, S. Wongso.



78. *Cryptocoryne ×purpurea* Ridl. 1904
(*C. cordata* × *C. griffithii*)

Distribution: Two nothovarieties are recognised within *C. ×purpurea*: nothovar. *borneoensis* is known from an area in southern Kalimantan in Indonesian Borneo; nothovar. *purpurea* is endemic to southern Peninsular Malaysia, where it is known from seven widely separated sites.

EOO: 202,190 km²

AOO: 56 km²

Countries of Occurrence: Indonesia (Kalimantan), Malaysia (Peninsula).

Population: There is no information on population size and trends in *C. ×purpurea*.

Habitats and Ecology: *C. ×purpurea* has been recorded growing in a large river, forest streams and marshes in slow or fast-flowing clear or tannin-stained water over silt or reddish clays with abundant plant debris with *Barclaya* sp. and *Utricularia* sp. It has been recorded from secondary forest, areas cleared for small-scale or industrial agriculture such as oil-palm plantations, streams in and associated with settlements in peat swamp forest, particularly in Tasek Bera Forest Reserve where it occurs in open tannin-stained water channels. In Sungai Sedili Kechil, Johor, large populations occur in the fresh water tidal zone. 0-65 m.

General Use and Trade Information: *C. ×purpurea* is easily cultivated. There is no information on commercial availability of *C. ×purpurea* and as with all very rare hybrids, it may be vulnerable to over-collection.

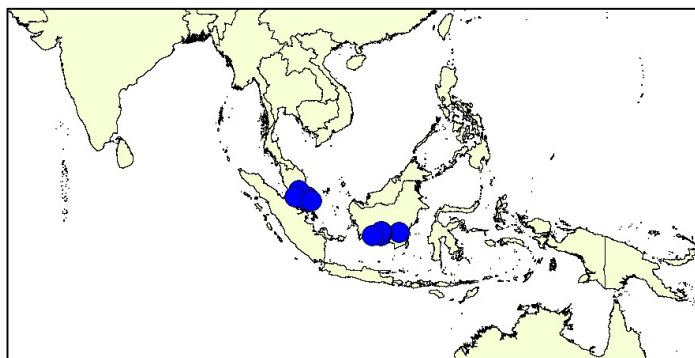
Threats: Most sites supporting *C. ×purpurea* have been significantly modified by logging and clearance, followed by conversion to small-sale or industrial agriculture or even settlements. There is ongoing pressure on many of these areas toward increased urbanisation or agricultural intensification. However, it is clear that this hybrid can persist in modified habitats and is able to tolerate quite severe habitat degradation. The protected status of Tasek Bera conveys a level of protection to populations of this hybrid on the site, however threats affecting the site as a whole, such as a decline in water levels and other hydrological modification as a consequence of habitat exploitation in the catchment, mean that even these populations are potentially threatened. It may also be threatened by uncontrolled and/or illegal collection.

Conservation: *C. ×purpurea* occurs in Tasek Bera Forest Reserve where it is recognised in conservation plans and management. There are no other conservation measures in place for *C. ×purpurea*. This hybrid should be taken into account and, if possible, included in site and habitat protection for other species. There is a need to acquire a quantitative baseline for monitoring to inform assessment of population trends.

Red List Assessment: LC

Assessment Rationale: *C. ×purpurea* is known from a total of 13 sites, each of which is treated as a separate location. Given the intense pressure on both the broader habitats in which populations occur and the specific threats to river habitats, it is likely that this hybrid will undergo a decline, in the future, even if there is no current decline. However, many sites are widely separated and whilst all are vulnerable to threats which affect all wetland habitats in the region, it must be considered reasonably secure both due to its wide range and to its occurrence in Tasek Bera. It is therefore classed as Least Concern.

Reviewers: N. Jacobsen, S. Wongso



78a. *Cryptocoryne* × *purpurea* nothovar. *borneoensis* N.Jacobsen, Bastm. & Yuji Sasaki 2002
(*C. cordata* var. *grabowskii* × *C. griffithii*)

Distribution: *C. ×purpurea* nothovar. *borneoensis* is endemic to Borneo, where it is known from an area in southern Kalimantan in Indonesia.

EOO: 10,500 km²

AOO: 24 km²

Countries of Occurrence: Indonesia (Kalimantan).

Population: There is no information on population size and trends in *C. ×purpurea* nothovar. *borneoensis*.

Habitats and Ecology: *C. ×purpurea* nothovar. *borneoensis* has been recorded growing in a large river, streams and marshes in slow or fast-flowing clear or tannin-stained water over silt or reddish clays with abundant plant debris and with *Barclaya* sp. and *Utricularia* sp. All sites from which it has been recorded are in secondary forest or areas cleared for small-scale or industrial agriculture such as oil-palm plantations. At one site, the pH of the water was pH 4-5, conductivity 7-20 µS/cm. 0-20 m.

General Use and Trade Information: *C. ×purpurea* nothovar. *borneoensis* is easily cultivated. There is no information on commercial availability of *C. ×purpurea* nothovar. *borneoensis* and as with all very rare hybrids, it may be vulnerable to over-collection.

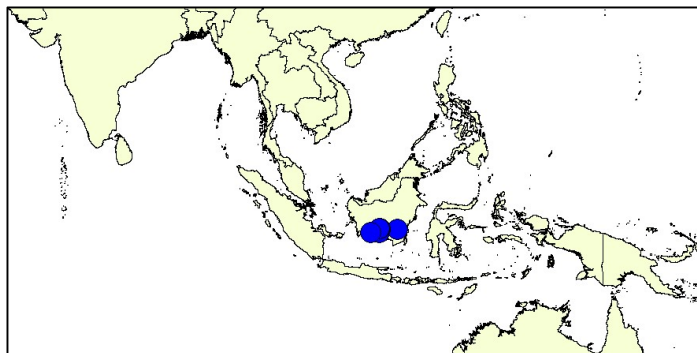
Threats: All sites from which *C. ×purpurea* nothovar. *borneoensis* has been recorded have been significantly modified by logging and clearance, followed by conversion to small-scale or industrial agriculture or even settlements. There is ongoing pressure on many of these areas toward increased urbanisation or agricultural intensification. However, it is clear that this hybrid can persist in modified habitats and is able to tolerate quite severe habitat degradation. It may also be threatened by uncontrolled and/or illegal collection.

Conservation: There are no conservation measures in place for *C. ×purpurea* nothovar. *borneoensis*. This hybrid should be taken into account and, if possible, included in site and habitat protection for other species. There is a need to acquire and quantitative baseline for monitoring to inform assessment of population trends.

Red List Assessment: NT VU B2ab(i, ii, iii)

Assessment Rationale: *C. ×purpurea* nothovar. *borneoensis* is known from a total of six sites, each of which is treated as a separate location. Given the intense pressure on both the broader habitats in which populations occur and the specific threats to river habitats, it is likely that this hybrid will undergo a decline in the future, even if there is no current decline. This hybrid is therefore classed as Near Threatened, with the expectation that it will be shown to be Vulnerable through further surveys and population monitoring.

Reviewers: N. Jacobsen, S. Wongso



78b. *Cryptocoryne* × *purpurea* nothovar. *purpurea*
(*C. cordata* var. *cordata* × *C. griffithii*)

Distribution: *C. ×purpurea* nothovar. *purpurea* is endemic to southern Peninsular Malaysia, where it is known from seven widely separated sites.

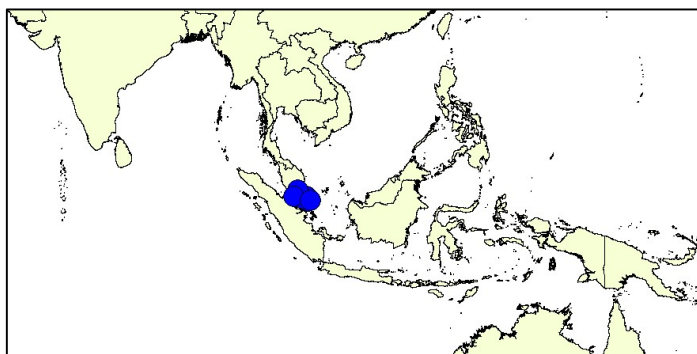
EOO: 14,262 km²

AOO: 32 km²

Countries of Occurrence: Malaysia (Peninsula).

Population: There is no information on population size or trends in *C. ×purpurea* nothovar. *purpurea*.

Habitats and Ecology: *C. ×purpurea* nothovar. *purpurea* has been recorded from small streams and rivers in secondary forest, streams in and associated with settlements and in ditches in oil-palm and rubber plantations. However, the most important populations are in peat swamp forest, particularly in Tasek Bera Forest Reserve where it occurs in open tannin-stained water channels. In Sungai Sedili Kechil, Johor, large populations occur in the fresh water tidal zone. 0-65 m.



General Use and Trade Information: *C. ×purpurea* nothovar. *purpurea* is easily cultivated in leaf peat. There is no information on commercial availability of *C. ×purpurea* nothovar. *purpurea* and as with all very rare hybrids, it may be vulnerable to over-collection.

Threats: Whilst many populations are in degraded habitats and threatened by issues such as agricultural intensification, *C. ×purpurea* nothovar. *purpurea* can persist beyond conversion of natural habitats to even industrial-scale agriculture or urbanisation. The protected status of Tasek Bera conveys a level of protection to populations of this hybrid on the site, however threats affecting the site as a whole such as a decline in water levels and other hydrological modification as a consequence of habitat exploitation in the catchment mean that even these populations are potentially threatened. It may also be threatened by uncontrolled and/or illegal collection.



Conservation: *C. ×purpurea* nothovar. *purpurea* occurs in Tasek Bera Forest Reserve where it is recognised in conservation plans and management. Other populations are not protected.

Red List Assessment: LC

Assessment Rationale: *C. ×purpurea* nothovar. *purpurea* occurs in at least seven widely separated areas and whilst all are vulnerable to threats which affect all wetland habitats in the region, it must be considered reasonably secure both due to its wide range and to its occurrence in Tasek Bera. It is therefore classed as Least Concern.

Reviewers: N. Jacobsen, S. Wongso.

79. *Cryptocoryne* ×*schulzeioides* N.Jacobsen 2020
(*C. griffithii* × *C. schulzei*)

Distribution: *C. ×schulzeioides* is known from a single collection made in Johor State, Peninsular Malaysia but the exact location of the collection is unknown.

EOO: ?

AOO: ?

Countries of Occurrence: Malaysia (Johor).

Population: There is no information on population size or trends in *C. ×schulzeioides* and it is not certain that it is still extant.

Habitats and Ecology: There is no information on the ecology of *C. ×schulzeioides*.

General Use and Trade Information: *C. ×schulzeioides* is easily cultivated. There is no information on commercial availability of *C. ×schulzeioides* and as with all very rare hybrids, it may be vulnerable to over-collection.

Threats: As the site where *C. ×schulzeioides* occurred is unknown, it is not possible to assess threats. If it survives, it may also be threatened by uncontrolled and/or illegal collection.

Conservation: There are no conservation measures in place for *C. ×schulzeioides*. There is an urgent need to carry out surveys to try to find extant populations of this hybrid. It is likely that the most effective approach would be to initially target areas where the parents co-exist and if this is unsuccessful then to target areas where one or other of the parents occurs in isolation.

Red List Assessment: DD

Assessment Rationale: Available information is inadequate to derive an informed assessment of the conservation status of *C. ×schulzeioides* and it is not possible to be certain that it is not extinct. It is therefore classed as Data Deficient.

Reviewers: N. Jacobsen, S. Wongso.

80. *Cryptocoryne ×timahensis* Bastm. 2001
(*C. nurii* var. *nurii* × *C. schulzei*)

Distribution: *C. ×timahensis* is known from three areas, a single site in Johor State in Peninsular Malaysia, Bukit Timah Nature Reserve in Singapore and Singkep Island, off Sumatra in Indonesia.

EOO: 4,637 km²

AOO: 12 km²

Countries of Occurrence:
Indonesia (Singkep), Malaysia (Johor), Singapore.

Population: There is no information on population size or trends in *C. ×timahensis*.

Habitats and Ecology: *C. ×timahensis* has been recorded from streams in rainforest. At Bukit Timah NR it occurs in a shallow forest stream flowing over soft silt in partial shade with dappled sunlight, at a point where two walls (which serve as weirs) across the stream cause water to back up, forming shallow pools. It may also occur downstream, where the stream flows over level ground. 0-70 m.

General Use and Trade Information: *C. ×timahensis* is easily cultivated in leaf peat. There is no information on commercial availability of *C. ×timahensis* and as with all very rare hybrids, it may be vulnerable to over-collection.

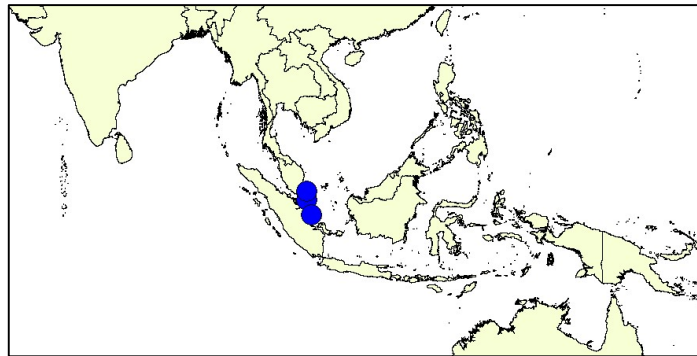
Threats: There is no information on threats to *C. ×timahensis*. It is highly likely that it will be under pressure from large- or industrial-scale agriculture, such as oil-palm plantation at some sites. It is also threatened by factors which affect all plants occurring in flowing water bodies in the region. These include forest clearance, urbanisation, agricultural intensification and the secondary effects of these factors, particularly increased turbidity, pollution and casual habitat degradation.

Conservation: There are no conservation measures in place specifically for *C. ×timahensis* and none needed. It occurs in Bukit Timah Nature Reserve, where it has persisted since at least the early 1900s and appears to be stable. At Bukit Timah the population is currently surveyed twice a year by Dennis Sng of Singapore Botanic Garden.

Red List Assessment: LC

Assessment Rationale: In spite of the small number of population and potential threat to populations outside Singapore, the security and stability of the population at Bukit Timah Nature Reserve means that *C. ×timahensis* is unlikely to become extinct. It is therefore classed as Least Concern.

Reviewers: N. Jacobsen, S. Wongso.



81. *Cryptocoryne ×willisii* Reitz 1908
(*C. beckettii* × *C. parva*)

Distribution: *C. ×willisii* is endemic to central Sri Lanka, where it is known from three widely separated sites between Kandy and Polonnaruwa.

EOO: 646 km²

AOO: 12 km²

Countries of Occurrence: Sri Lanka.

Population: There is no quantified information on population size or trends in *C. ×willisii*, however there is a suggestion that populations in the Mahaweli-Ganga have declined (N. Jacobsen in litt.).

Habitats and Ecology: *C. ×willisii* is known from bays and the margins of the Mahaweli-Ganga, as well as in small streams and rivers and the margin of a large lowland lake. Most populations are in settled areas, some of which are urban. 60-460 m.

General Use and Trade Information: *C. ×willisii* is easily cultivated and has been in cultivation for more than 100 years. There is no information on the commercial availability of *C. ×willisii* and as with all very rare hybrids, it may be vulnerable to over-collection.

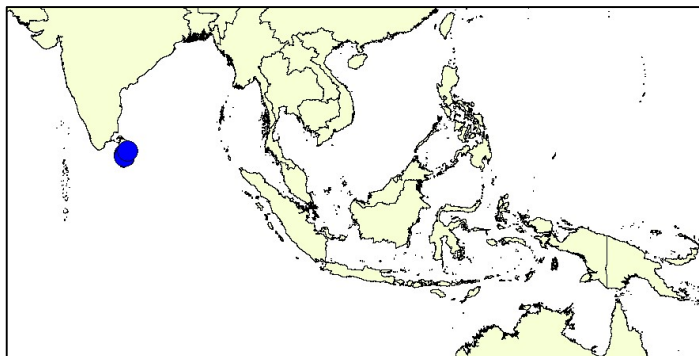
Threats: The habitats where *C. ×willisii* occurs are threatened by factors which affect all plants occurring in flowing water bodies in the region. These include forest clearance, river regulation, urbanisation, agricultural intensification and the secondary effects of these factors, particularly increased turbidity, pollution, and casual habitat degradation. It may also be threatened by uncontrolled and/or illegal collection.

Conservation: There are no conservation actions in place specifically for *C. ×willisii* and it is not known from any protected areas. It was classed as CR B1ab(i, ii, iii)+2ab(i, ii, iii) (National Red List 2020). See detailed proposal Chapter 5.4.7.

Red List Assessment: EN B1ab(iii)+2ab(iii)

Assessment Rationale: In spite of occurring three widely separated areas, each known population is in degraded habitat and vulnerable to further modification and urbanisation. *C. ×willisii* is therefore classed as Endangered.

Reviewers: N. Jacobsen, S. Wongso.



82. *Cryptocoryne* ×*zukaii* Rataj 1974
(*C. cordata* × *C. minima*)

Distribution: Two nothovarieties are recognised within *C. ×zukaii*: Nothovar. *sumateraensis* is endemic to Sumatra in Indonesia, where it is known only from the type locality near Kamphar Pentapahan in Riau Province. Nothovar. *zukaii* is based on cultivated specimens assumed to come from the north-western part of Peninsular Malaysia. Data are inadequate to enable mapping of the distribution of *C. ×zukaii*.

EOO: 8 km²

AOO: 8 km²

Countries of Occurrence: Indonesia (Sumatra), Malaysia (Peninsular).

Population: There is no information on population size or trends in *C. ×zukaii*.

Habitats and Ecology: *C. ×zukaii* nothovar. *sumateraensis* is known only from drainage ditches and small streams flowing through oil palm plantations. There is no information on the ecology of *C. ×zukaii* nothovar. *zukaii*. It is assumed to grow in slow-flowing acid streams, rivers, and pools in lowland forest. It may also persist in drainage ditches in rubber plantations after forest clearance. 50-100 m.

General Use and Trade Information: *C. ×zukaii* is easily cultivated. There is no information on commercial availability of *C. ×zukaii* and as with all very rare hybrids, it may be vulnerable to over-collection.

Threats: The two sites supporting known populations represent remnant wetland habitats within industrialised agriculture. It is highly likely that both sites will be subject to agricultural intensification. It may also be threatened by uncontrolled and/or illegal collection.

Conservation: There are no conservation actions in place specifically for *C. ×zukaii* nothovar. *sumateraensis* and it is not known from any protected areas. There is an urgent need to carry out surveys to try to find extant populations of *C. ×zukaii* nothovar. *zukaii*. See detailed proposal Chapter 5.4.6.

Red List Assessment: DD.

Assessment Rationale: Available information is inadequate to derive an informed assessment of the conservation status of *C. ×zukaii*. It is therefore classed as Data Deficient.

Reviewers: N. Jacobsen, S. Wongso.

82a. *Cryptocoryne* ×*zukaii* nothovar. *sumateraensis* W.Reichert
(*C. cordata* var. *diderici* × *C. minima*)

Distribution: *C. ×zukaii* nothovar. *sumateraensis* is endemic to Sumatra in Indonesia, where it is known from the type locality near Kamphar Pentapahan in Riau Province.

EOO: 8 km²

AOO: 8 km²

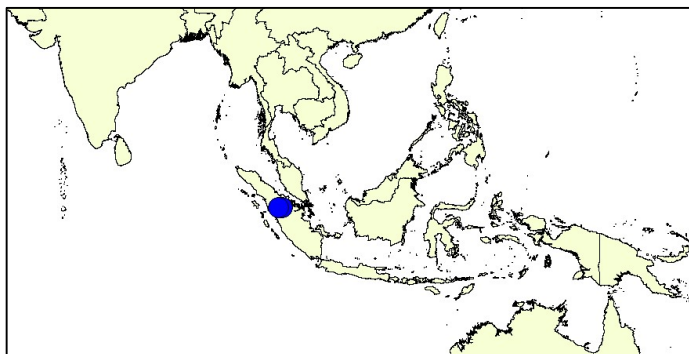
Countries of Occurrence:
Indonesia (Sumatra)

Population: There is no information on population size or trends in *C. ×zukaii* nothovar. *sumateraensis*.

Habitats and Ecology: *C. ×zukaii* nothovar. *sumateraensis* is known only from drainage ditches and small streams flowing through oil palm plantations. 50-100 m.

General Use and Trade Information: *C. ×zukaii* nothovar. *sumateraensis* is easily cultivated. There is no information on its commercial availability and as with all very rare hybrids, it may be vulnerable to over-collection.

Threats: The two sites supporting known populations represent remnant wetland habitats within industrialised agriculture. It is highly likely that both sites will be subject to agricultural intensification. It may also be threatened by uncontrolled and/or illegal collection.



Conservation: There are no conservation actions in place specifically for *C. ×zukaii* nothovar. *sumateraensis* and it is not known from any protected areas. See detailed proposal Chapter 5.4.6.

Red List Assessment: CR 1ab(iii)+2ab(iii).

Assessment Rationale: *C. ×zukaii* nothovar. *sumateraensis* occurs in two sites within 50 km of each other, both of which are in oil palm plantations and highly vulnerable to intensification. Even though it is clearly able to persist in modified wetlands after complete conversion of the surrounding habitat, the risk of damage to populations from management of the plantations is enough that it is classed as Critically Endangered.

Reviewers: N. Jacobsen, S. Wongso.



82b. *Cryptocoryne ×zukaii* nothovar. *zukaii*
(*C. cordata* var. *cordata* × *C. minima*)

Distribution: *C. ×zukaii* nothovar. *zukaii* was named from cultivated specimens assumed to come from the north-western part of Peninsular Malaysia.

EOO: ?

AOO: ?

Countries of Occurrence: Malaysia.

Population: There is no information on population size or trends in *C. ×zukaii* nothovar. *zukaii* and it is not certain that it is still extant.

Habitats and Ecology: There is no information on the ecology of *C. ×zukaii* nothovar. *zukaii*.

General Use and Trade Information: This hybrid is easily cultivated in leaf peat. There is no information on commercial availability of *C. ×zukaii* nothovar. *zukaii* and as with all very rare hybrids, it may be vulnerable to over-collection if it persists in the wild.

Threats: As the site where *C. ×zukaii* nothovar. *zukaii* occurred is unknown, it is not possible to assess threats.

Conservation: There are no conservation measures in place for *C. ×zukaii* nothovar. *zukaii*. There is an urgent need to carry out surveys to try to find extant populations of this hybrid.

Red List Assessment: DD

Assessment Rationale: Available information is inadequate to derive an informed assessment of the conservation status of *C. ×zukaii* nothovar. *zukaii* and it is not possible to be certain that it is not extinct. It is therefore classed as Data Deficient.

Reviewers: N. Jacobsen, S. Wongso.