

Low functional diversity promotes niche changes in natural island pollinator communities**Masayoshi K. HIRAIWA¹*, Atushi USHIMARU¹**Author affiliation: ¹Graduate School of Human Development and Environment, Kobe University, Kobe 657-8501, Japan

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Electronic supplementary material

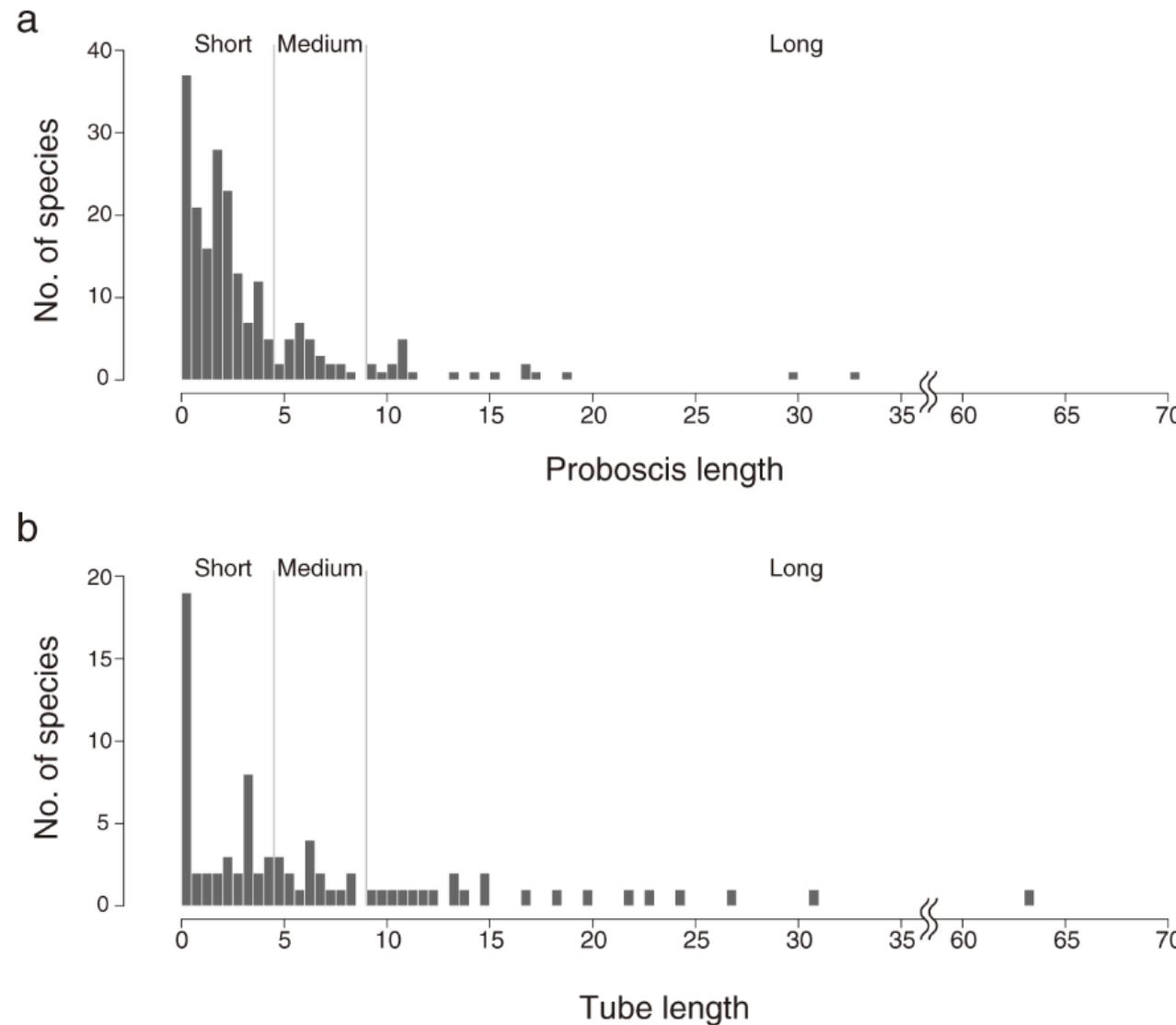


Figure S1. Histograms of proboscis (a) and corolla tube (b) lengths. Vertical lines show delineations between functional groups.

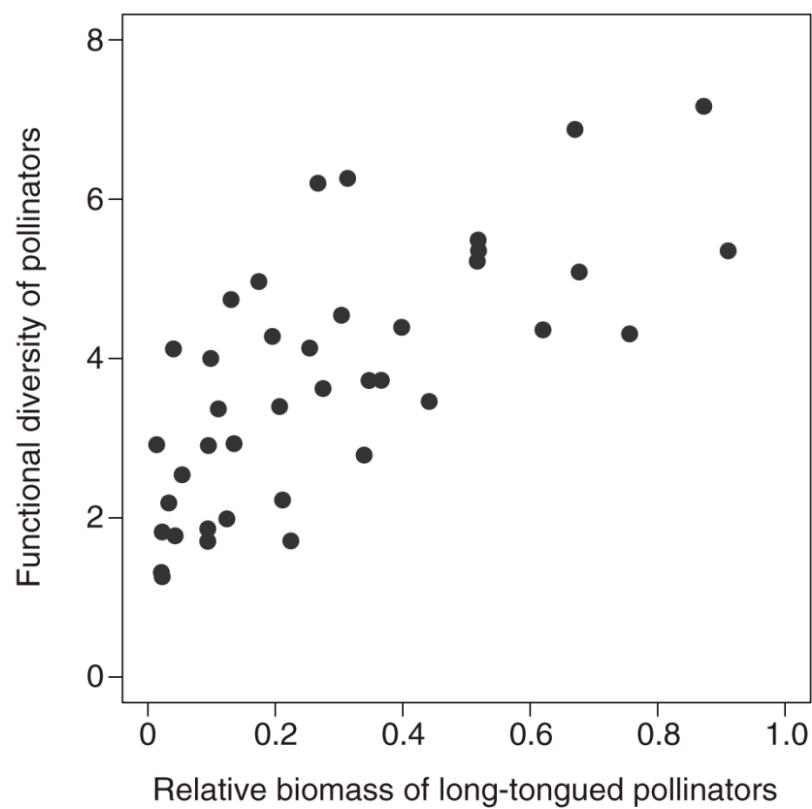


Figure S2. Relationship between the relative biomass of long-tongued pollinators and pollinator functional diversity.

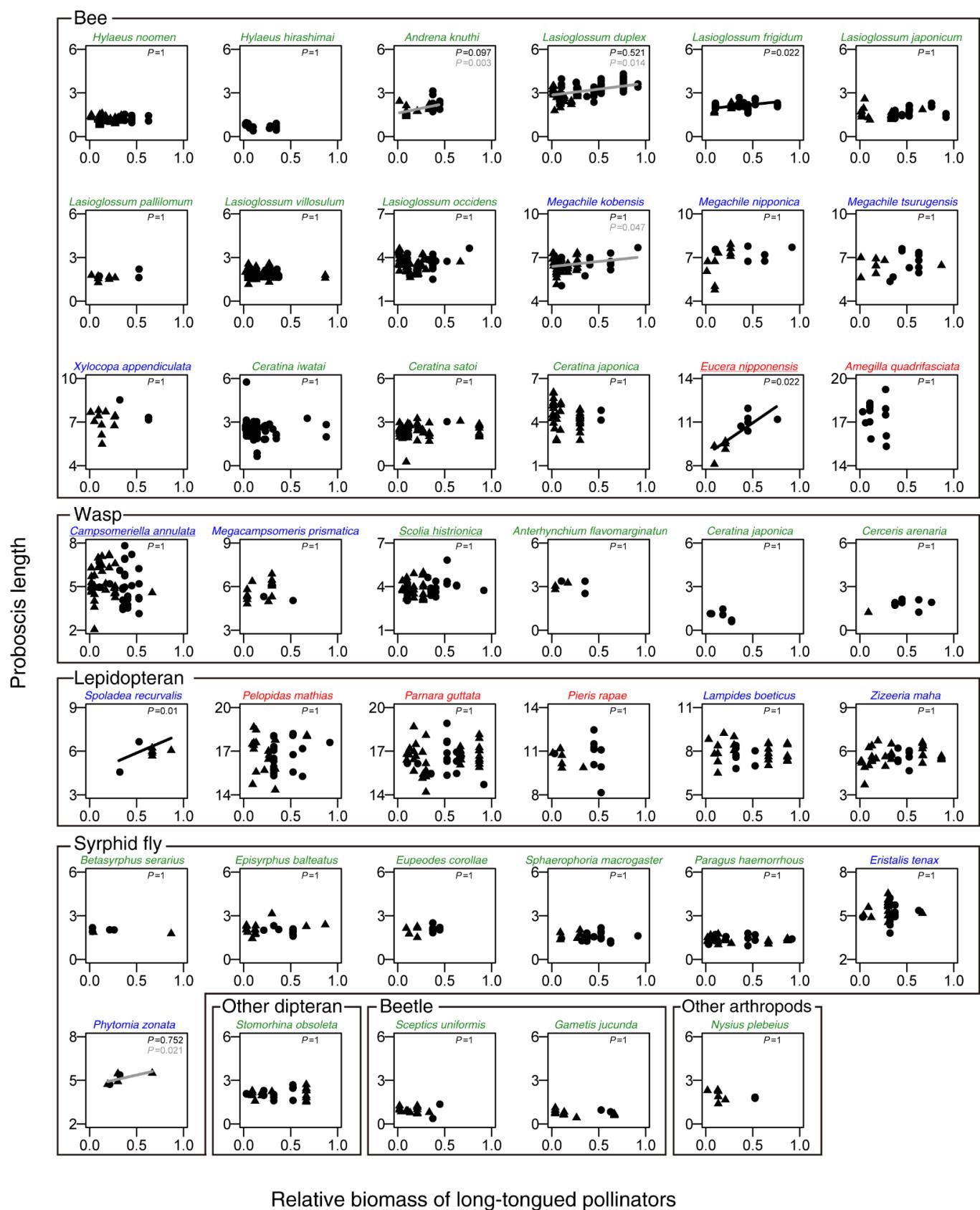


Figure S3. Changes in proboscis length with the RBLP for pollinator species (green, blue, and red names indicate short-, medium-, and long-tongued species, respectively). Black lines show fitted significant regressions from the GLMM: gray ones indicate those that became non-significant after adjusting the P values. Circles and triangles indicate data from continental and oceanic islands, respectively. Species with underlines belong to the two different pollinator groups: the primary category was indicated.

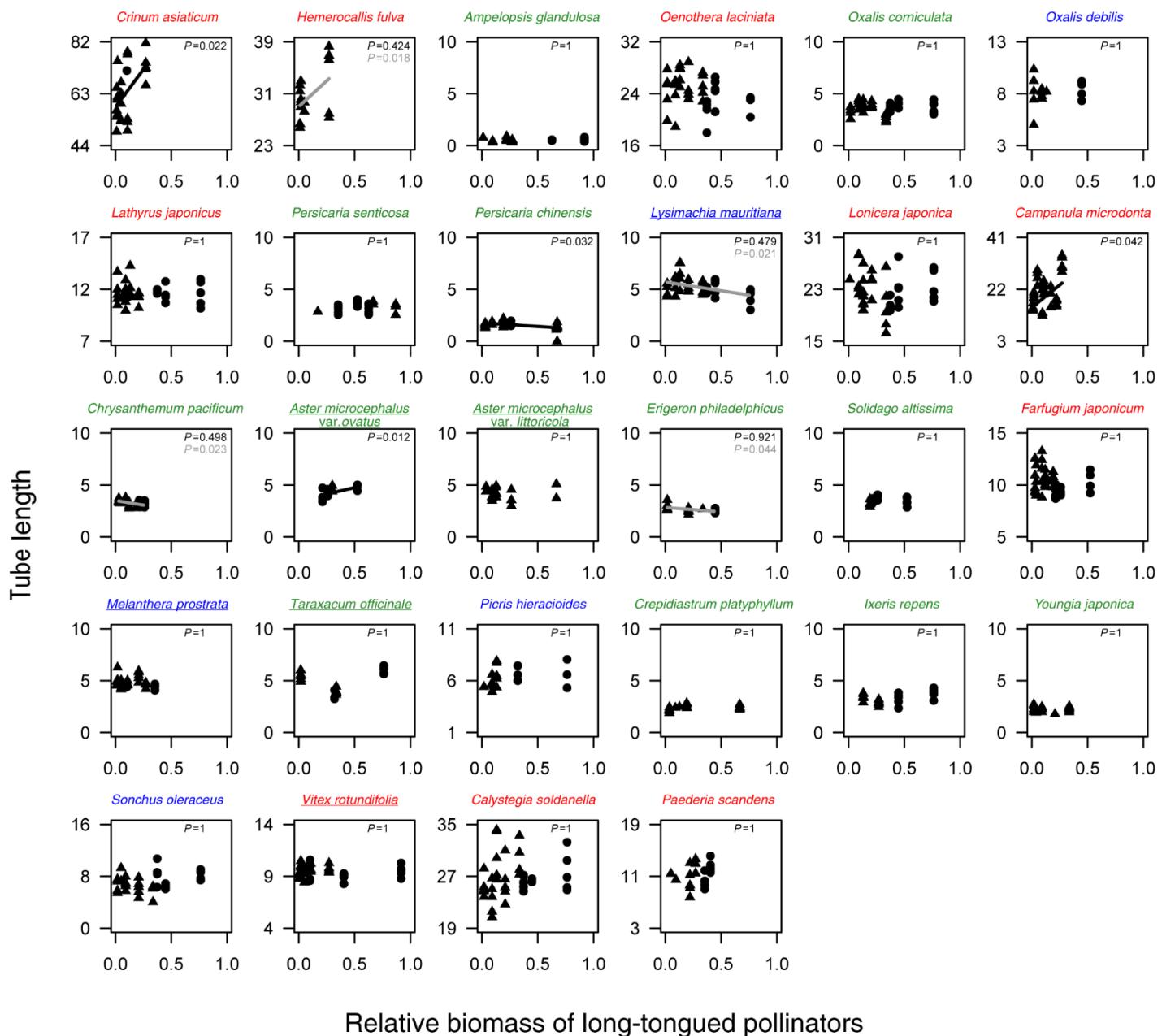


Figure S4. Changes in the tube length with the RBLP for plant species (green, blue, and red names indicate short-, medium-, and long-tubed species, respectively). Black lines show fitted significant regressions from the GLMM: gray ones indicate those that became non-significant after adjusting the *P* values. Circles and triangles indicate data from continental and oceanic islands, respectively. Species with underlines belong to the two different flower groups: the primary category was indicated.

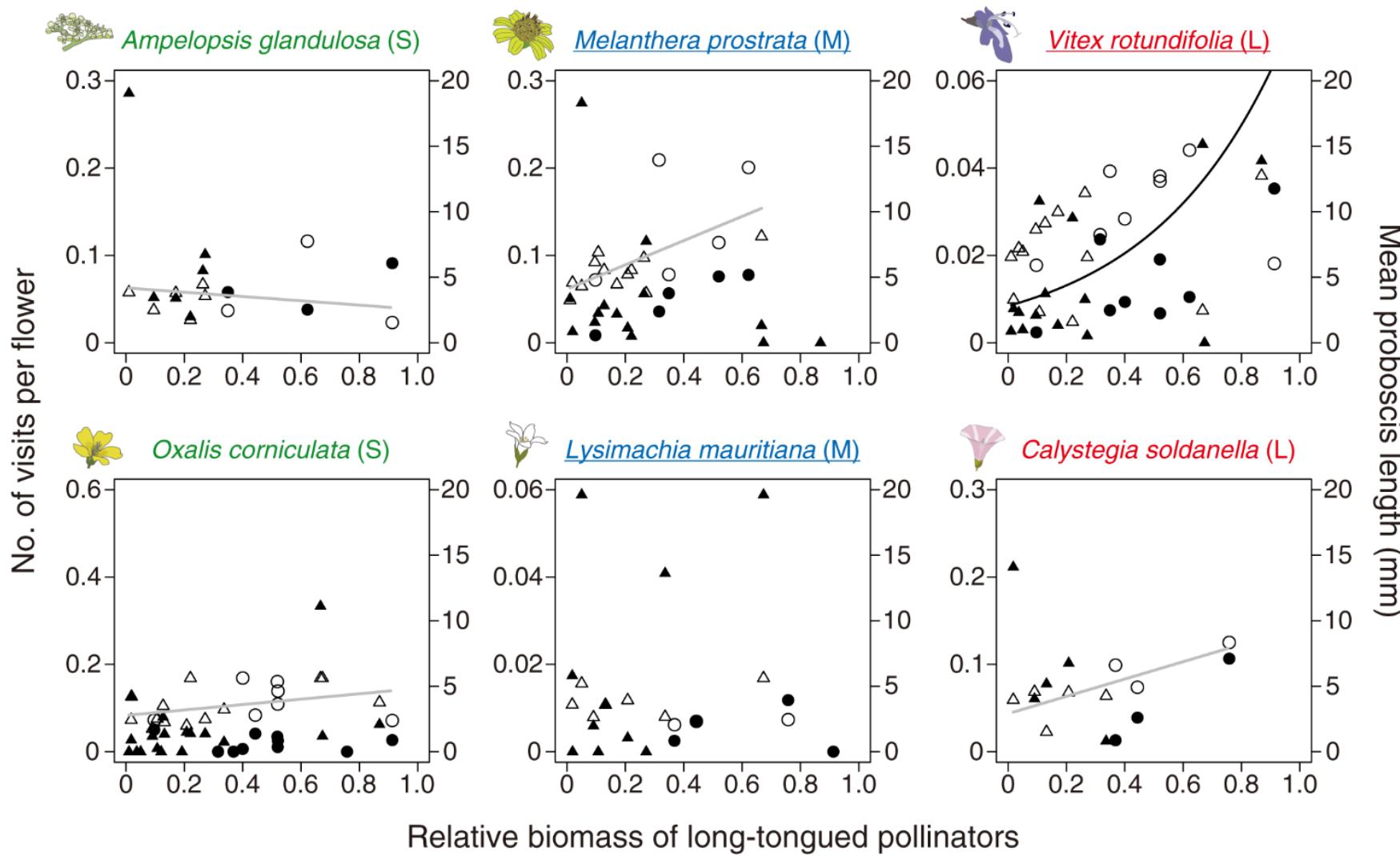


Figure S5. Changes in the number of visits per flower (closed circles and black lines) and the mean proboscis length of visiting pollinators (open circles and gray lines) with the RBLP for six dominant plant species. Lines show fitted regressions from the GLM or GLMM. Circles and triangles indicate data from continental and oceanic islands, respectively. Species with underlines belong to the two different flower groups: the primary category was indicated.

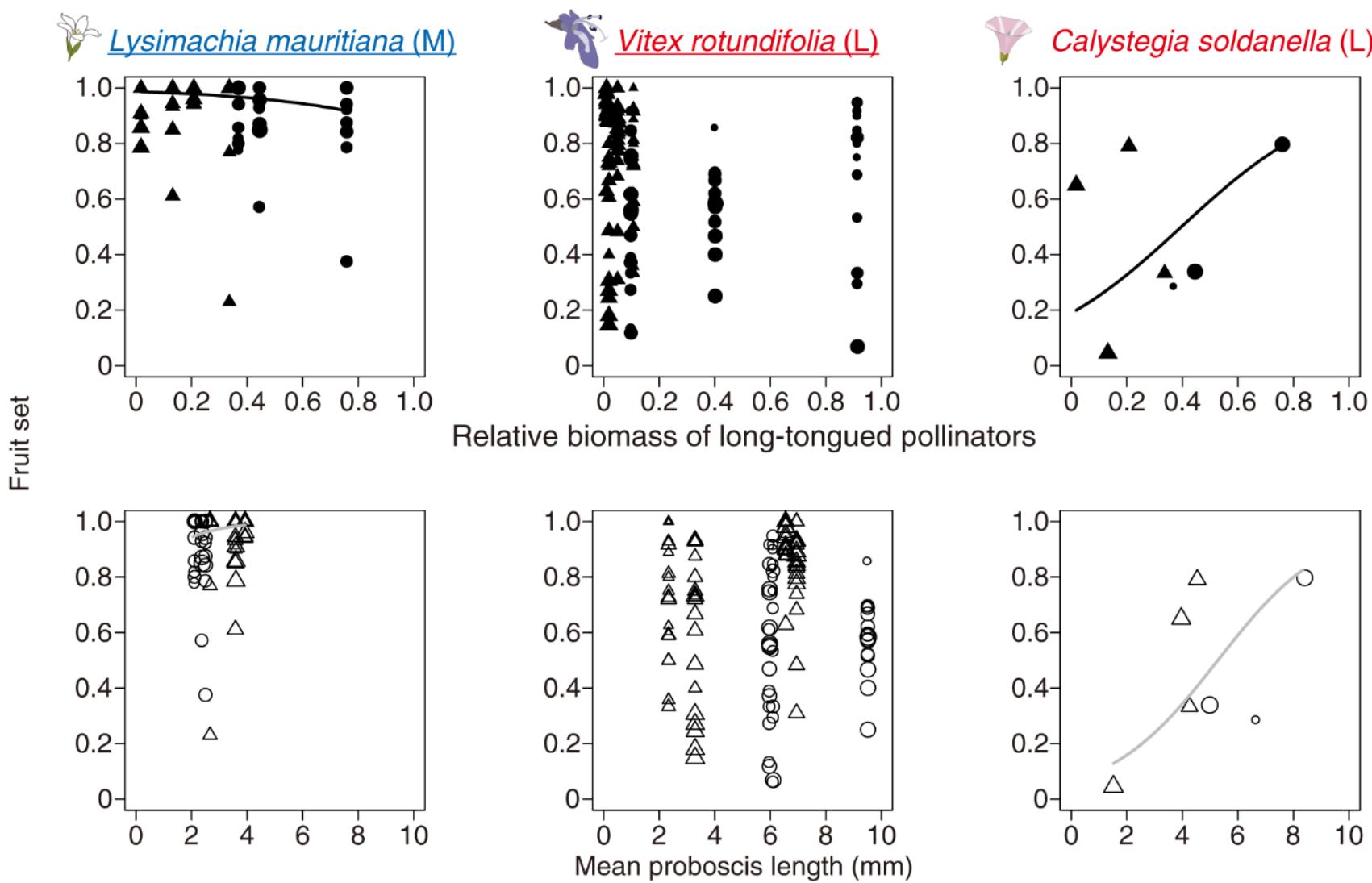


Figure S6. Changes in fruit set with the RBLP (closed circles and black lines) and the mean proboscis length of visiting pollinators (open circles and gray lines) for three dominant plant species. Lines show fitted regressions from the GLMM. Circles and triangles indicate data from continental and oceanic islands, respectively. Circle size indicates the number of sampled inflorescences. Species with underlines belong to the two different flower groups: the primary category was indicated.

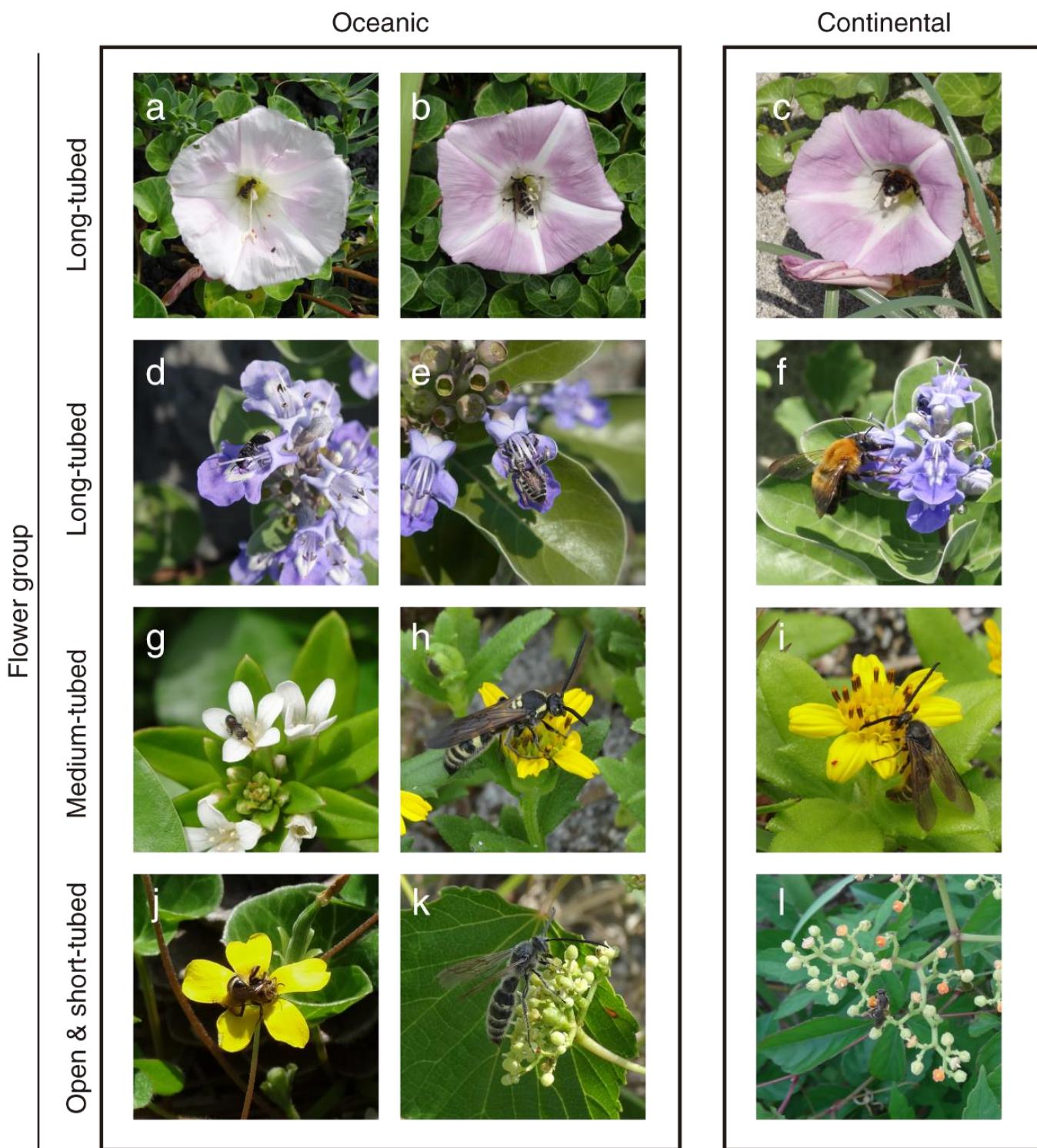


Figure S7. Photos of plant-pollinator interactions on continental and oceanic islands. Short-, medium- and long-tongued pollinators are denoted by S, M, and L, respectively. *Ceratina* sp. (S, a), *C. annulata* (M, b) and *Bombus diversus diversus* (L, c) visited *Calystegia soldanella*. *Hylaeus* sp. (S, d), *Megachile kobensis* (M, e), and *B. diversus diversus* (L, f) visited *Vitex rotundifolia*. *Ceratina* sp. (S, g) visited *Lysimachia mauritiana* flowers. *Scolia histrionica* (S, h) and *Campsomeriella annulata* (M, i) visited *Melanthera prostrata* flowers. *Oxalis corniculata* were visited by *Lasioglossum* sp. (S, j). *Campsomeriella annulata* (M, k) and *Lasioglossum* sp. (S, l) visited *Ampelopsis glandulosa* flowers.

Table S1. Characteristics of the study sites. The area of each island is taken from the Geospatial Information Authority of Japan (2014). Distances from Honshu Island are taken from Yamane (1990). Precipitation and temperature during May–December over the last decade were recorded at nearby automated meteorological data acquisition points by the Japan Meteorological Agency. Pollinator functional diversity and relative biomass of long-tongued pollinators are given as medians, with the minimum and maximum values in parentheses. Pollinator composition for each site is given as the percentage of individuals that belonged to each taxonomic group.

Bee	258	(41.6)	499	(60.9)	255	(21.7)	226	(32.4)	420	(54.3)	260	(36.7)	602	(68.3)	371	(63.9)	2891	(46.2)
Wasp	99	(16.0)	59	(7.2)	79	(6.7)	98	(14.1)	93	(12.0)	137	(19.3)	34	(3.9)	2	(0.3)	601	(9.6)
Syrphid fly	94	(15.2)	109	(13.3)	117	(10.0)	70	(10.0)	27	(3.5)	69	(9.7)	55	(6.2)	25	(4.3)	566	(9.0)
Other dipteran	63	(10.2)	70	(8.5)	175	(14.9)	140	(20.1)	28	(3.6)	96	(13.5)	28	(3.2)	56	(9.6)	656	(10.5)
Lepidopteran	53	(8.5)	72	(8.8)	502	(42.7)	106	(15.2)	42	(5.4)	104	(14.7)	91	(10.3)	64	(11.0)	1034	(16.5)
Beetle	4	(0.6)	8	(1.0)	18	(1.5)	43	(6.2)	140	(18.1)	27	(3.8)	36	(4.1)	44	(7.6)	320	(5.1)
Other arthropods	49	(7.9)	3	(0.4)	29	(2.5)	14	(2.0)	24	(3.1)	16	(2.3)	35	(4.0)	19	(3.3)	189	(3.0)

Table S2. List of pollinator species examined in the study sites. Pollinator group: S = short-tongued; M = medium-tongued; L = long-tongued. Study sites: HT = Hitachi; HN = Hitachinaka; TY = Tateyama; OS = Ohshima; NJ = Niijima; KZ = Kozu; MY = Miyake; HJ = Hachijo.

Order	Family	Species	Pollinator group	Proboscis		No. of visit per site							
				length (mm)	Biomass (mg)	HT	HN	TY	OS	NJ	KZ	MY	HJ
Isopoda	Armadillidiidae	<i>Armadillidium vulgare</i>	S	0.4	17.1	0	1	12	0	0	0	0	0
	Tylidae	<i>Tylos granulatus</i>	S	0.3	25.5	0	0	1	0	0	0	0	0
Ephemeroptera	-	Ephemeroptera sp.	S	0.4	2.2	0	0	0	0	0	0	0	1
Dermaptera	-	Dermaptera sp.	S	0.3	10.6	0	0	0	0	0	0	28	7
Orthoptera	Tettigoniidae	Conocephalinae spp.	S	0.6	18.9	0	1	3	0	13	0	0	2
	Phaneropteridae	<i>Phaneroptera falcata</i>	S	0.8	84.1	0	0	1	0	0	0	0	0
		<i>Phaneroptera nigroantennata</i>	S	1.6	112.2	1	0	0	0	0	0	0	0
	Mogoplistidae	<i>Ornebius kanetataki</i>	S	0.4	21.3	0	0	7	0	0	0	0	0
	Pyrgomorphidae	<i>Atractomorpha lata</i>	S	1.3	39.4	0	0	0	0	0	0	0	1
Blattodea	Blattidae	<i>Blattella</i> spp.	S	0.4	12.5	0	0	5	13	4	0	5	8
Hemiptera	Coreidae	<i>Cletus punctiger</i>	S	3.9	16.5	0	0	0	0	0	5	0	0
	Lygaeidae	<i>Geocoris varius</i>	S	2.4	5.8	1	0	0	0	0	0	0	0
		<i>Graptostethus servus</i>	S	4.1	16.6	0	1	0	0	0	8	0	0
		<i>Nysius plebeius</i>	S	1.9	2.1	33	0	0	0	5	2	1	0
		<i>Nysius graminicola</i>	S	2.0	2.1	11	0	0	1	1	0	0	0
	-	Hemiptera sp. 1	S	2.9	6.7	1	0	0	0	0	0	0	0
		Hemiptera sp. 2	S	2.4	2.4	0	0	0	0	0	0	0	1
		Hemiptera sp. 3	S	2.6	1.6	1	0	0	0	0	1	0	0
		Hemiptera sp. 4	S	3.1	4.7	0	0	0	0	1	0	0	0
		Hemiptera sp. 5	S	2.8	7.4	1	0	0	0	0	0	0	0
Hymenoptera	Leucospidae	<i>Leucospis sinensis</i>	S	1.9	25.5	0	0	0	2	0	0	0	0

	<i>Euodynerus nipanicus</i>	S	2.0	18.1	0	0	1	3	0	0	0	0
	<i>nipanicus</i>											
	<i>Stenodynerus</i> spp.	S	1.1	7.8	5	5	0	5	7	1	0	2
	<i>Eumeninae</i> sp.	S	2.0	17.6	0	0	0	0	0	1	0	0
	<i>Polistes chinensis</i>	S	1.8	30.4	0	5	0	0	0	0	0	0
	<i>Polistes jokahamae</i>	S	2.4	99.9	0	0	4	11	0	0	0	0
	<i>Polistes nipponensis</i>	S	2.0	44.7	0	1	0	0	0	0	0	0
	<i>Polistes snelleni</i>	S	2.0	35.5	2	0	0	0	0	0	0	0
	<i>Vespa simillima</i>	S	3.0	114.9	0	0	0	1	0	0	0	0
Sphecidae	<i>Isodontia nigella</i>	S	2.6	46.2	0	0	0	3	0	0	0	0
Crabronidae	<i>Bembix niponica</i>	M	6.1	89.6	0	0	1	2	0	0	0	0
	<i>Bembecinus hungaricus</i>	S	1.0	10.5	0	0	0	2	1	2	1	0
	<i>japonicus</i>											
	<i>Oxybelus nipponicus</i>	S	0.6	1.7	0	3	0	0	0	0	0	0
	<i>Cerceris albofasciata</i>	S	1.9	26.5	2	1	3	0	0	0	0	0
	<i>Cerceris arenaria</i>	S	1.8	12.4	2	3	5	1	0	0	0	0
	<i>Cerceris japonica</i>	S	2.2	18.8	1	0	0	0	0	1	1	0
	Crabronidae sp. 1	S	1.0	18.9	0	0	0	0	0	0	0	1
	Crabronidae sp. 2	S	2.2	5.6	0	0	0	0	0	0	0	1
Colletidae	<i>Colletes patellatus</i>	S	2.7	30.1	1	3	0	0	0	0	0	0
	<i>Hylaeus insularum insularum</i>	S	1.1	3.7	0	0	0	0	0	0	0	60
	<i>Hylaeus matsumurai</i>	S	1.3	4.3	0	0	1	0	0	0	0	0
	<i>Hylaeus noomen</i>	S	1.2	5.0	0	2	23	14	1	3	12	188
	<i>Hylaeus transversalis</i>	S	1.0	6.4	0	0	0	0	0	0	1	0
	<i>Hylaeus hirashimai</i>	S	0.7	2.3	0	0	0	3	3	1	4	5
Andrenidae	<i>Andrena knuthi</i>	S	2.0	11.1	0	12	3	9	0	3	5	6
	<i>Andrena japonica</i>	S	2.8	30.0	0	0	0	3	0	0	0	0

Halictidae	<i>Halictus aerarius</i>	S	2.4	4.7	0	6	8	20	0	0	0	0
	<i>Lasioglossum duplex</i>	S	3.2	10.4	72	11	15	43	6	13	4	0
	<i>Lasioglossum sibiriacum</i>	S	2.1	6.3	0	0	0	0	0	1	0	0
	<i>Lasioglossum vulsum</i>	S	1.6	5.8	0	0	4	0	0	0	0	0
	<i>Lasioglossum frigidum</i>	S	2.1	3.4	9	4	24	6	0	0	0	0
	<i>Lasioglossum japonicum</i>	S	1.6	4.4	11	20	2	1	1	4	2	11
	<i>Lasioglossum kiautschouense</i>	S	1.7	3.4	3	0	0	0	0	0	0	8
	<i>Lasioglossum pallilorum</i>	S	1.7	3.1	2	0	1	4	0	3	0	0
	<i>Lasioglossum villosulum</i>	S	1.9	4.3	0	4	0	24	68	8	0	7
	<i>Lasioglossum (Evylaeus) sp. 1</i>	S	1.6	5.1	0	2	0	7	0	0	0	0
	<i>Lasioglossum (Evylaeus) sp. 2</i>	S	1.5	4.1	0	0	0	3	2	7	0	1
	<i>Lasioglossum (Evylaeus) sp. 3</i>	S	1.6	2.2	3	0	2	7	0	2	0	1
	<i>Lasioglossum laeviventre</i>	S	3.8	12.3	0	0	0	0	0	1	0	0
	<i>Lasioglossum mutilum</i>	S	3.5	14.4	0	0	0	0	0	7	9	9
	<i>Lasioglossum occidens</i>	S	3.6	21.5	3	14	4	11	6	19	19	4
	<i>Lasioglossum scitulum</i>	S	3.4	11.0	12	2	6	0	0	0	0	0
	<i>Sphecodes</i> sp.1	S	1.0	3.3	0	0	0	0	0	1	0	0
	<i>Sphecodes</i> sp.2	S	1.1	2.9	0	0	0	1	0	0	0	0
	<i>Sphecodes</i> sp.3	S	2.8	11.0	0	0	0	0	0	0	2	0
Megachilidae	<i>Heriades fujiyamai</i>	S	3.4	6.0	0	0	0	0	0	0	0	2
	<i>Coelioxys formosicola</i>	S, M	4.7	17.4	0	2	2	0	0	0	0	0
	<i>Megachile sculpturalis</i>	L	10.7	186.3	0	0	0	0	0	0	1	0
	<i>Megachile spissula</i>	S	4.0	17.8	0	0	0	0	0	0	0	3
	<i>Megachile kobensis</i>	M	6.5	27.7	11	2	25	30	55	11	22	0
	<i>Megachile willughbiella</i> <i>sumizome</i>	M	6.1	48.5	0	2	0	0	0	0	0	1
	<i>Megachile nipponica nipponica</i>	M	7.0	37.7	0	1	15	0	5	9	4	0

		<i>Megachile tsurugensis</i>	M	6.5	35.9	1	1	14	8	0	1	9	0
Apidae		<i>Xylocopa appendiculata circumvolans</i>	M	7.2	242.7	0	0	37	5	179	64	96	0
		<i>Ceratina iwatai</i>	S	2.5	2.7	0	0	0	2	36	27	39	27
		<i>Ceratina satoi</i>	S	2.4	2.4	0	1	4	14	5	14	0	36
		<i>Ceratina flavipes</i>	S	3.9	7.1	0	2	0	0	0	0	0	0
		<i>Ceratina japonica</i>	S	4.4	7.5	2	0	0	2	6	1	369	0
		<i>Nomada aswensis</i>	S	2.2	3.5	0	0	0	2	0	0	2	0
		<i>Nomada okubira</i>	S	2.3	3.5	1	0	0	0	0	0	0	0
		<i>Tripeolus ventralis</i>	M	5.4	27.8	0	1	0	0	0	0	0	0
		<i>Eucera spurcatipes</i>	L	10.8	45.0	3	34	0	0	0	0	0	0
		<i>Eucera nipponensis</i>	M, L	10.3	49.9	1	1	16	3	0	7	0	0
		<i>Tetraloniella mitsukurii</i>	M	6.0	24.5	0	104	0	0	0	0	0	0
		<i>Amegilla quadrifasciata</i>	L	17.4	77.7	0	0	0	2	47	50	0	2
		<i>Amegilla florea</i>	L	19.0	89.4	0	0	0	0	0	2	1	0
Coleoptera		<i>Thyreus decorus</i>	M	7.8	53.3	0	0	0	0	0	1	1	0
		<i>Bombus diversus diversus</i>	L	14.3	79.2	88	99	0	0	0	0	0	0
		<i>Bombus ardens ardens</i>	L	9.7	80.7	28	0	0	2	0	0	0	0
		<i>Apis cerana japonica</i>	M	4.9	25.5	0	8	0	0	0	0	0	0
		<i>Apis mellifera</i>	M	5.9	31.6	7	161	49	0	0	0	0	0
	Dermestidae	<i>Anthrenus verbasci</i>	S	0.1	1.0	0	0	1	0	0	0	0	1
	Phalacridae	Phalacridae sp.	S	0.1	1.0	0	0	1	0	0	0	0	0
	Curculionidae	<i>Anthonomus</i> sp.	S	1.3	1.2	0	0	0	0	5	0	0	0
		<i>Scepticus uniformis</i>	S	0.9	15.8	0	1	1	2	1	19	2	3
		Curculionidae sp.	S	0.5	1.8	0	0	0	0	1	0	0	0
Scarabaeidae		<i>Maladera japonica</i>	S	0.2	24.6	0	0	0	0	0	0	1	0
		<i>Anomala schonfeldti</i>	S	0.6	32.3	0	0	1	1	2	0	0	0

		<i>Gametis jucunda</i>	S	0.8	83.7	1	0	3	0	4	4	7	0
		<i>Protaetia pryeri</i>	S	0.4	463.4	0	0	0	0	0	0	0	17
Elateridae		Negastrinae sp.	S	0.2	1.2	0	0	0	5	0	0	0	0
		<i>Agrypnus tsukamotoi</i> <i>tsukamotoi</i>	S	0.4	13.3	0	0	0	0	1	0	0	0
		<i>Melanotus</i> sp.	S	0.5	32.8	0	0	0	1	0	0	0	0
		<i>Carpophilus chalybeus</i>	S	0.2	2.2	0	0	0	0	0	0	8	0
		<i>Paracardiophorus sequens</i>	S	0.2	3.9	0	0	0	11	5	0	0	3
Melyridae		<i>Malachius prolongatus</i>	S	0.5	3.7	0	4	0	0	0	0	0	0
		<i>Dasytes</i> sp.	S	0.2	1.8	0	0	0	0	0	0	0	11
Coccinellidae		<i>Propylaea japonica</i>	S	0.2	3.5	0	0	0	0	0	0	1	0
		<i>Cheilomenes sexmaculatus</i>	S	0.2	5.9	0	0	0	0	0	0	1	0
		<i>Harmonia axyridis</i>	S	0.3	12.7	0	0	0	0	0	0	0	1
		<i>Coccinella septempunctata</i>	S	0.4	7.6	1	1	2	1	0	0	0	0
Mordellidae		<i>Mordellidae</i> sp.	S	0.2	1.5	0	0	0	0	3	1	9	1
		<i>Mordellistena comes</i>	S	0.3	3.1	0	0	0	0	118	3	1	5
Tenebrionidae		<i>Borboresthes cruralis</i>	S	0.5	10.7	0	0	0	19	0	0	0	0
Oedemeridae		<i>Eobia cinereipennis</i> <i>cinereipennis</i>	S	0.3	8.0	0	0	0	0	0	0	0	1
		<i>Oedemeronia lucidicollis</i>	S	0.5	7.1	1	2	9	0	0	0	0	0
Cerambycidae		<i>Chlorophorus muscosus</i>	S	0.7	13.1	0	0	0	3	0	0	0	0
Chrysomelidae		<i>Nonarthra cyaneum</i>	S	0.2	3.1	1	0	0	0	0	0	0	0
		<i>Aulacophora nigripennis</i>	S	0.3	16.7	0	0	0	0	0	0	1	0
		<i>Aulacophora femoralis</i>	S	0.3	12.1	0	0	0	0	0	0	5	0
		<i>Colaspis dauricum</i>	S	0.4	8.3	0	0	0	0	0	0	0	1
Lepidoptera	Yponomeutidae	<i>Yponomeuta</i> sp.1	M	5.7	5.2	0	0	0	1	0	0	0	0
		<i>Yponomeuta</i> sp.2	S	3.4	5.4	0	0	1	0	0	0	0	0

			S	2.2	2.7	0	0	0	0	0	0	4	0
Zygaenidae	<i>Illiberis tenuis</i>		M	6.0	7.9	0	0	0	0	0	0	1	0
Crambidae	<i>Bradina</i> sp.		M	7.4	5.1	0	0	0	1	1	0	0	0
	<i>Maruca vitrata</i>		L	10.8	9.2	0	1	0	0	0	0	0	0
	<i>Palpita nigropunctalis</i>		L	9.4	13.8	0	0	0	0	0	0	0	1
	<i>Spoladea recurvalis</i>		M	5.9	7.4	1	0	1	1	0	5	0	0
Sphingidae	<i>Mactoglossum pyrrhosticta</i>		L	29.6	116.7	0	0	0	0	1	0	0	0
	<i>Theretra japonica</i>		L	32.8	188.0	0	0	1	0	0	0	1	0
Noctuidae	<i>Hermonassa cecilia</i>		M	8.4	110.5	0	0	0	0	0	0	1	0
Hesperiidae	<i>Pelopidas mathias oberthuri</i>		L	16.7	38.5	1	4	26	2	9	7	0	27
	<i>Parnara guttata guttata</i>		L	16.6	48.0	29	47	421	66	10	58	64	4
Papilionidae	<i>Graphium sarpedon nipponum</i>		L	12.3	116.9	2	0	0	3	1	1	0	1
Pieridae	<i>Pieris rapae crucivora</i>		L	10.6	26.1	2	3	6	1	0	0	1	6
	<i>Pieris melete</i>		L	10.2	20.0	1	0	0	0	0	0	0	0
Lycaenidae	<i>Lycaena phlaeas chinensis</i>		M	6.4	13.4	3	7	1	0	0	0	0	0
	<i>Lampides boeticus</i>		M	7.9	12.1	0	2	18	18	9	16	15	0
	<i>Zizeeria maha argia</i>		M	5.6	7.1	12	7	1	8	11	16	3	20
	<i>Everes argiades argiades</i>		S	4.3	4.5	0	0	0	0	0	0	0	3
	<i>Celastrina argiolus ladonides</i>		M	5.7	13.5	0	1	0	0	0	0	0	0
Nymphalidae	<i>Parantica sita niphonica</i>		L	15.3	110.5	0	0	0	0	0	1	0	0
	<i>Polygonia c-aureum c-aureum</i>		M, L	10.0	41.7	2	0	1	0	0	0	0	0
	<i>Vanessa cardui</i>		L	13.5	65.5	0	0	25	5	0	0	0	3
Diptera	Sciaridae	<i>Sciaridae</i> sp.	S	0.2	1.7	0	0	0	0	0	0	1	0
	Syrphidae	<i>Allograpta iavana</i>	S	1.8	6.1	0	0	0	0	0	2	0	1
		<i>Betasyrphus serarius</i>	S	2.0	13.5	4	1	1	4	0	5	0	0
		<i>Episyrrhus balteatus</i>	S	2.0	7.7	39	4	1	2	2	14	25	10
		<i>Eupeodes bucculatus</i>	S	2.1	10.2	1	0	0	0	0	1	0	2

	<i>Eupeodes corollae</i>	S	2.1	7.4	0	7	5	2	0	6	0	1
	<i>Meliscaeva omogensis</i>	S	2.5	11.9	0	0	0	0	0	6	0	0
	<i>Sphaerophoria indiana</i>	S	1.9	4.4	4	1	0	3	0	0	0	1
	<i>Sphaerophoria macrogaster</i>	S	1.6	2.5	23	38	11	8	0	0	3	2
	<i>Syrphus dubius</i>	S	2.3	17.7	1	1	0	1	0	0	0	0
	<i>Syrphus ribesii</i>	S	2.7	37.9	1	0	0	0	0	0	0	0
	<i>Syrphus torvus</i>	S	2.5	25.2	1	0	0	0	0	0	0	0
	<i>Melanostoma</i> sp.	S	1.2	2.1	0	3	1	0	1	0	0	0
	<i>Paragus clauseni</i>	S	1.6	4.5	0	0	0	0	1	0	0	0
	<i>Paragus haemorrhou</i> s	S	1.4	2.0	2	8	13	30	8	24	1	1
	<i>Eumerus</i> spp.	S	1.4	6.0	0	0	0	0	7	0	2	0
	<i>Eristalinus quinquestriatus</i>	S	3.7	26.5	0	0	7	1	0	0	0	0
	<i>Eristalis cerealis</i>	S	4.0	21.4	7	16	1	4	0	0	0	0
	<i>Eristalis tenax</i>	M	5.3	48.1	9	28	52	8	4	10	18	7
	<i>Phytomia zonata</i>	M	5.1	59.1	0	2	10	3	3	1	6	0
	<i>Helophilus eristaloideus</i>	S	3.9	35.5	2	0	3	4	1	0	0	0
	<i>Rhinotropidia rostrata</i>	S	3.0	12.4	0	0	12	0	0	0	0	0
Conopidae	<i>Conops curtulus</i>	M	5.5	15.4	0	0	0	0	1	0	0	0
	Conopidae sp.	S	2.2	1.3	0	0	0	0	0	0	3	0
Tephritidae	Tephritidae sp.	S	1.0	4.0	0	0	0	0	0	0	1	0
Anthomyiidae	Anthomyiinae sp.1	S	0.9	1.8	1	6	1	1	0	0	1	2
	Anthomyiinae sp.2	S	1.2	2.4	0	0	0	1	0	0	0	0
	Fuceliinae sp.1	S	0.6	0.7	0	0	145	26	6	52	1	4
	Fuceliinae sp.2	S	0.6	0.6	0	4	0	0	0	1	0	0
	Fuceliinae sp.3	S	0.3	0.9	0	0	0	0	0	0	0	1
Calliphoridae	<i>Calliphora nigribarbis</i>	S	3.5	31.3	0	0	0	3	4	3	8	5
	Lucilinae spp.	S	2.6	15.4	2	1	2	1	2	3	3	14

	<i>Stomorhina obsoleta</i>	S	2.1	4.1	50	50	21	104	2	29	2	9
	Calliphoridae sp.	S	1.6	2.8	1	0	0	0	0	0	4	0
Sarcophagidae	Sarcophagidae sp.1	S	2.1	10.6	8	4	2	3	4	2	1	9
	Sarcophagidae sp.2	S	1.9	4.4	0	0	4	0	1	1	0	12
	<i>Ectophasia rotundiventris</i>	S	2.0	10.6	0	0	0	1	0	0	0	0
Tachinidae	<i>Gymnosoma rotundatum</i>	S	2.0	4.2	0	0	0	0	0	0	2	0
	Siphonini sp.	S	2.2	1.7	0	0	0	0	0	4	1	0
	Tachinidae sp.1	S	3.6	28.0	0	4	0	0	3	0	0	0
	Tachinidae sp.2	S	3.7	35.1	1	1	0	0	5	1	0	0

Table S3. List of plant species examined in the study sites. Flower group: S = short-tubed; M = medium-tubed; L = long-tubed; flower formula: r = radius, l = length, w = width. Study sites: HT = Hitachi; HN = Hitachinaka; TY = Tateyama; OS = Ohshima; NJ = Niijima; KZ = Kozu; MY = Miyake; HJ = Hachijo

Order	Family	Species	Flower group	Tube length (mm)	Visual size (mm^2)	Flower formula	No. of flowers per study site							
							HT	HN	TY	OS	NJ	KZ	MY	HJ
Liliales	Liliaceae	<i>Lilium maculatum</i>	S	0.0	117.7	πr^2	0	10	5	0	0	640	0	0
Asparagales	Iridaceae	<i>Crocosmia × crocosmiiflora</i>	L	13.2	12.1	πr^2	0	1316	0	0	85	0	12	0
	Amaryllidaceae	<i>Crinum asiaticum</i> var. <i>japonicum</i>	L	63.2	82.0	πr^2	0	0	13	598	320	273	63	785
	Xanthorrhoeaceae	<i>Hemerocallis fulva</i> var. <i>littorea</i>	L	30.5	105.9	πr^2	0	0	0	24	4	138	73	0
	Asparagaceae	<i>Scilla japonica</i>	S	0.0	32.2	$2\pi rl$	428	0	0	0	0	0	0	0
Commelinaceae	Commelinaceae	<i>Commelina communis</i>	S	0.0	2.0	lw	801	193	151	306	73	98	534	0
Ranunculales	Ranunculaceae	<i>Clematis terniflora</i>	S	0.0	8.2	πr^2	3937	354	0	0	69	0	1183	0
Saxifragales	Crassulaceae	<i>Sedum japonicum</i> subsp. <i>oryzifolium</i>	S	0.0	0.5	πr^2	0	0	0	0	35	115	0	0
Vitales	Vitaceae	<i>Cayratia japonica</i>	S	0.0	38.0	πr^2	70	0	0	0	0	0	0	0
		<i>Ampelopsis glandulosa</i> var. <i>hancei</i>	S	0.5	5.7	πr^2	0	223	1188	2017	193	182	7	202
Brassicaceae	Brassicaceae	<i>Brassica rapa</i> var. <i>nippo-oleifera</i>	M	6.2	2.2	πr^2	0	395	0	0	0	0	0	0
		<i>Nasturtium officinale</i>	S	3.3	0.4	πr^2	0	1705	0	0	0	0	0	0
		<i>Raphanus sativus</i> var.	L	10.7	3.4	πr^2	0	0	6439	11539	0	0	53	0

					<i>hortensis</i> f.									
					<i>raphanistroides</i>									
Myrtales	Lythraceae	<i>Lythrum anceps</i>	M	5.9	2.4	πr^2	0	23510	0	0	0	0	0	0
	Onagraceae	<i>Oenothera laciniata</i>	L	24.0	6.9	πr^2	680	7243	5232	1598	3863	1031	1190	8762
Geriales	Geraniaceae	<i>Geranium thunbergii</i>	S	0.0	1.6	πr^2	0	30	0	0	0	0	0	0
Celastrales	Celastraceae	<i>Euonymus japonicus</i> var. <i>radicifer</i>	S	0.0	0.9	πr^2	0	0	0	3224	0	0	0	1370
Oxalidales	Oxalidaceae	<i>Oxalis corniculata</i> var. <i>trichocaulon</i>	S	3.6	1.4	πr^2	486	316	215	559	467	674	238	566
		<i>Oxalis debilis</i> subsp. <i>corymbosa</i>	M	8.2	2.6	πr^2	0	0	746	27	6	0	92	0
Rosales	Rosaceae	<i>Rhaphiolepis indica</i> var. <i>umbellata</i>	S	1.6	2.7	πr^2	405	4935	0	0	0	0	0	28
		<i>Rosa luciae</i>	S	0.0	12.6	πr^2	100	0	80	0	9	0	0	0
		<i>Rosa rugosa</i>	S	0.0	25.6	πr^2	0	15	0	0	0	0	0	0
Fabales	Fabaceae	<i>Lotus corniculatus</i> var. <i>japonicus</i>	M	6.5	1.1	<i>lw</i>	1549	164	149	0	0	0	0	0
		<i>Trifolium repens</i>	S	3.5	0.2	<i>lw</i>	15159 7	0	0	0	0	0	33320	0
		<i>Lathyrus japonicus</i>	L	11.6	2.9	<i>lw</i>	862	1762	57	870	273	48	674	0
		<i>Canavalia lineata</i>	L	13.2	5.7	<i>lw</i>	0	0	0	0	7	0	0	77
Caryophyllales	Polygonaceae	<i>Persicaria senticosa</i>	S	3.3	2.5	$4\pi r^2$	87	5010	4462	227	0	10	0	0
		<i>Persicaria chinensis</i>	S	1.5	2.2	$4\pi r^2$	0	0	2214	3105	357	1210	135	7452
		<i>Fallopia japonica</i> var. <i>hachijoensis</i>	S	1.0	20.7	$2\pi rl$	0	0	0	0	0	2151	655	0
	Aizoaceae	<i>Tetragonia</i> <i>tetragonoides</i>	S	0.8	0.7	πr^2	0	1210	0	75	0	0	0	0

	Caryophyllaceae	<i>Stellaria media</i>	S	0.0	0.1	πr^2	0	0	688	0	0	0	0	0
		<i>Dianthus japonicus</i>	L	18.5	1.8	πr^2	0	2393	0	0	618	2	0	0
		<i>Silene gallica</i> var. <i>gallica</i>	M	8.5	0.7	πr^2	0	0	0	111	0	1344	0	1109
		<i>Hydrangea macrophylla</i> f. <i>normalis</i>	S	0.0	87.4	πr^2	0	0	0	0	0	2	8	0
Cornales	Hydrangeaceae													
Ericales	Primulaceae	<i>Lysimachia mauritiana</i>	S, M	5.2	0.9	πr^2	763	19844	5895	2897	5622	11878	1206	640
	Ericaceae	<i>Rhododendron indicum</i>	L	14.7	16.3	πr^2	384	0	0	0	0	0	0	0
Dipsacales	Caprifoliaceae	<i>Lonicera japonica</i>	L	22.6	4.2	<i>lw</i>	86	441	1901	56	159	53	16	86
Apiales	Pittosporaceae	<i>Pittosporum tobira</i>	M	6.0	1.9	πr^2	0	903	0	0	0	0	0	0
	Apiaceae	<i>Angelica keiskei</i>	S	0.0	1.6	πr^2	0	0	0	0	0	1036	9901	0
		<i>Glehnia littoralis</i>	S	0.0	0.9	πr^2	26	11	228	990	162	521	0	0
		<i>Peucedanum japonicum</i> var. <i>japonicum</i>	S	0.0	0.4	πr^2	0	0	0	0	50	1862	300	0
		<i>Ligusticum scoticum</i> subsp. <i>hultenii</i>	S	0.0	1.8	πr^2	129	0	0	0	0	0	0	0
Asterales	Campanulaceae	<i>Campanula microdonta</i>	L	21.7	11.0	$2\pi rl + \pi r^2$	0	0	0	189	292	88	6	447
		<i>Adenophora triphylla</i> var. <i>japonica</i> f. <i>glabra</i>	L	13.6	6.6	$2\pi rl + \pi r^2$	0	0	0	0	0	322	195	0
	Asteraceae	<i>Chrysanthemum pacificum</i>	S	3.3	0.6	πr^2	0	5746	47800	4884	52984	9126	11327	54067
												5	2	

<i>Chrysanthemum × marginatum</i>	S	3.0	2.6	πr^2	0	1343	882	0	0	0	0	0
<i>Nipponanthemum nipponicum</i>	S	3.4	33.2	πr^2	619	30	0	0	0	0	0	0
<i>Aster microcephalus</i> var. <i>ovatus</i>	S, M	4.3	5.5	πr^2	1398	14	986	0	0	0	0	0
<i>Aster microcephalus</i> var. <i>littoricola</i>	S, M	4.2	5.2	πr^2	0	0	0	480	108	292	2167	149
<i>Erigeron philadelphicus</i>	S	2.6	2.8	πr^2	0	0	188	0	0	70	846	2
<i>Solidago altissima</i>	S	3.5	5.9	lw	6536	8894	608	0	55	0	0	0
<i>Farfugium japonicum</i>	L	10.2	21.5	πr^2	812	104	294	208	141	3650	1410	545
<i>Eclipta thermalis</i>	S	1.3	0.7	πr^2	0	0	0	0	0	0	1086	0
<i>Melanthera prostrata</i>	S, M	4.8	4.9	πr^2	0	499	9211	148	511	10847	119	3842
<i>Bidens pilosa</i> var. <i>pilosa</i>	S	4.2	0.6	πr^2	3374	0	0	402	0	0	0	0
<i>Cirsium japonicum</i>	L	16.8	39.2	$2\pi rl + \pi r^2$	78	0	0	0	0	0	0	0
<i>Cirsium maritimum</i>	L	20.0	23.7	$2\pi rl + \pi r^2$	0	0	0	0	0	0	0	81
<i>Cirsium hachijoense</i>	L	14.9	28.0	$2\pi rl + \pi r^2$	0	0	0	0	0	42	1213	0
<i>Taraxacum platycarpum</i>	M	7.9	13.7	πr^2	0	0	1	1	0	0	0	0
<i>Taraxacum officinale</i>	S, M	4.9	8.6	πr^2	31	1	4	0	0	0	186	18
<i>Picris hieracioides</i> subsp. <i>japonica</i>	M	6.2	6.5	πr^2	11	0	480	642	326	0	1	0
<i>Picris hieracioides</i> subsp. <i>japonica</i> f. <i>maritima</i>	M	6.8	7.8	πr^2	0	0	531	0	0	0	0	0

		<i>Crepidiastrum platyphyllum</i>	S	2.4	1.2	πr^2	0	0	0	424	1956	640	6232	0
		<i>Ixeris repens</i>	S	3.3	4.2	πr^2	2010	0	15	29	19	0	0	0
		<i>Ixeris stolonifera</i>	S	3.4	3.6	πr^2	0	0	23	0	0	0	72	199
		<i>Ixeris japonica</i>	S	3.5	6.7	πr^2	0	62	0	0	0	0	0	0
		<i>Youngia japonica</i>	S	2.2	0.8	πr^2	0	0	0	487	0	8	420	118
		<i>Pterocypsela elata</i>	M	5.0	1.6	πr^2	0	0	0	0	62	0	0	0
		<i>Sonchus oleraceus</i>	M	7.0	3.4	πr^2	76	573	128	51	10	89	52	12
Lamiales	Plantaginaceae	<i>Linaria japonica</i>	L	12.1	1.4	lw	6393	49	0	0	0	0	0	0
	Lamiaceae	<i>Vitex rotundifolia</i>	M, L	9.5	2.4	lw	3062	2067	42678	41003	53293	19458	48982	7198
	Verbenaceae	<i>Lantana camara</i> var. <i>aculeata</i>	L	9.7	7.7	πr^2	0	0	0	370	12	0	0	0
		<i>Phyla nodiflora</i>	S	2.5	0.2	πr^2	0	0	1505	0	0	0	0	0
Solanales	Convolvulaceae	<i>Calystegia soldanella</i>	L	26.8	18.7	πr^2	884	11787	748	396	206	207	847	1877
		<i>Cuscuta campestris</i>	S	0.6	0.1	πr^2	4432	0	0	0	16986	0	0	0
	Solanaceae	<i>Lycium chinense</i>	M	6.0	1.7	πr^2	0	5093	116	116	0	0	0	0
		<i>Solanum maximowiczii</i>	S	0.0	0.3	πr^2	0	0	0	0	0	283	0	0
Gentianales	Apocynaceae	<i>Vincetoxicum japonicum</i>	S	0.0	0.9	πr^2	0	0	0	0	498	0	702	171
	Rubiaceae	<i>Paederia scandens</i> var. <i>maritima</i>	L	11.5	1.2	$2\pi rl + \pi r^2$	608	114	0	105	21	0	0	175
		<i>Diodia teres</i>	M	4.9	0.4	πr^2	0	2352	0	0	0	0	0	0

Table S4. List of pollinator and plant species belonging to the two functional groups. The number indicates the mean proboscis and tube length for each study site. Study sites: HT = Hitachi; HN = Hitachinaka; TY = Tateyama; OS = Ohshima; NJ = Niijima; KZ = Kozu; MY = Miyake; HJ = Hachijo; Functional group: S = short; M = medium; L = long.

Species	HT	HN	TY	OS	NJ	KZ	MY	HJ
Pollinators								
<i>Coelioxys formosicola</i>	-	5.4 (M)	4.0 (S)	-	-	-	-	-
<i>Eucera nipponensis</i>	11.2 (L)	10.7 (L)	11.3 (L)	8.7 (M)	-	9.5 (L)	-	-
<i>Campsomeriella annulata</i>	4.3 (S)	5.3 (M)	6.0 (M)	5.4 (M)	5.1 (M)	5.3 (M)	6.3 (M)	-
<i>Scolia histrionica</i>	4.2 (S)	3.8 (S)	3.8 (S)	3.7 (S)	3.9 (S)	4.8 (M)	-	-
<i>Polygonia c-aureum c-aureum</i>	8.1 (M)	-	12.0 (L)	-	-	-	-	-
Plants								
<i>Lysimachia mauritiana</i>	4.2 (S)	4.9 (M)	5.2 (M)	5.5 (M)	6.5 (M)	5.2 (M)	5.0 (M)	5.2 (M)
<i>Aster microcephalus</i> var. <i>ovatus</i>	4.7 (M)	3.8 (S)	4.2 (S)	-	-	-	4.6 (M)	-
<i>Aster microcephalus</i> var. <i>littoricola</i>	-	-	-	3.9 (S)	4.3 (S)	4.0 (S)	4.6 (M)	4.3 (S)
<i>Melanthera prostrata</i>	-	4.4 (S)	4.5 (S)	4.6 (M)	4.6 (M)	5.3 (M)	4.6 (M)	4.7 (M)
<i>Taraxacum officinale</i>	6.0 (M)	4.9 (M)	3.6 (S)	-	-	-	5.4 (M)	4.0 (S)
<i>Vitex rotundifolia</i>	8.8 (M)	9.5 (L)	9.6 (L)	9.7 (L)	9.4 (L)	10.0 (L)	9.1 (L)	9.7 (L)

Table S5. The numbers of total and common species and individuals of seven pollinator taxonomic groups on five oceanic islands.

Common species here is defined as those found on both continental and oceanic islands. The percentages of common species and their individuals are given in parentheses.

	No. of species		No. of individuals		
	Total	Common	Total	Common	
Bee	40	21 (52.5)	1879	1508 (80.3)	
Wasp	30	12 (40.0)	364	332 (91.2)	
Syrphid fly	18	14 (77.8)	246	227 (92.3)	
Other dipteran	20	10 (50.0)	348	309 (88.8)	
Lepidopteran	18	9 (50.0)	407	392 (96.3)	
Beetle	26	5 (19.2)	290	47 (16.2)	
Other arthropods	12	6 (50.0)	108	64 (59.3)	
Total	164	77 (47.0)	3642	2879 (79.0)	

Table S6. Factors affecting selection probability and pollinator composition. Estimated coefficients are given as the median, and R-hat shows the convergence criterion (<1.1 indicates convergence). Effects in bold show factors whose 95% CIs did not overlap with zero. Short-tubed flowers or short-tongued pollinators were used as the baseline.

Explanatory variables	Estimate	95% CI		R-hat		
		2.5 %	97.5 %			
Pollinators						
Short-tongued						
RBLP (Medium-tubed)	-1.900	-3.251	-0.543	1.002		
Intercept (Medium-tubed)	-0.594	-2.505	1.297	1.001		
RBLP (Long-tubed)	-1.479	-2.298	-0.660	1.001		
Intercept (Long-tubed)	-1.753	-3.205	0.118	1.006		
Medium-tongued						
RBLP (Medium-tubed)	-0.384	-2.165	1.263	1.004		
Intercept (Medium-tubed)	0.847	-0.974	2.574	1.002		
RBLP (Long-tubed)	-2.003	-3.168	-0.823	1.002		
Intercept (Long-tubed)	-0.235	-1.984	1.485	1.004		
Long-tongued						
RBLP (Medium-tubed)	0.274	-1.563	2.363	1.001		
Intercept (Medium-tubed)	0.964	-1.077	2.871	1.001		
RBLP (Long-tubed)	0.852	-0.564	2.407	1.000		
Intercept (Long-tubed)	1.191	-0.738	2.926	1.013		
Plants						
Short-tubed						
RBLP (Medium-tongued)	-0.238	-1.142	0.620	1.002		
Intercept (Medium-tongued)	-1.709	-2.977	-0.391	1.006		
RBLP (Long-tongued)	3.494	2.368	4.639	1.001		
Intercept (Long-tongued)	-4.298	-6.315	-2.202	1.005		
Medium-tubed						
RBLP (Medium-tongued)	0.230	-0.986	1.358	1.003		
Intercept (Medium-tongued)	-0.393	-4.027	1.903	1.036		
RBLP (Long-tongued)	3.555	2.281	4.761	1.001		
Intercept (Long-tongued)	-2.646	-5.444	-0.279	1.010		
Long-tubed						
RBLP (Medium-tongued)	1.886	0.660	3.211	1.001		
Intercept (Medium-tongued)	-1.285	-4.325	1.928	1.023		
RBLP (Long-tongued)	6.320	5.171	7.515	1.001		
Intercept (Long-tongued)	-2.459	-4.684	-0.459	1.005		

Table S7. GLMM and GLM results describing changes in the number of pollinator visits and mean proboscis length in relation to decreasing long-tongued pollinators in six dominant plants. Functional group: S = short-tongued; M = medium-tongued; L = long-tongued. Effects for which $P < 0.05$ are highlighted in bold.

Response variable	species	Flower group	Explanatory variable	Coefficients				model
				Estimate	SE	Z	P	
No. of pollinator	<i>Ampelopsis glandulosa</i>	S	RBLP	0.372	0.590	0.63	0.529	GLMM
			Total no. of pollinator	-0.002	0.001	-2.95	0.003	
			Total floral area	0.071	0.023	3.09	0.002	
			Intercept	-3.074	0.185	-16.65	< 0.001	
	<i>Oxalis corniculata</i>	S	RBLP	-0.141	0.611	-0.23	0.820	GLMM
			Total no. of pollinator	-0.003	0.002	-1.41	0.160	
			Total floral area	-0.033	0.033	-0.98	0.330	
			Intercept	-2.905	0.452	-6.42	< 0.001	
	<i>Melanthera prostrata</i>	M	RBLP	-0.404	1.146	-0.35	0.720	GLMM
			Total no. of pollinator	0.003	0.002	1.49	0.140	
			Total floral area	-0.006	0.059	-0.11	0.910	
			Intercept	-3.492	0.583	-6.00	< 0.001	
	<i>Lysimachia mauritiana</i>	M	RBLP	0.338	1.241	0.27	0.790	GLMM
			Total no. of pollinator	0.002	0.005	0.30	0.760	
			Total floral area	-0.056	0.042	-1.32	0.190	
			Intercept	-4.774	1.036	-4.61	< 0.001	
	<i>Vitex rotundifolia</i>	L	RBLP	2.222	0.681	3.26	< 0.001	GLMM
			Total no. of pollinator	4.4×10^{-4}	0.001	-0.32	0.748	

			Total floral area	-0.052	0.037	-1.42	0.156	
			Intercept	-4.777	0.413	-11.58	< 0.001	
<i>Calystegia soldanella</i>	L	RBLP		0.864	0.668	1.29	0.196	GLM
		Total no. of pollinator		0.012	0.003	3.71	< 0.001	
		Total floral area		-0.140	0.025	-5.71	< 0.001	
		Intercept		-4.356	0.627	-6.95	< 0.001	
Mean proboscis length	<i>Ampelopsis glandulosa</i>	S	RBLP	-1.643	0.097	-16.86	< 0.001	GLMM
			Intercept	4.190	0.777	5.39	< 0.001	
<i>Oxalis corniculata</i>	S	RBLP		2.058	0.968	2.13	0.034	GLMM
		Intercept		2.777	0.479	5.80	< 0.001	
<i>Melanthera prostrata</i>	M	RBLP		9.240	2.570	3.59	< 0.001	GLMM
		Intercept		4.100	0.910	4.51	< 0.001	
<i>Lysimachia mauritiana</i>	M	RBLP		-0.496	1.509	-0.33	0.740	GLMM
		Intercept		3.554	0.590	6.02	< 0.001	
<i>Vitex rotundifolia</i>	L	RBLP		4.970	2.850	1.74	0.082	GLMM
		Intercept		6.600	1.180	5.61	< 0.001	
<i>Calystegia soldanella</i>	L	RBLP		6.609	1.847	3.58	< 0.001	GLM
		Intercept		2.904	0.676	4.29	< 0.001	

Table S8. GLMM results that describe changes in fruit set of three plant species in relation to decreasing RBLP or mean proboscis length. Visit frequency was incorporated as a covariate.

Functional group: M, medium-tubed; L, long-tubed. Effects for which $P < 0.05$ are highlighted in bold.

Species	Flower group	Explanatory variable	Coefficients			
			Estimate	SE	Z	P
<i>Lysimachia mauritiana</i>	M	RBLP	-2.645	1.125	-2.35	0.019
		Visit frequency	-43.175	24.470	-1.76	0.078
		Intercept	4.783	0.605	7.90	< 0.001
	L	Mean proboscis length	0.845	0.362	2.33	0.020
		Visit frequency	-42.878	24.321	-1.76	0.078
		Intercept	1.475	1.065	1.38	0.166
	<i>Vitex rotundifolia</i>	RBLP	-1.134	1.515	-0.75	0.454
		Visit frequency	-2.427	34.450	-0.07	0.944
		Intercept	1.314	0.485	2.71	0.007
	<i>Calystegia soldanella</i>	Mean proboscis length	-0.021	0.177	-0.12	0.910
		Visit frequency	-20.854	29.479	-0.71	0.480
		Intercept	1.422	1.286	1.11	0.270
	L	RBLP	3.67	1.87	1.96	0.050
		Visit frequency	15.30	6.56	2.33	0.020
		Intercept	-2.68	1.05	-2.56	0.011
		Mean proboscis length	0.508	0.154	3.31	0.001
		Visit frequency	10.879	4.511	2.41	0.016
		Intercept	-3.553	0.917	-3.87	< 0.001