

## Supplementary Material

### Global dispersal and diversification in ground beetles of the subfamily Carabinae

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## Supplementary results

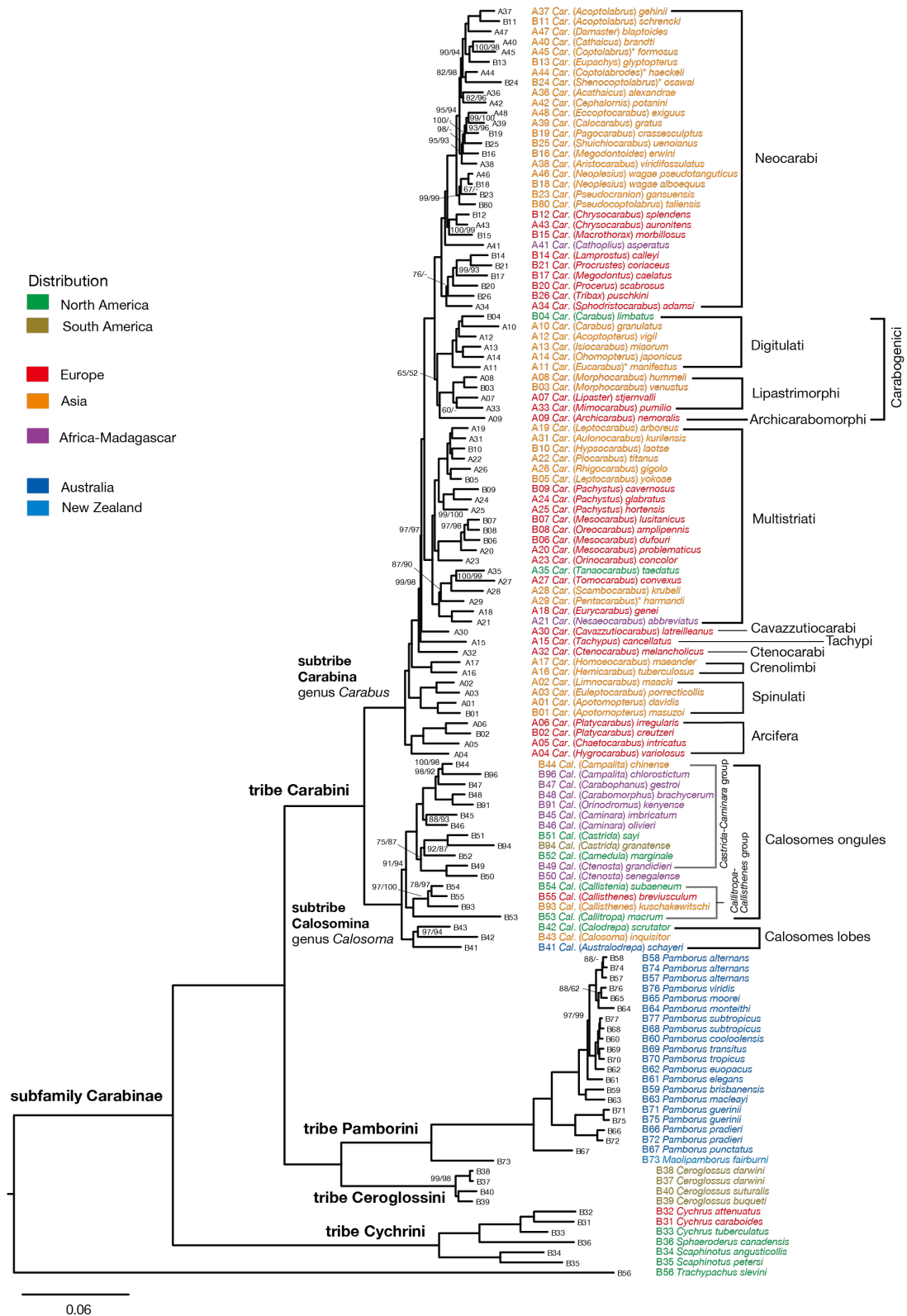
### Phylogenetic relationships among groups in subtribe Carabina

Here, we describe our results regarding the relationships among taxonomic groups proposed by Deuve (2019) obtained through the comparison of maximum-likelihood trees based on six datasets (Figs. S1–S3). In general, our results were consistent with those of Deuve et al. (2012) and Deuve (2019), but some differences were also found. Arcifera was found to be the most basal group sister to all other Carabina groups, which are collectively called Eucarabi. Spinulati is the next basal group and is sister to Ligulati. In Ligulati, Crenolimbi is sister to all others, designated Heterocarabi. The basal clades of Heterocarabi are Ctenocarabi, Tachypi, and Cavazzutiocarabi. Ctenocarabi and Tachypi are sister to each other in the all\_70p tree, but this relationship is not present in the other trees. Cavazzutiocarabi is sister to Orthocarabi. Orthocarabi comprises Multistriati and Apocarabi, for which monophyly was strongly supported. Thus, these relationships are summarized as (Arcifera, (Spinulati, (Crenolimbi, (Ctenocarabi, (Tachypi, (Cavazzutiocarabi, (Multistriati, Apocarabi)))))).

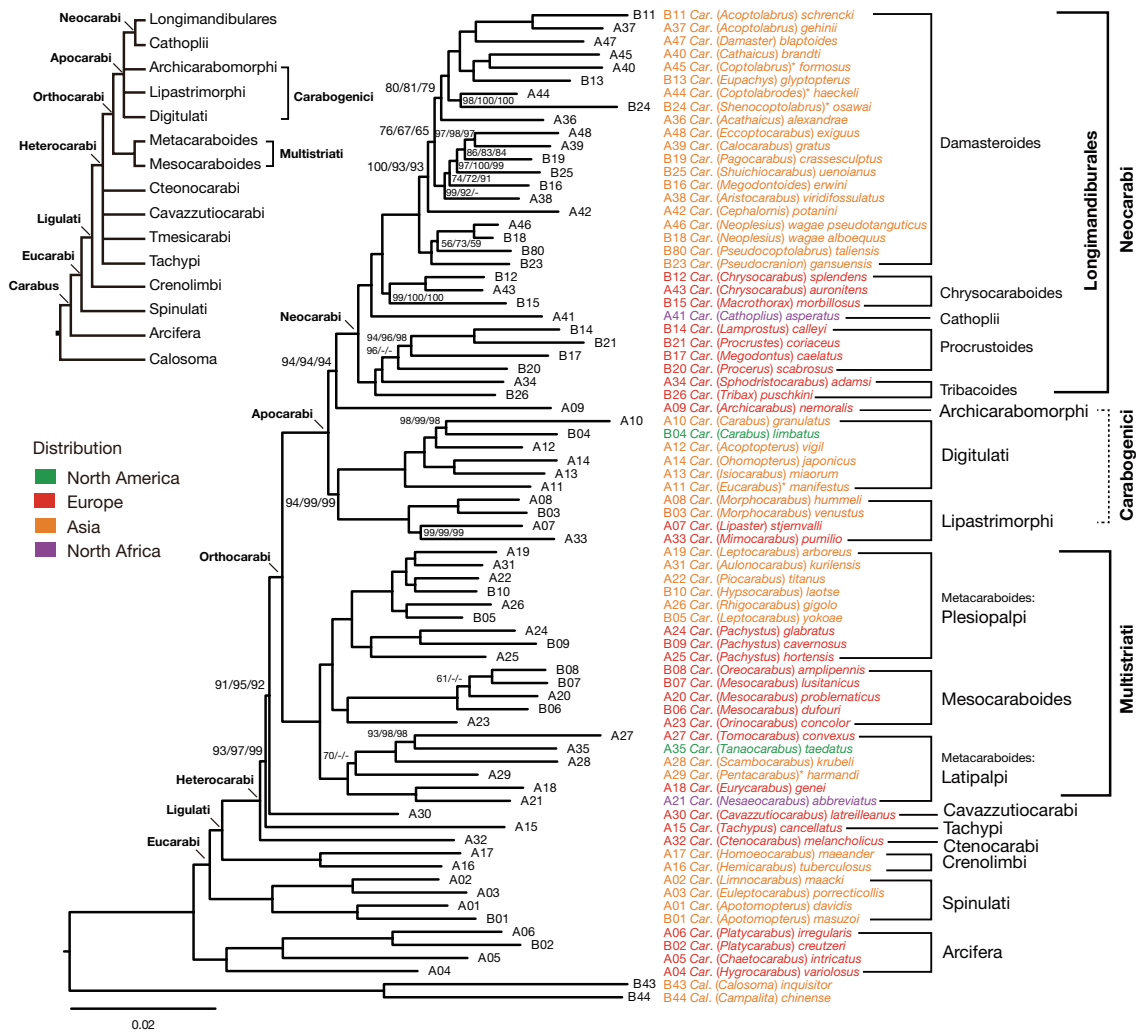
Multistriati includes Mesocaraboides and Metacaraboides, with the latter comprising Plesiopalpi and Latipalpi in the analysis of Deuve (2019). However, our results show that Plesiopalpi is sister to Mesocaraboides, whereas Latipalpi is sister to all other Multistriati. Thus, Metacaraboides is paraphyletic. Apocarabi comprises three Carabogenici groups and Neocarabi. Carabogenici includes Digitulati, Lipastrimorphi, and Archicarabomorphi (Ishikawa 1978), and these are located intermediate between Neocarabi and Multistriati, as in previous studies (Sota and Ishikawa 2004; Deuve 2012). In the all\_70p tree (Fig. S1), these groups are not monophyletic; the relationships among the four groups are as follows: (Digitulati, (Lipastrimorphi, (Archicarabomorphi, Neocarabi))), with weak support for the relationships of (Lipastrimorphi, (Archicarabomorphi, Neocarabi)). In the all\_50p and all\_60p trees, Carabogenici is monophyletic with weak bootstrap support (Fig. S2). In the phylogenies based only on *Carabus* data (*Carabus*\_50p. 60p. 70p), Digitulati is sister to Lipastrimorphi, Archicarabomorphi is sister to Neocarabi, and the relationships can be summarized as ((Digitulati, Lipastrimorphi), (Archicarabomorphi, Neocarabi)) (Fig. S3). Thus, the precise relationships among the three Carabogenici groups remain unresolved.

Lastly, Neocarabi is the most derived group and contains a large number of species. Although subgenus *Cathoplius* was sister to all Neocarabi in Deuve et al. (2012) and treated as *Cathoplini* in Deuve (2019), it was placed within Neocarabi and found to be sister to *Chrysocaraboides* and *Damasteroides* in the present analysis.

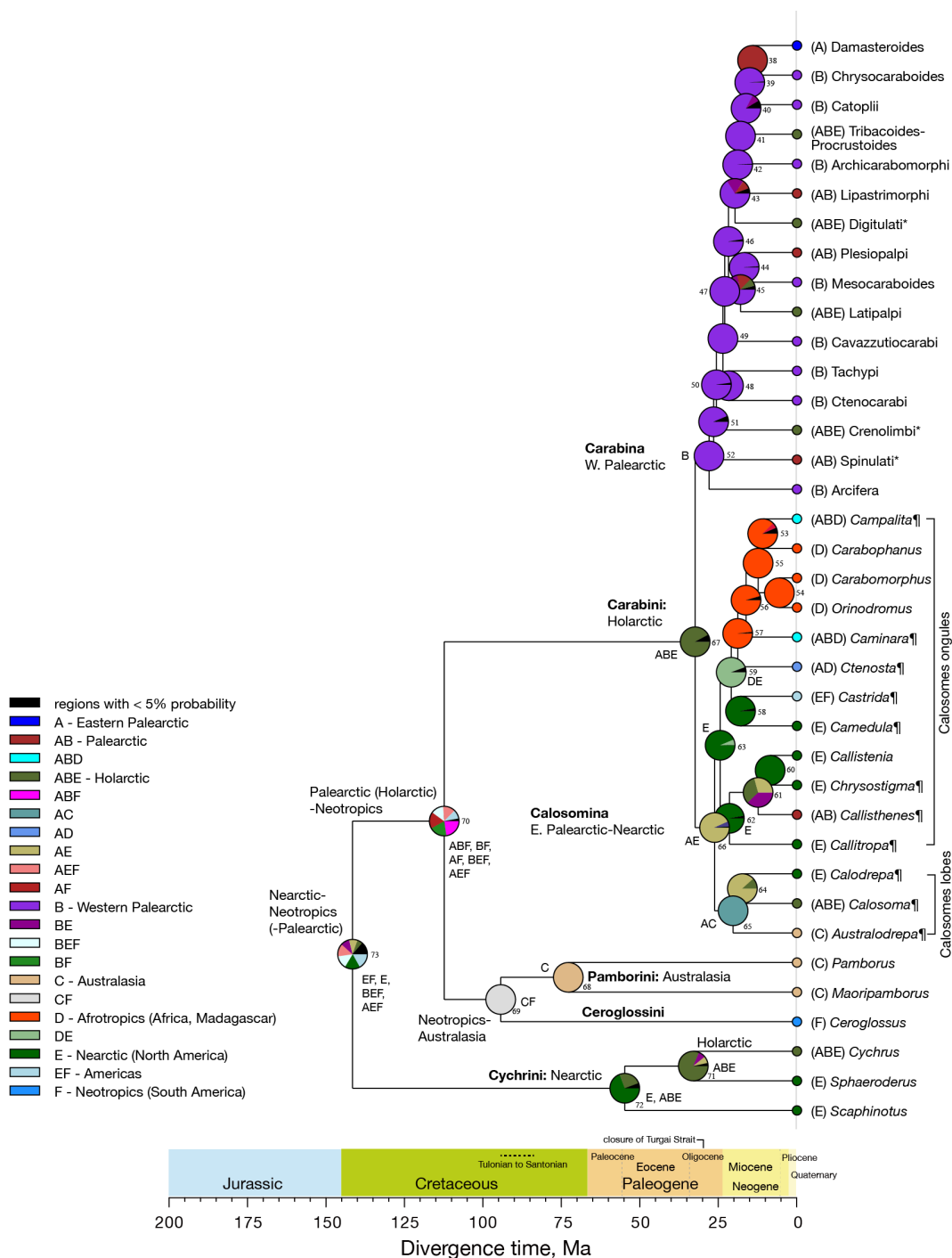




**Fig. S2.** Maximum-likelihood tree of the subfamily Carabinae derived from IQ-TREE analysis with all\_50p and all\_60p data. At each node, the ultrafast bootstrap values obtained for the ML trees with all\_50p/ all\_60p data sets are shown except for the case with all 100% (i.e., 100/100).



**Fig. S3.** Maximum-likelihood tree of the subtribe Carabina (genus *Carabus*) derived from IQ-TREE analysis using the *Carabus\_70p*, *60p*, and *50p* data in comparison with the phylogenetic systematics by Deuve (2019). (top left). The tree is a maximum-likelihood tree resulting from data for Carabina. At each node, the ultrafast bootstrap values obtained for the ML trees with *Carabus\_70p*/*Carabus\_60p*/*Carabus\_50p* data sets are shown except for the case with all 100% (i.e., 100/100/100).



**Fig. S4.** Reconstructed historical biogeography of subfamily Carabinae based on the DIVALIKE model. The pie graph at each node represents probabilities of the ancestral ranges. Node numbers (refer to Table S5) are indicated beside the pie graphs. The global dispersal history of major groups is schematically illustrated on paleogeographic maps of 120, 90, and 23 Ma. The maps were obtained from the ODSN Plate Tectonic Reconstruction Service (<https://www.odsn.de/odsn/services/paleomap/paleomap.html>). In Calosomina, ¶ indicates that all or some species in the group are macropterous; in Carabina, \* indicates that one or more species in the group are polymorphically macropterous. All other groups are apterous or brachypterous.





**Table S1.** List of samples species used in the molecular phylogenetic analysis.

Tribe/subtribe	UCEno	index	group	genus	subgenus	Species	Sex [specimen type]	date	Locality (permit, if applicable) [specimen depository]	Sequence data accession: BioSample ID (BioProject: PRJDB9367)
Carabini/Calosomina	B54	F7	Callisthenes	<i>Callistenia</i>	<i>Callistenia</i>	<i>subaeneum</i>	male [R]	2016	USA: Washington, Okanogan [KUZ]	SAMD00325014
Carabini/Calosomina	B55	G7	Callisthenes	<i>Callisthenes</i>	<i>Callisthenes</i>	<i>breviusculum</i>	male [E]	2013	Armenia: Ardenis (NAS-SSZH) [KUZ]	SAMD00325015
Carabini/Calosomina	B93	E12	Callisthenes	<i>Callisthenes</i>	<i>Callisthenes</i>	<i>kuschakewitschi</i>	female [D]	1964	Kazakhstan: Karatau [Ishikawa]	SAMD00325041
Carabini/Calosomina	B92	D12	Callisthenes	<i>Chrysostigma</i>	<i>Chrysostigma</i>	<i>semulaeve</i>	male [D]	1957	USA: Arizona, Portal [Ishikawa]	SAMD00325040
Carabini/Calosomina	B53	E7	Callitropa	<i>Callitropa</i>	<i>Callitropa</i>	<i>macrum</i>	female [E]	2013	USA: Texas, Brownwood [KUZ]	SAMD00325013
Carabini/Calosomina	B52	D7	Callitropa	<i>Camedula</i>	<i>Camedula</i>	<i>marginale</i>	male [E]	2012	USA: Texas, Austin [KUZ]	SAMD00325012
Carabini/Calosomina	B41	A6	Calosomes lobes	<i>Australodrepa</i>	<i>Australodrepa</i>	<i>schayeri</i>	male [E]	1996	Australia: NSW, Narrabri [KUZ]	SAMD00325001
Carabini/Calosomina	B42	B6	Calosomes lobes	<i>Calodrepa</i>	<i>Calodrepa</i>	<i>scrutator</i>	male [E]	2015	USA: Kentucky, Paducah [KUZ]	SAMD00325002
Carabini/Calosomina	B43	C6	Calosomes lobes	<i>Calosoma</i>	<i>Calosoma</i>	<i>inquisitor</i>	male [R]	2016	Japan: Hokkaido [KUZ]	SAMD00325003
Carabini/Calosomina	B45	E6	Castrida-Caminara	<i>Caminara</i>	<i>Caminara</i>	<i>imbricatum</i>	male [R]	2017	South Africa: Northern Cape, Nakop [KUZ]	SAMD00325005
Carabini/Calosomina	B46	F6	Castrida-Caminara	<i>Caminara</i>	<i>Caminara</i>	<i>olivieri</i>	male [R]	2012	Morocco: Cape Rhir [KUZ]	SAMD00325006
Carabini/Calosomina	B44	H6	Castrida-Caminara	<i>Campalita</i>	<i>Campalita</i>	<i>chinense</i>	female [R]	2015	Japan: Aomori [KUZ]	SAMD00325004
Carabini/Calosomina	B96	D12	Castrida-Caminara	<i>Campalita</i>	<i>Campalita</i>	<i>chlorostictum</i>	female [D]	1967	St Helena Island [Ishikawa]	SAMD00325043
Carabini/Calosomina	B48	H6	Castrida-Caminara	<i>Carabomorphus</i>	<i>Carabomorphus</i>	<i>brachycerum</i>	male [D]	1957	Tanzania: Mt. Meru [Ishikawa]	SAMD00325008
Carabini/Calosomina	B47	G6	Castrida-Caminara	<i>Carabophanus</i>	<i>Carabophanus</i>	<i>gestroi</i>	male [D]	1971	Ethiopia: Bale Prov. [Ishikawa]	SAMD00325007
Carabini/Calosomina	B51	C7	Castrida-Caminara	<i>Castrida</i>	<i>Castrida</i>	<i>sayi</i>	female [R]	2015	USA: Mississippi, Grenada [KUZ]	SAMD00325011
Carabini/Calosomina	B94	F12	Castrida-Caminara	<i>Castrida</i>	<i>Castrida</i>	<i>granatense</i>	male [D]	2009	Galapagos: Santa-Cruz I. [Ishikawa]	SAMD00325042
Carabini/Calosomina	B49	A7	Castrida-Caminara	<i>Ctenosta</i>	<i>Ctenosta</i>	<i>grandidieri</i>	male [R]	2009	Madagascar: Majunga (Direction du Systeme des Aires Protegees, No. 287) [KUZ]	SAMD00325009
Carabini/Calosomina	B50	B7	Castrida-Caminara	<i>Ctenosta</i>	<i>Ctenosta</i>	<i>senegalense</i>	male [R]	2017	Namibia: Hardap, Maltahöhe (Ministry of Environment and Tourism, Namibia, No. 2244/2017) [KUZ]	SAMD00325010
Carabini/Calosomina	B91	C12	Castrida-Caminara	<i>Orinodromus</i>	<i>Orinodromus</i>	<i>kenyense</i>	female [D]	1953	Kenya: Mt. Elgon [Ishikawa]	SAMD00325039
Carabini/Carabina	A09	A2	Archicicarabomorphi	<i>Carabus</i>	<i>Archicarabus</i>	<i>memoralis</i>	female [R]	2016	USA: Washington State [KUZ]	SAMD00324926
Carabini/Carabina	A05	E1	Arceifera	<i>Carabus</i>	<i>Chaetocarabus</i>	<i>intricatus</i>	female [R]	2015	Czech Republic: Moravia [KUZ]	SAMD00324922
Carabini/Carabina	A04	D1	Arceifera	<i>Carabus</i>	<i>Hygrocarabus</i>	<i>variolosus</i>	missing [E]	2004	Czech Republic: Moravia [KUZ]	SAMD00324921
Carabini/Carabina	A06	F1	Arceifera	<i>Carabus</i>	<i>Platycarabus</i>	<i>irregularis</i>	female [R]	2015	Czech Republic: Moravia [KUZ]	SAMD00324923
Carabini/Carabina	B02	B1	Arceifera	<i>Carabus</i>	<i>Platycarabus</i>	<i>creutzeri</i>	female [E]	2000	Italy: Taipana [KUZ]	SAMD00324967
Carabini/Carabina	A30	F4	Cavazzuocarabi	<i>Carabus</i>	<i>Cavazzuocarabus</i>	<i>latreilleanus</i>	male [E]	2000	Italy: Ivrea [KUZ]	SAMD00324947
Carabini/Carabina	A16	H2	Crenolimbi	<i>Carabus</i>	<i>Hemcarabus</i>	<i>tuberculosis</i>	female [E]	2018	Japan: Chiba, Kashiwa [KUZ]	SAMD00324933
Carabini/Carabina	A17	A3	Crenolimbi	<i>Carabus</i>	<i>Homoecarabus</i>	<i>mucander</i>	missing [E]	1998	Japan: Hokkaido [KUZ]	SAMD00324934
Carabini/Carabina	A32	H4	Ctenocarabi	<i>Carabus</i>	<i>Ctenocarabus</i>	<i>melancholicus</i>	missing [E]	1996	Spain: Madrid [KUZ]	SAMD00324949
Carabini/Carabina	A12	D2	Digitulati	<i>Carabus</i>	<i>Acoptopterus</i>	<i>vigil</i>	male [E]	2012	China: Gansu, Lianhuashan (CAS-IZ) [KUZ]	SAMD00324929
Carabini/Carabina	A10	B2	Digitulati	<i>Carabus</i>	<i>Carabus</i>	<i>granulatus</i>	male [E]	2014	Japan: Hokkaido, Kushiro [KUZ]	SAMD00324927
Carabini/Carabina	B04	D1	Digitulati	<i>Carabus</i>	<i>Carabus</i>	<i>limbatus</i>	male [E]	2011	USA: Tennessee, Blount [KUZ]	SAMD00324969
Carabini/Carabina	A11	C2	Digitulati	<i>Carabus</i>	<i>Carabus</i> <Eucarabus>	<i>manifestus</i>	male [E]	2011	China: Beijing, Linshan (CAS-IZ) [KUZ]	SAMD00324928
Carabini/Carabina	A13	E2	Digitulati	<i>Carabus</i>	<i>Isocarabus</i>	<i>miaorum</i>	male [E]	2004	China: Guangxi, Maoshan (CAS-IZ) [KUZ]	SAMD00324930
Carabini/Carabina	A14	F2	Digitulati	<i>Carabus</i>	<i>Ohomopterus</i>	<i>japonicus</i>	male [E]	2017	Japan: Saga, Kabeshima [KUZ]	SAMD00324931
Carabini/Carabina	A07	G1	Lipastrimorphi	<i>Carabus</i>	<i>Lipaster</i>	<i>stjernvalli</i>	missing [E]	2017	Armenia: Ashotsk (NAS-SSZH) [KUZ]	SAMD00324924
Carabini/Carabina	A33	A5	Lipastrimorphi	<i>Carabus</i>	<i>Mimocarabus</i>	<i>pumilio</i>	missing [E]	2005	Armenia: Kotayk, Mt. Azhdahak (NAS-SSZH) [KUZ]	SAMD00324950
Carabini/Carabina	A08	H1	Lipastrimorphi	<i>Carabus</i>	<i>Morphocarabus</i>	<i>hummeli</i>	male [E]	2005	Russia: Primorsky, Lazovsky Pass (RAS-IBSS, 2005) [KUZ]	SAMD00324925
Carabini/Carabina	B03	C1	Lipastrimorphi	<i>Carabus</i>	<i>Morphocarabus</i>	<i>venustus</i>	male [E]	2013	China: Liaoning, Gannemshan [KUZ]	SAMD00324968
Carabini/Carabina	A31	G4	Multistriati	<i>Carabus</i>	<i>Aulonocarabus</i>	<i>kurilensis</i>	male [E]	1998	Japan: Hokkaido, Kamishihoro [KUZ]	SAMD00324948
Carabini/Carabina	A18	B3	Multistriati	<i>Carabus</i>	<i>Eurycarabus</i>	<i>genoi</i>	female [R]	2017	Italy: Sardinia [KUZ]	SAMD00324935
Carabini/Carabina	B10	B2	Multistriati	<i>Carabus</i>	<i>Hypocarabus</i>	<i>laotse</i>	male [E]	2012	China: Gansu, Lianhuashan (CAS-IZ) [KUZ]	SAMD00324975
Carabini/Carabina	A19	C3	Multistriati	<i>Carabus</i>	<i>Leptocarabus</i>	<i>arboreus</i>	missing [E]	1998	Japan: Hokkaido, Rusutsu [KUZ]	SAMD00324936
Carabini/Carabina	B05	E1	Multistriati	<i>Carabus</i>	<i>Leptocarabus</i>	<i>yokoei</i>	male [E]	2007	China: Sichuan, Micangshan (CAS-IZ) [KUZ]	SAMD00324970
Carabini/Carabina	A29	E4	Multistriati	<i>Carabus</i>	<i>Leptocarabus</i> <Pentacarabus>	<i>harmandi</i>	missing [E]	1998	Japan: Nagano [KUZ]	SAMD00324946
Carabini/Carabina	A20	D3	Multistriati	<i>Carabus</i>	<i>Mesocarabus</i>	<i>problematicus</i>	male [E]	2000	Italy: Piemonte [KUZ]	SAMD00324937
Carabini/Carabina	B06	F1	Multistriati	<i>Carabus</i>	<i>Mesocarabus</i>	<i>duffouri</i>	missing [E]	missing	Spain: Malaga [KUZ]	SAMD00324971
Carabini/Carabina	B07	G1	Multistriati	<i>Carabus</i>	<i>Mesocarabus</i>	<i>lusitanicus</i>	missing [E]	1996	Spain: Madrid [KUZ]	SAMD00324972
Carabini/Carabina	A21	E3	Multistriati	<i>Carabus</i>	<i>Nesaeocarabus</i>	<i>abbreviatus</i>	male [R]	2017	Spain: Tenerife, Las Lagunetas (Calildo de Tenerife, No. 2017-01144) [KUZ]	SAMD00324938
Carabini/Carabina	B08	H1	Multistriati	<i>Carabus</i>	<i>Oreocarabus</i>	<i>amplipennis</i>	missing [E]	2000	Spain: Zamora [KUZ]	SAMD00324973
Carabini/Carabina	A23	G3	Multistriati	<i>Carabus</i>	<i>Orinocarabus</i>	<i>concolor</i>	male [E]	2000	Italy: Monte Rosa [KUZ]	SAMD00324940
Carabini/Carabina	A24	H3	Multistriati	<i>Carabus</i>	<i>Pachystus</i>	<i>glabratus</i>	male [E]	2000	Italy: Ivrea [KUZ]	SAMD00324941
Carabini/Carabina	A25	A4	Multistriati	<i>Carabus</i>	<i>Pachystus</i>	<i>hortensis</i>	missing [E]	2000	Greece: Sparta [Ishikawa]	SAMD00324942
Carabini/Carabina	B09	A2	Multistriati	<i>Carabus</i>	<i>Pachystus</i>	<i>cavernosus</i>	female [E]	2000	Italy: L'Aquila [KUZ]	SAMD00324974
Carabini/Carabina	A22	F3	Multistriati	<i>Carabus</i>	<i>Pococarpus</i>	<i>titanus</i>	male [E]	2005	China: Hubei, Shennongjia (CAS-IZ) [KUZ]	SAMD00324939
Carabini/Carabina	A26	B4	Multistriati	<i>Carabus</i>	<i>Rhigocarabus</i>	<i>gigolo</i>	male [E]	2012	China: Gansu, Lianhuashan (CAS-IZ) [KUZ]	SAMD00324943
Carabini/Carabina	A28	D4	Multistriati	<i>Carabus</i>	<i>Scambocarabus</i>	<i>kruberi</i>	male [E]	2013	China: Liaoning, Benxi (CAS-IZ) [KUZ]	SAMD00324945
Carabini/Carabina	A35	C5	Multistriati	<i>Carabus</i>	<i>Tanocarabus</i>	<i>taedatus</i>	male [E]	2010	USA: WA, Hoodspoor [KUZ]	SAMD00324952
Carabini/Carabina	A27	C4	Multistriati	<i>Carabus</i>	<i>Tomocarabus</i>	<i>convexus</i>	male [E]	2000	Italy: Ivrea [KUZ]	SAMD00324944
Carabini/Carabina	A41	A6	Neocarabi/Cathopi	<i>Carabus</i>	<i>Cathophilus</i>	<i>asperatus</i>	male [E]	2012	Morocco: Oualidia [KUZ]	SAMD00324958
Carabini/Carabina	A36	D5	Neocarabi/Logima	<i>Carabus</i>	<i>Acalathicus</i>	<i>alexandrae</i>	male [E]	2007	China: Gansu (CAS-IZ) [KUZ]	SAMD00324953
Carabini/Carabina	A37	E5	Neocarabi/Logima	<i>Carabus</i>	<i>Acotolabrus</i>	<i>gehini</i>	male [E]	1999	Japan: Hokkaido, Akkeshi [KUZ]	SAMD00324954
Carabini/Carabina	B11	C2	Neocarabi/Logima	<i>Carabus</i>	<i>Acotolabrus</i>	<i>schrenkii</i>	male [E]	2012	Russia: Primorsky, Krasny Yar (RAS-IBSS) [KUZ]	SAMD00324976
Carabini/Carabina	A44	D6	Neocarabi/Logima	<i>Carabus</i>	<i>Acotolabrus</i> <Coptolabroses>	<i>haeckeli</i>	male [E]	2012	China: Shaanxi, Taibaishan (CAS-IZ) [KUZ]	SAMD00324961
Carabini/Carabina	A38	F5	Neocarabi/Logima	<i>Carabus</i>	<i>Aristocarabus</i>	<i>viridifossulatus</i>	female [E]	2013	China: Sichuan, Jiudingshan (CAS-IZ) [KUZ]	SAMD00324955
Carabini/Carabina	A39	G5	Neocarabi/Logima	<i>Carabus</i>	<i>Calocarabus</i>	<i>gratus</i>	female [E]	2013	China: Sichuan, Jiapona (CAS-IZ) [KUZ]	SAMD00324956
Carabini/Carabina	A40	H5	Neocarabi/Logima	<i>Carabus</i>	<i>Cathaicus</i>	<i>brandti</i>	male [E]	2011	Beijing, China (CAS-IZ) [KUZ]	SAMD00324957
Carabini/Carabina	A42	B6	Neocarabi/Logima	<i>Carabus</i>	<i>Cephalornis</i>	<i>potanini</i>	female [E]	2012	China: Gansu, Wenxian (CAS-IZ) [KUZ]	SAMD00324959
Carabini/Carabina	A43	C6	Neocarabi/Logima	<i>Carabus</i>	<i>Chrysocarabus</i>	<i>aurontiens</i>	female [E]	1996	France: Gard, L'Esperou [KUZ]	SAMD00324960



Carabini/Carabina	B12	D2	Neocarabi/Logima	<i>Carabus</i>	<i>Chrysocharabus</i>	<i>splendens</i>	female [E]	1997	France:Ariege [KUZ]	SAMD00324977
Carabini/Carabina	A46	F6	Neocarabi/Logima	<i>Carabus</i>	<i>Neoplesius</i>	<i>wagae pseudotanguticus</i>	male [E]	2013	China:Qinghai,Yushu-Zhiduo (CAS-IZ) [KUZ]	SAMD00324963
Carabini/Carabina	A47	G6	Neocarabi/Logima	<i>Carabus</i>	<i>Dumaster</i>	<i>blaptoides blaptoides</i>	male [E]	2014	Japan:Kyoto,Yawata [KUZ]	SAMD00324964
Carabini/Carabina	A45	E6	Neocarabi/Logima	<i>Carabus</i>	<i>Dumaster</i>	<i>formosus</i>	male [E]	2012	China:Gansu,Hendang (CAS-IZ) [KUZ]	SAMD00324962
Carabini/Carabina	B24	H3	Neocarabi/Logima	<i>Carabus</i>	<i>Dumaster</i>	<i>osawai</i>	male [E]	2007	China:Sichuan (CAS-IZ) [KUZ]	SAMD00324988
Carabini/Carabina	A48	H6	Neocarabi/Logima	<i>Carabus</i>	<i>Eccoptocarabus</i>	<i>exiguus</i>	male [E]	2012	China:Gansu,Lianhuashan (CAS-IZ) [KUZ]	SAMD00324965
Carabini/Carabina	B13	E2	Neocarabi/Logima	<i>Carabus</i>	<i>Eupachys</i>	<i>glyptopterus</i>	male [E]	2011	China:Hubei (CAS-IZ) [KUZ]	SAMD00324978
Carabini/Carabina	B14	F2	Neocarabi/Logima	<i>Carabus</i>	<i>Lamprostus</i>	<i>calleyi</i>	male [E]	2013	Armenia (NAS-SSZH) [KUZ]	SAMD00324979
Carabini/Carabina	B15	G2	Neocarabi/Logima	<i>Carabus</i>	<i>Macrothorax</i>	<i>morbillosus</i>	female [E]	2009	Italy:Sicily [KUZ]	SAMD00324980
Carabini/Carabina	B16	H2	Neocarabi/Logima	<i>Carabus</i>	<i>Megodontoides</i>	<i>erwini</i>	female [E]	2013	China:Sichuan,Maoxian (CAS-IZ) [KUZ]	SAMD00324981
Carabini/Carabina	B17	A3	Neocarabi/Logima	<i>Carabus</i>	<i>Megodontus</i>	<i>caelatus</i>	female [E]	2000	Italy:Taipana [KUZ]	SAMD00324982
Carabini/Carabina	B18	B3	Neocarabi/Logima	<i>Carabus</i>	<i>Neoplesius</i>	<i>wagae alboequus</i>	male [E]	2004	China:Yunnan (CAS-IZ) [KUZ]	SAMD00324983
Carabini/Carabina	B19	C3	Neocarabi/Logima	<i>Carabus</i>	<i>Pugocarabus</i>	<i>crassesculptus</i>	male [E]	2012	China:Shanxi,Luliang (CAS-IZ) [KUZ]	SAMD00324984
Carabini/Carabina	B20	D3	Neocarabi/Logima	<i>Carabus</i>	<i>Procerus</i>	<i>scabrosus</i>	female [E]	2013	Armenia:Khndzoresk (NAS-SSZH) [KUZ]	SAMD00324985
Carabini/Carabina	B21	E3	Neocarabi/Logima	<i>Carabus</i>	<i>Procrustes</i>	<i>coriaceus</i>	male [E]	2000	Italy:Taipana [KUZ]	SAMD00324986
Carabini/Carabina	B80	H10	Neocarabi/Logima	<i>Carabus</i>	<i>Pseudocoptolabus</i>	<i>italiensis</i>	male [E]	2004	China:Yunnan (CAS-IZ) [KUZ]	SAMD00325038
Carabini/Carabina	B23	G3	Neocarabi/Logima	<i>Carabus</i>	<i>Pseudocarabion</i>	<i>gansuensis</i>	male [E]	2012	China:Gansu,Lianhuashan (CAS-IZ) [KUZ]	SAMD00324987
Carabini/Carabina	B25	A4	Neocarabi/Logima	<i>Carabus</i>	<i>Shunichiocarabus</i>	<i>uenoianus</i>	female [E]	2013	China:Hubei,Shennongjia (CAS-IZ) [KUZ]	SAMD00324989
Carabini/Carabina	A34	B5	Neocarabi/Logima	<i>Carabus</i>	<i>Sphodristocarabus</i>	<i>adamsi armeniacus</i>	female [E]	2005	Armenia:Gegharkunik (NAS-SSZH) [KUZ]	SAMD00324951
Carabini/Carabina	B26	B4	Neocarabi/Logima	<i>Carabus</i>	<i>Tribax</i>	<i>pushkini</i>	female [E]	missing	Armenia (NAS-SSZH) [KUZ]	SAMD00324990
Carabini/Carabina	B01	A1	Spinulati	<i>Carabus</i>	<i>Apotomopterus</i>	<i>musuzoi</i>	male [E]	2012	Taiwan:Anmashan [KUZ]	SAMD00324966
Carabini/Carabina	A01	A1	Spinulati	<i>Carabus</i>	<i>Apotomopterus</i>	<i>davidis</i>	male [E]	2006	China:Jiangxi,Jinggangshan (CAS-IZ) [KUZ]	SAMD00324918
Carabini/Carabina	A03	C1	Spinulati	<i>Carabus</i>	<i>Euleptocarabus</i>	<i>porrecticollis</i>	male [E]	1998	Japan:Niigata,Tsunan [KUZ]	SAMD00324920
Carabini/Carabina	A02	B1	Spinulati	<i>Carabus</i>	<i>Limnocarabus</i>	<i>maacki</i>	male [E]	1999	Japan:Aomori,Nakadomari [KUZ]	SAMD00324919
Carabini/Carabina	A15	G2	Tachypa	<i>Carabus</i>	<i>Tachypus</i>	<i>cancellatus</i>	female [E]	2000	Italy:Trino,Samone [KUZ]	SAMD00324932
Ceroglossini	B37	E5		<i>Ceroglossus</i>		<i>darwini</i>	female [R]	2015	Chile:Puyehue (CONAF, No. 022/2015) [KYZ]	SAMD00324997
Ceroglossini	B38	F5		<i>Ceroglossus</i>		<i>darwini</i>	male [R]	2015	Chile:Puyehue (CONAF, No. 022/2015) [KYZ]	SAMD00324998
Ceroglossini	B39	G5		<i>Ceroglossus</i>		<i>buqueti</i>	male [R]	2015	Chile:Puyehue (CONAF, No. 022/2015) [KYZ]	SAMD00324999
Ceroglossini	B40	H5		<i>Ceroglossus</i>		<i>suturalis</i>	female [R]	2015	Chile:Mallagenes (CONAF, No. 022/2015) [KYZ]	SAMD00325000
Cychrini	B31	G4		<i>Cychrus</i>		<i>caraboides</i>	missing [E]	2000	Italy:Val Sessera [KUZ]	SAMD00324991
Cychrini	B32	H4		<i>Cychrus</i>		<i>attenuatus</i>	missing [E]	2000	Italy:Taipana [KUZ]	SAMD00324992
Cychrini	B33	A5		<i>Cychrus</i>		<i>tuberculatus</i>	male [R]	2016	USA:Washington,Olympia [KUZ]	SAMD00324993
Cychrini	B34	B5		<i>Scaphinotus</i>		<i>angusticollis</i>	male [R]	2016	USA:Washington [KUZ]	SAMD00324994
Cychrini	B35	C5		<i>Scaphinotus</i>		<i>petersi</i>	male [R]	2016	USA:Arizona,Pinal Mts. [KUZ]	SAMD00324995
Cychrini	B36	D5		<i>Sphaeroderus</i>		<i>canadensis</i>	missing [R]	2016	USA:Virginia,Bath Co. [KUZ]	SAMD00324996
Pamborini	B73	A10		<i>Maoripamborus</i>		<i>fairburni</i>	female [E]	2002	New Zealand:Waipoua (Department of Conservation, New Zealand Govt., No. CWL008) [KUZ]	SAMD00325033
Pamborini	B57	A8		<i>Pamborus</i>		<i>alternans</i>	male [E]	2001	Barrington House, NSW, Australia (NSW-NPWS, No. A3070) [KUZ]	SAMD00325017
Pamborini	B58	B8		<i>Pamborus</i>		<i>alternans</i>	missing [E]	2001	Australia:Queensland,Binna Burra (QLD-PWS, No. F1/000456/01/SA) [KUZ]	SAMD00325018
Pamborini	B74	B10		<i>Pamborus</i>		<i>alternans</i>	male [E]	2010	Australia:Queensland,BunyaMts. (QLD-PWS, No. WITK08220710) [KUZ]	SAMD00325034
Pamborini	B59	C8		<i>Pamborus</i>		<i>brisbanensis</i>	male [E]	2002	Australia:Queensland,Kroombit (QLD-PWS, No. WITK00622802) [KUZ]	SAMD00325019
Pamborini	B60	D8		<i>Pamborus</i>		<i>cooloolensis</i>	male [E]	2002	Australia:Queensland,Cooloola (QLD-PWS, No. WITK00622802) [KUZ]	SAMD00325020
Pamborini	B61	E8		<i>Pamborus</i>		<i>elegans</i>	male [E]	2001	Australia:Queensland,Windsor Tableland (QLD-PWS, No. 1684) [KUZ]	SAMD00325021
Pamborini	B62	F8		<i>Pamborus</i>		<i>euopacus</i>	missing [E]	2001	Australia:Queensland,Windsor Tableland (QLD-PWS, No. 1684) [KUZ]	SAMD00325022
Pamborini	B71	G9		<i>Pamborus</i>		<i>guerinii</i>	female [E]	2001	Australia:Queensland,Binna Burra (QLD-PWS, No. F1/000456/01/SA) [KUZ]	SAMD00325031
Pamborini	B75	C10		<i>Pamborus</i>		<i>guerinii</i>	male [E]	2010	Australia:Queensland,Bribie I. (QLD-PWS, No. WITK08220710) [KUZ]	SAMD00325035
Pamborini	B63	G8		<i>Pamborus</i>		<i>macleayi</i>	male [E]	2001	Australia:Queensland,Binna Burra (QLD-PWS, No. F1/000456/01/SA) [KUZ]	SAMD00325023
Pamborini	B64	H8		<i>Pamborus</i>		<i>montethi</i>	male [E]	2002	Australia:Queensland,Kroombit (QLD-PWS, No. WITK00622802) [KUZ]	SAMD00325024
Pamborini	B65	A9		<i>Pamborus</i>		<i>moorei</i>	female [E]	2001	Australia:New South Wales,Woolloombi (NSW-NPWS, No. A3070) [KUZ]	SAMD00325025
Pamborini	B66	B9		<i>Pamborus</i>		<i>pradieri</i>	female [E]	2001	Australia:New South Wales,Barrington House (NSW-NPWS, No. A3070) [KUZ]	SAMD00325026
Pamborini	B72	H9		<i>Pamborus</i>		<i>pradieri</i>	male [E]	2001	Australia:New South Wales,New England N.P. (NSW-NPWS, No. A3070) [KUZ]	SAMD00325032
Pamborini	B67	C9		<i>Pamborus</i>		<i>punctatus</i>	female [E]	2001	Australia:Queensland,Mt Hyppamee (QLD-PWS, No. F1/000456/01/SA) [KUZ]	SAMD00325027
Pamborini	B68	D9		<i>Pamborus</i>		<i>subtropicus</i>	female [E]	2002	Australia:Queensland,Kroombit (QLD-PWS, No. WITK00622802) [KUZ]	SAMD00325028
Pamborini	B77	E10		<i>Pamborus</i>		<i>subtropicus</i>	male [E]	2010	Australia:Queensland,BunyaMts. (QLD-PWS, No. WITK08220710) [KUZ]	SAMD00325037
Pamborini	B69	E9		<i>Pamborus</i>		<i>transitus</i>	male [E]	2001	Australia:Queensland,Eungella (QLD-PWS, No. F1/000456/01/SA) [KUZ]	SAMD00325029
Pamborini	B70	F9		<i>Pamborus</i>		<i>tropicus</i>	male [E]	2001	Australia:Queensland,Mt Baldy (QLD-PWS, No. 1684) [KUZ]	SAMD00325030
Pamborini	B76	D10		<i>Pamborus</i>		<i>viridis</i>	male [E]	2010	Australia:Queensland,Bunya Mts. (QLD-PWS, No. WITK08220710) [KUZ]	SAMD00325036
Trachypachidae	B56	H7		<i>Trachypachus</i>		<i>slevini</i>	female [R]	2018	USA:Oregon [KUZ]	SAMD00325016

Subgenus: Classification of subgenera followed Deuve (2019); alternative subgeneric names that may be appropriate based on the present molecular phylogenies are given in angle brackets.

Specimen type: E, ethanol-fixed; R, RNAlater-fixed; D, pinned dry specimen.

Permit: Research/collection permits were obtained from or cared by the organizations indicated in the parentheses when necessary. Abbreviations are as follows. CAS-IZ, Institute of Zoology, Chinese Academy of Science; NSW-NPWS, National Parks and Wildlife Service, New South Wales Government; QLD-PWS, Parks and Wildlife Service, Queensland Government; CONAF, Corporacion Nacional Forestal, Chile; NAS-SSZH, Scientific Center of Zoology and Hydroecology, National Academy of Science, Republic of Armenia; RAS-IBSS, Institute of Biology and Soil Science, Far Eastern Branch, Russian Academy of Science.

Specimen depository: [KUZ] Department of Zoology, Graduate School of Science, Kyoto University; [Ishikawa]: Collection (pinned specimens) of Professor Emeritus R. Ishikawa at Tokyo Metropolitan University. The specimens are due to be deposited at the University Museum of the University of Tokyo.

**Table S2.** Taxonomic composition and the number of brachypterous/micropterous species in the subtribe Calosomina (genus *Calosoma*). The taxonomy is based on Bruschi (2013) with an addition of *Calosoma (Aplothorax) burchelli*.

Group	Subgenus	Geographic region	No. of species	No. of brachypterous/ micropterous (apterous) species	UCE data sample ID
Calosomes lobes					
	<i>Australodrepa</i>	Australia, Indonesia (Australian, Oceanian, Oriental)	2	0	B41
	<i>Calodrepa</i>	N, C America (Nearctic, Panamanian)	4	0	B42
	<i>Calosoma</i>	Holarctic (Palearctic, Sino-Japanese, Saharo-Arabian)	6	0	B43
Calosomes ongules					
	<i>Campalita</i>	Africa, Madagascar, Palearctic	4	0	B44,B96
	<i>Caminara</i>	Africa, Asia, Mediterranean	5	0	B45,B46
	<i>Charmosta</i>	Europe, Asia	2	0	non
	<i>Carabops</i>	Ethiopia,Tanzania,Angola,Malawi	7	7	non
	<i>Carabophanus</i>	Ethiopia	4	4	B47
	<i>Orinodromus</i>	Kenya (Mt. Elgon, Mt. Kenya), Mt. Kilimanjaro; high altitudes	7	7	B91
	<i>Carabomorphus</i>	Mt. Kenya, Mt. Kilimanjaro	3	3	B48
	<i>Ctenosta</i>	Africa, Madagascar, India	8	0	B49,B50
	<i>Aplothorax</i>	St Helena	1	1	non
	<i>Castrida</i>	S, C, N America	15	4	B51,B94
	<i>Camedula</i>	C America to S USA	7	0	B52
	<i>Callitropa</i>	USA, Mexico	10	7	B53
	<i>Carabomimus</i>	Mexico	10	10	non
	<i>Calopachys</i>	Mexico	4	4	non
	<i>Chrysostigma</i>	North America, Mexico	8	1	B92
	<i>Callistenia</i>	North America	6	6	B54
	<i>Callisthenes</i>	Central Asia and Europe	15	14	B55,B93
Total no. species			128	68	

**Table S3.** Taxonomic composition of the subtribe Carabina according to Deuve (2019) and the number of species sampled in this study.

Group A/B	B 1-3	B 3.1-5	B 3.5.1-2	B 3.5.1-2.x	B 3.5.1-2.x.x	B 3.5.1-2.x.x.x	No.. subgenera	No. species	No. species sampled
Archifera							4	9	4
Eucarabi	Spinulati						3	142	4
	Crenolimbi						2	5	2
	Heterocarabi	Tachypi					1	2	1
		Timesicarabi					1	1	0
		Cavazzutiocarabi					1	1	1
		Ctenocarabi					1	2	1
		Orthocarabi	Multistriati	Mesocaraboides			3	16	5
				Metacaraboides	Plesiopalpi	Pachystoides	2	16	3
						Leptocaraboides	5	80	7
					Latipalpi	Tomocaraboides	8	67	3
						Eurycaraboides	2	6	2
			Apocarabi	Carabogenici	Digitulati		5	100	6
					Lipastrimorphi		6	80	4
					Archicarabomorphi		3	13	1
				Neocarabi	Cathoplii		1	3	1
					Longimandibulares	Chrysocaraboides	3	14	3
						Procrustoides	7	81	4
						Tribacoides	4	70	2
						Deroplectoides	4	22	0
						Tianshanocarabi	8	55	0
						Damasteroides	93	160	19
						Total	167	945	73

**Table S4.** Species number data used in medusa and diversitree analyses.

## (a) Species number data used in the Medusa analysis

Tribe/subtribe	Genus/subgenus/division	No. species
Cydrini	<i>Cydrus</i>	184
Cydrini	<i>Sphaeroderus</i>	55
Cydrini	<i>Scaphinotus</i>	5
Ceroglossini	<i>Ceroglossus</i>	8
Pamborini	<i>Pamborus</i>	16
Pamborini	<i>Maoripamborus</i>	1
Carabina	Arcifera	9
Carabina	Spinulati	142
Carabina	Crenolimbi	5
Carabina	Tachypi	2
Carabina	Cavazzutocarabi	1
Carabina	Ctenocarabi	2
Carabina	Mesocaraboides	16
Carabina	Plesiopalpi	96
Carabina	Latipalpi	73
Carabina	Digitulati	100
Carabina	Lipastrimorphi	80
Carabina	Archicarabomorphi	13
Carabina	Cathoplii	3
Carabina	Chrysocaraboides	14
Carabina	TribacoidesProcrustoides	228
Carabina	Damasteroides	160
Calosomina	<i>Australodrepa</i> , <i>Calodrepa</i> , <i>Calosoma</i>	12
Calosomina	<i>Campalita</i> , <i>Carabops</i> , <i>Carabophanus</i> , <i>Orinodromus</i> , <i>Carabomorphus</i>	25
Calosomina	<i>Caminara</i> , <i>Charmosa</i>	7
Calosomina	<i>Ctenosta</i> , <i>Aplothorax</i>	9
Calosomina	<i>Castrida</i> , <i>Camedula</i>	22
Calosomina	<i>Callitropa</i> , <i>Carabomimus</i> , <i>Calopachys</i>	24
Calosomina	<i>Chrysostigma</i> , <i>Callistenia</i> , <i>Callisthenes</i>	29

## (b) Species number and character state data used in the diversitree analysis

Subtribe	Subtribe	No. species	n1 (macropterous)	n0 (degenerated)
Carabina	<i>Archicarabus</i>	10	0	10
Carabina	<i>Chaetocarabus</i>	2	0	2
Carabina	<i>Hygrocarabus</i>	2	0	2
Carabina	<i>Platycarabus</i>	5	0	5
Carabina	<i>Cavazzutocarabus</i>	1	0	1
Carabina	<i>Hemicarabus</i>	4	0	4
Carabina	<i>Homoeocarabus</i>	1	0	1
Carabina	<i>Ctenocarabus</i>	2	0	2
Carabina	<i>Acoptopterus</i>	45	0	45
Carabina	<i>Carabus</i>	21	0	21
Carabina	<i>Eucarabus</i>	8	0	8
Carabina	<i>Isticarabus</i>	12	0	12
Carabina	<i>Ohomopterus</i>	12	0	12
Carabina	<i>Lipaster</i>	2	0	2
Carabina	<i>Mimocarabus</i>	5	0	5
Carabina	<i>Morphocarabus</i>	35	0	35
Carabina	<i>Eurycarabus</i>	2	0	2
Carabina	<i>Pentacarabus</i>	1	0	1
Carabina	<i>Nesaeocarabus</i>	4	0	4

Carabina	<i>Scambocarabus</i>	5	0	5
Carabina	<i>Tanaocarabus</i>	5	0	5
Carabina	<i>Tomocarabus</i>	20	0	20
Carabina	<i>Aulonocarabus</i>	14	0	14
Carabina	<i>Hypsocarabus</i>	8	0	8
Carabina	<i>Leptocarabus</i>	10	0	10
Carabina	<i>Piocarabus</i>	9	0	9
Carabina	<i>Rhigocarabus</i>	35	0	35
Carabina	<i>Mesocarabus</i>	4	0	4
Carabina	<i>Oreocarabus</i>	3	0	3
Carabina	<i>Orinocarabus</i>	9	0	9
Carabina	<i>Pachystus</i>	11	0	11
Carabina	<i>Cathoplius</i>	3	0	3
Carabina	<i>Chrysocarabus</i>	7	0	7
Carabina	<i>Macrothorax</i>	5	0	5
Carabina	<i>Acoptolabrus</i>	7	0	7
Carabina	<i>Coptolabrodes</i>	1	0	1
Carabina	<i>Aristocarabus</i>	2	0	2
Carabina	<i>Calocarabus</i>	26	0	26
Carabina	<i>Cathaicus</i>	1	0	1
Carabina	<i>Cephalornis</i>	1	0	1
Carabina	<i>Damaster</i>	1	0	1
Carabina	<i>Coptolabrus</i>	18	0	18
Carabina	<i>Shenocoptolabrus</i>	1	0	1
Carabina	<i>Eccoptocarabus</i>	2	0	2
Carabina	<i>Eupachys</i>	2	0	2
Carabina	<i>Megodontooides</i>	4	0	4
Carabina	<i>Neoplesius</i>	23	0	23
Carabina	<i>Pagocarabus</i>	7	0	7
Carabina	<i>Pseudocoptolabrus</i>	11	0	11
Carabina	<i>Pseudocranion</i>	20	0	20
Carabina	<i>Shunichiocarabus</i>	1	0	1
Carabina	<i>Lamprostus</i>	19	0	19
Carabina	<i>Megodontus</i>	22	0	22
Carabina	<i>Procerus</i>	4	0	4
Carabina	<i>Procrustes</i>	8	0	8
Carabina	<i>Sphodristocarabus</i>	15	0	15
Carabina	<i>Tribax</i>	49	0	49
Carabina	<i>Cupreocarabus</i>	27	0	27
Carabina	<i>Apotomopterus</i>	139	0	139
Carabina	<i>Euleptocarabus</i>	1	0	1
Carabina	<i>Limnocarabus</i>	2	0	2
Carabina	<i>Tachypus</i>	2	0	2
Calosomina	<i>Australodrepa</i>	2	2	0
Calosomina	<i>Calodrepa</i>	4	4	0
Calosomina	<i>Calosoma</i>	6	6	0
Calosomina	<i>Campalita</i>	4	4	0
Calosomina	<i>Camina</i>	5	5	0
Calosomina	<i>Carabophanus</i>	4	0	4
Calosomina	<i>Orinodromus</i>	7	0	7
Calosomina	<i>Carabomorphus</i>	3	0	3
Calosomina	<i>Ctenosta</i>	8	8	0
Calosomina	<i>Castrida</i>	15	11	4
Calosomina	<i>Camedula</i>	7	7	0
Calosomina	<i>Callitropa</i>	10	3	7
Calosomina	<i>Chrysostigma</i>	8	7	1
Calosomina	<i>Callistenia</i>	6	0	6
Calosomina	<i>Callisthenes</i>	15	1	14

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**Table S5.** Results of BioGeoBEARS analysis.

Results of model test

	LnL	No. parameters	d	e	j	AICc	AICc_wt	
DEC	-101	2		0.44	0.023	0	206.4	0.0003
DEC+J	-93.26	3		0.65	1.00E-12	0.026	193.2	0.25
DIVALIKE	-94.29	2		0.8	2.00E-08	0	192.9	0.29
DIVALIKE+J	-92.66	3		0.71	1.00E-12	0.016	192	0.46
BAYAREALIKE	-110.6	2		0.68	2.12	0	225.6	2.30E-08
BAYAREALIKE+J	-101.7	3		0.38	1.31	0.033	210.2	5.30E-05

Ancestral areas estimated by top 3 models (DIVALIKE+J, DIVALIKE, DEC+J). Estimated ancestral areas with top five probabilities are shown.

Node numbers are those indicated in Fig. 3.

DIVALIKE+j [best mo]	Top 1	% Prob.	Top 2	% Prob.	Top 3	% Prob.	Top 4	% Prob.	Top 5	% Prob.
node 38	A	73.37608	AB	17.65156	B	8.972354	D	0	F	0
node 39	B	97.08385	A	1.882828	AB	1.033319	D	0	F	0
node 40	B	60.29888	A	14.97327	E	13.72316	BE	5.733237	AB	3.179122
node 41	B	99.78076	E	0.093778	A	0.066217	BE	0.028081	AB	0.027817
node 42	B	97.39955	A	1.945051	AB	0.651901	E	0.00245	BE	0.000547
node 43	B	54.96239	A	15.51818	E	14.46257	BE	7.857586	AB	4.442003
node 44	B	97.15082	A	1.863543	AB	0.985645	D	0	F	0
node 45	B	43.59133	A	15.06677	E	14.06629	BE	13.24369	AB	7.34991
node 46	B	83.04075	A	7.974242	E	6.924025	BE	0.928954	AB	0.90392
node 47	B	99.90859	A	0.044638	E	0.034843	AB	0.006622	BE	0.004929
node 48	B	100	D	0	F	0	E	0	BD	0
node 49	B	99.99963	AB	0.000108	A	0.000104	E	0.000086	BE	0.000077
node 50	B	92.9063	E	3.580938	A	1.654668	BE	1.075127	AB	0.633082
node 51	B	68.68077	A	26.40233	AB	4.162357	E	0.366163	AE	0.242748
node 52	B	99.56731	AB	0.413344	A	0.010294	ABE	0.004435	BE	0.004338
node 53	D	70.22689	B	10.61052	A	8.122813	BD	4.551332	AD	3.656755
node 54	D	100	DF	0	DE	0	BD	0	F	0
node 55	D	99.76421	BD	0.073603	AD	0.062237	B	0.044286	A	0.032561
node 56	D	91.94162	B	2.420207	BD	2.157512	AD	1.514905	A	1.32199
node 57	D	97.3625	A	1.401053	AD	1.11144	BD	0.045711	B	0.04311
node 58	E	94.58746	EF	2.82019	F	2.592351	B	0	BE	0
node 59	D	45.8424	DE	42.617	E	4.582011	DF	1.981147	F	1.031572
node 60	E	100	EF	0	DE	0	F	0	BE	0
node 61	BE	26.08761	ABE	23.67859	AE	20.45702	B	11.63506	A	8.453375
node 62	E	95.39214	BE	1.404918	AE	1.169305	B	1.021695	A	0.760459
node 63	E	91.99348	DE	5.169175	D	2.216118	EF	0.144147	DEF	0.064543
node 64	A	52.76065	AE	36.96427	AB	5.313135	ABE	4.961949	E	0
node 65	AC	52.76619	A	34.66878	AE	8.413379	AB	3.245241	ABE	0.906412
node 66	AE	78.26866	E	9.300263	ADE	4.867007	AD	2.262849	A	2.210239
node 67	ABE	81.04996	BE	6.810731	ABD	4.281267	AB	3.062033	BDE	2.462045
node 68	C	100	A	0	AD	0	AB	0	AE	0
node 69	CF	86.1513	F	13.83776	C	0.01095	DF	0	AF	0
node 70	BF	19.67854	ABF	18.38507	AF	16.20826	BEF	11.39552	AEF	10.42961
node 71	ABE	70.04475	BE	8.068064	AE	7.946573	AB	6.666318	E	3.763908
node 72	E	70.0668	ABE	23.12818	BE	3.206625	AE	3.202678	AB	0.134985
node 73	EF	17.82498	E	15.75034	BEF	13.98909	AEF	12.70223	BE	9.339776

DIVALIKE	Top 1	% Prob.	Top 2	% Prob.	Top 3	% Prob.	Top 4	% Prob.	Top 5	% Prob.
node 38	AB	99.99999	A	0.000004	B	0	AD	0	AF	0
node 39	B	98.84928	AB	1.150713	A	0	BD	0	BF	0
node 40	B	82.78183	BE	8.541599	AB	4.615976	A	2.961181	ABE	1.03861
node 41	B	99.98214	BE	0.00903	AB	0.008493	ABE	0.000334	BD	0
node 42	B	99.2817	AB	0.713122	A	0.005109	AE	0.000025	BE	0.000024
node 43	B	66.15876	BE	18.44432	AB	9.750601	A	3.003175	ABE	2.56174
node 44	B	98.91507	AB	1.084931	A	0	BD	0	BF	0
node 45	B	40.36753	BE	30.94337	AB	16.03595	ABE	8.407662	A	4.05291
node 46	B	97.61127	E	0.736543	A	0.680509	BE	0.522627	AB	0.4066
node 47	B	99.99857	AB	0.00072	BE	0.000696	ABE	0.000009	BD	0

node 48	B	100	BD	0	BF	0	BE	0	AB	0
node 49	B	100	AB	0.000001	BE	0.000001	ABE	0	BD	0
node 50	B	97.86604	BE	1.370835	AB	0.716096	ABE	0.047033	E	0.000002
node 51	B	93.62236	AB	3.981543	A	2.301815	ABE	0.041098	AE	0.037353
node 52	B	99.96868	AB	0.030569	ABE	0.000545	BE	0.000209	BD	0
node 53	D	87.54766	BD	6.155645	AD	4.965321	ABD	1.331372	B	0
node 54	D	100	DF	0	DE	0	BD	0	AD	0
node 55	D	99.95094	BD	0.023319	AD	0.020301	ABD	0.005437	DF	0
node 56	D	95.49685	BD	2.416406	AD	1.693997	ABD	0.363114	B	0.018921
node 57	D	98.45966	AD	1.169819	A	0.334937	BD	0.014512	ABD	0.013188
node 58	E	96.94343	EF	3.056576	F	0	BE	0	AE	0
node 59	DE	94.3159	DF	1.834896	DEF	1.794231	ADE	1.265701	AE	0.677192
node 60	E	100	EF	0	DE	0	BE	0	AE	0
node 61	BE	37.84319	ABE	33.01298	AE	29.14382	E	0	BEF	0
node 62	E	97.16216	BE	1.465018	AE	1.210602	ABE	0.162219	B	0
node 63	E	93.74395	DE	5.907924	EF	0.096523	DEF	0.08963	BDE	0.048004
node 64	AE	88.43238	ABE	11.56761	E	0.000002	A	0.000002	BE	0
node 65	AC	99.99999	AE	0.000002	A	0.000001	ABE	0	AB	0
node 66	AE	93.34212	ADE	5.57846	AD	0.813251	AEF	0.115528	A	0.051775
node 67	ABE	92.3392	ABD	2.961777	BDE	1.735248	AB	1.611355	BE	1.206249
node 68	C	100	A	0	AD	0	AB	0	AE	0
node 69	CF	100	F	0	C	0	AF	0	DF	0
node 70	ABF	22.7711	BF	19.11803	AF	18.23682	BEF	13.84165	AEF	13.45832
node 71	ABE	81.35675	BE	7.775029	AE	7.533698	E	3.334517	BDE	0
node 72	E	69.34039	ABE	25.16959	BE	2.766959	AE	2.723048	BDE	0
node 73	EF	17.07378	E	16.56404	BEF	14.25841	AEF	13.87505	BE	9.483823

DEC+j	Top 1	% Prob.	Top 2	% Prob.	Top 3	% Prob.	Top 4	% Prob.	Top 5	% Prob.
node 38	A	82.79962	B	11.08952	AB	6.110851	F	0	D	0
node 39	B	93.98258	AB	3.424172	A	2.593246	BF	0	BD	0
node 40	B	39.3784	A	15.86326	BE	15.33377	E	13.16455	AB	11.00672
node 41	B	97.20398	BE	1.40609	AB	0.814085	E	0.275214	A	0.205692
node 42	B	93.83658	AB	3.041533	A	2.864697	BE	0.198259	ABE	0.025028
node 43	B	49.9725	BE	12.50501	A	11.58646	AB	10.40542	E	9.617641
node 44	B	93.38688	AB	4.274441	A	2.338675	BF	0	BD	0
node 45	B	35.23293	BE	19.13902	AB	15.43329	A	10.10734	ABE	9.072533
node 46	B	42.47155	A	17.03936	E	13.00255	BE	12.61859	AB	11.4166
node 47	B	96.74818	BE	1.245143	AB	1.223876	A	0.38443	E	0.303006
node 48	B	100	BF	0	BD	0	BE	0	F	0
node 49	B	99.72478	AB	0.133059	BE	0.130848	ABE	0.00514	A	0.003158
node 50	B	81.8768	E	5.824687	BE	5.279491	AB	2.342518	A	2.288822
node 51	B	52.33554	A	22.72676	AB	16.56947	ABE	5.037273	BE	2.248751
node 52	B	95.79388	AB	3.142958	ABE	0.627505	BE	0.373802	A	0.058371
node 53	D	36.5555	BD	20.69307	AD	15.61419	ABD	11.96225	B	7.872931
node 54	D	100	DF	0	DE	0	BD	0	AD	0
node 55	D	90.79653	BD	4.481128	AD	3.261279	ABD	1.172943	B	0.152836
node 56	D	60.19375	BD	17.41855	ABD	7.630295	AD	7.181558	B	4.794544
node 57	D	74.66994	AD	15.11955	ABD	3.869775	BD	3.427392	A	2.544117
node 58	E	77.887	EF	18.46609	F	3.646913	DEF	0	BEF	0
node 59	D	30.03519	DEF	30.00076	DE	14.46561	ADE	8.006809	DF	3.803776
node 60	E	100	EF	0	DE	0	BE	0	AE	0
node 61	B	26.5507	ABE	22.57093	A	17.46287	BE	13.14505	AE	9.443536
node 62	E	81.03805	BE	6.265755	AE	5.027547	B	3.110324	ABE	2.238723
node 63	E	28.84572	DEF	28.54273	DE	23.1855	ADE	9.072112	BDE	2.536425
node 64	ABE	50.13136	AE	40.42834	A	8.102002	AB	1.338292	E	0
node 65	A	57.4179	AC	18.0121	AE	13.74071	ABE	7.846251	AB	2.983029
node 66	ADE	41.58465	AE	29.3702	ABE	12.78267	E	6.351671	AEF	3.716078
node 67	ABE	83.25192	BE	3.894989	BDE	3.741519	ABD	2.670607	AB	2.28655
node 68	C	100	A	0	AD	0	AB	0	AE	0
node 69	CF	65.5631	F	34.34386	C	0.093043	DF	0	AF	0
node 70	ABF	18.13994	BEF	17.52498	AEF	16.06041	BF	9.582355	AF	8.050235
node 71	ABE	87.1659	AE	4.711823	BE	4.704541	E	1.751738	AB	0.566668
node 72	ABE	60.2485	E	28.08927	AE	5.665136	BE	5.64123	A	0.146569
node 73	BEF	12.10326	AEF	11.25908	ABE	10.48283	EF	10.40452	E	10.22217



**Table S6.** Results of diversitree analyses for the effect of hind wing degeneration on speciation rates.

Analysis for Carabini (Calosomina and Carabina)

constraint for speciation rates	df	speciation rate		extinction rate	log-likelihood	AICc	ChiSq	Pr(> Chi )
		winged	degenerated					
equal speciation rates <sup>1</sup>	4	68.37451	68.37451	56.51252	-142.82	293.65		
different speciation rates <sup>2</sup>	5	51.85789	61.64965	46.7019	-139.44	288.88	6.7649	0.0093

<sup>1</sup>the constraint of equal speciation rates between winged and degenerated states.

<sup>2</sup>no constraint on speciation rates between winged and degenerated states.