Electronic supplementary material for:

Postnatal ontogeny and the evolution of macrostomy in snakes

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A. Specimens examined

Institutional Abbreviations

AMNH, American Museum of Natural History, New York; NHMUK, British Museum of Natural History, London; CAS, California Academy of Science, San Francisco; CENAI, Centro Nacional de Investigaciones Biológicas (currently housed in MACN), Buenos Aires; CM, Carnegie Museum of Natural History, Pittsburgh; FML, Fundación Miguel Lillo, Tucumán; FMNH, Field Museum of Natural History, Chicago; IB, Instituto Butantan, Sao Paulo; LSUMZ, Louisiana State University Museum of Zoology, Baton Rouge; MACN, Museo Argentino de Ciencias Naturales "Bernardino Rivadavia", Buenos Aires; MCN, Museo de Ciencias Naturales de Salta, Salta; MECN, Museo Ecuatoriano de Ciencias Naturales, Quito; MLP, Museo de La Plata, La Plata; MNHN, Museum National d´Histoire Naturelle, Paris; MPEG, Museu Paraense "Emílio Goeldi", Belém; MUCPv, Museo Universidad Nacional del Comahue, Neuquén; MZUSP, Museu de Zoologia, Universidade de Sao Paulo, Sao Paulo.

Fossil species

Postnatal ontogenetic sequences

Dinilysia patagonica (MACN-N 106, MACN-RN 976, MACN-RN 1013, MACN-RN 1014, MLP 26-410, MLP 71-VII-29-1, MPCA 527, MUCPv 38)

Adult specimens

Messelophis ermannorum (HLMD Me 7915 (Paratype), SMF ME 71, SMF ME 759, SMF ME 760, SMF ME 1370, SMF ME 1565 a+b, SMF ME 1576, SMF ME 1677, SMF ME 1805, SMF ME 1810, SMF ME 1812 a+b+c+d+e (Holotype), SMF ME

1816 a+b, SMF ME 1820, SMF ME 2608, SMF ME 11426. *Messelophis variatus* (AMNH FARB 30650, SMF ME 756, SMF ME 904, SMF ME 958 b, SMF ME 1541 a+b, SMF ME 1780 a+b, SMF ME 1805, SMF ME 1815, SMF ME 1823 (Paratype), SMF ME 1828 a+b (Holotype), SMF ME 2379 (Paratype); *Najash rionegrina* (MPCA 390-398, MPCA 385).

Extant lizard species

Postnatal ontogenetic sequences

Bachia bicolor (Tarazona et al., 2008); *Mabuya mabouya* (Jerez, 2007); *Neusticurus ecpleopus* (Bell et al., 2003); *Ophiodes intermedius* (MCN 4443, MCN 4444, FML 2304, FML 3484); *Varanus exanthematicus* (Bhullar, 2012).

Adult specimens

Feylinia currori (FML 1010, FML 1013-8); *Heloderma suspectum* (MACN 39064); *Homonota fasciata* (FML 2422); *Iguana iguana* (AMNH 1269); *Lacerta agilis* (Rieppel, 1993, 1994); *Liolaemus albiceps* (MCN 2586, MCN 2585); *Mabuya dorsivittata* (FML 896);; *Ophiodes* sp. (); *Ophisaurus apodus* (MACN 36529); *Ophisaurus* sp. (AMNH 41); *Varanus bengalensis* (AMNH 1041); *Varanus niloticus* (MLP.R 5209); *Varanus* sp. (FML 14813, FML 14814).

Extant snake species

Postnatal ontogenetic sequences

Amerotyphlops brongersmianus (MCN 4427, MCN 4428, MCN S/N); *Anilius scytale* (CENAI 3883, MACN 8817a, MACN 8817b, IB 46686, MZ 14572, MZUSP 14574); *Atractus reticulatus* (MCN 4459, MCN 4460); *Boa constrictor* (MACN 39025,

MZUSP 2553, MZUSP 13843, MCN 4432); *Bothrops diporus* (MCN 4436, MCN 4437, MCN 4438); *Epictia albipunctus* (MCN 4461, MCN 4462, MCN 4463, MCN 4464); *Hydrodynastes gigas* (MLP JW-128, MLP JW-955, MLP R-5143); *Micrurus pyrrhocryptus* (MCN 88, MCN 2189, MCN 4454, MCN 4455); *Python molurus* (AMNH 57819, AMNH 57783, AMNH 57798, AMNH 57819, AMNH 74615); *Xenodon merremi* (MACN 40015, MCN 4440, MCN 4441, MCN 4442).

Adult specimens

Achalinus formosanus (LSUMZ 19354; NHMUK 1983-192); *Acrantophis madagascariensis* (MNHN 1983.484); *Acrantophis dumerili* (MZUSP 14430); *Acrochordus granulatus* (AMNH 66367); *Acrochordus javanicus* (AMNH 140813); *Ahaetulla ahaetulla* (MNHN C 952-36/-37/-38); *Ahaetulla prasina* (MNHN C 2943-29/-30/-31); *Ahaetulla subocularis* (MNHN 1973.142A); *Antaresia childreni* (AMNH 86213); *Apostolepis dimidiata* (AMNH 62192); *Apostolepis flavotorquata* (AMNH 93559); *Aspidites melanocephala* (AMNH 18681); *Atractaspis irregularis* (MNHN 1991.4071/4072); *Bitis arietans* (CENAI 3386); *Boiruna maculata* (MACN 40006, MACN 40007); *Boiruna sertaneja* (MZUSP 7031); *Bothrops alternatus* (MACN 40018); *Bungarus fasciatus* (CENAI 3887); *Calabaria reinhardtii* (AMNH 45901, CM 147738); *Candoia aspera* (AMNH 142843); *Candoia carinata* (MZ 14111, MZ 14112); *Casarea dussumieri* (MNHN 1992-27, MNHN 1993.3382); *Causus rhombeatus* (MNHN 1991.4146/4147); *Causus maculatus* (MNHN 1991.4140); *Causus resimus* (MNHN 1991.4144); *Cerberus rhynchops* (MNHN 1991.4352); *Charina bottae* (CM 36539, MZ, 8854); *Clelia rustica* (MACN 40004); *Corallus hortulanus* (MZ 13050);; *Cylindrophis maculatus* (AMNH 85496); *Daboia russelli* (MNHN 1991.4112/4113/4114, MNHN 1997.6005/6037); *Dasypeltis scabra* (CENAI

3853); *Dendroaspis polylepis* (MACN S/N); *Enhydris bocourti* (MNHN 1970-557A); *Enhydris enhydris* (MNHN C 3458-23/-24); *Enhydris innominata* (MNHN 1970-560A); *Enhydris plumbea* (MNHN C 3461-15/-19); *Enhydris dussumieri* (MNHN 2009.0206); *Enhydris jagorii* (MNHN 1970.554A); *Enhydris sieboldii* (MNHN 2009.0204); *Epicrates angulifer* (CM 35999); *Erpeton tentaculatus* (MNHN 1970.573A); *Eryx conicus* (AMNH 89273, CM 91863); *Eryx jaculus* (MZ 14101); *Eryx johni* (AMNH 99701); *Eryx miliaris* (AMNH 143770); *Eunectes murinus* (MPEG 16443); *Eunectes notaeus* (MZUSP 7622); *Eunectes deschauensis* (MPEG 18019); *Exiliboa placata* (AMNH 102892); *Helicops leopardinus* (MACN 40014); *Homoroselaps lacteus* (MNHN 1991.4162); *Hydrophis* sp. (MNHN 1986.0596); *Langaha nasuta* (MNHN 1991.4355, MNHN 1950.178A); *Leiopython albertisii* (AMNH 95140, MZUSP 14427); *Liasis fuscus* (AMNH 86222); *Ligophis miliaris* (MACN 40013); *Ligophis poecilogyrus* (MACN 40011); *Macrelaps microlepidotus* (CENAI 3858, LSUMZ 55387); *Madagascarophis colubrinus* (MNHN C 2451-37/-38); *Malpolon monsspesulanus* (MNHN 1988.6505, MNHN 1994.4175, MNHN 1991.4358, MNHN 1991.4562); *Mastigodryas bifossatus* (MACN 40017); *Mehelya capensis* (MACN 3857); *Mimophis madagascariensis* (MNHN 1989.2917, MNHN 1989.2918, MNHN 1989.2919, MNHN 1989.2961); *Morelia viridis* (AMNH 95135, MZUSP 14428); *Morelia spilota* (MNHN 1991.4048); *Naja nivea* (CENAI 3881); *Nerodia rhombifer* (CENAI 3838); *Notechis* sp. (MNHN 1991.4100); *Oxyrhabdium modestum* (LSUMZ 11814); *Oxyrhopus rhombifer* (MACN 40010); *Pareas mollendorfi* (AMNH 27770); *Parias sumatranus* (CENAI 3783); *Philodryas patagoniensis* (MACN 40008); *Philodryas mattogrossensis* (MACN 33420); *Philotamnus hoplogaster* (CENAI 3856); *Phimophis vittatus* (MACN 40005); *Psammophis crucifer* (MNHN 1991.4214); *Psammophis lineatus* (MNHN

1989.2942); *Pseudotyphlops philippinus* (BMNH 1978.1092); *Ramphiophis togoensis* (MNHN 1991.4184); *Ramphiophis maradiensis* (MNHN 1994.0587); *Rhinophis blythi* (AMNH 85076); *Rhinophis drummondhayi* (AMNH 85076); *Sanzinia madagascariensis* (MNHN 1900.122a); *Thamnodynastes hypoconia* (MACN 40016); *Trachyboa gularis* (AMNH 28982); *Tropidophis canus* (AMNH 73066, AMNH 45839); *Tropidophis feicki* (AMNH 81128, AMNH 81132); *Tropidophis melanurus* (AMNH 82880, AMNH 46690, AMNH 93002); *Tropidophis semicinctus* (AMNH 7386); *Tropidophis tackzanowskii* (MECN 3037); *Ungaliophis continentalis* (LSUMZ 55454); *Ungaliophis panamensis* (AMNH 58845, AMNH 62639); *Uropeltis ceylonicus* (AMNH 43343); *Uropeltis pulmeyensis* (MNHN 1994-756); *Uropeltis woodmansoni* (NHMUK 1930.5.8.73–74); *Vipera ammodytes* (MNHN 1991.4068); *Vipera berus* (MNHN 1991.4128); *Vipera latasti* (MNHN 1991.4145); *Xenodon dorbignyi* (MACN 40009); *Xylophis perroteti* (MNHN 1991.4426).

Three-dimentional reconstructions based on HRXCT data

Comparative specimens available from the Digital Morphology Library at the University of Texas (www.digimorph.com)

Angolosaurus skoogi (juvenile) California Academy of Sciences (CAS 206977)

Angolosaurus skoogi (adult) California Academy of Sciences (CAS 206978)

Anilius scytale (adult) National Museum of Natural History (USNM 204078)

Bothrops asper (adult) Field Museum of Natural History (FMNH 31162)

Casarea dussumieri (adult) University of Michigan Museum of Zoology (UMMZ 190285)

Chilabothrus striatus (adult) National Museum of Natural History (USNM 59918)

Heloderma suspectum (juvenile) Texas Memorial Museum (TNHC 62767)

Heloderma suspectum (adult) Texas Memorial Museum (TNHC 62766)

Lampropeltis getula (late embryo) Texas Memorial Museum (uncatalogued)

Lampropeltis getula (adult) Field Museum of Natural History (FMNH 95184)

Loxocemus bicolor (adult) Field Museum of Natural History (FMNH 104800)

Micrurus fulvius (adult) Field Museum of Natural History (FMNH 39479)

Shinisaurus crocodylurus (juvenile) Texas Memorial Museum (TNHC 62987)

Shinisaurus crocodylurus (adult) Field Museum of Natural History (FMNH 215541)

Trimorphodon biscutatus (adult) Field Museum of Natural History (FMNH 42171)

Typhlops jamaicensis (adult) National Museum of Natural History (USNM 12378)

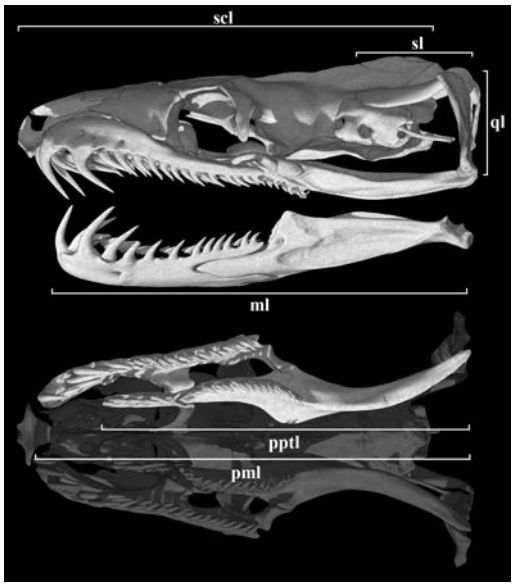
Varanus gouldi (adult) Texas Memorial Museum (TMM M-1295)

Xenopeltis unicolor (adult) Field Museum of Natural History (FMNH 148900)

B. Quantitative analysis

	svl	scl	scl/av scl	pml	ql	sl	ml
Ophiodes intermedius	32	6.7	0.59	4.8	1.3	0.8	5.1
Ophiodes intermedius	56	8.1	0.71	6.8	1.6	1.1	7.6
Ophiodes intermedius	114	11.8	1.04	9.8	2	1.7	10.9
Ophiodes intermedius	237	18.9	1.66	16.5	3.2	2.8	17.8
Epictia albipunctus	85	4.2	1.12	2.4	1.6	n	1.6
Epictia albipunctus	145	4.7	1.25	3	1.7	n	1.8
Epictia albipunctus	218	4.8	1.28	3	1.6	n	1.9
Epictia albipunctus	276	5.1	1.36	3.1	1.8	n	2.1
Anilius scytale	665	16.7	0.64	16.1	2.5	1.9	16.5
Anilius scytale	?	18.7	0.72	16.6	3	2.7	17.4
Anilius scytale	?	25.9	0.99	23.7	3.3	3.1	24.9
Anilius scytale	895	27.1	1.04	24.9	3.7	3.3	25.4
Anilius scytale	?	42.1	1.61	40.9	6.1	5.8	39.2
Boa constrictor	311	20.5	0.43	18.7	5.8	4.3	21.1
Boa constrictor	463	24.4	0.52	28.5	8.8	7	25
Boa constrictor	1623	50.2	1.06	58.8	13.8	17.9	59.2
Boa constrictor	?	68.3	1.45	78.7	19	23.9	79.9
Boa constrictor	3124	72.4	1.53	80.2	20.2	25.6	81.1
Micrurus pyrrhocryptus	182	8.3	0.57	6.2	1.2	1.1	7.5
Micrurus pyrrhocryptus	395	12.1	0.84	10.8	2	2.5	12.5

Micrurus pyrrhocryptus	802	17.8	1.23	15.2	3.5	3.7	18.6
Micrurus pyrrhocryptus	921	19.5	1.35	18.3	4.2	4.5	21.2
Bothrops diporus	229	13.6	0.67	14.3	4.6	3.9	16.2
Bothrops diporus	509	17.5	0.86	19.8	7.2	4.8	22.1
Bothrops diporus	554	18.9	0.93	22.7	8.2	5.7	24.6
Bothrops diporus	762	25.8	1.26	30.7	10.6	7.8	33.1
Bothrops diporus	892	26.3	1.29	33.4	13.5	9.1	37.5
Xenodon merremi	157	11.2	0.57	12.8	3.9	3.4	12.8
Xenodon merremi	202	12.6	0.64	14.2	5.5	4.1	15.3
Xenodon merremi	492	19.9	1.01	23.8	10	7.8	25.2
Xenodon merremi	753	27.1	1.37	34.2	15.4	12.5	37.6
Xenodon merremi	870	27.9	1.41	35	16.8	11.6	38.2
Python molurus	?	24.1	0.3	23.4	4.9	6.3	25.2
Python molurus	?	54.8	0.68	60	13.6	18.1	61.1
Python molurus	?	78.8	0.97	85.9	23.3	25.4	90.6
Python molurus	?	104.3	1.29	123.4	34.8	39	125.2
Python molurus	?	142.1	1.76	168.9	39	43.8	147.7



Selected measurements (in mm). Due to the large variation in snout-condyle length (hereafter, SCL), I rescaled the value of the SCL for each species dividing it with the average of the SCL of all specimens of each species. ml, mandible length; pml, palatomaxillary bar length; pptl, pterygopallatine bar length; ql, quadrate length; scl, snout-condyle length; sl, supratemporal length; svl, snout-vent length.

C. Macrohabitat definitions

For several years, scientists have employed different terms to define macrohabitats occupied by snakes, most of which have not been matched by the development of explicit definitions. Moreover, in much of the literature authors have coined several terms in order to describe intermediate macrohabitats (e.g. semifossorial, semiaquatic) that introduced more confusion. Regrettably, this situation entails the negative consequence of hinder comparisons between macrohabitats and their evolutionary implications for species that occupy them. Hence, I provide an explicit terminology that imparts each macrohabitat with information about its anatomical correlates in snakes. However, a caveat must be made because some snakes are capable to occupy different macrohabitats without specific anatomical structures. A good example of this situation is the arboreal capabilities of several snakes, even present in fossorial scolecophidians of the family Leptotyphlopidae (Vanzolini, 1970; pers. obs.). This attempt is based on previous works that employed macrohabitat definitions, in special the papers of Duellman (1978), Cadle and Greene (1993) and Martins and Oliveira (1998).

Underground macrohabitats

It is important to note that most snakes are facultatively sheltering due to the ecological plasticity of their elongated limbless bauplan. Despite of this plastic condition, some groups display habitat specializations, which usually are correlated with discrete anatomical traits. Most basal groups of snakes and some groups of macrostomatans inhabit in tunnels, crevices or below of different strata composed by many kinds of leaf litters and other loose substrates present in poorly consolidated substrates. Common among snakes that occupy underground macrohabitats is the small body size (SVL < 1000 mm), strong to moderate reduction of eyes and consequently orbits, reduction of the number of dorsal scale rows, fusion of head scales and strong abbreviation of the tail (Bogert, 1947; Inger and Marx, 1965; Downs, 1967; Gans, 1974; Shine and Wall, 2008). Because head is the principal locomotor organ in this kind of snakes, head morphology is strongly constrained due to the ability to penetrate the substrate and exposure of cranial bones to stress. Head width also may be reduced and cranial rigidity increased by shortening the supratemporals and quadrates whit the subsequent shortening of the lower jaws, robustness and shape modification of the premaxilla bone and naso-frontal joint, narrowing of the braincase and rearrangement of muscular and glandular elements (Gans, 1974; Savitzky, 1978, 1983). Associated with the reduction of body diameter, neural spines are strongly reduced or absent (Johnson, 1955).

Fossorial (=burrowing, subterranean, active burrower)

Fossorial snakes are those capable of burrowing and/or using soil galleries and regularly spend their activity time in the soil. I consider truly fossorial snakes all

scolecophidians and basal alethinophidian such as uropeltids and species of the genus *Anomochilus*. These snakes exhibit strong body modifications such as rigid skull and very narrow heads (usually both body extremes are similar in shape), strongly reduced eyes covered by a scale and modifications in the caudal scalation to form tail shields or spines. Nearly all species of these groups have thin, small bodies (SVL < 600 mm), and a homogeneous cylindrical body shape.



Representatives of fossorial snakes. Left, the typhlopid *Argyrophis muelleri* (SVL 550 mm) (Credit: www.indiansnakes.org); right, the uropeltid *Melanophidium wynaudense* (SVL 300 mm) (Credit: https://bangkokherps.wordpress.com). White arrow indicates the position of the vent.

Cryptozoic (=sub fossorial, sand swimmers, crevice-dwellers, leaf litter inhabitants, litter-swimmers)

Are those snakes that regularly spend part of their activity time inside the leaf litter or other kinds of loose substrate. Usually, these snakes exhibit slightly slender body sizes than fossorial forms. We consider truly cryptozoic snakes basal alethinophidians such as *Anilius scytale* and species of the genus *Cylindrophis*, basal macrostomatans *Xenopeltis* (*X. unicolor* and *X. hainanensis*) and *Loxocemus bicolor*, erycine boas, and some species of caenophidians. Within this last clade exist several cryptozoic forms, some of which represent entire subclades such as elapomorphine

dipsadids, old and new world coral snakes, african atractaspidids, and sonorine colubrines, among others.



Representatives of cryptozoic snakes. Left, the basal alethinophidian *Anilius scytale* (SVL 1100 mm); right, the colubroid *Apostolepis ammodites* (SVL 500 mm) (Credit: www.licenciamento.ibama.gov.br). White arrow indicates the position of the vent.

Surface macrohabitats

Snakes that occupy surface macrohabitats display an important range of body sizes (SVL ≈ or > 1000 mm) including large forms that can reach several meters. Surface snakes spend most part of their activity time above the substrate, climbing plants or in the water column. Due to the relevance of the postcranial body as locomotor organ in surface snakes, exist some anatomical traits related with the different surface macrohabitats. Related with the increase of body size, surface snakes have more vertebrae than underground snakes (Lindell, 1994). It is important to note that few taxa exhibit characters present in underground forms. An example of this is the shortening of the suspensorium and jaws present in presumably paedomorphic surface snakes such as some boine species of the genus *Chilabothrus* (Kluge, 1989).

Terrestrial (= ground inhabitants, surface-dwelling)

Terrestrial snakes are those that regularly spend this activity time on the ground, above to different kind of substrates (leaf litter, sand, rocks, etc). Terrestrial snakes display the most generalised forms with respect of body shape. It is important to underline that largest snake species (SVL > 3000 mm) occupy this macrohabitat.



Representatives of terrestrial snakes. Left, the colubroid *Bothrops atrox* (SVL 1600 mm) (Credit: www.jungledragon.com); right, the booid *Python molurus* (SVL 700 mm) (Credit: www.novanature.org).

Arboreal (=bush and tree inhabitants)

Arboreal snakes are those that regularly spend part of their activity time on the vegetation (epiphytes, vines, shrubs and trees) above the ground level (Martins and Oliveira, 1999). Their body is usually slender and thin, and usually tail is more slender than terrestrial or aquatic forms (Marx and Rabb, 1972; Lillywhite and Henderson, 1993; Lindell, 1994). Usually, arboreal forms have more precloacal vertebrae than terrestrial and aquatic forms, and some species of colubroids (e.g. *Leptophis ahaetula*) have elongated vertebral centra.



Representatives of arboreal snakes. Left, *Corallus ruschenbergerii* (SVL 1500 mm) (Credit: www.guaquira.net); right, *Leptophis stimsoni* (SVL 700 mm) (Credit: www.flickr.com).

Aquatic (=water snakes, marine snakes)

Aquatic indicates those snakes that regularly spend part of their activity time inside the water. Some freshwater forms like the boid *Eunectes*, homalopsine and hydropsine colubroids show external nares and eyes in the dorsal region of the head. Sea snakes exhibit a dorso-ventrally elongated body (due to a prominent ventral keel), and the tail (a major propulsive structure during swimming) is higher and thinner than in terrestrial snakes (i.e., paddle-shaped) but shorter relative to body length (Brischoux and Shine, 2011). Simoliophiids were fossil Mesozoic snakes recovered invariably in marine sedimentary formations, which display some particular postcranial traits usually attributed to a marine habitat such as pronounced pachyostosis in vertebrae and ribs (Lee and Caldwell, 1998; Rieppel et al., 2003; Rage and Escuillié, 2000), and elongated haemal arches in postcloacal region (but see Rieppel and Head [2006] for the homology status of these caudal structures).



Representatives of aquatic snakes. Left, *Eunectes murinus* (SVL 6000 mm) (Credit: https://respectgreen.wordpress.com); right, *Hydrophis coggeri* (SVL 1350 mm) (Credit: www.endemia.nc).

D. Prey types

This definition of prey types is reproduced with some modifications from the classical work of Cundall and Greene (2000) about snake feeding.

Type I

Preys of this type consist on relatively small items in mass and cross-sectional area regardless of shape, such as adult insects and their different developmental stages (pupae, larvae), fish eggs, among others.



Representatives of Type I preys. (a) nymphs and adults of termite *Mastotermes darwiniensis* (weight: 0,004 g; length: 3-5 mm) (Credit: http://darwinblog. blogspot.com.ar/); (b) pupae and adults of ants of the family Formicidae (weight: 0,005 g; length: 5-8 mm) (Credit: www.biodiversidadvirtual.org).

Type II

Type II preys are elongate, often without protruding locomotor organs like arthropod appendages or tetrapod limbs. I include in this category earthworms, elongated fishes, legless tetrapods, small elongated legged lizards and soft-shelled squamate eggs. This kind of preys has a small cross-sectional area.



Representatives of Type II preys. (a) Earth worm *Lumbricus* sp. (weight: 0,6 g; length: 50 mm) (Credit: www.teara.govt.nz); (b) the Asian swamp eel *Monopterus albus* (weight: 10 g; length: 240 mm) (Credit: http://safeimufti. wordpress.com); (c) the caecilian *Ichthyophis kohtaoensis* (weight: 34 g; length: 343 mm) (Credit:); (d) spotted worm lizard *Amphisbaena fuliginosa* (weight: 10 g; length: 190 mm) (Credit: http:// calphotos.berkeley.edu); (e) South African blind snake *Afrotyphlops bibronii* (weight: 34 g; length: 320 mm) (Credit: www.sareptiles. co.za/forum/viewtopic.php?f=141&t=26352&start=120); (f) Australian skink *Lerista muelleri* (weight: 4 g; length: 100 mm) (Credit: www.arod.com.au); (g) eggs of colubrid snake *Coluber constrictor* (weight: 2 g; length 50 mm) (Credit: http://www. susanleachsnyder.com/GopherTortoise Preserve/Reptiles.html).

Type III

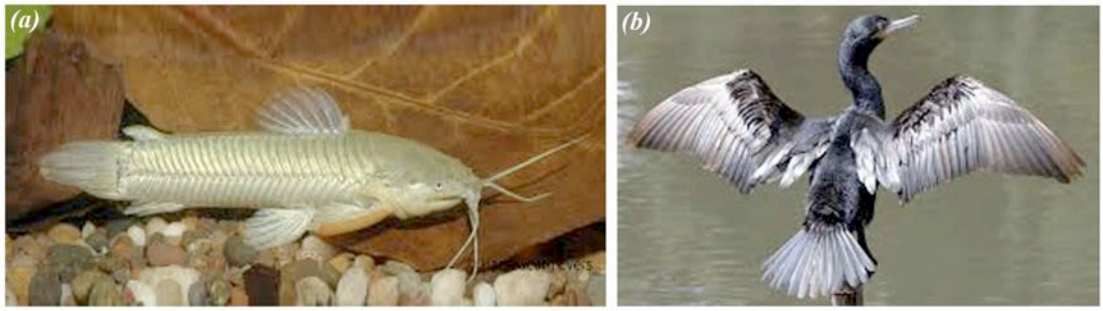
Type III prey are fusiform or roughly spherical as well as relatively heavy so they necessitate compensation for both high handling cost and increased gape. We incorporate large lizards in this category.



Representatives of Type III preys. (a) toad *Rhinella arenarum* (weight: 130 g; length: 100 mm) (Credit: http://amiralles.com); (b) black iguana *Ctenosaura similis* (weight: 300 g; length: 540 mm) (Credit: http://en.wikipedia.org); (c) guinea pig *Cavia aperea* (weight: 350 g; length: 200 mm) (Credit: http://elaniorapaz.blogspot.com).

Type IV

Type IV prey weigh substantially less than predicted by their maximum diameter, either because their cross-sectional shape is not circular (e.g., many fishes) or they possess protruding body parts (e.g. wings of birds and bats) so they require large gape but not specialized immobilization mechanisms.



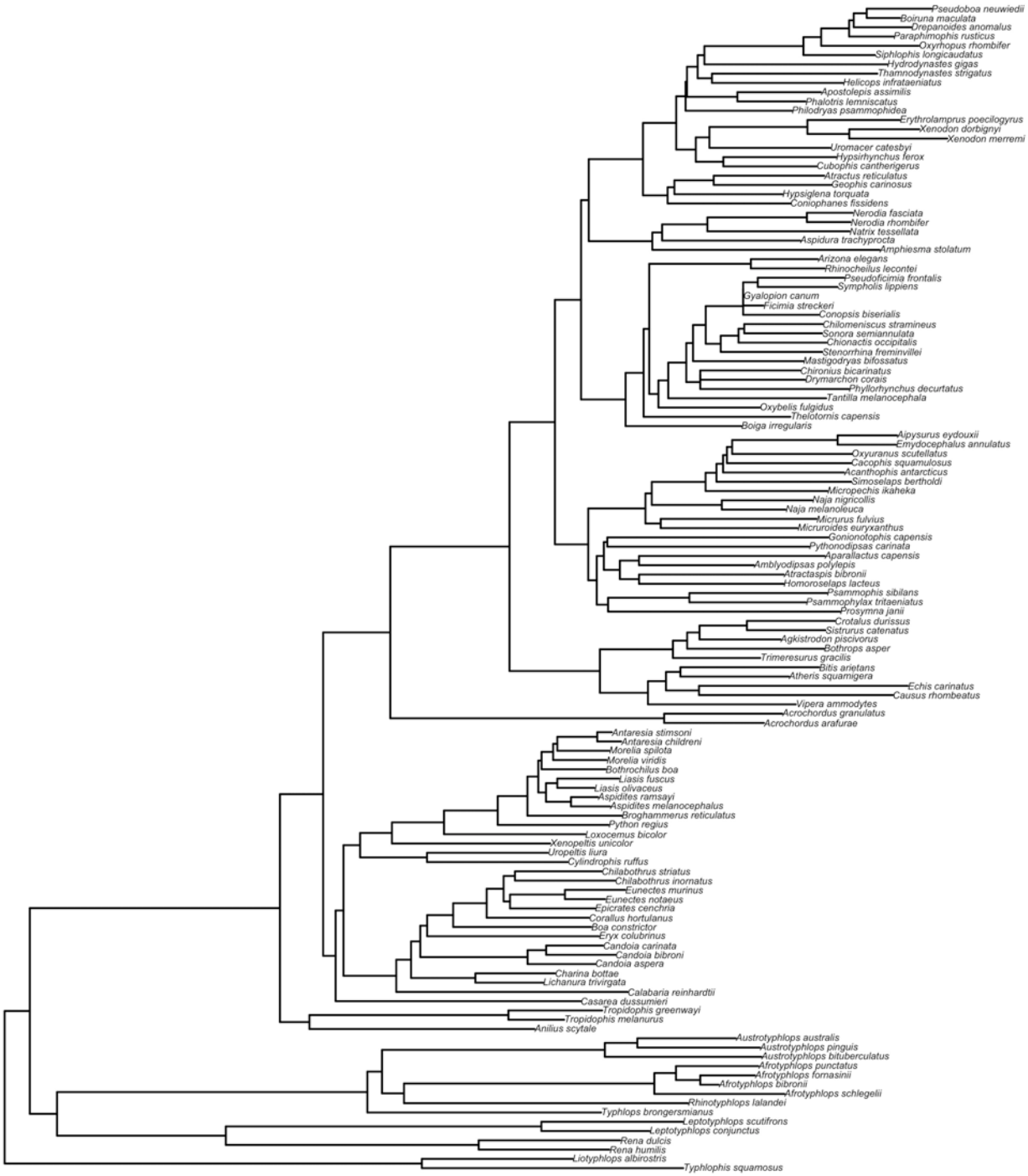
Representatives of Type VI preys. (a) catfish *Callichthys callichthys* (weight: 80 g; length: 170 mm) (Credit: www.planetcatfish.com); (b) neotropical cormorant *Phalacrocorax brasilianus* (weight: 1000 g; length: 640 mm) (Credit: www.ebirdr.com).

E. Phylogenetic MANOVA

Type I (Sequential) Sums of Squares and Cross-products
Randomization of Raw Values used

	df	SS	MS	Rsq	F	Z	P.value
Size	1	246.8	246.764	0.062554	8.274	4.521	0.0042996
Residuals	124	3698.0	29.823				
Total	125	3944.8					

Results of the phylogenetic MANOVA performed in R used to compare the significance of differences between most of the species employed in the morphological-ecological survey for the macrohabitat and prey type.



Phylogenetic tree utilized in the MANOVA analysis. This tree corresponds with the maximum-likelihood tree published by Pyron et al. (2013), which was pruned to include only the species employed in this study.

F. Supplementary figures

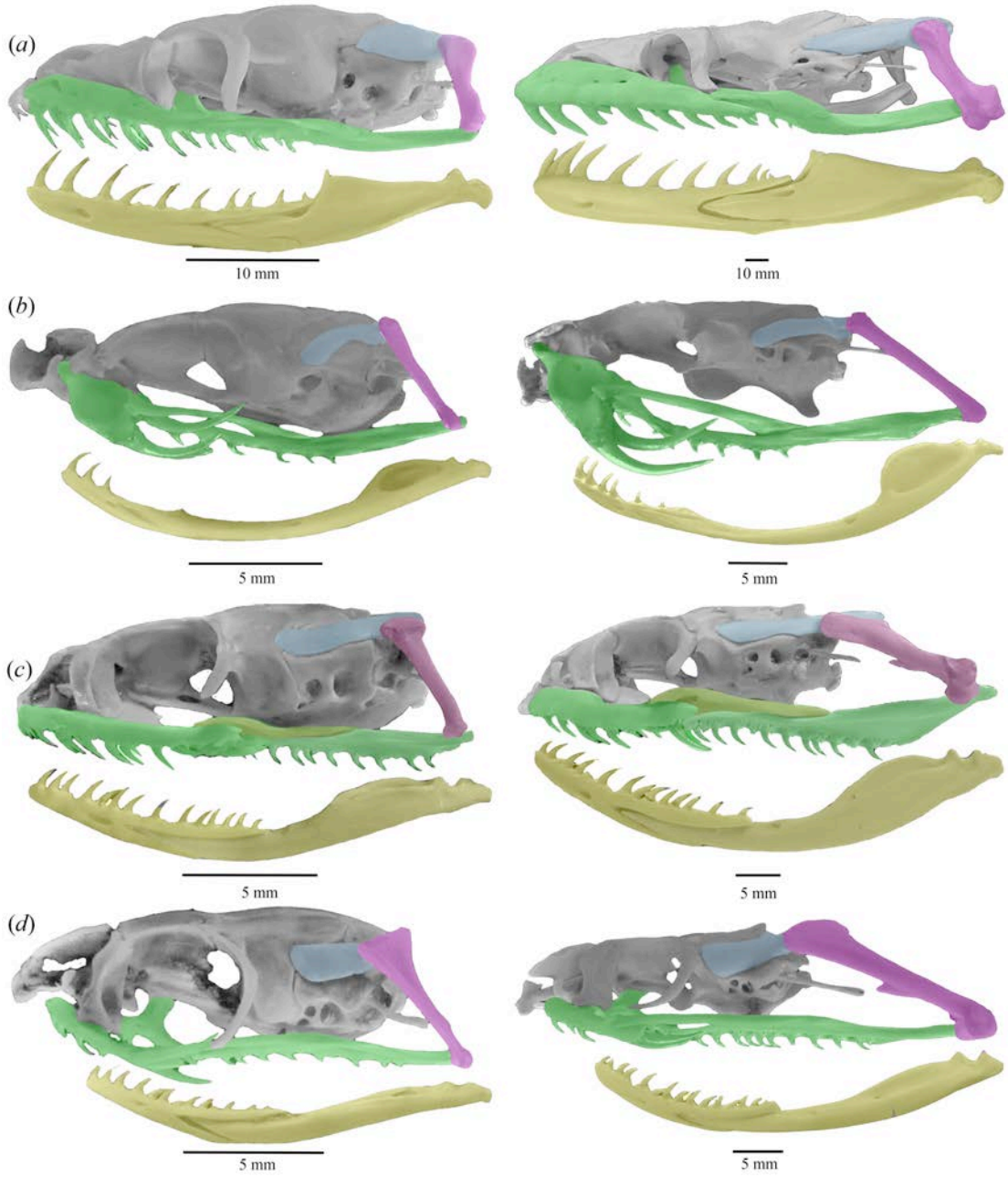


Figure S1. A, lateral view of the skull of a juvenile (SVL 489 mm; left) and adult (SVL 4030 mm; right) specimens of the pythonid *Malayopython reticulatus*; B, juvenile (SVL 251 mm; left) and adult (SVL 848 mm; right) specimens of the viperid *Bothrops diporus*; C, juvenile (SVL 289 mm; left) and adult (SVL 1108 mm; right) specimens of the dipsadid colubroid *Hydrodynastes gigas*; D, juvenile (SVL 231 mm; left) and adult (SVL 990 mm; right) specimens of the dipsadid colubroid *Xenodon merremi*.

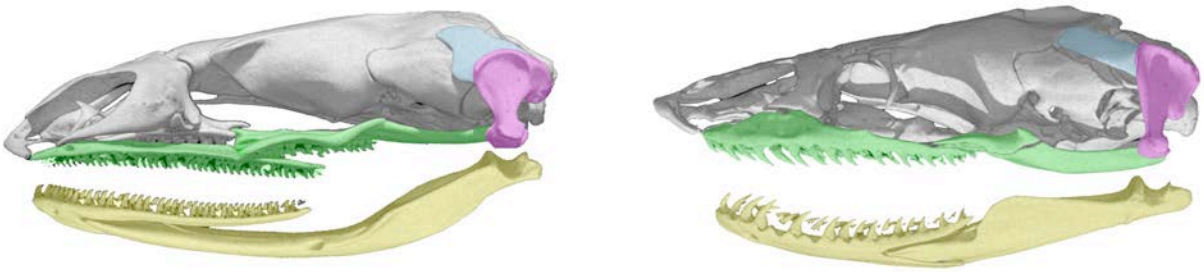


Figure S2. Three-dimensional reconstruction of the lateral view of the skull of *Xenopeltis unicolor* (left) and *Loxocemus bicolor* (right) based on HRXCT data. Not to scale.

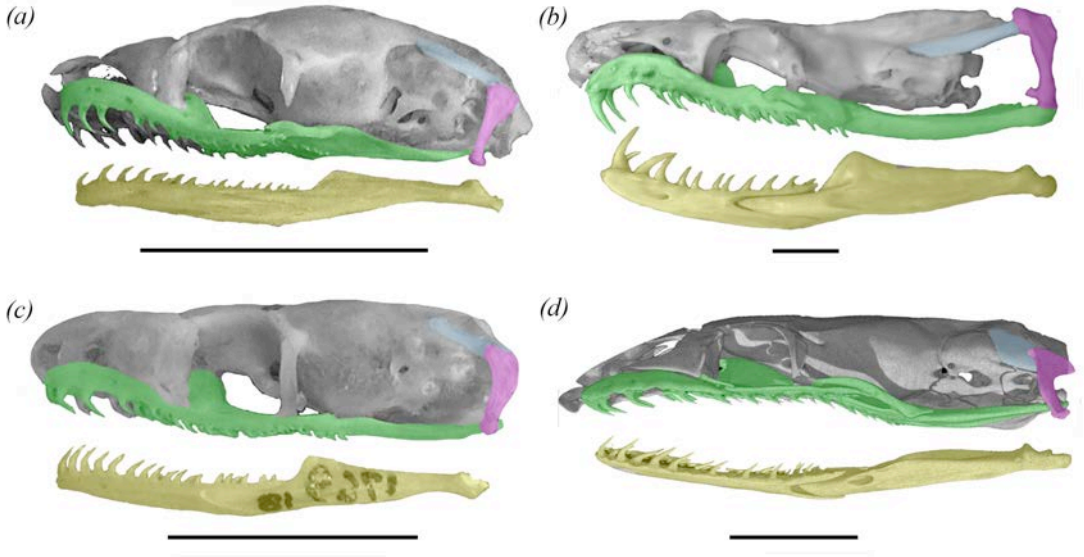


Figure S3. Lateral view of the skull of a juvenile (SVL 390 mm; a) and adult (SVL 2030 mm; b) specimens of *Chilabothrus subflavus*, adult specimen of *Chilabothrus gracilis* (SVL 760 mm; c), and adult specimen of *Casarea dussumieri* (three-dimensional reconstruction based on HRXCT data). Scale bar 5 mm.



Figure S4. Three-dimensional reconstructions of the skull in lateral (left) and dorsolateral (right) views of adult specimens of the boine *Chilabothrus striatus* (a), the colubrid *Trimorphodon biscutatus* (b), and the viperid *Bothrops asper* based on HRXCT data. Not to scale.

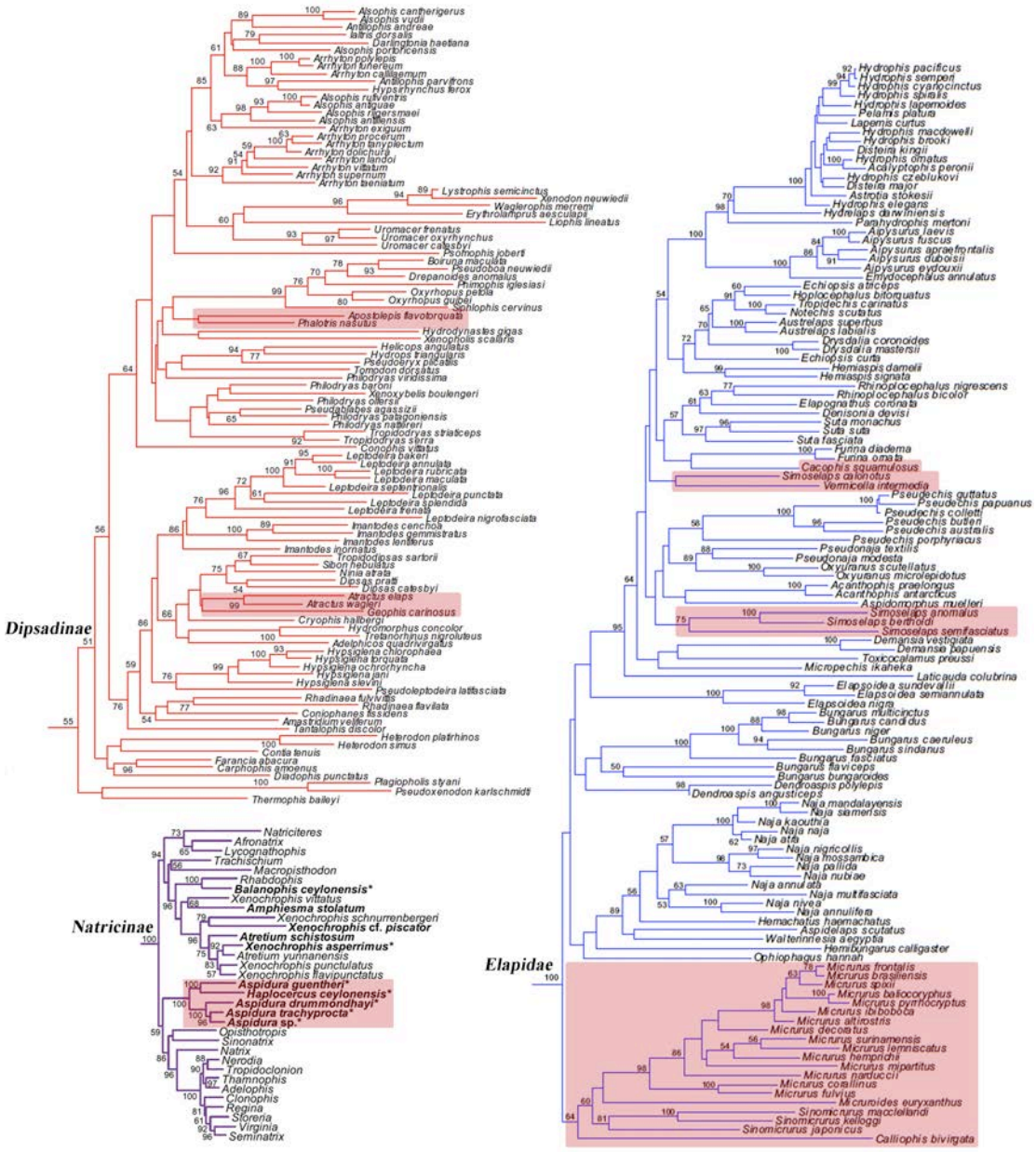


Figure S5. Molecular phylogeny of colubroid snakes (Pyron et al., 2011, 2013). Red rectangles highlight cryptozoic species/clades.

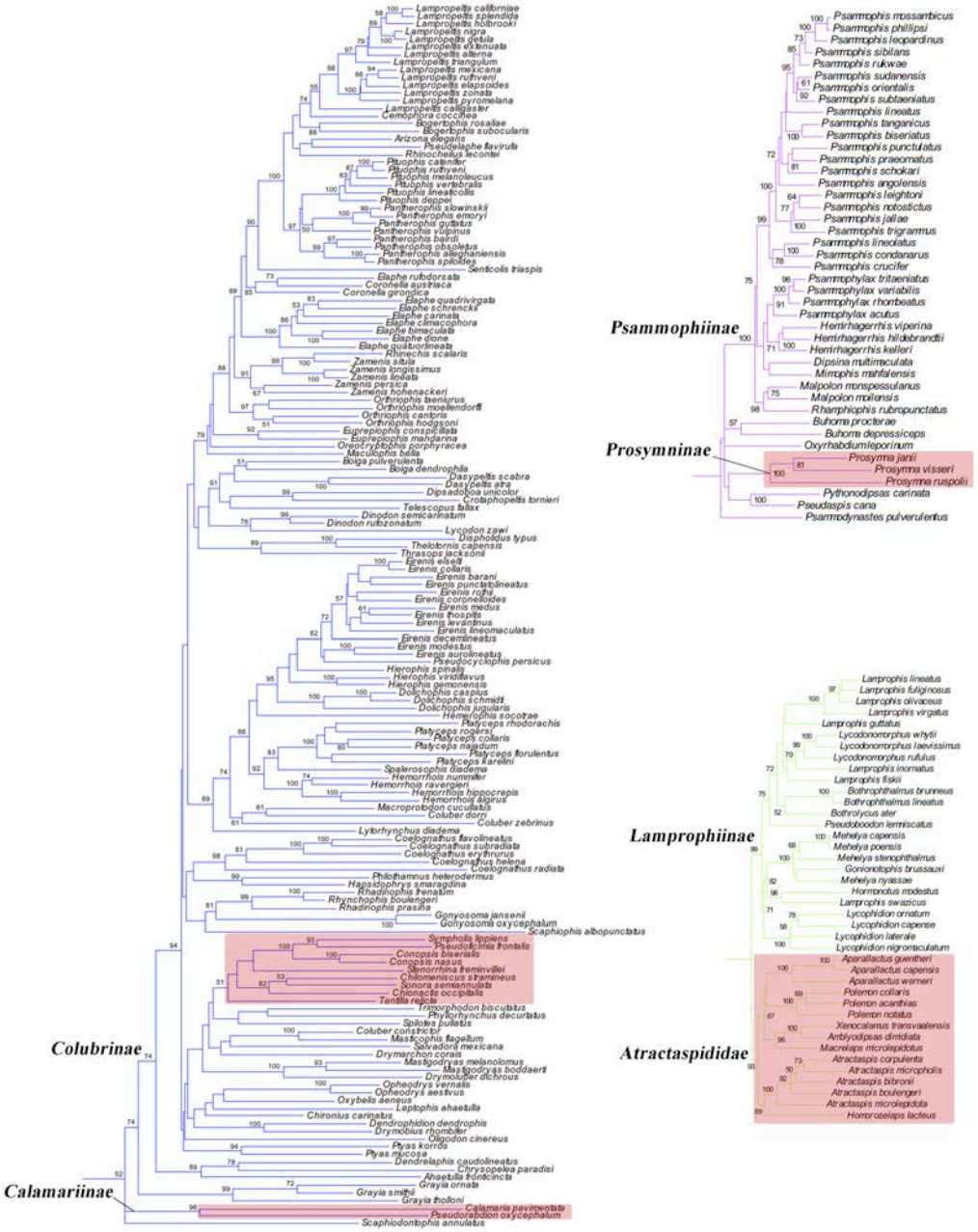


Figure S5 (continued).

F. References for electronic supporting materials

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