Zootaxa 3860 (5): 449–463
www.mapress.com/zootaxa/

Article

ISSN 1175-5326 (print edition)
ZOOTAXA
ISSN 1175-5334 (online edition)

http://dx.doi.org/10.11646/zootaxa.3860.5.4
http://zoobank.org/urn:lsid:zoobank.org:pub:2894C38A-2CEC-4091-92D2-39198776820F

Extension of historical range of Betylobraconinae (Hymenoptera: Braconidae) into Palaearctic Region based on a Baltic amber fossil, and description of a new species of *Mesocentrus* Szépligeti from Papua New Guinea

BUNTIKA AREEKUL BUTCHER[1,4], ALEJANDRO ZALDIVAR-RIVERÓN[2], THOMAS VAN DE KAMP[3], TOMY DOS SANTOS ROLO[3], TILO BAUMBACH[3] & DONALD L. J. QUICKE[1]

[1]*Department of Biology, Faculty of Science, Chulalongkorn University, BKK 10330, Thailand*
[2]*Colección Nacional de Insectos, Instituto de Biología, Universidad Nacional Autónoma de México, 3er. circuito exterior s/n Cd. Universitaria, Copilco, Coyoacán, A. P. 70-233, C.P. 04510., D.F., México.*
[3]*ANKA / Institute for Photon Science and Synchrotron Radiation, Karlsruhe Institute of Technology (KIT), D-76344 Eggenstein-Leopoldshafen, Germany*
[4]*Corresponding author. E-mail: buntika.a@chula.ac.th*

Abstract

Two new species of the parasitic wasp genus *Mesocentrus* Szépligeti (Betylobraconinae) are described. One based on a new species from Papua New Guinea, the other the first Palaearctic member of the subfamily based on a 30+ mya, species from Baltic amber. The second species is illustrated using synchrotron X-ray microtomography. Whereas the extant Betylobraconinae are restricted to Australia, New Guinea and New Caledonia, their ancestral distribution is now known to have extended considerably further. A key to the four species of *Mesocentrus* known from Papua New Guinea is provided. Both species possess some putatively plesiomorphic characters absent in other extant *Mesocentrus* spp. The new extant species differs in having a considerably larger number of antennal segments and a less laterally depressed frons, while the extinct one has the clypeus separated from the face dorsally and strongly developed hypoclypeal depression. Availability of sequence data for this species enabled further analysis of the relationships of the subfamily, which we present in a phylogenetic analysis additionally including the release of a number of new sequences of related taxa.

Key words: *Betylobracon*, *Rhinoprotoma*, distribution, fossil, palaeontology, historical biogeography, new taxa

Introduction

Since its description by Tobias (1979), the Betylobraconinae has undergone expansion and subsequent contraction. It was based on a highly derived Australian genus, *Betylobracon*, which despite not being physically cyclostome, displayed other characters such as possession of hind wing vein m-cu, suggesting that it probably belonged to that group. Van Achterberg (1984) recognised that it was related to the less derived and distinctly cyclostome genus *Mesocentrus* described from Australia by Szépligeti (1900), both genera possessing robust legs with the fore tarsal segments shortened and telotarsus enlarged. Subsequently, three further tribes were added to the subfamily; van Achterberg added the Facitorini for three new tropical genera, and the Planitorini for the Australian genus *Planitorus*, and Belokobylskij & Long (2005) added the Aulosaphobraconini for their new genus *Aulosaphobracon* from Vietnam. However, Belokobylskij *et al*. (2008) using DNA sequence data showed that the Facitorini were actually not close to *Betylobracon* and *Mesocentrus*, but instead belonged in the rogadine tribe Yeliconini, and further, they showed that most probably *Aulosaphobracon* belonged elsewhere, although in the absence of strong support for any other placement they left it the Betylobraconinae. Sharanowski *et al*. (2011) then showed that *Planitorus*, which like *Betylobracon* is not physically cyclostome, was really not a member of the cyclostome braconid lineage at all, but rather a member of the non-cyclostome subfamily Euphorinae. Thus the Betylobraconinae now comprises just *Betylobracon* and *Mesocentrus*, with *Aulosaphobracon incertae sedis* but most likely belonging to the Lysiterminae.

Accepted by J. Jennings: 14 Aug. 2014; published: 9 Sept. 2014

time. Mark Shaw (National Museums of Scotland) and Darren Ward (Landcare Research, New Zealand) allowed us to use sequence data from some of their specimens. We would like to thank Chulalongkorn University Centenary Academic Development Project for support to DQ.

References

Belokobylskij, S.A. & Long, K.D. (2005) The braconid wasps of the subfamily Betylobraconinae (Hymenoptera, Braconidae) in Vietnam. *Deutsche Entomologische Zeitschrift*, 52, 155–164.
http://dx.doi.org/10.1002/mmnd.200410008

Belokobylskij, S.A., Zaldivar-Riverón, A., Maetô, K. & Sáez, A.G. (2008) Asian Betylobraconinae (Hymenoptera, Braconidae), with description of a new genus and phylogenetic affinities of the tribe Facitorini. *Insect Systematics and Evolution*, 39, 133–154.
http://dx.doi.org/10.1163/187631208788784110

Butcher, B.A., Smith, M.A., Sharkey, M.J. & Quicke, D.L.J. (2012) A turbo-taxonomic study of Thai *Aleiodes (Aleiodes)* and *Aleiodes (Arcaleiodes)* (Hymenoptera: Braconidae: Rogadinae) based largely on COI bar-coded specimens, with rapid descriptions of 179 new species. *Zootaxa*, 3457, 1–232.

Gillespie, J.J., Yoder, M.J. & Wharton, R.A. (2005) Predicted secondary structure for 28S and 18S rRNA from Ichneumonoidea (Insecta: Hymenoptera: Apocrita): impact on sequence alignment and phylogeny estimation. *Journal of Molecular Evolution*, 61, 114–137.
http://dx.doi.org/10.1007/s00239-004-0246-x

Hrcek, J., Miller, S.E., Quicke, D.L.J. & Smith, M.A. (2011) Molecular detection of trophic links in a complex insect host-parasitoid food web. *Molecular Ecology Resources*, 11, 786–794.
http://dx.doi.org/10.1111/j.1755-0998.2011.03016.x

Papp, J. (2005) Five new *Mesocentrus* Szépligeti species from the Australian region (Hymenoptera: Braconidae: Betylobraconinae). *Acta Zoologica Academiae Scientiarum Hungaricae*, 51, 97–111.

Quicke, D.L.J., Smith, M.A., Miller, S.E., Hrcek, J. & Butcher, B.A. (2012a) *Colastomion* Baker (Braconidae, Rogadinae): nine new species from Papua New Guinea reared from Crambidae. *Journal of Hymenoptera Research*, 28, 85–121.

Quicke, D.L.J., Smith, M.A., van Achterberg, C., Miller, S.E. & Hrcek, J. (2012b) A new genus and three new species of parasitoid wasp from Papua New Guinea and redescription of *Trigonophatnus* Cameron (Hymenoptera, Braconidae, Rogadinae). *Journal of Natural History*, 46, 1369–1385.
http://dx.doi.org/10.3897/jhr.28.3484

Quicke, D.L.J., Smith, M.A., Hrcek, J. & Areekul-Butcher, B. (2013) *Cystomastacoides* van Achterberg (Braconidae, Rogadinae): first host record and descriptions of three new species from Thailand and Papua New Guinea, *Journal of Hymenoptera Research*, 28, 135–141.
http://dx.doi: 10.3897/JHR.28.3192

Ritzkowski, S. (1997) K-Ar Altersbestimmungen der bernsteinführenden Sedimente des Samlandes (Paläogen, Bezirk Kaliningrad). *In:* Ganzelewski, M., Rehren T.H., & Slotta, R. (Eds.), *Metalla, Sonderheft 66 zum Symposium Neue Erkenntnisse zum Bernstein.* Bochum, Germany: Deutsches Bergbau Museum pp. 19–24.

Sharanowski, B.J., Dowling, A.P.G. & Sharkey, M.J. (2011) Molecular phylogenetics of Braconidae (Hymenoptera: Ichneumonoidea), based on multiple nuclear genes, and implications for classification. *Systematic Entomology*, 36, 549–572.
http://dx.doi.org/10.1111/j.1365-3113.2011.00580.x

Sharkey, M.J. & Wharton, R.A. (1997) Morphology & terminology. *In:* Wharton, R. A., Marsh, P.M. & Sharkey, M.J. (Eds.), *Identification Manual to the New World Genera of Braconidae*. Special Publication of the International Society of Hymenopterists, pp. 19–37.

Stamatakis, A. (2006) RAxML-VI-HPC: Maximum likelihood-based phylogenetic analyses with thousands of taxa and mixed models. *Bioinformatics*, 22, 2688–2690.
http://dx.doi.org/10.1093/bioinformatics/btl446

Stamatakis, A., Hoover, P. & Rougemont, J. (2008) A rapid bootstrap algorithm for the RAxML web-servers. *Systematic Biology*, 75, 758–771.
http://dx.doi.org/10.1080/10635150802429642

Szépligeti, G.V. (1900) Braconiden aus Neu-Guinea in der Sammlung des Ung. National-Museums. *Természetrajzi Füzetek*, 23, 49–65.

Szépligeti, G.V. (1902) Braconiden aus Neu-Guinea in der Sammlung des Ung. National-Museums. II. *Természetrajzi Füzetek*, 25, 39–84.

Tobias, V.I. (1979) Two new and little known subfamilies of Braconidae (Hymenoptera) from Australia. *Entomologicheskoe Obozrenie*, 58, 128–142. [In Russian]

van Achterberg, C. (1984) Essay on the phylogeny of Braconidae (Hymenoptera: Ichneumonoidea). *Entomologisk Tidskrift*, 105, 41–58.

van Achterberg, C. (1988) Revision of the subfamily Blacinae Foerster (Hymenoptera: Braconidae). *Zoologische Verhandelingen, Leiden*, 249, 1–324.
van Achterberg, C. (1995) Generic revision of the subfamily Bethylobraconinae (Hymenoptera: Braconidae) and other groups with modified fore tarsus. *Zoologisches Verhandelingen, Leiden*, 298, 1–242.
Weitkamp, T., Haas, D., Wegrzynek, D. & Rack, A. (2011) ANKAphase: software for single-distance phase retrieval from inline X-ray phase-contrast radiographs. *Journal of Synchrotron Radiation*, 18, 617–629. http://dx.doi.org/10.1107/S0909049512044871
Zaldivar-Riverón, A., Areekul, B., Shaw, M.R. & Quicke, D.L.J. (2004) Comparative morphology of the venom apparatus in the braconid wasp subfamily Rogadinae (Insecta, Hymenoptera, Braconidae) and related taxa. *Zoologica Scripta*, 33, 223–238. http://dx.doi.org/10.1111/j.0300-3256.2004.00144.x
Zaldivar-Riverón, A., Mori, M. & Quicke, D.L.J. (2006) Systematics of the cyclostome subfamilies of braconid parasitic wasps (Hymenoptera: Ichneumonoidea): a simultaneous molecular and morphological Bayesian approach. *Molecular Phylogenetics and Evolution*, 38, 130–145. http://dx.doi.org/10.1016/j.ympev.2005.08.006
Zaldivar-Riverón, A., Belokobylskij, S.A., León-Regagnon, V., Briceño-G, R. & Quicke, D.L.J. (2008a) Molecular phylogeny and historical biogeography of the cosmopolitan parasitic wasp subfamily Doryctinae (Hymenoptera:Braconidae). *Invertebrate Systematics*, 22, 345–363. http://dx.doi.org/10.1071/is07028
Zaldivar-Riverón, A., Shaw, M.R., Sáez, A.G., Mori, M., Belokobylskij, S.A., Shaw, S.R. & Quicke, D.L.J. (2008b) Evolution of the parasitic wasp subfamily Rogadinae (Braconidae): phylogeny and evolution of lepidopteran host ranges and mummy characteristics. *BMC Evolutionary Biology*, 8, 329–349. http://10.1186/1471-2148-8-329
Zaldívar-Riverón, A., Rodríguez-Jiménez, A., Sarmiento, C.E., Pedraza-Lara, C. & López-Estrada, E.K. (2013) Phylogenetic relationships and description of *Bolivar*, a new genus of Neotropical doryctine wasps (Hymenoptera: Braconidae). *Invertebrate Systematics*, 27, 673–688.

SUPPLEMENT

TABLE 1. Material included in molecular analysis and Genbank sequence accessions numbers.

Species	Voucher code	Provenance	Genbank accession numbers	
			28S D2-D3 rDNA	COI
Betylobraconinae				
Betylobracon waterhousei		Australia	AJ245686	-
Mesocentrus sasquatch **sp. nov.**	BKK0002	Papua New Guinea	KM067176	KM067253
Mesocentrus sp2.	BF000422	Australia	KM067175	JF963534
Mesocentrus sp1.	BCLDQ0636	Australia	-	JF963533
Mesocentrus sp3	JM645	Australia	AY935461	-
Doryctinae				
Dendrosoter protuberans	JM920	Turkey	EF645736	EF645775
Doryctes erythromelas		USA	GQ374709	GQ374627
Heterospilus prosopidis		lab. culture UK	AY935469	AY935396
*Hypodoryctes sibiricus**	none & JM981	Finland & no data	AJ302895	DQ498965
Megaloproctus sp.		Colombia	AY935466	AY935393
Hormiinae				
Hormius moniliatus		Greenland	-	KF604624
Hormius sp.	JM582	Madagascar	AY935455	AY935385
Parahormius sp.	JM576	Cameroon	AY935456	AY935386
Lysiterminae				

.....continued on the next page

TABLE 1. (Continued)

Species	Voucher code	Provenance	Genbank accession numbers	
			28S D2-D3 rDNA	COI
Acanthormius sp.	JM692	Madagascar	AJ302883	AY935381
Atritermus pedestris	NHM675950	Madagascar	DQ414401	-
Katytermus sp.	Hym-08	Japan	EU854406	EU979624
Lysitermus sp.	BF000511	Nigeria	KM067177	JF963503
Pentatermus sp1	JM695	Benin	AY935453	AY935383
Pentatermus sp2	BCLDQ00264	Thailand	KM067179	KM067254
Pentatermus sp3	NHM671109 & NHM671669	Madagascar	KM067178	FN662435
Platyrmus maichaui			EU854407	-
Tetratermus sp1	BF000596	Nigeria	KM067180	JF963422
Tetratermus sp2	AL0217	Uganda	AY935452	AY935452
Lysiterminae gen. sp.	DQBJS001	Australia	KM067181	KM067255
Pambolinae-Chremylini				
Cedria sp.	JM579	Madagascar	AY935460	AY935390
Carinitermus sp..	NHM671037	Madagascar	DQ414402	JF963048
Pambolinae-Pambolini				
Notiopambolus depressicauda	JM651	Australia	AY935459	JF963049
Pambolus sp1	JM597	Venezuela	AY935458	AY935388
Pambolus sp 2	AW125	Costa Rica	JN212493	JN212220
Pambolus sp 3	BF000614	Nigeria	KM067185	JF963048
Parachremylus			EU854408	-
Rhysipolinae				
Noserus ?flavicola	JM696	Russia	AY935454	AY935384
Pseudorhysipolis sp.	JM758	Costa Rica	AY935450	AY935377
Rhysipolis temporalis	JM886	Russia	AY935449	AY935376
Rhysipolis sp.	JMH2010	-	GQ374708	GQ374626
Rogadinae-Aleiodini				
Aleiodes antescutum	BCLDQ00210	Thailand	KM067183	JF962536
Aleiodes apiculatus	MRS028	UK	EF115440	EF115455
Aleiodes grassator	MRS163	Hungary	EU854332	EU979584
Aleiodes nigricornis	MRS216	UK	AJ784934	EU979585
Aleiodes nobilis	BCLDQ00123	UK	KM067184	JF962562
Aleiodes pallidator	MRS001	Turkey	EU854333	EU979586
Aleiodes praetor	MRS067	UK	EU854334	KM067256
Aleiodes rufipes	MRS312	Sweden	KM067186	KM067257
Aleiodes testaceus	AL0058	UK	EF115493	EF115454
Arcaleiodes siamensis	BCLDQ00781	Thailand	KM067187	JQ388379
Arcaleiodes sp.	BCLDQ00286	Nepal	KM067188	JF962914
Athacryvac sp.	BCLDQ00697	French Guyana	KM067189	JF962609
Heterogamus dispar	AL201	UK	KM067190	JF963404
Heterogamus fasciatipennis	MRS394	Sweden	EU854358	EU979609

.....continued on the next page

TABLE 1. (Continued)

Species	Voucher code	Provenance	Genbank accession numbers	
			28S D2-D3 rDNA	COI
Rogadinae-Clinocentrini				
Artocella askewi		Spain	AY93335451	AY935379
Clinocentrus cuncator	JM702	UK	AJ784962	AY935378
Clinocentrus sp1	BCLDQ01211	Colombia	KM067192	HM435170
Clinocentrus sp 2	NHM671058	Madagascar	KM067194	-
Clinocentrus sp 3	BF000440	Hungary	KM067193	JF963115
Clinocentrus sp 4	BCLDQ00835	Colombia	KM067191	JF963113
Confusocentrus panturat	BCLDQ01571	Thailand	-	KM067258
Kerevata clarksoni	DQBKK0006	Papua New Guinea	KM067195	KM067259
Kerevata hammondi	DQBKK0008	Papua New Guinea	KM067196	KM067260
Kerevata jamesmayi	DQBKK0007	Papua New Guinea	KM067197	KM067261
Tebennotoma	AL170	Taiwan	AJ784933	AY935380
Rogadinae-Rogadini				
Canalirogas sp.	BCLDQ00235	Thailand	KM067198	JF963044
Colastomion gregarius	USNMENT00680021	Papua New Guinea	KM067200	JF963128
Cornutorogas sp.	BCLDQ00149	Thailand	KM067201	KM067262
Darnilia sp.	BCLDQ00165	Thailand	KM067199	KM067263
Gyroneuron sp.	BCLDQ00187	Thailand	KM067202	JF963364
Macrostomion sp.	BCLDQ00136	Thailand	KM067203	JF963522
Megarhogas ?maculipennis	AL0138	Thailand	EU854379	JF963804
Rectivena sp.	AL0204	Benin	EU854384	EU979618
Rhinoprotoma masneri	NZHYM174-10	New Zealand	-	KM201332
Rogas luteus	CNIN200	France	KM067204	KM067264
Spinaria sp.	BCLDQ0638	Thailand	KM067205	FN662444
Triraphis tricolor	MRS553	Netherlands	KM067206	KM067265
Rogadinae-Stiropiini				
Choreborogas sp.	AL508	Costa Rica	KM067207	JF963107
Polystenidea sp.	JM821	Colombia	AY935448	AY935374
Stiropius sp1	AW004	Costa Rica	JN212496	JN212223
Stiropius sp.	JM730	Costa Rica	AJ784961	AY935373
Rogadinae-Yeliconini-Facitorina				
Asiabregma sp.		Malaysia	AY935462	-
Conobregma sp.	Zoo27	Dominican Republic	JF979880	JF963138
Facitorus sp.	HYM011	Vietnam	EU450765	EU450766
Rogadinae-Yeliconini-Yeliconina				
Bulborogas compressifemur	BMNHE897754	Belize	KM067209	KM067266
Bulborogas sp.	AL0202	Colombia	AJ784930	-
Bulborogas sp.	AL0203	French Guyana	EU854359	AY935372
Pseudoyelicones limonensis	JM738	Costa Rica	AJ784929	-
Pseudoyelicones sp.	DHJPAR0035971	Costa Rica	KM067210	KM067267

.....continued on the next page

TABLE 1. (Continued)

Species	Voucher code	Provenance	Genbank accession numbers	
			28S D2-D3 rDNA	COI
Yelicones artitus	BCLDQ0457	Costa Rica	KM067211	JF963958
Yelicones belokobylskiji	BCLDQ01346	Taiwan	AJ784322	AJ784322
Yelicones delicatus	JM762	USA	AJ784327	KM067268
Yelicones kibaleiensis	AL0210	Uganda	AJ784321	AJ784321
Yelicones siamensis *	AL0115 & BCLDQ01451	Thailand	AJ784323	JN278234
Yelicones spectabile	JM734	Madagascar	AJ784319	AJ784319
unplaced				
Anachyra sp. **	-	Malaysia	AY935463	-
Aulosaphobracon capitatus	-	Vietnam	EU450764	-

* combined sequences from two individuals;
** In this and several other analyses, the genus appears to belong to the Clinocentrini rather than the Rhyssalinae.