A remarkable new genus and species of Rogadinae (Hymenoptera: Braconidae) of uncertain tribal placement, from Papua New Guinea, resembling Betylobraconini stat. nov.

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Cyranorogas gen. nov. (type species C. depardeui sp. nov.) from Papua New Guinea is described and illustrated. The new taxon has a uniquely produced mid-longitudinal facial ridge, which differentiates it from all other genera of Braconidae. The difficulty of distinguishing the Betylobraconinae from the Rogadinae, especially from various members of the Yeliconini, is discussed, and they are formally synonymised here with the Betylobraconini recognised as a tribe of Rogadinae. No clear synapomorphy with either Yeliconini or Betylobraconini could be found for Cyranorogas leaving its tribal placement uncertain, attempts to obtain molecular sequence data having been unsuccessful.

http://zoobank.org/urn:lsid:zoobank.org:pub:62F13CF8-7821-451C-9F14-C40B2D1CC4B5

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Introduction

The island of New Guinea is very diverse, with many endemic faunal and floral elements, and has fascinated biologists for a long time. However, relatively little is known about its braconid wasp fauna, and on the basis of recent food web studies (Hrcek et al. 2011), it is becoming clear that it has a very large number of undescribed species (Quicke et al. 2012a) and at least some undescribed genera (Quicke et al. 2012b). Despite the vast amount of material being reared, many taxa are only collected by other means such as canopy fogging, light and Malaise trapping. The specimen described here was collected as part of the Our Planet Reviewed – IBISCA Niugini 2012–2013, a joint project between Muséum national d’Histoire naturelle, Paris, Pro-Natura International, International Relief & Development (IRD), the University of Papua New Guinea, the Binatang Research Centre, the Royal Belgian Institute of Natural Sciences and Divine Word University of Madang. The project operated Malaise traps along an altitudinal transect at Mt Wilhelm in Madang Province. The specimen belongs to the cyclostome section of the Braconidae and is highly distinctive with strongly modified legs (robust femora and shortened tarsi) and has a strongly produced, almost blade-like face. Similarly modified legs are characteristic of various groups of Rogadinae, for example, Yelicones and relatives including the Facitorini (Belokobylskij et al. 2008), some

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Aleiodes species (e.g. A. globifemorus Quicke and Butcher and A. nonicones Quicke and Butcher; Butcher et al. 2012), and genera currently placed in the Betylobraconinae: tribe Betylobraconini (van Achterberg 1995).

Unfortunately we were unable to obtain DNA sequence data from the only known specimen of the new species described below, so assessment of the affinities of the new genus is necessarily based on morphology. This exercise led to the realisation that the characters used to separate Betylobraconinae (recently restricted to just Betylobraconini) from Rogadinae are insufficient to justify retaining it as a separate subfamily, especially as its always closely associated with Rogadinae in molecular analyses (see Discussion). Further, we are unable to place the new genus with any great confidence at tribe level, with various of its characters supporting placement either with the Betylobraconini or with the Yeliconini: Faciorina.

Terminology and methodology
The type material is deposited in the Muséum national d’Histoire naturelle, Paris. Wing vein terminology follows Sharkey and Wharton (1997); other terminology follows van Achterberg (1988). Illustrations were made using an Olympus SXZ16 microscope with automated multiple image capture at preset focal levels using an Olympus DP72 camera, and image combination using the Cell^D image processing system.

Systematics

Cyranorogas Quicke and Butcher gen. nov.

Generic description

FEMALE. Terminal flagellomere pointed but not acuminate. All flagellomeres with prominent sensilla placodea occupying entire length. Occipital carina incomplete, broadly absent mediodorsally, weak but distinctly joining hypostomal carina far from mandible base. Cyclostome, but hypocypleal depression small. Mandibles very small, twisted so appearing unidentate when viewed from the front, but concealed rear tooth quite broad at apex but not bifid as in Yelicones. Face strongly produced into a blade-like form. Frons rather flat with mid-longitudinal groove. Trancautal articulation complete. Prepectal carina complete. Precoxal sulcus present. Fore wing vein M+CU quite strongly curved on apical half making sub-basal cell somewhat narrowed. 2nd submarginal cell rather long. Vein 2cu-a absent. Propodeum with midlongitudinal carina on anterior half. Femora strongly swollen. Claws rather small, simple, without obvious pecten. Dorsal carinae of 1st tergite uniting close to base and forming strong midlongitudinal carina. 2nd metasomal tergite with a broad basal triangular area and well-differentiated midlongitudinal carina. Ovipositor short, exserted part about as long as hind basitarsus, needle-like and sharply-pointed.
Etymology
Named in allusion to the facial protuberance after the Parisian poet, dramatist and duelist, Hercule-Savinien Cyrano de Bergerac (1619–1655), who reportedly had such an exceptionally large nose that people would travel miles to see it. (Masculine.)

Type species
*C. depardeui* sp. nov.

Notes
In van Achterberg’s (1995) key to the genera of Braconidae with highly modified fore tarsi, the new genus falters at couplet 42, but is immediately recognisable by its strongly and sharply produced face. The new genus differs from *Rhinoprotoma* van Achterberg, from New Zealand, which also has a somewhat protruding face in that, in *Rhinoprotoma*, the face is smoothly rounded and not formed into a midlongitudinal ridge (see Figure 346 in van Achterberg 1995). In addition, *Rhinoprotoma* lacks a mid-longitudinal propodeal carina, lacks a mid-longitudinal carina on the 1st tergite, lacks a mid-basal area on the 2nd tergite and does not have such robust legs.

*C. depardieui* Quicke and Butcher sp. nov.  
(Figures 1–3)

Holotype ♀, Papua-New-Guinea, Province Madang, Mt Wilhelm 1700 m (−5.759269,145.2356), 28–29/10/2012, leg Valeba, Tulei, Novotny, Leponce, Plot 4, understorey; Malaise – MAL-MW1700D-04/16-d04.

Length of body 3 mm. Antenna with 25 flagellomeres. Median flagellomeres approximately 1.9× longer than wide. Length of fore wing 3 mm. Precoxal sulcus, deep, rather short, crenulate, located rather low down side of mesopleuron. Scutellar sulcus wide, deep, curved, with six strong carinae between outer ones. Mesopleuron largely smooth and shiny. Propodeum with midlongitudinal carina on anterior 0.7, where it divides to form a weak transverse carina, and posterior to this propodeum irregularly rugose. Body largely honey-yellow, posterior of propodeum, base of hind coxa narrowly, metasomal tergites 1 and 2 and basal part of tergum 3 white. Wings hyaline with brown venation.

Etymology. Named in honour of the actor Gérard Depardieu who played Cyrano de Bergerac in the 1990 film adaptation.

Discussion
The limits of the Betylobraconinae have been subject to a great deal of change considering that the subfamily was only erected in 1979 by Tobias for his newly described and highly aberrant Australian genus *Betylobracon* which, despite not being cyclostome, he considered might be related to the ‘Braconinae phylogenetic branch’, i.e. a member of the otherwise largely morphologically cyclostome lineage of braconids. Subsequently, van Achterberg (1984) recognised that *Betylobracon* was closely related to the long forgotten genus *Mesocentrus* from Australia and New Guinea,
described by Szépligeti (1900), which is very distinctly cyclostome and has a quite Rogadinae-like appearance. Indeed, *Mesocentrus* species have been confused quite often with members of the undoubted rogadine genus *Yelicones*. Van Achterberg (1995) in his revision of those, principally cyclostome, Braconidae with shortened fore tarsi described two new tribes within Betylobraconinae as well as adding a genus (*Promesocentrus*) to the nominal tribe, Betylobraconini. These tribes were the Facitorini, comprising *Facitorus, Conobregma* and *Jannya*, and the Planitorini, comprising the single genus *Planitorus* from Australia. Belokobylskij and Long (2005)

Figure 1. *Cyranorogas depardeui* gen. nov. et sp. nov. Holotype female: (A) habitus; (B) head, lateral view; (C) head, dorsal view; (D) head, anterior view.
Figure 2. *Cyranorogas depardeui* gen. nov. et sp. nov. Holotype female: (A) mesoscutum to scutellum, dorsal view; (B) mesosoma lateral view; (C) propodeum and metasomal tergites 1–3, oblique dorsal view.
added the tribe Aulosaphobraconini for their new genus, _Aulosaphobracon_, from Vietnam which differed from the other taxa in having a relatively longer ovipositor.

Molecular data have, however, resulted in major changes to the composition of the subfamily. The Planitorini turned out not to be cyclostome braconids at all, but instead are members of the subfamily Euphorinae (Sharanowski et al. 2011) and, indeed, they show no indication of the cyclostome condition and lack hind wing vein m-cu which is present in all other taxa placed in the Betylobraconinae. Nor are the remainder of the subfamily monophyletic. Belokobylskij et al. (2008) and Zaldivar-Riverón et al. (2008) both failed to recover the subfamily as monophyletic. _Aulosaphobracon_ was recovered very basal to the group comprising Rogadinae + Lysiterminae + Betylobraconini, which is consistent with its completely areolate propodeum, longer ovipositor and dorsal carinae on 1st metasomal tergite remaining separate. In fact, it is hard to know why it was ever included with the other betylobraconines; it may best be regarded as a cyclostome *incertae sedis*. The Facitorini, represented in the molecular data set by _Facitorus_ and _Asiabregma_ (Belokobylskij et al. 2008), were recovered with significant support as part of the Yeliconini (Rogadinae) and thus Belokobylskij et al. (2008) synonymized it with the Yeliconini, retaining it therein as a subtribe, the Facitorina. Additional 28S ribosomal DNA data for _Conobregma_ also support this conclusion (Quicke, unpublished).

Figure 3. *Cyranobracon depardeui* gen. nov. et sp. nov. Holotype female: (A) fore wing; (B) hind wing.
Although in earlier molecular investigations the Betylobraconinae s.s., i.e. *Betylobracon* and *Mesocentrus*, were sometimes recovered separate from the Rogadinae (e.g., Belshaw et al. 2000), more recent molecular investigations including larger numbers of rogadine and other cyclostome taxa have consistently been recovered either as a sister group to the Rogadinae (e.g., Zaldivar-Riverón et al. 2008) or nested within the Rogadinae (e.g., Zaldivar-Riverón et al. 2006; Belokobylskij et al. 2008; Quicke et al. 2014), albeit sometimes with the Rogadinae not recovered as monophyletic (Butcher et al. 2014). They have effectively been retained as a separate subfamily only because *Betylobracon* itself is so morphologically derived. Betylobraconines share with the Rogadinae a more or less developed basal triangular area on the 2nd metasomal tergite, a first tergite with well-developed dorsal carinae that unite close to the anterior end of the tergum, and a short and apically simple ovipositor (though it is considerably longer in the Clinocentrini).

Endoparasitism of Lepidoptera larvae which are subsequently mummified with the wasp pupating inside the eaten out host remains is the principal synapomorphy of the Rogadinae. It is therefore a great shame that no betylobraconines have been reared and so nothing is known about their mode of parasitism, despite at least *Mesocentrus* being quite speciose, widely distributed in Australia and some islands in Oceania. The short and finely tipped ovipositors of both *Cyranorogas*, *Betylobracon* and *Mesocentrus* strongly suggest that they oviposit into a small host, and the robust legs and protruding or shield-like faces of most species suggest that they force their way into the host’s microhabitat and would be consistent with hosts either living in silk webbing or in the soil (Quicke, in press).

Given the above, and despite lack of biological data, we consider that morphology and DNA sequence data provide convincing evidence that the Betylobraconinae are a derived group of Rogadinae, and we hereby formally synonymise Betylobraconinae Tobias, 1979 (= Rogadinae Foerster, 1862) and treat them as the tribe Betylobraconini therein.

Characters of the new genus and putative relatives are summarised in Table 1. *Betylobracon* and *Mesocentrus* both lack or have a very reduced fore wing vein 2cu-a (interpreted as Cu1b by some authors), whereas most members of the Rogadinae, including the Facоторini, have it well developed (van Achterberg 1995), and thus this character might help in ascertaining the affinities of *Cyranorogas* gen. nov. In the new genus the vein is virtually absent (Figure 3A), though there is a distinct break in the posterior margin at the junction of what would be veins 2CUa and 2CUb, as indeed do some *Mesocentrus* species and *Promesocentrus*, although keyed as having the vein absent (van Achterberg 1995), appears to have at least a trace of the vein (Figure 287 in van Achterberg 1995). Thus, on the basis of this characteristic, *Cyranorogas* gen. nov. could be a member of the Betylobraconini. However, its strongly medially produced face, the closely opposed antennal sockets, and rather strongly curved fore wing vein M+CU are much more like the condition of Facоторina. But it lacks their apomorph hind wing venation, with a ‘spurious’ longitudinal vein arising at what would normally be called vein r-m, though the possibility that this represents a shift in the position of vein 2-M cannot, we think, be excluded. We also can not completely exclude the possibility that *Cyranorogas* gen. nov. belongs to the Aleiodini, though the wide scutellar sulcus and wide and posteriorly somewhat rounded basal area on the 2nd metasomal tergite is not typical for that group. We are therefore uncertain as to where it should be classified, and indeed, we are not fully
Table 1. Summary of features of *Cyranorogas* gen. nov. and other Rogadinae with bulbous or protruding face or swollen femora or shortened fore tarsi.

| Cyranorogas Facitorini Yelicones Aulosaphobraconini Pseudoyelicones Rhinoprotoma Bulborogas Aleiodes Betylobraconini globifemorus |
|---|---|---|---|---|---|---|---|---|
| Number of flagellar segments | Face protruding | ● | ● | ● | ● | ● | ○ | ○ |
| Fore tarsal segments 2-4 shortened | Face not protruding | ● | ● | ● | ● | ● | ○ | ○ |
| Femora strongly swollen | Tarsal segments of normal proportion | ● | ● | ● | ● | ● | ○ | ○ |
| Hind wing with spurious longitudinal vein arising from R | Femora of normal proportion | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| Fore wing vein M+CU strongly bowed distally | Hind wing without spurious vein | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| Fore wing vein 2cu-a absent | Fore wing vein M+CU not or only slightly curved | ○ | ● | ○ | ○ | ○ | ○ | ○ |
| 2nd metasomal tergite without midlongitudinal carina | Fore wing vein 2cu-a present | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| 2nd metasomal tergite with carina | 2052 B.A. Butcher and D.L.J. Quicke |
convinced that *Promesocentrus* is truly also a member of the Betylobraconini. It is to be hoped that molecular data will become available for these taxa in the not too distant future.

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**Disclosure statement**

No potential conflict of interest was reported by the author(s).

**References**

Belokobylskij SA, Long KD. 2005. The braconid wasps of the subfamily Betylobraconinae (Hymenoptera, Braconidae) in Vietnam. Deutsche Entomol Z. 52:155–164.

Belokobylskij SA, Zaldívar-Riverón A, Maetô K, Sáez AG. 2008. Asian Betylobraconinae (Hymenoptera, Braconidae), with description of a new genus and phylogenetic affinities of the tribe Facitorini. Insect Syst Evol. 39:133–154.

Belshaw R, Downton M, Quicke DLJ, Austin AD. 2000. Estimating ancestral geographic distributions: a Gondwanan origin for a group of principally north temperate aphid parasitoids. Proc R Soc Lond B. 267:491–496.

Butcher BA, Smith MA, Sharkey MJ, Quicke DLJ. 2012. A turbo-taxonomic study of Thai *Aleiodes (Aleiodes)* and *Aleiodes (Arcaleiodes)* (Hymenoptera: Braconidae: Rogadinae) based largely on COI barcoded specimens, with rapid descriptions of 179 new species. Zootaxa. 3457:1–232.

Butcher BA, Zaldívar-Riverón A, van de Kamp T, dos Santos Rolo T, Baumbach T, Quicke DLJ. 2014. 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. Zootaxa. 3860:449–463.

Hrcek J, Miller SE, Quicke DLJ, Smith MA. 2011. Molecular detection of trophic links in a complex insect host-parasitoid food web. Mol Ecol Res. 11:786–794.

Quicke DLJ. in press. Biology, systematics, evolution and ecology of braconid and ichneumonid parasitoid wasps. Chichester (UK): Wiley Blackwell.

Quicke DLJ, Shaw MR, van Achterberg C, Bland KP, Butler BA, Lyszkowski R, Zhang YM. 2014. A new Australian genus and five new species of Rogadinae (Hymenoptera: Braconidae), one reared as a gregarious endoparasitoid of an unidentified limacodid (Lepidoptera). Zootaxa. 3881:237–257.

Quicke DLJ, Smith MA, 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. J Hym Res. 28:135–141.

Quicke DLJ, Smith MA, Miller SE, Hrcek J, Butler BA. 2012a. *Colastomion* Baker (Braconidae, Rogadinae): nine new species from Papua New Guinea reared from Crambidae. J Hym Res. 28:85–121.

Quicke DLJ, Smith MA, van Achterberg C, Miller SE, Hrcek J. 2012b. A new genus and three new species of parasitoid wasp from Papua New Guinea and redescription of
Sharanowski BJ, Dowling APG, Sharkey MJ. 2011. Molecular phylogenetics of Braconidae (Hymenoptera: Ichneumonoidea), based on multiple nuclear genes, and implications for classification. Syst Ent. 36:549–572.

Sharkey MJ, Wharton RA. 1997. Morphology & terminology. In: Wharton RA, Marsh PM, Sharkey MJ, editors. Identification manual to the new world genera of Braconidae, Vol. 1. Washington (DC): Special Publication of the International Society of Hymenopterists; p. 19–37.

Szépligeti G. 1900. Braconiden aus Neu-Guinea in der Sammlung des Ung. National-Museums. Termész Füz. 23:49–65.

Tobias VI. 1979. [Two new and little known subfamilies of Braconidae (Hymenoptera) from Australia]. Entomol Obozr. 58:128–142. Russian.

van Achterberg C. 1984. Essay on the phylogeny of Braconidae (Hymenoptera: Ichneumonoidea). Entomol Tidsskr. 105:41–58.

van Achterberg C. 1988. Revision of the subfamily Blacinae Foerster (Hymenoptera: Braconidae). Zool Verh Leiden. 249:1–324.

van Achterberg C. 1995. Generic revision of the subfamily Bethylobraconinae (Hymenoptera: Braconidae) and other groups with modified fore tarsus. Zool Verh Leiden. 298:1–242.

Zaldivar-Riverón A, Areekul B, Shaw MR, Quicke DLJ. 2004. Comparative morphology of the venom apparatus in the braconid wasp subfamily Rogadinae (Insecta, Hymenoptera, Braconidae) and related taxa. Zool Scripta. 33:223–237.

Zaldivar-Riverón A, Mori M, Quicke DLJ. 2006. Systematics of the cyclostome subfamilies of braconid parasitic wasps (Hymenoptera: Ichneumonoidea): a simultaneous molecular and morphological Bayesian approach. Mol Phyl Evol. 38:130–145.

Zaldivar-Riverón A, Shaw MR, Sáez AG, Mori M, Belokobylskij SA, Shaw SR, Quicke DLJ. 2008. Evolution of the parasitic wasp subfamily Rogadinae (Braconidae): phylogeny and evolution of lepidopteran host ranges and mummy characteristics. BMC Evol Biol. 8:329.