

# Clarification of the author and year of publication of *Cotesia chilonis*, a species used widely for biological control of *Chilo* stem borers

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## Abstract

*Cotesia chilonis* (Munakata, 1912) (Hymenoptera: Braconidae, Microgastrinae) is a species used widely for biological control of several species of *Chilo* (Lepidoptera: Crambidae) stem borers. The genus name, species author and year of publication associated with this parasitoid wasp species have varied historically. Based on the available evidence, a complete account of the history and nomenclatural acts associated with *C. chilonis* is presented, the different alternatives are weighed and discussed, and what is considered as the best alternative is proposed. It is expected that this paper will contribute to clarity and stability in the use of this species name, author and year.

## Keywords

*Cotesia chilonis*, Microgastrinae, *Chilo* stem borers, biocontrol, taxonomy, Japan

## Introduction

*Cotesia chilonis* (Munakata, 1912) is a parasitoid wasp (Braconidae: Microgasterinae) originally described from Japan and widely used in biological control projects against caterpillar stem borers in the genus *Chilo* (Lepidoptera: Crambidae), pests of graminaceous crops in the Oriental and Afrotropical regions (Kfir et al. 1992, Polaszek and Walker 1992, Polaszek 1998).

*Cotesia chilonis* belongs to the *Cotesia flavipes* species complex, which includes four species parasitizing stem-boring pests associated with sugarcane and cereal crops (Walker 1994, Muirhead et al. 2008). The monophyly of the complex is well supported by molecular (Smith and Kambhampati 1999; Michel-Salzat and Whitfield 2004; Muirhead et al. 2006, 2008) and morphological characters, such as a dorsoventrally compressed mesosoma (Watanabe 1965; Walker 1994, Muirhead et al. 2008).

The correct genus of the species, as well as its author and publication year (= original description) have long been in a state of confusion. As a result, the considerable literature on *C. chilonis* is replete with errors. The species has been placed either in *Apanteles* or in *Cotesia*, the authorship has been attributed either to Tetsuzo Munakata or to Shonen Matsumura, and the year of the original description has been cited as either 1910 or 1912.

Because of the importance of this species in biological control, the generic placement, author and year of description of *Cotesia chilonis* must be clarified.

## Methods

We carefully examined the scientific literature relating to this species, including the report in which the species was originally described (Anonymous 1912). We made an effort to study all taxonomic references to *Cotesia chilonis* that we are aware of, and also consulted several colleagues who are proficient in Japanese and/or had seen the original paper (see Acknowledgments).

We estimated the number of citations for the different variants of the species names, species author, and year of publication by performing searches on Zoological Record, Google Scholar, and Google.

## Results

*Cotesia chilonis* was originally described in *Apanteles* (the original description has 'Apanteles' misspelled as 'Apantetus', see Fig. 1). However, Mason (1981) divided *Apanteles* into several genera, either new or resurrected (such as *Cotesia* Cameron, 1891) and transferred many known species, but unfortunately not *Apanteles chilonis*, to his newly proposed genera. Mason's (1981) study was instrumental in highlighting the polyphyly of *Apanteles* s.l., a finding that led to the separation of *Cotesia* and *Apanteles* s.str. as separate, unrelated genera.

墨色、複眼黒褐色楕圓形、單眼三個頭頂ニアリ、觸角糸狀二十六節ヨリナル、胸部黒色翅蓋及ビ翅ノ基部黄色、翅透明、翅脈黄褐色、脚ハ橙黄色ヲ呈シ、後脛節ノ末端ハ黒色腹部紡錘形八節ヨリナリ産卵管赤褐色、

四、アヲモリコマユバチ

(第二圖ノ四)

學名 *Microplitis aomoriensis* Mats.

♀、体長二分、翅ノ開張四分二厘計リアリ、頭部黒色、複眼楕圓形ニシテ黒色、單眼三個、觸角糸狀十八節ヨリナル、第一節ハ膨大シ、第二節ト共ニ黒色ナレ共第三節以下ハ橙黄色ヲ呈ス、胸部黒色、翅殆ント透明ニシテ翅脈黄褐色ナリ、第二副前緣室ハ頗ル小形ニシテ第三副前緣室ハ脛室ト合一シ、背走脈一個ヲ有ス、脚ハ基部跗節ノ末端及ビ後脛節ノ末端ヲ除クノ外ハ悉ク橙黄色ナリ、腹部橙黄色ニシテ八節ヨリナリ、腹端部ニ黒斑ヲ有ス、産卵管赤褐色ニシテ長サ六厘許リアリ、♂ハ後脚跗節ノ黒色ナルト腹部ノ後端ニ於ケル黒色部多キトニヨリ區別セラル、

五、メイテユウコマユバチ

(第二圖ノ五)

學名 *Apanteles chilonis* Mats.

♂、体長八厘、翅ノ開張一分六七厘アリ、頭部黒色、腹眼黒褐色ニシテ楕圓形、單眼橙黄色、觸角糸狀十八節ヨリナル、胸部黒色ニシテ細毛ヲ裝ヒ、翅透明、翅脈橙黄色、脛室

Figure 1. Copy of page 69 of the 1912 anonymous report with the original description of *Cotesia chilonis* (Munakata, 1912). The red square shows the original species name and attributed author.

Austin and Dangerfield (1989: 137) were the first authors to propose unequivocally the new combination, and to formally transfer the species to *Cotesia* (although they did so briefly in a paper section discussing unrelated species of *Apanteles*, and the nomenclatural act was not mentioned elsewhere). One year later Papp (1990: 117), unaware of that reference, proposed the same new combination (he did so in an Appendix rather unrelated to the main content of his paper, which was devoted to reporting Microgastrinae species from Korea). The fact that the new nomenclatural act was not clearly visible or referenced in either of those two papers probably contributed to subsequent overlooking of the new generic placement of *chilonis*. [Both Austin and Dangerfield (1989) and Papp (1990) attributed the authorship of the species to Matsumura instead of Munakata, see below for more discussion on that].

*Cotesia* has been universally recognized and accepted as a valid genus by the taxonomic and biological control research community (e.g., Yu et al. 2012, and references to the genus cited therein). However, due to the confusing circumstances detailed above, the species *C. chilonis* has continued to be variously placed in either *Apanteles* or *Cotesia*. For example, basic searches made in November, 2014 using the names ‘*Apanteles chilonis*’ or ‘*Cotesia chilonis*’ revealed, respectively 35 and 28 citations in Zoological Record and, 651 and 714 citations in Google Scholar. At the same time a general search in Google reveals 4,280 and 6,020 results, respectively.

Searches performed with Zoological Record, Google Scholar, and Google revealed an equally confusing mix for the author and publication year of *C. chilonis* (Table 1). *Cotesia chilonis* was originally described in a report of the Agriculture Experiment Station of Aomori, Japan. The report does not clearly state its author, but apparently it was written by Tetsuzo Munakata, although the species is mentioned in the paper as ‘*Apantetus chilonis* Mats.’ (Fig. 1).

Watanabe (1965) provided additional and useful information on the author and year of publication, and it should be taken as the best information available to settle the issue. Watanabe (1965: 114, reproduced in Fig. 2) states that “In 1912 *Apanteles chilonis* was originally described anonymously as a parasite of the rice stem borer, *Chilo suppressalis*, but there are certain evidences that the author is Tetsuzo Munakata.” The next sentences from Watanabe (see Fig. 2) suggest that Munakata sent the

**Table 1.** Searches performed in November 2014 on three different online databases or search engines, using two different strings of words: “Apanteles+Cotesia+chilonis+Matsumura” or “Apanteles+Cotesia+chilonis+Munakata”.

Online Database/ Search Engine	<i>Apanteles/Cotesia chilonis</i> Matsumura (Total)	<i>Apanteles/Cotesia chilonis</i> Munakata (Total)
Zoological Record	8	9
Google Scholar	66	49
Google	3180	256

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Okinawa, Mauritius and Australia.

***Apanteles chilonis* [Munakata]**

*Apantetus* (!) *chilonis* [Munakata], Extra Report Agr. Exp. Sta. Aomori No. 2: 69, 1912. JAPAN: Aomori. Host: *Chilo suppressalis* (= *C. simplex*).

*Apanteles* (*Stenopleura*) *chilocida* Viereck. Proc. U. S. Nat. Mus. 43: 582, 1913. JAPAN. Host: *Chilo suppressalis*.

*Apanteles chilocida*: Wilkinson, Bull. Ent. Res. 19: 94, 1928.

*Apanteles flavipes* f. *chilonis*: Watanabe, Trans. Sapporo Nat. Hist. Soc. 12: 69, 1932.

In 1912 *Apanteles chilonis* was originally described anonymously as a parasite of the rice stem borer, *Chilo suppressalis*, but there are certain evidences that the author is Tetsuzo Munakata. The type is lost, and yet in the Entomological Institute, Hokkaido University, are deposited authentic material (4 ♀♀, Aomori, 1911, on a block of pith with a determination label — "*Apanteles chilonis* n. sp." — in Matsumura's own hand-writing) which was sent by Munakata to Prof. Matsumura for identification. From the series I have selected as neotype of *chilonis* the single female which is in the best condition. Just after the above-mentioned publication Viereck (1913) described originally *Apanteles chilocida* as a parasite of the same host. This name, however, already has been suppressed as a synonym of *chilonis* by Watanabe (1932).

This insect is so closely related to *A. flavipes* that there are two different views about the taxonomy of the Japanese form: Wilkinson (1928, etc.) treats it as a full species; on the other hand Watanabe (1932, etc.) considers it a form of *flavipes*. Having examined a number of specimens of both the forms I am much inclined to the opinion that *chilonis* should be treated as a distinct species. Differences are noticeable between the two in the punctuation of the prothorax, mesopleura and hind coxae as well as in the colouration of the hind coxae as states in the present key. These differences would seem to be more reliable to separate the two than the prominence of the face and the declivity of the propodeum which are characters used by Wilkinson in his key: because in *chilonis* those features tend to become inconspicuous, while in *flavipes* they seem to be very variable in strength.

In general, this species is darker in colour than *flavipes*: the antennae are yellowish brown to brown, not reddish yellow as in *flavipes*. Having examined the genitalia of both sexes I have found that there are no special differences between the two species in genital structures. The first abscissa of the radius is not clearly shorter than the transverse cubitus but as long as or sometimes rather longer than the latter.

JAPAN: Aomori, 4 ♀♀ (including the neotype of *chilonis*), 1911 (T. Munakata). Many other specimens examined are collected at the following localities: —Kyushu: Taniyama (S. Fukamachi); Yokkaichi and Fukuoka (I. Tateishi); Futsukaichi (K. Yano); and Miyazaki (H. Sakimura). Honshu: Masuda, Taito, Hikawa, Ota and Hamada (T. Fujishima); Kanazawa (H. Kawase); Shonai and Omagari (T. Hidaka); Nishiki-mura and Omagari (M. Kikuchi); and Morioka (H. Omori).

**Figure 2.** Copy of page 114 of Watanabe (1965). The red square shows the most relevant paragraphs. The words underlined with gray were made by an unknown source to the copy available to us for study, and are not related to the present paper.

specimens to Shonen Matsumura, who identified the species as '*Apanteles chilonis* n. sp.' and sent it back to Munakata, who then published the report with the species description in 1912.

From the above account, it seems evident that Matsumura was the one recognizing the new species, but Munakata was the one publishing it. This opinion from Watanabe agrees with that of other Japanese entomologists, e.g. the braconid specialist Kaoru Maeto (personal communication) and the ichneumonid specialist Jinhaku Sonan (1930: 141). Actually, the 1930 paper from Sonan provides an interesting fact. Sonan was dealing with another species described in the 1912 report (the ichneumonid '*Ophionellus biguttulus*' currently named '*Temelucha biguttula*'), and he also considered that, even though the original paper had written '*Ophionellus biguttulus* Mats.', Matsumura did not describe the species but it was Munakata (compare Figs 3 and 4).

Because the author of the species is not clear from the contents of the 1912 report, the author of the report (Munakata) should also be considered as the author of the species, as explained in The International Code of Zoological Nomenclature (ICZN). Article 50.1.1 states "However, if it is clear from the contents that some person other than an author of the work is alone responsible both for the name or act and for satisfying the criteria of availability other than actual publication, then that other person is the author of the name or act. *"If the identity of that other person is not explicit in the work itself, then the author is deemed to be the person who publishes the work."* The last sentence (our italics) clearly applies here, and it should be used to recognize Munakata as the author of the species.

Watanabe, who should also be considered as the First Reviser, *sensu* Article 24.2 of the ICZN, unambiguously stated the authorship of the species in two papers: Watanabe (1932a: 69) and Watanabe (1965: 114). Unfortunately he was not followed by subsequent authors. Most notably, the latest comprehensive list of world species of Braconidae (Shenefelt 1972: 468) mentioned Matsumura as the author. Shenefelt was probably the source of the mistake followed by other important references on Microgastrinae (Table 2) which unintentionally contributed to perpetuating the mistake—at least partially—until the present.

Last but not least, the year of publication has, at times, been confused by some sources (Table 2). The most common mistake (1910 instead of 1912) might have originated from another paper of Shenefelt (1965: 400), which misspelled Munakata as 'Munakato' and incorrectly assigned 1910 as the date for his report on *Cotesia chilonis*. For clarification about the actual date, we again follow Watanabe (1932a, 1932b, 1965), as he actually saw the report, studied Munakata's specimens, and even designated a neotype (Watanabe 1965: 114; see also Fig. 2).

The unfortunate chain of omissions and confusion in publications on *Cotesia chilonis* has led to this important species to be referred to by several generic names, authors, and years of publication. For the sake of clarity and stability, it is useful to provide in a single paper a complete account of the history and nomenclatural acts associated with this species. Based on the revised evidence, the history of names associated with *C. chilonis* is presented below. It is hoped that the correct names and dates (as presently understood) are adopted by future researchers.

J. Sonan: A few host-known Ichneumonidae found in Formosa (Hym.) (2). 141

$\frac{2}{3}$  as long as the body; mesonotum abruptly sloping apically, closely punctate and shortly pubescent, notauli obsolete; scutellum convex, closely rugose; propodeum rugose, with a rather broad, but shallow median furrow, which is transversely striated, external and lateral areae distinct; spiracles elliptical; first tergite linear, glabrous, apex fusiform; 4th-9th tergites strongly compressed laterally throughout; tarsal claws pectinate.

Black. Apex of mandibles reddish brown; palpi, tegulae and legs yellowish brown; antennae, coxae and hind trochanter black; hind femorae reddish brown, base and apex of tibiae, apex of metatarsi and 2nd-5th joints dark brown; wings hyaline, stigma brown, areolet somewhat large, triangular, with a distinctly petiole; recurrent nervure straight, emitting from a little beyond the middle of areolet; basal nervure continuous.

Length: Body 8mm; ovipositor 4mm; fore wing 5mm.

Host. Larvae of *Homona menciata* Walker (Author).

Hab. Type ♀, Shiuchiku, Apr. 4, 1921 (Author); Paratype ♀, Heichin (Shinchiku-Shu), May 1, 1930 (Author).

This species is allied to *Limnerium forticarinatum* Cameron (1906) and *L. quettaeus* Cameron (1906), but differs from them by the wanting of areola of propodeum, elliptical spiracles, yellowish brown legs, and black apices of hind tibiae.

**CREMASTUS**, Cravenhorst. Ichn. Europ. iii, p. 730(1829).

Subgen. **TARYTIA** Cameron, Journ. Bombay Nat. Hist. Soc. p. 588 (1907) 4764

**CREMASTIDEA**, Viereck, Proc. U. S. Nat. Mus. 43, no. 1942 p. 587 (1912).

1950 **Cremastus (Tarytia) biguttulus** (Munakata).

*Ophioellus biguttulus* Matsumura (non desc.), Munakata.

Extra Report Agric. Exp. Stat. Aomori, no. 2, p. 67, pl. ii

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Trans. N. H. S. F. Vol. XX. (Jun. 1930)

fig. 1, ♀ (1910); Kondo, Extra Rept. Agric. Stat. Nagasaki, no. 15, p. 101 (1917); Nawa, Insect world Giftu, xix, no. 219, p. 456 (1915). (Japan).

17275 *Cremastus (Cremastidea) chinensis* Viereck, Proc. U. S. Nat. Mus. 43, no. 1942, p. 587, ♂ ♀ (1912). (China, Japan).

*Deaparsis japonica* Uchida (nec Ashmead), Jour. Fac. Agric. Hokk. Imp. Univ Sapporo, xxi, pt. 2, p. 285, pl. vi, fig. 16, ♂ (1928).

**Figure 3.** Copy of pages 141 and 142 (partially) of Sonan (1930). The red square shows Sonan's interpretation of the species author for one of the species described by Munakata in 1912. The annotations added with a pencil (in gray) were made by an unknown source to the copy available to us for study, and are not related to the present paper.

本調査ニ依レバ、藁打法ハ、螟虫驅除法ノ中最モ有効ナルモノノ一タルヲ失ハズ、而シテ其ノ回数ハ五十回ヲ以テ最適度ト認ムベキガ如シ、

### 七、敵蟲ニ關スル調査

#### 第二十五、寄生蜂ニ關スル調査

本縣産二化螟虫ノ寄生蜂ニシテ從來發見シタルモノ六種アリ(内一種ハ第二寄生蜂ト認ムベキモノナリ)皆幼虫ニ寄生スルモノニシテ彼ノ他縣ニ多キ卵蜂ハ未ダ終ニ採集シタル事ナシ、寄生蜂ニ關シテハ目下研究中ニ屬シ何レ他日ノ調査ヲ俟テ再ビ發表スル處アルベシト雖モ、今回ハ聊カ從來ノ發見ニ係ル寄生蜂ノ種類及ビ形態ノ概要ヲ記載シ以テ讀者ノ參考ニ供セントス、而シテ標本ハ全部東北帝國大學農科大學教授松村博士ノ鑑定ヲ乞ヒシニ何レモ新種トセラレ博士ノ好意ニヨリ學名及ビ和名ノ通知ヲ得タルモノナリ、

四十二年乃至四十四年調査

(第二圖ノ一)

一、メイチュウアメバチ

學名

Ophionclius biguttulus Mats.

Figure 4. Copy of page 67 of the 1912 anonymous report. The red square shows the original species name and attributed author (compare it against Figure 3 above).



**Table 2.** Important published and/or web resources about Microgastrinae with differing accounts for the species *Cotesia chilonis* (Munakata, 1912). Comments in square brackets provide additional information when needed.

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**a) Sources with Munakata as author of the species, and publication year of 1912 (unless a different date is indicated in square brackets):**

- Taxapad (<http://www.taxapad.com/local.php?&indexstartGS=53166&taxgroupGS=ichneumonoidea>) [As *Cotesia chilonis* (Munakata, 1910), the year 1910 and the authorship used in Taxapad were based on the following reference: Shenefelt, R.D. 1965. A contribution towards knowledge of the world literature regarding Braconidae (Hymenoptera: Braconidae). *Beiträge zur Entomologie*. 15(3/4):243-500. On page 400, the Munakata paper is dated as 1910 – and the name Munakata is misspelled as Munakato].
- Catalog of Life (<http://www.catalogueoflife.org/annual-checklist/2014/search/all/key/Cotesia+chilonis/match/1>).
- GBIF (<http://www.gbif.org/species/1257878>).
- Encyclopedia of Life (<http://eol.org/pages/12063541/overview>).
- Wikipedia ([http://en.wikipedia.org/wiki/List\\_of\\_Cotesia\\_species](http://en.wikipedia.org/wiki/List_of_Cotesia_species)) [Merely a citation from EOL].
- Microgastrinae Wasps of the World (<http://microgastrinae.myspecies.info/microgastrinae/Cotesia-chilonis>).
- Barcode of Life Data Systems ([http://www.boldsystems.org/index.php/Public\\_SearchTerms?query=%22Cotesia%20chilonis%22\[tax\]](http://www.boldsystems.org/index.php/Public_SearchTerms?query=%22Cotesia%20chilonis%22[tax])) [The records included in BOLD were mined from GenBank].

**b) Sources with Matsumura as author of the species, and publication year of 1912 (unless a different date is indicated in square brackets):**

- ZooBank ([http://zoobank.org/Search?search\\_term=Apanteles+chilonis](http://zoobank.org/Search?search_term=Apanteles+chilonis)) [As *Apanteles chilonis* Matsumura, 1912. ZooBank does not have any record as '*Cotesia chilonis*'].
  - Shenefelt 1972 (Braconidae 4. Microgasterinae: *Apanteles*. *Hymenopterorum Catalogus*, 1972: page 468) [This paper represents the last comprehensive list of world species of Braconidae].
  - Whitfield Lab website (<http://www.life.illinois.edu/whitfield/CotesialCotesia.htm>) [As *Cotesia chilonis* Matsumura, 1926; the year is most likely a typographical mistake. This website contains a significant number of *Cotesia* species illustrations and is a valuable reference on the topic].
  - Sharkey Lab website (<http://www.sharkeylab.org/Cotesia/Cotesia.cgi>) [This website contains a significant number of *Cotesia* species illustrations and is a valuable reference on the topic].
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### ***Cotesia chilonis* (Munakata, 1912)**

*Apantetus chilonis* Munakata, 1912: 69. Original description. Misspelling of the genus name.

*Apanteles chilonis* Matsumura in Munakata, 1912: 69. Shenefelt 1972: 468. Incorrect assignment of author of the species. [Subsequently followed by a substantial number of authors, websites, and online databases].

*Apanteles flavipes* f. *chilonis* Watanabe, 1932: 84. Junior subjective synonym [In the References below, this paper is cited as 'Watanabe 1932b' to distinguish it from another work published by Watanabe in 1932 and also cited in the present paper].

*Apanteles chilonis* Munakata, 1912. Watanabe 1965: 114. Reinstatement as valid species.

*Cotesia chilonis* (Matsumura, 1912). Austin and Dangerfield 1989: 137. New combination. Incorrect assignment of author of the species.

*Cotesia chilonis* (Matsumura, 1912). Papp 1990: 117. Unnecessary ‘new combination’. Incorrect assignment of author of the species.

*Cotesia chilonis* Munakata, 1910. Yu et al. 2012. Incorrect assignment of date for species description.

*Apanteles chilocida* Viereck, 1912: 582. Watanabe 1932: 69. Junior subjective synonym. Incorrect date (1913) assigned to Viereck’s paper. [In the References below, this paper is cited as ‘Watanabe 1932a’ to distinguish it from another work published by Watanabe in 1932 and also cited in the present paper].

## Acknowledgements

The decisions made in this paper about names, authors and dates related to *Cotesia chilonis* benefited considerably from fruitful discussion with several colleagues. Dr John Steel (University of Otago, New Zealand) helped in establishing contact with Japanese colleagues and kindly sent copies of some of the most important references used for this paper. Dr Katsuhiko Sayama (Hokkaido Research Center, Forestry and Forest Products Research Institute, Japan) kindly provided useful comments and copies of some of the most important references used for this paper. Dr Kaoru Maeto (Kobe University, Japan) kindly shared his opinions on the names and authors historically associated with the species. Dr John Huber and Dr Gary Gibson (Canadian National Collection of Insects, Ottawa, Canada) revised earlier versions of the manuscript and helped to clarify contents.

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