A HOME AT LAST! *CHANGANIA CHOUI* TSENG, 1965 BELONGS TO *THIENEMANNIELLA* KIEFFER, 1911 (DIPTERA: CHIRONOMIDAE: ORTHOCLADIINAE)

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Abstract

The midge *Changania choui* Tseng, 1965 (Insecta, Diptera, Nematocera), originally described in the family Cecidomyiidae and recently transferred to the Ceratopogonidae, is recognised as an adult female in the Chironomidae, subfamily Orthocladiinae. The type material is missing, and the published description and illustrations are limited. Although the genus name *Changania* Tseng, 1965 becomes a new junior synonym of *Thienemanniella* Kieffer, 1911, *Thienemanniella choui* (Tseng 1965), new combination, should be treated as a *nomen dubium*. A combination of two ratios calculated from wing measurements shows promise for taxonomic diagnostics in the grouping of genera around *Corynoneura* Winnertz.

Introduction

In a book on gall midges and other insects found as pests or visitors of wheat in China, Tseng (1965) described, figured and discussed *Changania choui* Tseng as a new genus and species in Cecidomyiidae (Diptera: Nematocera).

Tseng, Sheng [曾省; alternative transliterations: Ceng, Sheng or Zeng, Sheng] (1899-1968) was an agricultural entomologist who had received academic training in China and France; in 1957 he was transferred to Beijing to serve as a plant protection researcher at the Chinese Academy of Agricultural Sciences. Chou, Io [周尧; alternative transliteration: Zhou, Yao] (1912-2008) studied entomology in China and Italy, then founded one of the earliest entomological collections in his home country, where he became quite influential in both science and society.

The names *Changania* and *C. choui* have been mentioned very rarely in the literature. Eitschberger (1999: 362) incompletely referred to a 68-page book published in China (in the same year?) as "Six decades of glorious flowers in spring and solid fruits in autumn - In honour of the sixtieth anniversary of teaching activities of Prof. Chou Io". We have not seen this volume, but it reportedly includes a list of 43 patronyms for taxa named in Chou's honour. Jiao and Bu (2014) listed *Changania choui* in Cecidomyiidae, but indicated the identification as doubtful and added that the genus "may belong to Ceratopogonidae ... (Dr. Mathias Jaschhof, personal communication)" (*op. cit.*: 203). Gagné and Jaschhof (2021: 620) then excluded *Changania* from the Cecidomyiidae and suggested placement in Ceratopogonidae.

The latter re-assignment was questioned when one of us (AB) prepared updates and errata to a world catalog of the Ceratopogonidae (Borkent and Dominiak 2020). In September of 2021, a copy of Tseng's original description and figure was sent to PSC by AB accompanied by a suggestion that the species might be an orthoclad Chironomidae instead. Subsequent consultations soon led all present coauthors to concur that the taxon belongs to the grouping that includes *Corynoneura* Winnertz, 1846 and other genera. Consequently, we decided to settle *Changania* Tseng in its appropriate systematic home.

Material and methods

The sequence of present coauthors' names is in alphabetical order, except for the first author (designated by the others). It does not rank the respective individual contributions.

Upon our requests, material of *Changania choui* Tseng has been searched for at the Institute of Plant Protection, Chinese Academy of Agricultural Sciences, Beijing (the depository declared by Tseng 1965: 147), and at Northwestern A&F University, Xianyang (collection founded by Chou). Since

neither Tseng's slide nor any other specimen has been found, we interpret *Changania* and *C. choui* from their original presentation (Tseng 1965: 147-148).

Because the holotype's allocation to sex and the taxon's placement in contemporary systematics relies on Tseng's illustration (1965: fig 46; our Fig. 1D), we photographed (Fig. 1A-C) and/or measured representative female wings from the following material (all from China, in coll. H.-Q. Tang).

Corynoneura arctica Kieffer, 1923. 2♂, 2♀: Inner Mongolia, Hulunbuir City, Hailar River, 49°9.483', 119°45.150'; 31.vii.2016, leg. Feng, L.-H. 1♂, 1♀: Tibet, Lhasa City, Lalu wetland, 29°40.020', 91°05.870'; 05.vii.2014, leg. Liu, J.

Corynoneura medicina Fu, Sæther & Wang, 2009. 3♂, 5♀: Yunnan Prov., Yiliang County, Yangzong Town, Yangzong Lake wetland, 24°51.451', 103°0.073'; 15.vi.2016, leg. Tang, H.-Q.

Corynoneura yoshimurai Tokunaga, 1936. 1♂, 1♀: Guangdong Prov., Guangzhou City, Conghua District, Wenquan Town, 23°37.509', 113°38.107'; 16.i.2011, leg. Tang, H.-Q.

Onconeura togamijika (Sasa & Okazawa, 1992) [see Note 1]. 3♂, 3♀: Tibet, Medog County, Beibeng Town, the Third Bridge to Hanmi, 29°14.957', 95°08.762'; 11.viii.2015, leg. Tang, H.-Q.

Thienemanniella curva Fu, Fang & Wang, 2013 [see Note 2]. 1♂, 1♀: Guangdong Prov., Guangzhou City, Conghua District, Lyutian Town, Guifeng Mt., 23°48.036', 114°00.987'; 28.iii.2016, leg. Li, L.-M.

Thienemanniella majuscula (Edwards, 1924). 2♂, 4♀: Guangdong Prov., Guangzhou City, Conghua District, Liangkou Town, 23°43.087', 113°43.156'; 28.iii.2016, leg. Li, L.-M.

Notes

(1) *Onconeura togamijika* was described originally in *Thienemanniella*, but regarded as a new combination and first East Asian record of *Onconeura* Andersen & Sæther, 2005 by Li (2018), whose suggestion we follow here. (2) In the original publication (Fu *et al.* 2013) the species name was spelled in two ways, *Th.* 'curva' and *Th.* 'curvare', but in Fu *et al.* (2020) the original authors have fixed *Thienemanniella curva* as the correct spelling; see ICZN (1999) Article 24.2.4.

Identification

The species identifications of female specimens are based on respectively corresponding adult males linked by molecular sequences and/or by co-occurrence in the same sample; see Table 1. The BOLD data can be accessed as a dataset via http://dx.doi.org/10.5883/DS-CORY001.

Results

Original publication

Tseng (1965: 147-148) treated *Changania choui* as the fourth of five numbered taxa diagnosed in an 'Appendix. Sap-sucking insects similar to gall midges' (*op. cit.*: 137), subsection '(5) Examples of adults' (*op. cit.*: 144). All other taxa in this subsection continue to be considered as members of the Cecidomyiidae (*e.g.*, Jiao and Bu 2014). Likewise, all genus names other than *Changania* in

Table 1. References to individual molecular sequence data connected to the present study. Numbering of female specimens as in Tables 2-4.

Taxon	Specimen	BOLD Process ID	BOLD barcode index number (BIN)	GenBank accession number
Corynoneura arctica	female 3	JNU051-18	AAB0079	OM502160
Corynoneura arctica	male	JNU121-18	AAB0079	OM502166
Corynoneura medicina	female 5	JNU007-18	ADL1874	OM502158
Corynoneura medicina	male	JNU006-18	ADL1874	OM502159
Corynoneura yoshimurai	female	—	—	—
Corynoneura yoshimurai	male	JNU031-18	ADL1776	OM502163
Onconeura togamijika	female 1	JNU026-18	ADL0738	OM502165
Onconeura togamijika	male	JNU055-18	ADL0738	OM502162
Thienemanniella curva	female	—	—	—
Thienemanniella curva	male	JNU104-18	ADL1365	OM502161
Thienemanniella majuscula	female 1	JNU130-18	ADL1673	OM502167
Thienemanniella majuscula	male	JNU001-18	ADL1673	OM502164

Tseng's text as translated below refer to members of Cecidomyiidae (for details and current subfamily assignments see Gagné and Jaschhof 2021). The name "Memmieria" does not exist in zoological nomenclature. We interpret it as a lapsus for *Meunieria* Kieffer, which was still treated in Heteropezinae in all keys (Felt 1925, 1929; Mani 1946) referred to by Tseng (1965: 137).

The following translations attempt to stay as close to the Chinese texts as feasible, wherever this is considered as potentially critical. All terms given between square brackets are interpretations or comments inserted by the present authors.

4. Chang'an Chou Gall Midge (*Changania* Choui, Tseng)*[parenthesis with Latin lettering exactly as reproduced here]*. Among plenty of gall midge specimens kindly donated by professor Io Chou [Yao Zhou], Northwest Agricultural College, there is one (labelled Cec. 028) that is extremely small (body size in the slide mount 0.95 × 0.35 mm), the distribution of wing veins is very special, much as in *Leptosyna*, but the tarsus has 5 segments, the first segment is longer than the second, and the palp has 5 segments, different from *Epimyia* (palp with 3 segments), *Frirenia* (palp with 2 segments), *Lyptosyna[sic!, typographical error for Leptosyna]* (palp with 1 segment) and *Meinertomyia* (palp with 3 segments) in the subfamily Heteropezinae, and it is also different from *Neostenoptera*, *Memmieria[sic!, see the comment above this translation]*, *Miastor* and other genera. The third vein [R_{4+5}] does not reach the tip of the wing, the palp is with 5 segments, the wing carries spinules, hence a new genus and species is established, and the name Chang'an Chou Gall Midge (*Changania* Choui, Tseng, Gen. et Sp. Nov.) expresses the great pleasure and gratitude to Io Chou for his discoveries in Chang'an. The specimen is deposited in the Institute of Plant Protection, Chinese Academy of Agricultural Sciences, Beijing. Its characteristics are as follows:

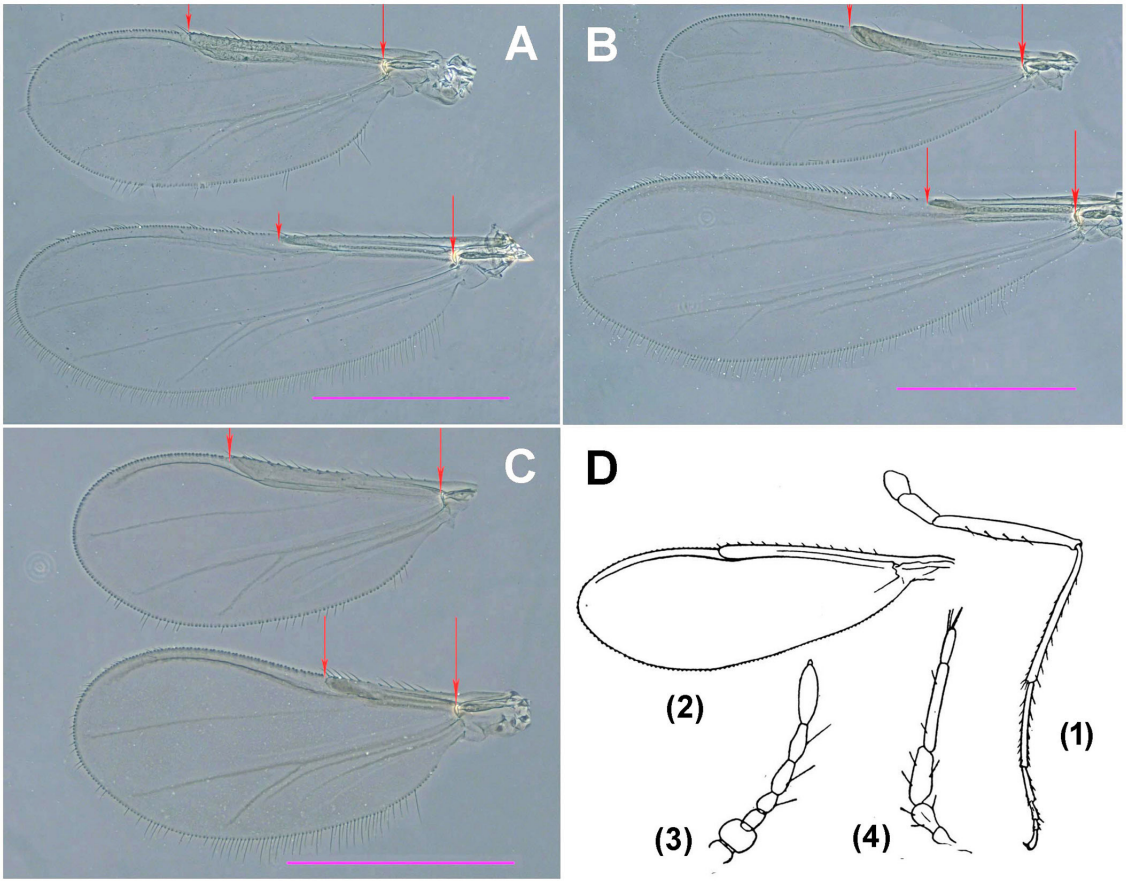

Figure 1. A-C. Photographs (by Tang, H.-Q.) of wings in the *Corynoneura* group (respective upper wing: female; lower: male; red arrows mark extent of clavus; scales 400 µm); for specimen data see Material and methods, and Table 2. D. Line-drawings modified from Tseng (1965). A. *Thienemanniella majuscula* (Edwards, 1924); B. *Corynoneura medicina* Fu, Sæther & Wang, 2009; C. *Onconeura togamijika* (Sasa & Okazawa, 1992); D. *Changania choui* Tseng, 1965. (1) leg, (2) wing, (3) antenna, (4) maxillary palp (caption texts translated from original fig. 46; subfigure positions re-arranged).

Tarsus with 5 segments, first segment longer than the other segments. Antennae without ring hairs [i.e., without distinct whorls of elongate setae], whole wing with only three longitudinal veins, and the third vein [R_{4+5}] is very close to the front edge (the fourth and fifth veins [M and Cu] are completely reduced, sometimes only remnant traces are vaguely seen), there are no transverse veins [RM, MCu], no scaly hairs on the wing surface, and the sparse clothing of spinules is more pronounced on the wing edge. The third longitudinal vein [R_{4+5}] ends before reaching the wing tip, but a small branch at about mid-length [of R_{4+5}] connects to the front edge, enclosing a long, narrow space (Cell)*[parenthesis printed in Latin letters]* beyond [that branch], which is dark brown in colour, different from its surroundings. The submarginal vein [subcosta] is very thin, extends between the anterior marginal vein [costa] and the third vein [R_{4+5}], and reaches only 1/3 of the length of the marginal vein. The palp is with 5 distinct segments. The antenna is 7-segmented, the second segment [pedicel] is enlarged and oblate, the remaining segments are oblong, the terminal segment is particularly elongate and with a flattened rod-shaped apex (fig. 46). *[end of translation]*

Morphological comparisons

The short, thickened and fused anterior wing veins (including R_{4+5}) form a 'clavus' (Fig. 1). This characteristic morphology implies a member of a grouping of genera in the subfamily Orthocladiinae that is represented in the known fauna of China by *Corynoneura* Winnertz, *Onconeura* Andersen & Sæther, 2005, and *Thienemanniella* Kieffer, 1911. A relative minority of published chironomid systems have allocated this grouping to a separate tribe, Corynoneurini, with support from molecular phylogenetic evidence (Cranston *et al*. 2011). At this time, however, the present authors consider tribal allocation amongst the diverse Orthocladiinae as unwarranted.

Two sources point to the holotype of *Changania choui* being female. The adult antenna described and figured by Tseng (1965: fig. 46, 3; our Fig. 1D, bottom left) comprises scape, pedicel and five flagellomeres, and although some few male orthoclads have female-like antennae (more commonly in some harsh environments, *e.g.* in marine and alpine fauna), in the grouping under consideration the male antenna comprises from 9 to 12 flagellomeres, and their structure differs from the female antennae.

Table 2. Wing lengths and proportions for females in the *Corynoneura* group sampled in China. Specimens (numbered within each species) in alphabetical order of genus and species names.

Taxon	Wing length [µm] (arculus to tip)	Wing width / wing length	Clavus length / wing length
Changania choui (Fig. 1D)	unknown	0.40	0.56
Corynoneura arctica 1, Inner Mongolia	1100	0.40	0.47
Corynoneura arctica 2, Inner Mongolia	1125	0.42	0.48
Corynoneura arctica 3, Tibet	1180	0.43	0.47
Corynoneura medicina 1	730	0.41	0.48
Corynoneura medicina 2	780	0.38	0.47
Corynoneura medicina 3	800	0.36	0.49
Corynoneura medicina 4	810	0.38	0.47
Corynoneura medicina 5 (Fig. 1B)	820	0.41	0.49
Corynoneura yoshimurai	720	0.40	0.42
Onconeura togamijika 1 (Fig. 1C)	630	0.46	0.57
Onconeura togamijika 2	700	0.46	0.56
Onconeura togamijika 3	850	0.47	0.59
Thienemanniella curva	750	0.44	0.59
Thienemanniella majuscula 1 (Fig. 1A)	800	0.44	0.55
Thienemanniella majuscula 2	800	0.43	0.55
Thienemanniella majuscula 3	930	0.43	0.54
Thienemanniella majuscula 4	940	0.41	0.55

A comparison with females from six species in the *Corynoneura* grouping of genera that are known and sampled from China allows further separation by reference to two ratios calculated from individual wing measurements (Table 2, columns 3 and 4 from left).

To test those ratios for possible dependence on adult body size, the same specimens are ranked by increasing wing length (second column from left) in Table 3. Column 1 shows some of the species sorted out near either end of the total size range in our sample, and others with their ranges overlapping. The ratio values in columns 3 and 4, respectively, evidently are not correlated to wing length.

However, when the table rows are reordered according to the ratios calculated from wing measurements (Table 4), a pattern independent of body size emerges that allows inference to be drawn on systematic relations at genus level.

Systematic deduction

As evident from Table 4, the relatively high clavus/wing length ratio shown by *Changania* rules out genus identity with *Corynoneura*, and the low relative wing width eliminates *Onconeura*. Consequently, we identify *Changania choui* as a member of *Thienemanniella*; for further explanation see the discussion below.

Taxonomic placements

Thienemanniella Kieffer, 1911
[for details see Ashe (1983)]
Changania Tseng, 1965: 147, ***syn. nov.***
Type species (by monotypy): *Changania choui* Tseng, 1965.

Thienemanniella choui (Tseng, 1965), ***comb. nov.***, *nomen dubium*.
Changania choui Tseng, 1965: 147, fig. 46.

Type material: Holotype female, on slide labelled 'Cec. 028', ex coll. I. Chou. – Although Tseng's (1965) text on the species does not include a term such as holotype, he did mention seeing one specimen only. His very detailed instructions on methods to study such midges (*op. cit.*: 137-139) may suggest that he had made the holotype slide himself, but he did not state so explicitly.

Type locality: CHINA, Shaanxi Province, Chang'an County (now Chang'an District, Xi'an City).

Table 3. Female specimens and their wing data from Table 2, resorted by ascending wing length, then (where necessary) alphabetically by taxon name.

Taxon	Wing length [µm] (arculus to tip)	Wing width / wing length	Clavus length / wing length
Changania choui (Fig. 1D)	unknown	0.40	0.56
Onconeura togamijika 1 (Fig. 1C)	630	0.46	0.57
Onconeura togamijika 2	700	0.46	0.56
Corynoneura yoshimurai	720	0.40	0.42
Corynoneura medicina 1	730	0.41	0.48
Thienemanniella curva	750	0.44	0.59
Corynoneura medicina 2	780	0.38	0.47
Corynoneura medicina 3	800	0.36	0.49
Thienemanniella majuscula 1 (Fig. 1A)	800	0.44	0.55
Thienemanniella majuscula 2	800	0.43	0.55
Corynoneura medicina 4	810	0.38	0.47
Corynoneura medicina 5 (Fig. 1B)	820	0.41	0.49
Onconeura togamijika 3	850	0.47	0.59
Thienemanniella majuscula 3	930	0.43	0.54
Thienemanniella majuscula 4	940	0.41	0.55
Corynoneura arctica 1, Inner Mongolia	1100	0.40	0.47
Corynoneura arctica 2, Inner Mongolia	1125	0.42	0.48
Corynoneura arctica 3, Tibet	1180	0.43	0.47

Table 4. Female specimens and their wing data from Table 2, resorted by descending relative clavus length, then (where necessary) by descending relative wing width.

Taxon	Wing length [µm] (arculus to tip)	Wing width / wing length	Clavus length / wing length
Onconeura togamijika 3	850	0.47	0.59
Thienemanniella curva	750	0.44	0.59
Onconeura togamijika 1 (Fig. 1C)	630	0.46	0.57
Onconeura togamijika 2	700	0.46	0.56
Changania choui (Fig. 1D)	unknown	0.40	0.56
Thienemanniella majuscula 1 (Fig. 1A)	800	0.44	0.55
Thienemanniella majuscula 2	800	0.43	0.55
Thienemanniella majuscula 4	940	0.41	0.55
Thienemanniella majuscula 3	930	0.43	0.54
Corynoneura medicina 5 (Fig. 1B)	820	0.41	0.49
Corynoneura medicina 3	800	0.36	0.49
Corynoneura arctica 2, Inner Mongolia	1125	0.42	0.48
Corynoneura medicina 1	730	0.41	0.48
Corynoneura arctica 3, Tibet	1180	0.43	0.47
Corynoneura arctica 1, Inner Mongolia	1100	0.40	0.47
Corynoneura medicina 4	810	0.38	0.47
Corynoneura medicina 2	780	0.38	0.47
Corynoneura yoshimurai	720	0.40	0.42

Discussion

Separation of *Thienemanniella* from *Corynoneura* can be made readily on the immature stages, although confident separation of adults has declined since Edwards' (1924, 1929) studies. In the following, we recall three pertinent statements in Edwards (1929: 365-367):

(1) Referring to *Corynoneura* in the broader sense, which included *C.* s. str. and *Thienemanniella* as subgenera: "R_1 and R_{4+5} entirely fused with one another and almost entirely so with the thickened costa, forming a "clavus" which extends less than half the wing-length in ♂ and about one-half to two-thirds of the wing-length in ♀; in the latter the clavus is thicker" (p. 365-366);

(2) In the diagnosis for *C.* (*Thienemanniella*): "Hind tibiae not swollen and without apical projection on inner side. Front trochanters keeled but evenly rounded above. Costa extending to about two-fifths of wing-length and nearly to FCu in ♂, beyond middle of wing and beyond FCu in ♀" (p. 366);

(3) In contrast, the diagnosis for *C.* (*Corynoneura*) begins: "Hind tibiae somewhat swollen at tip, obliquely truncate and with a conspicuous apical projection on inner side. Front trochanters with a more or less conspicuous flat dorsal expansion on apical half or more. Costa extending from scarcely one-third to about two-fifths of wing-length and ending far before FCu in ♂; to about middle of wing and not quite to FCu in ♀"(p. 367).

Tseng's (1965) low magnification illustration of the wing (see our Fig. 1D) lacks the faint posterior venation that requires good microscopy, yet together with his description is passable for comparison with Edwards' (1929) morphological differentiation of *Corynoneura* and *Thienemanniella*. Thus, the sexual dimorphism in wing shape, and the clavus strength and termination relative to the wing length (Fig. 1, quantified in Tables 2-4) conform best to a female of *Thienemanniella*.

Tseng (1965) did not specify which particular leg he described and illustrated, but the combination of unmodified tibial apex and relatively long trochanter (Fig. 1D) suggests a foreleg. The trochanter, shown lacking a keel, does not match expectations for this structure in a female of *Corynoneura*. With no description or illustrations of a hind leg, the posterior wing venation or the extent and length of microtrichia surrounding the facets of the eye, other potentially discriminatory features are unavailable. Few female adults in *Thienemanniella* or *Corynoneura* have been reported since Edwards

(1929). However, *Onconeura*, described from the Neotropics by Andersen and Sæther (2005), is now recognised as present in East Asia (Li 2018). The female wing in *Onconeura* is proportionally wider than many others in the genus grouping (Fig 1C and Table 4), significantly differing from the narrower *Changania* wing; thus, *Onconeura* can be eliminated from the present consideration. In addition, although the distinctiveness of adults of *Corynoneura* has been weakened especially due to recent Neotropical material (Wiedenbrug *et al.* 2013), *Changania* cannot be allocated to this genus either. The balance of available evidence indicates that *Changania* Tseng is congeneric with *Thienemanniella*, the latter now ranked as a genus (*e.g.*, Ashe 1983).

The species *Changania choui* Tseng from Shaanxi, China, cannot be associated with any named species of *Thienemanniella* from Asia (Makarchenko and Makarchenko 2006, Fu *et al.* 2010, Fu *et al.* 2013, Fu *et al.* 2020, Fang *et al.* 2021). Even if the material described by Tseng (1965) had included a male, it is unlikely that this could have improved the situation. With over 55 species globally, diversity is high and reared specimens clearly aid in discrimination (*e.g.*, Wiedenbrug *et al.* 2013). However, there is no information on immature stages for any of the species recently described from China. Thus, contemporary species discrimination still relies on features of the adult male such as ratios of flagellomeres, and subtle details of shapes in the hypopygium (genitalia), including the gonostylus and genitalic lobes (*e.g.*, Fu and Sæther 2012). Although these character states might not have been discernible to Tseng anyway, the female features discussed above evidently do locate *C. choui* within *Thienemanniella*. However, the missing holotype and inability to allocate to a described species mean that *C. choui* should be treated as a *nomen dubium*.

A larger-scale revision of morphology in the *Corynoneura* grouping of genera was beyond the scope of the present work, which focused on adult female specimens from China that were readily available and identifiable to species via reasonably sufficient links to respective males. Nevertheless, the sampling includes material from the Palaearctic and Oriental regions, and from lower and higher elevations. Thus, the authors hope that the wing features applied as taxonomic criteria here will prove useful also in future studies on such chironomids.

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