

## Mayflies (Ephemeroptera) of Taiwan: Species composition, taxonomic shifts, distribution and biogeographical analysis

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### Abstract

Based on revision of an extensive material at least 65 species (28 genera, 9 families) are contained in the Taiwan Ephemeroptera checklist. *C. virens*, *Habrophlebioides gilliesi*, *Uracanthella rufa* and the genera *Cloeodes* and possibly *Moribaetis* are recorded for the first time. The following taxonomic shifts are suggested: *Pseudocloeon mustum* (KANG & YANG) comb. n., *Ecyonurus littoranus* (KANG & YANG) comb.n., *E. mitificus* (KANG & YANG) comb. n., *E. obscurus* (KANG & YANG) comb. n., *Ephacerella glebosa* (KANG & YANG) comb. n., *E. montana* (KANG & YANG) comb. n. Of the 65 (named) species, 28 genera and 9 families, a single genus (*Eburella*) and 54 species are considered endemic, 5 inhabit also Japan or Philippines, 4 represent East Palaearctic or South-East Oriental species and 2 those with large Oriental areas. Known distribution of all species within the island as well as findings still not verified are summarized and discussed.

**Keywords:** checklist, new combinations, faunal inventory, new distributional records, Oriental, endemism.

### Introduction

History of mayfly research of Taiwan started in the beginning of the last century when Ulmer (1912) described two new species of *Isonychia* and *Ephemer*, respectively, from the material of H. Sauter's entomological expeditions. Since then this group had remained untouched till the 1980's when Braasch (1981) described a new species of *Epeorus* earlier incorrectly determined as *E. psi* EATON, and Müller-Liebenau (1985) and Waltz and McCafferty (1985) described three new species of Baetidae collected earlier by G. F. Edmunds in the Tatu River near Tsaotun.

Our knowledge of the Taiwan Ephemeroptera has increased very rapidly thanks to a series of papers by S. C. Kang, C. T. Yang and H.C. Chang published in the 1990's. They sampled hundreds localities evenly distributed all over the island and described altogether more than 45 species of Ameletidae, Baetidae, Heptageniidae, Leptophlebiidae, and Caenidae (Kang and Yang, 1994b, c, d, 1995, 1996a, b; Kang *et al.*, 1994) in addition to redescription of earlier species (Kang and Yang, 1994a, e) and description of a new species of *Potamanthus* based on misidentification of presumably Taiwan populations of the valid species *Potanthodes formosus* (EATON) (Bae and McCafferty, 1991; Bae 1997). Since then, despite of some ecological papers dealing also with mayflies and faunistic lists (e.g. Her and Hsu, 1977; Yang *et al.*, 1980; Chou, 1996; Perng *et al.*, 1999 or Shieh and Yang, 1999), mayfly taxonomy and distribution in Taiwan have not been studied at all. Moreover, generic classification of the Oriental Ephemeroptera has been changing very intensively and most of original names were no more valid.

The objective of the present paper is to (i) define species composition of the Ephemeroptera of Taiwan on the basis of a revision of the collection deposited the Department of Entomology, National Chung-Hsing University in Taichung and to present some new findings on the basis of limited field work in 2000, (ii) review all the taxonomical shifts including necessary new nomenclature combination (iii) summarize all earlier data on individual species distribution according to their occurrence in individual administrative units and (iv) analyze the island's fauna composition from the biogeographical point of view.

## Results

### *Species composition*

There are 65 species of 28 genera and 9 families (Baetidae: 8 genera, 21 species; Ameletidae (1 genus, 3 species; Isonychiidae: 1 genus, 1 species; Heptageniidae: 5 genera, 11 species; Leptophlebiidae: 5 genera, 10 species; Ephemeridae: 1 genus, 2 species; Potamanthidae: 1 genus, 1 species Ephemerellidae: 5 genera, 8 species, and Caenidae: 1 genus, 8 species). Their list and generic and familial classification arranged in the same sequence of families as noted above are apparent from Tables 1, 2.

The check-list as presented here (Table 1) contains only species the material of which could be revised and is deposited (including all the type series designed by S. C. Kang, C. T. Yang and H.C. Chang at the National Chung-Hsing University in Taichung) or in some other collections (cf. Braasch, 1981; Müller-Liebenau, 1985; Waltz and McCafferty, 1985; Bae and McCafferty, 1991) Except for *Acentrella lata* (MÜLLER-LIEBENAU) we have studied at least larvae of all the species presented in Table 1. Of course, there are some earlier records on other species. As noted above those on *Epeorus psi* and *Potamanthus formosus* actually belong to *E. (Belovius) erratus* and *Potamanthus (Potamanthodes) idiocerus*, respectively, (cf. Braasch, 1981; Bae and McCafferty, 1991) and *Neobaetiella macani* MÜLLER-LIEBENAU, described from the Tatu River (Müller-Liebenau, 1985: 108) falls into the synonymy of *Baetiella bispinosa* (GOSE) as suggested by Waltz and McCafferty (1987). Ulmer's (1912) records on *Ephemerella japonica* McLACHLAN and *E. supposita* EATON most probably refers to *E. sauteri* ULMER since he does not mention these species in his later reports on the Oriental mayflies (Ulmer, 1920, 1924, 1925). Similarly, *Acentrella gnom* (KLUGE), the presence of which in Taiwan is suggested in the check-list by Chou (1996: 14) most probably refers to some other species of the genus and some other Oriental species mentioned in some ecological papers by other authors from Taiwan cannot be taken into an account without a revision of the original material.

In addition to the species mentioned above and described or redescribed by S. C. Kang, C. T. Yang and H.C. Chang in 1994 – 1996, some species apparently new to the fauna of Taiwan have been found. Perng *et al.* (1999) formally reports *Cloeon marginale* (HAGEN) from Taiwan for the first time although this species is very

abundant in lenitic habitats here and mentioned as *Cloeon* sp. many times in ecological papers. The same concern *C. virens* KLAPÁLEK that is reported for the first time to Taiwan in the present paper. Many localities of these species are, for instance, presented in the unpublished theses by Chang (1991) although under different names. On the other hand, *Uracanthella rufa* (IMANISHI) and *Habrophlebiodes gilliesi* PETERS were really collected for the first time in Taiwan although the former species is probably mentioned (as *Serratella* sp.) by Her and Hsu (1977) and Shieh and Yang (1999).

Naturally, there are still unnamed species in Taiwan and further new species are yet to be collected. Of the former, the most important are 2 species of the genus *Cloeodes* TRAVER and at least two other species of the family Baetidae which might belong to the genus *Moribaetis* also mentioned in unpublished theses (Chang, 1991; formal descriptions are being prepared). Of the latter, further endemic species of e.g. genera *Procloeon* (Baetidae) or *Ephemerella* (Ephemeridae) have been collected recently (Soldán and Yang, in prep.) Consequently, further studies on mayflies of Taiwan as well as detailed collecting activities are urgently needed. Moreover, more than 20 species are so far known only in the larval stage, further 31 species in the egg and larval stage and the number of species the adults of which have been already described is negligible (Table 1).

### *Taxonomic shifts*

All substantial earlier taxonomic shifts are presented in the checklist of mayflies of Taiwan presented in Table 1 so that they are not commented in detail here. Detailed analysis of both collection specimens and literature data, however, revealed to suggest the following new combinations:

*Pseudocloeon mustum* (KANG & YANG) comb. n. This species was originally placed in the genus *Baetis*, subgenus *Labiobaetis* by Kang and Yang (1996a). Later, the subgenus *Labiobaetis* NOVIKOVA & KLUGE was reclassified into the generic rank (McCafferty and Waltz, 1995). Recently, however, Lugo-Ortiz *et al.* (1999) reclassified the genus *Pseudocloeon* KLAPÁLEK on the basis of both larval and imaginable characters and the genus *Labiobaetis* fell into its synonymy. Although adults of *P. mustum* remain unknown, the arrangement of mouthparts - antennal process, maxillary palps segment excavation, labial palps enlargement well apparent in this species Kang and Yang (1996a: 62, Figs. 1,

3, 6) – clearly show to a new generic placement. Taiwan were transferred to *Pseudocloeon*. Similarly, other species of the original subgenus *Mullerbaetis* KANG & YANG described from KLAPÁLEK sensu Lugo-Ortiz *et al.* (1999).

Table 1 - Checklist of the Ephemeroptera species so far recorded from Taiwan including the original descriptions, taxonomic shift, new combinations, and the stage known (A – adult, L – larva, E – egg)

Species	Described as/by	Taxonomic shift	Stage known
<i>Acentrella lata</i> (MÜLLER-LIEBENAU, 1985)	<i>Pseudocloeon</i> : Müller-Liebenau, 1985: 100.	Waltz & McCafferty, 1987: 553.	L
<i>Acentrella ultima</i> (MÜLLER-LIEBENAU, 1985)	<i>Pseudocloeon</i> : Müller-Liebenau, 1985: 100.	Waltz & McCafferty, 1987: 553.	L
<i>Alainites clivosus</i> (CHANG & YANG, 1994)	<i>Baetis (Acerbaetis)</i> : Chang & Yang in Kang, Chang & Yang, 1994: 37.	Waltz & McCafferty, 1997: 135.	L
<i>Alainites yehi</i> (KANG & YANG, 1994)	<i>Baetis (Acerbaetis)</i> : Kang & Yang in Kang, Chang & Yang, 1994: 39.	Waltz & McCafferty, 1997: 135.	L
<i>Baetiella ardua</i> (KANG & YANG, 1994)	<i>Baetis (Tenuibaetis)</i> : Kang & Yang in Kang, Chang & Yang, 1994: 29.	Waltz & McCafferty, 1997: 108.	L
<i>Baetiella bispinosa</i> (GOSE, 1980)	<i>Pseudocloeon</i> : Gose 1980: 211.	Waltz & McCafferty, 1987: 563	L
<i>Baetiella inornata</i> (KANG & YANG, 1994)	<i>Baetis (Tenuibaetis)</i> : Kang & Yang in Kang, Chang & Yang, 1994: 29.	Waltz & McCafferty, 1997: 108.	L
<i>Baetiella pseudofrequenta</i> MÜLLER-LIEBENAU, 1985)	<i>Baetis</i> : Müller-Liebenau, 1985: 98.	Waltz & McCafferty, 1997: 108.	L
<i>Baetis tatuensis</i> MÜLLER-LIEBENAU, 1985	original designation		L
<i>Nigrobaetis candidus</i> (CHANG & YANG, 1996)	<i>Baetis (Fallceon)</i> : Chang & Yang, 1996: 61.	Waltz & McCafferty, 1997: 138.	L
<i>Nigrobaetis facetus</i> (CHANG & YANG, 1994)	<i>Baetis (Margobaetis)</i> : Chang & Yang in Kang, Chang & Yang, 1996: 21.	Waltz & McCafferty, 1997: 138.	L
<i>Nigrobaetis gracilentus</i> (CHANG & YANG, 1994)	<i>Baetis (Margobaetis)</i> : Chang & Yang in Kang, Chang & Yang, 1996: 17.)	Waltz & McCafferty, 1997: 138.	L
<i>Nigrobaetis mundus</i> (CHANG & YANG, 1994)	<i>Baetis (Margobaetis)</i> : (Chang et Yang in Kang, Chang & Yang, 1996: 13.)	Waltz & McCafferty, 1997: 138.	E, L
<i>Nigrobaetis taiwanensis</i> MÜLLER-LIEBENAU, 1985: 94.	<i>Baetis</i> : Müller-Liebenau, 1985: 94.	Waltz & McCafferty, 1997: 138.	E, L
<i>Nigrobaetis terminus</i> (CHANG & YANG, 1994)	<i>Baetis (Margobaetis)</i> : Chang et Yang in Kang, Chang & Yang, 1996: 19.	Waltz & McCafferty, 1997: 138.	L
<i>Pseudocloeon molawinense</i> (MÜLLER-LIEBENAU, 1982)	<i>Baetis (Mullerbaetis)</i> : Müller-Liebenau, 1982: 76.	Lugo-Ortiz, McCafferty & Waltz, 1999: 25	L
<i>Pseudocloeon morum</i> (CHANG ET YANG, 1994)	<i>Baetis (Mullerbaetis)</i> : Chang & Yang in Kang, Chang & Yang, 1994: 33.	Lugo-Ortiz, McCafferty & Waltz, 1999: 25	L
<i>Pseudocloeon mustum</i> (CHANG & YANG, 1996)	<i>Baetis (Labiobaetis)</i> : Chang & Yang, 1996: 63.	new combination	L
<i>Cloeon marginale</i> (HAGEN, 1858)	<i>Cloe</i> : Hagen, 1858: 477.	Eaton, 1885: 181	L, A
<i>Cloeon virens</i> KLAPÁLEK, 1905	original designation		L, A
<i>Procloeon tatalis</i> WALTZ & MCCAFFERTY, 1985	original designation		L
<i>Ameletus atratus</i> KANG & YANG, 1994	original designation		L
<i>Ameletus formosus</i> KANG & YANG, 1994	original designation		E, L
<i>Ameletus montivagus</i> KANG & YANG, 1994	original designation		L
<i>Isonychia formosana</i> (ULMER, 1912)	<i>Chirotometes</i> (Ulmer, 1912: 371)	Uéno, 1931: 210	L, A
<i>Afronurus chihpenensis</i> KANG & YANG, 1994	original designation		E, L
<i>Afronurus floreus</i> KANG & YANG, 1994	original designation		L
<i>Afronurus hyalinus</i> (ULMER, 1912)	<i>Ecdyurus</i> (Ulmer, 1912: 372)	Kang & Yang, 1994b: 2	E, L, A
<i>Afronurus nanhuensis</i> KANG & YANG, 1994	original designation		

<i>Ecdyonurus littorosus</i> (KANG & YANG, 1994)	<i>Nixe</i> ( <i>Nixe</i> ): Kang & Yang, 1994c: 23	new combination	E, L
<i>Ecdyonurus mitificus</i> (KANG & YANG, 1994)	<i>Nixe</i> ( <i>Nixe</i> ): Kang & Yang, 1994c: 28.	new combination	E, L
<i>Ecdyonurus obscurus</i> (KANG & YANG, 1994)	<i>Nixe</i> ( <i>Nixe</i> ): Kang & Yang, 1994c: 30.	new combination	E, L
<i>Epeorus erratus</i> BRAASCH, 1981	original designation		E, L, A
<i>Electrogena fracta</i> KANG & YANG, 1994	original designation		E, L
<i>Rhithrogena ampla</i> KANG & YANG, 1994	original designation		E, L
<i>Rhithrogena parva</i> ULMER, 1912	original designation		E, L, A
<i>Choroterpes taiwanensis</i> KANG & YANG, 1994	original designation		E, L
<i>Choroterpes trifurcatus</i> UÉNO, 1928	original designation		E, L
<i>Choroterpides nigella</i> KANG & YANG, 1994	original designation		E, L
<i>Thraululus fatuus</i> KANG & YANG, 1994	original designation		E, L
<i>Thraululus macilentus</i> KANG & YANG, 1994	original designation		E, L
<i>Thraululus umbrosus</i> KANG & YANG, 1994	original designation		E, L
<i>Habrophlebiodes gilliesi</i> PETERS, 1963	original designation		E, L, A
<i>Habrophlebiodes tenella</i> KANG & YANG, 1994	original designation		E, L
<i>Paraleptophlebia erratica</i> KANG & YANG, 1994	original designation		E, L
<i>Paraleptophlebia spina</i> KANG & YANG, 1994	original designation		E, L
<i>Ephemerella formosana</i> ULMER, 1919	original designation		E, L, A
<i>Ephemerella sauteri</i> ULMER, 1912	original designation		E, L, A
<i>Potamanthus idiocerus</i> BAE & McCAFFERTY, 1991	original designation		E, L, A
<i>Cincticostella fusca</i> KANG & YANG, 1995	original designation		E, L
<i>Cincticostella colossa</i> KANG & YANG, 1995	original designation		E, L
<i>Eburella brocha</i> KANG & YANG, 1995	original designation		E, L
<i>Ephacerella glebosa</i> (KANG & YANG, 1995)	<i>Acerella</i> : Kang & Yang, 1995: 96	new combination	E, L
<i>Ephacerella montana</i> (KANG & YANG, 1995)	<i>Acerella</i> : Kang & Yang, 1995: 98.	new combination	E, L
<i>Torleya glareosa</i> KANG & YANG, 1995	original designation		E, L
<i>Torleya lutosa</i> KANG & YANG, 1995	original designation		E, L
<i>Uracanthella rufa</i> (IMANISHI, 1937)	<i>Ephemerella</i> : Imanishi, 1937: 327.	Bae, Yoon & Chun, 1994: 37	L, A
<i>Caenis argillosa</i> KANG & YANG, 1994	original designation		E, L
<i>Caenis bella</i> KANG & YANG, 1994	original designation		E, L
<i>Caenis cornigera</i> KANG & YANG, 1994	original designation		L
<i>Caenis corpulenta</i> KANG & YANG, 1994	original designation		L
<i>Caenis granifera</i> KANG & YANG, 1994	original designation		E, L
<i>Caenis nitida</i> KANG & YANG, 1994	original designation		E, L
<i>Caenis montana</i> KANG & YANG, 1994	original designation		E, L
<i>Caenis yangi</i> KANG & YANG, 1996	original designation		E, L

*Nigrobaetis candidus* (KANG & YANG) comb. n. This species was originally placed in the genus *Baetis*, subgenus *Falceon* WALTZ & McCAFFERTY. Related species from Taiwan, namely *Nigrobaetis facetus*, *N. gracilentus*, *N. mundus*, *N. taiwanensis*, and *N. terminus* were originally placed into the genus *Baetis*, subgenus *Margobaetis* KANG & YANG described in 1996 (cf. Kang *et al.*, 1994a). Later, (Kang and Yang, 1996a) synonymized their subgenus *Margobaetis* with *Falceon*. However, as shown by Waltz and McCafferty (1997), *Falceon* possesses rather remote relationships to *Margobaetis*, while the latter is identical with the genus *Nigrobaetis* KAZLAUSKAS and transferred all the above species here, synonymizing *Margobaetis* with

*Nigrobaetis*. *N. candidus* evidently belongs to this group (see e.g. the absence of the first tracheal gill pair and other characters, cf. Waltz *et al.*, 1994) and thus should be transferred as well to the genus *Nigrobaetis*.

*Ecdyonurus littoranus* (KANG & YANG) comb.n., *E. mitificus* (KANG & YANG) comb.n., and *E. obscurus* (KANG & YANG) comb.n. These three species were originally described in the genus *Nixe* FLOWERS, subgenus *Nixe* s.str. Based on morphological characters of both larvae and adult Kluge (1988) synonymized *Nixe* with the Palearctic genus *Ecdyonurus* EATON. We do not want to discuss this synonymy in general; all the Nearctic species comprised in the original *Nixe* can be characterized by rather different

morphological arrangement of some critical characters. However, the species from Taiwan are much more related to Palaearctic and especially the Far East species all of which are classified within the genus *Ecdyonurus* (cf. Kluge, 1988).

*Ehacrerella glebosa* (KANG & YANG) comb.n., and *E. montana* (KANG & YANG) comb.n. Both these two species were described in the genus *Acerella* ALLEN. Morphological characters perfectly fit the original diagnosis (Allen, 1971) and there is no doubt that they are

congeneric with other South-East Asian species. However, Paclt (1994) showed a homonymy between the genera *Acerella* ALLEN, 1971 (Ephemeroptera) and *Acerella* BERLESE, 1909 (Protura) and named, by the law of the first revising author, the former *Ephacrerella* PACLT. Although the remaining South-East Asian species have been renamed, the species from Taiwan have not yet been transferred by this author. Hence, this is the reason for the above new combinations.

Table 2 - Global areas and distribution of the Ephemeroptera species in Taiwan according to administrative units shown in Fig. 1. Data compiled from Kang Yang (1994a, 1994b, 1994c, 1994d, 1994e, 1995, 1996a, 1996b; Kang *et al.*, 1994), Müller-Liebenau (1985)(\*), Perng *et al.* (1999) (\*\*), and original findings (\*\*\*)

Species	Distribution (global area)	Distribution in Taiwan
<i>Acetrella lata</i>	Endemic to Taiwan	*Tatu River 4 km N of Taotsun
<i>Acentrella ultima</i>	Endemic to Taiwan	*Tatu River 4 km N of Taotsun
<i>Alainites clivosus</i>	Endemic to Taiwan	1, 2, 3, 5, 6, 7, 8, 11, 13, 14
<i>Alainites yehi</i>	Endemic to Taiwan	13
<i>Baetiella ardua</i>	Endemic to Taiwan	7
<i>Baetiella bispinosa</i>	Japan and Taiwan	*Tatu River, 4 km N of Taotsun
<i>Baetiella inornata</i>	Endemic to Taiwan	2, 3
<i>Baetiella pseudofrequenta</i>	Endemic to Taiwan	1, 3, 6, 7, 8, 11, 13, 14
<i>Baetis tatuensis</i>	Endemic to Taiwan	1, 2, 3, 4, 5, 6, 7, 8, 10, 11, 13, 14, 15
<i>Nigrobaetis candidus</i>	Endemic to Taiwan	6
<i>Nigrobaetis facetus</i>	Endemic to Taiwan	1, 5, 7, 8, 11, 13, 15
<i>Nigrobaetis gracilentus</i>	Endemic to Taiwan	1, 2, 3, 4, 5, 6, 8, 14
<i>Nigrobaetis mundus</i>	Endemic to Taiwan	1, 2, 3, 4, 7, 13
<i>Nigrobaetis taiwanensis</i>	Endemic to Taiwan	3, 7, 8, 10, 13, 14
<i>Nigrobaetis terminus</i>	Endemic to Taiwan	2, 3, 4, 6, 8, 11, 14
<i>Pseudocloeon molawinense</i>	Philippines (Luzon) and Taiwan	2, 3, 4, 6, 7, 8, 13, 14
<i>Pseudocloeon morum</i>	Endemic to Taiwan	1, 3, 4, 6, 8, 14
<i>Pseudocloeon mustum</i>	Endemic to Taiwan	6
<i>Cloeon marginale</i>	Oriental, widely distributed	** 15
<i>Cloeon virens</i>	Oriental and Australian, widely distributed	*** 2, 3, 4, 6, 7, 8, 13, 14 (new to mayfly fauna of Taiwan)
<i>Procloeon tatalis</i>	Endemic to Taiwan	1, 3, 4, 6, 8, 14
<i>Ameletus atratus</i>	Endemic to Taiwan	6
<i>Ameletus formosus</i>	Endemic to Taiwan	3, 7
<i>Ameletus montivagus</i>	Endemic to Taiwan	7, 8
<i>Isonychia formosana</i>	Japan and Taiwan	1, 3
<i>Afronurus chihpenensis</i>	Endemic to Taiwan	3
<i>Afronurus florens</i>	Endemic to Taiwan	3, 6, 7, 8, 11, 13
<i>Afronurus hyalinus</i>	Taiwan and China	7, 8
<i>Afronurus nanhuensis</i>	Endemic to Taiwan	1, 3
<i>Ecdyonurus littorosus</i>	Endemic to Taiwan	14
<i>Ecdyonurus mitificus</i>	Endemic to Taiwan	2, 3, 4, 5, 6, 7, 8, 13, 15
<i>Ecdyonurus obscurus</i>	Endemic to Taiwan	1, 3, 4, 8, 11, 13, 14
<i>Epeorus erratus</i>	Endemic to Taiwan	3, 6
<i>Electrogena fracta</i>	Endemic to Taiwan	1, 3, 5, 7, 8, 13, 14
<i>Rhithrogena ampla</i>	Endemic to Taiwan	1
<i>Rhithrogena parva</i>	Java, China, and Taiwan	4
<i>Choroterpes taiwanensis</i>	Endemic to Taiwan	1, 2, 3, 4, 6, 7, 8, 13, 14, 15
<i>Choroterpes trifurcates</i>	Japan and Taiwan	1, 8, 15
<i>Choroterpides nigella</i>	Endemic to Taiwan	3, 4, 6, 8, 13
<i>Thraululus fatuus</i>	Endemic to Taiwan	3, 6, 7, 8, 13, 14
<i>Thraululus macilentus</i>	Endemic to Taiwan	1, 3, 4, 7, 8, 14
<i>Thraululus umbrosus</i>	Endemic to Taiwan	1, 4, 6, 8, 13, 15
<i>Habrophlebiodes gilliesi</i>	Oriental, South-East Asia	*** 1, 3 (new to mayfly fauna of Taiwan)
<i>Habrophlebiodes tenella</i>	Endemic to Taiwan	6, 8, 15
<i>Paraleptophlebia erratica</i>	Endemic to Taiwan	1, 2
<i>Paraleptophlebia spina</i>	Endemic to Taiwan	13

<i>Ephemera formosana</i>	Japan (Ryukyu) and Taiwan	1, 3, 4, 7, 8, 11, 13, 14
<i>Ephemera sauteri</i>	Endemic to Taiwan	1, 4, 8, 11, 13, 14, 15
<i>Potamanthus idiocerus</i>	Endemic to Taiwan	1, 3, 4, 13
<i>Cincticostella fusca</i>	Endemic to Taiwan	3, 6, 8, 11, 13
<i>Cincticostella colossa</i>	Endemic to Taiwan	1, 3, 4, 7, 8, 11, 13, 14
<i>Eburella brocha</i>	Endemic to Taiwan	3, 4, 7, 8, 11, 13
<i>Ephacerella glebosa</i>	Endemic to Taiwan	1, 3, 4
<i>Ephacerella Montana</i>	Endemic to Taiwan	6
<i>Torleya glareosa</i>	Endemic to Taiwan	1
<i>Torleya lutosa</i>	Endemic to Taiwan	1, 4
<i>Uracanthella rufa</i>	Japan, Korea, Russia	*** 14
		(new to mayfly fauna of Taiwan)
<i>Caenis argillosa</i>	Endemic to Taiwan	1, 4, 6, 8, 13, 14
<i>Caenis bella</i>	Endemic to Taiwan	1, 6, 8, 13
<i>Caenis cornigera</i>	Endemic to Taiwan	3, 4, 6, 7, 8, 13
<i>Caenis corpulenta</i>	Endemic to Taiwan	8
<i>Caenis granifera</i>	Endemic to Taiwan	1, 4, 5, 8, 13, 14, 15
<i>Caenis nitida</i>	Endemic to Taiwan	1, 7, 8, 11, 13
<i>Caenis Montana</i>	Endemic to Taiwan	1, 4, 8, 13
<i>Caenis yangi</i>	Endemic to Taiwan	6, 8

Naturally, some taxonomical problems are left to be solved on the basis of careful examination of respective holotypes or detailed study of both larvae and adults. This concerns mainly *Baetis taiwanensis*, *Rhithrogena parva* and *Choroterpes trifurcatus*, and some other species. At the generic level, a detailed attention has to be paid to some Heptageniidae, i. e. the appropriate placement to *Afronurus* species from Taiwan. Like other Asian species, all three species from this area might fall into the genus *Ecdyonurus*. As supposed e.g. by Kluge (1988). *Afronurus hyalinus*, shifted by Kang and Yang (1994b) to this genus was originally described within *Ecdyonurus* (cf. Ulmer, 1912).

#### Distribution and Biogeographic analysis

The aim of the present paper is, among other, to summarize published data on distribution of individual species of the island. For technical reasons, we analyzed and classified individual localities according to their occurrence in the administrative units, in Hsiens (= Counties), not taking into account the number of localities in each of them. Respective administrative units are apparent from Fig. 1. Consequently, we are mapping a density of localities, not a density (or quantitative abundance) of individual species. Despite this rather very simple approach, we are able to differentiate widely spread species (e.g. *Alainites clivosus*, *Baetis tatuensis* or *Choroterpes taiwanensis*) from local and rare species (e.g. *Ameletus atratus*, *Ephacerella montana* or *Acentrella ultima*), often known only from the type locality (Table 2).

Taking into account the occurrence of 19 families, 104 genera and about 540 species recorded from the Oriental region and transition areas (Soldán, 2001) the mayfly fauna of Taiwan represents about 47 % of families, 27 % of genera and 12 % of species of the whole respective biogeographic region.

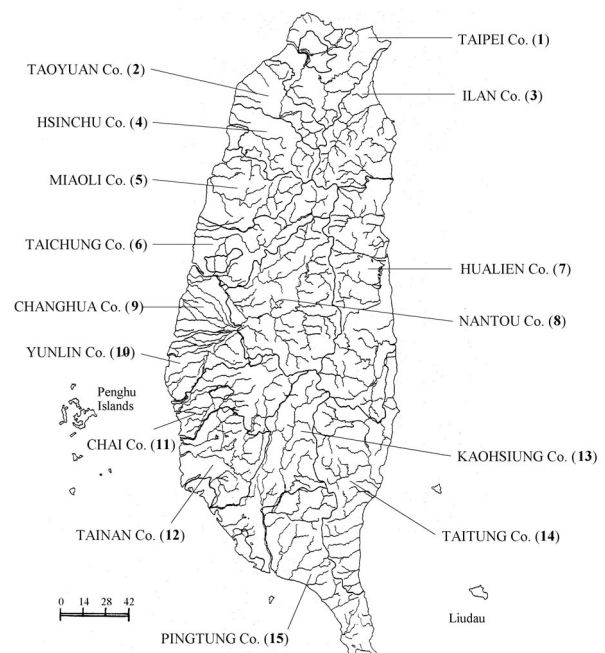


Fig. 1 - Map of Taiwan showing basic river network and respective administrative units (Hsiens). Their numbers correspond to those presented in Tab. 2

As a whole the mayfly fauna of the island is characterized by a very high degree of endemism. This is not apparent at the level of families, and negligible at the generic level. There is only a single genus, namely *Eburella* that do not occur at any other place except for Taiwan. However, a

single representative of it, *E. brocha* does not seem to be rare or endangered although its larvae usually inhabit larger rivers with cumulative pollution.

Besides *Eburella*, composition of mayfly genera in Taiwan (total number of 28 genera, plus *Cloeodes* and possibly *Moribaetis*) looks as follows: 4 genera (*Baetis*, *Cloeon*, *Pseudocloeon*, and *Caenis*) represent ones with very large (cosmopolitan) areas, and there are at least 9 "Old World" or Palaeotropic genera (*Afronurus*, *Nigrobaetis*, *Ameletus*, *Isonychia*, *Epeorus*, *Rhithrogena*, *Paraleptophlebia*, *Choroterpes*, and *Ephemerella*). If the genus *Cloeodes* actually live in Taiwan (its Asian species might belong to different genus, cf. Braasch and Soldán, 1980) then this genus exhibits a very peculiar, Nearctic-Neotropic-Oriental distribution. The same concerns the genus *Moribaetis*.

As far as the species analysis is concerned (Table 2), 53 species (and *E. brocha* mentioned above) are considered endemic, 5 inhabit also Japan and/or Philippines, 4 represent East Palearctic or South-East Oriental species and 2 those with large Oriental areas. Of the latter, the largest area (Oriental and Australian) is shown by *C. virens*.

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