

## Redescription and biology of *Limonia badia* (Walker) (Diptera: Limoniidae)

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*Limonia badia* (Walker, 1848), previously known from the Nearctic Region only, is redescribed from Finland. Its systematic position and biology are currently debated. *Limonia indigenoides* (Alexander, 1920), another Nearctic species, is synonymized with *L. badia*. The species is distinguished by several distinctive characters, such as the wing pattern and the structure of the male terminalia. These characters are illustrated for the first time. Immature stages are probably associated with decaying wood of aspen (*Populus tremula* L.). A list of species of the Tipuloidea associated with *L. badia* in Finland – including *Gnophomyia acheron* Alexander, 1950, a species new to Europe – is presented.

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### 1. Introduction

The genus *Limonia* Meigen, 1803 is relatively rich in species: a total of 65 taxa (species and sub-species) are known from the Palaearctic Region (Savchenko *et al.* 1992). The larvae of the genus inhabit a wide array of habitats, such as aquatic/semiaquatic and terrestrial substrates (Brinkmann 1991), leaf detritus (Tjeder 1958), decaying wood (Beling 1886) and fungi (Lindner 1958).

During an investigation of insect material collected by trunk-window traps in Finland in 1996, some highly interesting species of Tipuloidea were discovered (see section 4.2 and Appendix). The material included *Limonia badia* (Walker, 1848), a species new to the Palaearctic fauna. Here, we redescribe the species and illustrate its diagnostic features.

### 2. Material and methods

The material was collected with trunk-window traps in two localities, Sb (Savonia borealis): Savonranta, central Finland, and Obb (Ostrobothnia): Rovaniemi municipality, northern Finland, in 1996 (Martikainen 2001). Solution of water, salt and detergent was used as a preservative in the traps, and later the material obtained was preserved in ethanol. Type specimens were borrowed from The Natural History Museum, Department of Entomology, London, UK (BMNH) and Ohio State University, Department of Entomology, Museum of Biological Diversity, Columbus, USA (OSU).

The morphological terminology follows McAlpine (1981), except for notation of the veins, which essentially is in accordance with Hennig (1954). The outer radial field in the

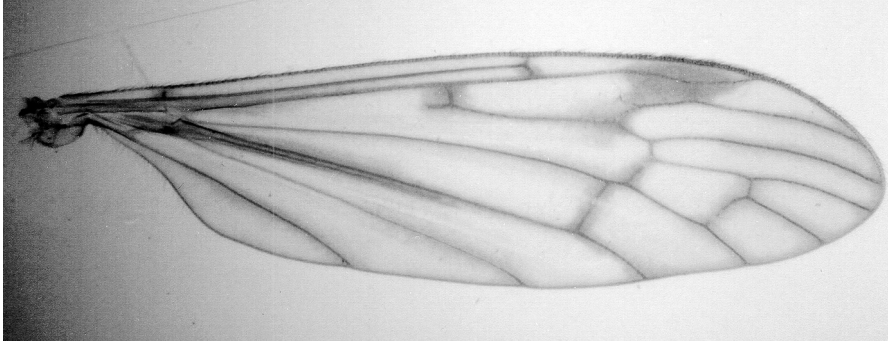


Fig. 1. Wing of *Limonia badia* (Walker) (Finland, Savonranta). Photo: T. Nieminen.

Limoniinae is interpreted as proposed by Stary (1992), and the veins and their parts participating in the so-called reticulation pattern are named accordingly.

### 3. *Limonia badia* (Walker, 1848)

*Limnobia badia* Walker, 1848: 46 (description).

*Limonia (Limonia) badia*: Alexander 1943: 300 (diagnosis, note, key) (reprinted 1966); Alexander 1965: 43 (Nearctic catalogue).

*Limnobia indigenoides* Alexander, 1920: 193 (description). syn.nov.

*Limonia (Limonia) indigenoides*: Alexander, 1962: 13 (faun. record); Alexander 1965: 43 (Nearctic catalogue, tentative synonymy with *badia*).

Note: Other records under *badia* probably refer to *Dicranomyia (Dicranomyia) humidicola* Osten Sacken, 1860.

**Diagnosis.** General coloration brown, somewhat shiny, greyish pruinose in parts, patterned with paler and darker hues. Antenna moderate in length, verticils on flagellomeres over twice the length of respective segments. Wing with distinct stigma, and broad seams along most of the veins. Venation of general type as in other *Limonia*, Rs angulated and spurred, discal cell widened distally. Femora with narrow ring before tip. Tarsal claws slender, with only two teeth near base. Gonocoxite of male terminalia with broad ventromesal lobe. Gonostylus comparatively long. Paramere broad, darkly pigmented. Body length 8.5–14 mm, wing length 8–10 mm.

**Redescription** (male). Head dark brown, mostly dull. Palpus and antenna brown, the latter

14-segmented, moderate in length, not reaching to base of wing. Scape and pedicel slightly darker than flagellomeres. Scape cylindrical, about 1.5 length of pedicel, the latter short-oval to nearly spherical. Flagellomeres suboval to elongate, becoming paler, narrower and longer towards apex of antenna. Terminal segment longest, slightly constricted at midlength, or beyond it, with little-distinct transversal suture at that place, so that feebly separated segment 15 often distinguishable. Longest verticils somewhat more than twice length of respective segments. Whole surface of flagellum with dense, short, semierect pubescence.

Thorax generally brown, somewhat shiny, partly greyish pruinose, and variously patterned with paler or darker hues. Pronotum essentially pale brown, with sparse setae in anterior half medially, and with another group of setae at posterior margin. Prescutum divided in colour into three areas by two diffused, longitudinal, yellowish brown streaks, marked with rows of setae. Median area, representing broad median stripe, generally brown, darker anteriorly. Pale capillary line splitting median stripe sometimes apparent in specimens preserved in ethanol (not so in those dried from ethanol). Lateral areas (stripes) appearing a little paler, provided with fairly distinct dark brown patch at lateral margin of prescutum, just before wing base. Scutum distinctly darker on lobes than most of prescutum, dirty yellowish brown in middle. Both scutellum and post-scutellum brown, darkest in middle. Pleuron patterned with various hues of brown, somewhat shiny and more greyish pruinose than prescutum, with anepisternum, katepisternum and posterior part of so-called subspiracular sclerite (as termed

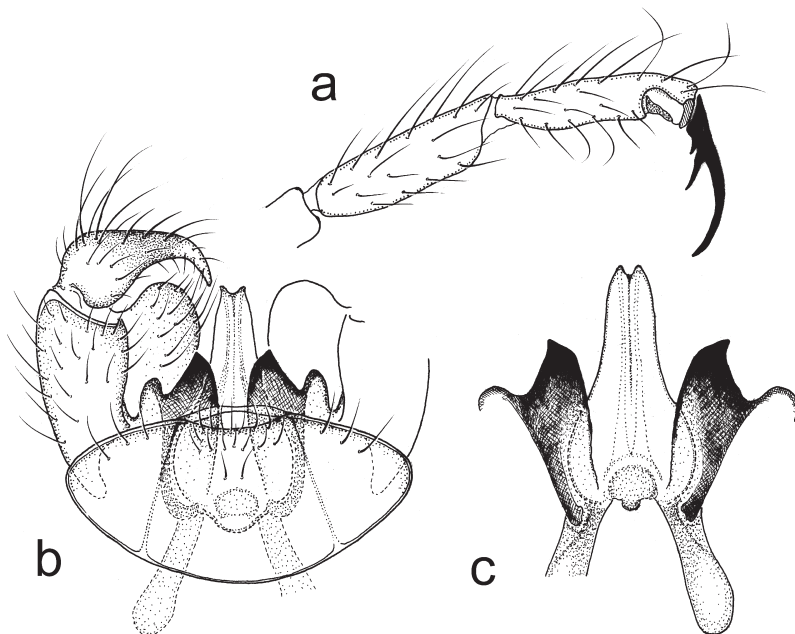


Fig. 2. *Limonia badia* Walker (Finland, Savonranta). – a. Distal part of male hind tarsus, lateral view. – b. Male terminalia, dorsal view. c. – Aedeagal complex, dorsal view.

so by Starý 1992) representing darkest areas. Group of setae on laterotergite dorsally.

Wing (Fig. 1) tinged with yellowish, with distinct dark brown stigma and broad seams along most of veins, most pronounced so along Rs, Cu and on cross-veins. Insides of cells without any markings. End of Sc<sub>1</sub> darkened. Seam along Rs markedly diffused into larger clouds on both ends; distal cloud fused with stigma. Venation of general type as in other *Limonia*, yet differing in many details from many other European species. Sc<sub>1</sub> rather long, ending at about midlength of Rs. R<sub>2+3</sub> (mostly termed cross-vein r or R<sub>2</sub>) slightly less so or about twice as long as R<sub>3</sub> (distal section beyond attachment of cross-vein r of what previously was termed R<sub>1</sub> through its entire course; or R<sub>1+2</sub>, or distal section of Sc<sub>2</sub> in various papers by Alexander). Rs angulated and distinctly spurred proximally. Discal cell essentially trapezoid or irregularly pentagonal (in former case often with another spur directed inside discal cell at deflection of M<sub>3</sub>), widened distally, with basal section of M<sub>3</sub> (within discal cell) twice as long as m-m, or more, and often arched, so that lower distal margin of discal cell obliquely concave. Halter dirty yellowish, comparatively short, slightly darkened at midlength of stem.

Abdomen brown, with tergites yellow at pos-

terior margins. Proximal sternites with yellow colour more extended.

Legs rather long, generally yellow to yellowish brown. Coxae and trochanters pale yellow, fore and mid coxae darkened at base. Femora yellowish, with narrow, not especially dark, ring just before tip. Tibiae yellowish, narrowly tipped with darker. Tarsi dark except for base of basitarsus. The latter long, about three times as long as tarsomere 2, this about twice length of tarsomere 3. Both last tarsomeres subequal in length, about half the length of tarsomere 3. Tarsal claws (Fig. 2a) rather long and very slender, slightly shorter than last tarsomere, mostly smooth, with only two slender teeth near base, a longer one, situated more distally and a little shorter than half length of claw beyond it, and a minute proximal one.

Male terminalia (Fig. 2b–c): Tergite 9 generally transversally elliptic, with shallow median emargination at posterior margin enclosed by pale bar. Gonocoxite short and stout, with broad, slightly darkened ventromesal lobe. Gonostylus comparatively long, swollen at base, then drawn out into long beak, the latter stout and almost straight proximally, gradually narrowed into slender obtuse tip curved caudally. Gonostylus mostly darkly pigmented, except at base and tip,

and provided with very long setae in proximal half. Aedeagus rather broad. Paramere broad and comparatively short, somewhat sclerotized and conspicuously darkened distally, with subacute tip directed outwardly. Other details are evident from Fig. 2b–c.

*Description* (female). Resembles male in general appearance and structure, but antenna slightly shorter than those of male. Wing venation and wing pattern identical in both sexes. Tarsal claws much shorter than in male, about one third length of last tarsomere, with two teeth shorter than in male, otherwise, however, similar in position and relative length. In contrast to male, last tarsomere longer than penultimate, about 1.5 length of the latter. Female terminalia, not examined in detail, with cercus generally slender, subequal in length to female tergite 10.

*Type material examined.* *Limonia badia*: Holotype ♀: [Canada: Nova Scotia]; in BMNH. Labels: “R” (hand-written, a green rhomboid label) “Limnobia/ badia/ Walker./ (type).” (hand-written) “Type” (printed, a green-margined circular label), “Identified as the type/ by E. A. Waterhouse.” (printed) “HOLOTYPE” (printed, a red-margined circular label), “HOLOTYPE/ Limnobia/ badia/ Francis Walker/ 1848 (G. B. 1960)/ G. W. Byers” (partly hand-written, red). The specimen pinned; tip of the right wing missing, all legs and both antennae broken off. *Limonia indigenoides*: Holotype ♂ [USA], Alaska, Katmai, August 1917 (J.S Hine leg.); in OSU. Labels: “Katmai/ Alaska/ Aug ’17” (printed) “Jas S Hine/ Collector” (printed) “Holotype/ Limnobia indigenoides/ C. P. Alexander” (species name hand-written, red) (in OSU). The specimen pinned; left wing missing; left mid and hind legs and right fore leg broken off. Tip of abdomen was cleared in KOH by the present authors and placed in a microvial with glycerine, pinned with the specimen.

*Other material examined* (22♂, 43♀). Finland: Sb: Savonranta, 10.VIII.–4.IX.1996, 3 ♂, 4.IX.–2.X.1996, 15 ♂, 38 ♀; Obb: Rovaniemi mlk, 25.VII.–27.VIII.1996, 4 ♂, 5 ♀ (all P. Martikainen leg.); in Finnish Museum of Natural History, Zoological Museum, Helsinki, in coll. J. Salmela, Jyväskylä and in coll. J. Starý, Olomouc. All specimens originally preserved in ethanol, 3 ♂ dissected on slides, 3 ♂ and 3 ♀ dried

from ethanol and mounted on points.

Comparative material: *Limonia indigena*: USA, Pennsylvania, Westmoreland Co., 10 km S Ligonier, Powdermill Nature Reserve (400 m), 27.IX.1986, 1 ♂, 1 ♀ (C.W. Young leg. et det.); in coll. J. Starý, Olomouc.

*Distribution.* Holarctic: Canada: Nova Scotia; USA: Alaska, Maine; Finland. First record from the Palaearctic Region.

## 4. Discussion

### 4.1. Distinction between *L. badia* and other *Limonia* species

*Limonia badia* was redescribed from a large series of specimens, all teneral in various degrees, preserved in ethanol, of which a few were subsequently dried from ethanol and mounted on cardboard points. Both dry-mounted type specimens examined appear somewhat darker, more greyish pruinose, otherwise, however, they are identical with the Finnish material in all external characters and in the structure of the male terminalia (in case of *indigenoides*). As usual for *Limonia*, female terminalia do not provide significant features, yet identity of the other material with the type of *L. badia* is beyond any doubt.

By its wing pattern, shape of the tarsal claws and details in the structure of the male terminalia (Figs. 1–2), *L. badia* takes up a somewhat isolated systematic position and cannot be confused with any of its Palaearctic and Nearctic congeners. It is distinctive in that its wing pattern is exclusively associated with venation, leaving insides of cells without any markings, and being represented, except for the stigma, by well-pronounced seams along veins only. The tarsal claws bear only two teeth. These external characters are quite sufficient for distinguishing the species.

Based on the darkly pigmented parameres and some other details in the structure of the male terminalia, *L. badia* appears to be distantly related to the Palaearctic *L. macrostigma* (Schummel, 1829) and *L. alpicola* (Lackschewitz, 1928), in which, however, the wing pattern is extremely reduced, the tarsal claws bear at least three teeth, and the parameres are much more slender, spine-like.

Closer affinities of *L. badia* probably occur with the Nearctic *L. indigena* (Osten Sacken, 1860), including the subspecies *L. indigena jacksoni* (Alexander, 1917) and *L. indigena loloensis* Alexander, 1958. The latter species is somewhat similar to *L. badia* in general appearance, also sharing the reduced number of teeth on the tarsal claw, but the wing pattern is more extensive. The pattern consists of a broad crossband along the so-called cord, and another one (more proximal and broken) formed by clouds in the cells R, M, Cu and A<sub>1</sub>. The parameres are darkened, but slender, rather ribbon-shaped, strongly curved and truncate at apex.

#### 4.2. Biology of *L. badia*

The Finnish specimens of *L. badia* were collected with trunk-window traps placed on dead aspens (*Populus tremula* L.) in two localities, namely Sb: Savonranta (62°15'N, 29°00'E) and Obb: Rovaniemi (66°10'N, 25°55'E) (for details, see Martikainen 2001). The studied trees were in clear-cuts (open habitat) or in old-growth forests (shaded habitat), either recently died or more or less decayed (bark partly loose). Only trees and snags with a diameter at breast height of >25 cm were selected for sampling. The sampling period was from 21 May to 2 October 1996 in Savonranta, and from 28 May to 12 September 1996 in Rovaniemi. Both localities, particularly Savonranta, are aspen-rich stands and harbour several rare and threatened beetles and polypore fungi associated with aspen (Martikainen *et al.* 2000, Martikainen 2001).

Our data indicate that *L. badia* is an autumnal species, since the majority of the specimens were caught in September. Virtually all collected specimens were teneral, suggesting that larval habitat was located close to the trap: the species may well be a saproxylic limoniid living in dead and decaying aspen wood. Larvae of some other members of the genus were reported to inhabit rotten wood, such as *Limonia macrostigma* (cf. Beling 1886).

In addition to *L. badia*, some rare and poorly-known Tipuloidea were collected on the same occasion, such as *Elephantomyia krivosheinae*, *Lipsothrix ecucullata*, *Ula bolitophila*, *Tipula (Lunatipula) circumdata* and *T. (Pterelachisus)*

*wahlgreni*, including *Gnophomyia acheron*, a species new to Europe, so far known from West Siberia, Russian Far East and Japan (cf. Savchenko *et al.* 1992; for complete list, see Appendix).

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Appendix. A list of species of Tipuloidea collected with trunk-window traps at Savonranta and Rovaniemi mlk 1996, P. Martikainen leg. \* = < 10 ex.; \*\* = 11–20 ex; \*\*\* = > 20 ex.

Species	Savonranta	Rovaniemi mlk
<b>Limoniidae</b>		
<i>Austrolimnophila (Archilimnophila) unica</i> (Osten-Sacken, 1869)	*	—
<i>Euphylidorea phaeostigma</i> (Schummel, 1829)	*	—
<i>Phylidorea (Paraphylidorea) fulvonervosa</i> (Schummel, 1829)	**	—
<i>Erioptera (E.) sordida</i> Zetterstedt, 1838	*	—
<i>Gnophomyia acheron</i> Alexander, 1950	*	—
<i>Ormosia (O.) ruficauda</i> (Zetterstedt, 1838)	*	—
<i>Dicranomyia (D.) autumnalis</i> (Staeger, 1840)	*	—
<i>Dicranomyia (D.) didyma</i> (Meigen, 1804)	—	*
<i>Dicranomyia (D.) handlirschi</i> Lackschewitz, 1928	*	—
<i>Dicranomyia (D.) modesta</i> (Meigen, 1818)	—	*
<i>Dicranomyia (Idiopyga) stigmatica</i> (Meigen, 1830)	—	*
<i>Discobola annulata</i> (Linnaeus, 1758)	***	—
<i>Discobola caesarea</i> (Osten-Sacken, 1854)	*	—
<i>Elephantomyia krivosheinae</i> Savchenko, 1976	*	—
<i>Lipsothrix ecucullata</i> Edwards, 1938	*	—
<i>Neolimonia dumetorum</i> (Meigen, 1804)	**	—
<i>Metalimnobia quadrimaculata</i> (Linnaeus, 1761)	**	—
<i>Metalimnobia zetterstedti</i> (Tjeder, 1968)	—	*
<i>Limonia badia</i> (Walker, 1848)	***	**
<i>Limonia sylvicola</i> (Schummel, 1829)	*	—
<i>Rhipidia (R.) maculata</i> Meigen, 1818	**	*
<i>Rhipidia (R.) uniseriata</i> Schiner, 1864	*	*
<b>Pediciidae</b>		
<i>Ula bolitophila</i> Loew, 1869	*	—
<i>Ula mixta</i> Starý, 1983	*	—
<i>Ula sylvatica</i> (Meigen, 1818)	**	—
<b>Tipulidae</b>		
<i>Tipula (Lunatipula) circumdata</i> Siebke, 1863	—	***
<i>Tipula (Lunatipula) limitata</i> Schummel, 1833	—	*
<i>Tipula (Pterelachisus) irrorata</i> Macquart, 1826	*	—
<i>Tipula (Pterelachisus) wahlgreni</i> Lackschewitz, 1925	*	—
<i>Tipula (Savtshenkia) limbata</i> Zetterstedt, 1838	*	*
<i>Tipula (Savtshenkia) signata</i> Staeger, 1840	*	—
<i>Tipula (Schummelia) variicornis</i> Schummel, 1833	*	—
<i>Tipula (Tipula) paludosa</i> Meigen, 1830	*	—
<i>Tipula (Vestiplex) nubeculosa</i> Meigen, 1804	*	—
<i>Tipula (Vestiplex) scripta</i> Meigen, 1830	*	*
<b>Cylindrotomidae</b>		
<i>Triogma trisulcata</i> (Schummel, 1829)	*	—