



A new species for *Limulopteryx* from Cameroon with the first record of termitophilous Ptiliidae (Coleoptera) outside the Neotropics

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Abstract

A new and apparently termitophilous featherwing beetle *Limulopteryx hintelmanni* sp.n. from Cameroon is described and extensively illustrated. This is the first record of termitophilous Ptiliidae outside the Neotropical Region. Taxonomic position of the new species and that of the genus *Limulopteryx* are discussed. All records of Ptiliidae associated with termites are reviewed.

Key words: Taxonomy, beetle

Introduction

The family Ptiliidae is a cosmopolitan group of small beetles normally not exceeding 1.5 mm in body length. The family includes about 630 described species in some 85 genera (Newton & Thayer, 2007). Termitophily as a rare phenomenon was recorded for representatives of five genera: *Urotriainus* Silvestri with three species, as well as monotypic *Pycnopteryx* Dybas, *Xenopteryx* Dybas, *Dybasina* Lundgren, and *Limulopteryx* Hall (Fig. 15; see also Kistner, 1982, Hall, 2003). All termitophilous Ptiliidae are characterised by a limuloid body (Figs 6, 7), which is believed to co-evolve as an adaptation to life in the hostile environment of social insects' nests (Kistner, 1982). All these taxa are restricted to the Neotropical zoogeographical region and are known from a very few scattered records.

This paper reports the discovery of a new *Limulopteryx* species collected together with Nasutitermitinae termites in Cameroon, West Africa. Its association with termites, as well as the limuloid body shape suggest that this is the first record of termitophilous Ptiliidae outside the Neotropical Region.

Material and methods

Both known specimens of the new *Limulopteryx* species were collected by peeling tree bark over a beating sheet and then preserved in 70% ethanol. One specimen was attached by Hercules glue to a point on an entomological pin to allow its free rotation for environmental Scanning Electron Microscopy without metal coating (Figs 6–11). This specimen was later removed from the point, soaked with 70% ethanol, and photographed together with another specimen and termite hosts under a dissecting microscope in reflected light (Figs 1–2). Both beetles, along with two specimens of termite hosts, were macerated in 10% KOH, impregnated with iso-propanol, and mounted on two microscope slides in Euparal medium (one beetle plus one termite per slide under two separate cover slips). Cleaned beetles were photographed under a compound microscope in transmitted light (Figs 3–5).

Genus *Limulopteryx* Hall, 2003

Type species. *Limulopteryx loebli* Hall, 2003: 88, by original designation

Description. This genus was adequately described when erected (Hall, 2003). Some generic characters, however, show difference between the type species and the new one. They are listed below in the key for both known *Limulopteryx* species.

Distribution. The genus *Limulopteryx* is currently known from the Neotropical (Belize, Panama, Colombia, Ecuador, Peru) and Afrotropical (Cameroon) zoogeographical regions.

Monophyly and taxonomic position. There is currently no phylogenetic hypothesis based on numerical analysis to support monophyly of *Limulopteryx*. The overall similarity of both included species, particularly limuloid body form (Fig. 2), presence of the spatulate ventral process protruding between mesocoxae (Figs 11, 14), as well as association with termites (Fig. 15), are the only viable indications that the genus might be a monophyletic group. The latter is challenged by the fact that none of these features is unique for *Limulopteryx* within Ptiliidae, as this genus is currently understood. See below for more extensive phylogenetic discussion.

Limulopteryx hintelmanni sp. n.

(Figs 1–14)

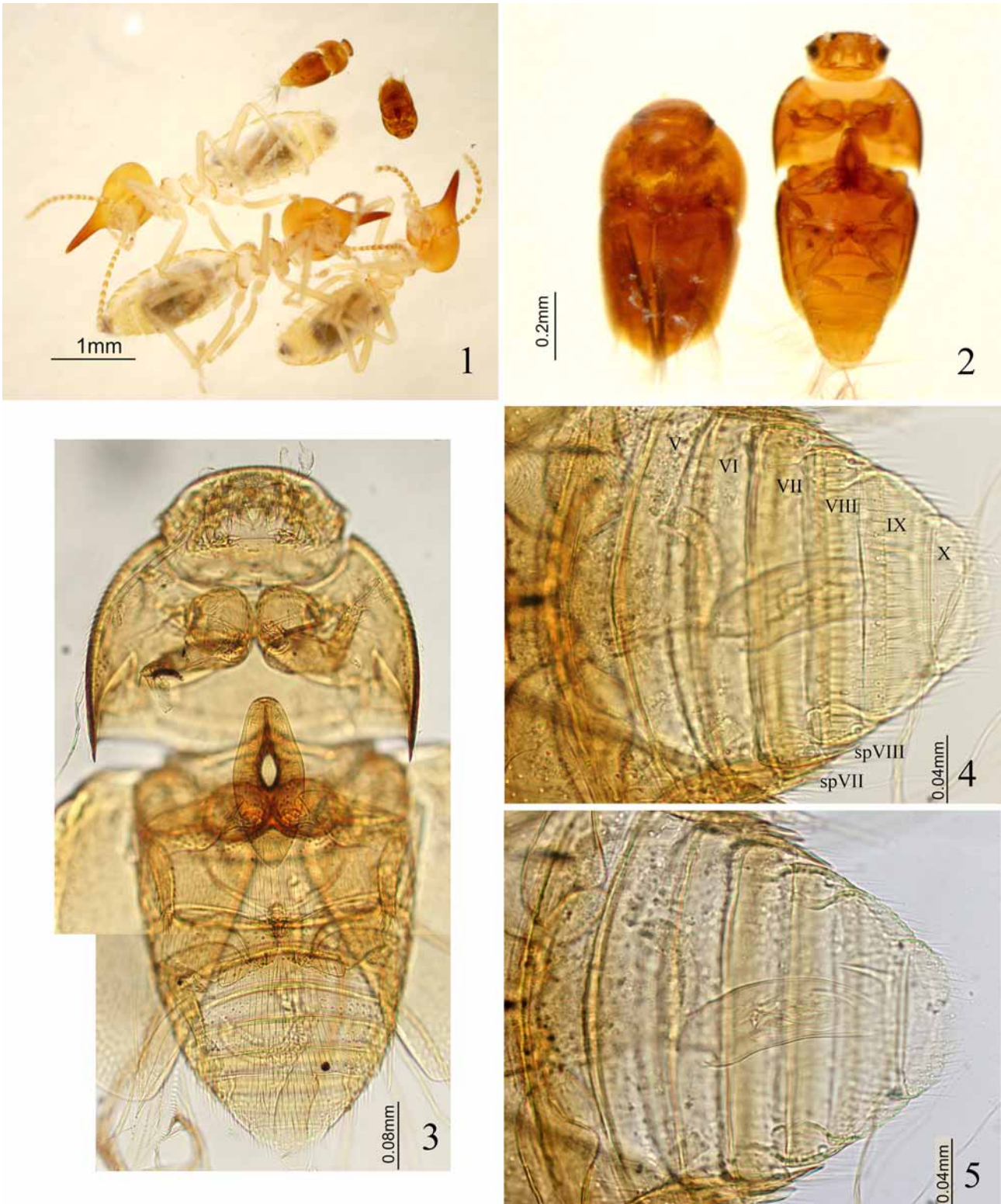
Description. Similar in all characters to *L. loebli*, except as noted below and in the diagnosis. Body length from clypeus to apex of tergite X 0.93–1.00mm (n=2; beetles slightly expanded in Euparal medium); head maximal width 0.25 mm (n=2); eye partly reduced in size, with some 20–28 facets; pronotal maximal width 0.45mm (n=2); abdominal glands not found; aedeagus elongate (Fig. 5) with fine internal sclerotisation; eyes, wings, wing-folding patches in tergites II–V and hindwing cleaning (=toiletry) device (see Hall, 2003) on posterior margin of tergite VII present and fully developed.

Diagnosis. *Limulopteryx hintelmanni* can be distinguished from *L. loebli*, its only congener, using the following key:

1. Prosternal process absent; spatulate ventral process protruding between mesocoxae 2.3X times longer than wide (Figs 7, 14); meso-metaventral suture almost straight and transverse; mesoscutellum 2.4X wider than long; metascutellum short (Fig. 13); tergite X without apical projections, evenly rounded apically (Fig. 5); metacoxae almost contiguous (Fig. 3); basal stalk of metendosternite narrow (Fig. 14); metacoxae posteriorly angulate, not serrate (Figs 7, 11) *Limulopteryx hintelmanni* sp.n.
- Prosternal process present; spatulate ventral process protruding between mesocoxae 1.7X times longer than wide; meso-metaventral suture bent anteriorly; mesoscutellum 2.0X wider than long; metascutellum long (Hall 2003, fig. 11); tergite X with apical tooth; metacoxae separated by about ¼ of metaventral width (Hall, 2003, fig. 3); basal stalk of metendosternite about as wide as distance between metacoxae (Hall, 2003, fig. 3); metacoxae posteriorly rounded and serrate (Hall, 2003, fig. 14d)
..... *Limulopteryx loebli* Hall, 2003

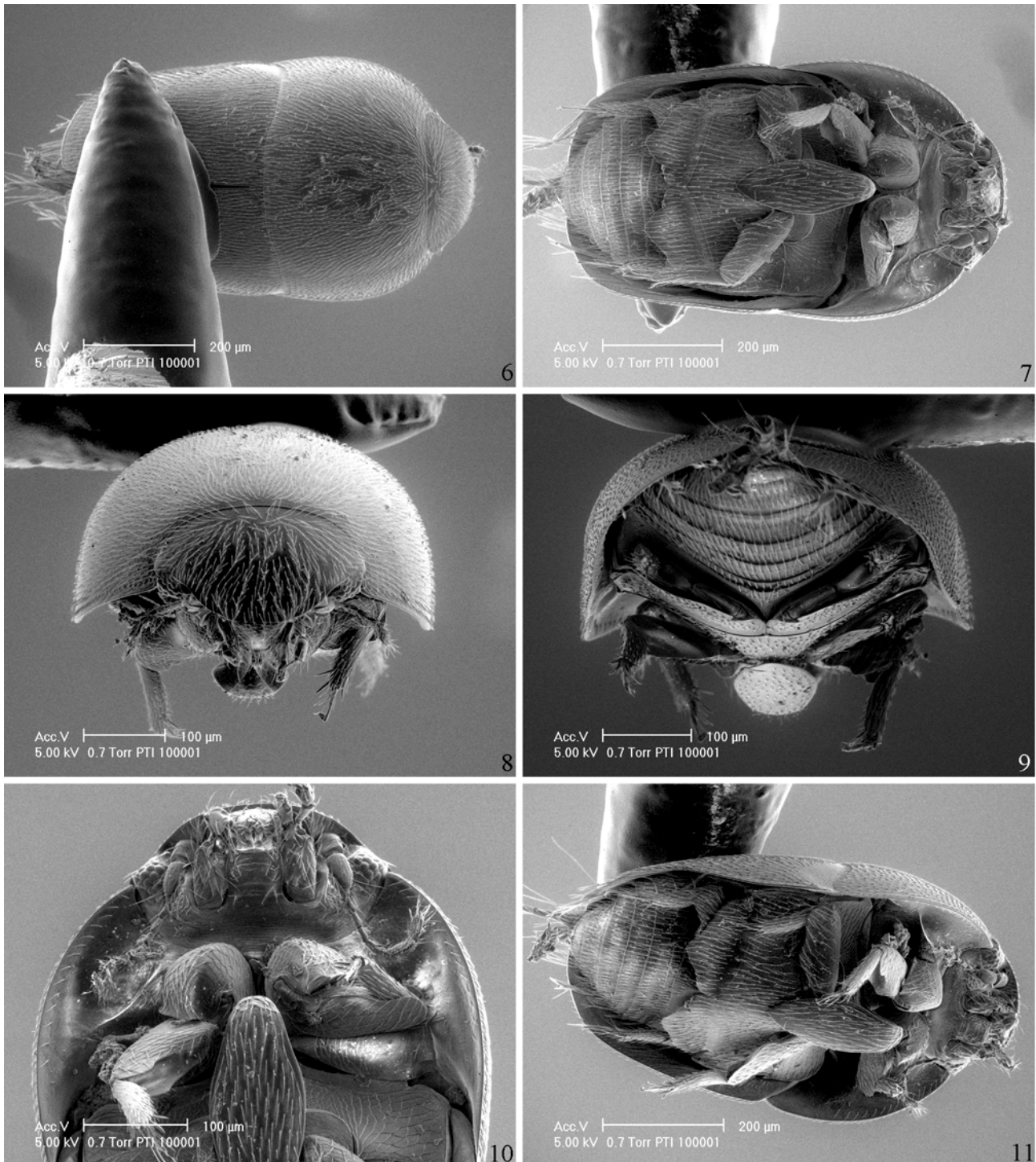
Material Examined. Holotype: male, “Cameroon, S.-West Province, Bakingili, N04°03.35’ E009°03.823’, 24–26.V.2006, 250m, under bark of dry dead standing tree together with termites, V. Grebennikov” (Canadian National Collection of Insects, Arachnids, and Nematodes, Ottawa, Canada). Paratype: male, same data as holotype (Royal Museum for Central Africa, Tervuren, Belgium).

Distribution and Bionomics. *Limulopteryx hintelmanni* is known from the single locality on the south slope of Mt. Cameroon at about sea level. The type locality of this species is about one kilometre North-East from the point where a 1999 lava flow crossed the Limbe-Bakingili highway. Both known specimens were



FIGURES 1–5. *Limulopteryx hintelmanni* sp.n. (Coleoptera: Ptiliidae) from Cameroon. 1—Habitus view of two beetles together with three associated *Nasutitermitinae* termites; 2—dorsal (left, body contracted) and ventral (right, body expanded) habitus view; 3—habitus, ventral view; 4—abdomen with elytra opened, dorsal view; roman numbers indicate tergites; 5—the same as 4, but focusing at the aedeagus and the shape of tergite X (pygidium).

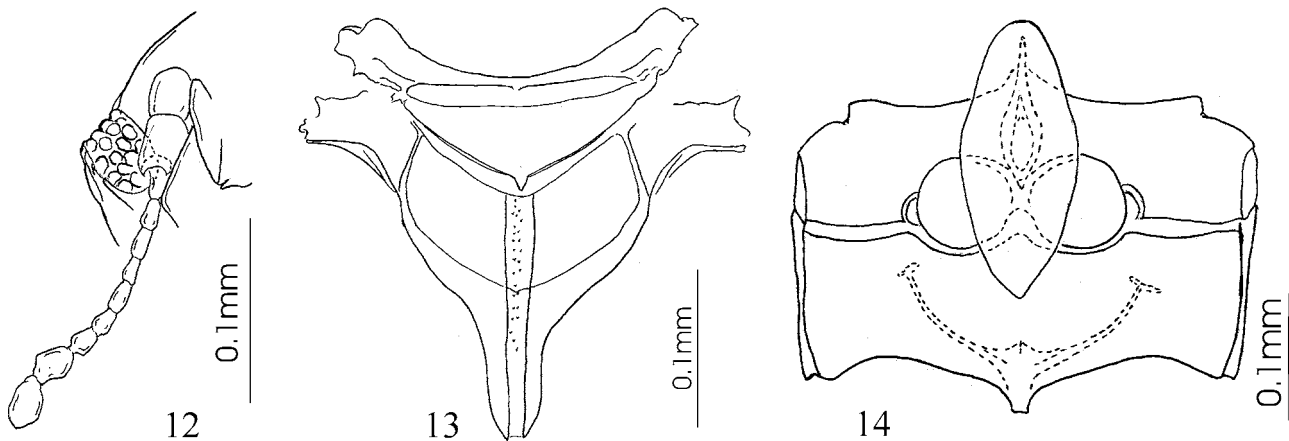
collected under loose dry bark from a dead standing tree. Termites were the most abundant insects in the sample with well over a thousand specimens; they were identified as *Nasutitermes incurvus* (Sjöstedt) by Timothy



FIGURES 6–11. *Limulopteryx hintelmanni* sp.n. (Coleoptera: Ptiliidae) from Cameroon. 6—habitus, dorsal view; 7—habitus, ventral view; 8—habitus, anterior view; 9—habitus, posterior view; 10—head, pro- and mesothorax, ventral view; 11—habitus, right ventro-posterio-lateral view.

G. Myles (personal communication). About one hundred beetle specimens that were collected included mainly rove beetles (subfamily Aleocharinae and Pselaphinae) and featherwing beetles (presumably termitophilous *Limulopteryx hintelmanni* sp. n. and *Bambara* sp.). The latter species markedly outnumbered specimens of *Limulopteryx hintelmanni* sp. n. under bark of the termite-infested tree.

Etymology. Patronymic, to commemorate the memory of the late Robert J. H. Hintelmann (Munich, Germany).



FIGURES 12–14. *Limulopteryx hintelmanni* sp.n. (Coleoptera: Ptiliidae) from Cameroon. 12—right antenna and eye, with the base of antenna partly hidden in the antennal groove, ventral view; 13—meso- and metascutellum, dorsal view; 14—meso- and metaventrum showing spatulate process, transverse meso-metaventral sutures and metendosternite, ventral view.

Discussion

Taxonomic position of Limulopteryx hintelmanni

Morphological characters of the new species described above and its association with termites satisfactorily fit the slightly amended generic boundaries of *Limulopteryx*. Some uncertainty of placement still remains due to the scarcity of specimens of the new species. Thus the presence (or absence) of abdominal glands in the new species, which is one of putative synapomorphies of Ptinellini, cannot be firmly assessed. There is also lack of adequate data on existence of polymorphic forms, as well as information about spermathecal characters in the new species.

When erected (Hall, 2003), the genus *Limulopteryx* was assigned to the tribe Ptinellini (sensu Hall, 2005), which includes all currently known limuloid-shaped termitophilous Ptiliidae plus a number of other, not termitophilous, species. Monophyly of this tribe, however, has never been proposed using parsimony or other topology-building approaches based on adequate amounts of phylogenetically relevant data. Instead, the tribe was hypothesised to be a monophylum due to a number of presumably synapomorphic characters of adult external morphology and biology, such as occurrence of polymorphic forms, presence of abdominal glands, and association with bark of decaying logs (Hall, 2003).

Sister-group relationships of *Limulopteryx* within Ptinellini have never been proposed. Besides *Limulopteryx*, only the non-Ptinellini genus *Kuschelidium* with one species in both New Zealand and Japan possesses spatulate ventral process protruding between mesocoxae and partly covering them mesally when viewed from below. This highly characteristic and likely evolutionary novel structure was called a “mesosternal plate” by Johnson (1982) or “anterior process of metasternum” by Sawada and Hirowatari (2002). The latter terminology is, however, confusing, because in both *Kuschelidium maori* Johnson, the type species of the genus, and the new *Limulopteryx* species described below this process clearly originated anterior of mesocoxae, thus being a part of mesoventrum (Johnson, 1982, fig. 2; Fig. 3). Moreover, both genera similarly have limuloid body with posteriorly protruding pronotal angles and contiguous metacoxae; both these characters, however, are occasionally found throughout Ptiliidae and it is doubtful whether they might be considered as putative synapomorphies for *Kuschelidium* and *Limulopteryx*. The genus *Kuschelidium*, however, was not mentioned as a possible relative of *Limulopteryx* when the latter was described; neither was it assigned to Ptinellini (Hall, 2003). Sawada and Hirowatari (2002) concluded that *Kuschelidium* is most closely related to *Mikado* Matthews; the genus *Limulopteryx* was then undescribed and, apparently, unknown to these authors. Moreover, their study was based on the Japanese species of *Kuschelidium*, which is not the type species of this genus and markedly differs from the latter.

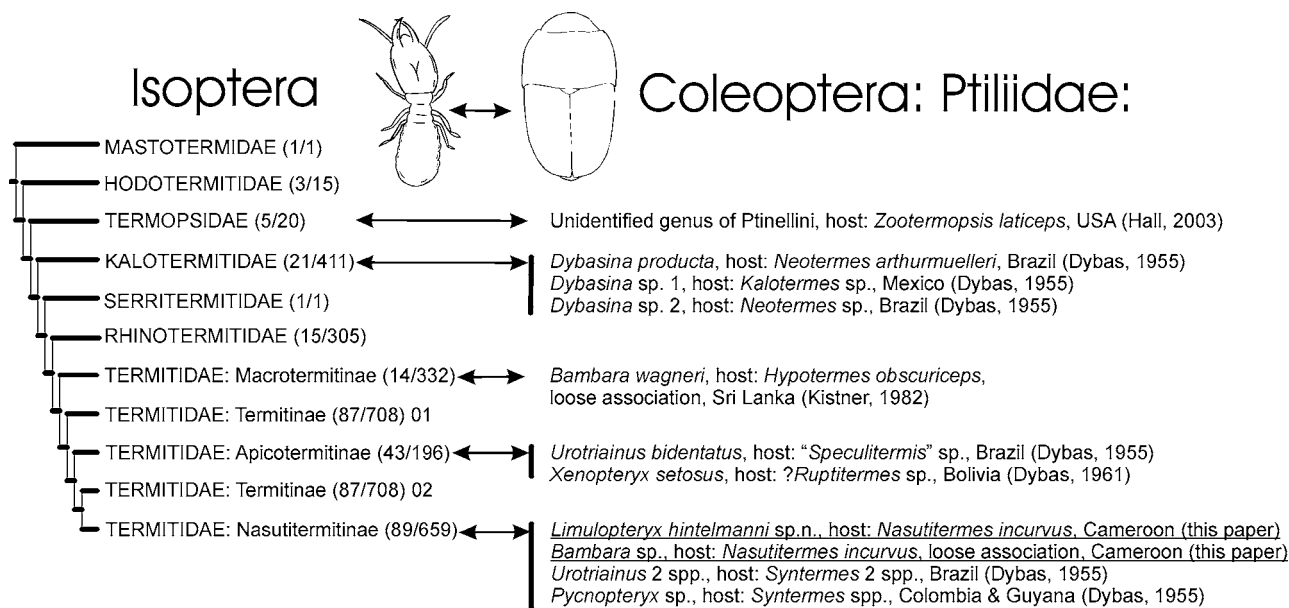


FIGURE 15. Graphical summary of known records of Ptiliidae (Coleoptera) associated with termites (Isoptera). Number of termite genera and species is indicated in brackets and separated by slash (/) following the family/subfamily name. Number of genera/species for termite families/subfamilies and phylogenetic hypothesis from Kambhampati and Eggleton (2000).

The genus *Kuschelidium* seems to be the second best choice to assign the new species to. This scenario requires, however, more significant assumptions, such as its overall monophyly, lack of data on spermathecal characters for its type species, and no records of its biological association with termites. Yet there is the third scenario to consider all four species currently assigned to *Limulopteryx* and *Kuschelidium* as members of the same clade, which is mainly supported by the presence of the spatulate ventral process protruding between mesocoxae. This approach would require re-examination of monophyly of Ptinellini and necessity to study numerous type specimens; this task, however, lies outside of the scope of this paper.

Hall (2003: 93) alluded to the existence of spatulate ventral process in an undescribed genus of Acrotrichinae, which, if true, implies higher possibility of independent origin of this remarkable structure within the family. Because of these uncertainties and for the time being, the new species from Cameroon is assigned to the ptinelline genus *Limulopteryx* (although Gene Hall, personal communication, disagreed with this action), while close relationships of the latter to the genus *Kuschelidium* is considered as a viable hypothesis for subsequent testing.

Ptiliidae associated with termites

Complexity and the multitude of relationships between social insects and co-inhabitants of their colonies is a fascinating evolutionary phenomenon. In Coleoptera alone this connection was reported for about two dozen families (Kistner, 1982). When they are adequately known, biological interactions between the guests of social insects and their hosts vary from almost non-existing to highly complex and intriguing. In most cases guest species develop peculiar morphological modifications to facilitate their life in the highly hostile environment of social insects' nest.

Termitophily in Ptiliidae, as presently know, is restricted to a handful of species in five Ptinellini genera (Fig. 15). Termitophilous Staphylinoidea show two main morphological traits: physogastry (i.e. having abdomen disproportionately large) and limuloid shape (Kistner, 1979, 1982), although cases not clearly attributed to any of these two strategies are also known (Solodovnikov, 2006). Limuloid modifications, as exemplified by

Limulopteryx hintelmanni, normally include reduction of the appendages' length, overlapping body regions in repose, and the development of shields to protect appendages from host aggression (Kistner, 1982). Physogastric species are normally thought to be deeply incorporated into termite societies while limuloids are much less incorporated (Kistner, 1982: 406). This seems to hold true for Ptiliidae, although biological data are highly fragmented and no detailed observation on guest-host interactions are known. Collecting data for *Limulopteryx* in the New World (Hall, 2003) suggest that in most of the cases beetles were found in various habitats outside of termite nests, such as forest leaf litter, stream beds near water, mammal dung, with only a single record from a termite nest in a rotting log (Hall, 2003). This indicates rather loose connections existing between at least some limuloid termitophilous Ptiliidae and their termite hosts.

Numerous specimens of a *Bambara* species were collected together with the two specimens of *L. hintelmanni*. The former was also found in hundreds of specimens in the leaf litter well outside of termite nests. Moreover, species of *Bambara* do not demonstrate morphological modifications for its co-occurrence with termites and, therefore, are deemed to be non-termitophilous species only sharing with termites suitable niches. Kistner (1982: 54) arrived to the similar conclusion after his discovery of *Bambara wagneri* (Dybas) in a nest of the fungus-growing termite *Hypotermes obscuriceps* Wasmann in Sri Lanka.

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