

**A new species of *Sphaeropsocus* Hagen from southeastern United States: the first living species of its genus (Psocodea “Psocoptera”: Troctomorpha: Sphaeropsocidae)<sup>1</sup>**

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**Abstract:** *Sphaeropsocus bicolor* n. sp. is described. It is the first living species of its genus, known otherwise only from the generotype, *Sphaeropsocus kuenowii* Hagen, a fossil species from the Baltic amber (Eocene). A key to the living and fossil genera of the family Sphaeropsocidae, based on females, is included.

**Key Words:** Psocoptera, Sphaeropsocidae, new species, fossil genus, southeastern United States

The psocid family Sphaeropsocidae is a relatively small family in which macropterous females have elytriform forewings and lack hindwings (the female of one species is strongly brachypterous, see Lienhard and Ashmole, 2011), while males, where known, are either apterous or micropterous. The family is very old (Grimaldi and Engel, 2006) and is one of a few psocid taxa documented as having survived the Cretaceous – Tertiary boundary. Modern members of the group have restricted distributions, but are scattered sparsely over much of the world (Grimaldi and Engel, 2006; Mockford, 2009), and most of them seem to be scarce wherever they occur.

Within suborder Troctomorpha, the sphaeropsocids are members of infraorder Nanopsocetae, which includes also the louse taxa, family Liposcelididae (booklice) and its sister (or daughter?) taxon Phthiraptera, the true lice (see Lyal, 1985; Yoshizawa and Johnson, 2003, 2006; Johnson et al., 2004). Thus, a more detailed knowledge of the Sphaeropsocidae may contribute to our still tenuous understanding of the evolutionary history of the true lice.

I have received sphaeropsocid material from a part of North America (southeastern United States) from which the family was previously not recorded. Preliminary examination of the new material revealed characters that seemed to place it in the presumably extinct early Tertiary genus *Sphaeropsocus* Hagen, otherwise known from a single species in Baltic and Ukrainian (Rovno) amber. Subsequent comparisons have confirmed the placement of the new material as a distinct species in that genus. The present paper describes the new species and provides a key to the known genera of the family, living and extinct, based on macropterous females.

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### Methods

The material examined consists of fifteen macropterous females collected at the type locality, Highland Lake, Blount County, Alabama. Comparisons were made with two macropterous females of *Sphaeropsocus kuenowii* Hagen in Baltic amber in my collection, which agree with published data on that species. To confirm the generic position of the new species, other comparisons were made with data from published accounts of *S. kuenowii* and other sphaeropsocid taxa and with material on hand of other sphaeropsocid taxa.

Illustrations were made with the aid of a drawing tube. Photographs were taken with a ProgRes™ C10 camera on a dissecting microscope (whole specimen) and on a compound microscope (forewing and cuticle sculpture). Orientation of figures follows Mockford (1993). Interpretation of the wing venation follows Grimaldi and Engel (2006) with differences in nomenclature. Measurements, expressed in  $\mu\text{m}$ , were made either on a whole specimen (body length) or on slide mounted parts, with a filar micrometer. Color descriptions are based on observations through a dissecting microscope on specimens preserved in 95% ethyl alcohol.

Abbreviations used in the description and measurements are as follows: BL = body length; F = length of hind femur; f1...f4 = first to fourth flagellomeres and their lengths; FW = forewing length; P4 = terminal segment of maxillary palpus and its length; T = length of hind tibia; t1...t3 = first to third hind tarsomeres and their lengths; V = greatest width of vertex, taken immediately behind eyes; v1...v3 = first, second, and third ovipositor valvulae (ventral, dorsal, and lateral gonapophyses respectively). The nomenclature of differentiated facial setae follows Badonnel (1963). The nomenclature of wing venation follows Yoshizawa (2005).

The holotype will be deposited in the collection of the Illinois Natural History Survey (INHS), Champaign, Illinois, USA. Paratypes will be deposited in INHS, also in the Museum of Natural History, Geneva, Switzerland (MHNG), and in the author's collection, currently housed in the School of Biological Sciences, Illinois State University, Normal, IL (ELM).

### Systematics

#### Family Sphaeropsocidae Menon (1942)

A detailed definition of the family was presented by Mockford (2009). *Globopsocus* Azar and Engel (2008), a fossil from late Cretaceous Siberian amber, appears to be an electrentomoid rather than a sphaeropsocid and is excluded from the above key on that account. Its many-faceted compound eyes reaching the hind margin of the vertex, and the two most posterior veins of the forewing, here interpreted as A1 and A2, fusing together beyond their origin, are electrentomoid characters. Macropterous (coleopteriform) females of both living and fossil forms may be determined to genera by the following key.

**Key to the Genera of Sphaeropsocidae, macropterous females**

1. Compound eyes touching or very close to hind margin of head. Forewing with two basal closed cells..... 2
- Compound eyes well separated from hind margin of head. Forewing lacking basal closed cells..... 3
2. Forewing with claval furrow but lacking distal closed cell .....*Sphaeropsocites* Grimaldi and Engel (2006, fossil, early Cretaceous amber, Lebanon)
- Forewing lacking claval furrow but with distal closed cell .....*Asphaeropsocites* Azar et al. (2010, fossil, early Cretaceous amber, Lebanon)
3. Forewing weakly sclerotized, with 2 – 3 longitudinal veins..... 4
- Forewing well sclerotized, with 4 – 6 longitudinal veins .....5
4. Mesonotum divided in middle. Forewing with 2 longitudinal veins; outer wing margin bent inward, covering side of abdomen at rest .....*Badonnelia* Pearman (1953, living)
- Mesonotum undivided in middle. Forewing with 3 longitudinal veins, not bent inward on sides ..... *Troglosphaeropsocus* Mockford (2009, living)
5. Humeral area of forewing scarcely bulging; M stem of forewing long, nearly half length of second M branch ..... *Sphaeropsocoides* Grimaldi and Engel (2006, fossil, late Cretaceous amber, Canada)
- Humeral area of forewing decidedly bulging; M stem of forewing < one-fifth length of second M branch or M simple .....6
6. Forewing with 6 longitudinal veins, including a short A1.....7
- Forewing with 4 longitudinal veins, M simple and A1 absent .....*Sphaeropsocopsis* Badonnel (1963, living)
7. In forewing, longitudinal veins not reaching wing margin. Meso-metapleuron with a lateral lobe extending to first abdominal segment .....*Prosphaeropsocus* Mockford (2009, living)
- In forewing, some longitudinal veins frequently reaching wing margin. Meso-metapleuron lacking lateral lobe..... *Sphaeropsocus* Hagen (1882, fossil and living)

***Sphaeropsocus* Hagen**

*Sphaeropsocus* Hagen, 1882: 226.

*Palaeotroctes* Enderlein, 1911: 350. Synonymy: Pearman, 1958: 51.

Diagnosis. With the characters of the family (Mockford, 2009) plus the following. Compound eyes well separated from hind margin of head, those of adult females consisting of ca. 10 facets. Adult females with well sclerotized, elytriform forewings with 6 longitudinal veins, including a short A1; all longitudinal veins usually reaching wing margin. Inner margin of forewing with

a row of denticles along its length (Figure 2 and Hagen, 1882). Males apterous. See also key to genera.

***Sphaeropsocus bicolor* n. sp.**

Figures 1-17

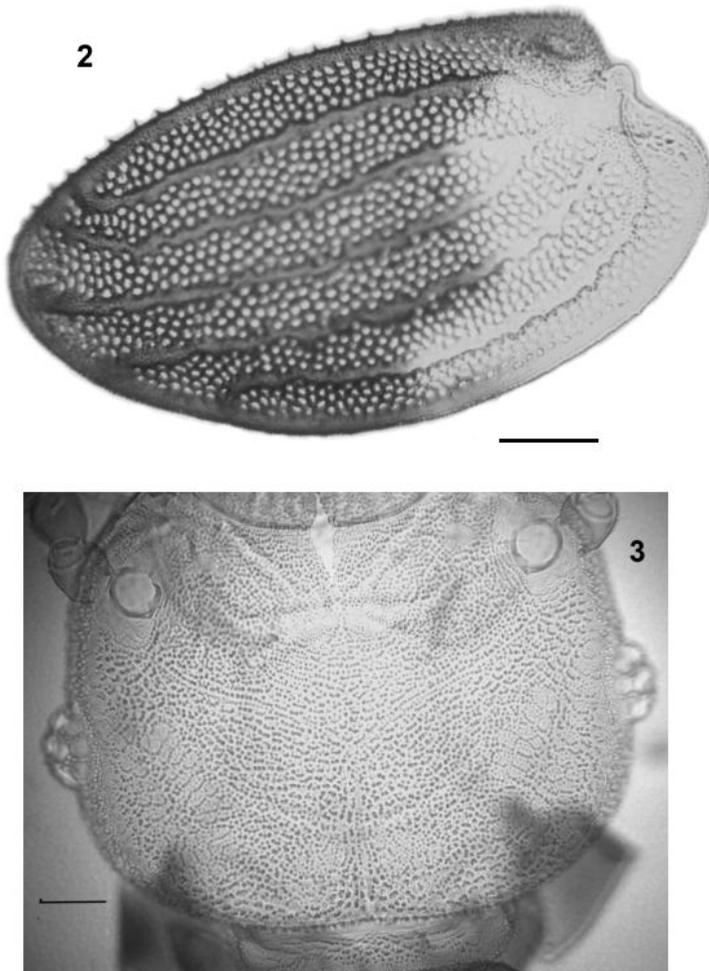
Diagnosis. With the characters of the genus plus the following. Differing from its single congener, *Sphaeropsocus kuenowii* Hagen, in strikingly bicolored forewings (Figs. 1, 2). Vein Cu1 of forewing unbranched. All veins clearly reaching wing margin.



Figure 1. *Sphaeropsocus bicolor* n. sp., female, habitus, right forewing removed. Scale bar = 0.5mm.

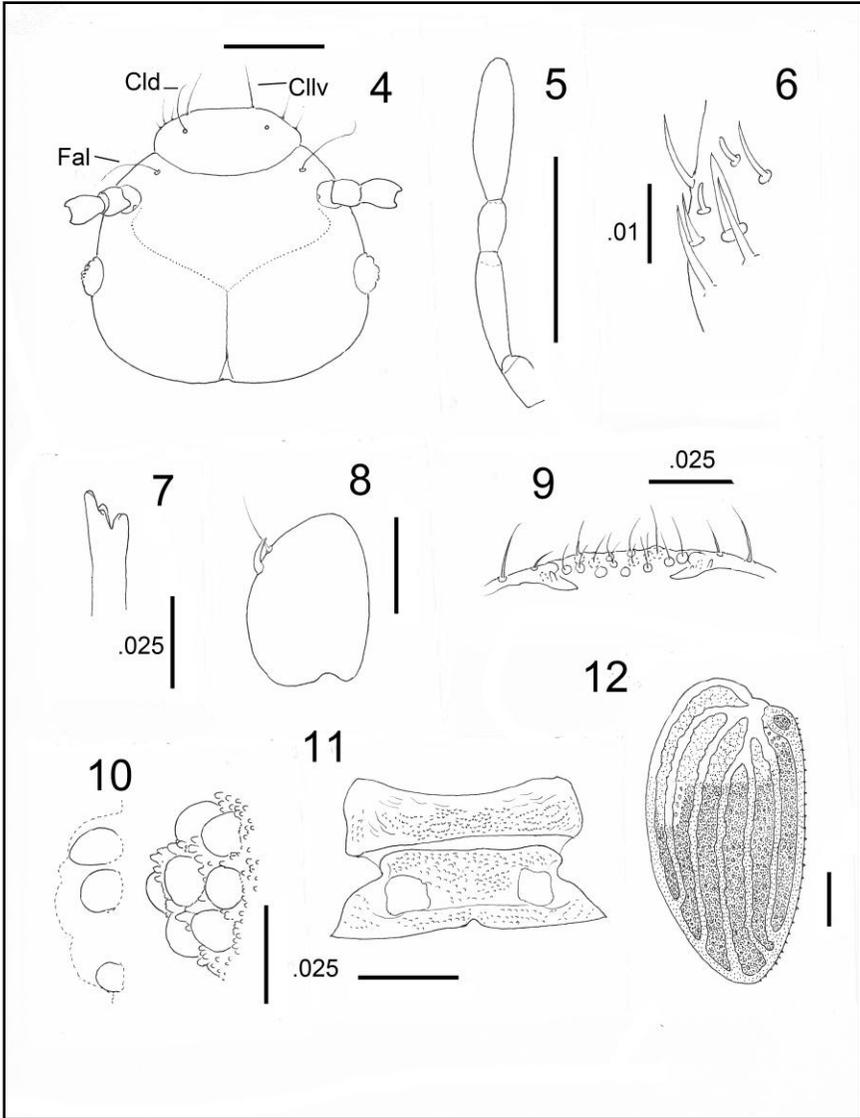
Female color (in alcohol 3 months). Head yellowish-brown; postclypeus and antennal base (scape and pedicel) somewhat paler. Thorax dark brown dorso-laterally and on pleura; pronotum and middle of mesonotum yellowish-brown. Legs brown, slightly darker than head; tarsi paling to colorless distally on t1, colorless throughout t2 and t3. Forewing (Figs. 2, 12): basal one-third white on veins, mostly colorless on membrane except dusky to wing base along hind margin and in cell Cu1; rest of wing purplish-brown, somewhat paler on veins than on reticulate network between veins. Preclunial abdominal segments colorless, with pale tan internal tissues showing through clear cuticle. Clunium dark brown. Subgenital plate medium brown.

Female structural characters. Habitus as in Figure 1 (right forewing removed). Epicranial and frontal ecdysial lines conspicuous (Figure 4), the latter curving inward near antennal bases. Antenna with 13 flagellomeres; all flagellomeres bearing sparse setae slanting distad; those of f1 and f2 slightly shorter than width of their segment; more distal setae longer, those of f4 to tip ca. 1.5x as long as width of their segment; all flagellomeres ringed with whorls of microtriches; from distal one-third of f3 outward, the whorls separated by slender clear lines; f3, f6, and f10 each with a slender subapical sense club. Maxillary palpus (Figure 5) slender, P4 slightly widened before middle, its sensory field (Figure 6) with 5 slender setiform sensilla, 1 broad, pointed-tipped and 2 short, blunt-tipped sensilla. Lacinial tip (Figure 7): lateral cusp much longer than median, with a short, rounded inner tooth. Labial palpus with slender sense club on outer margin (Figure 8). Distal labral sensilla as in Figure 9. Compound eyes (Figure 10) with 8 (– 10?) facets surrounded and interspersed with heavy integumentary granules. Thoracic nota (Figure 11) lacking median divisions; forewing sockets conspicuous. Legs: femora moderately swollen medially, each with a stout seta subapically on inner surface; tibiae sparsely setose, each with 2 apical spurs; each pretarsal claw with a preapical denticle preceded by a row of minute microtriches. Forewing (Figs. 2, 12) broad-elytiform with row of irregular, pointed denticles along median margin; veins broad with irregular edges; intervals between veins: those of unpigmented wing base with moderately heavy network bearing rows of colorless granules; those of pigmented distal region with much heavier network bearing rows of black granules; Rs and R1 with short basal stem, likewise branches of M; vein Cu unbranched; vein A1 joining with continuous costal vein, the two forming an enclosure around anal cell. Preclunial abdominal segments weakly sclerotized except segments 1 and 2 each with a slender transverse dorsal sclerite. Subgenital plate (Figure 13) rounded, closely joined (but not fused) to clunium on each side; T-shaped sclerite with straight arms. Spermatheca (Figure 14): region of spermapore in middle of field of spinelets (typical of the family); duct curved; sac very small, suggesting parthenogenesis. Ovipositor valvulae (Figs. 15, 16): v1 slightly curved, pointed apically, with a single sclerotized strip running along its outer margin; v2 with a slender sclerotized basal arm and an outer and inner sclerotized strip converging in middle of its outer surface and continuing as a slender line to its apex; v3 slightly bilobed distally. Epiproct (Figure 17) triangular with a distal lobe bearing short setae on its apex. Paraprocts (Figure 17) semicircular, bearing setae near their junction with epiproct.

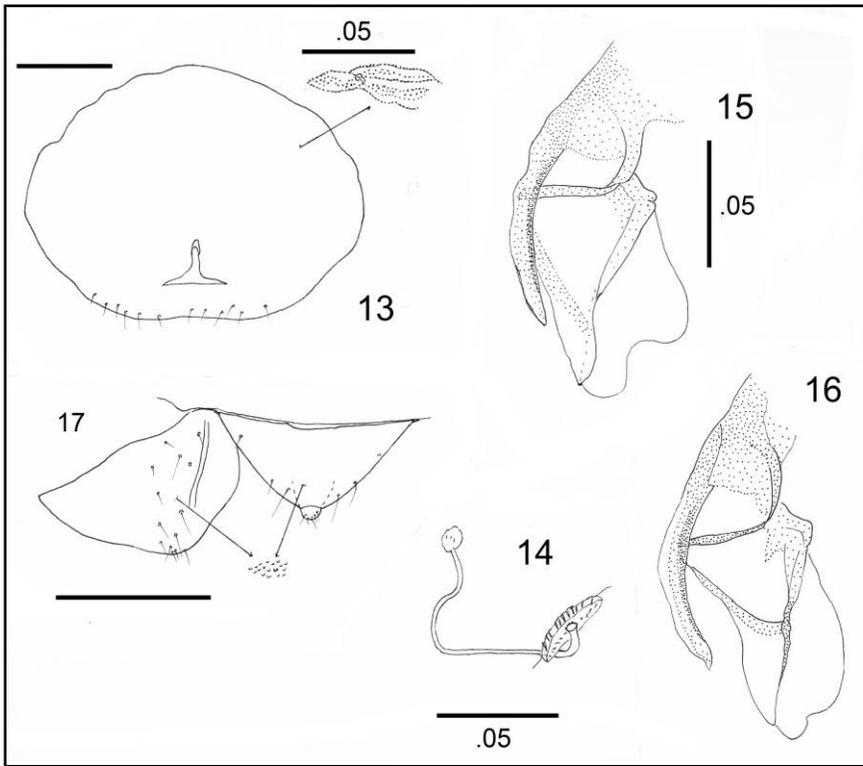


Figures 2-3. 2. *Sphaeropsocus bicolor* n. sp., female, right forewing. Scale bar = 0.1mm.  
 3. *Sphaeropsocus bicolor* n. sp., female, vertex showing sculpture. Scale bar = 0.05mm.

Female sculpture of integument. Head (Figure 3) with densely placed small papillae becoming areolate laterally on vertex, with large papillae enclosing groups of smaller papillae. Pronotum with clear areoles separated by lines along its anterior margin, remainder with densely placed small papillae forming wavy transverse lines in some areas. Rest of thoracic nota, preclunial abdominal segments, and legs with small, densely placed papillae. Clunium and subgenital plate with transverse areoles bordered by papillae, enclosing smaller papillae. Epiproct and paraprocts with densely-placed small papillae.



Figures 4 – 12. *Sphaeropsocus bicolor* n. sp., female. 4. Head, dorsal view (see text for explanation of notations). 5. Maxillary palpus (ciliation not shown). 6. Sensory field of P4. 7. Lacinial tip. 8. Labial palpus showing sense club and accompanying seta (other setae not shown). 9. Distal labral sensilla in dorsal view. 10. Compound eye, dorsal view right, ventral surface seen through eye left". 11. Thoracic terga. 12. Left forewing (sculpture of regions between veins oversimplified: see Figure 3). Scale bars = 0.1 mm unless noted otherwise.



Figures 13 – 17. *Sphaeropsocus bicolor* n. sp., female. 13. Subgenital plate. 14. Spermatheca: region of spermapore, duct, and sac. 15. Ovipositor valvulae (female no. 6560). 16. Ovipositor valvulae (female no. 6561), same scale as Figure 15. 17. Epiproct and left paraproct. Scale bars = 0.1 mm unless noted otherwise.

Female chaetotaxy. Vertex with very sparse, minute setae. Facial setae (see Badonnel, 1963, Figs. 58, 60) Fal, Cld, and Cllv differentiated (Figure 4). Legs with sparse setae dorsally on femora and on all tibiae. Wings with minute, sparse setae on all veins and on front wing margin. Preclunial abdominal terga 3 – 8 each with a transverse row of minute, sparse setae. Clunium with sparse, very minute setae. Subgenital plate with scattered setae, longest along hind margin (Figure 13). Setae of epiproct and paraproct as in Figure 17.

Female Measurements: BL = 884; V = 317; P4 = 80; FW = 701; F = 192; T = 282; t1 = 103; t2 = 37; t3 = 39; f1 = 117; f2 = 138; f3 = 125; f4 = 80.

Material Examined: Holotype female and 1 female paratype, USA: Alabama: Blount County: Highland Lake, 33°51'05N, 86°25'19W, 30 October 2011, Berlese sample with rotten oak limbs, T. N. King collector (INHS). Same locality, mode of collection, and collector, 13 December 2011, 1 female

paratype (ELM). Same locality, mode of collection, and collector, 8 – 11 June 2012, 12 female paratypes (4 each to ELM, INHS, and MHNG).

Etymology. The species name refers to the striking color of the elytriform forewings with a white or colorless base and dark purple, near black remainder.

### Discussion

Since the type species of *Sphaeropsocus*, *S. kuenowii*, is a fossil, comparisons are limited to wing form and venation plus other very obvious surface features. For comparison of the new species with the type species, I have used seven sources of information: 1) Hagen's description and figures (Hagen, 1882), 2) Enderlein's description and figures (Enderlein, 1911), 3) the photographs and line drawing in Weitschat and Wichard (2002), 4) Scheven's (2004) photograph, 5) the description and figures of Grimaldi and Engel (2006), based on three specimens in the University of Kansas Museum and their observations on a specimen studied by Hagen, and 6 and 7) two specimens on hand from Baltic amber (unknown localities). A published photograph of a specimen in Rovno amber (western Ukraine) (Engel and Perkovsky, 2006) does not allow detailed comparison and is not accompanied by any description.

Hagen's (1882) description and figures were based on examination of four specimens lent to him by G. Künow, the preparator of the Königsberg Museum (see Hagen, 1882, pg. 267). A habitus figure (Hagen, 1882, Pl. II, Figure 1) was a copy from a figure executed by Künow. It seems very likely that this figure was made from a single individual and can, thus, be regarded as representing the type for the species. It shows median and frontal ecdysial lines and all long veins (except Cu of the left wing) reaching the wing margin. Unfortunately, we do not know which individuals were used for Hagen's other figures, and more than one species could have been included. Enderlein's figures (Enderlein, 1911, Table XXVI, Figs. 97, 98, 100, 101) were based on specimens from the Klebs collection. His habitus figure (Figure 97) shows a very long base of M and a branch off vein Cu, suggesting Cu1b. Enderlein noted that the latter condition was seen only in one (Klebs K5565) of the nine adult specimens that he examined (thus, the depicted branch was not a lapse of accuracy on his part as suggested by Grimaldi and Engel (2006)). The illustrations in Weitschat and Wichard (2002, pp. 114, 115) consist of two photographs and one line drawing. Although the photographs are rather obscure, one of them (Pl. 38c) suggests that the M veins reach the wing margin. The line drawing shows distinct median and frontal ecdysial lines and R2 and both M veins reaching the margin in both wings. Scheven's photograph (2004, pg. 33, upper left) shows a median ecdysial line (frontal region obscured) and the R veins of the right wing and R2 and M1 of the left wing reaching the margin. The photograph in Grimaldi and Engel (2006, Figure 2b), but not the line drawing based on the same specimen, shows the R veins reaching the margin in both wings, while the M veins stop short of the margin, with M1 coming very close in the left wing. Of the two

specimens on hand, one (ELM#A-1) shows the R veins and M1 reaching the margin in the left wing and all veins but M2 reaching the margin in the right wing. The other specimen (ELM#A-2) shows a median ecdysial line and all veins (including Cu) reaching the margin in both wings.

Among the seven independent sources of information about the type species, the following characters are in common: a strongly protruding humeral region of the forewing; five major longitudinal veins plus a short vein A1, vein R1 of the forewing strongly arched in its basal region; vein A1 originating independently at the wing base; a well-sclerotized and strongly patterned membrane region between veins of the forewing. Although there is much variation concerning the long veins (R, M, and Cu) reaching the wing margin, all do in some cases, and R and M veins frequently do. A median ecdysial line is generally seen and frontal ecdysial lines are usually notable when that part of the head can be observed. Enderlein (1911, Figure 100) illustrated the terminal flagellomere showing multiple secondary annulations as transverse lines of weak cuticle. These were also described by Hagen (1882), but the latter author did not note on which segments they occur.

It should be noted that there is no holotype of *Sphaeropsocus kuenowii*. Hagen (1882), as noted above, based his description on four specimens without designating a type. These must be regarded as syntypes, and although there may be only one left, it is still a syntype.

*Sphaeropsocus bicolor* agrees with all of the characters noted above except for the two variations seen in Enderlein's (1911) figure 97. Its antennae show subdivisions by numerous clear transverse lines on all flagellomeres from the distal one-third of f3 to the tip.

*Sphaeropsocus bicolor* differs from the other known genera of Sphaeropsocidae as noted in the diagnosis and the key. At present, then, there seems to be no choice but to place it in the genus *Sphaeropsocus*. Additional material of *S. bicolor*, including the male, and a more detailed knowledge of *S. kuenowii* may eventually require reassessment of relationships.

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#### Literature Cited

- Azar, D. and M. S. Engel. 2008. A sphaeropsocid bark louse in late Cretaceous amber from Siberia (Psocoptera: Sphaeropsocidae). *Transactions of the Kansas Academy of Science* 111: 141 – 146. [http://dx.doi.org/10.1660/0022-8443\(2008\)111\[141:ASBLIL\]2.0.CO;2](http://dx.doi.org/10.1660/0022-8443(2008)111[141:ASBLIL]2.0.CO;2)
- Azar, D., M. S. Engel, and D. A. Grimaldi. 2010. A new genus of sphaeropsocid bark lice from the early Cretaceous amber of Lebanon (Psocodea: Sphaeropsocidae). *Annales de la Société entomologique de France (Nouvelle série)* 46: 103 – 107.
- Badonnel, A. 1963. Psocoptères tricolores, lapidicoles et corticicoles du Chili. *Biologie de l'Amérique australe* 2: 291 – 338.

- Enderlein, G. 1911. Die fossilen Copeognathen und ihre Phylogenie. *Palaeontographica* 58: 279 – 360.
- Engel, M. S. and E. E. Perkovsky. 2006. *Sphaeropsocus kuenowii* Hagen in Rovno amber from the Ukraine (Psocoptera: Sphaeropsocidae). *Systematic Palaeontology* 117: 243 – 245.
- Grimaldi, D. and M. S. Engel. 2006. Extralimital fossils of the “Gondwanian” Family Sphaeropsocidae (Insecta: Psocodea). *American Museum Novitates* 3523: 1 – 18. [http://dx.doi.org/10.1206/0003-0082\(2006\)3523\[1:EFOTGF\]2.0.CO;2](http://dx.doi.org/10.1206/0003-0082(2006)3523[1:EFOTGF]2.0.CO;2)
- Hagen, H. A. 1882. Beiträge zur Monographie der Psociden. Über Psociden in Bernstein. *Stettiner Entomologische Zeitung* 43: 217 – 237, 265 – 276, 276 – 300, 524 – 526, pls. I, II.
- Johnson, K. P., K. Yoshizawa, and V. S. Smith. 2004. Multiple origins of parasitism in lice. *Proceedings of the Royal Entomological Society of London, Series B* 271: 1771 – 1776. <http://dx.doi.org/10.1098/rspb.2004.2798>
- Lienhard, C. and N. P. Ashmole. 2011. The Psocoptera (Insecta: Psocodea) of St. Helena and Ascension Islands (south Atlantic) with a new record from South Africa. *Revue Suisse de Zoologie* 118: 423 – 449.
- Lyal, C. H. 1985. Phylogeny and classification of the Psocodea, with particular reference to the lice (Psocodea: Phthiraptera). *Systematic Entomology* 10: 145 – 165. <http://dx.doi.org/10.1111/j.1365-3113.1985.tb00525.x>
- Menon, R. 1942. Studies on Indian Copeognatha (Psocoptera) II. Nanopsocetae and Psocatropetae. *Indian Journal of Entomology* 4: 23 – 42.
- Mockford, E. L. 1993. North American Psocoptera (Insecta). Flora and Fauna Handbook 10. Sandhill Crane Press. Gainesville, Florida, USA. xviii + 455 pp.
- Mockford, E. L. 2009. Systematics of North American species of Sphaeropsocidae (Psocoptera). *Proceedings of the Entomological Society of Washington* 111: 666 – 685. <http://dx.doi.org/10.4289/0013-8797-111.3.666>
- Pearman, J. V. 1953. A new generic form allied to *Sphaeropsocus* Hagen (Psocoptera, Pachytrictidae). *Entomologist's Monthly Magazine* 89: 262.
- Pearman, J. V. 1958. Augmented description of *Badonelia titei* Pearman (Psoc, Sphaeropsocidae). *Entomologist's Monthly Magazine* 94: 49 - 52.
- Scheven, J. 2004. Bernstein-Einschlüsse, eine untergegangene Welt bezeugt die Schöpfung – Erinnerungen an die Welt vor der Sintflut. Hofheim, a. T.
- Weitschat, W. and W. Wichard. 2002. Atlas of Plants and Animals in Baltic Amber. Munich, Germany. 256 pp.
- Yoshizawa, K. 2005. Morphology of Psocomorpha (Psocodea: ‘Psocoptera’). *Insecta Matsumurana, New Series* 62: 1 – 44.
- Yoshizawa, K. and K. P. Johnson. 2003. Phylogenetic position of Phthiraptera (Insecta: Paraneoptera) and elevated rate of evolution in mitochondrial 12S and 16S rDNA. *Molecular Phylogenetics and Evolution* 29: 102 – 114. [http://dx.doi.org/10.1016/S1055-7903\(03\)00073-3](http://dx.doi.org/10.1016/S1055-7903(03)00073-3)
- Yoshizawa, K. and K. P. Johnson. 2006. Morphology of male genitalia in lice and their relatives and phylogenetic implications. *Systematic Entomology* 31: 350 – 361. <http://dx.doi.org/10.1111/j.1365-3113.2005.00323.x>