



<http://dx.doi.org/10.11646/zootaxa.3741.4.3>

<http://zoobank.org/urn:lsid:zoobank.org:pub:ADDD0FAB-506E-4380-8307-17BC5E8E3CBF>

A revision of the New World sharpshooter genus *Xyphon* Hamilton (Hemiptera: Cicadellidae: Cicadellinae)

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Abstract

A phylogenetic analysis of *Xyphon* was completed using 45 adult morphological characters and 1,076 base pairs of the mtDNA gene NADH dehydrogenase 1. Multiple specimens, representative of the range of morphological variation found in each previously described species, were scored for the morphological data matrix to test the monophyly of each species. These tests supported the following synonymies: *Xyphon gillettei* (Ball, 1901) to include *X. balli* (Knull, 1940) syn. nov.; and *X. reticulatum* (Signoret, 1854) to include *X. diductum* (Fowler, 1900) syn. nov., *X. dyeri* (Gibson, 1919) syn. nov., and *X. sagittiferum* (Uhler, 1895) syn. nov. Parsimony and Bayesian techniques were used to infer relationships among species, resulting in almost identical tree topologies. In all analyses *Xyphon* was monophyletic and *Draeculacephala* was its sister genus although clade support for *Xyphon* was generally low. The analyses suggest that a clade comprising *X. flaviceps* (Riley) and *X. fulgidum* (Nottingham) is sister to the remainder of the genus, and a clade comprising *X. gillettei* and *X. spadice* **sp. nov.** was sister to a clade containing *X. triguttatum* (Nottingham), *X. nudum* (Nottingham), and *X. reticulatum*. The six currently recognized species, including *X. spadice* **sp. nov.**, are described and illustrated and a key to adult *Xyphon* is provided.

Key words: Auchenorrhyncha, leafhopper, revision, phylogenetic relationships

Introduction

The family Cicadellidae is a globally distributed group of sap-feeding insects that contains approximately 22,000 described species (Dietrich 2004), many of which are vectors of plant pathogens (Nielson 1968). Among the most diverse and economically important groups of Cicadellidae are the xylem-feeding sharpshooters (subfamily Cicadellinae). The sharpshooter genus *Xyphon* Hamilton is a small monophyletic group that is common throughout the New World from Argentina to Canada (Hamilton 1985), and has been introduced into parts of the Old World including Guam and western Africa. Three species, *X. triguttatum*, *X. fulgidum*, and *X. flaviceps*, are vectors of Pierce's disease, an important bacterial disease in grapes, and other crop plants (Nielson 1968).

Draeculacephala Ball, 1901 was originally characterized by the presence of reticulate tegminal venation. Ball later (Ball 1927) erected *Carneocephala* for species of *Draeculacephala* that possessed an inflated head and a conically produced crown that lacked a definite lateral margin. Hamilton (1985) returned the type species of *Carneocephala*, *Draeculacephala floridana* Ball, to *Draeculacephala*, thus synonymizing the two genera. He proposed a new genus, *Xyphon* Hamilton, to receive the remaining species of *Carneocephala*, designating *Diedrocephala flaviceps* Riley as the type species. Hamilton (1985) identified two putative synapomorphies supporting a sister-group relationship between *Draeculacephala* and *Xyphon*: (1) the presence of reticulate antepical venation in the forewing, and (2) an aedeagus that is thickest at the base (in lateral view) and bears lateroapical flanges. *Xyphon* was erected for species within this group with a convex crown, no median sulcus on the crown, the proepisternum irregular apically, the forewing appendix extending to the costal margin, and male pygofer and subgenital plates without setae.

Xyphon triguttatum (Nottingham 1932)

(Figs 3F, 4G, 4H)

Carneocephala triguttata Nottingham 1932

Xyphon triguttata (Nottingham 1932): Hamilton 1985

Diagnosis. This is a large (female 5.4 mm; male 4.2 mm) leafhopper. It is similar in appearance to *X. nudum* but can be identified by the presence of a conspicuous dark spot (brown or black) on a lightly colored crown.

Head. Clypellus-frontoclypeus junction in lateral view, evenly convex; color pattern of frontoclypeus entirely yellow (possibly with brown muscle scars) (55%) or mottled yellow and tan (45%). Crown, anterior margin, angular (90%) or rounded (10%); white band present but broken by face color (41%), absent (41%), or complete (17%); median spot present and well defined (93%) or present, but poorly defined (7%). Dark markings (other than median spot) on crown absent; orange pigment typically present (93%) or rarely absent (3%). Lateral view crown flat (97%) or rarely concave (3%). Distance from ocelli to lateral edge of head no more than 2 times ocelli width and distance between ocelli no more than 7.5 times ocelli width.

Thorax. Pronotum lacking dark green to brown circular markings; circular indentations typically absent (97%) or rarely present (3%); midline of pronotum, white (76%) or concolorous with lateral areas of pronotum (24%). Mesonotum, green with visible parts unmarked; proepisternum, posterior edge, irregular (52%) or not irregular (48%).

Forewings. Green pigments present (97%) or rarely absent (3%); main color green (86%) or gray (7%) or black/brown (7%). Apex with few crossveins. Anal veins white (69%) or pale blue (31%).

Legs. Hind femur with macrosetal formula 2+1 (93%) or rarely 2+0 (3%). Plantar surface of hind tarsomere with paleate setae numbering 1–3 (46%) or 4–5 (54%).

Abdomen. Abdominal sterna of male mostly yellow.

Male Genitalia. Pygofer, erect basolateral setae, absent (71%) or small and scattered (21%). Subgenital plate, macrosetae, absent (36%) or small and scattered (64%). Aedeagal shaft in lateral view with dorsal process, acute, compressed, and taller than wide. Shaft in ventral view, arrow shaped with distinct basolateral angles. Shaft in dorsal view not compressed. Paraphrases in lateral view almost forming a circle, an oval, or forming a U. Style with single seta.

Material examined. We coded 17 males, 12 females and examined approximately 300 specimens.

Host data. Alfalfa (*Medicago* sp.), sideoats grama (*Bouteloua curtipendula*), prickly Russian thistle (*Salsola tragus*), bermudagrass (*Cynodon dactylon*), desert pepperweed (*Lepidium fremontii*), sickle saltbush (*Atriplex falcata*) and saltgrass (*Distichlis spicata*)

Distribution. Southwestern United States.

Primary types. Holotype and 32 paratypes, SEMC. Holotype is a male in good condition. Verbatim locality label: Coachella Calif / 7-15-30 / David G. Hall.

Acknowledgements

We wish to thank the institutions who loaned *Xyphon* specimens for study. These included TAMU, INHS, USNM, OSU, UCR, UKY, KSU, SEC, CNC, AMNH, NYSM, CSU, UCO, UDE, BMNH, and NMW. Additionally, we wish to thank Nova Silvy and John Oswald for reviewing earlier drafts of this manuscript and providing numerous helpful suggestions, and D. Dmitriev, S. Krishnankutty, and J. Zahniser for technical assistance. DNA sequencing was funded by NSF PEET grant DEB 0529679 to Jason Cryan, Chris Dietrich, and Chris Simon.

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APPENDIX 1. Morphological Characters and States.

All multistate characters were treated as unordered in all analyses.

1. Crown-face, anterolateral margin, lateral: (0) rounded, (1) carinate.
2. Clypellus-frontoclypeus junction, lateral: (0) evenly convex, continuing contour of frontoclypeus; (1) distinctly angular.
3. Frontoclypeus, color pattern: (0) mottled yellow and tan, (1) entirely yellow or yellow with brown muscle scars, (2) uniformly tan (muscle scars appearing slightly darker), (3) cream with thin, broken lines, (4) mottled dark brown and yellow.
4. Face, white band along border with crown: (0) complete, well defined and not irregularly marked with face color, (1) poorly defined white band, splotched white and face color, (2) absent.
5. Crown, shape, dorsal view: (0) angular, (1) rounded.
6. Crown, median sulcus: (0) present, (1) absent.

7. Crown, medioapical macula: (0) absent or poorly delimited, (1) entirely yellow or yellow with brown spot, (2) uniformly tan, (3) dark brown.
8. Crown, median spot: (0) present, well defined, (1) present, without defined edges (fading into background color) or with patches of background color mixed in with median spot, (2) absent.
9. Crown, pattern: (0) without dark lines or patterns, (1) with dark, vermiform lines, (2) with irregular brown spots, (3) brown background with light patches, (4) light brown lines (concentrated in middle of crown), (5) with medioapical macula only.
10. Crown, dark markings other than median spot anteriorly: (0) without dark markings other than median spot anteriorly, (1) with dark markings other than median spot anteriorly.
11. Crown, orange pigment: (0) present, (1) absent.
12. Ocelli, distance from ocelli to lateral edge of head: (0) no more than twice ocellar width, (1) more than twice ocellar width.
13. Ocelli, distance between ocelli: (0) no more than 7.0 times ocellar width, (1) at least 7.0 times ocellar width.
14. Crown shape, lateral view: (0) convex, (1) concave, (2) flat.
15. Postocellar maculae: (0) absent, (1) large and well developed, (2) part of a broader pattern.
16. Antenna scape: (0) with posterior lobe, (1) without posterior lobe.
17. Ventral preocular macula: (0) absent, (1) present.
18. Thoracic sterna, color, male: (0) yellow, (1) mesosternum with brown longitudinal macula, (2) thoracic sterna entirely brown.
19. Proepisternum, posterior edge: (0) irregularly shaped, (1) not irregularly shaped.
20. Transpleural macula of thorax: (0) absent, (1) present but incomplete, poorly delimited, (2) present, concolorous with frontoclypeus and ventral maculae, (3) present, distinctly darker than frontoclypeus.
21. Pronotum, anterior edge, dark green/brown circular markings: (0) present, (1) absent.
22. Pronotum, anterior edge, circular indentations: (0) present, (1) absent.
23. Pronotum and wings, color, blue pigment: (0) midline of pronotum and forewing veins white, (1) midline of pronotum and anal veins of forewing pale blue, (2) midline of pronotum concolorous with pronotum, forewing veins white, (3) midline of pronotum white, anal veins of forewing pale blue, (4) midline of pronotum concolorous with pronotum, anal veins of forewing pale blue, (5) midline of pronotum white, anal veins of forewing green, (6) midline of pronotum concolorous with pronotum, anal veins of forewing green.
24. Pronotum and forewing color (majority): (0) green, (1) tan, (2) gray, (3) nearly black/brown, (4) cream, (5) straw.
25. Mesonotum, pattern on exposed part: (0) unmarked, (1) marked with pair of submedial spots, (2) marked with submedial spots and anterolateral triangles, (3) very lightly marked.
26. Forewings, green pigment: (0) present, (1) absent.
27. Forewing, crossveins at apex: (0) many crossveins, resembling a spiderweb especially at anterior edge of forewing, (1) more than 3 crossveins, but still with distinct rows of cells, large cells separated by thin veins, (2) only 2 or 3 crossveins at the proximal portion of the apex.
28. Forewing, appendix, length: (0) extends to costal margin, (1) not extending to costal margin.
29. Hind femur, macrosetal formula: (0) 2+1, (1) 2+1+1, (2) 2+0.
30. Hind tarsomere, number of paleate setae on plantar surface: (0) 0, (1) 1–3, (2) 4–5, (3) 6 or more.
31. Abdominal sternum, color, male: (0) yellow, (1) brown, (2) red or orange.
32. Pygofer: (0) approximately the same length as subgenital plate, (1) much longer than subgenital plate.
33. Pygofer, erect basolateral setae: (0) absent, (1) present, scattered, (2) present, arranged in a definite band.
34. Subgenital plate, long fine dorsal setae: (0) absent, (1) present, numerous, distributed throughout dorsal margin.
35. Subgenital plate, macrosetae: (0) absent, (1) present, small and scattered, (2) present, large, forming distinct band.
36. Aedeagus, form, lateral view: (0) thickest at base, (1) not thickest at base.
37. Aedeagal shaft, dorsal process, lateral view: (0) acute, compressed, (2) acute, not compressed.
38. Aedeagus, dorsal process, shape laterally: (0) absent, (1) wider than tall, (2) taller than wide.
39. Aedeagal shaft, ventral view: (0) narrowly ovoid, (1) broadly ovoid, (2) narrow with basolateral expansions, (3) with acute lateral processes at base of aedeagal shaft, (4) arrow shaped.
40. Aedeagus, ventral flange: (0) basolateral angles distinct, (1) not distinct (basal portion of aedeagus rounded).
41. Aedeagal shaft, dorsal margin: (0) compressed, (1) not compressed.
42. Paraphyses, shape in ventral view: (0) forming a circle, (1) oval with basal side wider than apex, (2) forming a U.
43. Paraphyses, ventral view: (0) short and stout, if reaching the shaft curved across shaft at or basad of midlength, (1) long and narrow, curved across shaft distad of midlength.
44. Paraphyses, lateral view: (0) sinuate, (1) arcuate, curved caudally then dorsally.
45. Style, preapical setae: (0) absent, (1) single seta, (2) pair of setae.

APPENDIX 2. Coded morphological data for all specimens used in phylogenetic study. Specimen numbers refer to individual number affixed to each specimen. Characters that could not be coded because the structure was absent were treated as missing ("?").