Zootaxa 3620 (4): 589–595
www.mapress.com/zootaxa/

Article

ISSN 1175-5326 (print edition)
ZOOTAXA
ISSN 1175-5334 (online edition)

http://dx.doi.org/10.11646/zootaxa.3620.4.8
http://zoobank.org/urn:lsid:zoobank.org:pub:5F89FC52-2EEB-4810-BBDF-C817DA76C19E

Larva of *Nothotrichia shasta* Harris & Armitage (Trichoptera: Hydroptilidae) from California, USA, with its phylogenetic and taxonomic implications

KATHERINE A. PARYS[1] & STEVEN C. HARRIS[2]

[1]*USDA-ARS, Southern Insects Management Research Unit, 141 Experiment Station Road, Stoneville, MS 38776. E-mail:katherine.parys@ars.usda.gov*

[2]*Department of Biology, Clarion University, Clarion, PA 16214. E-mail:sharris@clarion.edu*

Abstract

Nothotrichia Flint 1967 is a small genus of infrequently collected microcaddisflies known from Chile and Brazil in South America, Costa Rica in Central America, and the United States in North America. Previously known only from adult specimens, we provide the first description and illustration of a larva in the genus, the larva of *N. shasta* from California, USA. We provide characters to separate *Nothotrichia* from other similar genera and an updated key to larval Hydroptilidae modified from that of Wiggins (1996). Larval characters provide additional evidence for the phylogeny and classification of the genus, which we now place tentatively in tribe Ochrotrichiini (subfamily Hydroptilinae).

Key words: caddisflies, microcaddisflies, United States

Introduction

The genus *Nothotrichia* was erected by Flint (1967) for *N. illiesi* in Chile. A second species, *N. cautinensis*, also from Chile was added by Flint in 1983. The genus was thought to be Neotropical in distribution until a third species, *N. shasta*, was described from California, USA, by Harris and Armitage (1997). In 2002, two additional species were described from Brazil and Costa Rica by Holzenthal and Harris. In 1997, Harris and Armitage described the females of the Chilean species, but the larvae remained undescribed. Despite the fairly wide distribution, *Nothotrichia* are infrequently collected and all current records are based on adults. In this paper, we describe the larva of *N. shasta* and provide a key to the genera of larval Hydroptilidae of North America, modified from that of Wiggins (1996).

Material and methods

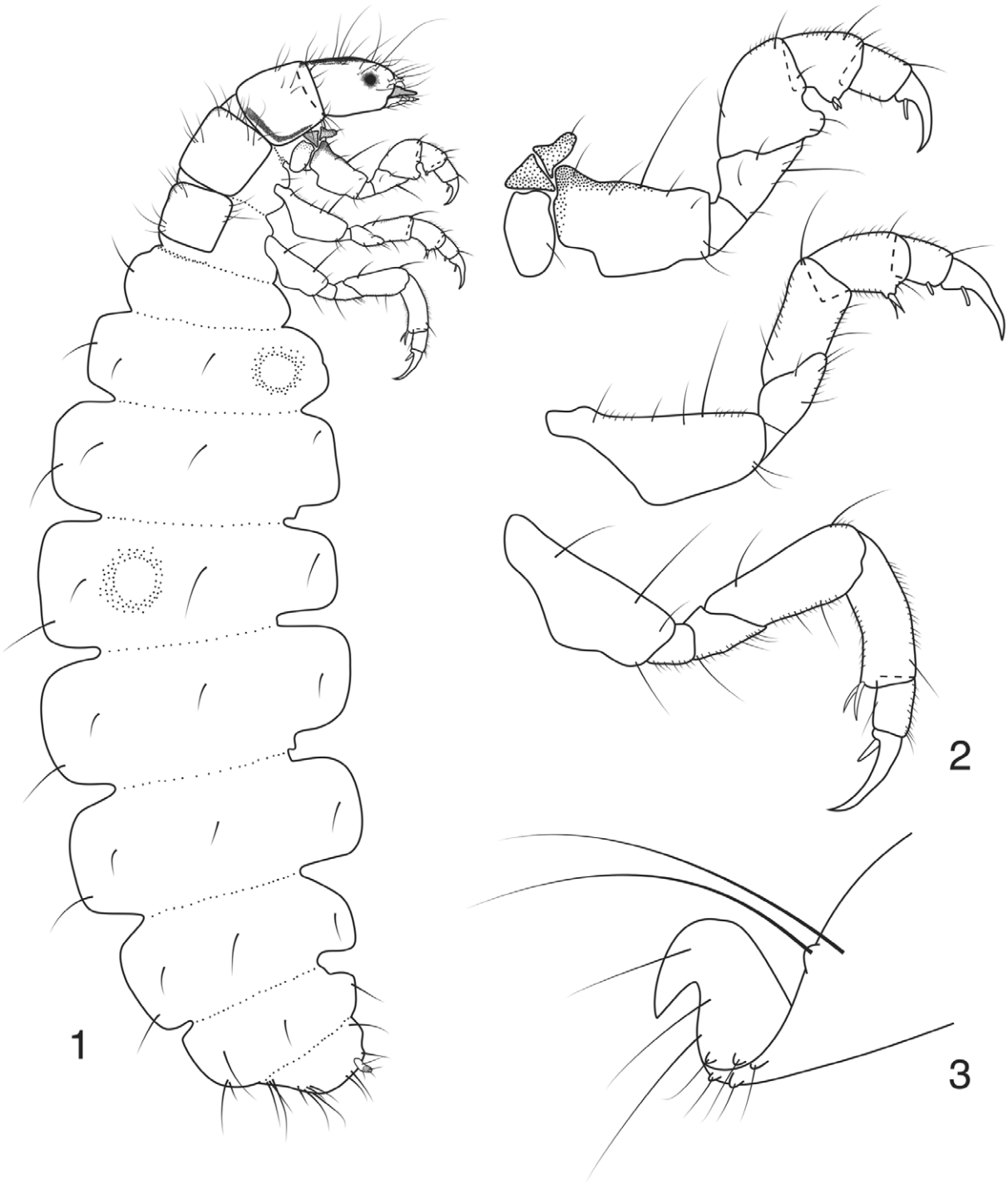
Larvae of *Nothotrichia shasta* were hand-collected from rocks in fast-moving streams and preserved in 70% ethyl alcohol. Metamorphotypes (Milne 1938) collected at the same time as the final instar larvae were determined to be *N. shasta*. Larval sclerites remaining in the pupal cases matched those of the final instar larvae of *N. shasta*. Larvae were mounted in depression slides using CMCP media and drawn using a compound microscope at magnifications of 40X, 100X, and 250X. Penciled drawings were scanned and inked using Adobe Illustrator CS5. Voucher specimens are deposited at the U.S. National Museum of Natural History, Smithsonian Institution, and collections of the authors. Description terminology follows that of Wiggins (1996).

Accepted by J.C. Morse: 23 Jan. 2013; published: 8 Mar. 2013

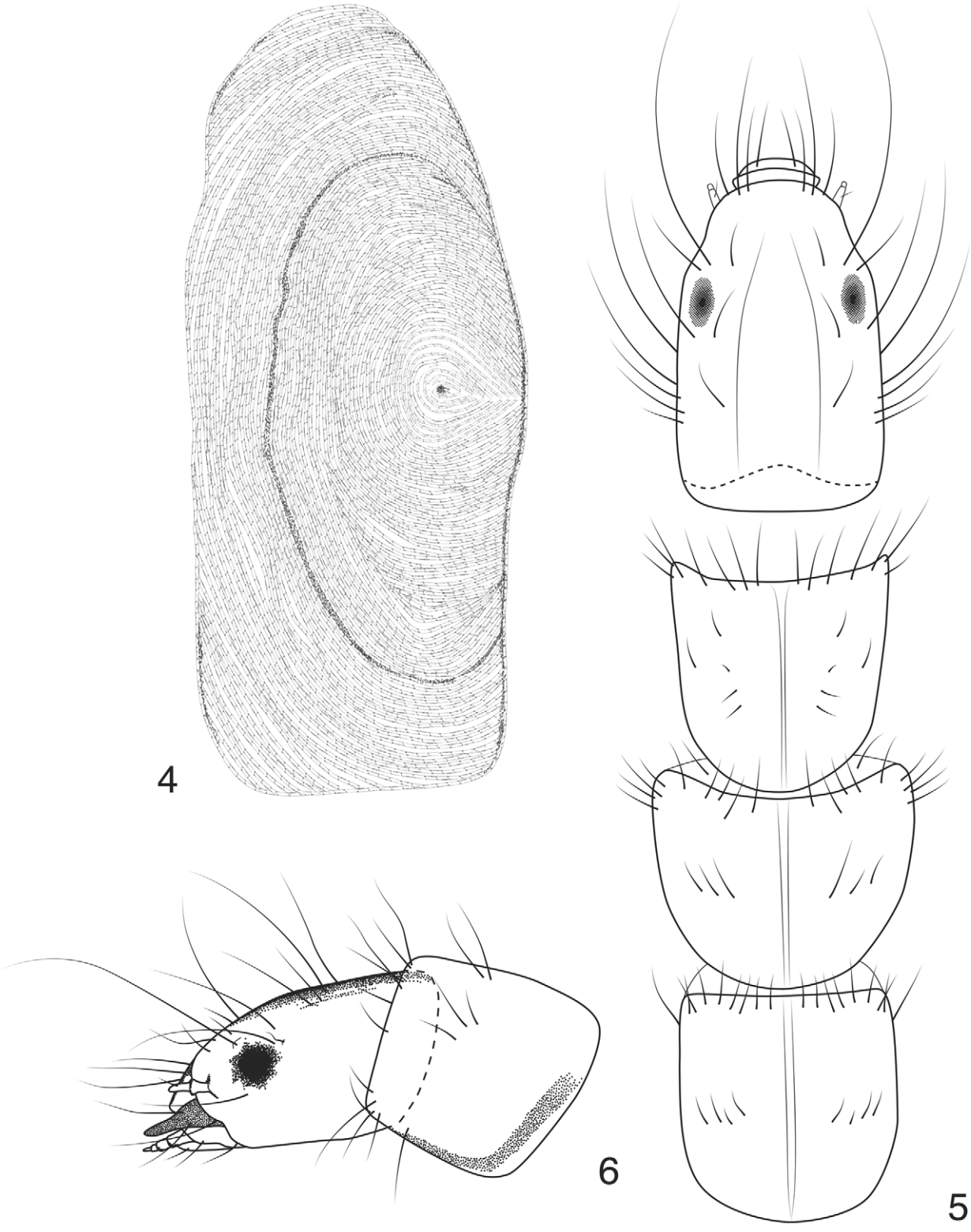
Larval description

Final-instar larva (Figs. 1–10) overall length 4.5–4.7 mm (n = 11).

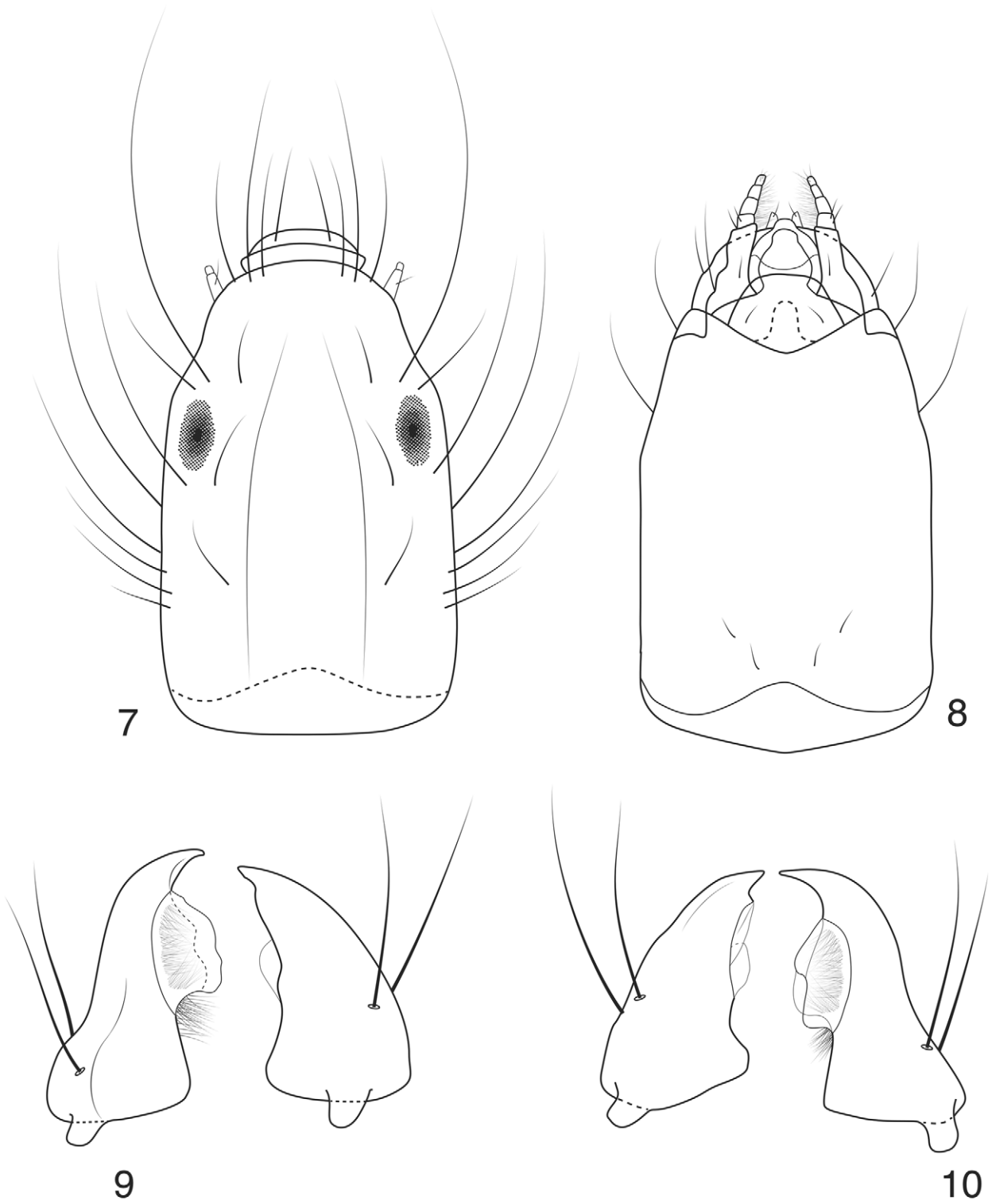
Head (Figs. 1, 5–10) sclerotized and unicolorous brown. In dorsal view (Fig. 7), cylindrical posteriorly, narrowing distally beyond stemmata to rounded anterior margin, elongate seta anterior of stemmata, frontoclypeal sutures indistinct, coronal sutures not evident, antennae short, 2-segmented; clypeus and labrum narrow. Mandibles heavily sclerotized (Fig. 6), wide basally in dorsal and ventral views (Figs. 9, 10), asymmetrical, left mandible more slender than right mandible, with prostheca on inner margin bearing extensive light setation, penicillus posterior to cusp, pair of elongate setae basolaterally; right mandible triangular, small prostheca on inner margin, pair of elongate setae basolaterally.



FIGURES 1–3. *Nothotrichia shasta* larva. 1, right lateral view. 2, right fore, middle, and hind legs, right posterolateral view. 3, right anal proleg, right lateral view.



FIGURES 4–6. *Nothotrichia shasta*. 4, larval case, dorsal view. 5, larval head and thorax, dorsal view. 6, larval head and prothorax, right lateral view.



FIGURES 7–10. *Nothotrichia shasta* larva. 7, head, dorsal view. 8, head, ventral view. 9, mandibles, dorsal view. 10, mandibles, ventral view.

Thoracic nota (Figs. 1–5) sclerotized and unicolorous brown. Pronotum subquadrate, rounded posteriorly, anterior margin slightly incised and bearing row of 7 pairs of stout setae, 5 pairs of scattered setae lateral of mesal suture (Fig. 5) with dark band posterolaterally extending anteriorly along ventral margin 2/3rds of distance to anterior margin and posteriorly along posterior margin half of distance to suture, mesal suture indistinct. Mesonotum wide anteriorly and tapering posteriorly to rounded posterior margin, with row of 5 pairs of setae on

anterior margin, clump of 4 setae on each side anterolaterally, clump of 3 setae at mid length on each side of suture, mesal suture indistinct. Metanotum subquadrate, rounded posteriorly, row of 9 pairs of setae on anterior margin, clump of 4 setae at mid length on each side of mesal suture, mesal suture indistinct.

Legs (Figs. 1, 2) light brown. Forelegs slightly shorter and wider than middle and hind legs, each with foretrochantin as long as episternum and apically blunt, coxa broad, trochanter subdivided at basal third, femur extended basoventrally as broad, truncate lobe, tibia with subapicooventral lobe bearing pair of stout setae, tarsus slightly shorter than tibia, tarsal claw tapering distally and bearing stout basal seta posteroventrally. Middle legs more slender, each femur without basoventral lobe, tibia with slightly wider subapicoventral lobe bearing pair of stout setae, tarsus with stout seta subapicoventrally. Hind legs slender, each with femur, tibia and tarsus cylindrical except tibia with pair of stout setae apicoventrally, tarsus with stout basal seta ventrally.

Abdomen (Figs. 1, 3) strongly compressed laterally, segments deeply incised, segments II and IV each bearing lateral humps, anal prolegs small, each curved ~135° at mid length and narrowing to acute apex, pair of elongate setae anteriorly.

Case (Fig. 4) length 4.7–5.8 mm (n = 11). Bright green in color when freshly collected, yellowing in alcohol, consisting of two symmetrical subrectangular to oval valves and neatly constructed of algal filaments with only a few stray algal strands. Case shape sometimes with dilated center similar to that seen in *Agraylea* larvae.

Material examined. CA [California], Fresno County, Bear Creek app. 1.4 mi [2.25 km] above Lower Creek, ML # 7073 E. map, 7 August 2001, 13 larvae; CA, Trinity County, Mumba Creek, app. 1.8 mi [2.9 km] E. Little Bear Gulch, ML # 6851 E. map, 29 July 2001, 2 larvae.

Biology. Larvae occur among filamentous green algae on the tops of rocks in fast-flowing streams at higher elevations. An examination of the gut contents of several larvae revealed the presence of strands of filamentous algae, suggesting the larvae are feeding by scraping algae from the rock surfaces.

Distribution. Fresno, Trinity, and Shasta Counties, CA.

Discussion

Because we now know the larva of *Nothotrichia*, albeit for only *Nothotrichia shasta*, we have modified the key to North American genera of Hydroptilidae larvae by Wiggins (1996). *Nothotrichia* runs to *Ochrotrichia* Mosely 1934 in Wiggins' (1996) key, but it is easily separated by differences in case construction. In *Ochrotrichia* the valves of the case are made of silk and sand, while in *Nothotrichia* the case is constructed of filamentous algae. As well, *Nothotrichia shasta* lacks the anterolateral lobes of the meso- and metanota found on most *Ochrotrichia* species.

Key to genera of North American Hydroptilidae larvae (modified from Wiggins 1996)

Couplets 1–8 as in the key by Wiggins (1996).

9. All three pairs of legs approximately the same length (Figs. 1, 2; Wiggins 1996, figs. 3.4A, 3.10G) 10
- Middle and hind legs much longer than fore legs (Wiggins 1996, figs. 3.1A, 3.12A) 12
10. Three filamentous gills arising from posterior end of abdomen (Wiggins 1996, fig. 3.4A) 11
- Posterior end of abdomen lacking 3 filamentous gills (Fig. 1; Wiggins 1996, fig. 3.10G) 11A
11A. Portable case usually consisting of two silken valves covered with sand grains (Wiggins 1996, figs. 3.10J, K); meso- and metanota usually produced as anterolateral lobes (Wiggins 1996, figs. 3.10G, H); abdominal segments usually each with dorsomedian sclerite and transverse sulcus ventrally (Wiggins 1996, figs. 3.10A, G) . . . . . *Ochrotrichia*
- Portable case consisting of two valves constructed of filamentous algal strands (Fig. 4); meso- and metanota not produced as anterolateral lobes (Fig. 1); abdominal segments lacking dorsomedian sclerites and ventral sulci . . . . . .*Nothotrichia*

12, etc. Couplets 12–15 as in the key by Wiggins (1996).

Taxonomic and phylogenetic considerations

The taxonomy of the Hydroptilidae is problematical owing to their small size (1.5–5.0 mm), making it difficult to see diagnostic features clearly. As well, larvae and females have not been associated for all genera. The family has

long been divided into two subfamilies, Hydroptilinae Stephens 1836 and Ptilocolepinae Martynov 1913. In 2005, Malicky elevated Ptilocolepinae to full family status as Ptilocolepidae. However, Holzenthal *et al.* 2007, retained the subfamily status of Ptilocolepinae on the basis of molecular studies which consistently grouped *Palaeagapetus* and *Ptilocolepus* with other genera of Hydroptilidae. Following the recent classification of Holzenthal *et al.* 2007, the subfamily Hydroptilinae consists of 6 tribes; Hydroptilini Stephens 1836, Leucotrichiini Flint 1970, Neotrichiini Ross 1956, Ochrotrichiini Marshall 1979, Orthotrichiini Nielsen 1948, and Stactobiini Botosaneanu 1956.

The placement of *Nothotrichia* within this tribal classification has been problematical. Marshall (1979) left the genus unplaced as *incertae sedis*, but suggested it may be an early offshoot of the Hydroptilini. Wells (1980, 1983) thought *Nothotrichia* closely related to *Maydenoptila* 1977 in Australia, *Caledonotrichia* 1967 from New Caledonia, and *Dibusa* Ross 1939 from North America based on characteristics of adults. Harris & Armitage (1997) examined males of *Caledonotrichia*, *Dibusa*, *Maydenoptila*, *Ochrotrichia* Mosely 1937, and *Rhyacopsyche* Muller 1879 and suggested *Nothotrichia* be placed in the Ochrotrichiniini. Holzenthal *et.al* (2007) placed *Nothotrichia* in the Orthotrichiini with *Ithytrichia* 1873 and *Orthotrichia* Eaton 1873. Olah & Johanson (2011) agreed with Harris and Armitage (1997) that *Nothotrichia* belongs in the Ochrotrichiini and tabulated 15 diagnostic characters for the 9 genera they included in the tribe, *Angrisanoia* Özdikmen 2008, *Caledonotrichia*, *Dibusa*, *Maydenoptila*, *Metrichia* Ross 1938, *Nothotrichia*, *Ochrotrichia*, *Ragatrichia* Olah & Johanson 2011, and *Rhyacopsyche*.

A comparison of the described larvae of the above genera with those of *Nothotrichia* provides additional characters for evaluation. Each foreleg of *Nothotrichia* has a prominent setal-bearing lobe on the tibia near the tarsus, a character also seen in *Agraylea* Curtis 1834 (Hydroptilini), *Ochrotrichia*, *Metrichia*, *Maydenoptila*, *Rhyacopsyche* (Ochrotrichiini). In *Dibusa* (Ochrotrichiini). *Orthotrichia* (Orthotrichiini), each protibia has only a slight ventral expansion, although still bearing a pair of stout setae, and in *Ithytrichia* (Orthotrichiini) and *Caledonotrichia* (Ochrotrichiini) the protibia lacks any expansion. Also in *Agraylea* and *Nothotrichia* there is a lobate ventral expansion of the profemur, not seen in those genera mentioned above.

Of the five genera with a lobate protibia, only *Agraylea* and one species of *Maydenoptila* build a case consisting partly or completely of algal filaments. The larva of *Dibusa angata* Ross 1939 also builds an algal case and *Metrichia* species incorporate algal filaments into the largely silken cases, but the other genera listed above build cases of silk or sand grains. Another character seen in *Nothotrichia*, *Agraylea*, *Ithytrichia* is the deep incision of the abdominal segments, although the abdominal segments of *Nothotrichia* lack the lobate processes from the dorsum and sternum of these segments, which are pronounced in both *Agraylea* and *Ithytrichia*. On the basis of the larvae, *Nothotrichia* shares few characters with those of *Ithytrichia* or *Orthotrichia*, which would suggest it not be placed within the Orthotrichiini as suggested by Holzenthal *et al.* 2007, and would appear to be most similar to *Agraylea*, but such similarity is not supported by characters of the adults. We hesitate to suggest placement of *Nothotrichia* based on the larvae of only one species, when five are now known to occur in the genus, but considering characters of the larvae discussed above, combined with such adult characters as the mesoscutellum having a transverse suture and metascutellum convex, males with elongate inferior appendages and tubular phallus without spiral paramere, and females with bursa copulatrix having an elongate, narrow anterior process, we would agree with Olah and Johanson (2011), that *Nothotrichia* appears to fall within the Ochrotrichiini.

Acknowledgements

The specimens used in this study were collected by personnel at the Center for Ecosystem Research at California State University–Chico and we thank A. Brady Richards for providing them for our use. Brady Richards and his colleagues also made the associations of the metamorphotypes with those of *Nothotrichia shasta*. John Morse, Michael Ferro, Gordon Snodgrass, and two anonymous reviewers all provided numerous helpful comments.

Literature cited

Botosaneanu, L. (1956), Recherches sur les Trichoptères de Bulgarie recueillis par MM. le Prof. A. Balkanov et B. Rusev (Trichoptera), *Beiträge zur Entomologie*, 6, 354–402.

Curtis, J. (1834) Descriptions of some hitherto nondescript British species of mayflies of anglers. *The London and Edinburgh Philosophical Magazine and Journal of Science*, 4, 212–218.
http://dx.doi.org/10.1080/14786443408648304

Eaton, A.F. (1873) On the Hydroptilidae, a family of the Trichoptera. *Transactions of the Entomological Society of London*, 2, 125–149.
http://dx.doi.org/10.1111/j.1365-2311.1873.tb00639.x

Flint, O.S., Jr. (1967) Studies of Neotropical caddisflies, II: Trichoptera collected by Prof. Dr. J. Illies in the Chilean subregion. *Beiträge zur Neotropischen Fauna*, 5, 45–63.
http://dx.doi.org/10.1080/01650526709360395

Flint, O.S., Jr. (1970) Studies of Neotropical caddis flies, X: *Leucotrichia* and related genera from North and Central America (Trichoptera: Hydroptilidae). *Smithsonian Contributions to Zoology*, 60, 1–64.
http://dx.doi.org/10.5479/si.00810282.60

Flint, O.S., Jr. (1983) Studies of Neotropical caddisflies, XXXIII: New species from austral South America (Trichoptera). *Smithsonian Contributions to Zoology*, 377, 1–100.
http://dx.doi.org/10.5479/si.00810282.377

Harris, S. C. & Armitage, B.J. (1997) New member of the Chilean genus *Nothotrichia* from North America (Trichoptera: Hydroptilidae). *In*: Holzenthal, R.W. and Flint, O.S., Jr. (Eds.), *Proceedings of the 8th International Symposium on Trichoptera*. Ohio Biological Survey, Columbus, Ohio, pp 123–128.

Holzenthal, R.W. & Harris, S.C. (2002) New species of *Nothotrichia* Flint (Trichoptera: Hydroptilidae) from Brazil and Costa Rica. *Proceedings of the Entomological Society of Washington*,104, 106–110.
http://dx.doi.org/10.1664/0028-7199(2002)110[0049:TNGOHF]2.0.CO;2

Holzenthal, R.W., Blahnik, R.J., Prather, A.L. & Kjer, K.M. (2007) Order Trichoptera Kirby, 1813 (Insecta), Caddisflies. *Zootaxa*, 1668, 639–698.

Kolenati, F.A. (1848) Genera et species Trichopterorum. Pars prior. *Acta Regiae Bohemoslovenicae Societatis Scientiarum*, Prague, 6, 1–108.

Malicky, H. (2005) Ein kommentiertes Verzeichnis der Köcherfliegen (Trichoptera) Europas und des Mediterrangebiets. *Linzer Biologische Beiträge*, 37, 533–596.

Martynov, A.V. (1913) Contribution to the knowledge of the Trichopterous fauna of the Caucasus [in Russian]. *Travaux de la Laboratoire de Zoologie, Universite de Varsovie*, 1912, 1–111.

Marshall, J.E. (1979) A review of the genera of the Hydroptilidae (Trichoptera). *Bulletin of the British Museum (Natural History), Entomology series*, 39, 135–239.

Milne, M.J. (1938) The "metamorphotype method" in Trichoptera. *Journal of the New York Entomological Society*, 46, 435–437.

Mosely, M.E. (1937) Mexican Hydroptilidae (Trichoptera). *Transactions of the Royal Entomological Society of London*, 86, 151–189.
http://dx.doi.org/10.1111/j.1365-2311.1937.tb00242.x

Müller, F. (1879) Über Phryganiden (Letters to his brother). *Zoologischer Anzeiger*, 2, 38–40, 180–182, 283–284, 405–407.

Neboiss, A. (1977) A taxonomic and zoogeographic study of Tasmanian caddis flies (Insecta: Trichoptera). *Memoirs of the National Museum of Victoria*, 38, 1–208, plates 1–3.

Nielsen, A. (1948) Postembryonic development and biology of the Hydroptilidae. A contribution to the phylogeny of the caddis flies and to the question of the origin of the case-building instinct. *Biologiske Skrifter*, 5, 1–200.

Oláh J. & Johanson, K. A. (2011) New Neotropical Hydroptilidae (Trichoptera). *Annales Historico-Naturales Musei Nationalis Hungarici*, 103, 117–255.

Özdikmen, H. (2008) A nomenclatural act for caddisflies (Trichoptera). *Munis Entomology & Zoology*, 3, 614–616.

Ross, H.H. (1938) Lectotypes of North American caddisflies in the Museum of Comparative Zoology. *Psyche*, 45, 1–61.
http://dx.doi.org/10.1155/1938/25928

Ross, H.H. (1939) New species of Trichoptera from the Appalachian Region. *Washington Entomological Society Proceedings*, 41, 65–72.

Ross, H.H. (1956) *Evolution and Classification of the Mountain Caddisflies*. University of Illinois Press, Urbana, 213 pp.

Stephens, J.F. (1836) *Illustrations of British Entomology; or a Synopsis of Indigenous Insects: Containing their Generic and Specific Distinctions; with an Account of their Metamorphoses, Times of Appearance, Localities, Food, and Economy, as far as Practicable. Mandibulata. Vol. VI.* [Trichoptera, pages 146–208]. Baldwin and Cradock, London, 240 pp.

Sykora, J. (1967) Trichoptera collected by Prof. J. Illies in New Guinea and New Caledonia, *Pacific Insects*, 9, 585–595.

Ulmer, G. (1912) Die Trichopteren des Baltischen Bernsteins. *Beiträge zur Naturkunde Preussens*, 10, 1–380.

Wells, A. (1980) A review of the Australian genera *Orphninotrichia* Mosely and *Maydenoptila* Neboiss (Trichoptera: Hydroptilidae), with descriptions of new species. *Australian Journal of Zoology*, 31, 635–655.
http://dx.doi.org/10.1071/ZO9800627

Wells, A. (1983) New species in the Australian Hydroptilidae (Trichoptera), with observations on relationships and distributions. *Australian Journal of Zoology*, 31, 629–649.
http://dx.doi.org/10.1071/ZO9830629

Wiggins, G.B. (1996) *Larvae of the North American caddisfly genera* (*Trichoptera*), *2nd edition*. University of Toronto Press, Toronto, 457 pp.