

A NEW JUNIOR SYNONYM FOR *RAPTOHEPTAGENIA CRUENTATA* (WALSH, 1863) AND REMARKS ABOUT NEARCTIC *HEPTAGENIA* WALSH, 1863 (INSECTA: EPHEMEROPTERA: HEPTAGENIIDAE)

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ABSTRACT. Examination of a rediscovered slide of holotype genitalia of *Heptagenia patoka* Burks, 1946, (Insecta: Ephemeroptera: Heptageniidae) revealed that *H. patoka* is synonymous with *Raptoheptagenia cruentata* (Walsh, 1863) [= *H. patoka*, **new synonym**]. With the synonymy of *H. patoka* under *R. cruentata*, all North American *Heptagenia* Walsh, 1863, species are known in the larval stage. The larvae of *H. dolosa* Traver, 1935, and *H. townesi* Traver, 1935, have not been described yet, but recently they were associated with adults. Both species are part of the *H. marginalis* Banks, 1910, species group. *Heptagenia townesi* differs from *H. marginalis* by having longer apical spines on the segments of the caudal filaments, but further study of *H. dolosa* will be required to elucidate possible diagnostic characters.

Keywords: Mayflies, systematics, taxonomy, aquatic insects

INTRODUCTION

The mayfly genus *Heptagenia* Walsh, 1863, (Insecta: Ephemeroptera: Heptageniidae) is distributed throughout the Holarctic biogeographic realm and part of the Oriental realm, with twelve species currently recognized from North America (Webb et al. 2007; Webb & McCafferty 2008). A thirteenth Holarctic species may be present (Kjærstad et al. 2012).

Heptagenia patoka Burks, 1946, has been considered a species endemic to the Central Lowlands of Illinois and Indiana, USA (Randolph & McCafferty 1998). It was described on the basis of a single male adult collected 19 July 1945 from Patoka, Illinois (Burks 1946), and its larva remains unknown (Webb et al. 2007). The species has been reported from only one other location in Illinois and from two locations in Indiana (Randolph & McCafferty 1998).

Webb et al. (2007) recently restricted the concept of *H. patoka* to the holotype, and they noted that subsequent reports were based on specimens from places where a very similar species, *Raptoheptagenia cruentata* (Walsh,

1863) (Whiting & Lehmkuhl 1987), has been found (Randolph & McCafferty 1998), including the Indiana locale of the *R. cruentata* neotype (McCafferty 1988). *Raptoheptagenia cruentata* is a species of big rivers from much of central North America (Waltz et al. 1998).

Webb et al. (2007) indicated that *H. patoka* and *R. cruentata* might be synonymous but that the synonymy could not be determined because the genitalia of the *H. patoka* holotype had been lost. Burks (1946: 6, 1953: Fig. 369) provided figures of those genitalia. Burks (1953: 181) distinguished *H. patoka* from *R. cruentata* by the narrower apices of the median penes titillators in *H. patoka*. Burks (1953) also indicated a concave shape of the apices of the penes lobes for *H. patoka* (Burks 1953: Fig. 367), compared to a convex shape of the same lobes for *R. cruentata* (Burks 1953: Fig. 369). The species otherwise are similar, including body coloration and wing maculation.

METHODS

We confirmed that the material reported by Randolph & McCafferty (1998) as *H. patoka* (see materials examined, below) actually is *R. cruentata*.

We located the slide containing the missing holotype genitalia of *H. patoka* at the Illinois

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Natural History Survey (see materials examined, below), where the rest of the holotype is housed (Webb 1980). We examined it carefully via compound light microscopy, paying particular attention to details revealed by passing the plane of focus up and down through the slide.

Materials examined are deposited in the Biodiversity Institute of Ontario, Guelph, Ontario, Canada [BIO]; the Clemson University Arthropod Collection, Clemson, South Carolina, USA [CUAC]; the Illinois Natural History Survey, Champaign, Illinois, USA [INHS]; collections of Pennington and Associates, Inc., Cookeville, Tennessee, USA [PAI]; and the Purdue University Entomological Research Collection, West Lafayette, Indiana, USA [PERC].

RESULTS

Examination of the *H. patoka* holotype genitalia revealed that the penes lobes of *H. patoka* are apically convex, unlike the illustration given by Burks (1953: Fig. 367). The median titillators appear to be narrower than those attributed to *R. cruentata* only because of their fixed orientation on the slide. This observation is apparent upon microscopic examination when the plane of focus is passed up and down through the slide; although the genitalia are slide-mounted, they are three-dimensional, and only parts of the genitalia are in focus at any given time while examining them using a standard compound light microscope. Furthermore, dorsolateral and dorsal submedian spines are absent from the penes lobes, which is the case with *R. cruentata* but with none of the other North American *Heptagenia*. On the basis of these observations, we consider *H. patoka* to be synonymous with *R. cruentata* (Walsh, 1863) [= *H. patoka* Burks, 1946, **new synonym**].

DISCUSSION

With the synonymy of *H. patoka* and *R. cruentata*, the larval stages of all North American *Heptagenia* species now are known. Larvae of the southeastern species (McCafferty et al. 2010) *H. dolosa* Traver, 1935, and *H. townesi* Traver, 1935, have not yet been described, but they tentatively have been associated with identified adults through molecular methods (Webb et al 2012). Both *H. dolosa* and *H. townesi* share the longitudinal dark abdominal markings characteristic of

larvae in the *H. marginalis* Banks, 1910, species group.

Heptagenia townesi appears to differ from larvae of *H. marginalis* by having longer apical spines on the segments of the caudal filaments (1/3 the length of the segment for *H. townesi* compared to 1/8 the length of the segment for *H. marginalis*).

Only a single larval specimen of *H. dolosa* is known, and no reliable morphological characters for species diagnosis of this stage have been discovered. However, the male and female adults are identifiable on the basis of a combination of characters, including small size, pale caudal filaments, a single median femoral band, a lack of dark mesonotal markings and limited markings on the middles of abdominal terga. The male adult is further distinguishable from related species by the absence of distinct projections on the inner margins of the penes lobes (Traver 1935, Traver 1935: Figs. 94–95).

Webb et al. (2007) flagged *H. dolosa* and the perhaps more widespread (Jacobus & McCafferty 2001: 66) *H. julia* Traver, 1933, as “doubtfully good species” at that time. However, recent evidence from DNA barcoding (Webb et al. 2012) suggests that both *H. dolosa* (discussed above) and *H. julia* are highly divergent from other North American *Heptagenia* and thus are likely good species.

Heptagenia julia is most similar to *H. pulla* (Clemens, 1913). Male adults of *H. julia* differ from those of *H. pulla* primarily by having penes with more acute apical projections and median spines that are subequal in size, their smaller size, and their indistinctly colored caudal filaments. Later larval instars of the two species differ mostly in size, with *H. julia* being nearly 3 mm shorter in body length than *H. pulla* (Traver 1935).

MATERIALS EXAMINED

***Heptagenia dolosa*.**—One larva, USA, Georgia, Oconee/Rabun Counties, Chattooga River at State Road 28, 5-V-2010, J Worsham [PAI]. One female adult, USA, North Carolina, Swain County, Oconaluftee River at the Blue Ridge Parkway, 23-VII-2009, CR Parker, A Kumar [BIO].

***Heptagenia julia*.**—Two male subimagos, USA, North Carolina, Swain County, Oconaluftee River at Blue Ridge Parkway, 23-VII-2009, CR Parker, A Kumar [BIO].

Heptagenia marginalis.—One larva, USA, Kentucky, Whitley County, Cumberland Falls State Park, Cumberland River at State Road 90, 21-VI-2005, B Barnd [PERC]. One larva, USA, Pennsylvania, Wyoming County, Susquehanna River, 4 miles SSE of Meshoppen, 25-VII-2005, EB Kratzer, DH Funk [PERC].

Heptagenia patoka.—HOLOTYPE, one male adult, USA, Illinois, Marion County, Patoka, 19-VII-1945, Ross, Sanderson, genitalia on slide [INHS].

Heptagenia townesi.—One female adult, USA, North Carolina, Swain County, Ekeneetlee Creek, 75 m upstream of confluence with Eagle Creek, 10-V-2003, BD Heinold, S Higdon [INHS]. One larva, USA, South Carolina, Pickens County, Estatoe Creek at Laurel Valley Road, 19-IX-1997, S Spichiger [CUAC].

Raptoheptagenia cruentata.—NEOTYPE larva, USA, Indiana, Martin County, East Fork White River at Hindostan Falls Public Fishing Site, 15-VII-1982, AV Provonsha, V VanAllen [PERC]. One male adult, one female adult, USA, Illinois, Pike County, lights at Motel Pike, west side of Pittsfield, 10-VI-1997, MA Harris, DL Adolphson [INHS]. One larva, USA, Indiana, Jefferson County, Ohio River, 26-V-1981 [PERC]. One male adult, two female adults, USA, Indiana, Martin County, East Fork White River at Hindostan Falls Public Fishing Site, 8-VI-1978, M Minno, D Bloodgood [PERC]. One male adult, same locale, 2-VII-1974, Provonsha, Lick [PERC]. One male adult, two female adults, same locale, 2-VII-1974, AV Provonsha, L Dersch, M Lick [PERC]. One adult, same locale, 20,21-VI-1974, AV Provonsha, L Dersch [PERC]. Adults (number unknown), USA, Indiana, Parke County, Racoon Lake, 24-VI-1973, HR Lawson [PERC]. One adult, USA, Indiana, Tippecanoe County, Wabash River at West Lafayette, 13-VII-1973, Provonsha [PERC]. Three adults, same locale, 18-VI-1974, Provonsha [PERC].

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