

**KELTONIA RUBROFEMORATA KNIGHT AND *K. WHEELERI* HENRY
(HEMIPTERA: MIRIDAE): DISTRIBUTIONS, HOST PLANTS, HABITATS,
AND SEASONALITY OF SPECIALISTS ON *POLYGONELLA* SPP.
(POLYGONACEAE)**

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Abstract.—The phyline plant bugs *Keltonia rubrofemorata* Knight and *K. wheeleri* Henry are specialist herbivores on *Polygonella* species (Polygonaceae); the former mirid has been known only from *P. myriophylla* (Small) Horton in the Lake Wales Ridge of central peninsular Florida and the latter only from *P. americana* (Fisch. & C.A. Mey.) Small in portions of the Georgia and South Carolina Sandhills. Sampling of *P. americana*, *P. myriophylla*, and several other species of *Polygonella* in the Southeast from 1998 to 2003 provided further evidence for the restricted host and distributional ranges of both mirids. Whereas the range of *K. rubrofemorata* coincided with that of *P. myriophylla*, which essentially is a Lake Wales Ridge endemic, that of *K. wheeleri* on *P. americana* did not; the bug was not found in northern areas of the Fall-line Sandhills of South Carolina or in disjunct populations of *P. americana* in Georgia. Both mirids are multi-voltine, the overwintered eggs of *K. wheeleri* hatching about mid-March and those of *K. rubrofemorata* in January. Adults of both species persisted until late November or early December.

Key Words: Heteroptera, Miridae, Phylinae, *Keltonia*, *Polygonella*, Fall-line Sandhills, endemism, Lake Wales Ridge, *Prepops rubrovittatus*

Phytophages, which account for about one-fourth of all described species of insects, generally are host restricted. Host specialists can include strict monophages that develop only on one plant species throughout their geographic ranges (e.g., Mitter et al. 1988; Bernays and Chapman 1994; Thompson 1994, 1998; Janz et al. 2001). The little-known mirid *Keltonia rubrofemorata* Knight and a recently described congener, *K. wheeleri* Henry, not only are each thought to be limited to one host species but also to exhibit restricted geographic ranges (Henry 2002). Here I provide additional evidence supporting the limited host and geographic ranges of both plant bugs,

characterize the habitats in which they are found, and give notes on their seasonal histories.

METHODS

American jointweed, *Polygonella americana* (Fisch. & C.A. Mey.) Small, the only known host of *K. wheeleri*, was sampled at irregular intervals from 1998 to 2003 by tapping the main stem, ascending secondary branches, and prostrate basal branches over a white enamel pan to detect nymphs and adults. To further delimit this plant bug's range, *P. americana* was sampled nearly throughout its range in South Carolina; at numerous sites in Georgia, includ-

ing several disjunct populations; and in the Sandhills of North Carolina. Adults from each locality were deposited in the National Museum of Natural History, Smithsonian Institution, Washington, D.C.

Information on the seasonality of *K. wheeleri* was obtained principally from two disturbed sandhills in South Carolina, one in Barnwell County southwest of Williston and the other in Edgefield County southwest of Eureka, and from a similar plant community in McDuffie County, Georgia, southwest of Dearing. Emphasis was placed on determining the approximate time that eggs hatch in early season, when adults of the first generation begin to appear, and how long the last-generation adults persist in the fall. Nymphs ($n = 1-10$, depending on abundance) of all instars were collected live or placed in 70% ethanol and the instars determined in the laboratory. *Polygonella polygama* (Vent.) Engelm. & Gray in the Fall-line Sandhills from south-central North Carolina to eastern Georgia was sampled to determine whether it serves as a host for *K. wheeleri*, and *P. fimbriata* (Ell.) Horton was sampled similarly in southeastern Georgia.

Biological information on *K. rubrofemorata* was obtained by sampling *P. myriophylla* (Small) Horton at irregular intervals from 1998 to 2003 in the Lake Wales Ridge of peninsular Florida. Mats of this more prostrate *Polygonella*, known as sandlace or Small's jointweed, were shaken over an enamel pan or shallow beating net. Sampling and sorting of nymphs otherwise was the same as that used to study *K. wheeleri* on *P. americana*. The main study sites were in Highlands County north and northwest of Lake Placid, southwestern Orange County, and Polk County south of Frostproof. Co-occurring species of *Polygonella* that were sampled as possible hosts of the mirid included *P. basiramia* (Small) Nesom & Bates, *P. ciliata* Meisn., and *P. gracilis* Meisn.

Keltonia rubrofemorata Knight

Knight (1966) described *Keltonia* and *K. rubrofemorata* from 8 males and 13 females collected from *P. myriophylla* by the miridologist L.A. Kelton at Sebring (Highlands Co.), Florida, on 30 April 1961. The only other published record of this plant bug is north of Frostproof (Polk Co., Florida), where nymphs and adults (27 ♂, 19 ♀) were taken on the same host on 25 April 1984 (Henry 1991).

Distribution.—The following new records of *K. rubrofemorata*, except one in Highlands County in 1998, are based on my collecting from *P. myriophylla*. Roman numerals indicate the nymphal instars present.

FLORIDA: Highlands Co., nr. jct. Livingston & Tivoli rds., 7 km NW of Avon Park, 27°38.3'N, 81°33.5'W, 25 Feb. 2002 (II–III, V), 21 Mar. 2002 (I–III), 3 Nov. 2002 (I–III), 5 Feb. 2003 (1 ♀; I–II, IV); Sun 'n Lake community, 8.1 km NW of Sebring, 27°32.2'N, 81°30.6'W, 25 Feb. 2002 (I–III), 20 Nov. 2002 (1 ♂, I–V), 6 Feb. 2003 (I–II, V); Rt. 27, 9 km NNW of Lake Placid, 27°22.3'N, 81°24.1'W, 17 Apr. 1998, T.J. Henry & A.G. Wheeler, Jr. (1 ♂, 3 ♀); Rt. 27, 9.5 km NNW of Lake Placid, 27°22.5'N, 81°24.3'W, 1 Dec. 2000 (1 ♂, 1 ♀), 3 Mar. 2001 (I–V), 25 Feb. 2002 (I–V); 7.2 km NW of Lake Placid nr Lake June in Winter, 27°19.5'N, 81°25.5'W, 25 Feb. 2002 (I–II), 20 Nov. 2002 (IV); Orange Co., county rd. 545, 0.1 km N of Rt. 192, 14.2 km NNW of Loughman, 28°20.9'N, 81°39.8'W, 26 Feb. 2002 (I), 20 Mar. 2002 (II–V), 13 Apr. 2002 (1 ♀, II–V), 9 Aug. 2002 (1 ♂, 2 ♀, I–V), 3 Nov. 2002 (I–V), 20 Nov. 2002 (1 ♀, III–V), 5 Feb. 2003 (1 ♀, V), 5 Apr. 2003 (2 ♂, 3 ♀; II–V), 11 May 2003 (2 ♂, 3 ♀, I–V); Polk Co., Rt. 17 (= 27A), nr Hickory Lake, 5.2 km S of Frostproof, 27°42.0'N, 81°31.9'W, 3 Mar. 2001 (I–V), 24 Feb. 2002 (I–II), 21 Mar. 2002 (II, IV), 3 Nov. 2002 (III), 5 Feb. 2003 (1 ♀, V), 5 Apr. 2003 (II–IV); Rt. 27, 4.8 km N of Highlands Co. line, SSW of Frostproof, 27°41.0'N, 81°33.4'W, 24 Feb.

2002 (I–III); Washington St. W of Rt. 27, 8.5 km S of Lake Wales, 27°49.8'N, 81°35.5'W, 3 Nov. 2002 (IV), 5 Feb. 2003 (1 ♀, V).

Host plant and habitat.—My collections of *K. rubrofemorata*, as well as the two previously published records, were from *P. myriophylla*. Syntopic populations of *P. basiramia*, *P. ciliata*, and *P. gracilis* in the Lake Wales Ridge did not yield specimens of the plant bug.

The host plant is endemic or precinctive (*sensu* Frank and McCoy 1990) to scrub communities on relict beach ridges and dune fields of peninsular Florida (Huck et al. 1989, Menges 1999). Essentially restricted to the Lake Wales Ridge (ca. 160 km long), *P. myriophylla* is found mostly in Highlands and Polk counties (Christman and Judd 1990, Lewis and Crawford 1995). This rare, state and federally endangered plant (McCoy and Mushinsky 1992, Coile 2000, Stout 2001) also is known from small portions of Orange and Osceola counties (Christman and Judd 1990).

A woody, prostrate perennial (flowering branches are erect) with persistent needle-like leaves, sandlace forms dark-green mats on pure white sands of peninsular scrubs. The tree layer of scrubs, often including sand pine (*Pinus clausa* (Chapm.) ex Engelm. Vasey ex Sarg.), and sparse ground or herb layer are secondary to a layer of xeromorphic shrubs dominated by oaks, ericads, palmettos, and sometimes Florida rosemary (*Ceratiola ericoides* Michaux) (e.g., Abrahamson et al. 1984, Myers 1990, Stout and Marion 1993, Menges 1999, Stout 2001). Sandlace grows in the more open sites or gaps between shrubs and in vacant lots and on highway slopes among adventive plants such as bahiagrass (*Paspalum notatum* Flügge) and natalgrass (*Rhynchelytrum repens* (Willd.) C.E. Hubbard. Bare zones associated with mature colonies of sandlace are not only the result of infrequent, intense fires but also are due to this plant's allelopathy (Weidenheimer and Romeo 1989).

Seasonal history.—Collections of late instars and adults in early February suggest that eggs began to hatch about mid-January. Nymphs of all instars that were found in late February and early March likely represented those of a second generation; a fifth instar collected on 3 March eclosed later that same day. Adults were not collected from late February to late March. A fifth instar collected on 20 March eclosed a week later. Early instars observed in late March might have been those of a third generation. Adults, probably representing the third generation, have been collected from mid-April to early May (Knight 1966, Henry 1991). Populations of the mirid were not sampled again until early August when adults and instars I–V were observed. In 2002, nymphs of all instars were present in early and late November; only one adult was taken (a female on the 20th) during November. In 2001, a male and a female were found on 1 December in southern Highlands County, but no nymphs were observed.

Keltonia wheeleri Henry

Henry (2002) described *K. wheeleri* from six counties in Georgia and five counties in South Carolina. Type material was based on my collections from *Polygonella americana* in the Fall-line Sandhills of those states. On the basis of a previous phylogenetic analysis of *Keltonia* (Henry 1991), Henry (2002) was able to state that *K. wheeleri* is most closely related to *K. rubrofemorata*.

Distribution.—Nearly all my localities for *K. wheeleri* were cited in the original description of the species (Henry 2002). Only the three main sites used for seasonal-history observations are cited here. For South Carolina, the site in Barnwell County was listed by Henry (2002), as was the one in Edgefield County (as "4.5 mi. SSW of Trenton"); the sample site in McDuffie County, Georgia, was not given in the original description. Adults observed on *P. americana*, but not collected, are indicated

as “adults”; roman numerals denote the nymphal instars present.

GEORGIA: McDuffie Co., Culberth Rd., 0.4 km SW of jct. Ellington Airline Rd., 3.5 km SW of Dearing, 33°23.7'N, 82°24.9'W, 18 Mar. 2000 (I), 1 Apr. 2000 (I–II), 16 Apr. 2000 (II–V), 6 May 2000 (5 ♂, 3 ♀; V), 20 May 2000 (4 ♀, I), 11 Mar. 2001 (I), 21 Oct. 2001 (“adults”; II, V), 9 Nov. 2002 (2 ♀, V). SOUTH CAROLINA: Barnwell Co., Rt. 39, 0.3 km N of jct. Rt. 278, 7.2 km SW of Williston, 33°21.7'N, 81°29.0'W, 27 June 1998 (2 ♂, 3 ♀; IV–V), 18 Oct. 1998 (1 ♂, 2 ♀; IV–V), 28 Mar. 1999 (I), 4 Apr. 1999 (I–II), 18 Apr. 1999 (II–IV), 18 Mar. 2000 (I), 11 Mar. 2001 (I), 31 Mar. 2001 (I–III), 7 Apr. 2001 (II–IV), 9 Nov. 2002 (2 ♀, V), 26 Apr. 2003 (III–V); Edgefield Co., S-19-407 nr. jct. S-19-37, 8.5 km SW of Eureka, 33°39.5'N, 81°51.6'W, 5 June 1998 (1 ♂, 1 ♀; II), 27 June 1998 (2 ♂, 1 ♀; IV–V), 28 Nov. 1998 (1 ♂, 1 ♀), 18 May 1999 (“adults”; IV–V), 16 Apr. 2000 (II–III), 21 Oct. 2001 (1 ♀, V).

Host plant and habitat.—All collections of *K. wheeleri* have been from American jointweed, *P. americana*. My sampling of *P. polygama* from the Fall-line Sandhills of North Carolina and South Carolina and *P. fimbriata* in Georgia failed to produce specimens of this mirid.

Polygonella americana is a suffrutescent (somewhat woody) perennial that in early season appears as depressed, matted leaves and shoots. It is closest in appearance to *P. myriophylla* but has a more upright growth habit (Horton 1963, Kral 1983).

American jointweed is weedy and often found along sandy roadsides and hillsides and in other ruderal sites (Horton 1963). In South Carolina, it is a plant of disturbed sandhills along the fall line (Radford et al. 1968, Porcher and Rayner 2001). The range is from the North Carolina Sandhills, where populations apparently are adventive (Sorrie et al. 1997), to South Carolina, Georgia, and Alabama, west to Texas and New Mexico, and north up the Mississippi Valley to

southern Missouri. Although *P. americana* is one of the more widespread species of the genus, the range is discontinuous. Only small, isolated populations along river banks and on rocky outcrops in rivers are found in the middle of its range (Horton 1963, Lewis and Crawford 1995).

Seasonal history.—Overwintered eggs of *K. wheeleri* hatched during March in the Fall-line Sandhills of Georgia and South Carolina. First instars were found as early as 11 March in 2001. Based on the presence of fifth instars in the last half of April, first-generation adults probably appear from late April to early May. First instars of the second generation were observed by late May in 2000. Reproduction probably continues throughout spring and summer. Fifth instars were present in early November, and adults were taken as late as 28 November.

DISCUSSION

Keltonia wheeleri was found only on *P. americana* in Georgia and South Carolina, but in the areas sampled in the Southeast, its range was not coincident with that of its host. Although populations of *P. americana* are nearly continuous in South Carolina along Interstate Highway 20 from North Augusta to Columbia, *K. wheeleri* was not found in Richland or Kershaw counties in the Columbia area. The plant bug also was not found in disjunct populations of *P. americana* in Houston and Jasper counties in Georgia or in disjunct but apparently adventive populations of the plant in the North Carolina Sandhills. Because nymphs and adults of *K. wheeleri* can be easily collected from American jointweed, the likelihood of detecting the mirid is high; the failure to find it in certain areas, therefore, seems informative.

Keltonia rubrofemorata also was found only on a single species of *Polygonella*, *P. myriophylla*. Unlike *K. wheeleri*, its distribution nearly coincided with that of its host: mainly Highlands and Polk counties in Florida's Lake Wales Ridge. This plant bug can be added to the list of insects consid-

ered endemic or precinctive to Florida scrub (Deyrup 1989, 1990). Deyrup (1989) pointed out that insects dependent on plants restricted to scrub habitats are less known than those that depend directly on aspects of the physical environment, such as the deep, sterile, excessively well-drained sands, and further noted that herbivores restricted to scrub-endemic hosts remain unstudied.

Florida is considered the center of distribution for *Polygonella* (Horton 1963). Plants ancestral to present species of the genus presumably were forced southward during the Pleistocene glaciations, eventually reaching Florida and spreading into sandy habitats. The Lake Wales Ridge might have provided refuge for plants during periods of higher sea levels (e.g., Delaney et al. 1989, Huck et al. 1989). Through range fragmentation or short-distance dispersal, followed by genetic differentiation, the present species are thought to have arisen. With retreat of the ice sheets, the genus probably reradiated northward and westward (Horton 1963, Huck et al. 1989).

Phylogenetic analysis based on morphological data suggests that *P. americana* and *P. myriophylla* represent sister taxa. The latter species, even though its range is narrow, shows greater allozyme diversity than the widespread *P. americana*, which underwent mass migrations corresponding to advances and retreats of ice sheets. The greater gene diversity of *P. myriophylla* apparently is the result of population stability during glacial cycles (Lewis and Crawford 1995).

The plant bugs *K. wheeleri* and *K. rubrofemorata*, which apparently are monophagous on *P. americana* and *P. myriophylla* respectively, are themselves considered sister species (Henry 2002). A host shifting or transfer—colonization of novel host plants—perhaps has been involved in speciation within *Keltonia*. In the case of *K. wheeleri* and *K. rubrofemorata*, whether populations on the new and original host

plants diverged genetically in allopatry or sympatry is unknown.

The only other mirids collected on *Polygonella* species during the present study were mirines of the tribe Restheniini. Host relationships in this tribe remain little known (Wheeler 2001). Nymphs and adults of *Prepops rubrovittatus* Stål were found infrequently on *P. americana* in South Carolina and on *P. myriophylla* in Florida. Overwintered eggs hatched by mid-March in disturbed sandhills of South Carolina. Nymphs also were observed during April and early June; an adult was taken in mid-May. In Florida, fifth instars were found in early and late February and late March; adults were observed in late March and late November. Nymphs of *P. rubrovittatus*, in addition to being larger than those of the *Keltonia* species, are reddish, whereas nymphs of *Keltonia* are green. In South Carolina, an adult of another restheniine, *Oncerometopus nitens* Knight, was collected on *P. americana* in early October at each of two sites in Kershaw and Richland counties.

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