LIFE HISTORY AND LABORATORY REARING OF *ARILUS CRISTATUS* (HETEROPTERA: REDUVIIDAE) IN SOUTHERN ILLINOIS

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ABSTRACT

The life history of *Arilus cristatus* (L.) was studied in southern Illinois from March 1997 to November 1998. The bug also was reared in the laboratory at 26 ± 0.5°C under a 16:8 (L:D) photoperiod. This univoltine species overwintered as eggs. First instars were found from early May to late June, second instars from mid-May to early June, third instars from late May to early July, fourth instars from early June to mid-July, fifth instars from early June to mid-August, and adults from early July to late November. In the laboratory, the five nymphal stadia averaged 15.64, 14.04, 15.17, 20.53, and 28.61 d, respectively. Also, the incubation periods of two egg clusters oviposited by two field-collected females were 60 and 61 d.

Key Words: *Arilus cristatus*, life history, southern Illinois, laboratory rearing

RESUMEN

El ciclo de vida de *Arilus cristatus* (L.) fué estudiado en el sur de Illinois de Marzo de 1997 a Noviembre de 1998. El insecto también fué criado bajo condiciones de laboratorio a 26 ± 0.5°C y con un fotoperíodo de 16 horas día/8 horas noche. Esta especie uniovular pasa el invierno en estadío de huevecillo. Los primeros instars se encontra-

ron desde principios de Mayo hasta fines de Junio; los segundos instars desde mediados de Mayo hasta principios de Junio; los terceros instars desde fines de Mayo hasta principios de Julio; los cuartos instars desde principios de Junio a mediados de Julio; los quintos instars desde principios de Junio hasta mediados de Agosto y los adultos desde principios de Julio hasta fines de Noviembre. En el laboratorio, los cinco estadíos ninfales promediaron 15.64, 14.04, 15.17, 20.53 y 28.61 días, respectivamente. Asímismo, los períodos de incubación de grupos de huevecillos ovipositados por dos hembras colectadas en el campo fueron de 60 y 61 días.

The wheel bug, *Arilus cristatus* (L.), occurs from Ontario and New York south to Florida and west to Iowa, Kansas, and New Mexico; it also has been reported from Mexico and Guatemala (Froeschner 1988). Adults are recognized easily because of their large size (26-36 mm), blackish brown body, reddish brown antennae, and a distinctive, high, toothed, median ridge on the pronotum. Although a common species, most published information on its biology consists of scattered notes.

This species commonly is found on trees and shrubs (e.g., Barber 1920, Elkins 1951, Froeschner 1944, Readio 1926, Swadener & Yonke 1973) but can be collected from other vegetation (Barber 1920, Blatchley 1926, Elkins 1951, Readio 1926, Wheeler & Stimmel 1983, Whitcomb & Bell 1964). It is predaceous and feeds on a wide variety of insects including, among others, the fall webworm, *Hyphantria cunea* (Drury); imported cabbageworm, *Pieris rapae* (L.); Mexican bean beetle, *Epilachna varivestis* Mulsant (Thompson & Simmonds 1965); orangedog, *Papilio cresphontes* Cramer (Watson 1918); tent caterpillar, *Malacosoma* (Surface 1906); and bollworm, *Helicoverpa zea* (Boddie) (Whitcomb & Bell 1964).

Arilus cristatus is univoltine, with five nymphal instars (Readio 1927, Todd 1937). It overwinters as eggs (Froeschner 1944; Garman 1916; Readio 1926, 1927; Swadener & Yonke 1973; Todd 1937) that are laid in clusters in the fall on the bark of tree trunks and twigs (Barber 1920; Froeschner 1944; Garman 1916; Readio 1926, 1927; Swadener & Yonke 1973). The eggs hatch the following spring, and nymphs are found from May to July and adults from June to October (Froeschner 1944). Copulation occurs in the fall (Barber 1920) and the eggs are laid shortly thereafter (Garman 1916; Readio 1926, 1927). Not unexpectedly, the life cycle is somewhat different in Florida; for example, nymphs appear in April and some adults survive into the winter (Mead 1974).

Several egg parasites have been reported including the eupelmid *Anastatus reduvii* (Howard), and the encyrtids *Ooencyrtus johnsoni* (Howard) (Peck 1963) and *O. clisiocampae* (Ashmead) (Swadener & Yonke 1973).

This species has been reared in an insectary under uncontrolled conditions (Todd 1937), and the eggs (Readio 1926, 1927) and nymphal instars, except the second (Readio 1927), have been described.

In this paper, we present information on this insect's field life history in southern Illinois and laboratory rearing under controlled conditions.

Materials and Methods

Field life history.—This study was conducted from March 1997 to November 1998 in conjunction with a general survey of the Reduviidae of southern Illinois. Southern Illinois was defined as the 11 southernmost counties (i.e., Jackson, Williamson, Saline, Gallatin, Union, Johnson, Pope, Hardin, Alexander, Pulaski, and Massac) (Fig. 1). Samples were collected weekly with the entire study area sampled 3 times per

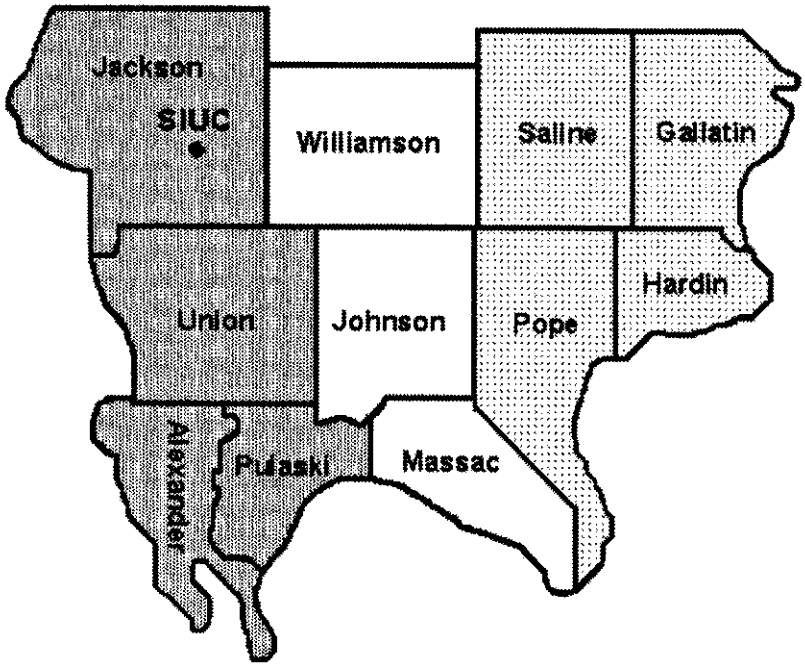

Fig. 1. Southern Illinois map showing counties surveyed and the three collecting subareas.

year (i.e., May-June, July-August, and September-October). However, because the area was so large, it was subdivided into 3 smaller areas with the Southern Illinois University campus serving as a home base (Fig. 1). During each of the 3 bimonthly sampling periods, each subarea was sampled daily at various locations over a 4-day period. Therefore, sampling of the entire study area per year occurred during 36 collecting trips. Finally, additional sampling was conducted sporadically in Jackson County during November 1997 and 1998 until the insects no longer were active.

Sampling was conducted along major roads with side trips to promising habitats. Insects were collected by sweeping, beating foliage, and handpicking along roadsides, grassy fields, and forest edges; preserved in 70% EtOH; and taken to the laboratory. Field-collected nymphs were determined to instar by comparison with laboratory-reared specimens. Field data (e.g., collection sites, times of occurrence of developmental stages, habitat types) were supplemented with data associated with specimens housed in the Southern Illinois University Entomology Collection.

Laboratory rearing.—During November 1997 and January-March 1998, 12 egg clusters were collected in Jackson, Williamson, and Union counties from the bark of trees. The clusters were brought to the laboratory and each was placed on moistened filter paper on the bottom of a petri dish (approximately 9 cm diam., 2 cm depth) and covered with the lid. Approximately 4-6 drops of distilled water were added every 1-2 d to keep the filter paper moist.

Of the 12 clusters, 10 were heavily parasitized or contained several eggs that did not hatch for unknown reasons. The remaining 2 contained 315 eggs (n = 123, 192), 252 of which hatched. Of these, 210 were chosen for further study based on their apparent good health.

Nymphs were kept in petri dishes prepared similarly to those for egg clusters. One *Tenebrio* sp. larva per nymph was provided daily as food. The dishes were examined daily, molts recorded, and exuviae removed. Initially, nymphs were grouped by hatch date at a density of 10 per dish. As molts occurred, nymphs were grouped by molting dates to determine stadia accurately. Filter paper was moistened daily and replaced when necessary, usually every 5-7 d.

To determine if eggs of Illinois populations could develop without a cold winter diapause, two pairs of adults were collected from the field during September 1998 and brought to the laboratory. Each pair (1 ♂, 1 ♀) was kept in a one-quart (approximately 0.95 liter) mason jar with a moistened disc of filter paper on the bottom and fed 2-3 *Tenebrio* sp. larvae every other day. A strip of bark (approximately 4 cm wide, 16 cm long) was propped against the inner surface of the jar to provide additional walking surface and to serve as a possible ovipositional site.

All specimens were kept in incubators maintained at 26 ± 0.5°C and a photoperiod of 16:8 (L:D) (approximately 2,800 lux).

Results and Discussion

Life history.—This species was collected in all 11 counties. It was univoltine and overwintered as eggs, which were laid in hexagonal clusters and glued to the trunks of sassafras (*Sassafras albidum* [Nuttall]), beech (*Fagus grandifolia* Ehrhart), and maple (*Acer* sp.). First instars were found from early May to late June, second instars from mid-May to early June, third instars from late May to early July, fourth instars from early June to mid-July, fifth instars from early June to mid-August, and adults from early July to late November (Fig. 2). Copulation (1 pair) was observed in September. Unhatched egg clusters were found as early as early October.

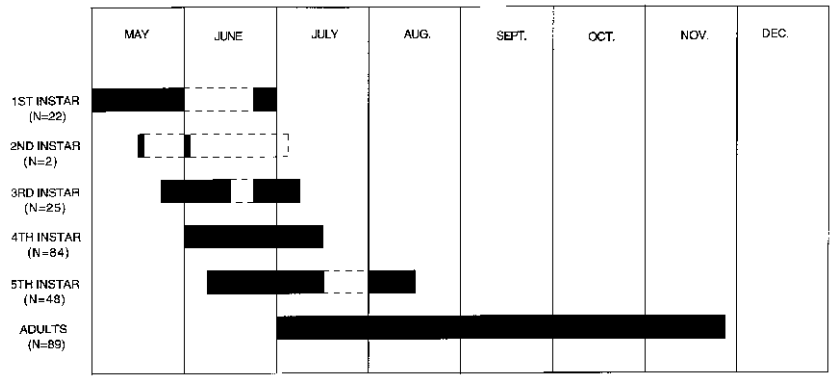

Fig. 2. Field life cycle of *A. cristatus* in southern Illinois (combined 1997-1998 data). Periods represented by dashes lines indicate only probable occurrence because no specimens were collected.

Nymphs were collected most often by sweeping weeds and short woody vegetation along the margins of forested areas. Adults frequently were collected by sweeping or beating the branches of trees.

Several prey were collected during the study, all of which had been captured by late instars or adults. These items and the attacking stages included single adult specimens of the cercopid *Clastoptera proteus* Fitch (fourth instar), the chrysomelid *Ophraella* sp. (fifth instar), and a halictid (adult). Also, two bugs (1 fifth instar, 1 adult) were observed with their beaks inserted in the cases of bagworms (*Thyridopteryx* sp.?). One adult male was seen inserting its beak into a flower of goldenrod (*Solidago* sp.).

As noted earlier, several field-collected egg clusters were heavily parasitized. The parasitoids were identified as *Ooencyrtus johnsoni* and *Anastatus reduvii*.

Laboratory rearing.—Field-collected eggs were dark brown to black cephalad, red posterad, and attached by their posterior ends. Eye spots were not visible. The first instars emerged through a circular opening in the cephalic end of the egg, pushing aside a cap. They were orangish at this time but darkened to the more typical coloration (i. e., head, thorax, and appendages black; abdomen red) within 3-4 h. They fed on *Tenebrio* sp. larvae within 1 d.

The first, second, third, fourth, and fifth stadia averaged 15.64, 14.04, 15.17, 20.53, and 28.61 d, respectively. The total development period averaged 93.99 d (Table 1).

Mortality during the nymphal stadia resulted from incomplete ecdysis, predation by other nymphs, and unnatural causes (e. g., drowning in water condensation in the dishes).

The two females collected for ovipositional data each deposited a single egg cluster on the wall of its jar. The clusters contained 79 and 48 eggs, which hatched in 60 (n = 58 eggs, 73.42%) and 61 (n = 23 eggs, 47.92%) d, respectively. Therefore, a cold period apparently is not necessary for normal egg development. Sailer (1957) reported that eggs he collected in late September hatched in early December, supporting our conclusion.

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TABLE 1. DURATION (IN DAYS) OF EACH NYMPHAL STADIUM OF *A. CRISTATUS* IN THE LABORATORY.

Stage	No. completing stadium	Range	Mean ± SE	Cumulative mean age
1st instar[1]	174	11-27	15.64 ± 0.22	15.64
2nd instar	170	10-31	14.04 ± 0.24	29.68
3rd instar	163	9-37	15.17 ± 0.33	44.85
4th instar	135	12-47	20.53 ± 0.52	65.38
5th instar	93	16-51	28.61 ± 0.81	93.99

[1]210 began stadium.

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