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LIFE HISTORY AND DESCRIPTIONS OF THE IMMATURE STAGES OF THE PLANTHOPPER *PROKELISIA CROCEA* (VAN DUZEE) (HOMOPTERA: DELPHACIDAE)

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Abstract.—The life history of *Prokelisia crocea* (Van Duzee) was studied in Missouri from May to October 1988 and the immature stages described. *P. crocea* feeds and reproduces on prairie cordgrass, *Spartina pectinata* Link, is trivoltine and overwinters as nymphs. Nymphal instars differed in body size, development of wingpads, number of metatibial spines, and shape and dentition of metatibial spurs.

Extensive ecological studies of two of the five species of *Prokelisia*, *P. marginata* (Van Duzee) and *P. dolus* (Wilson), have focused on laboratory rearing, nutrition, parasites, predators, and wing morphology (literature summarized in Denno et al., 1985, 1986). The host plants of these salt marsh species are *Spartina alterniflora* Loisel and *S. foliosa* Trin. No information is available on the biology of planthoppers occurring on the inland species of *Spartina*, *S. pectinata* Link.

Prokelisia crocea (Van Duzee) is monophagous on prairie cordgrass (*S. pectinata*) and has been recorded from Maine south to Connecticut, and west to North Dakota and New Mexico (Metcalf, 1943; Wilson, 1982). Wilson (1982) and Heady and Wilson (1990) provided detailed descriptions of male and female adults of *P. crocea*.

The present study summarizes the life history of *P. crocea* on prairie cordgrass in Missouri, and provides information on laboratory rearing and descriptions and illustrations of immature stages with a key to nymphal instars.

MATERIALS AND METHODS

Field study. The field study was conducted on plots of *Spartina pectinata* along roadsides and native tallgrass prairies in Saline, Pettis, and Johnson Counties, Missouri. Weekly sweep and D-vac suction samples (Holder and Wilson, in prep.) were taken from 24 May to 10 October 1988 and 26 April to 11 May 1989. Some specimens were placed in vials and returned to the laboratory for rearing. Most were preserved in 70% isopropyl alcohol for phenological analysis, measurements and descriptions. Information recorded from these samples included number of individuals captured and number of each nymphal instar. Feeding and oviposition sites were determined, in both field and laboratory studies, by observing individuals on the host plants. Attempts were made to collect overwintering nymphs by gathering thatch from host plant sites in five 20-gallon plastic garbage bags in February, March, November and December, 1989, and placing it in a large modified Berlese funnel; these samples produced no planthoppers. A further attempt at collecting specimens with a modified leaf vacuum (Wilson et al., in prep.) was made on 24 November 1990.

Laboratory study. Plants were collected from roadside areas and potted in 12 cm

diam pots. An environmental chamber was unavailable thus plants were maintained in a laboratory under fluorescent lights on a 12-hr light-dark cycle; temperature ranged from 18 to 32°C. Adults were collected and placed on potted plants (Calvert and Wilson, 1986), nymphs were collected and placed on individual plants but survival was poor. Immatures were also placed in 2.5 cm diam culture tubes containing a fresh *S. pectinata* leaf and plugged with cotton (Calvert et al., 1987). Insufficient data were collected to determine stadia of nymphal instars due to low survival of nymphs.

The 5th instar is described in detail but only major differences are described for 4th through 1st instars. Measurements are given in mm as mean \pm SD. Length was measured from apex of vertex to apex of abdomen, width across the widest part of the body, and thoracic length along the midline from the anterior margin of the pronotum to the posterior margin of the metanotum. Eggs were obtained by excising them with a fine needle from the potted host plants.

RESULTS AND DISCUSSION

Field study. *P. crocea* is trivoltine in Missouri and overwinters as fifth instar nymphs which were collected on 24 November and 26 April (Figs. 1, 2). Adults were found from 26 April to 9 June and 23 June to 20 September. First instar nymphs were first collected on 9 June and found sporadically until 2 October. Second through fifth instar nymphs showed similar seasonal distributions.

Nymphs and adults were observed feeding along the midrib on the axial surface of leaves near the base of the leaf and on the stem. Two percent of adult *P. crocea* (N = 100) were found to be brachypterous.

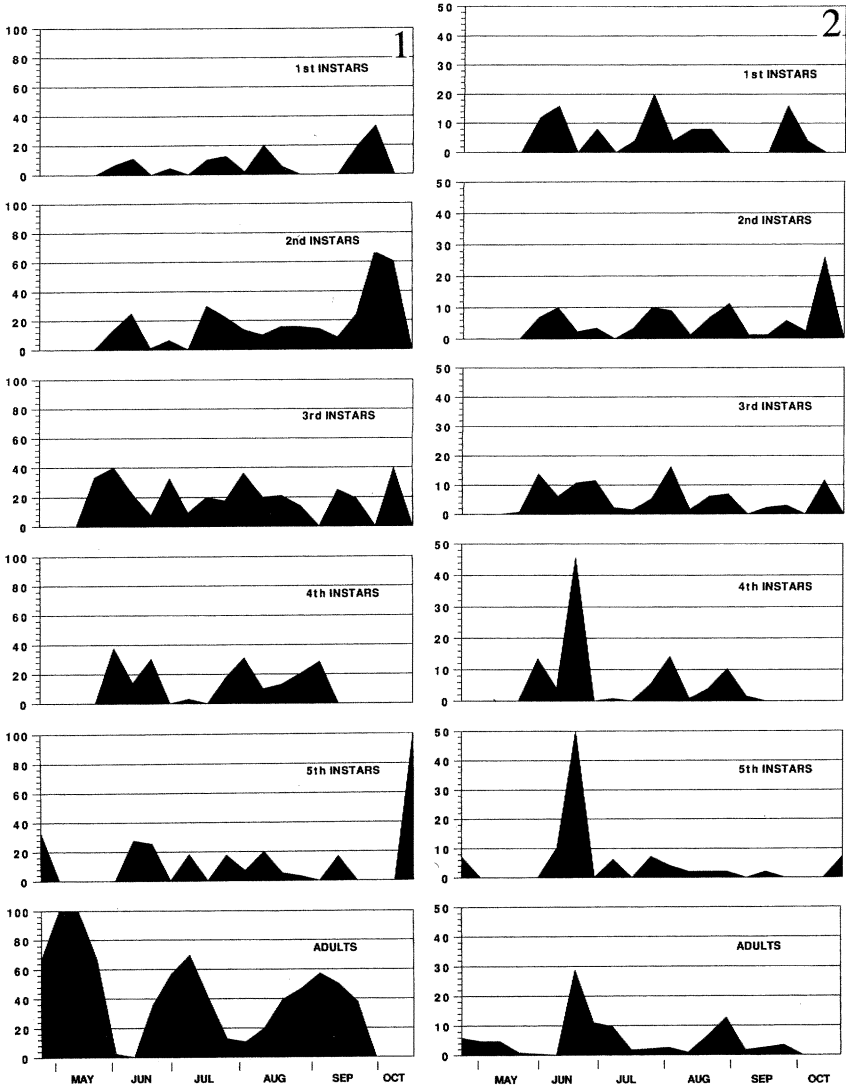
Laboratory study. Numerous attempts to rear field collected specimens on potted *S. pectinata* in the laboratory were only partially successful. Because an incubator was unavailable, plants were kept in a laboratory where low humidity apparently reduced survival of nymphs during hatching and ecdysis.

Females deposit eggs singly in slits made with the ovipositor along the midrib of either the axial or adaxial surface of a leaf. After eggs have been inserted into the plant tissue they are covered with wax from the 9th abdominal tergite.

Descriptions. *Fifth instar* (Figs. 3–6, 16). Length 2.7 ± 0.21 ; thoracic length 0.9 ± 0.09 ; width 0.9 ± 0.13 . N = 13.

Body straw color with white middorsal line extending from vertex almost to end of the abdomen. Form elongate, subcylindrical, slightly flattened dorsoventrally, widest across mesothoracic wingpads.

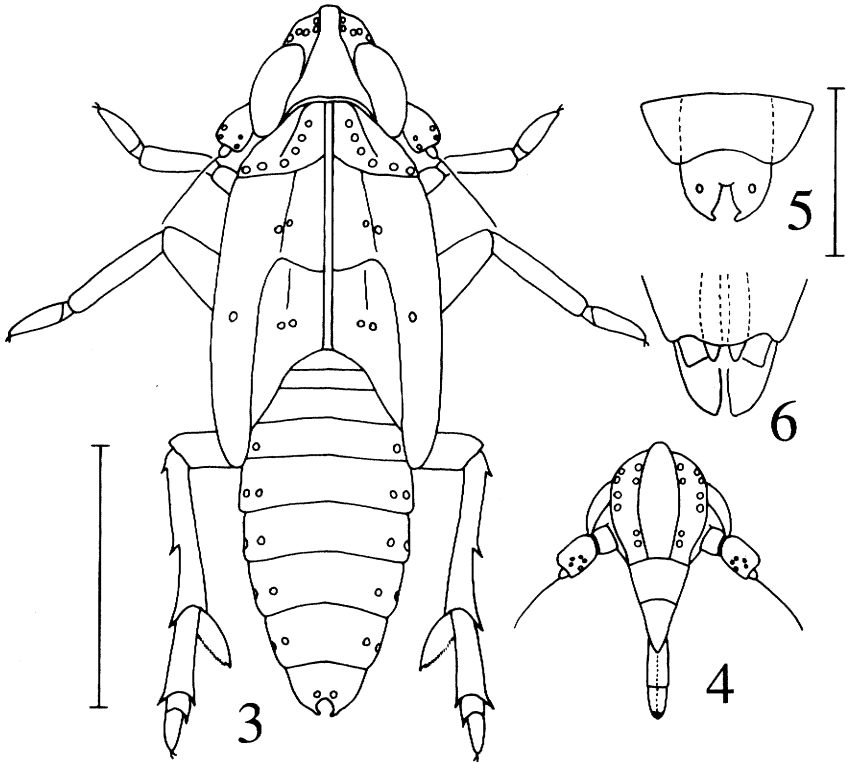
Vertex subtriangular, narrowing anteriorly; posterior margin concave, lateral margins concave in anterior $\frac{1}{2}$. Frons yellowish with white longitudinal median line; border with clypeus slightly convex; lateral margins convex and carinate (outer carinae) and paralleled by second pair of carinae (inner carinae) continuous with lateral margins of vertex; area between inner carinae forming trough; area between inner and outer carinae with 9 pits on each side (8 visible in frontal view); 4 pits between each outer carina and eye. Clypeus yellow, narrowing distally, consisting of subconical basal postclypeus and cylindrical distal anteclypeus. Beak 3-segmented, cylindrical, segment 1 hidden by anteclypeus, segment 2 ca. $1.3 \times$ length of segment 3, segment 3 with black apex. Antennae 3-segmented; scape short, cylindrical; pedicel subcylindrical, $2 \times$ length of scape, with ca. 8–10 pit-like sensoria; flagellum bulbous basally,



Figs. 1-2. Seasonal occurrence of *P. crocea* in Missouri. 1. Number of individuals of each stage is expressed as percentage of total individuals of all stages collected per collection date. 2. Number of individuals of each stage is expressed as percentage of all individuals of that stage collected throughout the study ($N_A = 236$, $N_5 = 98$, $N_4 = 127$, $N_3 = 130$, $N_2 = 89$, $N_1 = 25$).

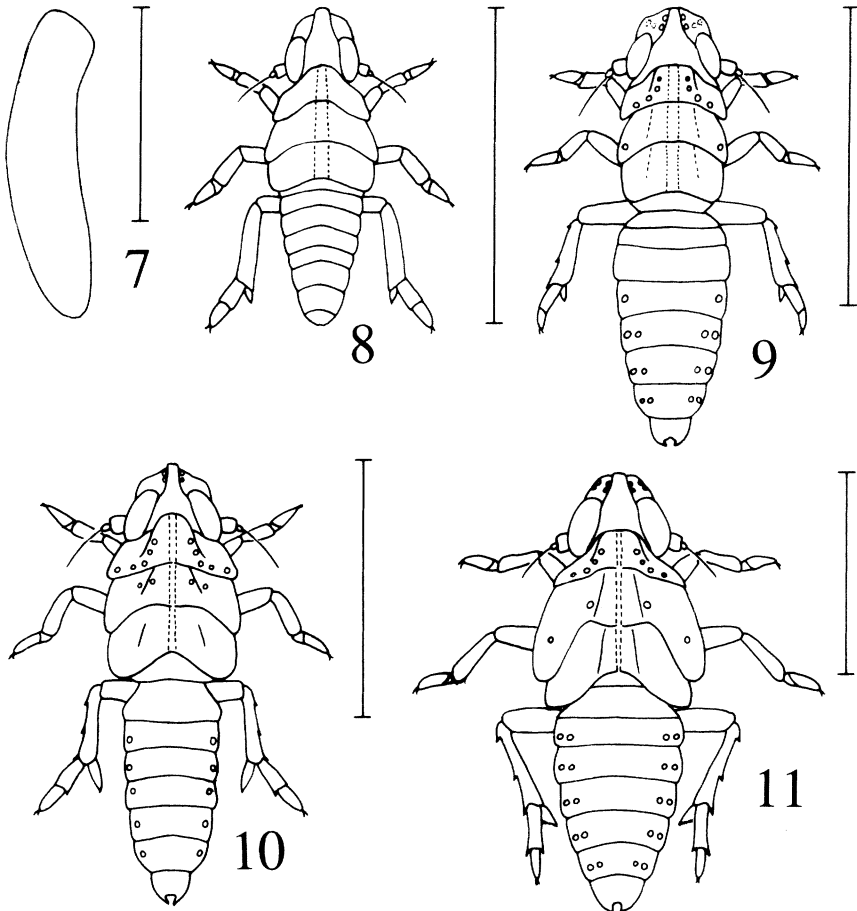
with elongate bristle-like extension distally, bulbous base ca. $0.2 \times$ length of pedicel. Eyes red.

Thoracic nota divided by middorsal line into three pairs of plates. Pronotal plates subtriangular; anterior margin convex following posterior border of eye; posterior



Figs. 3–6. *P. crocea* fifth instar. 3. Habitus. 4. Frontal view of head. 5. Apical part of venter of male abdomen. 6. Apical part of venter of female abdomen. Vertical bar = 1.0 mm (3, 4); = 0.5 mm (5, 6).

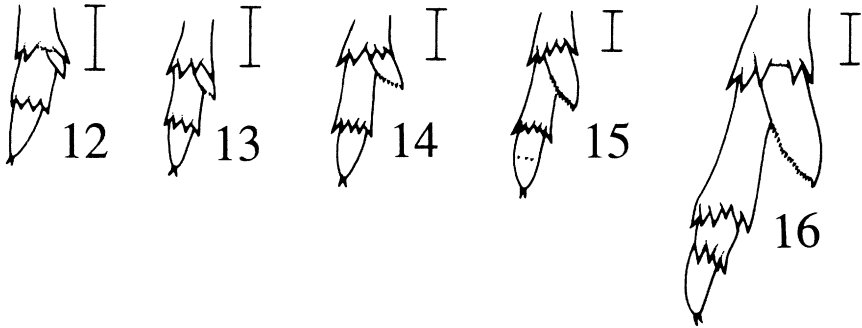
border sinuate; each plate with row of 7 pits originating at anterior margin curving distally from middorsal line to lateral margin (lateralmost pits often not visible in dorsal view). Mesonotum with median length $1.5 \times$ that of pronotum; subrectangular; elongate lobate wingpads extending to tips of metanotal wingpads; each plate with posterolaterally directed carina originating on anterior margin in median $\frac{1}{4}$ and terminating on posterior margin in lateral $\frac{1}{2}$; area between carinae elevated and triangular; 2 pits near carina and 1 pit on lateral $\frac{1}{3}$. Metanotum with median length ca. $1.25 \times$ that of mesonotum; subrectangular, lobate wingpads extending to middle of 4th tergite; each plate with weak longitudinal carina and 2 pits near middle of plate. Pro- and mesocoxae elongated and directed posteromedially; metacoxae fused to sternum. Metatrochanter short and subcylindrical. Pro- and mesofemora and tibiae with 2 ventral and 1 dorsal longitudinal rows of setae. Metatibia with 2 spines on lateral aspect of shaft, an apical transverse row of 5 black-tipped spines on plantar surface and a subtriangular flattened movable spur with 13–14 teeth on posterior margin. Pro- and mesotarsi with 2 tarsomeres, tarsomere 1 wedge-shaped; tarsomere



Figs. 7–11. *P. crocea* immature stages. 7. Egg. 8. First instar. 9. Second instar. 10. Third instar. 11. Fourth instar. Vertical bar = 0.5 mm (7); = 1.0 mm (8–11).

2 subconical, ca. $4\times$ length of tarsomere 1, with pair of apical claws and median membranous pulvillus. Metatarsi with 3 tarsomeres; tarsomere 1 with apical transverse row of 6 black tipped spines on plantar surface; tarsomere 2 cylindrical, ca. $4\times$ length of tarsomere 1, with apical transverse row of 4 black tipped spines on plantar surface; tarsomere 3 subconical, ca. $2\times$ length of tarsomere 2 with pair of apical claws and median pulvillus.

Abdomen 9-segmented; slightly flattened dorsoventrally; widest across 5th abdominal segment. Tergite 1 small, subtriangular; 2 subrectangular, ca. $0.5\times$ width of 3; tergites 4–8 each with 2 lateral pits on either side (lateralmost pits not always visible in dorsal view). Segment 9 surrounding anus, with 3 pits; female with 1 pair of acute processes extending from juncture of sternites 8 and 9; males lacking processes.



Figs. 12–16. *P. crocea* apices of metathoracic legs. 12. First instar. 13. Second instar. 14. Third instar. 15. Fourth instar. 16. Fifth instar. Vertical bars = 0.1 mm.

Fourth instar (Figs. 11, 15). Length 2.1 ± 0.26 ; thoracic length 0.7 ± 0.06 ; width 0.7 ± 0.09 . $N = 11$.

Antennal pedicel with 4–6 sensoria; basal portion of antennal flagellum $0.3 \times$ length of pedicel.

Mesonotal wingpads shorter, each covering ca. $\frac{2}{3}$ of metanotal wingpad laterally. Metanotal median length $1.125 \times$ that of mesonotum; carinae weaker; wingpad extending to tergite 2. Metatibial spur slightly smaller, with 8–10 teeth on margin. Metatarsi with 2 tarsomeres; tarsomere 1 with apical transverse row of 6 black-tipped spines on plantar surface; tarsomere 2 subconical with 3 black-tipped spines in middle of tarsomere on plantar surface.

Third instar (Figs. 10, 14). Length 1.8 ± 0.14 ; thoracic length 0.6 ± 0.09 ; width 0.6 ± 0.06 . $N = 11$.

Basal flagellum of antenna ca. $0.5 \times$ length of pedicel.

Mesonotal wingpads shorter, each covering $\frac{1}{3}$ of metanotal wingpad laterally. Metanotal wingpad extending to juncture of tergites 1 and 2. Metatibial spur smaller; with 5 marginal teeth. Metatarsomere 1 with apical transverse row of 5 black-tipped spines on plantar surface.

Second instar (Figs. 9, 13). Length 1.4 ± 0.15 ; thoracic length 0.4 ± 0.08 ; width 0.4 ± 0.07 . $N = 13$.

Mesonotal plates each with 1 pit; wing pads undeveloped. Metanotal wingpads undeveloped. Metatibia with apical row of 4 black-tipped spines on plantar surface; spur small with 3 marginal teeth, ca. $3 \times$ length of longest metatibial spine; metatarsomere 1 with 4 apical black-tipped spines.

First instar (Figs. 8, 12). Length 1.1 ± 0.15 ; thoracic length 0.3 ± 0.04 ; width 0.2 ± 0.05 . $N = 15$.

Bulbous base of antennal flagellum subequal in length to that of pedicel.

Metatibia lacking spines on shaft, with apical row of 3 black-tipped spines on plantar surface; metatibial spur smaller, ca. $1.5 \times$ length of longest metatibial spine, lacking marginal teeth.

Egg (Fig. 7). Length 0.7 ± 0.05 ; width 0.2 ± 0.02 . $N = 8$.

Eggs laid singly; white; cylindrical, slightly flattened; curved in anterior $\frac{1}{4}$; chorion translucent, smooth.

KEY TO *P. CROCEA* NYMPHAL INSTARS

1. Metatibial spur with more than 7 marginal teeth; mesonotal wingpads overlapping more than half length of metanotal wingpads (Figs. 3, 11, 15, 16) 2
- Metatibial spur with fewer than 7 marginal teeth; mesonotal wingpads overlap less than half length of metanotal wing pads (Figs. 8–10, 12–14) 3
2. Metatarsi with 3 tarsomeres; metatibial spur with more than 11 marginal teeth (Fig. 16) 5th Instar
- Metatarsi with 2 tarsomeres; metatibial spur with fewer than 11 marginal teeth (Fig. 15) 4th Instar
3. Metatibia with transverse row of 5 apical spines, spur with 5 marginal teeth (Fig. 14) 3rd Instar
- Metatibia with fewer than 5 apical spines, spur with fewer than 5 marginal teeth (Figs. 12, 13) 4
4. Metatibia with 2 lateral spines on shaft and 4 apical spines, spur with 3 marginal teeth (Fig. 13) 2nd Instar
- Metatibia without lateral spines on shaft and with 3 apical spines, spur without marginal teeth (Fig. 12) 1st Instar

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