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LIFE HISTORY AND LABORATORY REARING OF *PELOCORIS FEMORATUS* (HEMIPTERA: NAUCORIDAE), WITH DESCRIPTIONS OF IMMATURE STAGES

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Abstract.—The life history of *Pelocoris femoratus* (Palisot de Beauvois) was studied in southern Illinois, and the immature stages were described. The bug was reared from egg to adult in the laboratory. Adults of this univoltine species overwintered in mud and detritus at the bottom of their aquatic habitat and became active in early March. Eggs were found between late April and mid-May and had been glued singly to leaves of *Ceratophyllum demersum* L. beneath the surface of the water. First instars appeared in mid-May followed by marked overlapping of the subsequent instars. Active adults were last observed in November. This species was reared on *Chaoborus americanus* (Johannsen) larvae under a 16L:8D photoperiod at 26.7 ± 1.5°C. The incubation period averaged 17.7 days. Durations of the five subsequent stadia averaged 10.5, 9.7, 11.0, 12.6, and 19.5 days, respectively.

The naucorid *Pelocoris femoratus* (Palisot de Beauvois) ranges in continental United States from New England south to Florida and west to the Dakotas (Slater and Baranowski, 1978), Kansas, Oklahoma, and Texas (Sanderson, 1982). It occurs throughout Illinois (Lauck, 1959).

Scattered notes have been published on this bug's field life history. It is predaceous, feeding on small mollusks, dragonfly naiads, and other aquatic animals (Lauck, 1959; Uhler, 1884). It inhabits various lentic (e.g. lakes, ponds, pools) (Blatchley, 1926; Bobb, 1974; Ellis, 1952; Froeschner, 1962; Gonsoulin, 1973; Hungerford, 1927 [as *P. carolinensis* Torre-Bueno; see La Rivers, 1948]; Lauck, 1959; Polhemus, 1979; Slater and Baranowski, 1978; Torre-Bueno, 1923; Wilson, 1958) and the sluggish parts of lotic habitats (Gonsoulin, 1973; Polhemus, 1979) where it is usually well concealed amidst thick growths of aquatic plants (e.g. *Alternanthera, Chara, Lemna, Myriophyllum, Nitella*) (Bobb, 1974; Ellis, 1952; Gonsoulin, 1973; Hungerford, 1927; Lauck, 1959; Polhemus, 1979; Slater and Baranowski, 1978; Torre-Bueno, 1903, 1905, 1923; Wilson, 1958).

Adults overwinter at the bottoms of ponds and pools in muck and detritus (Blatchley, 1926; Bobb, 1974; Uhler, 1884) and emerge in spring to feed and reproduce. Oviposition begins in spring (Bobb, 1974; Torre-Bueno, 1903) and continues at least until the middle of the summer (Torre-Bueno, 1903). Nymphs have been found during the summer (Bobb, 1974; Torre-Bueno, 1903). There appears to be only one generation per year (Sanderson, 1982) although nymphs may be collected in several stages at the same time (Sanderson, 1982; Torre-Bueno, 1903, 1923).

Pelocoris femoratus has been reared in the laboratory under uncontrolled conditions from egg to adult and the immature stages have been briefly described (Hungerford, 1927; Torre-Bueno, 1903).

For the past three years (i.e. 1983–1985), we have studied the life history of a population of *P. femoratus* occurring in the La Rue-Pine Hills Ecological Area. This area, located ca. 30 km northeast of Cape Girardeau, Missouri, in the northwest corner of Union County, Illinois, is part of the Shawnee National Forest. It includes both heavily forested areas atop limestone bluffs, and moist forests at the base of these bluffs that surround La Rue Swamp and Winters Pond. These aquatic habitats are continuous and the naucorid occurs throughout the area. Much of the study area is blanketed with duckweeds (i.e. *Lemna, Spirodela, Wolffia,* and *Wolffiella*) along the shoreline.

This paper presents information on the life history and laboratory rearing of *P. femoratus* and includes descriptions of the immature stages.

Materials and Methods

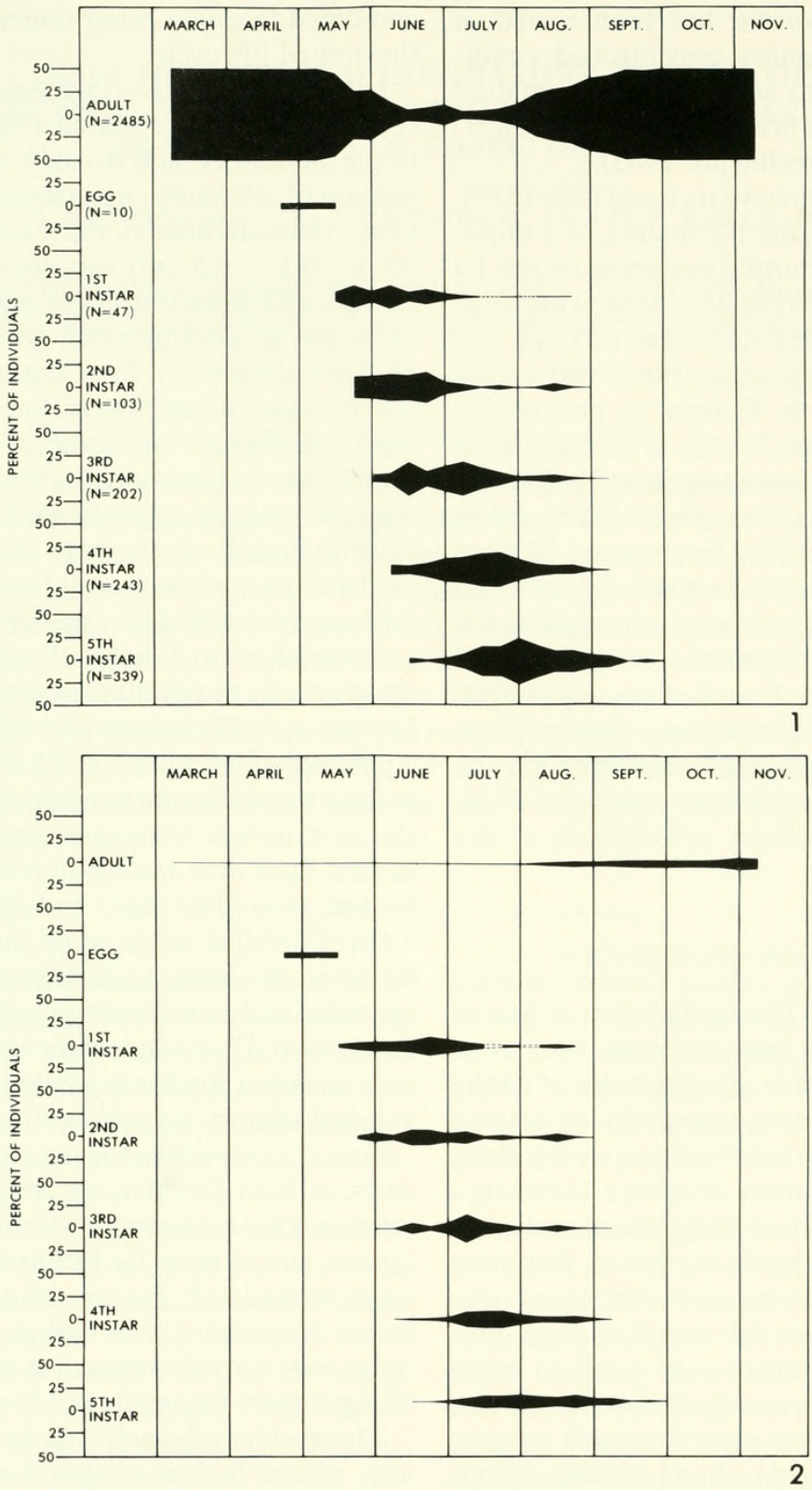
Life history.—The study began in March 1983, before the bugs emerged from overwintering sites that year. Samples of adults and/or nymphs were taken with an aquatic net at ca. weekly intervals at six sites along the edge of the study area into November after all nymphs had disappeared and adult activity had markedly decreased. Sampling during the following two years was conducted similarly. All samples were preserved in 75% ethanol and examined in the laboratory to accurately determine the developmental stages present in each sample. Eggs were collected by hand-picking and returned to the laboratory for incubation to confirm their identity when the first instars emerged. Occasional collections were made also during the winter months to determine overwintering stage(s) and sites. Data gathered during the three years of this study were combined to gain a better understanding of the annual life cycle.

Laboratory rearing.—Eighteen adults were collected during late March 1985, returned to the laboratory, and divided between two aquaria (8, 10 adults; no attempt was made to sex the individuals). Each aquarium (ca. 30 × 20.5 × 15 cm) was covered on the bottom with aquarium gravel and filled with ca. 6 cm of dechlorinated water. *Ceratophyllum demersum* L. (Ceratophyllaceae) was provided as an oviposition site. Adults were maintained on larvae of *Chaoborus americanus* (Johannsen) (Diptera: Chaoboridae). Aquaria were cleaned as the water became fouled, ca. every 20 days.

The *C. demersum* was replaced daily; any sections with attached eggs were removed and placed in petri dishes. Each dish (ca. 9 cm diam, 4 cm depth) was covered on the bottom with filter paper and filled with ca. 1 cm of distilled water, which was sufficient to keep the eggs submerged. Upon hatching, the first instars were also placed in petri dishes. Each dish was again covered on the bottom with filter paper and filled with ca. 1 cm of distilled water, more than sufficient to cover the bugs. Later instars were also provided sufficient water to just keep them submerged. Five first instars were placed in each dish but further separated as they developed through subsequent instars.

One *C. americanus* larva was provided daily as food for first and second instars, increased to two larvae for third and fourth instars, and to three for fifth instars. Dishes were checked daily for exuviae and prey carcasses removed. Clean dishes, paper, and water were provided at each molt; water was changed more frequently if it became fouled.

Three pairs of newly emerged F_1 adults were placed in finger bowls (one male and one female per bowl) to determine if they would reproduce. Each finger bowl (10.5 cm ID, 3.5 cm depth) was filled with 2.5 cm of dechlorinated water, and *C. americanus* larvae and a section of *Elodea canadensis* Michaux (Hydrocharitaceae) were provided



Figs. 1, 2. Field life cycle of *P. femoratus* during 1983–1985 combined seasons in Union Co., Illinois. 1, Percent of individuals in each stage per sample. 2, Percent in each sample of total individuals of same stage collected during season. For both figures, dashed lines between first and last dates for first instar indicate no specimens were found.

as food and an oviposition site, respectively. The finger bowls were cleaned as the water became fouled (ca. every 20 days).

The aquaria, petri dishes, and finger bowls were kept in incubators maintained at ca. 26.7 ± 1.5°C and a 16L:8D photoperiod (ca. 260 ft-c).

Descriptions of immature stages.—First to fifth instars were selected from field samples, eggs from those deposited in the laboratory by field-collected adults; all specimens had been preserved in 75% ethanol. The description of each stage is based on ten individuals. Drawings were made with the aid of a camera lucida, measurements with an ocular micrometer. Dimensions are expressed in mm as $\bar{x}$ ± SE.

Results and Discussion

Life history.—This species overwintered as adults at the bottom of the swamp in mud and detritus and became active in early March (Figs. 1, 2). Eggs (10) were found between late April and mid-May but undoubtedly were laid well beyond this period, based on the late seasonal appearance of first instars. All had been glued singly (i.e. not in clusters) to leaves of *C. demersum* beneath the surface of the water.

The first instars were found from mid-May to the third week of August, second instars from the third week of May to late August, third instars from late May to early September, fourth instars from early June to early September, and fifth instars from mid-June to late September. No active adults were found after November.

This species is apparently univoltine. Our conclusion is based in part on the fluctuations in numbers of the adults and nymphs during the season. Although there was marked overlapping of the various stages and, thus, any particular sample could have any combination of individuals (Fig. 1), weekly plotting of data for each stage showed only one peak for the first, fourth, and fifth instars, and adults (i.e. a buildup of new generation adults); the second and third instars show more fluctuations in seasonal numbers but this may be a reflection of small sample sizes which, by chance, was not apparent with the first instars (Fig. 2).

Table 1. Duration (in days) of each immature stage of *P. femoratus* under controlled laboratory conditions.

Stage	Number Completing Stadium	Range	$\bar{x}$ ± SE	Cumulative Mean Age
Egg	325[a]	11–22	17.7 ± 0.06	17.7
Nymph				
1st instar	206	8–20	10.5 ± 0.11	28.2
2nd instar	174	6–14	9.7 ± 0.12	37.9
3rd instar	156	6–16	11.0 ± 0.13	48.9
4th instar	144	9–24	12.6 ± 0.16	61.5
5th instar	124	16–26	19.5 ± 0.18	81.0

[a] 369 eggs were laid.

Laboratory rearing.—As in the field, eggs were glued singly to the leaves of *C. demersum* beneath the surface of the water. They were white at oviposition but darkened to yellowish with brown markings during maturation. The incubation period averaged 17.7 days (Table 1).

The first instar emerged through a slit in the cephalic end of the egg. It was whitish at this time but soon darkened to its normal color (see description). It usually fed on its first *C. americanus* larva within one day.

The first through fifth stadia averaged 10.5, 9.7, 11.0, 12.6, and 19.5 days, respectively (Table 1). The total developmental period averaged 81.0 days.

F_1 adults maintained in the laboratory for six weeks never reproduced. This further supports our conclusion that this species is univoltine in southern Illinois.

Descriptions of Immature Stages

Egg (Fig. 3).—Length, 1.37 ± 0.01; width, 0.77 ± 0.01. Eggs laid singly and glued to aquatic vegetation, each egg white at oviposition, but turning yellowish with brown markings during maturation; chorion with primarily irregular hexagonal pattern; micropylar plug at cephalic end.

Table 2. Measurements (mm)[a] of *P. femoratus* instars.

	Nymph				
	1st Instar	2nd Instar	3rd Instar	4th Instar	5th Instar
Body length	2.55 ± 0.05	3.39 ± 0.01	4.74 ± 0.05	6.24 ± 0.08	8.17 ± 0.09
Body width[b]	1.58 ± 0.02	2.13 ± 0.03	2.97 ± 0.02	3.93 ± 0.06	5.33 ± 0.05
Width at eyes	0.90 ± 0.01	1.20 ± 0.01	1.56 ± 0.01	2.10 ± 0.02	2.73 ± 0.02
Synthlipsis	0.49 ± 0.02	0.58 ± 0.01	0.85 ± 0.02	0.95 ± 0.03	1.21 ± 0.01
Head length[c]	0.60 ± 0.02	0.66 ± 0.02	0.94 ± 0.02	1.05 ± 0.03	1.14 ± 0.04
Pronotal length[c]	0.25 ± 0.01	0.39 ± 0.01	0.64 ± 0.01	0.93 ± 0.02	1.37 ± 0.02
Mesonotal length[c]	0.20 ± 0.01	0.25 ± 0.01	0.44 ± 0.01	0.70 ± 0.03	1.16 ± 0.03
Metanotal length[c]	0.31 ± 0.00	0.41 ± 0.01	0.60 ± 0.01	0.80 ± 0.02	1.02 ± 0.01
Leg lengths:					
profemur	0.60 ± 0.01	0.78 ± 0.01	1.13 ± 0.01	1.51 ± 0.01	1.93 ± 0.02
protibia	0.34 ± 0.01	0.49 ± 0.01	0.72 ± 0.01	1.01 ± 0.02	1.36 ± 0.01
protarsus	0.21 ± 0.00	0.23 ± 0.01	0.27 ± 0.01	0.28 ± 0.01	0.33 ± 0.01
mesofemur	0.50 ± 0.01	0.69 ± 0.01	1.02 ± 0.01	1.39 ± 0.01	1.81 ± 0.02
mesotibia	0.41 ± 0.01	0.55 ± 0.01	0.83 ± 0.01	1.13 ± 0.02	1.46 ± 0.01
mesotarsus	0.25 ± 0.00	0.32 ± 0.01	0.43 ± 0.01	0.59 ± 0.01	0.76 ± 0.01
metafemur	0.64 ± 0.01	0.89 ± 0.01	1.32 ± 0.01	1.80 ± 0.02	2.33 ± 0.03
metatibia	0.71 ± 0.01	0.95 ± 0.01	1.40 ± 0.02	1.87 ± 0.02	2.49 ± 0.03
metatarsus	0.39 ± 0.01	0.50 ± 0.01	0.68 ± 0.01	0.93 ± 0.01	1.23 ± 0.01

[a] $\bar{x}$ ± SE; SE values rounding off to less than 0.005 listed as 0.00.
[b] Measured across metanotum.
[c] Measured along midline.

Nymphal instars.—The first instar is described in detail, but only major changes that have occurred from previous instars are described for subsequent instars. Length is measured from tip of tylus to tip of abdomen; width across metanotum for 1st–4th instars, across mesonotal wing pads at level of metanotum for 5th. Additional measurements are given in Table 2.

First instar (Fig. 4).—Length, 2.55 ± 0.05; width, 1.58 ± 0.02. Body elongate oval, general appearance dorsoventrally flattened, greatest width at metathorax; dorsally convex; ventrally, flattened to slightly concave laterally, convex medially; brownish with yellowish white markings dorsally, yellowish white with brown markings ventrally.

Head broadly triangular, recessed into prothorax to level of eyes; anterior margin convex, continuous with lateral margins of prothorax; posterior margin arcuate, often subtruncate medially. Dorsally, head yellowish white with posteriorly directed, broad, brown, anchor-shaped mark medially, and thin yellowish line originating near midpoint of inner margin of each eye, both lines continuing posteriorly and converging medially near back of head to form broad V-shaped pattern and giving rise posteriorly to short line that is continuous with middorsal yellow line of thorax. Eyes red, synthlipsis (taken near anterior margin of eyes) ca. 2.5× width of one eye. Antennae yellowish, 3-segmented, segment 2 ca. 2× length of segment 1 and 0.7× length of segment 3. Beak yellowish, broadly triangular, 3-segmented, segment 2 ca. 3× length of segment 1 and ca. 1.5× length of segment 3.

Thoracic nota generally brownish with yellowish or whitish markings, more whitish laterally, these lateral areas usually lacking brown spots. Anterior margin of pronotum concave; posterior margin nearly straight. Mesonotum shortest of thoracic nota, ca. 0.8× length of pronotum along

midline, posterior margin straight medially, arcuate laterally; mesonotal wing pads evident. Metanotum longest of the thoracic nota, ca. 1.6× length of mesonotum along midline; posterior margin nearly straight; ratio of mesonotal wing pad to metanotum along lateral edge ca. 3:4. Metanotum often overlapping abdominal segment 1 and much of 2.

Prothoracic leg raptorial, yellowish, frequently with brownish streak on outer margin of femur. Procoxa ca. 2× length of trochanter and 0.5× length of femur. Profemur flattened laterally, markedly tapering distally, basally ca. 4× width distally; ventrally with 2 contiguous rows of pegs. Protibia and tarsus much narrower than femur, together equal to length of femur ventrally. Tibia with ventral surface forming shallow groove, this groove extending onto tarsus; pegs of femur approximating edge of groove of tibia and tarsus when these segments are apposed; tarsus 1-segmented with single minute claw.

Meso- and metathoracic legs yellowish; all leg segments on metathorax longer than respective segments on mesothorax. Mesocoxa elongate, ca. 2× length of trochanter and 0.8× length of femur. Mesotarsus 2-segmented, segment 1 ca. 0.2× length of 2, the 2 claws of equal length. Metacoxa and trochanter resembling those of mesothoracic leg in shape and relative proportions, fringed with long hairs on outer and inner margins, respectively. Meso- and metatibiae and tarsi furnished with row of swimming hairs on outer surface, most developed on hindlegs.

Abdomen, dorsally, brown with yellowish white markings; ventrally, yellowish white, covered by long hairs and greatly convex in middle ⅓; 7 pairs of spiracles evident but minute, 1st pair more medially placed. Paired ostioles of scent glands present dorsally between segments 3–4.

Second instar (Fig. 5).—Length, 3.39 ± 0.01; width, 2.13 ± 0.03. Body widest at metanotum and 3rd abdominal segment.

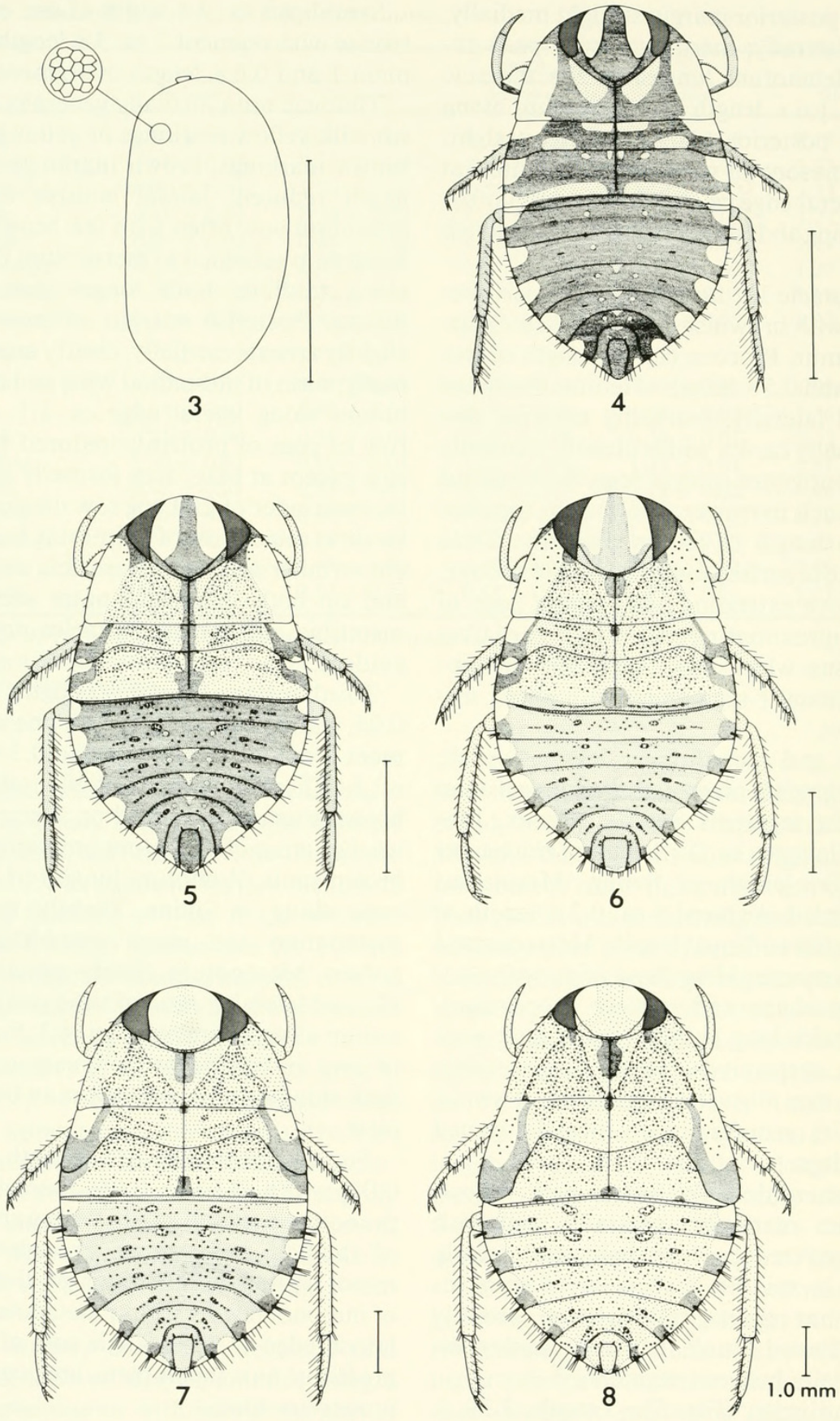
Synthlipsis ca. 2× width of one eye. Antennae with segment 2 ca. 3× length of segment 1 and 0.6× length of segment 3.

Thoracic nota medially generally brownish with yellow markings or yellowish with brown markings, brown markings may be much reduced; lateral whitish areas of pronotum now often with few brown spots. Pronotum subequal to metanotum in length along midline, both longer than mesonotum. Posterior margin of mesonotum slightly arcuate medially, clearly arcuate laterally; ratio of mesonotal wing pad to metanotum along lateral edge ca. 1:1. Double row of pegs of profemur reduced to single row except at base, area formerly occupied by remainder of 2nd peg row now occupied by short setae. Row of swimming hairs present on outer surface of mesotibia and tarsus, and on both inner and outer surfaces of metatibia and tarsus. Spiracles now more evident.

Third instar (Fig. 6).—Length, 4.74 ± 0.05; width, 2.97 ± 0.02. Antenna with segment 2 ca. 2× length of 1 and 0.5× length of 3. Thoracic nota medially often with brown markings reduced or absent; lateral whitish areas of pronotum now with several brown spots. Pronotum longest of thoracic nota along m idline, slightly exceeding metanotum and much exceeding mesonotum. Mesonotum clearly arcuate medially and laterally; ratio of wing pad to metanotum along lateral edge ca. 4:3. Single row of pegs on profemur now surrounded on each side by setae, peg row may be incomplete.

Fourth instar (Fig. 7).—Length, 6.24 ± 0.08; width, 3.93 ± 0.06. Lateral area of pronotum now yellowish. Pronotum longest of thoracic nota, much exceeding either meso- or metanotum along midline. Ratio of mesonotal wing pad to metanotum along lateral edge ca. 2:1. Single row of pegs on profemur now incomplete, area covered by numerous setae.

Fifth instar (Fig. 8).—Length, 8.17 ± 0.09; width, 5.33 ± 0.05. Wing pads of meso-



Figs. 3–8. Immature stages of *P. femoratus*. 3, Egg. 4, First instar. 5, Second instar. 6, Third instar. 7, Fourth instar. 8, Fifth instar.

and metanota (latter present but covered by those of mesonotum) just extending to abdominal segment 3 laterally. Single row of pegs on profemur now almost absent, numerous setae present.

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