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A LIFE HISTORY STUDY OF CAECILIUS AURANTIACUS (HAGEN) (PSOCOPTERA: CAECILIIDAE)

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Caecilius aurantiacus is a common, widely distributed psocid in well established forested areas of North America. Published information on this species is fragmentary and limited primarily to taxonomy. This paper is a description of the habits and biology of this small, little known, but common insect. Of the 212 named species in the genus *Caecilius* (Smithers, 1967), the bionomics of only *Caecilius manteri* have been published.

METHODS

Most specimens used in this study were collected in the timber west of Funks Grove, McLean County, Illinois. A few were collected at Gull Lake Biological Station of Michigan State University at Hickory Corners, Michigan. Dr. Edward Mockford, of Illinois State University, collected a male and returned it alive to Illinois from a collecting trip to Florida.

Collections were made during the months when the trees were leafed out by beating living branches over an inverted umbrella. The undersides of both green leaves and dried leaves on hanging branches were also individually searched. During the spring and fall months, collecting in leaf litter was accomplished by placing the fallen leaves in a leaf litter sieve and beating it over an open umbrella. Both adults and nymphs were collected from the umbrella with a camel hair brush and placed in vials.

Laboratory cultures were kept in three dram vials (19×65 mm) in which food was placed. Each vial was then plugged with cotton. The food consisted of three parts by volume of dried yeast (Red Star Brand) mixed with one part ground guinea pig chow. Other brands of yeast seem to be unpalatable for cultures soon died out when they were used. This is perhaps due to preservatives which were added to the yeast. This mixture was moistened to a thick watery consistency and spread on small strips of paper (about 10×25 mm). Although other types of paper were sometimes used, 16 or 18 pound weight typing paper was most satisfactory. The strips of paper with the food spread on them were changed about every two days. If longer periods of time were used before replacement, mold would tend to become abundant and the cultures would start to die out. A mold inhibitor, 0.5% propionic acid, was mixed in the food to control this problem but the psocids refused to eat the new mixture. Immediately after hatching, special care was taken to see that the food source was in contact with the side of the vial and near the top of the vial. The young nymphs move to the top of the vial and remain there after hatching. If food is not in the area, they soon starve. Small portions of dried maple or oak leaves (about 15×40 mm) were also placed in the vials as a more natural substrate and food source. The vials were kept in a second closed container in which wet paper toweling was present. This maintained a high relative humidity at all times.

In all cases, except those which are indicated otherwise, cultures were kept at room temperature. For controlled temperature environments, cultures were kept in a small styrofoam cooler. The cooler was equipped with a small appliance light bulb for a source of heat and placed in a refrigerator. A maximum-minimum thermometer was used to keep temperature records.

Observations were made by watching the psocids in the culture vials under a stereoscopic dissecting microscope.

DEVELOPMENT

EGG STAGE.—The eggs are oblong with rounded ends and slightly curved sides. The surface is smooth and shiny. When first laid, the eggs are milk white in color but after 24 to 36 hours the dorsal surface becomes bluish gray. The ventral surface and an irregular U-shaped area at the anterior end remain light gray. Width and length were measured for 50 eggs selected at random (Table 1).

Table 1. Length and greatest width of eggs of *Caecilius aurantiacus.*

	No.	Maximum	Minimum	Mean	S.D.
Width	50	0.29	0.19	0.23	0.024
Length	50	0.55	0.40	0.48	0.038

Embryonic development was not observed except to note the appearance of the embryo's eyes four to six days after the eggs were laid. The position of the eyes and body position at the time of hatching indicate that the embryo develops on its back. The embryonic exuviae left with the egg after hatching show the presence of an enveloping embryonic membrane. Hatching usually began in seven days when the eggs were kept at 70°F and in about six days at 75°F.

HATCHING.—The first observable indication of hatching is a slight lengthening and distortion of the anterior end of the egg. The head of the embryo appears to push its way by internal pressures through the egg. The head is pressed against the chorion and vitelline membrane, stretching the chorion until it gradually gives way to the pressure as the head emerges. The chorion does not appear to be cut by the egg burster or to split along a weakened line or ridge.

Fig. 1-2. Oviruptor of *Caecilius aurantiacus.* Fig. 1, dorsal view; Fig. 2, lateral view.

The egg burster (Fig. 1,2) is composed of three rib-like thickenings containing rows of small serrate teeth or spines and is situated above the frons, extending from about the eye level to the posterior border of the clypeus. Wachter (1925) and Pearman (1928) described the cutting of the chorion by the pulsating egg burster. Noting that the development of the egg burster was inside the embryonic membrane, Sommerman (1943a, b, c) believed the chorion and vitelline membrane split along a weakened anterior ridge to form a lid-like opening and the egg burster was used to puncture the embryonic membrane.

Wachter (1925) observed a direct relation between the movements of the egg burster and the accumulation of air in the digestive tract and proposed that the egg burster aided in the swallowing of air. The swallowing of air in *C. aurantiacus* appears to be more closely related to the action of a pulsatory area situated immediately behind the middle of the frons. The movement of air into the digestive tract and the movements of the pulsatory area continue after the egg burster is shed. The relationship between the egg burster and the movement of air is more likely due to the role the pulsatory area plays in the operation of the egg burster. The operation of the egg burster by the pulsatory area was described by Pearman (1928).

Internal pressures created by the swallowing of air and possibly muscular action slowly push the embryo into an erect position over the egg. In the erect position, only a small portion of the abdomen is left in the chorion. With the embryo in the erect

position, the embryonic membrane splits and is worked down over the body freeing the antennae and legs. This process is aided by an arching and backward bending of the body. When the last pair of legs is removed, the body is almost horizontal with the venter up. The legs are waved in the air and the body arched upward until the nymph can grasp the egg shell. By this time the legs are dried and hardened. The nymph pulls the remaining portion of the abdomen from the chorion. Fifteen to 20 minutes are generally required to complete hatching. Following the hatching process, the nymph usually remains quiet for a short time while the abdomen contracts to a normal length.

The embryonic membrane and egg burster are left protruding from the chorion.

NYMPHAL STAGES.—The number of nymphal instars was determined by rearing newly hatched nymphs in isolation. The nymphs of many psocids eat their exuviae after molting, but this is not true of *C. aurantiacus*. The presence of exuviae made it very convenient to count the number of nymphal instars and to determine the duration of nymphal instars. The number of nymphal instars is six. The duration of each instar is indicated in Table 2.

Nymphs are pale yellow in color. There is usually a slight darkening of the body color with the aging of the nymphs. The wing pads of the sixth instar nymph darken a few hours before molting the adult stage. The only other coloration found in the nymphal stage is the darkening of the ocellar triangle in the sixth instar. This pigmented area is also found in the adult. Nymphs collected during the first generation in leaf litter and those collected late in the fall, also in leaf litter, are usually darker and more dull yellow than those collected during the summer months. The dull, darker yellow color generally lightens with later instars when nymphs in early instars are taken in the field and reared in the laboratory.

Recognition of various instars can be accomplished by observing antennal segmentation and wing pad development. The antennae of the first instar are relatively much shorter than those of later instars. First-instar nymphs have eight antennal segments; second-instar nymphs have 12, and those of third instar have 12 distinct segments with the first flagellar segment faintly divided. This division becomes complete at the molt to fourth instar, and all subsequent instars have 13 antennal segments. Measurements of the first flagellar segment (Table 3) reflect its division by showing a reduction in its length immediately following the third instar. Sommerman (1943a) found the first flagellar segment faintly divided in the second nymphal instar of *Caecilius manteri*.

Wing pads do not appear until the third instar. Wing pad size, shape, and position makes each instar readily recognizable. Drawings of each instar of *C. manteri* have been published by Sommerman (1943a). These drawings show close similarity to comparable stages of *C. aurantiacus*.

Table 2. Duration in days of stages in the life cycle of *Caecilius aurantiacus* at 72°F, relative humidity near saturation, and fresh food provided every 48 hours.

Instar number	1st	2nd	3rd	4th	5th	6th	Adult
No. of psocids to reach instar	30	27	27	26	26	26	25
Minimum days to reach instar	—	2	4	6	9	11	14
Maximum days to reach instar	—	4	6	9	12	14	18
Mean No. of days to reach instar	—	2.7	5.2	7.7	10.2	13.0	15.6
Mean stadial length	2.7	2.5	2.5	2.4	2.8	2.6	15

Table 3. Measurements (mm) of indicated structures of laboratory-reared individuals of *Caecilius aurantiacus*. N = 10 in each case.

| | Instar Number | | | | | | |
	1st	2nd	3rd	4th	5th	6th	Adult
Length of 3rd segment of antenna							
Minimum	.06	.09	.13	.09	.15	.23	.38
Maximum	.08	.10	.17	.12	.19	.29	.47
Mean	.07	.10	.14	.11	.17	.26	.42
S.D.	.002	.004	.013	.009	.012	.018	.025
Length of posterior tibia							
Minimum	.14	.20	.26	.34	.41	.61	.77
Maximum	.17	.23	.32	.39	.57	.70	.87
Mean	.15	.21	.29	.36	.48	.65	.84
S.D.	.010	.009	.018	.016	.046	.025	.039
Minimal distance between eyes							
Minimum	.13	.18	.20	.24	.25	.29	.34
Maximum	.15	.20	.26	.26	.32	.35	.41
Mean	.14	.19	.23	.25	.28	.32	.37
S.D.	.007	.008	.016	.009	.020	.021	.017
Length of forewing or forewing-pad							
Minimum	—	—	.08	.19	.36	.70	2.30
Maximum	—	—	.12	.24	.43	.84	2.53
Mean	—	—	.10	.21	.38	.78	2.45
S.D.	—	—	.010	.017	.023	.038	.073
Total body length							
Minimum	.66	.93	1.04	1.32	1.55	1.88	2.07
Maximum	.79	.98	1.32	1.47	1.78	2.24	2.42
Mean	.73	.95	1.15	1.40	1.66	2.10	2.22
S.D.	.040	.018	.057	.046	.072	.115	.108
Number of segments in antenna							
	8	12	12	13	13	13	13

Table 3 contains measurements taken from live nymphs and adults to indicate growth rate and various morphological changes from instar to instar. The size ratio for minimal distance between eyes for adjacent instars varies 1.37 (between first and second) to 1.09 (between third and fourth), thus departing rather markedly from Dyar's rule.

ECDYSIS.—The process of ecdysis was observed in the third, fifth, and sixth instars. Most of the observations closely paralleled those of Pearman (1928).

In her studies of *Caecilius manteri*, Sommerman (1943a) noted that nymphs seem to return to the same general area to molt. Nymphs of *Caecilius aurantiacus* appear to return to about the same location as for previous molts before becoming inactive in preparation for the next molt. This preference of molting sites is probably due only to the availability of suitable sites in the small culture chambers. The period of inactivity before molting varies in duration from only a few minutes to, and one case, over one hour.

The first visible signs of molting are the contractions of the abdomen and the lowering of the head. The contractions occur at the rate of 10 to 20 per minute. The only other observable movement is a periodic movement of the mouth parts. Air bubbles can be seen moving in the abdomen. As molting begins, the abdomen extends, the thorax begins to raise, and the head position lowers. The old cuticle splits along the top of the head and thorax as the thorax is arched upward. The old cuticle is then worked over the head, over the sides of the thorax and down the abdomen. As the head is freed, it is straightened, freeing the antennae and the first two pairs of legs. The hind legs are the last to be freed and appear to be the most difficult to remove. If they are not freed within a short time, they dry in the old cuticle. Nymphs have been seen dragging their exuviae, attached by the hind leg, after ecdysis was completed. This problem is probably more acute in the laboratory where the atmosphere is drier than in nature.

After all the legs and the antennae are freed, the psocid remains suspended by the tip of its abdomen keeping the legs extended. The legs, while suspended, are waved and from time to time seem to vibrate as they are exercised and strengthened. While the legs are drying, the wing pads expand to the length typical of the new instar. Within two or three minutes the insect starts testing the new legs by gradually touching the tarsi to the substrate and lifting them. When the legs are completely dry, all legs are placed on the substrate and the nymph walks out of the remaining exuviae. During all this time air bubbles can be seen moving in the abdomen. About ten minutes are required to complete the entire molting process. The newly molted nymph generally remains rather inactive for several minutes before continuing normal activities.

ADULT STAGE.—The final molt is very much like the five previous molts. Four to five hours before the sixth instar molts the wing pads darken to a yellowish brown. Unlike the expansion of wing pads in earlier molts, the wings are expanded after the adult has completely freed itself from the exuviae. Ten to 15 minutes are needed to expand and straighten the wings to their normal adult length. A newly emerged adult is pale yellow and requires from 24 to 48 hours to acquire full adult coloration. During this time there is a continual darkening of the pale yellow body color until it has reached a bright yellow or in some cases more of a brownish yellow. The adult also acquires several distinct dark brown markings on the head, antennae, thorax, and wing veins during the first 24 hours after ecdysis. These markings have been described by Mockford (1965). The occurrence of the markings follows a definite sequence:

1) The posterior ends of veins R_{2+3}, R_{4+5}, M_1, M_2, M_{3+4}, and Cu_{1a} darken. The darkening of these veins occurs in about three hours.
2) In about five hours, the markings on the dorsal surface of the thorax start to appear. These markings continue to darken for about 48 hours.
3) The anterior margin of the anal region begins to darken in about 12 hours.
4) Head markings start to appear and the antennae start to darken in about 15 hours.

EFFECT OF TEMPERATURE ON COLORATION.—The above sequence is based on observations following the final molt of the psocid kept at a temperature of 70°F. Although timed observations were not made at other temperatures, the darkening appears to be more rapid and intense when the psocid is reared in a cooler environment. When temperatures averaged above 72°F, the body remained much lighter and the only markings to occur were those on the outer margin of the wing. Adults reared in the laboratory at approximately 75°F lack much of the dark coloration characteristic of field-collected specimens and those reared at approximately 70°F. These observations suggest that temperature plays an important role in the production of the body pigments.

The dark markings on the head, thorax and wings are much more prominent in adults collected in the field in early spring and late fall than in summer-collected adults. Similar observations were made on the nymphal states. It was also noted that specimens from Alaska and other northern areas were more darkly pigmented than those from more southern areas.

PARTHENOGENESIS.—The distribution of bisexual and male-less populations of this species was discussed by Mockford (1971). Males occur primarily in the geographically peripheral populations. In Illinois only three males have been found. During five years of
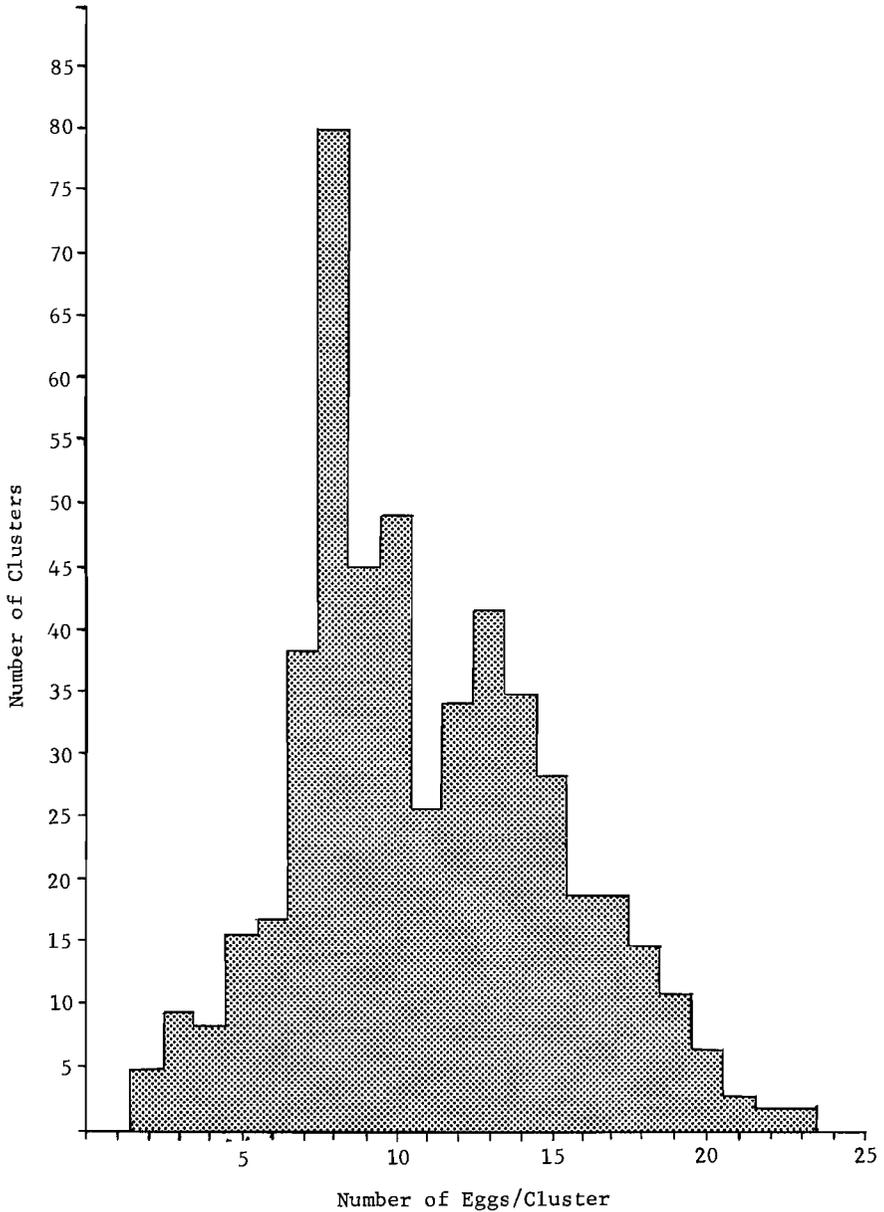
Fig. 3. Graph of distribution of number of eggs per cluster for *Caecilius aurantiacus.*

collecting this species at Funks Grove, Illinois, I have never collected a male. A laboratory strain from Funks Grove has been maintained for 17 generations without the appearance of a male.

On one occasion, a male was collected in Florida by Dr. Edward Mockford and returned to Illinois. When this male was introduced to females in the laboratory culture, the females exhibited a completely negative response to the presence of the male. Females of various ages were placed with the male but always with the same result.

OVIPOSITION.–Egg laying generally begins two to three days after the adult stage is reached. Once a female starts egg laying, one cluster per day is usually laid until her death. During this time 100 or more eggs are usually laid (Table 4). Eggs are laid in clusters with numbers ranging from 2 to 23 per cluster. Although the mean number of eggs per cluster is much higher, eight is the most common number (Fig. 3). The number of ovarioles present in different members of the family Caeciliidae is six, eight, or ten (Wong and Thornton, 1968). My observations of the internal morphology of *C. aurantiacus* showed the ovariole number of this species to be eight. Therefore, more than one mature egg per ovariole must be present at the time of oviposition.

Table 4. Summary of data on duration of adult life, pre-oviposition period, and oviposition for females of *Caecilius aurantiacus* collected in the stages indicated from Funks Grove, Illinois.

	Days lived as adult	No. Days to lay 1st eggs	No. egg clusters	Total No. eggs laid	Av. No. eggs per cluster
Collected as an adult (9)					
High	22	—	17	216	12.8
Low	7	—	5	34	6.5
Mean	16	—	12	119	9.9
S.D.	4.4	—	3.5	59.5	2.48
Collected in the 6th instar (20)					
High	21	5	14	229	17.2
Low	8	2	6	33	6.2
Mean	16	3	11	115	10.5
S.D.	3.5	—	2.8	38.8	3.55
Collected in the 4th and 5th instar (10)					
High	19	3	17	212	16.6
Low	11	1	7	69	8.6
Mean	15	2	11	138	12.5
S.D.	2.9	—	4.4	51.6	2.29

The number of eggs laid and the average number of eggs per cluster seemed to vary with the stage in the life cycle in which the psocid was collected (Table 4). Females collected as adults, during the sixth instar and during the fourth and fifth instars, when brought into the laboratory, averaged 9.9 (adults), 10.5 (sixth instar), and 12.5 (fourth and fifth instars) eggs per cluster. The means obtained from those collected as adults and those collected in the fourth and fifth instars lumped together were compared, using the "t" test. A "t" value of 2.3 (17 d.f.) was obtained, which is significant at the 5% level. The length of time required for these psocids to become adapted to the laboratory environment or the presence of larger quantities of food during development in cultures than in the natural environment could account for these differences.

The eggs are laid in crevices or along the veins on the undersides of leaves. If the leaves are dried and curled, eggs are laid mostly on the inner surfaces. In laboratory cultures, most eggs are laid on dried leaves rather than the paper on which food is placed. On occasion, eggs are laid on the glass surface of the culture vials.

A female about to oviposit walks nervously over a small area on which the eggs will be laid. During this time the abdomen is being contracted and extended in a pumping action probably orienting the eggs into laying position. As the egg starts to emerge, the tip of the abdomen is pressed down, the egg deposited, and then the abdomen raised. Fifteen to 20 minutes are generally required to lay a cluster of eggs. Immediately after the last egg is laid, the process of covering the eggs with webbing begins. The female rapidly moves her head back and forth over the eggs touching the labium to the leaf until the cluster is covered with a dense layer of webbing. The precise origin of the webbing was not observed. Ten to 15 minutes are generally required to cover a cluster. There are seldom more than two or three pauses for rest during the process.

The webs seem to help hold the eggs in place. The webs are firmly attached to the leaf surface, and also adhere to the eggs. With care, a web can be removed intact with eggs stuck to it. The webbing appears to offer little protection from predators. Mites were observed under the webbing and on occasions traces of egg masses were found where predators had stripped away the webbing. Parasitic mymarid wasps were also observed moving through the dense webbing, presumably to oviposit in the psocid eggs.

Laboratory specimens fed primarily yeast many times lack the ability to web eggs. On one occasion, after laying her last egg, a female went through the motions of webbing her eggs for ten minutes without leaving a single strand of silk.

DIAPAUSING EGGS.—Eggs collected in the field in late September and October frequently would not hatch when placed under normal laboratory conditions. These eggs appear to be in winter diapause and will be referred to as diapausing eggs in the following discussion.

On October 12, 1968, a large number of egg clusters were brought into the laboratory. Of these, all eggs hatched in eight clusters including 78 eggs; one egg hatched in each of three clusters including 33 eggs; no eggs hatched in 11 clusters including 106 eggs. The eggs which did not hatch remained normal in appearance.

The production of diapausing eggs by females collected in late September and October varied with the state of development of the female at the time of its capture. Some females captured as adults laid diapausing eggs for the remainder of their lives, while in others only the first cluster or two laid in the laboratory diapaused. Some females reared from nymphs collected in the sixth instar laid diapausing eggs in their first cluster after becoming adult, while their subsequent egg clusters hatched normally. Others laid all normal eggs from the beginning. Females reared from nymphs collected in lower instars never laid diapausing eggs.

Attempts to break this presumed diapause by using various cold temperatures over different time periods were largely unsuccessful. Only a few treated eggs showed sporadic hatching. Experiments designed to produce adults which would lay diapausing eggs, by altering temperatures during rearing to adult stage were also unsuccessful. Attempts to control the photoperiod to which eggs were subjected were not undertaken but the importance of light in the breaking of diapause in eggs seems unlikely since the eggs are normally found overwintering buried in the leaf litter.

BEHAVIOR

WEBBING.—Both nymphs and adults spin very fine strands of webbing which are sparsely spread above the feeding surface. Nymphs in the second instar and possibly the first instar have the ability to spin webs.

Webbing was never observed in the natural environment but was common in laboratory-reared specimens. The large grazing area and low population concentration may account for the lack of visible webbing in the natural environment.

The loose webs appear to serve the purpose of helping to keep the feeding surface clean. Fecal material and dead specimens were common in the webbing. Dead specimens were always young nymphs and probably the result of the individual becoming caught in the webbing and not being able to escape. The webbing is so sparsely spread that it is improbable that it could offer any protection. *C. aurantiacus* appears to lack the ability

to detect vibrations in the web as was observed in *Archipsocus floridanus* by Mockford (1957). All attempts to stimulate a reaction in nymphs by disturbing the web failed.

FLIGHT.—On several occasions in the laboratory and in the field, an adult would try to escape by flying. Although the wings of *C. aurantiacus* are well developed, its flight is rather weak. Very seldom would the psocid fly more than one or two feet before landing.

On no occasion did any individuals appear to be attracted to the lights in the room, although records of psocids being attracted to night lights are common in the literature (Mockford, personal communication). Mockford (1962) observed *Archipsocus frater* flying rapidly around the light of a desk lamp. *C. aurantiacus* males have been collected at night lights in Georgia.

USE OF "ABDOMINAL BLISTERS".—Located on the ventral surface of the abdomen are two expandable swellings, the "abdominal blisters", one between the fifth and sixth and other between the sixth and seventh segments. These structures secrete a moist, probably sticky, substance and can be protruded to come into contact with the substrate. The blisters aid the psocid in holding its position on a leaf when the leaf is moving. The use of these blisters was observed by tapping the side of a culture vial when the psocid was walking upside down on the glass. Each time the vial was tapped, the psocid dipped its abdomen so that it touched the surface. Contact of the blisters on the glass was noted by the moisture on the glass. The presence of the abdominal blisters is common among those psocids whose habitat is green leaves (Mockford, personal communication).

ECOLOGICAL OBSERVATIONS

GENERAL RANGE AND HABITAT.—*Caecilius aurantiacus* is found throughout the eastern half of the United States, across Canada to the Pacific Coast, along the coast from Oregon to southern Alaska, in eastern Mexico and the highlands of southern Mexico (Mockford, 1965).

This psocid can be collected on the foliage of broad-leaved trees and shrubs in well established wooded areas. It is most common on green leaves of Sugar Maple (*Acer saccharum* Marsh), Pawpaw (*Asimina triloba* Dunal), and Oak (*Querus* spp.). It can also be found on dried leaves. The first generation lives in the ground leaf litter.

ECOLOGICAL RELATIONSHIP TO OTHER PSOCIDS.—Two other species of psocid, *Caecilius sommermanae* Mockford, and *Polypsocus corruptus* (Hagen), have been collected feeding on the same leaves as *C. aurantiacus*. The life cycles of these three species seem to parallel each other and they appear to feed on the same material. Although a detailed study of the ecological relationships of these species is not available at this time, they appear to occupy the same ecological niche. Observations contrary to this idea have been made but whether these species avoid inter-specific competition is questionable. *C. aurantiacus* and *P. corruptus* lay eggs in clusters with webbing over the eggs. *C. sommermanae* lays eggs singly and with no webbing. The webbing covering the eggs of *C. aurantiacus* completely covers the eggs while the eggs of *P. corruptus* are only loosely covered by webbing. *C. sommermanae* is much more active than the other two species. *P. corruptus* is generally more gregarious than the others. *C. aurantiacus* is parthenogenic, while males are present in both *P. corruptus* and *C. sommermanae*.

LIFE CYCLE.—*Caecilius aurantiacus* can be collected in adult or nymphal stages in central Illinois between May 1 and November 1. The first generation hatches and matures in the ground leaf litter. When the adult stage of the first generation is reached in mid- to late May, the trees are fully leafed and the adults migrate from the ground leaf litter to the green leaves in the trees or to dried leaves on broken, hanging branches. All summer and early autumn generations are on the foliage. The insects fall to the ground with the leaves in late autumn. The latest date that these psocids can be collected is determined by the first hard freeze or snow fall. The latest collection dates at Funks Grove, Illinois, were November 10, 1964 (fourth and fifth-instar nymps and adults) and November 8, 1965 (adults—none found on November 14). On November 21, 1966, numerous frozen adults in good state of preservation were found following a snow fall the night before.

Table 5. Two years' collecting data for *Caecilius aurantiacus* at Funks Grove, Illinois, indicating probable generations.

1964		Generation No.	1965	
Date	Stages		Date	Stages
		1	May 8	2nd & 3rd instars
			May 16	5th & 6th instars
			May 22	Adults
		2	June 5	Eggs
			June 10	2nd instars
			June 16	3rd, 4th, & 5th instars
			June 24	6th instars
			July 5	Adults, eggs
		3	July 27	5th & 6th instars
Aug. 11	5th & 6th instars	4	Aug. 13	3rd instars
Aug. 17	4th, 5th, & 6th instars			
Aug. 19	5th & 6th instars and adults			
Aug. 26	Same			
Sept. 12	6th instar & adults			
		5	Oct. 2	All stages
Oct. 3	Adults			
Nov. 8	Adults			
Nov. 10	Adults			

Collecting data (Table 5) indicate four distinct generations and a probable fifth during one season in central Illinois. The length of a generation in nature is apparently greater than for specimens reared in the laboratory. The second generation at Funks Grove, Illinois, in 1965 required between 37 and 41 days, while an average laboratory generation at 72°F requires 25 days. Seven generations can be reared in the laboratory during the growing season for this species in central Illinois.

FOOD.—The digestive tracts of several adults were removed and squashed between a microscope slide and cover slip for microscopic observation of materials eaten. The gut samples consisted primarily of fungal hyphae, fungal spores, and particles believed to be fragments of leaf epidermal cells.

PARASITES AND PREDATORS.—Two types of parasites infect psocids. The first of these is represented by several species of tiny mymarid wasps of the genus *Alaptus* which parasitize the eggs. *Alaptus caecilii* Girault, has been observed emerging from the eggs of *Caecilius aurantiacus* on numerous occasions (Sommerman, 1943a, b). On several occasions *C. aurantiacus* eggs collected at Funks Grove, Illinois and Gull Lake, Michigan hatched as *A. caecilii* instead of the expected psocid. On one occasion, newly emerged wasps were observed ovipositing in *C. aurantiacus* eggs laid in the laboratory. Broadhead and Wapshere (1966) have made a comprehensive study of psocid populations and the effects of mymarid wasps.

The second type of parasite is a hymenopterous larva which feeds on psocid nymphs and adults. The larva lives in the abdomen of the psocid. It emerges from the abdomen to spin its cocoon and the psocid dies. Although this parasite is not known in *C. aurantiacus,* Sommerman (1956) observed the larvae in nymphs of *C. sommermanae* Mockford. These larvae were believed to be braconid wasps.

Literature on the arthropod predators of psocids was reviewed by Broadhead (1958). Betts (1955) observed predation on psocids by titmice. The only predator which I have seen in the field feeding on *C. aurantiacus* was a crab spider (Thomisidae). Mites are very common on the leaves with the psocid. Many times the mites would become so abundant in the laboratory cultures that the psocid population would die out. These mites probably affected the psocid population more as competitors than as predators although mites and mite eggs were observed under the webbing of the psocid egg clusters.

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