In Vitro Colonization of the Goat Biting Lice, *Bovicola crassipes* and *B. limbata*[1,2]

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ABSTRACT

Bovicola crassipes (Redow) and *B. limbata* (Gervais) (Mallophaga: Trichodectidae) were colonized in vitro by utilizing scrapings from goatskin as food. The lice were held throughout their life cycles in 0.5- and 1-dr glass shell vials. At 72% RH and 35±1.5°C, a generation of *B. crassipes* developed in an average 36.7 days; an average 94% of the eggs hatched, and an average 65.6% developed to adults. At 76% RH and 35±1.5°C, a generation of *B. limbata* developed in an average 32.2 days; an average 84% of the eggs hatched, and an average 67.0% developed to adults.

During biological and bionomic studies of Mallophaga, researchers have been able to maintain several species apart from the host animal for short periods (Martin 1934; Wilson 1934, 1939; Matthysse 1946; Scott 1952; White 1962[3]; Stockdale and Raun 1965); however, none apparently has been able to establish colonies apart from a host animal.

Bovicola crassipes (Redow) and *B. limbata* (Gervais) are parasites of goats of the Angora type. Peterson and Bushland (1957) reported that these biting lice live on the surface of the skin and feed on scales, bits of hair, and other debris of the skin surface. Heavy infestations cause severe discomfort to the host and may result in loss of weight, low vitality, and a reduction in the growth of mohair. Also, the quality of the mohair is reduced by the matting of the hair caused by the oviposition of the lice, and considerable loss of hair and a rough hair coat result when the host bites or scratches because of the discomfort.

Scott (1952) reared more than 100 specimens of *Bovicola ovis* (L.) (referred to by Scott as *Damalinia ovis* (L.)) on a mixture of sheep scurf and yeast, and White (1962[3]) reared small numbers of *B. limbata* in shell vials in the laboratory on a diet of goat's hair, scale, and yeast. Also, we had observed that goat lice, held in glass shell vials, fed on scales scraped from goatskin. The methods of these researchers and our observations were therefore used in an attempt to rear goat biting lice. The present paper describes techniques that were used successfully to colonize *B. crassipes* and *B. limbata* apart from the host. The work was done at the Kerrville, Texas Livestock Insects Laboratory, which is located in the center of a goat-producing area where Angora goats carry year-round infestations of lice.

MATERIALS AND METHODS

Food was prepared by cutting 20×20-cm sections from a fresh, closely sheared Angora goatskin, placing them flesh side down on glass plates, and freezing them. Then the flaky outer portion of the frozen skin was scraped off with a sharp knife, the scrapings were dried at 35°C for 24 hr, and the fragments were cut into particles small enough to pass through a 14×18-mesh screen. For long-term storage, the screened material was placed in moistureproof containers at −5°C; however, sufficient food for the colonies for 2–3 weeks could be removed from the frozen stock and held at 5–8°C.

The lice used to start the colonies were obtained by clipping mohair from infested Angora goats and separating the lice from the hair. A 24.5-cm-diam glass funnel was clamped in an upright position, a circular piece of ½-in.-mesh hardware cloth cut to fit was placed in it 2.5 cm below the top, and a sample of loosely packed infested mohair about 2.5 cm thick was placed on the cloth. When a 250-w reflecting infrared heat lamp was placed 66 cm above this mohair and moved closer in 4 15-cm steps every 5–10 min, the lice were driven from the hair. Since neither species can cling to a glass surface, all lice falling on the slanted sides of the funnel dropped through the funnel into a beaker placed beneath it. (Lice in good condition were collected from samples as much as 48 hr old; thus, enough food must remain in sheared mohair to sustain the lice for some time.) The nymphs and adults were separated, the nymphs were discarded, the adults were separated by species, and placed in glass shell vials (0.5 dr for <50 and 1 dr for 50–200 lice). Food was placed in the vials at the rate of 175 mg/100 lice. These vials were placed in 30- and 50-ml glass beakers which, in turn, were placed in round polystyrene containers (12-cm diam at top, 11-cm diam at bottom, and 14 cm tall) that had tight-fitting lids. A 95×35-mm polystyrene petri dish with holes in the bottom was inverted and placed in each container to make a platform on which to set the beakers.

Tests of egg hatchability and the results of several trial runs caused us to select 72% constant RH and a temperature of 35±1.5°C for the rearing of *B. crassipes* and 76% RH and 35±1.5°C for the rearing of *B. limbata*. The necessary humidities were maintained by placing about 100 ml of saturated aqueous solutions of either $NaClO_3$ (for 72% RH) or NH_4Cl (for 76% RH) in the polystyrene containers; the temperature was maintained by placing the containers in a constant-temperature cabinet. Although the lice

[1] Mallophaga: Trichodectidae. Identification of the species was confirmed by K. C. Emerson of 2704 North Kensington, Arlington, Va. 22200.

[2] Accepted for publication Nov. 18, 1968.

[3] H. W. White. 1962. The life cycles of *Damalinia limbata* (Gervais), order Mallophaga, and *Linognathus stenopsis* (Burmeister), order Anoplura. Unpublished M.S. thesis. Texas A&M University, College Station. 30 p.

were fed, handled, and studied outside the controlled environment, care was taken that the eggs were never exposed to temperatures below 27°C. The photoperiodic regimen consisted of ca. 15 hr of dark, 8 hr of dim light, and 1 hr of room light daily.

Adults were maintained in the vials at a ratio of 1 ♂:3 ♀. Parthenogenesis, demonstrated by Matthysse (1946) with *Bovicola bovis* (L.), was not observed in our studies (unpublished data) involving more than 100 ♀ of each species.

Since the lice in nature cement their eggs to mohair on the host animal, several unwashed goat hairs 4–8 cm long were made into loose coils and placed in the vials. Also, we made sure that portions of the mohair coils were covered with food because the lice in vials appeared to prefer to oviposit below the surface of the food. Eggs were collected every 1–4 days. Both species laid eggs singly. Female *B. crassipes* usually cemented each egg to 2 or 3 gathered hairs and oviposited almost exclusively on the mohair; female *B. limbata* usually cemented eggs to single hairs only, though as many as 50% of the eggs in some collections of *B. limbata* were not attached. To collect the eggs or to perform any of the other operations connected with the rearing (counting the lice or changing the food), we emptied the contents of a vial onto a piece of thin polyethylene film with a smooth surface that prevented the lice from clinging when we moved them, picked them up with forceps, or returned them to a vial. After the contents of a vial containing eggs were emptied onto this film, the hairs bearing the eggs were set aside, and the food was either changed or returned to the vial with fresh mohair loops and the lice. The eggs on the pieces of mohair were then counted and placed in new vials (0.5 dr for <50 and 1 dr for 50–200 eggs) to incubate after the loops bearing the eggs were cut into short lengths so emerging nymphs would have other hair or food particles to grasp. Food was added at the same time (35 mg/100 eggs) or when hatching began. Also, after 22 days (9 days for the eggs to hatch and 13 days for nymphal growth), a new vial and fresh food (140 mg/100 *B. crassipes* and 70 mg/100 *B. limbata*) were supplied. If ample food was provided, cultures could be reared successfully without making this change, but we normally provided a new container and fresh food at 22 days to minimize possible exposure to disease organisms. (At this time, the oldest *B. crassipes* were within 4 days of adulthood and the oldest *B. limbata* were within 1 day.) After the change, the vials were checked periodically for the presence of adults, and adults needed for experiments or for maintenance of the colonies were removed, handled, and fed the same as the original collections.

RESULTS AND DISCUSSION

Food prepared as described and stored below 0°C for as long as 5 months proved satisfactory. Also, adult lice provided with food that had been stored for 56 days at 5–8°C survived as well as those given freshly prepared food, and the females laid as many eggs. A skin from a 27–32-kg goat yielded 18–22 g of louse food.

Female *B. crassipes* 4–15 days old laid an average 1.16 eggs/day, and female *B. limbata* of the same ages laid an average 0.8 egg/day. Egg production by both species declined after the females were 15 or 16 days old. Average hatchability of undamaged eggs of *B. crassipes* was 94%, and 65.7% of the undamaged eggs developed to adults; however, as many as 25% of some collections were ruined by chorion punctures that appeared to have been made by the lice themselves. For *B. limbata,* the average egg hatchability was 84%, and 67% of the eggs collected developed to adults. The ratio of male to female adults was 1:1.2 for *B. crassipes* and 1:1.7 for *B. limbata.*

Our present colonies have now been maintained for more than 12 months without adding lice from outside sources. The original collection of *B. crassipes* consisted of 112 ♂ and 272 ♀; the original collection of *B. limbata* consisted of 82 ♂ and 207 ♀. The 1st 7 months after the colonies were established was a period of experimentation, and a variety of humidities, temperatures, and diets were tried. When rearing techniques were standardized during the 7th month of the study, the colony of *B. crassipes* consisted of 14 ♂, 17 ♀, 165 nymphs, and 100 eggs, and the colony of *B. limbata* contained 35 ♂, 80 ♀, about 230 nymphs, and 154 eggs. Two months later, we reached a level of production of more than 200 eggs/week of each species, and at present we maintain a stock of more than 100 ♀ of egg-laying age of each species. Since the rearing process is continuous, the generations overlap; however, on the basis of 36.7 days for a generation of *B. crassipes* and 32.2 days for a generation of *B. limbata,* the colonies now contain representatives of the 10th and 11th generations, respectively. Table 1 shows the time required for development of the stages in the life cycles of *B. crassipes* and *B. limbata* reared by our methods.

Table 1.—Life cycles of *B. crassipes* and *B. limbata* reared apart from the host animal.

Stage	No. days required for development	
	Range	Avg
	B. crassipes	
Egg	9–11	10.1
1st instar	6–11[a]	7.6
2nd instar	5–9	6.7
3rd instar, ♂	6–9	7.5
3rd instar, ♀	6–10	8.2
Preoviposition	3.5–5.5	4.1
Adult lifespan, ♂	10–42	21.8
Adult lifespan, ♀	8–43	19.5
	B. limbata	
Egg	9–12	9.8
1st instar	5–9	6.1
2nd instar	4–9	5.3
3rd instar, ♂	5–12	6.3
3rd instar, ♀	5–9	6.6
Preoviposition	3.5–7.5	4.4
Adult lifespan, ♂	9–41	21.0
Adult lifespan, ♀	5–53	18.8

[a] A small percentage of *B. crassipes* showed arrested development in the 1st instar. These nymphs, usually whitish, turned dark on the 3rd or 4th day, and the molt to the 2nd instar was delayed 9–53 days.

Thus, goat-biting lice fed a diet prepared from goatskin can be reared apart from the host animal. Moreover, the data suggest that any surface-feeding species of lice could be colonized apart from the host if it were fed a diet properly prepared from the host's integument.

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