

## A Redescription of *Siphonisca aerodromia* Needham (Ephemeroptera : Siphonuridae)

by

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The species *Siphonisca aerodromia* Needham is redescribed and illustrated from Maine, U. S. A. specimens. Scanning electron micrographs of the nymphal cuticle showing thoracic sternal projections, sternal setae, and eggs are presented. The similarity of primary diagnostic characters are discussed in relation to *Heterocloeon bernerii* (Müller-Liebenau).

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### INTRODUCTION

Needham (1908) established the genus *Siphonisca* for *S. aerodromia*, which he described from a single female imago collected by C. P. Alexander from Sacandaga Park, New York. Edmunds et al. (1976) presented the personal account of C. P. Alexander's first encounter with the species. Clemens (1915) provided the first description of the nymph of *S. aerodromia* from specimens collected by C. P. Alexander. In addition, Clemens included some of Alexander's field notes on the ecology of the species. Later descriptions, illustrations, and discussions of *S. aerodromia* by Needham et al. (1935), Burks (1953), Edmunds et al. (1963), Koss (1974), and Edmunds et al. (1976) were all made from specimens collected by C. P. Alexander or G. C. Crampton from the type locality. No other location for the species was known until Fiance (1978) reported finding a specimen in the Cornell University Collection labeled "Lake Melville, LABRADOR. July 10, 1952, W. Z. Lidicker". Precisely where the specimen came from is unknown because it was collected from a boat one mile from shore. Gibbs (1980) later reported collecting *S. aerodromia* from three sites in central and eastern Maine and Gibbs and Mingo (1985) gave information on the life history and feeding behavior of the species in Maine. The discovery of *Siphonisca* in Maine extends the known range of the species and provides the first opportunity since the 1930's to study living specimens of this species. In this paper *Siphonisca aerodromia* Needham is redescribed and illustrated from Maine specimens. Scanning electron micrographs of the nymphal cuticle showing the thoracic sternal projections, associated sternal setae, the ventral setae of the thoracic legs, and the surface structure of eggs are presented. The similarity of the primary diagnostic characters are discussed in relation to *Heterocloeon bernerii* (Müller-Liebenau).

## METHODS

All specimens of *S. aerodromia* used for this study were collected as nymphs from Tomah Stream south of Rt-6 in Washington County, Maine. A detailed description of the collection site is provided by Gibbs and Mingo (1985). Nymphs were collected from the flooded *Carex* marsh adjacent to the stream and transported to the laboratory for rearing. Nymphs were reared in six inch circular glass culture dishes with aerators within screened enclosures. A rock was placed in the center of each dish for the nymphs to crawl up on before the emergence of the subimago. *Carex* leaves from the marsh were also added to each dish and these were used by the developing predaceous nymphs as resting sites from which they attacked prey. Dishes were frequently stocked with *Siphonurus* nymphs on which the *S. aerodromia* nymphs fed. Only three *S. aerodromia* nymphs were placed in each dish. Subimagines were removed from the rearing dishes and placed in separate boxes to complete their development. The nymphal and subimaginal skins were preserved with each imago. All specimens were preserved in Kahle's fluid and then transferred to 80% ethanol.

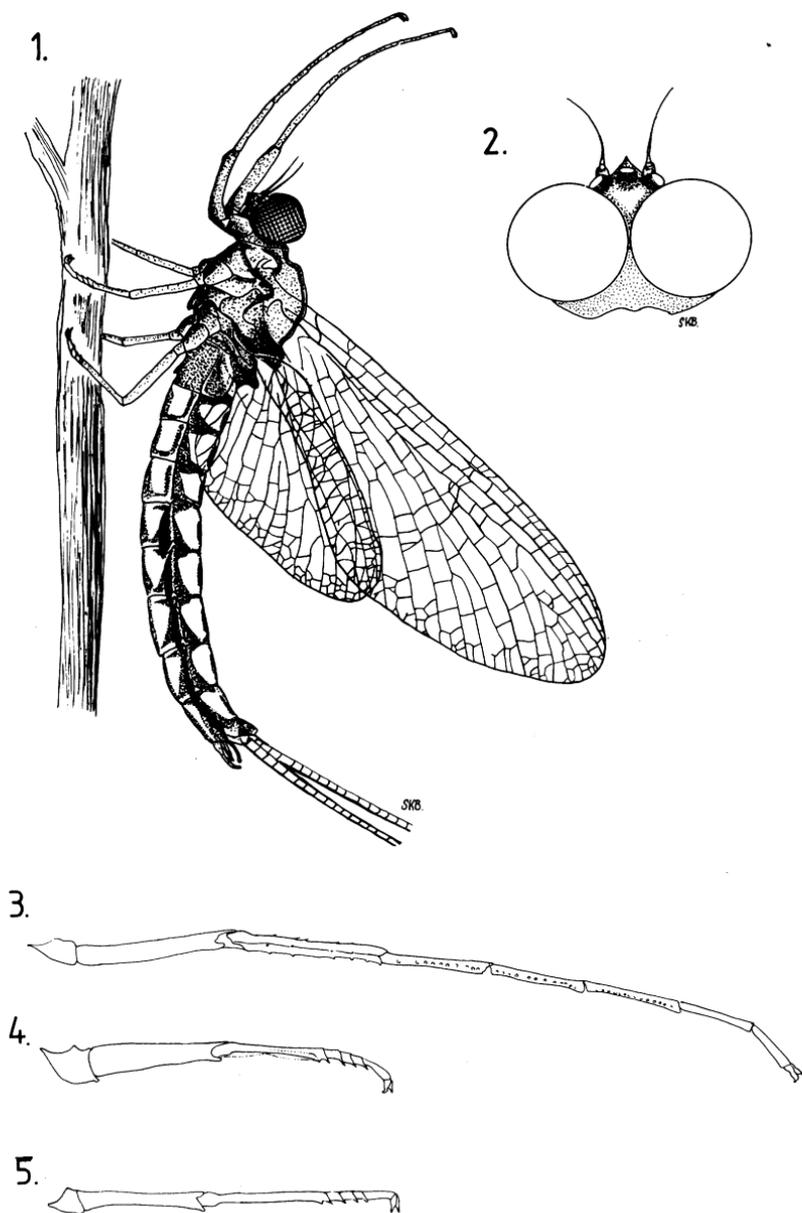
Structures prepared for SEM were dissected in 100% ethanol and the thoraces were cleaned using a technique modified from Dyer et al. (1982), using their 30 minute concentrated protease treatment. The acetone final washing procedure was omitted and structures were taken directly from 100% ethanol to the critical point drier. Dried specimens were attached to stubs with double sided tape and coated with 400 Å of gold in a sputter coater (eggs were coated with 250 Å). Specimens were examined in an AMR-1000 scanning electron microscope operating at an accelerating voltage of 5 Kv. Photographs of eggs and other structures were taken using Polaroid® 655 film.

Ten specimens of each life stage (i.e. nymphs with dark wing pads, subimagines, and adults) were measured. All measurements were made using a calibrated ocular micrometer and given to the nearest 0.1 mm and reported as a range. The relative length of each segment of the foreleg of the male imago was compared to the length of the prothoracic tibiae, which is given in parentheses. Width measurements of abdominal segments were made from the outer edges of the posterior lateral projections or flanges. All specimens examined were deposited in the insect collection of the Department of Entomology, University of Maine, Orono, Maine 04469.

#### *Siphonisca aerodromia* Needham (figures 1 - 28)

*Siphonisca aerodromia* Needham, 1908: 72; Clemens, 1915: 254; Needham, Traver, and Hsu, 1935: 501; Burks, 1953: 99; Edmunds, Jensen, and Berner, 1976: 136; Fiance, 1978: 208; Gibbs, 1980: 167; Unzicker and Carlson, 1982: 3.82.

*Male Imago* (in alcohol) as in Fig. 1, length 15.0 - 18.0 mm; forewings 15.0 - 15.5 mm; hindwings 7.4 - 7.7 mm; caudal filaments 19.5 - 20.0 mm.



Figs. 1-5. Male imago of *Siphlonisca aerodromia*: 1 - lateral view of male imago; 2 - dorsal view of head showing eyes and ocelli; 3 - prothoracic leg; 4 - mesothoracic leg; 5 - metathoracic leg.

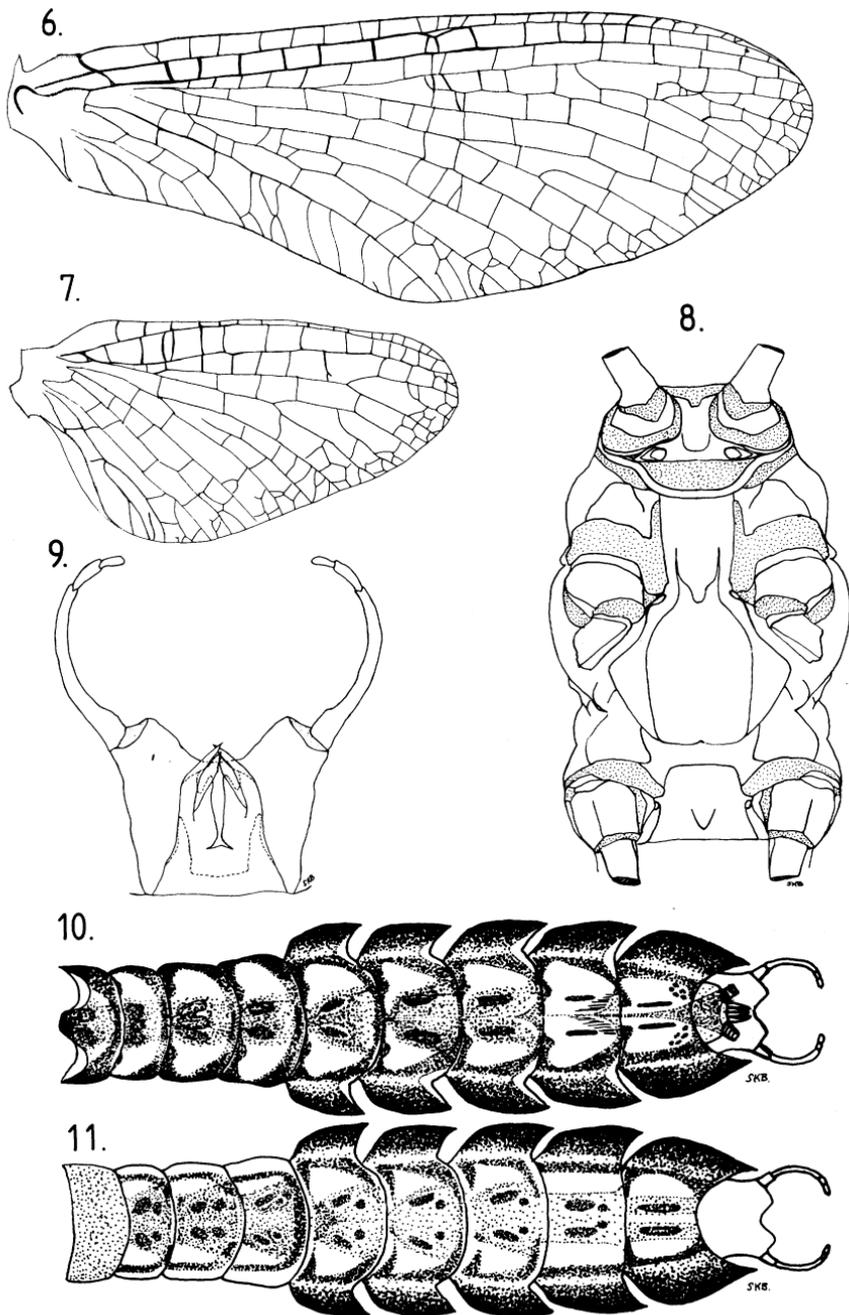
Head: Eyes contiguous dorsally (Fig. 2), head light-brown, darker around bases of the eyes. Bases of ocelli dark brown, almost black. Antennae pale and as long as head. Frontal shelf with a brown band below antennal sockets.

Thorax: Pronotum dark brown, anterior lateral margins lighter. Mesonotum light caramel brown with two lighter colored longitudinal lines present on either side of the median notal sulcus. Lateral margins of prescutum anterior to bases of forewings cream colored. Lateral areas of mesonotum between parapsidal suture and mesoscutellum shaded with reddish-brown. Dorsal and lateral areas of mesoscutellum dark brown almost black. Metanotum mostly dark brown, dorsal and lateral areas of metascutellum dark brown almost black. Thoracic sterna as in Fig. 8; prosternum dark brown, limits of heavily sclerotized cuticle well defined, basisternum arched upward to form a transverse ridge. Large furcal pits evident below prothoracic coxal cavities. Mesobasisternum dark reddish brown with a distinct posteriorly pointing spine (Fig. 8). Mesofurcaster-num large and convex, shading similar to basisternum, limits of heavily sclerotized cuticle less distinct (seeming to follow color gradation with darker areas heavily sclerotized and lighter areas less sclerotized or membranous). Metabasi-sternum also with a distinct spine, although shorter and more robust than mesosternal spine. Pleural sclerites dark brown, membranous areas white.

Legs: Ratio of segments of prothoracic legs, 1.01: 1.00 (2.98 mm): 0.63: 0.53: 0.56: 0.48: 0.32; claws paired with similar apical hooks. Prothoracic legs mostly brown, dorsa of femora pale. Rounded knobs and spines present on dorsa and sides of tibiae and tarsi (Fig. 3). Trochanters dark brown ventrally and laterally, pale dorsally. Coxae light brown, ventral apical margin with a thin dark brown line. Meso- and metathoracic legs pale, joints brown, dorsa of femora and tarsi brown. Meso- and metatrochanters pale. Coxae pale dorsally, dark brown ventrally and laterally.

Wings: Forewings as in Fig. 6, membrane between C, Sc, and  $R_1$  clouded from apical angle to bullae. C, Sc,  $R_1$ , and  $MA_1$  dark brown proximally, becoming lighter toward outer margin. Remaining longitudinal veins and crossveins mostly light brown. Hindwings as in Fig. 7, no distinct costal projection, costa and subcosta dark brown proximally becoming lighter distally. Membrane of discal part of forewings and hindwings slightly tinged with amber.

Abdomen: Abdominal segment 3: 1.8 - 2.2 mm wide, segment 5: 3.2 - 3.8 mm wide. Segments 5 - 9 with large lateral projections (resembling short airplane wings). Terga as in Fig. 10; dark brown triangular shaped slashes bracket the dorsum of each tergite forming trapezoid shaped pale areas with a pair of submedian longitudinal spots. Spots on segments 1-3 less distinct, merging with light brown medial background shading. Spots on segments 4-10 more distinct, especially on segments 6, 7, 8, and 9. Light brown medial shading becoming refined into a single medial line on segments 8 and 9. Spots on segment 10 diverging as diagonal streaks. Sterna as in Fig. 11; sterna pale brown or cream colored with a pair of dark lateral longitudinal stripes that run the length of each sternum. Two pairs of distinct submedian spots on most sterna,



Figs. 6-11. Male imago of *Siphonisca aerodromia*: 6 - forewing; 7 - hindwing; 8 - ventral view of thoracic sternite; 9 - dorsal view of genitalia; 10 - dorsal view of abdomen; 11 - ventral view of abdomen.

sometimes spots enveloped in a medial reddish-brown triangle with its base along posterior margin of each sternum. Only one pair of spots present on 9th sternum. Subgenital plate, forceps, and penes as in Fig. 9; genital forceps with three segments, segment 1 gray-brown, segment 2 slightly lighter color than segment 1, and segment 3 hyaline. Penes well sclerotized mostly brown. Outermost pair of projections with acute apices, next inner pair with a gray-brown band near middle and transparent acute apices, central pair of projections brown with blunt apices. Two accessory appendages ventrally at base of penes. Caudal filaments white, median terminal filament rudimentary.

*Female Imago* (in alcohol) length 16.0 - 19.0 mm; forewings 15.0 - 16.1 mm; hindwings 7.6 - 8.8 mm; caudal filaments 13.2 - 16.4 mm.

Head: Pale brown with dark brown u-shaped marks laterally. Bases of ocelli dark brown, almost black. Antennae as long as head, scapes brown, flagella pale. Frontal shelf dark brown below antennal sockets.

Thorax: Pronotum pale with lateral u-shaped brown marks. Mesonotum generally lighter than male imago, two brown submedian longitudinal lines present on either side of median notal sulcus, a submedian brown spot present on either side of median notal sulcus near the posterior margin of mesoscutum. Mesoscutellum dark brown almost black. Metanotum similar in color to mesoscutellum. Prosternum, mesosternum, and metasternum as in male imago, except slightly lighter in color. Limits of sclerotization indistinct. Pleuron lightly sclerotized, mostly membranous. Meso- and metepisternum and epimeron pale brown, subalars and basalars dark brown and heavily sclerotized.

Legs: Pale yellow, prothoracic femora brown ventrally. Apices of each tarsal segment brown. Claws as in male imago. Dorsa of forecoxae white, weakly sclerotized. Meso- and metathoracic coxae brown, heavily sclerotized.

Wings: Vein pattern and color as in male imago.

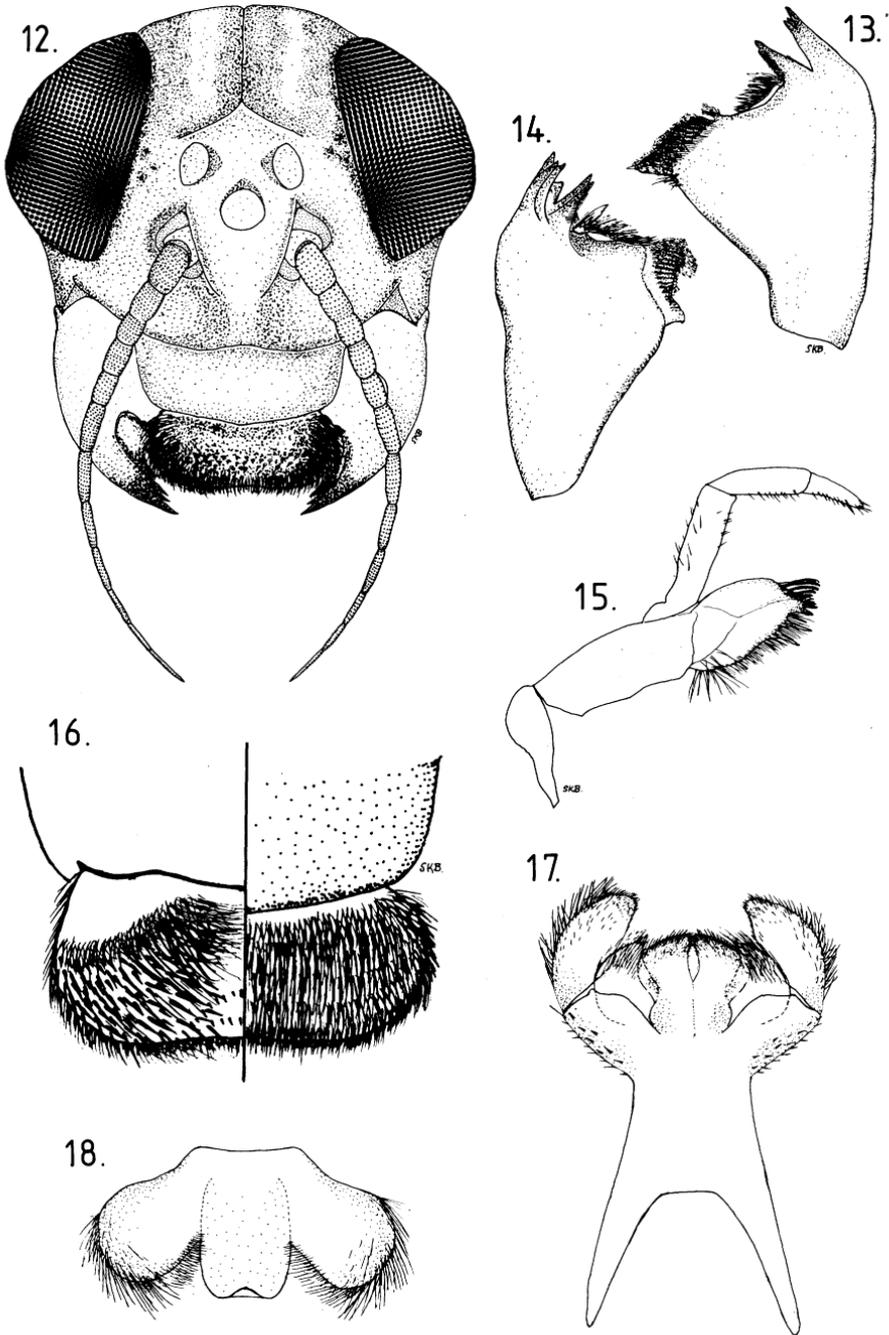
Abdomen: Abdominal segment 3: 1.9 - 2.3 mm wide, segment 5: 3.1 - 3.4 mm wide. Expanded lateral extensions present on segments 5 - 9 as in male imago. Maculation of terga and sterna as in male imago (Fig. 10 & 11), except paired submedian spots on sterna more distinct because median brown shading tends to be lighter than in male imago.

*Subimago* (in alcohol) similar to the imago in body size, morphology, and color. Membrane of both wings typically clouded, crossveins margined with brown throughout discal part of wings.

*Eggs* (in alcohol) are subspherical with a mean width of 0.34 mm and a mean length of 0.46 mm. The surface structure as in Fig. 28, attachment structures are composed of coils in a uniform layer over the entire surface of egg. Further details on the structure of the egg and activity of the anchor coils are provided by Koss (1974) and Gibbs and Mingos (1985).

*Nymph* (with dark wing pads in alcohol) as in Fig. 19, length 15.3 - 19.0 mm; caudal filaments 6.0 - 8.7 mm.

Head: Hypognathous, brown with slight mottling on vertex, frons slightly elevated between antennal sockets. Antennae pale and shorter than twice the



Figs. 12-18. Mature nymph of *Siphonisca aerodromia*: 12 - frontal view of head; 13 - right mandible; 14 - left mandible; 15 - maxillae with maxillary palp; 16 - labrum with dorsal view to right; 17 - labium with glossa and paraglossa; 18 - superlingua.

width of head (Fig. 12). Mouthparts (Fig. 13 - 18): dorsal setae of labrum as in Fig. 16, submedial and medial areas of stout setae ventrally (Fig. 16). Mandibles as in Fig. 13 and 14, row of fine setae along inner edge of incisor adjacent to prosthema, molars of both mandibles with a brush of fine setae and most distinctive on the left mandible. Maxillae as in Fig. 15, apex bifid, two large subapical spines present on inner margin among two or three rows of fine setae, outer subapical margin with 11 - 12 stout setae with bluntly serrate edges, segment 2 of palpi 5/6 as long as segment 1, segment 3 of palpi 2/3 as long as segment 2. Superlingua as in Fig. 18. Labium as in Fig. 17, labial palpi well developed, glossae ventral to paraglossae, paraglossae with rows of small spines on inner apical margins.

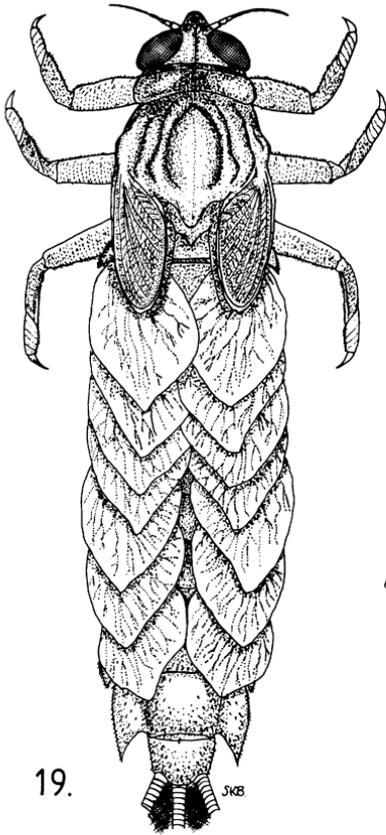
Thorax: Brown dorsally with slight mottling on mesonotum, wing pads parallel and widely separated (Fig. 19). Sterna as in Fig. 25, basisterna of each segment weakly sclerotized with many large flattened setae (Fig. 27), sternal projections present on meso- and metabasisterna. Each sternal projection clothed with many of the same large stout setae present on basisterna, setae most densely packed around apex of each projection. The meso- and metafurcasterna relatively free of large flattened setae.

Legs: As in Fig. 20 - 22, light brown, femora deeply grooved for reception of tibiae and tarsi (Fig. 26). Ventral surfaces of trochanters and basal-ventral part of femora with a dense brush of large flattened setae similar to those on thoracic sterna. Claws singular without denticles.

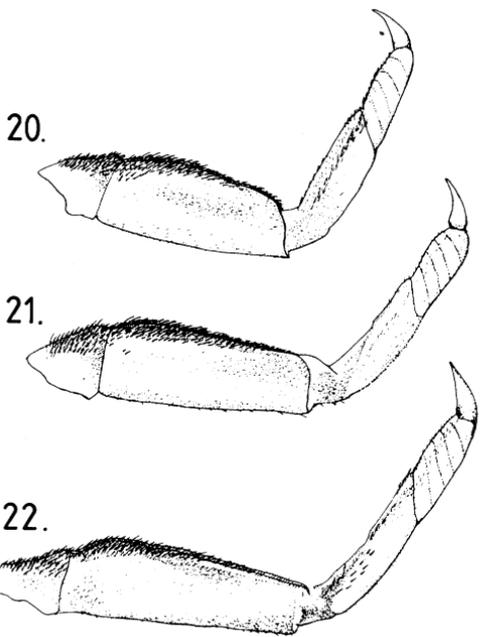
Abdomen: Segment 3: 3.5 - 4.0 mm wide, 5: 3.7 - 4.4 mm wide. Terga uniformly brown. Sternum of segment 1 with a small median projection similar to thoracic sternal projections (Fig. 25), black lateral longitudinal lines on sterna 1 - 9. Each segment with acute posterior lateral projections, segments 1 - 7 with large dorsal single subcordate gills (Fig. 19 and 24) that effectively cover most of the abdomen. Caudal filaments brown with white tips, lateral filaments with a fringe of fine setae along inner margins only (Fig. 23), median terminal filament slightly shorter than lateral filaments with setae along both inner and outer margins.

## DISCUSSION

*Siphonisca aerodromia* Needham can be distinguished by the large lateral projections on abdominal segments 5 - 9 and by the distinct projections on the thoracic sterna (and additionally on first abdominal sternum in the nymph). In general all new specimens examined for this study were smaller than those described by Needham (1908) and Clemens (1915). Measurements of body length, caudal filament length, and width of abdominal segments reported by Needham (1908) and Clemens (1915) were greater than or equal to the maximal value for the ranges obtained for our specimens. Traver in Needham et al. (1935) examined the type material in the Cornell University Collection and noted that



19.

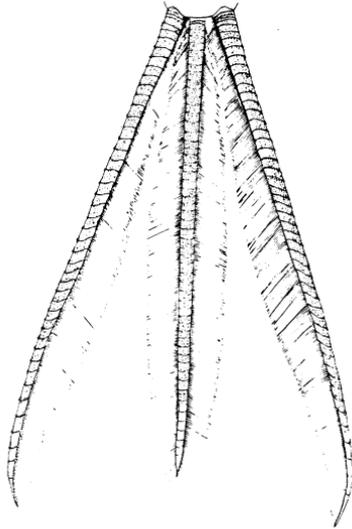


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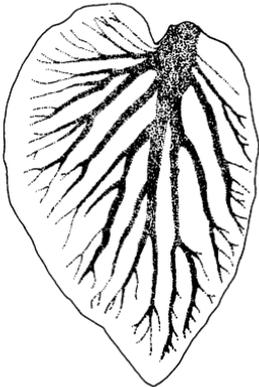
21.

22.

23.



24.



Figs. 19-24. Mature nymph of *Siphonisca aerodromia*: 19 - mature nymph dorsal view; 20 - prothoracic leg; 21 - mesothoracic leg; 22 - metathoracic leg; 23 - dorsal view of caudal filaments; 24 - subcordate gill from abdominal segment 3.

the abdomen was semi-translucent. None of our specimens examined had this character.

In Needham's type description he compared the abdominal structure of *Siphonisca aerodromia* to that of a New Zealand species *Oniscigaster wakefieldi* McLachlan noting the development of the lateral projections of *S. aerodromia* to be much greater than those of *O. wakefieldi*. These abdominal projections have been the center of attention since *Siphonisca* was first discovered. G. C. Crampton was cited by Edmunds et al. (1976) as having thought these structures reminiscent of those on some Carboniferous insects.

The ventral projections on the thoracic sterna and first abdominal segment attain their maximal size in the nymph. On the imago the projections are smaller, thinner, and lack setae. Sternal projections and weakly sclerotized basisterna of nymphs all have large setae (Fig. 25). These setae are particularly numerous around the apices of each projection and on the ventral basal part of each leg. It seems likely then, considering the position and arrangement of these setae, that they must have some specific function.

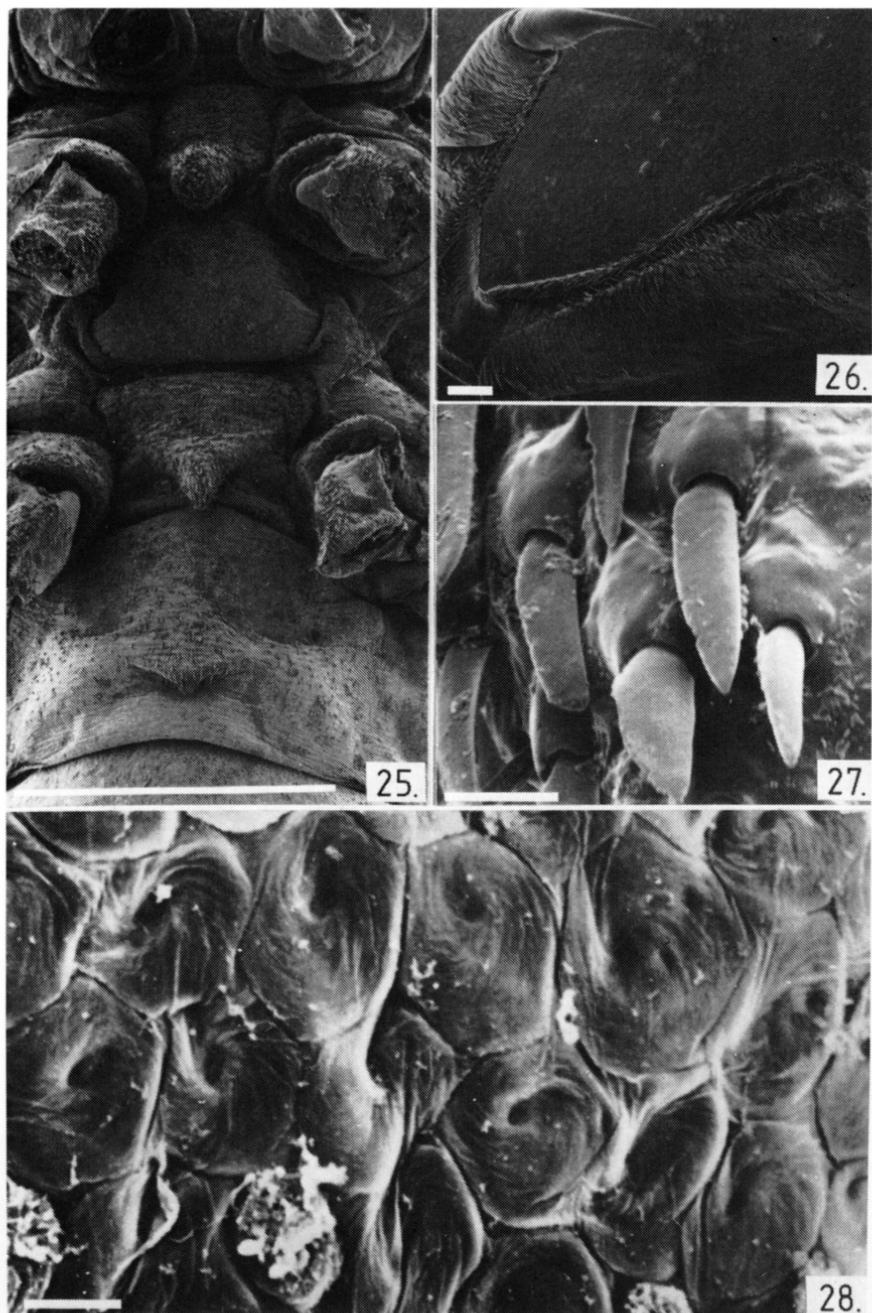
Although the ventral thoracic projections are unique among the Siphonuridae of North America they are not unique among all mayflies. Similar thoracic projections have been described by Muller-liebenau (1974) for the species *Heterocloeon bernerii* (Müller-Liebenau). Her description of the pattern and placement of the sternal projections and "bristles" seems similar to that observed on *S. aerodromia*. Although she did not observe the behavior of *H. bernerii* nymphs, she suggested that the sternal projections might be used as friction devices to aid the nymphs in maintaining their position on the substrate of fast flowing streams (from which she collected them). The similarity of this character between these two species is noteworthy because of the difference in habitats each occupies (*S. aerodromia* being a predator of flooded marshes and *H. bernerii* a resident of fast flowing cobbly streams). Some other examples of North American mayflies which have sternal projections are *Acanthametropus*, *Analetis*, and *Homoeoneuria* (W. L. Peters, personal communication).

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Figs. 25-28. Mature nymph and egg of *Siphonisca aerodromia*: 25 - ventral view of thoracic sternae and sternal setae, bar = 1000 µm; 26 - right prothoracic leg, bar = 100 µm; 27 - closeup of sternal setae, bar = 10 µm; 28 - photograph of surface structures of egg, bar = 10 µm.

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