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## THE EPHEMERID GENUS *BÆTISCA*\*

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### I. HISTORICAL

This very peculiar and interesting genus, erected by Walsh in 1862 to include Say's *Bætis obesa*, has up to the present time been represented in published accounts by two species, *B. obesa* Say, and *B. rubescens* Prov. Say, in 1839, described the subimago of *B. obesa*; the generic characters were drawn up by Walsh in 1862, from this one species; at the same time Walsh described the imago state, and in 1864 described and figured the nymph, which he had successfully reared. This latter article Joly (1880) translated into French, with annotations. Vaysiere, 1882, compared the nymph to that of *Prosopistoma*, figuring its parts in some detail. Eaton, in his "Recent Ephemeridæ," 1883-88, figured the nymph and all its appendages, likewise the wings, legs, and male genitalia of the imago. Needham, 1905, reported it from New York state, and figured labium and side view of the nymph, and wings of the subimago. Clemens, 1913 and 1915, reported it from Canada. Murphy, 1922, figured some of the mouthparts and included the genus in her discussion of mouthparts of mayfly nymphs in general.

Provancher, 1883, described as *Cloe unicolor* Hagen, later changing the name to *Cloe rubescens*, an imago from Canada having wings reddish at the base and the costal margin, and abdominal segments margined posteriorly with black. This species, placed later in *Bætis*, was transferred to *Bætisca* by McDunnough in 1921.

In this paper are presented two new species of the genus—*B. carolina*, from the Piedmont region of North Carolina, and *B. callosa*, from the northeastern portion of West Virginia. The former is represented by the entire life history, the latter by the nymphal stage alone.

\* Contribution from the Limnological Laboratory, Cornell University.

II. *BÆTISCA CAROLINA*

## A. NYMPH

## (1) HABITAT

The nymph of *B. carolina* was taken at two different stations in Guilford County, North Carolina. The first of these stations is one division of the outlet or overflow of an artificial pond, locally known as Hamburg Lake, and situated on the south branch of Reedy Fork River, eleven miles north of the city of Greensboro. The flow of water in that part from which the nymphs were taken is not constant, varying with the lake level, since it is not the main overflow. It is sometimes almost dry for a day or two at a time. The nymphs, however, were found in a round plunge-pool beneath the roots of a tree, water here varying from a few inches near the edge to nearly two feet in the deeper portions. The nymphs were seen swimming across the pool after some small stones in the shallow portion had been disturbed. One was taken on March 31, 1929, the other on April 5. Both were females, one much darker than the other. Repeated search in this pool and in all other branches of the overflow failed to yield any more nymphs, nor were any found during the remainder of the season of 1929 nor the season of 1930. The nymph caught March 31 transformed the forenoon of April 12, having undergone no moult since its capture. The second nymph from this station, which was likewise mature when captured, emerged April 22.

The second station for this species is the southern branch of Big Alamance Creek, fourteen miles south of Greensboro, at the extreme southern part of Guilford County. Here the flow of water is relatively constant, as Big Alamance is a fair-sized stream even in dry weather. The only two places in this stream where the nymphs have been found are directly above and a short distance below a ford leading to an old house known as Tom's Place. The bed of the stream is much the same in each place, being composed of loose gravel and sand near the quiet edge of the stream, areas of somewhat larger pebbles and small rocks in the center of the main current, and along one shore but also in the current many good-sized rocks. Nymphs could be collected here only by the use of the hand-screen and rake, as

repeated efforts to locate them by "hand-picking" the rocks and pebbles failed to yield a single one. However, the screen and rake used in the area just searched by "hand-picking," often yielded several nymphs. They were always found in the current.

During the season of 1929, only seven nymphs were found here, all of these being taken on April 13. Not a single nymph could be found on April 21, nor any cast skins. Three of these nymphs were males, one of which died as a nymph, the other two failing to transform from the subimago stage. One female nymph died, the others became imagoes. The dates of their transformations from the nymphal state are April 22 and May 1. In 1930, twenty-five nymphs were collected from this station on March 23. The season being much earlier than that of 1929, it was not surprising to find that many of these already showed the darkened wing-pads characteristic of the mature nymph. Seven of these were male, of which only three successfully attained to the imago state. Several of the twenty-five were killed and preserved, a few others died, the remainder transformed to imagoes from April 12 to April 15 inclusive. A period of very hot weather, with official temperatures ranging from 93° to 97°, occurred during these four days, and the *Bætiscas* transformed very rapidly—five on April 12, five more on April 13, nine on April 14, the remaining nymph on the following day.

The extreme localization of these nymphs is worthy of note. While the principal streams of a considerable portion of the piedmont and also of the mountain areas of the state of North Carolina have been quite thoroughly worked for mayflies, and some collecting done in the tidewater region, in none of these except at the two stations mentioned have the *Bætisca* nymphs been found. Not even in other parts of the same branches of Reedy Fork and Big Alamance, nor in their other branches, nor in streams closely adjacent, have any nymphs been taken.

## (2) HABITS

Although the nymphs normally live in flowing water, little difficulty was experienced in rearing them indoors in standing water, which was changed daily. Nor did tap water prove injurious to them. On being brought in from their native habitat,

they were kept at first in stream water; in a day or two, stream water to which was added a small percent of tap water was used, the percent of tap water being increased daily, until soon only tap water was used. The mortality among the nymphs was quite low, even in hot weather. They were kept in glass culture dishes, the covers of which had been removed. These dishes were then placed on the sill of an open screened window, so that a constant current of air passed over them.

The nymphs brought in during the season of 1929 were not supplied with food, but were given two rocks and a stick upon which to crawl. During the 1930 season however, stones from their native stream, well coated with lower forms of plant life, were provided, and the nymphs were often observed feeding on these plants, eating off the growth up to the water line.

Both in feeding and swimming, they were more active in the evening. During the day they usually rested on the under sides of the stones, often however leaving one stone, swimming about for a time and bumping into the edge of the dish repeatedly, before coming to rest beneath another stone. Toward evening, more were seen on the upper surfaces of the stones, climbing up as high as the water line. But when a light was flashed on them suddenly, away they all scurried to the dark shelter of the under surfaces.

In collecting, if other species such as those of *Ephemerella* or *Heptagenia* were put in the same jar with *Batisca* nymphs, the former soon collected in clumps on the backs of the *Batiscas*, which at once endeavored to shake off the "climbers." Sometimes a *Batisca* would be turned over on its back or side by such a group of nymphs of other species, and have some difficulty in righting itself. While on the stones in their dish, however, with only other *Batiscas* present, one frequently clambered over the back of another, with little annoyance being evidenced by the one climbed upon. Also if a large nymph came to rest on the bottom of the dish, several smaller ones often congregated upon it, the larger making no attempt to shake them off.

When at rest, it was quite characteristic for the last three abdominal segments to be bent upward and the setae held up over the body, reminding the observer of a squirrel. The nymphs

walked or crawled rather slowly, but swam quickly in spurts, usually in a straight line, vibrating the setae rapidly. The legs were used little if any in the actual process of swimming. The body of the insect did not undulate as it swam, but rather it forged straight on like a tiny steamboat. Periods of several minutes' rest between spurts of swimming were not unusual. Nymphs clung rather tightly to their stones, and some slight force had to be exerted to remove one. When a stone with nymphs clinging to it was lifted from the water, some of the nymphs let go their hold and swam off at once, while others could be lifted out of the water readily, still on the stone.

Before the transformation to the subimago state, these nymphs became quite or entirely quiescent for a period of from twenty-four to forty-eight hours. Most nymphs retired to the sheltered lower surface of one of the stones to undergo this period of quiescence, but one nymph clung tightly to a small stick on the bottom of the dish. Frequent observations over a period of forty-eight hours failed to reveal any change of its position on the stick. Variations in size and color pattern among the nymphs made it possible to keep some one nymph under observation over a period of time, especially when it was quiescent. It was also possible to determine which nymphs were mature by the relative darkness of the wing-pads, even before the quiescent period.

#### B. SUBIMAGO

When ready to emerge from the water, some nymphs swam or crawled restlessly about for several minutes, others clambered directly up on the stone under which they had undergone their period of rest. Up they crawled, to and above the water line, continuing their journey to the highest point of the rock. Settling themselves securely and holding firmly with all their claws, they sat motionless. Soon the mesonotal hood began to split along the mid-dorsal line, and the subimago was slowly pushed out of its nymphal skin by the intermittent contractions of the abdomen. The wings were then pulled from the hood, and a quick flip caused them to unfold and expand. The subimago, freeing now its legs and setæ, rested a moment before

giving a quick flutter of the wings and alighting a short distance from the now-empty nymphal skin. Often the subimagoes remained for fifteen or twenty minutes on the rim of the glass dish, before attaining the window screen with a second quick flutter. Here they sat, moving only occasionally, until captured.

The subimagoes were placed in glass fruit jars. A piece of cloth on the floor of the jar provided foothold for any that fell from above. A twig placed inside the jar was a support upon which many climbed and remained during the entire subimago stage. Others preferred to cling to the sides of the jar, or to the coarsely-woven cloth over the top. During the very hot weather of 1930, the mortality among them was at first very high. The subimagoes were utterly unable to finish their transformation, due apparently to too dry an atmosphere. To counteract this condition, leaves and stems of some succulent plant were put in each jar and replaced by fresh ones every few hours. *Claytonia virginica*, being at hand, was used principally for this purpose. The subimagoes then behaved more normally, and the percent of mortality decreased sharply.

The length of the subimago stage varied directly with the temperature. In 1929, during a period of cold weather, one female remained in this stage for fifty hours. In 1930 during the period of extreme heat, the length of this stage of the insect's life was much shorter, varying from twenty-one to twenty-four hours. The following tabulation gives a more complete record of the life period of the subimago. The first two records are of specimens taken at Hamburg Lake. All the others are from Big Alamance Creek.

### C. IMAGO

A fanning movement of the wings, which were gradually lowered parallel to the main axis of the body; a bulging of the head and thorax from the sudden rent in the subimago skin; quick and repeated contractions of the abdomen, and the subimago stage was at an end. The imago was pushed forth as was the subimago from the nymph skin, like a mummy from its shroud. Hanging now head down, the body aided by gravity in its escape from the enveloping cuticle, the imago first freed its legs, righted

SEX	EMERGENCE FROM NYMPH SKIN	FINAL TRANSFORMATION	TOTAL
♀	Apl. 22, '29—9—12 A. M.	Apl. 23—3—5: 30 P. M.	27—30 hrs.
♀	Apl. 22, '29—9—12 A. M.	Apl. 24—1: 45 P. M.	49—52
♂	Apl. 14, '30—8 A. M.	Apl. 15—6: 30 A. M.	22½
♂	Apl. 14, '30—8: 30 A. M.	Apl. 15—8: 15 A. M.	23½
♂	Apl. 13, '30—8: 45 A. M.	Apl. 14—7 A. M.	22½
♂	Apl. 13, '30—9: 55 A. M.	Apl. 14—8 A. M.	22
♀	Apl. 12, '30—9: 30 A. M.	Apl. 13—8 A. M.	22½
♀	Apl. 13, '30—10: 10 A. M.	Apl. 14—7: 30 A. M.	22½
♀	Apl. 13, '30—10: 15 A. M.	Apl. 14—8: 15 A. M.	22
♀	Apl. 14, '30—8: 30 A. M.	Apl. 15—8: 25 A. M.	24
♀	Apl. 14, '30—8: 35 A. M.	Apl. 15—7 A. M.	22½
♀	Apl. 14, '30—9: 10 A. M.	Apl. 15—7: 25 A. M.	22½
♀	Apl. 14, '30—9: 15—10 A. M.	Apl. 15—8: 15 A. M.	22½—23
♀	Apl. 14, '30—11: 10 A. M.	Apl. 15—8: 45 A. M.	21½
♀	Apl. 14, '30—11: 25 A. M.	Apl. 15—8: 20 A. M.	21
♀	Apl. 14, '30—12: 10 P. M.	Apl. 15—9: 20 A. M.	21½
♀	Apl. 15, '30—10: 00 A. M.	Apl. 16—7 A. M.	21

itself with a quick jerk, grasped the nearest support and pulled free the wings, abdomen and setæ. The newly-emerged imago rested but an instant, then with a sharp rustling sound from the rapidly-moving wings, flew to another part of the jar. It was active now for the remainder of its life.

*Bætisca carolina* new species

Measurements				
	Body	Tails	Wing	Foreleg
Male nymph				
(6 specimens) .....	7 - 9 mm.	1½-2 mm.		
Female nymph				
(13 specimens) .....	8 -10	1½-2½		
Male subimago				
(6 specimens) .....	6½- 9	3 -4½	9½-10½	3½-4½
Female subimago				
(4 specimens) .....	9 - 9½	4 -4½	11 -12	3½-4
Male imago				
(3 specimens) .....	8½-10	5½-7	9	7½-8¾
Female imago				
(9 specimens) .....	8 -10½	4 -7	9½-11½	3½-4½

NYMPH (Pl. V, Figs. 1, 3, 4, 9, 11, 18. Pl. VI, Figs. 24, 25, 26, 28B, 30.)

Large nymph, lacking dorsal spines on mesonotal shield, and with prominent black spot on each side of abdominal tergite 6. Lateral spines on mesonotal shield not exceeding  $\frac{1}{2}$  mm.; amber tinted, tipped with dark brown or black. Definite carina on each side of this shield, another along mid-dorsal line. Entire body very finely granulose, hairy. In addition, larger brown papillæ or granulations occur in patches on head, thorax, ventral side of femora of legs, and abdomen (except venter of last two segments). These granulations especially numerous on ventral side of body. Color variation considerable, without regard to sex or age. In living nymphs, this variation ranges from yellow sand-color faintly marked with light brown, through intermediate greenish forms with definite darker color pattern, to very dark brown on which the markings are less prominent. All fully-mature nymphs show darkening of the mesonotal shield over the wings. Frontal processes on head not apparent.

HEAD—Projections of genæ amber, tipped with brown or black. Basal segment of antenna faintly brown, three distal segments dark brown, remainder yellowish. Location of lateral ocelli indicated by yellowish ellipse surrounded by brown granulations. Compound eyes black, margined with brown; yellowish area around each. Genæ fringed with hairs. Vertex and occiput irregularly mottled with brown, brown areas more extensive in dark forms. Mouthparts darker, with parts of labrum, tips of mandibles and ligula of labium reddish brown. Labium and mandibles ventrally with numerous brown papillæ. Maxilla with prominent projecting angle on inner margin opposite palp; a definite outward-curving arch in middle of outer margin. Tufts of hairs near middle of both outer and inner margin of maxilla. Maxillary palp equals galea-lacinia in length. Joints of maxillary palp (basal to distal) are to each other as  $9\frac{1}{2}$ ;  $10\frac{1}{2}$ : 11. Labium as in *B. obesa*.

THORAX—Mesonotal shield, in light forms, sand-yellow with bars and irregular markings of light brown, and a few dark brown papillæ. In dark forms, the yellow background is almost obscured by thickly-set dark-brown papillæ scattered among brown markings. Saddle-shaped area between wing-roots remains lighter than other portions, in dark forms. Width of mesonotal shield, from tip to tip of lateral spines,  $5\frac{1}{2}$  mm. ventral margin of shield yellow to light brown, marked with brown in dark forms. Ventral aspect of thorax, in light forms, yellow marked with brown. On each pleura, a cluster of dark-brown papillæ above and anterior to each leg. Similar group in center of prosternum. Brown band with papillæ across anterior half of mesosternum, and on its posterior border two pyramidal forward-projecting brown areas on each side mid-ventral line. Anterior half of metasternum dark brown. In dark forms, background of thoracic sternites dark brown, with yellow area bordering mesonotal shield. Yellow horizontal bar on each sternum between second and third pairs of legs, and two round yellow spots on upper metasternum.



LEGS—Ventrally, patch of brown granulations on femur. In dark forms, dark band across center of femur ventrally. In all forms, dark patch on outer margin of tibia at femoral joining, another on outer margin of tarsus near middle. Joining of claw to tarsus, and tips of claw, dark brown. Legs hairy. Claw long and slender, sharp-pointed. Claw almost equals tibia. First leg, tarsus =  $2 \frac{1}{10}$  length of tibia; second leg, tarsus =  $1 \frac{4}{5}$  length of tibia; third leg, tarsus =  $1 \frac{2}{5}$  length of tibia.

ABDOMEN—Tergites 1-5 concealed beneath mesonotal shield. Segment very wide; yellow dorsally in light forms, light brown in dark forms. Erect projection into which posterior margin of mesonotal shield fits tipped with dark brown. Edges of its four carinas light brown. Large irregular dark brown spot in center of depressed area on each side. Two dark brown bars on posterior lateral angles, parallel to posterior margin. Posterior surface of this projection thickly set with rather long hairs. Lateral margins of abdominal segments 6-9 much as in *B. obesa*, but with extensions of posterior lateral angles less sharply acuminate. In this respect, intermediate between *B. callosa* and *Bætisca* nymph in Cornell collection. Tergites 7-9 in all forms yellow, with three to five prominent marks on each. Brown streak on anterior portion of mid-dorsal line. Irregular hour-glass-shaped marks on each side, slanting obliquely toward center; and in dark forms, another dark bar parallel to this mark, between it and pleural fold. Tergite 10 yellow; in light forms, unmarked; in dark forms, mid-dorsal line brown. Sternites 1-6 dark brown, in dark forms, marked with yellow. Sternite 1 (thoracic) yellow posteriorly. 2-6 completely margined with yellow, this margin widest at mid-ventral line. Round spot on each side of each of these sternites, near pleural fold. Sternites 7-9 yellow with irregular dark brown area in center, this area having on each side three projecting lobes, and an oblong yellow spot in center. 7-8 margined posteriorly with brown. Lateral projections of 9, and genital appendages, amber yellow. In light forms, sternites yellow with brown markings. 2-5 each with narrow brown central band, at each end of which is large dark brown spot almost enclosing a yellow area. 6-8 with same brown central band, also few brown granulations in posterior half of each. Ends of central band two-forked, on 6-8, not as in 2-5. 9 with horizontal dark mark in center on anterior border, another longer mark parallel to it a short distance back from anterior border. Appendages as in dark form.

SETÆ—Equal in length and thickness, tapering distally. Light amber-brown, somewhat darker toward tip. Fringed on both sides with rather long hairs, except at basal portion, which is almost bare.

Described from two nymphs taken in Big Alamance Creek, N. C., Mch. 23, 1930.

MALE SUBIMAGO (Pl. VI, Fig. 27.)

General color of body russet brown, the russet tinge most prominent on abdominal tergites 6-10 and on mesonotum. Head dark brown. Com-

pound eyes grey; antennæ brown. Posterior projection of mesonotum bordered widely with dark brown; sutures dark brown. *Abdomen*—tergites 1-5, and sternites of same, light tan. Sternites 6-9 with brown patches bordering pleural fold. Wings spotted and marked with very dark brown, the dark areas more extensive than in *B. obesa* (see also figure in Needham). Base of fore wing and entire hind wing with definite orange flush. *Legs* greenish tan, first and second pairs with tarsus darker than other joints. Claws and all joinings dark brown. *Setæ* light tan, darker at base.

#### FEMALE SUBIMAGO

General color of body purplish brown. Head as in male. Thorax and basal segments of abdomen darker than in male. Mesonotum very dark brown streaked widely with grey, except posterior projection, which has two yellow streaks. Abdomen with definite purplish tinge. Tergites 4-9, and sternites 7-9, with light markings on some specimens, while others have no such markings ventrally, but same brown patches as in male. Segment 10 light tan. Legs very similar to male, but in some specimens first pair are darker brown than other two. Wings as in male. *Setæ* light tan on some specimens, dark brown on others.

Subimagoes described from several specimens taken as nymphs in Big Alamance Creek on Mch. 23, 1930, which transformed Apl. 12 and 13, 1930.

#### MALE IMAGO (Pl. VI, Figs. 19, 20.)

Body stout, tapering posteriorly from sixth abdominal segment. Mesonotum greatly enlarged, prolonged posteriorly into a backward-projecting process which covers the metathorax dorsally and extends to the second abdominal segment. The fold or membrane extending backward from center of metathorax, and continuous on each side with the axillary cord, quite prominent, orange in color, and covering first abdominal segment. Mesosternum greatly developed, its anterior division two-lobed anteriorly, divided only between the lobes. Metasternum reduced to small horizontal bar lying directly anterior to first abdominal sternite, which is thoracic. Sixth abdominal segment widest, approximately equal to any two of 2-4; seventh next in width. Seventh, eighth and ninth wider ventrally than dorsally. 5, 8 and 9 approximately equal in width, as are also, 2, 3, 4 and 10. 1 is distally very narrow, wide as 5 ventrally. Penis lobes closely appressed on inner margin, tapering distally. Seminal ducts open separately, in pouch-like structures near tip of each lobe, at point where each begins to taper. Basal segment of tarsus fused with tibia, except in foreleg.

**HEAD**—Vertex and occiput light tan. Central carina and mouth region brown. Ocelli and antennæ yellowish white. Compound eyes grey margined with white.

THORAX—Pronotum light tan, Mesonotum with greenish tinge, definitely lighter in color than pronotum or pleura. Posterior prolongation of mesonotum tipped and margined with black, its sutures light tan. Pleura light brown, sutures slightly darker. Sternal plates yellowish tan, except anterior division of mesosternum, which is brown.

#### THORACIC APPENDAGES

LEGS—Greenish white. Tips of claws and basal edge of each tarsal segment, also joinings of all other segments, pale brown. Foreleg little shorter than body. In one specimen, femur of foreleg measured 2.3 mm.; tibia, 1.9 mm.; tarsus, 4.7 mm. Tarsal segments of foreleg range in length from one to five, in this order.

WINGS—Translucent, slightly iridescent. In fore wing, basal one-third of all principal longitudinal veins orange-brown, this color especially prominent in costa, subcosta and radius. In life, entire basal portion of wing flushed with orange (in alcohol, this color fades). Remaining longitudinal veins brown. Cross veins very faint, except those from third anal to inner margin. Large cell on inner margin next to wing base, deep orange. Hind wing orange-tinted throughout, the coloration deeper at the base, very faint on outer margin. Longitudinal veins, intercalaries and cross veins in upper half of wing brown; other cross veins faint.

ABDOMEN—Pleural fold purplish brown. Tergites 1-5, same color, anterior half of each darker than posterior. On each side, near pleural fold, an oblique darker mark, two such marks on tergite 5. Tergite 6 also purplish brown. Small projection in center of this tergite dark purplish-brown, ridges leading from it of same color. Small dark spot surrounded by lighter area on each side near mid-dorsal line, on anterior border. On each side near pleural fold, three or four small dark dots. Tergites 7, 8, 9, and 10 brownish, showing but faint purplish tinge. Of these, all but 10 with yellow flush. Sternites 1-6 light tan, faintly purple-tinged (except 1). Round brown dots on 2-5, brown dash on 6, on each side near pleural fold. On 2, short brown mark on each side mid-ventral line halfway to pleural fold. On 2-5, horizontal brown dash on anterior margin, in same position. Sternite 6 irregularly mottled with brown. 7, light brown, with brown dash near pleural fold. 8 and 9 whitish or light yellow.

FORCEPS—White or yellowish, brown at tip.

PENIS LOBES—Whitish, brown-tipped.

SETÆ—White, slightly brownish near base. Joinings in proximal half of seta very light tan. Setæ with fine hairs throughout entire length. Rudimentary median seta brownish.

Holotype—♂; reared from nymph taken in Big Alamance Creek, N. C., April 15, 1930. Cornell University collection, No. 1000.1.

**FEMALE IMAGO**—Head as in male. Thorax as in male, except that pleuræ are lighter in color. Wings as in male. Legs same coloration as male; in one specimen, femur of first leg measured 1.5 mm.; tibia, 0.9 mm.; tarsus, 1.7 mm. Tarsal joints, in order of length, 5, 1, 2, 3, 4.

**ABDOMEN**—Entire abdomen tinged with pinkish-orange (due to presence of eggs); this color most prominent on tergites. Purplish brown tinge on pleural fold and oblique marks near to it, of tergites 2-4. Oblique marks of same color on tergite five, one-third distance from pleural fold to mid-dorsal line. Very narrow posterior border of same on tergites and sternites of 1-5. Small hump on tergite 6 (less prominent than in male) and lines radiating from it, also purplish. Round black spot near pleural fold on sternites 2-5. Tergites 9 and 10 yellow faintly flushed with pink. Pinkish-orange band, bordered by narrow band of creamy white, extends along mid-ventral line from anterior border of second sternite to posterior border of sixth. (In some specimens, may extend to sternite 9. On some also, a lavender line borders the orange band, between it and the white, on 2-5.) Position of oviducts on 6 and 7 indicated by creamy white line. Sternites 8 and 9 creamy white, except that some specimens have orange marks in form of triangle with base directed anteriorly, at anterior margin of 8. Rudimentary median seta yellowish tan; lateral setæ creamy white.

Allotype—♀; reared from nymph taken in Big Alamance Creek, N. C. April 13, 1930. Cornell University collection, No. 1000.2.

Paratypes—2 ♂s, Big Alamance Creek, N. C. April 13, 1930. Cornell Collection, Nos. 1000.3 and 1000.4.

8 ♀s, same station, May 1, 1929, and April 13, 1930. Cornell Collection, Nos. 1000.5-1000.12.

### III. *BÆTISCA CALLOSA*

#### HABITAT AND HABITS

Prof. James G. Needham, who collected these nymphs from West Virginia, gives the following account of their habitat.

“These nymphs were first collected on August 18th, 1930, in Johnny Cake Run, near Mt. Storm, W. Va. This run is a small stream tributary to Abram’s Creek, which later joins the north branch of the Potomac River. All the specimens found that day were in a short stretch of riffle about midway between U. S. Highway Route 50 and the mouth of the run. The stream was low, with only a few inches depth of water flowing among the small stones and gravel, and the land round about was open pasture.

"About thirty nymphs were taken on screens held in the current. Hand picking from the stones obtained only one nymph. Apparently they let go their footing when the stones are lifted from the water.

"The nymphs are very hard shelled. In water they feign death for a time when disturbed, folding the legs closely beneath the body and laying the tail forward over the back. Thus they become very unlikelike, and are hardly discoverable among the bits of gravel, which their colors simulate. When placed in water they quickly resume activity, swimming slowly and laboriously by very rapid vertical lashings of the very short tail.

"The first specimen was found by Mr. P. N. Musgrave. The others were found by the various members of the W. Va. summer zoological expedition. I found only six of them myself in more than an hour of diligent searching. They were not so common as were other mayflies, such as *Heptagenia*, *Chironetes*, and *Leptophlebia*, or stoneflies such as *Pteronarcys*, *Perla*, and *Leuctra*.

"Later single specimens were found at three other points in this same (N. Branch of the Potomac) drainage, at New Creek, and Patterson Creek eastward, and at Buffalo Run near Kingwood, W. Va."

***Bætisca callosa* new species**

	Measurements	
	Body	Setæ
Nymph (6 specimens, immature) .....	3½-4¼ mm.	½-1 mm.

(Pl. V, Figs. 6, 8, 10, 12, 14, 15, 17. Pl. VI, Figs. 21, 22, 23, 28C, 31.)

**NYMPH**—Small nymph, lacking both dorsal and lateral spines on mesonotal shield, and with prominent black band across basal portion of setæ. Very short frontal processes.

General color grayish white to light tan dorsally, venter dark except last two segments which are white. Mesonotal shield lacking both dorsal and lateral spines, its lateral margin bearing only an obtusely rounded projection. Definite carina along mid-dorsal line of this shield, likewise a carina on each side as in *B. carolina*. Entire body finely granulose, with

patches of larger papilla-like granulations on venter (except last three segments), ventral surfaces of femora, mesonotal shield and sparingly on head. Color variation considerable.

**HEAD**—Projections of genae rounded at tip, not ending in spines; light grey or white. Mouthparts and ocelli dark brown. Basal portion of antennæ light brown; distal portion dark brown. Compound eyes black, bounded by light area. Vertex, occiput and genæ varying from grayish white to light tan. Two more or less distinct patches of brown granulations on occiput on its posterior margin. Labrum twice as wide as long. Maxillary palps as in *B. obesa*,—shorter than galea-lacinia. Tufts of hairs on inner margin of maxilla only. Joints of maxillary palps are to each other as 9:10:12. (basal to distal). Mandible more deeply serrate on outer border than in *B. carolina*; many large granular papillæ on basal portion, which is also very dark in color. Basal joint of labial palp considerably wider in proportion to length than in *B. obesa* or *B. carolina*.

**THORAX**—Mesonotal shield grayish white, irregularly marked with numerous dark-brown granulations. These brown patches more evident on saddle-shaped portion between wing-roots and near posterior border. Lateral margins of shield grayish white, marked with brown on anterior half. Posterior margin dark brown, slightly hairy. Ventral surface of thorax, light brown. Ventral margin of shield gray with brown marks. In some of the darker forms among the paratypes, the mesonotal shield dorsally is light tan, ventral surface of thorax dark brown, and ventral margin of shield light brown margined with gray.

**LEGS**—Coxa, trochanter and femur dark brown banded with white near each joint. Tibia and tarsus grayish white, each with a transverse central dark brown band. Claw grayish, in shape long and slender. Claw exceeds tibia in first and second leg, almost equals it in third leg. First leg, femur equals tibia plus tarsus; tarsus equals  $1\frac{1}{4}$  of tibia. Second leg, femur equals tibia plus tarsus; tarsus equals  $1\frac{1}{2}$  of tibia. Third leg, femur equal to  $\frac{1}{5}$  of tibia plus tarsus; tarsus equal to  $1\frac{1}{2}$  of tibia. In some of the darker paratypes, tibia and tarsus light brown, claw amber.

**ABDOMEN**—Dorsally, segment 6 brown on posterior margin and in depression on each side of erect carina. Remainder of this segment white, carina the same. Segments 7–9, white, each with brown streak on anterior portion of mid-dorsal line. Dark brown spot on each side, near pleural fold. On 7 and 8, few scattered dark brown spots on each side, more numerous on 7. In some of the paratypes, these are arranged in an oblique line from margin to center. Tergite 10 white, with two faint brown dots on each side near mid-dorsal line. These are lacking, on some of the paratypes. Sternites of abdomen light brown, to 8th. Sternite 8 white, with few small dark brown dots. Sternite 9 white, also marked with brown near anterior margin. In some of the paratypes, abdominal sternites 1 to 8 dark brown, sternite 8 likewise brown.

SETÆ—Equal in length and thickness, tapering distally. Basal one-third of each very dark brown to black. Distal portion yellowish white, well fringed with hairs.

Holotype—Nymph taken by Prof. James G. Needham in Johnny Cake Run, West Virginia, August 18, 1930. Cornell University Collection, No. 1001.1.

Paratypes—Six nymphs, same collector, same date and place. Cornell Collection, No. 1001.2–1001.7.

#### IV. BÆTISCA NYMPH FROM SACANDAGA RIVER, N. Y.

A nymph in the Cornell University collection, taken in the Sacandaga River by Mr. C. P. Alexander, has the following characteristics which distinguish it from *Bætisca obesa*, *B. carolina* and *B. callosa*.

#### Measurements

	Body	Setæ
Nymph		
(1 specimen, mature) .....	8 mm.	2½ mm.

(Pl. V, figs. 2, 5, 7, 13, 16. Pl. VI, figs. 28A, 29, 32, 33, 34.)

NYMPH—Large reddish brown nymph, lacking frontal processes on head, its median caudal seta neither as long nor as stout as the lateral ones.

HEAD—Neither frontal processes nor projections of genæ prominent. (Head had been removed and mounted previous to the date of these observations. On this mounted head, neither frontal processes nor projections of genæ are visible.) Labrum twice as wide as long. Maxilla and maxillary palp as in *B. obesa*. Joints of this palp are to each other as 7:8; 8 (basal to distal). Outer margin of right mandible curving gently upward to canines, greatest curve above center. Mandible thus appears to be thrust forward rather than being erect. Outer margin of left mandible curving gradually out at one-third distance from base, greatest curve above the center. Thus appears to be thrust upward and backward. Labium as in *B. obesa*.

THORAX—Mesonotal shield with dorsal and lateral spines, as in *B. obesa*. Lateral spine 1 mm. in length; yellow, not tipped with black. Width of shield from tip to tip of lateral spines,  $5\frac{1}{4}$  mm. Mid-dorsal carina only faintly indicated. Posterior margin of shield set with short hairs. General color reddish brown with darker markings. Saddle-shaped portion lighter than rest of shield. Venter of thorax light tan, more or less thickly marked with reddish brown. No indications of large papilla-like granulations.

LEGS—Yellowish brown. Small dark spot at inner margin of femoro-tibial joint. Tarsus with four slightly oblique streaks extending from outer margin halfway to middle of segment, and dark spot near base of claw. Tip of claw brown, basal portion almost white. Claw proportionately shorter and stouter than in *B. carolina* or *B. callosa*. First leg, femur equals twice tibia; tarsus equals 1 of tibia; claw almost equal to tibia. Second leg, femur equals twice tibia; tarsus 1 of tibia; claw almost equals tibia. Third leg, femur little less than twice tibia; tarsus 1 of tibia; claw of tibia.

ABDOMEN—Dorsal aspect, general color reddish brown. Lateral margins of abdominal segments 6 to 9 as in *B. obesa*. Margin of erect carina on tergite 6 set with short hairs. Definite darker color pattern on each side of tergites 7-9. Entire venter light tan with reddish brown markings.

SETÆ—Lateral setæ stout at base, tapering distally. Median seta much less stout, also tapering; not equal in length to the laterals. All three well fringed with hairs in distal half of length. Later setæ reddish, median seta yellowish red.

#### V. KEY TO NYMPHS

1. Mesonotal shield with well-developed spines.
  - Posterior angles of lateral margins on abdominal segments 6-9 ending in spines or spinous processes.....2.
  - Mesonotal shield lacking spines.
    - Posterior angles of lateral margins on abdominal segments 6-9 obtuse, without spinous processes.....*B. callosa*.
2. Both dorsal and lateral spines present.
  - Maxillary palp shorter than galea-lacinia.....3.
  - Only lateral spines present.
    - Maxillary palp equal to galea-lacinia.....*B. carolina*.



## 3. Head with prominent frontal projections.

Setæ equal in length and thickness ..... *B. obesa*.

Head without prominent frontal projections.

Median seta not equal to laterals in length or thickness.

*B.* nymph from Sacandaga River.

## VI. CONSIDERATION OF GENERIC CHARACTERS.

Due to the fact that the characters of the genus were drawn up by Walsh from the single known species, *Bætisca obesa*, it now becomes necessary to modify them slightly. The following nymphal characters should be reduced from generic to specific rank:—

1. setæ of equal length and thickness (not true of specimen from Sacandaga River).
2. maxillary palp shorter than galea-lacinia (not true of *B. carolina*).
3. presence of both dorsal and lateral spines on mesonotal shield (not true of *B. carolina* or *B. callosa*).
4. presence of tubercles at wing-roots (not true of *B. carolina* and *B. callosa*).
5. tarsus about  $1\frac{1}{2}$  as long as tibia (in *B. carolina*, more than twice as long in fore leg).
6. presence of frontal projections on head (not true of nymph from Sacandaga River).

The remaining nymphal characters as given by Walsh and Eaton still hold good. To them, however, might well be added:—outer canines of mandible, three; inner canines, two.

The generic characters of the adult which must now be reduced to specific rank are:—

1. penis-lobes unarmed, apparently combined into a single acute ovate lamellar intromittent organ, concave above and terminating with a single seminal pore (not true of *B. carolina*).
2. probably also the measurements for proportional lengths of abdominal segments 3–10 of female; as given by Eaton, from a dried specimen, these do not correspond with *B. carolina*, alcoholic specimen.

Other characters stand as given by Walsh and Eaton. To them could be added, however:—posterior margin of 10th abdominal segment of female bifid ventrally.

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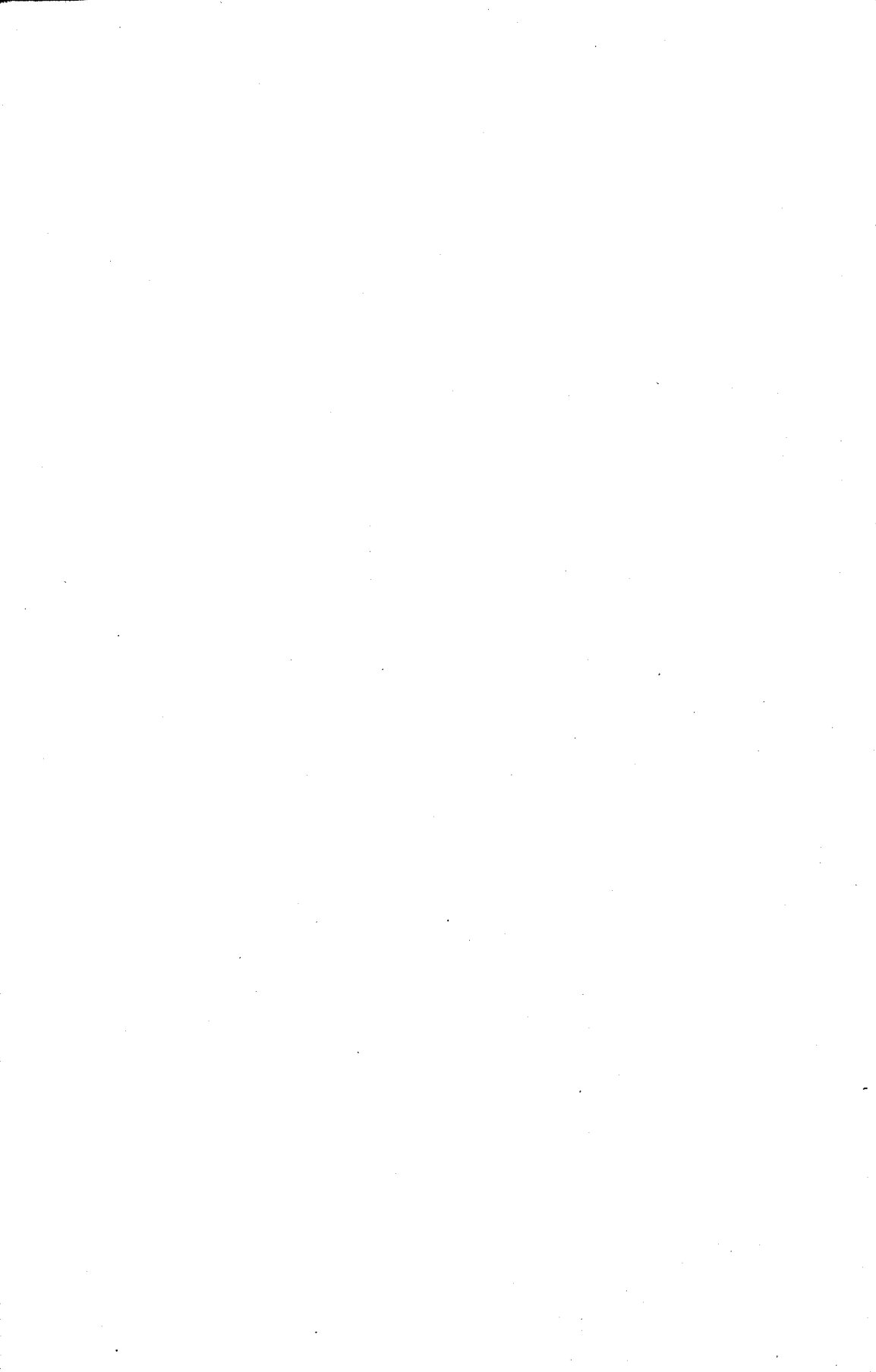
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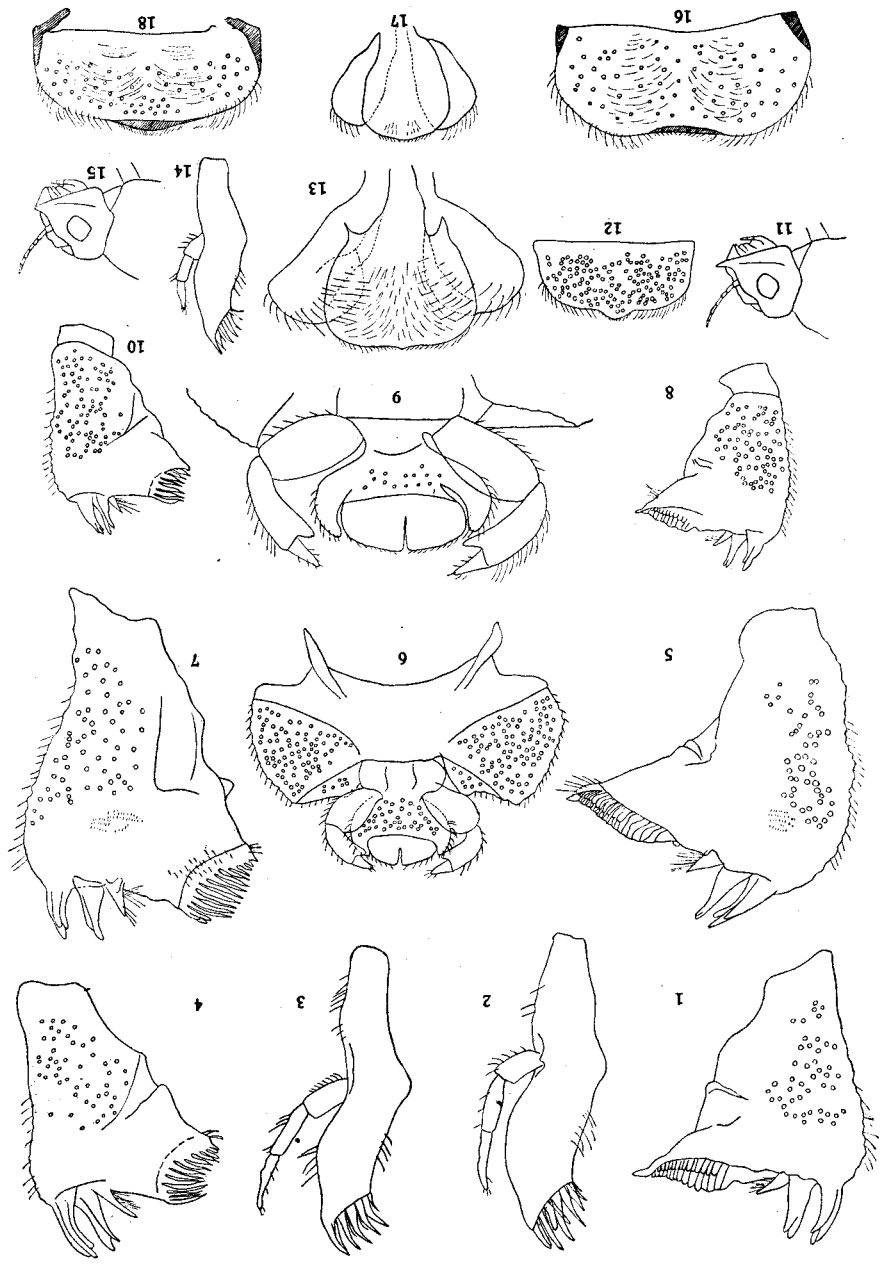
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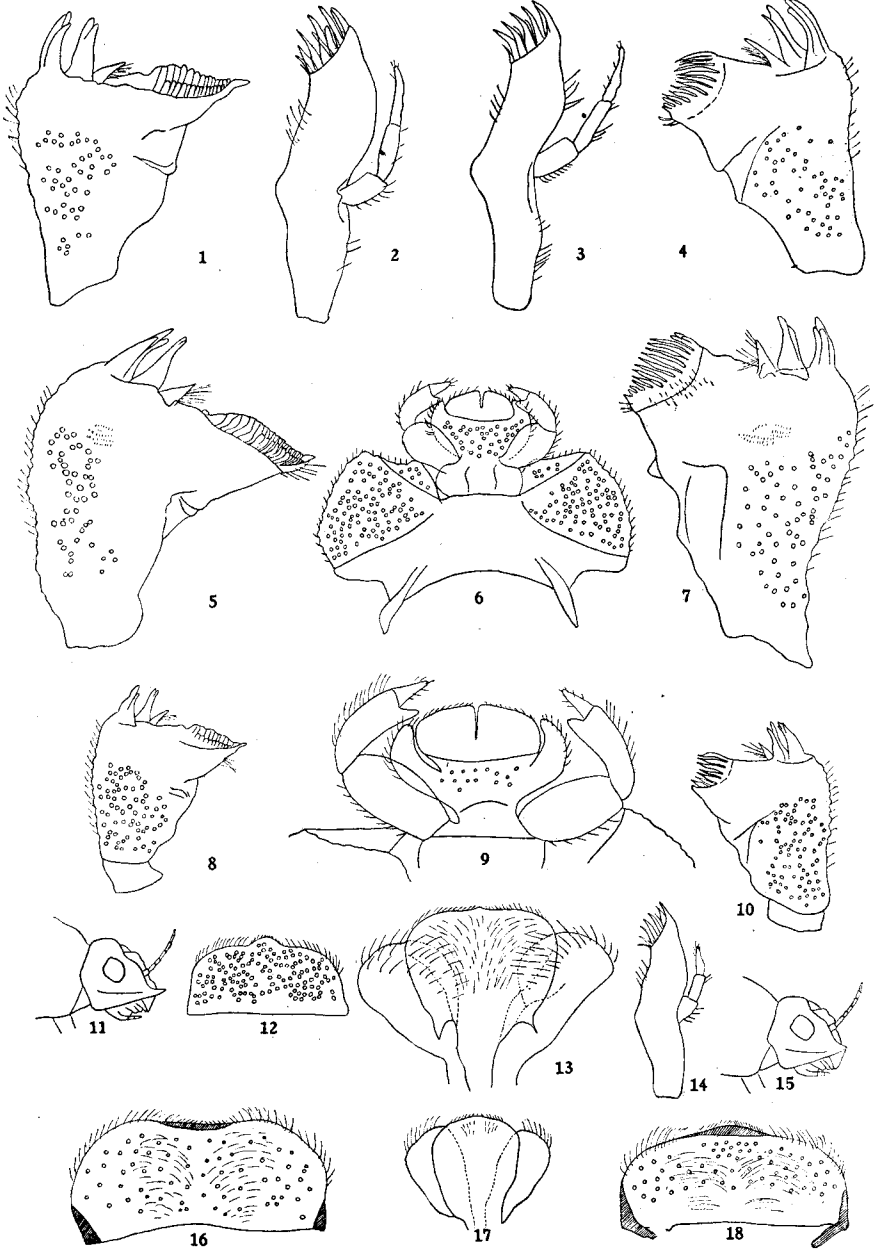
## PLATE V

- Figures 1 and 4. Right and left mandibles of *Bætisca carolina*.  
Figure 2. Left maxilla of *Bætisca* sp? from Sacandaga River.  
Figure 3. Left maxilla of *Bætisca carolina*.  
Figures 5 and 7. Right and left mandibles of *Bætisca* sp? from Sacandaga River.  
Figure 6. Labium of *Bætisca callosa*.  
Figures 8 and 10. Right and left mandibles of *Bætisca callosa*.  
Figure 9. Ligula and labial palps of *Bætisca carolina*.  
Figure 11. Head of nymph of *Bætisca carolina*, side view.  
Figure 12. Labrum of *Bætisca callosa*.  
Figure 13. Hypopharynx of *Bætisca* sp? from Sacandaga R.  
Figure 14. Left maxilla of *Bætisca callosa*.  
Figure 15. Head of nymph of *Bætisca callosa*, side view.  
Figure 16. Labrum of *Bætisca* sp? from Sacandaga River.  
Figure 17. Hypopharynx of *Bætisca callosa*.  
Figure 18. Labrum of *Bætisca carolina*.

BÆTTISCA



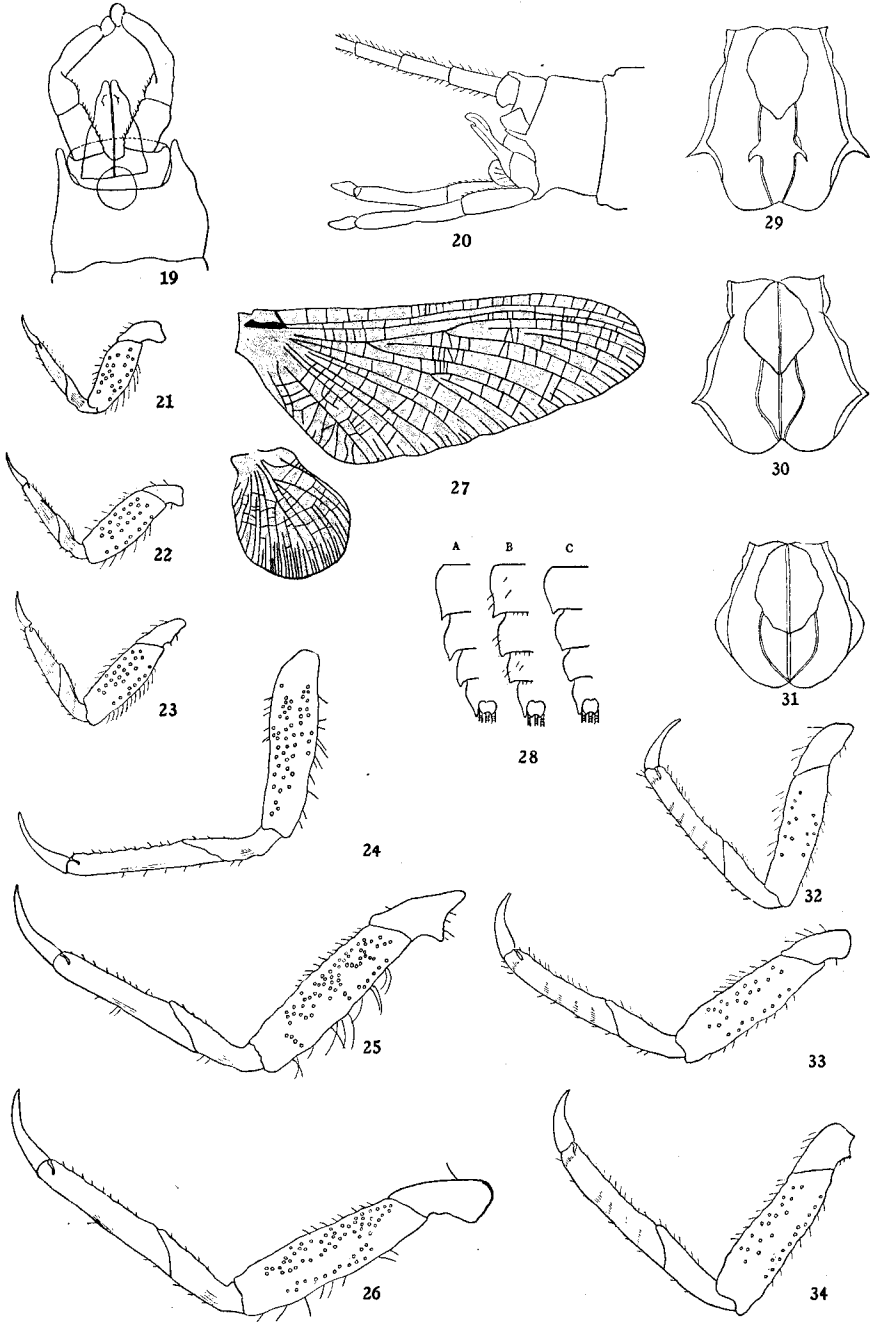
(PLATE V)



BÆTISCA

## PLATE VI.

- Figure 19. Male genitalia, *Bætisca carolina*, ventral aspect.  
Figure 20. Male genitalia, *Bætisca carolina*, side view.  
Figures 21-23. 1st, 2nd and 3rd legs of nymph of *Bætisca callosa*.  
Figures 24-26. 1st, 2nd and 3rd legs of nymph of *Bætisca carolina*.  
Figure 27. Wings of male subimago, *Bætisca carolina*.  
Figure 28. Lateral margins of abdominal segments 6-9 of nymphs:  
    A. *Bætisca* sp? from Sacandaga River.  
    B. *Bætisca carolina*.  
    C. *Bætisca callosa*.  
Figure 29. Mesonotal shield, nymph of *Bætisca* sp? from Sacandaga River.  
Figure 30. Mesonotal shield of nymph of *Bætisca carolina*.  
Figure 31. Mesonotal shield of nymph of *Bætisca callosa*.  
Figures 32-34. 1st, 2nd and 3rd legs of nymph of *Bætisca* sp? from  
    Sacandaga River.



BÆTISCA