THREE NEW NEARCTIC SPECIES OF SYSTENUS WITH A DESCRIPTION OF THE IMMATURE STAGES FROM TREE CAVITIES

(DIPTERA, DOLICHOPODIDAE)

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In the course of a general investigation of the dipterous inhabitants of moist tree holes and tree ulcers, I was fortunate in rearing two apparently new species of *Systenus* from tree-hole debris. In an attempt to identify them I came across a third undescribed species which had erroneously been labeled in the National Museum collection as *Systenus americanus* Van Duzee (1914). The latter has been the only known representative of the genus in North America and has been recorded only from North Carolina.

In Europe there are five species of *Systenus*, all of which have been reared from ulcerative sap and decaying wood of common trees. In fact this genus is known almost entirely from reared specimens. The immature stages of *S. adpropinquans* (Loew) have been described by Laboulbène (1873) and Lundbeck (1912) and those of *S. leucurus* (Loew) by Beling (1882).

The study of the immature stages of the Dolichopodidae is of considerable general interest because this family stands with the Empididae at the evolutionary apex of the Brachycera. It is here that morphologists have sought clues to the stages by which the structural organization of the larva of the lower families of Diptera underwent such radical changes which resulted in the peculiar maggot-type larva of the Cyclorrhapha. Unfortunately the immature stages of the Dolichopodidae are very poorly known, and for the most part the published descriptions, including those of *Systenus*, are old.

The general studies on dipterous larvae such as those by Brauer (1883), Meinert (1886), Becker (1910), De Meijere (1916) and Bischoff (1924), some of which included notes on Dolichopodidae, were excellent for their time. However, as indicated by Malloch's (1917) failure to include any important facts on the dolichopodid larvae in his basic classification of dipterous larvae, and the omission of this family in Cook's (1949) series of study forms, more serious work on representative species of Dolichopodidae, such as that of De Leon (1935), is greatly needed. The descriptions and figures of the immature stages of one of the new species of *Systenus* are offered, therefore, in the hope that they will aid and stimulate further comparative studies of the larvae of higher Brachycera and their place in the phylogeny of the Diptera.

Because *Systenus* was omitted from Curran's (1934) keys to the North American genera, I found it difficult to place my material correctly, finally relying on Lundbeck's (1912) Diptera Danica where the genus was excellently treated. *Systenus* is most closely related to *Rhaphium* Meigen. The characters originally given by Loew (1857) when he split *Systenus* from *Rhaphium* still serve well to characterize the genus: (1) antenna with first segment bare, second simple and transverse, third large, longer in the male than in the female, broad at the base, narrowed apically, long pubescent, the arista apical; (2) legs slender, plain in both sexes, with sparse bristles, hind basitarsus bare and about half as long as second segment; (3) last section of fourth vein with more or less flexure, the sixth vein distinct; and (4) male genitalia free and pedunculated.

I am greatly indebted to Fred C. Harmston of Salt Lake City, Utah, for his kindness in reading over my manuscript and in making available several specimens of *Systenus albimanus* for inclusion in my type series.

KEY TO THE NORTH AMERICAN SPECIES OF SYSTENUS

1. Palpus and upper orbital cilia pale yellowish or white; all legs pale 2
   Palpus and upper orbital cilia black; at least hind leg dark 3
2. Antenna entirely brownish black; mid tibia with two bristles at basal fourth only, none at middle; male with apex of wing white with a prominent, subapical, black spot between third and fourth veins ..... *apicalis*, new species
   Antenna yellowish at base to middle of third segment; mid tibia with one bristle at middle in addition to the two at basal fourth; male wing without black or white markings ..... *shannoni*, new species
3. All legs mainly black; bristle on outer side of hind coxa white; fore femur with fringe of long white hairs on lower outer edge ..... *americanus* Van Duzee
   Hind leg only with black markings; bristle on outer side of hind coxa black; fore femur without long hairs ..... *albimanus*, new species

Systenus apicalis, new species

Fig. 1

Male.—Length about 3 mm., wing 3 mm. by 1.2 mm.

Head black, frons and face with metallic-blue reflections overlaid with course gray pollen. Eyes finely pubescent. Face as broad as first antennal segment, upper two-thirds concave, lower third with a vertical carina narrowly shining in middle. Palpus yellow, short and broad with fine, black setae and long, apical, black bristle. Antenna (fig. 1b) brownish black, third segment finely pubescent, length two-thirds that of fore tibia; basal half broad, abruptly narrowed midway and distal half

very narrow; arista stout, 0.28 as long as third segment. Orbital cilia entirely white.

Thorax metallic green with blue and violet reflections and with coarse grayish pollen; bristles strong and black. Acrostichals biseriate, eight in each series, about a fourth as long as the dorsocentrals. Propleuron with a single, long, bristly, yellow hair.

Legs yellow, mid and hind coxae brownish above; tarsi darker toward apices, fifth segments of fore and hind tarsi black. Coxae with numerous yellow hairs on fore and middle legs; mid coxa with a strong yellow hair on outer side; hind coxa with a single, long, yellow, outer bristle. Distal segments of legs with fine, black setae; fore legs without bristles; mid and hind tibiae each with a pair of anterodorsal and posterodorsal, strong, black bristles at basal fourth and an anterior pair at apex. Apices of hind tibia and basitarsus each with a dense comb of short, flattened, scalelike, black hairs; hind basitarsus half as long as second segment.

Wing (fig. 1a) with extreme apex white, the membrane proximad of this area between third and fourth veins with a quadrate black spot; last section of fourth vein sinuate; crossvein subequal to last section of fifth vein. Calypters, their cilia, and halteres yellow.

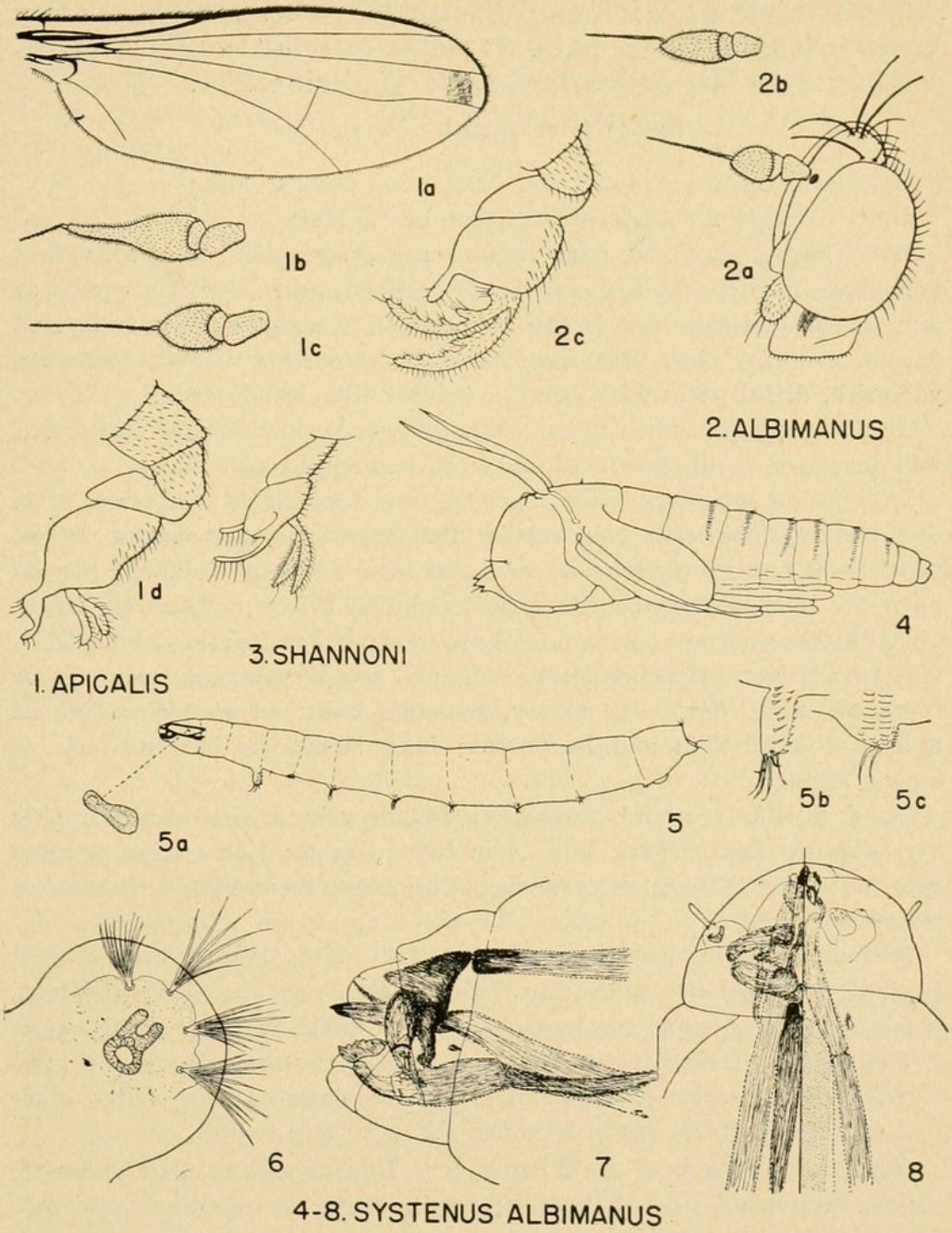
Abdomen metallic, bluish green; hairs strong, hind margin of first apparent tergite with especially strong, black bristles. Genitalia (fig. 1d) pedunculate, color brownish black; outer lamellae of tenth segment fused on basal third, with apices slender and slightly brownish; ventral lobes yellowish brown, stout at bases, apices hooklike and very slender, with a few fine hairs.

Female.—Similar to the male but antenna (fig. 1c) with third segment 1.2 times as long as broad, with subterminal arista about twice as long as segment. Wing without apical black or white spots, the fourth vein more nearly sraight.

Types.—Holotype ♂, allotype, 1 ♀ paratype, Falls Church, Virginia, April 15, 1951, W. W. Wirth, reared from wet debris in hollow of tulip tree, *Liriodendron tulipifera* (type no. 61311, U. S. N. M.). One male paratype, College Park, Maryland, June 16, 1935, C. T. Greene.

Easily recognized by the subapical black spot on the wing of the male, a character shared only by *Systenus scholtzii* (Loew) from Europe, which, however, has the fourth vein strongly curved toward the third at the apex, the palpi darker, the antenna yellowish with the third antennal segment more gradually narrowed, a pair of white hairs on the fore femur below at the base, and, according to Loew, the fifth segments on the fore and hind tarsi are not noticeably black.

Other Diptera which were reared from the same lot of tree-cavity debris at Falls Church were: *Dasyhelea oppressa* Thomsen, *Culicoides borinqueni* Fox and Hoffman and *Culicoides*



STRUCTURES OF SYSTENUS

Fig. 1a-d, *apicalis*, a—wing, b—male antenna, c—female antenna, d—male genitalia; fig. 2a-c, *albimanus*, a—head of female, b—male antenna, c—male genitalia; fig. 3, *shannoni*, male genitalia; figs. 4-8, *albimanus*, immature stages: fig. 4—pupa; fig. 5—larva, side view; f; g. 5a—anterior spiracle, enlarged; fig. 5b, pseudopod of third segment, enlarged; fig. 5c—pseudopod of sixth segment, enlarged; f; g. 6—right dorsal lobe of caudal segment of larva, caudal view; fig. 7—details of head of larva, lateral view; fig. 8—details of head of larva, left side dorsal view, right side ventral view.

piliferus Root and Hoffman (Heleidae); *Pachygaster pulcher* Loew (Stratiomyidae); and *Stomosis luteola* Coquillett (Milichiidae) (the last determined by C. W. Sabrosky).

Systenus shannoni, new species

Fig. 3

Male.—Length 2.7 mm., wing 2.5 mm. by 1.0 mm.

Head black; face and frons with dense gray pollen, face narrowest just above mouth with a short, sharp, polished, green, vertical carina at oral margin; palpi yellow including vestiture. Antennae about as figured for *apicalis* (fig. 1b); first, second and broad portion of third segments yellowish, distal parts dark brown. Orbital cilia wholly pale.

Thorax metallic, bluish green, with grayish pollen; bristles black and well-developed as in *apicalis;* propleuron with single pale bristle.

Legs yellow including coxae; fore femur without long hairs; fore tibia and tarsus white with pale setae; fifth tarsal segment brown on all legs. Strong, black bristles on mid and hind tibiae as follows: two on posterior side at basal fourth, a posterodorsal bristle midway and three apical bristles on mid leg; a dorsal series of six the length of hind tibia, and an anterior bristle on basal fifth and one at apex on hind leg. A comb of short, flattened, silvery, scalelike hairs on posterior side at apices of hind tibia and basitarsus; hind basitarsus half as long as second segment.

Wing hyaline, without markings; fourth vein nearly straight, only very slightly approaching third vein toward apex; last section of fifth vein 2.5 times as long as crossvein. Calypters, their cilia, and halteres yellow.

Abdomen metallic greenish, with yellowish hairs, those at apex of first tergite very long. Genitalia (fig. 3) pedunculate; same color as abdomen, outer lamellae of tenth segment pale yellow, fused on basal third, apices bladelike with fringe of very fine pubescence; ventral lobes with two slender unequal arms, the ventral arm three times as long as the other and bearing a sparse comb of about six very long hairs.

Types.—Holotype ♂, Plummer's Island, Maryland, June 8, 1914, Schwarz and Shannon, collectors, at light (type no. 61312, U. S. N. M.). One male paratype, same data except collected by R. C. Shannon, May 9, 1914.

Resembling *apicalis* closely in the shape of the antenna and in the yellowish legs and palpi, but differs in the yellowish base of the antenna, in the possession of a bristle at the middle of the mid tibia, and in the male, by lacking the subapical wing spots.

Systenus albimanus, new species

Fig. 2

Male.—Length 2.7 mm., wing 2.2 mm. by 0.8 mm.

Head black, with dense, grayish-green pollen; palpi black with black bristles. Antenna black, third segment (fig. 2b) triangular, twice as long as broad with long, dense pubescence; arista as long as third segment, coarsely pubescent. Lower orbital cilia pale, the upper half of orbital series black.

Thorax metallic, bluish green, with coarse gray pollen; bristles very strong and black; a single, yellow propleural hair.

Coxae yellow, anterior surface with dense, white hairs on fore leg, sparse, black setae on mid leg; hind coxa with a single, black, outer bristle. Femora without long hairs or bristles; fore tibia and tarsus white with white setae; fore femur and mid leg dusky yellow with black setae. Hind leg brownish black except knee and basal two-thirds of femur yellowish. Mid tibia with a posterodorsal and an anterodorsal, long black bristles at basal fourth, a series of three short bristles on posterior side and three long bristles at apex; hind tibia with a series of three short dorsal bristles and three apicals. Apices of hind tibia and basitarsus each with a conspicuous posterior comb of flattened, scalelike, silvery hairs; hind basitarsus 0.6 times as long as second segment.

Wing brownish hyaline, unmarked; fourth vein nearly straight and parallel to third, last section of fifth vein 2.2 times as long as crossvein. Calypters, their cilia, and halteres yellow.

Abdomen shining bluish green, with strong, black bristles and hairs. Genitalia (fig. 2c) pedunculate, normally at rest within sixth tergite; color brown, outer lamellae of tenth segment bifid, yellowish, the lobes ribbonlike.

Female.—Similar to the male, but the head (figure 2a) with the third antennal segment shorter and rounded; arista over twice as long as segment.

Types.—Holotype ♂, allotype, Falls Church, Virginia, March 25, 1951, W. W. Wirth, reared from moist debris in cavity in a beech tree (Type no. 61313, U. S. N. M.). Paratypes: 1 ♂, same data as type; 1 ♀, same except July 22; 1 ♀, Alexandria, Virginia, May 6, 1951, W. W. Wirth (reared from cavity in beech tree); 3 ♂ ♂, 2 ♀ ♀, 2 pupal exuviae, 7 larvae, same data except June 14 and 24; 3 ♂ ♂, with pupal exuviae, Falls Church, Va., April 19, 1913, C. T. Greene (reared ex *Liriodendron*).

This species resembles *S. americanus* Van Duzee in the black palpi and upper orbital cilia, but *americanus* differs in having all the legs mostly black, the outer bristle on the hind coxa white and a fringe of long, white hairs on the fore femur.

One of the larvae was found with the larval head capsule of a biting midge, *Dasyhelea oppressa* Thomsen, in the mid gut. This heleid, which is extremely common in tree-hole debris, probably forms the principal item of diet of these dolichopodid larvae. Other associates of the Falls Church tree

cavity were *Limonia* (*Rhipidia*) *fidelis* (Osten Sacken) (Tipulidae), *Phronia similis* Johannsen (Fungivoridae) (both determined by Alan Stone), *Chyromya flava* (Linnaeus) (Chyromyidae), *Coenosia* (*Neodexiopsis*) *basalis* (Stein) (Muscidae) (both determined by C. W. Sabrosky) and an undetermined, large species of Stratiomyidae which was not reared. Very closely related species inhabit the comparable environment in tree cavities in Britain, where Keilin (1927) recorded *Systenus adpropinquans* Loew and *S. scholtzii* Loew associated with *Phaonia cincta* Zetterstedt and *P. keilini* Collin (Muscidae) and *Rhipidia ctenophora* Loew (Tipulidae).

The Immature Stages of Systenus albimanus

Figs. 4-8

Pupa (fig. 4).—Length, about 3.5 mm. Enclosed in a loose, elliptical, whitish cocoon. Color creamy white, the respiratory organs and spines amber brown. The paired thoracic respiratory organs about half the length of pupa, blade-shaped, arising from dorsal side of cephalothorax near mid-line, each with a tubular basal section about half as long as free portion and extending under integument to the tracheal opening just above base of wing sheath. A pair of small, hemispherical tubercles just anterior to bases of free portions of respiratory organs, and a submedian pair of minute, sharp spines about halfway back on cephalothoracic dorsum. Ventrocephalic mid-line of cephalothorax with a contiguous pair of heavily sclerotized triangular tubercles, each bearing a shorter, spinelike, ventral tooth, and a small bristle-bearing tubercle just ventrolaterad of bases. A more widely separated pair of longer bristles above the bases of the anterior tubercles. Abdominal tergites 2-7 each with a transverse, subapical row of sharp, appressed, brownish spines; first, eighth and ninth segments bare.

Mature larva.—Length, about 7 mm. Color creamy white, only the sclerotized parts of head brown to black. Body (fig. 5) cylindrical, narrowed toward head; head segment very short and unsclerotized externally, internal parts extend past first thoracic segment. Posterior margin of third body segment with a long, thumblike, ventral pseudopod (fig. 5b) bearing several long spines at apex and shorter, retrorse hooks on posterior side; fourth segment with pseudopod reduced; posterior margins of fifth to ninth segments (fig. 5c) with progressively smaller ventral pseudopods, each bearing a median pair of long spines and double lateral rows of low, scalelike hooks; pseudopod between tenth and eleventh segment low and without longer spines; eleventh segment bearing a pair of low, semi-circular, anal lobes near front of ventral surface, flanked on each side by low, spinose warts and further laterad a pair of rosettes of warts. Posterior side of eleventh segment truncated and bearing two pairs of short lobes; the ventral pair longer and angular,

each lobe bearing a subapical and a subbasal palmate hair; the short, rounded, dorsal lobes (fig. 6) each bearing a spiracle which is flanked on upper and outer sides by a row of four long, palmate hairs. Anterior spiracles (fig. 5a) borne halfway back on sides of first body segment, with short internal chamber and simple exterior opening, apparently nonfunctional.

Head (figs. 7, 8).—Membranous externally, the labrum with two pairs of minute truncate sensillae on middle of dorsum. Antennae borne laterally, long and peglike, each with two minute conical sensillae at base and an adjacent semicircular sclerotized band with a group of minute conical sensillae. Maxillae marked externally by a flattened, membranous lobe with several subdivisions, none sclerotized, bearing minute conical, truncate and spinose sensillae. Labrum unsclerotized externally, with three pairs of minute truncate sensillae along anterior margin.

Internal sclerites of head consisting of two pairs of long, slender, sclerotized rods, the dorsal or metacephalic rods and the ventral tentorial rods, the more heavily sclerotized anterior ends of which articulate against the posteromedian side and the ventrolateral arms, respectively, of the median, heavily sclerotized, dorsal plate. Mandibles each divided in two sclerites; a smaller, vertical, barlike sclerite with the dorsal end bearing against the ventrolateral arm of the dorsal plate and the ventral end articulating apparently with the sclerotized cardo of the maxilla; the second sclerite of the mandible of the usual sickle-shaped mandibular form with the slender apex directed down and working in a verticolongitudinal plane, and the broad dorsal or proximal end articulating against the dorsolateral surface of the dorsal plate on the lateral side and against the anterodorsal side of the first sclerite on the inner side. Between the bases of the mandibles a triangular, bladelike, median epipharyngeal sclerite projects forward from under the anterior side of the dorsal plate, slightly past the upper lip. Labrum unsclerotized except for a very slender rod extending from base of the epipharynx to the dorsomedian surface of the labrum at the level of the group of four labral sensillae. Ventral side of head with a dorsoventrally flattened, pitted pharyngeal sclerite between the tentorial rods, the posterior end of which curves dorsad to lie between the posterior ends of the metacephalic rods. The salivary duct opens on the mid-line in an unsclerotized area just cephalad of the pharyngeal sclerite. Anterior end of pharyngeal sclerite flanked by a pair of slightly arcuate, barlike, hypopharyngeal sclerites, on the anterodorsal ends of which articulate a submedian, anterior pair of short, four- to six-toothed, labial sclerites.

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PROTHORACIC AORTIC SINUSES IN ANOPHELES, CULEX, AND AEDES

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In studies on the anatomy and physiology of the cardiac tube ("heart") of the mosquito, *Anopheles quadrimaculatus* Say, a hitherto undescribed structure was observed in its aortic (*i.e.*, thoracic) part in larvae, pupae, and adults.