

and broadly emarginate, the lateral lobes clothed with dense, long, light brown decumbent hair, the apices of the lobes visible from above as small, rounded projections adjacent to base of sixth tergum; sixth sternum strongly elevated along midline on apical half, a triangular area at base and a narrow strip along median ridge bare, the declivous areas laterad of median apical ridge clothed with very dense, short, erect silvery hair; seventh sternum completely retracted, very strongly raised along midline, apparently clothed as is the sixth; eighth sternum with exserted apical part very narrow, elongate linguiform, the sides minutely serrulate, apex bluntly rounded.

THREE NEW NORTH AMERICAN SPECIES OF TREE-HOLE CULICOIDES (DIPTERA, HELEIDAE)

By WILLIS W. WIRTH¹ and ROBERT H. JONES²

Increased attention to the taxonomy and biology of biting midges of the genus *Culicoides* has resulted in the rapid addition of many new species to the already large list of North American members of this genus. The recognition of these additional species is due in part to the utilization of more minute structural characters, and in part to rearing work which enables the procurement of species not ordinarily attracted to light traps or not commonly collected in series long enough to give the taxonomist adequate material for comparison and placement.

This paper increases the number of known Nearctic tree-hole breeders to ten, the previously described species being *arboricola* Root and Hoffman, *borinqueni* Fox, *flukei* Jones, *guttipennis* (Coquillett), *nanus* Root and Hoffman, *ousairani* Khalaf, and *villosipennis* Root and Hoffman. A few other described species probably breed in tree holes, but their biology is still unknown.

Since two of the species described here as new, *snowi* and *cavaticus*, fall into the *unicolor* complex, it seems advisable to present keys to the species involved. The two previously known species in this complex, *unicolor* (Coquillett) and *piliferus* Root and Hoffman, are not tree-hole species.

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Culicoides footei, new species³

(Figure 1)

A small species; mesonotum with a moderately distinct pattern; wings with second radial cell included in a dark area, with central portion devoid of light spots except for two basally in cell M_2 between crossvein and mediocubital fork; halteres white.

Female.—Wing length 0.8 mm., width 0.4 mm. Eyes separated. Antennal ratio (combined lengths of last five segments divided by combined lengths of preceding eight) 1.2; segments slender, longer than broad, segments IX plus X, and XI to XV in ratio of 1.4, 1, 1.0, 1.1, 1.2, 1.7; sensoria present on segments III to X (in one specimen from III to XII). Palpus with third segment (Fig. 1 c) distinctly swollen, 1.5 times as long as greatest breadth, with a small, very deep sensory pit; segments four and five small, subequal. Proboscis short, mandibular teeth minute, approximately 14 present.

Mesonotal disc (fig. 1 b) with a moderately distinct pattern of three longitudinal dark stripes, these defining two central light areas between them; the two wide lateral dark stripes joined with the lateral margins to enclose two light brown spots on each side anteriorly, a large rounded spot behind each humeral pit, directed obliquely inwards, and a smaller one immediately posterior to each large spot; anterolateral corners light gray, prescutellar dark spots distinct. Scutellum unicolorous brown, with four large marginal bristles and about eight hairs. Legs brown; knees somewhat darkened, with narrow light bands distad and adjacent to them; hind tibial comb with four large yellow spines.

Wing (Fig. 1 a) with second radial cell included in a dark area; macrotrichia sparse; color brown with the following distinct light spots: a small round one on crossvein, not extending through vein M and indistinctly extending to costa; a large one at apex of second radial cell, extending posteriorly to fold above vein R_5 and indistinctly extending basally under second radial cell; a large spot distally in anal cell, indistinctly connected posteriorly along wing margin to basal angle of wing; a large one centrally in cell Cu_1 , extending from vein M_1 to wing margin; one at apex of cell M_2 ; two light spots basally in cell M_2 , the more distinct one occupying angle of mediocubital fork and the indistinct narrow one anterior to this extending from crossvein to base of cell M_1 ; cells M_1 and R_5 each with an indistinct light spot apically; cell M_1 with a linear light spot extending from base beyond end of radial cells; and cell M_2 basally with linear light spot extending along axis for basal three-fourths of cell's length; crossvein brown in contrast to the surrounding light spot, lighter at its midpoint. Halter white.

Abdomen brown, cerci paler brown. Spermathecae two (Fig. 1 f) oval, with distinct, parallel-sided, sclerotized portion of duct at junction with each spermatheca; ring present, rudimentary spermatheca apparently absent.

Male.—Similar to the female with the usual sexual differences. Genitalia as illustrated (Fig. 1 d, e). Ninth sternum deeply excavated, membrane not spiculate; ninth tergum strongly tapered to apex, apicolateral processes well developed.

³We take great pleasure in naming this species in honor of Dr. Richard H. Foote, Entomology Research Branch, in recognition of his long interest in and outstanding contribution to the taxonomy of the *Culicoides* of the eastern United States.

Basistyle normal; ventral root well developed, boat-hook shaped, posterior projection small and close to margin of basistyle; dorsal root well developed, stout. Aedagus with stem equal in length to height of basal portion, with subapical projections; basal arms with distinct pointed posterior projections from posterior margin. Parameres separate; each with base slightly divergent, with a distinct lobelike swelling on stem before the recurved tips which are flattened and expanded with inner edges barbed.

Types.—Holotype, ♀, allotype ♂ : Alexandria, Virginia, 15 May 1955, W. W. Wirth and R. H. Jones, reared from oak tree hole (Type No. 62858, U.S.N.M.). Paratypes, 40 ♀ ♀, 71 ♂ ♂ : 21 ♀ ♀, 56 ♂ ♂ same data as types; 1 ♀ same data but reared from maple tree hole; 2 ♀ ♀, 3 ♂ ♂, Alexandria, Virginia, 6 and 14 June 1951, W. W. Wirth, reared from tree hole; 10 ♂ ♂, Falls Church, Virginia, 23 June 1951 and 7 April 1954, W. W. Wirth, reared from tree hole debris; 6 ♀ ♀, Mount Solon, Augusta County, Virginia, 2 July 1955, W. W. Wirth and R. H. Jones, reared from tree hole; 5 ♀ ♀, 2 ♂ ♂, Camden, Tennessee, 17 May 1954, W. E. Snow; 1 ♀, same data except 22 September 1954; 4 ♀ ♀, Morgan Creek, Tennessee, 7 July 1954, W. E. Snow.

Larvae were collected, also last larval and pupal exuviae were associated with emerged adults. These will be described elsewhere by the junior author.

This species is closely related to *haematopotus* Malloch, with male genitalia very similar. The female resembles *nanus* Root and Hoffman in general color and wing markings and also in palpal structure, but is distinguished by the presence of two light spots basally in cell M_2 between the mediocubital fork and crossvein, *nanus* having this area completely devoid of light markings; in *nanus* moreover, the halteres are dusky.

Culicoides snowi, new species⁴

(Figure 2)

A medium-sized species; mesonotum with a moderately distinct pattern; wing yellowish without distinct markings, second radial cell in a dark area.

Female.—Wing length 1.0 mm., width 0.5 mm. Eyes moderately separated. Antennal ratio 1.1, segments IV to X longer than broad, segments IX plus X and XI to XV in ratio of 1.3, 1, 1.0, 1.1, 1.1, 1.5; sensoria present on segments III, V, VII, IX, and XI to XV. Palpus (fig. 2 c) with third segment moderately swollen, 2.0 times as long as its greatest breadth, with a moderately broad and deep sensory pit; segment five slightly longer than segment four. Mandible with 15 teeth.

Thorax dull to slightly shining, light brown; mesonotal disc (Fig. 2 b) with a faintly indicated median line and a pair of elongate, sublateral bars darker

⁴We are very happy to dedicate this species to Dr. Willis E. Snow, Tennessee Valley Authority, who has made an intensive study of the fauna of tree holes for the past decade and has contributed many records of North American *Culicoides*.

brown, these extending indistinctly to scutellum; disc with numerous short, fine, yellowish hairs; anterolateral corners whitish pollinose, prescutellar dark spots distinct. Scutellum dark brown with four large blackish marginal bristles and from 10 to 15 short hairs. Legs pale brown, tibiae with indistinct, sub-basal pale bands; hind tibial comb usually with four large spines.

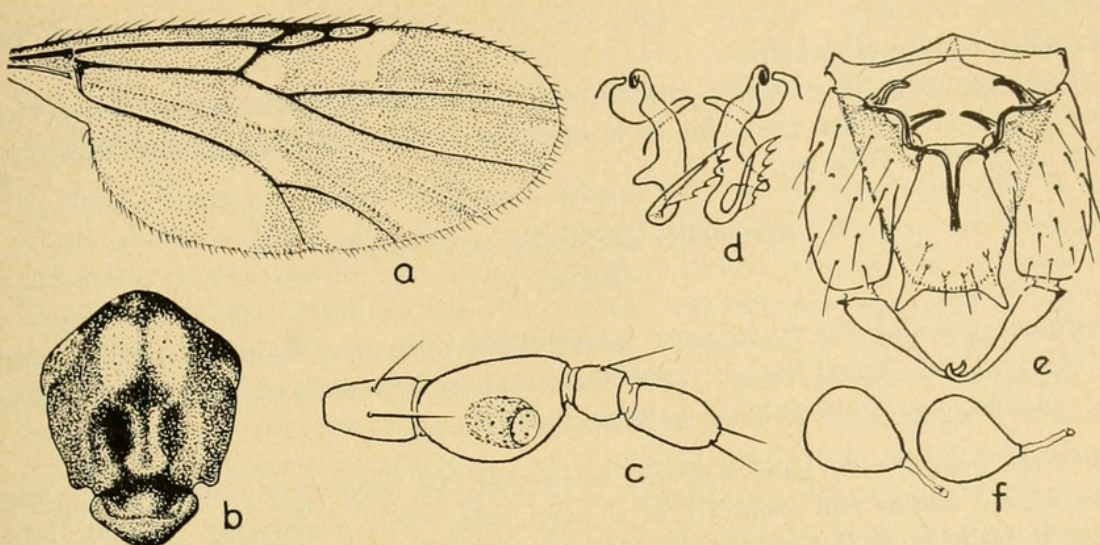
Wing (Fig. 2 a) with second radial cell included in a slightly darker spot, yellowish macrotrichia numerous, fairly long and evenly distributed, giving the wing a distinct yellowish color. Only two distinct pale spots present, one over crossvein and the other at apex of second radial cell, remainder of wing without distinct pale spots but appearing more or less pale yellowish gray between veins. Some specimens with vein Cu_1 distinctly bordered by a darker area, veins M_1 and M_2 less distinctly so. Crossvein light in color, not distinct from surrounding light spot. Halter whitish.

Abdomen brown; spermathecae (Fig. 2 f) two, slightly unequal, oval, the ducts with a very short sclerotized portion at juncture with spermathecae; ring and rudimentary spermatheca present.

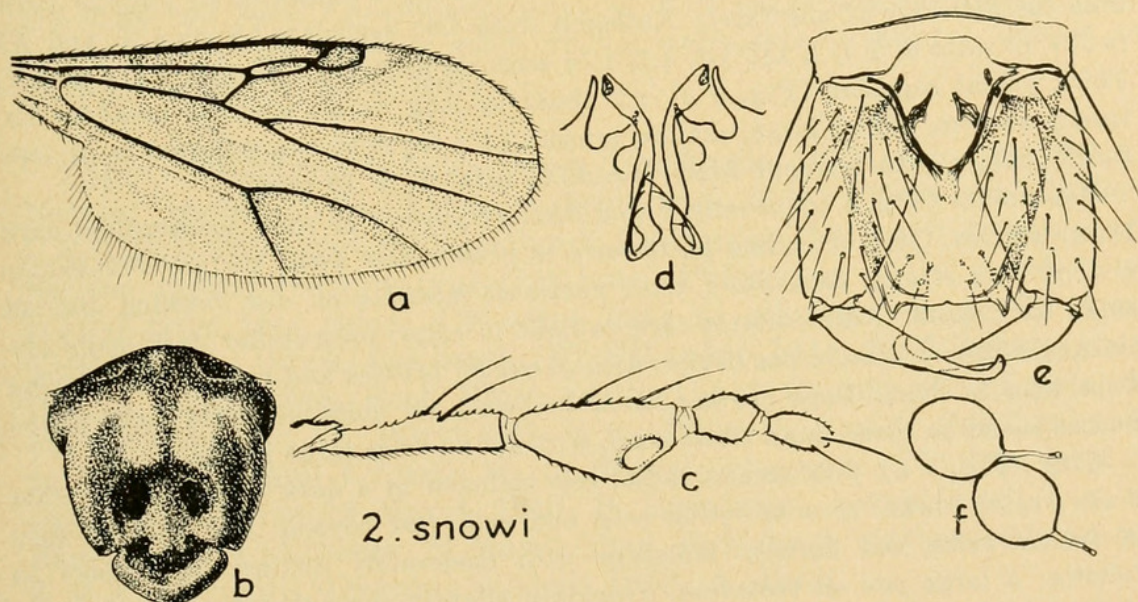
Male.—Similar to the female with the usual sexual differences. Genitalia as illustrated (Fig. 2 d, e). Ninth sternum with broad, deep caudomesal excavation, posterior membrane not spiculate; ninth tergum with apex slightly notched, apicolateral processes short and usually slender, sometimes broadened basally. Basistyle normal, slender; ventral root boat-hook shaped, the posterior projection short; dorsal root long, moderately stout and straight; dististyle slender with slender, in-curved apex. Aedeagus with basal arms well sclerotized, usually separated mesally by unsclerotized area; basal arms slender, widened posteriorly, slightly curved; anteromesal margin of basal arch at 0.7 of total length of aedeagus; distal stem short and tapering, typically indistinct, lightly sclerotized, with apex rounded. Parameres separate, basal portions divergent at about 45° ; each with point of basal angulation and portion immediately posterior to it distinctly narrowed, anteriorly tapering evenly to the swollen end; stem sinuate, broader centrally than anteriorly, distal portion curved evenly ventrocephalad and bearing about four widely separated barbs.

Types.—Holotype ♀, allotype ♂: Falls Church, Virginia, 17 February 1954, W. W. Wirth, reared from debris in tree hole (Type No. 62859, U.S.N.M.). Paratypes, 17 ♀♀, 7 ♂♂: 3 ♀♀, 1 ♂, same data as types; 2 ♀♀ same data as types except 25 March 1951 and 29 April 1953; 4 ♀♀, 2 ♂♂, same data except April 1951; 4 ♀♀, 2 ♂♂, Alexandria, Virginia, 1 and 29 April 1951 and 12 April 1953, W. W. Wirth, reared from tree hole; 2 ♀♀, Alexandria, Virginia, 15 May 1955, W. W. Wirth and R. H. Jones, reared from oak tree hole; 1 ♀, Maryland near Plummers Island, 8 May 1915, J. C. Crawford; 2 ♂♂, Morgan Creek, Tennessee, 25 March 1954, W. E. Snow; 1 ♀,

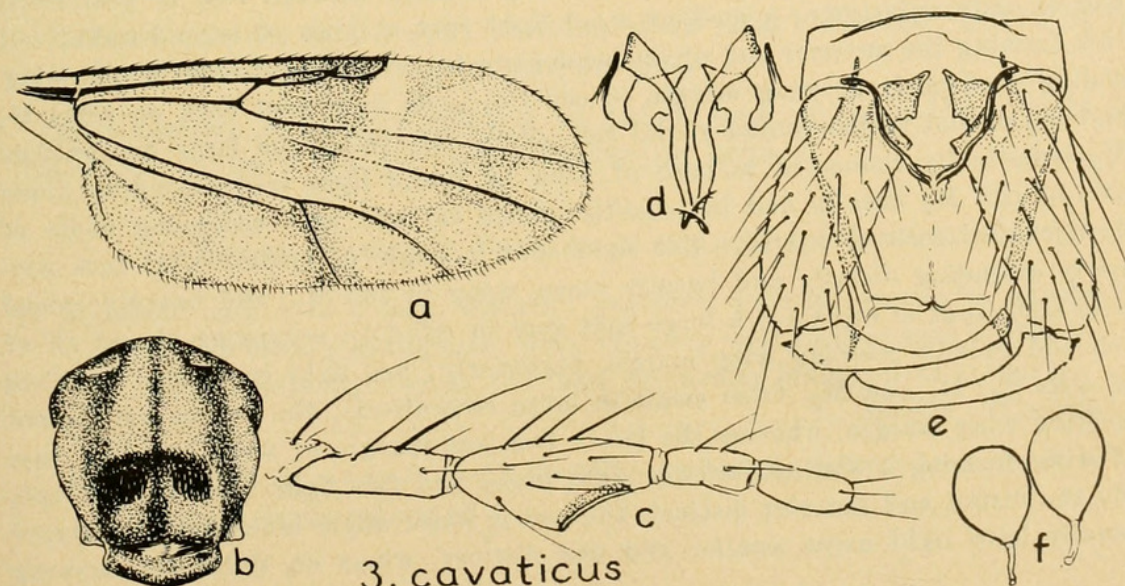
Fig. 1, *Culicoides footei*, n.sp.; Fig. 2, *Culicoides snowi*, n.sp.; Fig. 3, *Culicoides cavaticus*, n.sp. a, wing; b, mesonotal pattern; c, female palpus; d, male parameres; e, male genitalia, parameres removed; f, spermathecae.



1. *footei*



2. *snowi*



3. *cavaticus*

Grafton, Illinois, March 1950, W. E. Snow. No pupae, larvae or exuviae were collected.

This species is closely related to *unicolor* (Coquillett), *piliferus* Root and Hoffman and the new species from California, the description of which follows.

***Culicoides cavaticus*, new species**

(Figure 3)

Culicoides unicolor Wirth, in part (misidentification, not Coquillett, 1905), 1952, Univ. Calif. Publ. Ent. 9: 185 (California; "well-marked phase," tree hole records; fig. wing, palpus, male genitalia).

A large brown, very hairy species; mesonotal disc with three dark striae; wing with second radial cell included in a dark area, with moderately distinct light spots in addition to the two anterior distinct pale spots.

Female.—Wing length 1.6 mm., width 0.6 mm. Eyes separated by slightly more than the diameter of one facet. Antennal ratio 1.0; segments IX plus X, and XI to XV in ratio of 1.5, 1, 1.0, 1.2, 1.2, 1.7; sensoria present on segments III to XV. Third palpal segment (Fig. 3 c) 2.2 times as long as its greatest breadth, distinctly swollen, with a large, shallow sensory pit; segment five subequal to or one-fourth longer than segment four. Mandible with 15 to 18 teeth.

Mesonotum (Fig. 3 b) usually with a distinct pattern of three longitudinal dark brown stripes, these extending posteriorly to prescutellar area; surface abundantly clothed with strong, dark hairs, their points of insertion on disc forming distinct small dark spots. Anterolateral corners light in color, prescutellar dark spots distinct. Scutellum unicolorous brown, with about 30 bristles and hairs, these varying from long to short. Legs brown; knees darkened, an indistinct light band distad and adjacent to them; hind tibial comb with four or five large spines.

Wing (Fig. 3 a) with second radial cell included in a dark area; macrotrichia dense; color brown, area of radial cells and area just beyond light spot at apex of second radial cell darker. Holotype with moderately distinct light spots as follows: a large one on crossvein, extending slightly through vein M posteriorly and to costa anteriorly; a medium sized light spot at apex of second radial cell, this forming the anterior end of an incomplete transverse light band across wing, ending posteriorly at wing margin in cell Cu_1 ; one light spot each on veins M_1 and M_2 caudal to the second radial cell, one on M_1 small, the large one on vein M_2 indistinctly connected to base of wing by linear light spot extending along axis of cell M_2 basally and indistinctly joined to light area occupying angle of mediocubital fork in cell M_2 ; this light spot in angle of mediocubital fork narrowly extending distally and basally along veing in cell M_2 , and broadly joined with light spot in cell Cu_1 ; a large light spot in cell Cu_1 , occupying almost all of cell and broadly meeting wing margin posteriorly; one light spot each in apices of cells R_5 , M_1 and M_2 , from small to large respectively, the one in cell R_5 not meeting wing margin, whereas the latter two join margin of wing broadly; base of wing forming a distinct, narrow light area; and two light spots in anal cell, the one distad and anterior distinct, the one in basal angle indistinct. Paratypes usually have light areas smaller and less distinct, wings on slides not showing

presence of distinct light spots. Crossvein light in color, indistinct from surrounding light spot. Halter yellow.

Abdomen brown; spermathecae (Fig. 3 f) two, saclike, ducts unsclerotized, ring and rudimentary spermatheca present, rudimentary spermatheca at least partially developed.

Male.—Similar to female with usual sexual differences. Genitalia (Fig. 3 d, e). Ninth sternum with broad, deep, caudomesal excavation, posterior membrane not spiculate; ninth tergum with apical margin notched, apicolateral processes well developed, slender. Basistyle normal; ventral root well developed, stout, boat-hook shaped, the posterior projection broad, blunt; dorsal root well developed, moderately stout, straight; dististyle slender with blunt, incurved apex. Aedeagus with basal arms well sclerotized, usually separated mesally by unsclerotized area, basal arms slender, posteriorly widened, then tapering evenly into distal stem; antero-mesal margin of basal arch at 0.7 of total length of aedeagus; distal stem short, broad, nonsclerotized, apex rounded. Parameres separate, basal portions diverging at about 45°; each with basal end abruptly but slightly capitate, with margins and basal half heavily sclerotized; point of basal angulation not distinctly narrowed, stem sinuate, tapering evenly to the ventrocephally directed, pointed tip bearing four or five lateral barbs.

Types.—Holotype female: Davis, California, 22 March 1940, W. C. Reeves, reared from black walnut tree hole (Type No. 62860, U.S.N.M.). Allotype ♂, Woodland, California, 13 April 1940, W. C. Reeves, reared from walnut tree hole. Paratypes, 41 ♀♀, 66 ♂♂, reared from tree holes: 1 ♀ same data as allotype except 22 April 1940; 2 ♂♂, Davis, California, 21 February 1948, R. Bohart, walnut tree; 1 male, Alum Rock Park, Santa Clara County; California, 23 March 1949, W. W. Wirth; 21 ♀♀, 49 ♂♂, Sunol, California, 28 and 30 March and 1 April, W. C. Reeves, sycamore; 15 ♀♀, 5 ♂♂, same data except 14 March 1946, B. Brookman, cottonwood; 5 ♂♂, Sacramento, California, 21 March 1948, R. Bohart, cottonwood; 4 ♀♀, 4 ♂♂, Corvallis, Oregon, 8 April 1952, A. Roth.

Larvae, pupae, and pupal exuviae were also collected, but will be described elsewhere by the junior author.

This species is closely related to *snowi* new species, the points of difference being included in the following keys.

KEY TO CULICOIDES FEMALES OF THE *unicolor* COMPLEX

1. Mandible with 4 to 6 teeth distally; proboscis greatly tapered to narrow apex; eyes usually contiguous; wing typically well marked with moderately distinct, large light spots, but these frequently indistinct or absent.....
.....*unicolor* (Coquillett)
- Mandible with 12 or more teeth distally; proboscis moderately tapered to broad apex; eyes separated 2

2. Wing with anal cell almost entirely or entirely a unicolorous light area, at most vein Cu_1 bordered by a darker area, wing without distinct light spots; third palpal segment moderately swollen, with a moderately broad, deep sensory pit *snowi* n. sp.
- Wing with anal cell predominately a dark area, with at least moderately distinct light spots present; wing with at least moderately distinct spots in addition to the anterior two; third palpal segment swollen or not, the sensory pit shallow 3
3. Third palpal segment distinctly swollen, the sensory pit large and shallow; antennal ratio 1.0; a light brown species *cavaticus* n. sp.
- Third palpal segment at most slightly swollen, the sensory pit small and shallow; antennal ratio 1.2; a dark species *piliferus* Root & Hoffman

KEY TO CULICOIDES MALES OF THE *unicolor* COMPLEX

1. Aedeagus with distal stem distinct, long and distinctly narrow, usually at least moderately sclerotized 2
- Aedeagus with distal stem usually indistinct, short and broadly rounded apically, lightly sclerotized 3
2. Apicolateral processes stout, triangular; aedeagus usually with distinct lateral flanges projecting from angle formed by juncture of distal stem with basal arms; distal stem relatively short, narrow, only slightly curved ventrad, with apex rounded; basal arms stout to very stout, usually only slightly arcuate, anteromesal area between basal arms relatively short and rapidly tapered posteriorly; ventral root with anterior projection long and usually stout, posterior projection usually short and blunt; membrane posterior to ninth sternum usually spiculate *unicolor* (Coquillett)
- Apicolateral processes slender, fingerlike; aedeagus without lateral flanges; distal stem long, distinctly turned ventrally, apex therefore poorly visible in ventral aspect, usually appearing broadened and flattened; basal arms of aedeagus slender and distinctly arcuate; ventral root of basistyle with anterior and posterior projections both long and narrow; membrane usually not spiculate *piliferus* Root & Hoffman
3. Paramere with the point of basal angulation and portion immediately distad distinctly narrowed, anteriorly tapering evenly to the swollen end; apicolateral processes short, narrow to moderately wide basally *snowi* n. sp.
- Paramere not distinctly narrowed at point of basal angulation, anteriorly abruptly, slightly capitate; apicolateral processes long, usually narrow, sometimes broadened basally *cavaticus* n. sp.



Wirth, Willis Wagner and Jones, R H. 1956. "Three new North American species of tree-hole Culicoides (Diptera, Heleidae)." *Proceedings of the Entomological Society of Washington* 58, 161–168.

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