

GYNANDROMORPHIC SPECIMENS OF *SOMATOCHLORA* (ANISOPTERA: CORDULIIDAE)

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The external morphology of gynandromorphic specimens of *S. filosa* from Liberty Co, FL, USA, and *S. provocans* from Burlington Co., NJ, USA, is described in detail. A small series of additional specimens from Florida and North Carolina, all mostly female with some masculine features, is characterized briefly.

INTRODUCTION

Reports of Odonata specimens with male and female somatic characters in the same individual are rare; I have been able to discover only 14 in the literature prior to 1987 (SCHIEMENZ, 1953; GLOYD, 1971, 1975, and references therein; BELLE, 1976). Such specimens generally have been called gynandromorphs (RIS, 1929; GLOYD, 1971), although some authors restrict that term to individuals comprising a mosaic of pure male and pure female tissues, as contrasted with intersexes, in which male and female characters are blended at the cellular level (LAUGE, 1985).

Recently HARITONOVA (1987) and SIVA-JOTHY (1987) described additional coenagrionid and gomphid gynandromorphs, respectively. SIVA-JOTHY (1987) noted that a simple mechanism that is well known in *Drosophila* (MORGAN & BRIDGES, 1919; cf. also LAUGE, 1985), loss of an X chromosome during early cleavage, could account for production of balanced, genetic mosaic gynandromorphs, like the *Onychogomphus* he recorded and most other known specimens.

In this paper I describe gynandromorphs (in the broad sense) in the genus *Somatochlora* and briefly discuss the applicability of a genetic mechanism involving chromosome loss to these and similar examples. Certain patterns of

mixed male and female features appear surprisingly common in some species of this genus.

DESCRIPTIONS

In 1971 I collected in Florida an obviously gynandromorphic *S. filosa*; 14 years later in New Jersey I took a similar specimen of *S. provocans*. Both were collected from feeding swarms over roads, a circumstance that precluded any observations of reproductive behavior; their flight did not appear abnormal in any way. These two specimens are described and figured below. The *filosa* was collected at the same location as the gynandromorphic *S. filosa* recorded by GLOYD (1971), but almost 40 years later. The existence of these three specimens led me to make a rapid and very superficial search in the Florida State Collection of Arthropods (FSCA) for additional gynandromorphs of these and a few related species. Surprisingly, a number were found. These are described very briefly; all are more strongly female than the two individuals originally collected, so only masculinized features are noted. All of the localities are in the eastern United States. None of the specimens was dissected, so the condition of the internal reproductive organs is unknown.

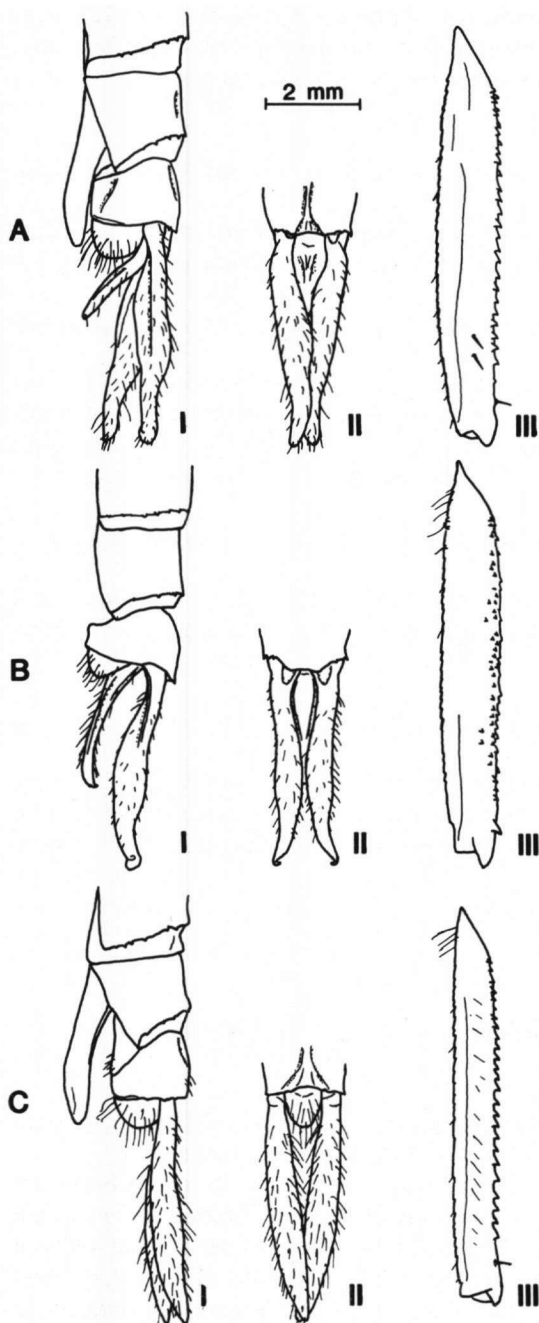
SOMATOCHLORA FILOSA (HAGEN)

Figure 1

(I) Florida, Liberty County, Torreya State Park, 6 August 1971, coll. by M.L. May, Collection of M.L. May. (Fig. 1).

Abdominal segment 2 with symmetrically developed genital lobes only slightly smaller than those of normal male. Genital fossa distinct, but neither penis nor anterior lamina present. Small strap-like structure within the fossa probably representing right hamule; left hamule entirely absent. Distinct but reduced auricles present on each side. Segment 3 strongly constricted as in male. Segment 9 with fully-formed and apparently normal vulvar lamina and sclerotized sternal papillae, characteristic of female. Segment 10 nearly like that of female but slightly male-like in having rim perceptibly excavated dorsolateral to bases of cerci. Latter structures intermediate in shape between those of normal male and female (sexes have cerci of roughly equal length in this species); male-like in having distinct ventral carina and strongly sinuate dorsal margin and in being

Fig. 1. *Somatochlora filosa* (Hagen): (A) Gynandromorph No. 1 (see text); — (B) Normal male: Florida, Alachua County, Gainesville, 13 October 1969, coll. by M.L. May, Coll. of M.L. May; — (C) Normal female: Florida, Liberty County, about 1 mi S of Torreya State Park, 27 September 1969, coll. by M.L. May, Coll. of M.L. May. — [I: Left lateral view of abdominal segments 9 and 10 and associated structures; — II: Dorsal view of apex of abdominal segment 10 and associated structures; — III: External view of right metafemur. Magnification uniform for all parts]



constricted and slightly out-curved in distal 1/3, with reduced but distinct apical hook. Epiproct shaped like that of male, but base situated more dorsally than normal, slightly less than 1/2 the length of the cerci (vs. about 5/8 normally), and without dorsoapical denticles. Hindwings angulate basally, although slightly less than in most males. Prothoracic tibiae with very short rudiments of keels at distal end. Metatibial keels present in middle 1/3 and again as very short distal rudiments; metafemora distinctly widened at midlength as in male, with double row of denticles along inner angle of flexor surface and basally doubled row along outer angle (vs. 3 or 4 rows of very small denticles along both angles in male, a single regular row of larger teeth along both in female), except for single stout seta or seta-like spur near distal end of latter (as in female; male bears short, stout spine here).

(2) North Carolina, Craven/Pamlico County, Upper Broad Creek, 22 July 1975, coll. by R.D. Cuyler, FSCA.

Abdominal segment 2 with distinct but reduced genital lobes. Dorsoapical

margin of segment 10 slightly excavated over the bases of the cerci. Cerci about as described for preceding specimen but with no development of apical hook. Metafemora also similar to first specimen. Numerous eggs adhering to vulvar lamina.

(3) North Carolina, Pasaquotank County, Morgan's Corners, 13 July 1973, coll. by R.D. Cuyler, FSCA.

Nearly identical to No. 2 except with doubling of rows of metafemoral denticles less extensive. Numerous eggs adhering to vulvar lamina.

(4) Florida, Columbia/Baker County line, Osceola National Forest, junction of Rte 90, malaise trap, 26 Sept.-8 Oct. 1976, coll. by J.R. Wiley, FSCA.

Abdominal segment 2 with distinct genital lobe, slightly wider than in North Carolina specimens but smaller than in specimen No. 1. Cerci similar to North Carolina specimens but with male-like features generally slightly less developed. Metafemora with general shape of male but spines like those of female.

(5) Florida, Alachua County, Hatchet Creek, 8 mi E of Gainesville, 6 Oct. 1973, coll. by J.B. Heppner, FSCA.

Nearly identical to No. 4 but with male-like features of cerci, although still distinct, further reduced, ventral carina absent. A few eggs adhering to vulvar lamina.

(6) Florida, Liberty County, 1 mi SE of Torreya State Park on Hgwy 271, 27 Sept. 1969, coll. by M.J. Westfall, FSCA.

Abdominal segment 2 with definite but very small genital lobes. Cerci very slightly sinuate on dorsal margins and barely curving outward in distal 1/3. Metafemora shaped like those of male but with spines like female.

(7) Florida, Calhoun County, Juniper Creek at Hgwy 20, 9 Sept. 1973, coll. by S.W. Dunkle, FSCA.

Practically identical to No. 6.

SOMATOCHLORA PROVOCANS CALVERT

Figure 2

(1) New Jersey, Burlington County, Wharton State Forest, Hampton Road, just N of Atsion Ranger Station, 11 July 1985, coll. by M.L. May, Collection of M.L. May. (Fig. 2).

The specimen is teneral and shows, e.g., slight lateral compression of abdominal segment 10 and outward buckling of the right cercus at 1/2 its length (Fig. 2b). Abdominal segment 2 with distinct and symmetrical but reduced genital lobes. Genital fossa and other secondary genitalia absent. Very small rudiments of auricles present on each side, but lateral pale markings confluent, as

in females. Abdominal segment 3 like that of female in shape, less abruptly constricted and shorter than that of male; anterodorsal pale spots small, as in male (although this character somewhat variable in both sexes). Segment 4 with weakly developed lateral keel, nearly like that of male (keel virtually obsolete in female). Segment 9 with vulvar lamina well developed but distinctly shorter (3.0 vs. about 3.5 mm, not extending to apex of paraprocts) and less curved than in normal female; sternal papillae, if present, hidden by lamina. Segment 10 with no dorsoapical protuberance or excavation dorsolateral to cerci. Cerci 3.0 mm long,

i.e., near normal range for male, with distinct ventral carina and lateral angulation at 3/5 length, constricted distally, but with all these features much less strongly developed than in normal male (cerci of females smoothly spindle-shaped except for short and weak laterobasal keel, usually about 2.1-2.3 mm long [CARLE, 1982]). Epiproct apparently entirely female-like. Prothoracic tibiae with distal rudiments of keels, slightly larger than in *filosa* specimen No. 1. Metathoracic tibiae bearing tiny, distal keel rudiments but no development of the keels near midlength; metafemora essentially identical to those of *filosa* No. 1.

(2) Florida, Liberty County, 1 mi S of Torreya State Park, 3 July 1973, coll. by J.B. Heppner, FSCA.

Tergite of abdominal segment 2 with ventroapical corner produced and slightly

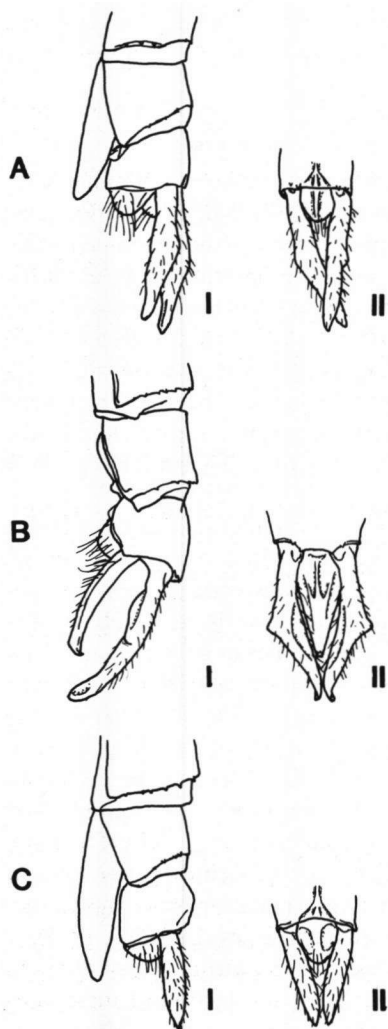


Fig. 2. *Somatochlora provocans* Calvert: (A) Gynandromorph No. 1 (see text); — (B) Normal male: New Jersey, Burlington County, Wharton State Forest, Hampton Road, just N of Atsion Ranger Station, 12 July 1984, coll. by M.L. May, Coll. of M.L. May; — (C) Normal female: Alabama, Tuscaloosa County, Moody Swamp, 20 July 1939, coll. by The Dragonets, FSCA. — [I: Left lateral view of abdominal segments 9 and 10 and associated structures; — II: Dorsal view of apex of abdominal segment 10 and associated structures. — Magnification same as Fig. 1]

elevated to form rudimentary genital lobe. Lateral carina on abdominal segment 4 weak but distinct. Vulvar lamina not extending to apex of paraprocts. Cerci slightly but distinctly constricted and angled inward at about 3/4 length and slightly longer than normal for a female (2.6 mm). Epiproct more acute distally than in normal females, possibly due to postmortem distortion. Metafemora shaped like those of male but with spines like female.

(3) North Carolina, Edgecombe County, Heartsease, 30 July 1975, coll. by R.D. Cuyler, FSCA.

This specimen barely distinguishable from normal female. Cerci very slightly angled inward at 2/3 length and about 2.6 mm long. Metafemora shaped like those of male but with spines like female.

DISCUSSION

These *Somatochlora* exhibit mixtures of male and female external characters ranging from almost entirely female to about equally divided; the first-described *filosa* might be considered a "balanced" gynandromorph, in the sense that neither sex clearly predominates. None, however, is readily interpreted as a genetic mosaic. They are not partitioned into large regions that have exclusively the characters of one sex or the other (usually primarily male on one side, female on the other). Rather, they are symmetrical in development, with normally dimorphic structures mostly having characters intermediate between the typical male and female conditions. This is particularly noticeable in the development of the genital lobes, cerci, and metathoracic legs. The *S. filosa* described by GLOYD (1971) was apparently similar in this respect.

It seems unlikely that such a blending of characters could arise by early loss of an X chromosome during embryonic cleavage or, indeed, any mechanism involving a simple postzygotic rearrangement of chromosomes. Possibly the specimens are actually intersexes. This condition can arise by a variety of mechanisms including unequal multiplication of autosomes or of X chromosomes to given abnormal X:A ratios and/or by action of mutations at specific autosomal loci (LAUGE, 1985). Thus, although SIVA-JOTHY's (1987) is the most parsimonious explanation for the largest category of known gynandromorphic Odonata, other mechanisms are very probably involved in the *Somatochlora* described here, and in at least a few other cases. For example, any specimen in which male characters clearly predominate (e.g., KLOTS, 1943; BELLE, 1976) is difficult to explain by a single loss of the X chromosome, at least in species with the usual XX/XO mode of sex determination, since this should result in at most 1/2 of the body with male characteristics (LAUGE, 1985).

Without more detailed knowledge of genetic and epigenetic control of sex in Odonata, any discussion of mechanisms underlying production of these non-mosaic gynandromorphs must be quite speculative. It may be significant,

however, that, with one exception, female somatic characters predominate in all the specimens described here. Also, although the gonads were not examined, the presence of eggs on the vulvar laminae of three *filosa* specimens suggest that they were functionally female. In *Drosophila*, several genetic abnormalities can produce individuals that are somatically mostly female with a varying admixture of male characters, and some of these apparently do not affect germ line cells (LAUGE, 1985). On the other hand, I must emphasize that my survey was extremely cursory; it is possible that certain masculine characters, especially presence of rudimentary genital lobes, are visually more obvious on primarily female specimens than are feminine characters, e.g. rudimentary vulvar lamina, on primarily male specimens.

It also is certainly of interest to note that the only reported gynandromorphs among *Somatochlora*, or, in fact, within the Corduliidae, are in two species considered by WALKER (1925) to be part of a small, distinct species group within the genus. The significance of this observation is, of course, difficult to assess on the basis of such extremely scanty data. Also, I did not check other species groups for similar aberrations, and, conversely, I searched for but failed to find gynandromorphs of other species within this group, *S. calverti*, *S. margarita*, and *S. ozarkensis*. Nevertheless, further morphological and cytological examination of all these species would be of interest.

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