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THE GENERA *MACROXYELA* KIRBY AND *MEGAXYELA* ASHMEAD (HYMENOPTERA: XYELIDAE) IN NORTH AMERICA

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Abstract.—Five species of *Megaxyela,* including ***Megaxyela alisonae,*** **n. sp.,** and two species of *Macroxyela* occur in North America. *Macroxyela bicolor* MacGillivray is a **new synonym** of *Macroxyela ferruginea* (Say). The species are keyed, described and illustrated, and biological information is summarized. Hosts include hickory, pecan, and elm.

Key Words: *Megaxyela, Macroxyela,* Xyelidae, *Ulmus, Carya,* pecan, North America

The large xyelids of the genera *Megaxyela* and *Macroxyela* are among the most intriguing groups of sawflies because of their odd appearance, scarcity, and probable primitive status in the Symphyta and Hymenoptera. They are apparently two relic genera in a family with a long fossil record (Rasnitsyn 1969). *Megaxyela* occurs only in eastern Asia and eastern North America, and *Macroxyela* only in North America. Larvae of both genera are associated with angiospermous trees, whereas all other Xyelidae are associated with conifers. They are seldom collected, although *Macroxyela ferruginea* (Say) can be collected in numbers on its host during its flight time. Why *Megaxyela* is so scarce is puzzling. Such large (10–15 mm long) and colorful insects with long hindlegs (Fig. 3) certainly should be sighted more frequently by collectors.

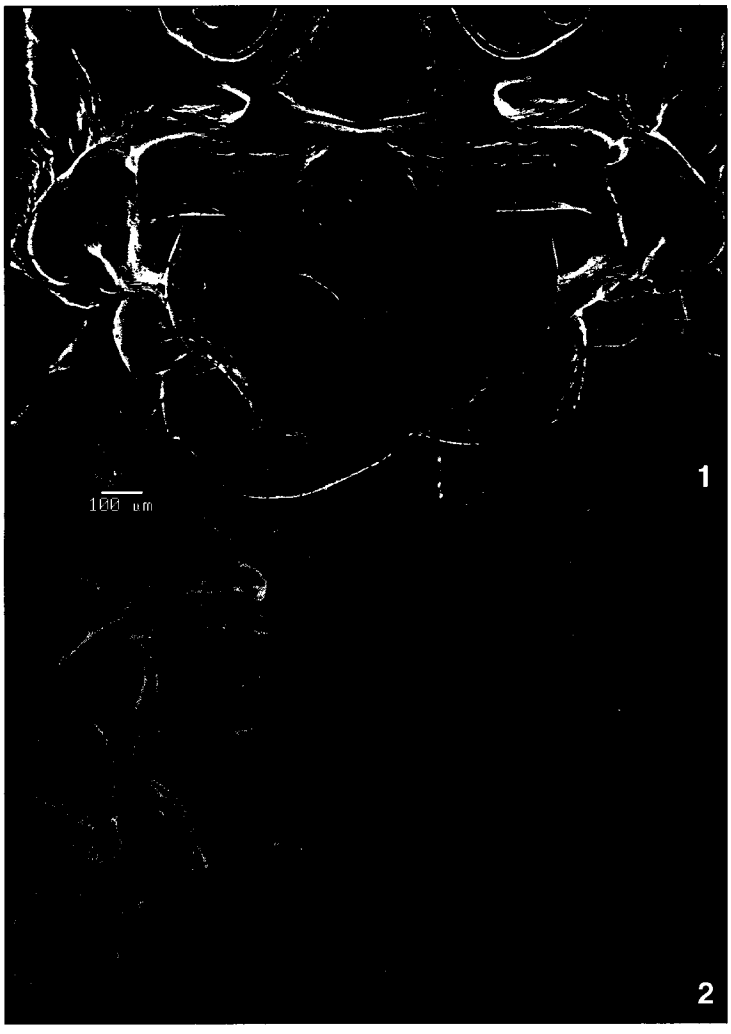
Both genera were revised by Ross (1932), but few specimens were available to him, and he was not able to resolve sex associations or present a complete concept of the North American fauna. Although he did not use subfamily or tribal categories for Xyelidae, he suggested that *Megaxyela* and *Macroxyela* form a natural unit based on wing venation and that *Xyela* Dalman, *Neoxyela* Curran (= *Xyela*) and *Pleroneura* Konow form a separate closely related group. Smith (1967) proposed a classification based on larval and adult characters and concluded that *Macroxyela* and *Megaxyela* form the tribe Macroxyelini in the subfamily Macroxyelinae. The other tribe of Macroxyelinae, Xyeleciini, includes *Xyelecia* Ross, a genus found in western North America and Japan.

We have accumulated about 600 specimens of the genera *Megaxyela* and *Macroxyela* and are now able to resolve some questions and present a more complete picture of species composition in North America. We recognize five species of *Megaxyela* and two species of *Macroxyela.*

Specimen depositories and acronyms used are in Acknowledgments.

TRIBE MACROXYELINI

The Macroxyelini differ from other Xyelidae by wing venation (Figs. 4–6): forewing



Figs. 1–2. Clypeus and labrum. 1, *Megaxyela aviingrata.* 2, *Macroxyela ferruginea.*

with vein Rs1; C free from Sc forming costal and subcostal cells; vein Sc2 distinct; Sc2 joining Sc + R1 apical to separation of Rs; hindwing with two closed submarginal cells (1Rs and 2Rs) (wing venation terminology follows Goulet and Huber 1993). Also, the apical filament of the antenna is short, one-quarter to one-third the length of the third segment, and 5–11 segmented, and the tarsal claws have a long inner tooth, nearly as long as the outer tooth.

Key to Genera of Macroxyelini

1. Clypeus with large median triangular tooth and labrum rounded with notch on anterior margin (Fig. 1); forewing with Sc2 joining Sc + R1 ¼ to ½ distance between separation of Rs and stigma (Fig. 4); labial palpus 4-segmented . . . . . *Megaxyela*
– Clypeus with small anterior median notch and labrum broad, rectangular, and nearly truncate anteriorly (Fig. 2); forewing with Sc2 joining Sc + R1 very slightly apical to juncture of Rs with Sc + R1 (Figs. 5, 6); labial palpus 3-segmented . . . . . *Macroxyela*

Genus *Megaxyela* Ashmead

Megaxyela Ashmead 1898: 214.—Ross 1932: 161–164 (N. Amer. species; syn.: *Odontophyes, Paraxyela*).—Ross 1951: 7 (N. Amer. catalog).—Smith 1978: 24

(world catalog).—Smith 1979: 10 (N. Amer. catalog).—Shinohara 1992: 783–786 (Asian species). Type species: *Xyela major* Cresson. Orig. desig.

Odontophyes Konow 1899: 42. Type species: *Pleroneura aviingrata* Dyar. By monotypy.

Megaloxyela Schulz 1906: 88. Emendation.

Paraxyela MacGillivray 1912: 294. Type species: *Xyela tricolor* Norton. Orig. desig.

Clypeus with sharp, median triangular tooth and labrum rounded with anterior, median notch (Fig. 1); labial palpus 4-segmented; forewing with Sc long, Sc2 joins Sc+R1 ¼ to ½ distance between the separation of Rs and stigma. Antennal flagellum 6–11 segmented. General habitus of all species similar to that of *M. alisonae,* n. sp. (Fig. 3).

Few specimens are available for study, but we have seen enough (about 65) to resolve several problems, including species identity and association of sexes, and present a better understanding of the North American fauna. We recognize five species.

The genus occurs only in eastern North America and eastern Asia. Shinohara (1992) treated three species from eastern Asia, *M. gigantea* Mocsáry from eastern Russia (Primorski Krai), Korea, and China; *M. togashii* Shinohara from Japan; and *M. parki* Shinohara from Korea.

Two species groups are apparent. The Asian species and *Megaxyela major, M. aviingrata,* and *M. alisonae* from North America form one group characterized by the short sheath with the ventral and dorsal margins curving mesally to an acute apex (Figs. 7–9), a thick hindbasitarsus (Fig. 15), the lance lacking dorsal teeth, and the lancet having indistinct serrulae (except *M. alisonae*) (Figs. 16–19). The other group includes the North American *Megaxyela tricolor* and *M. bicoloripes,* which have a long sheath, straight on its ventral margin (Figs. 10, 11), a slender hindbasitarsus (Fig. 14), the lance with distinct teeth at its apex, and the lancet with clearly defined serrulae at its apex (Figs. 22–29).

Known host plants are members of the Juglandaceae. The hosts for the North American *Megaxyela aviingrata* (Dyar) and *M. major* (Cresson) are *Carya* spp. and perhaps *Juglans* spp. The hosts for *M. gigantea* in eastern Asia are *Juglans* spp. and *Pterocarya* spp. (Shinohara 1992). The few known aspects of their biology is given under each species. A brief account of *M. gigantea* in Korea by Sato (1941), as given by Shinohara (1992), is noteworthy in that it contains some unusual habits for sawflies: "This species has a univoltine life cycle, with adult appearance from late April to early May. The female lays an egg along the midrib on the upper surface of the apical part of a newly growing leaf. Before oviposition, the female stands on the under surface of the leaf, with the head directing toward the base of the leaf. Then the female bends the tip of her abdomen to the upper surface of the apex of the leaf and oviposits there, folding by hind legs the apex of the leaf in half along the midrib upward and attaches the folded halves with glutinous material. One egg is laid per leaf. The larval period is from late May to early June. The larva always starts feeding from the apex of the leaf and coils on the midrib at rest. The larva has four molts and overwinters in the soil."

Key to Nearctic Species of *Megaxyela*

1. Legs black or orange brown, usually with hindtarsus white 2
– Legs bright orange with hindtibia and tarsus black or hindtibia black and hindtarsus white 3
2. Entirely black except for white hindtarsal segments 2–5 or 3–5; sheath about 2.5× longer than broad (Fig. 8) . . . . . *aviingrata* (Dyar)
– Usually entirely orange brown, sometimes various black markings on dorsum of head, thorax, and/or abdomen and on femora and tibiae; sheath about 3× longer than broad (Fig. 7) . . . . . *major* (Cresson)
3. Thorax black; sheath longer than hindtarsus, about 4× longer than broad (Fig. 11) (legs with hindtibia and hindtarsus black; hindbasitarsus

Fig. 3. Habitus of *Megaxyela alisonae,* length 12 mm.

slender, as in Fig. 14, about 6.5× longer than broad) . . . . . *tricolor* (Norton)

– Thorax black with mesosternum and mesepisternum orange; sheath shorter than hindtarsus and less than 3× longer than broad (Figs. 9, 10) 4

4. Hindtarsal segments 2–5 white; hindbasitarsus slender, about 6.5× longer than broad and tarsal segments 2–4 much longer than broad (Fig. 14); sheath at apex in lateral view nearly straight below, slightly emarginate on dorsum (Fig. 10) . . . . . *bicoloripes* (Rohwer)

– Hindtarsal segments 2–5 black; hindbasitarsus broad, about 3.5× longer than broad and tarsal segments 2–4 about as long as broad (Figs. 15); sheath at apex in lateral view emarginate on both dorsal and ventral margins (Fig. 9) . . . . . *alisonae,* new species

Megaxyela alisonae Smith and Schiff, new species

(Figs. 3, 9, 15, 20, 21)

Female.—Length, 10.5–12.0 mm. Antenna black with scape brownish. Head black with clypeus, labrum, mouthparts, and mandible white, tips of mandibles brownish, and apical labial palpal segment blackish. Thorax orange with pronotum, mesonotum, and upper corners of mesepisterum and mesepimeron black to purplish metallic; posterolateral portion of pronotum sometimes dark orange; mesonotal lateral lobe may be partly orange; tegula white. Abdomen or-

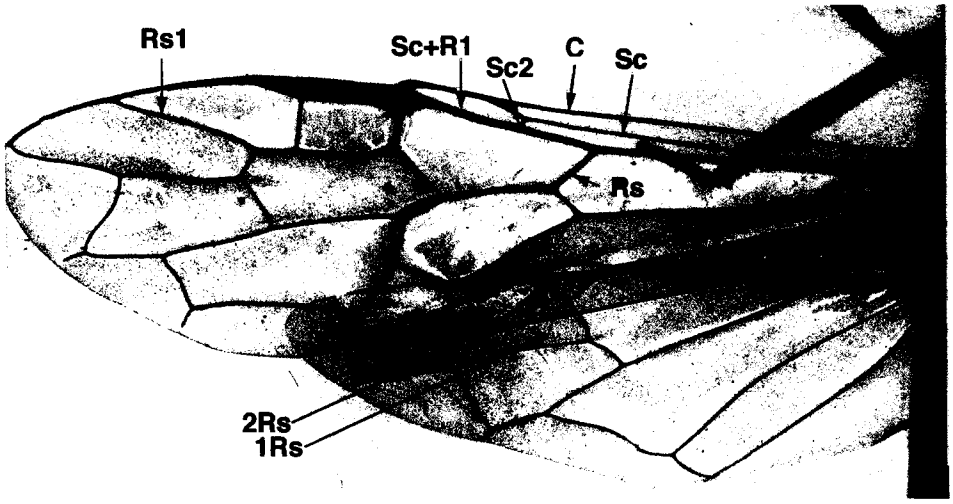


Fig. 4. Wings of *Megaxyela major*.

ange, terga with narrow black posterior margins; apical tergum black or about half of 8th and all of 9th black; sterna with posterior margins narrowly white; sheath black; basal plate orange. Legs orange with extreme tip of hindfemur, hindtibia, and hindtarsus black.

Antennal filament 9-segmented and subequal in length to scape; antennal length about 2.3× head width. Hindbasitarsus thick, about 3.5× longer than broad. Length of hindbasitarsus about 0.8× length of remaining tarsal segments combined; length of hindtarsus about 0.7× length of hindtibia. Sheath (Fig. 9) length about 1.1× length of basal plate and 0.6× length of hindtibia. Lance with serrate dorsal margin (Fig. 20); serrulae of lancet small, narrowly pointed at apices (Fig. 21).

Male.—Unknown

Holotype.—♀, labeled "U.S.A.: Pinebush, N.Y.: Albany Co., 42.42.45–75.52.53, 21 May 1983, T. McCabe, 100 m." Deposited in the New York State Museum, Albany, New York.

Paratypes.—NEW YORK: Ithaca, 21 May '36 (1 ♀, UCB). OHIO: Franklin Co., 5-22-79 (1 ♀, OSU).

Distribution.—New York, Ohio.

Etymology.—The specific epithet is in memory of Alison Wyn Schiff who was greatly amused by her brother's (NMS) choice of an entomological career.

Host.—Unknown.

Discussion.—The sheath shape (Figs. 7–9) and thick hindbasitarsus (Fig. 15) are similar to *Megaxyela major* and *M. aviingrata*. The largely orange thorax, abdomen, and legs and the serrate dorsal margin of the lance and distinct serrulae of the lancet will separate *M. alisonae* from those species.

Megaxyela aviingrata (Dyar)
(Figs. 1, 8, 16, 17)

Pleroneura aviingrata Dyar 1898a: 213.—Dyar 1899: 127 (larva).—Smith 1978: 26 (as a syn. of *M. tricolor*).—Smith 1979: 10.—Smith 1987: 386 (lectotype).

Odontophyes aviingrata: Konow 1899: 42.—MacGillivray 1906: pl. 23, fig. 32 (wings).

Megaxyela aviingrata: Ross 1932: 163.—Ross 1951: 7.—Burks 1958: 8.

Female.—Length, 11.0–12.5 mm. Black with following white: labrum except for black apical margin, labial palpus except for black apical segment, extreme apices of fore- and midtrochanters and most of hindtrochanter; extreme apices of fore- and midtibiae; hindtarsal segments 2 or 3 to 5 with

Figs. 5–6. Wings. 5, *Macroxyela ferruginea*. 6, *M. aenea*; arrow points to crossvein in cell Rs1.

sometimes extreme apex of hindbasitarus whitish and basal part of hindtarsal segment 2 blackish. Apex of mandible brownish. Wings hyaline with veins and stigma black.

Antennal filament 8–9 segmented; antennal length about 1.9× head width. Hindbasitarsus broad, about 3.5× or more longer than broad (similar to Fig. 15). Length of hindbasitarus about 0.7× length of remaining tarsal segments combined; length of

hindtarsus 0.8× length of hindtibia. Sheath (Fig. 8) about 1.1× length of basal plate and 0.6× length of hindtibia. Dorsal margin of lance smooth, without serrations; lancet without discernible teeth (Figs. 16, 17).

Male.—Length, 11.0 mm. Color and structure as for female. Genitalia similar to that of *M. major* (Fig. 33).

Specimens examined.—20 ♀, 1 ♂.

Distribution.—INDIANA: Pine, V-21-05. KANSAS: Riley Co. MASSACHUSETTS: Boston, V-18-15. MISSISSIPPI: State College, 3-24-32, pecan L834-13; 3-27-31, pecan L834-9; 4-28-31, pecan L834-11; 3-31, adult L777-22; Oktibbeha Co., Starkville, III-23-1975, in black light trap edge of deciduous woods. MISSOURI: Columbia, 9-30-56 (male). NEW YORK: Ithaca, IV-29-13; V-9-36; Bedford Park (Dyar 1898b). OKLAHOMA: Oklahoma City, V-4-1964, on pecan (larvae). ONTARIO: Guelph, VIII-8-86; Hamilton, V-18-80. PENNSYLVANIA: Notch, V-13 & 15-13 (larvae). Ross (1951) gave the distribution as eastern, west to Illinois. Ross (1932) stated that he collected two larvae on hickory at Charleston, Ill., May 31, 1931, and his record may be based on this larval collection. Identification of larvae, however, is tenuous. The identity of the two records from larvae need confirmation.

Lectotype.—The female designated by Smith (1987) is in the USNM; it was reared from larvae on hickory from Bedford Park, New York, by Dyar.

Hosts.—*Carya* sp. and pecan are the only definite hosts recorded. The records from pecan are from Mississippi (see Distribution). Dyar (1898a) observed larvae which he called *M. aviingrata* on hickory and butternut at other locations, but his rearings from these collections were not successful. Several species of *Megaxyela* are possible in the area of his collections, and it is possible these larvae may be something else. Ross (1951) recorded "*Hicoria,*" and Burks (1958) recorded *Carya* sp. and *Juglans cinerea* L. Both of their records of *Juglans* are based on Dyar's observations of larvae.

Biology.—Dyar's rearings bear his code "3C" (Smith 1987). Dyar (1898a) reared this species and presented some sketchy notes. He stated "curious larva resembling the excrement of birds". . ."on the young tender leaves of the hickory and butternut in May. The larvae disappear by the end of the month and reappear the following season. The larva is solitary, if abundant there may be several on one leaf. In the natural position of rest, curled spirally around a leaf petiole. . . ." "Enters the earth without ultimate stage. Single brooded, feeding only on immature leaves." His larval records are: Staten Island, N.Y., June 1; Bellport, Long Island; Bedford Park, N.Y., May 25; and Fort Lee and Plainfield, N.J., May 16.

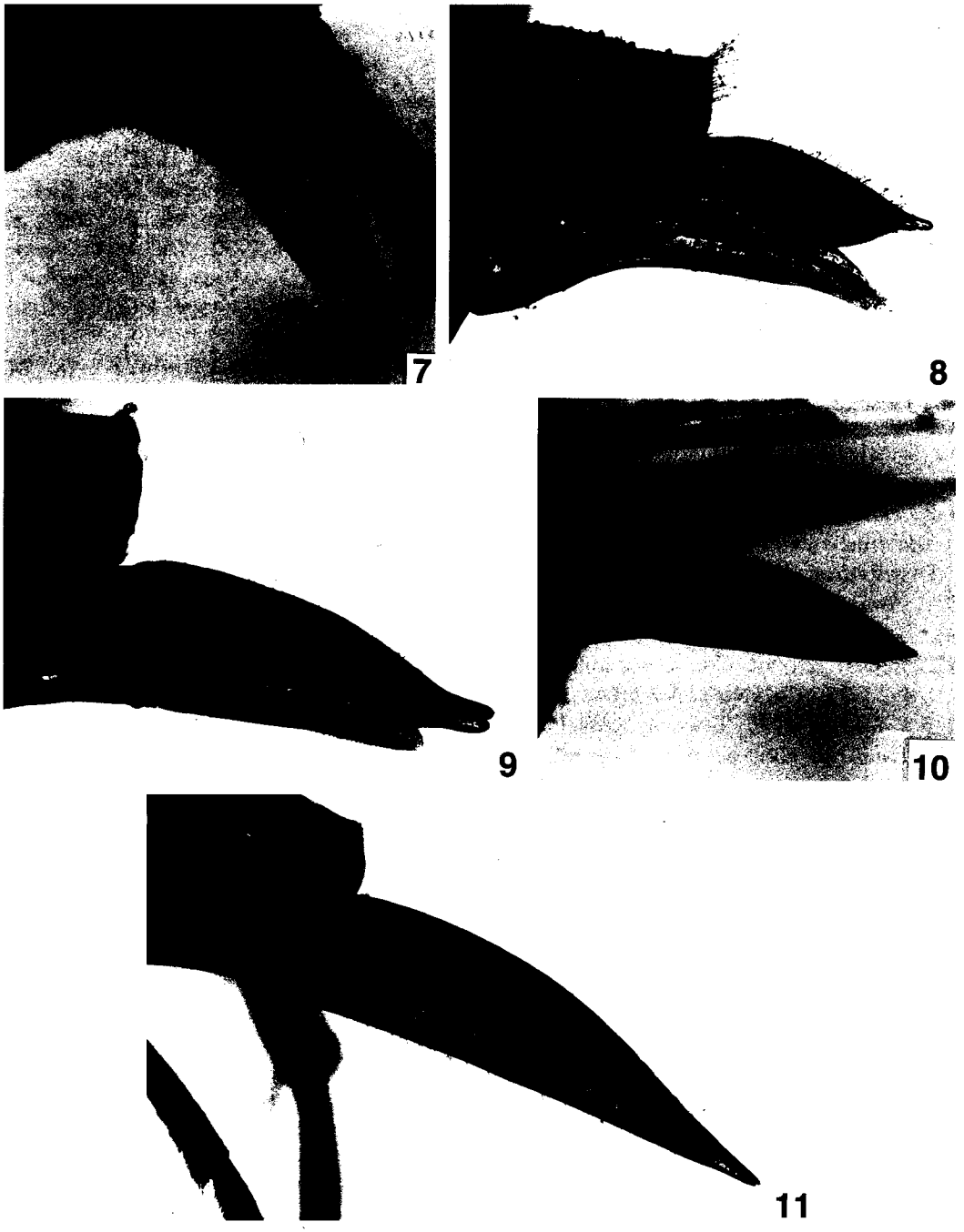
Discussion.—Only one male (a specimen collected in Missouri) was available for study. This species closely resembles *M. major,* except for the black coloration and stouter sheath (about 2.5× longer than broad; Fig. 8). Both *M. aviingrata* and *M. major* have a similar distribution and both have been recorded from pecan in Mississippi.

Megaxyela bicoloripes (Rohwer)
(Figs. 10, 14, 26–29, 34)

Odontophyes bicoloripes Rohwer 1924: 215.

Megaxyela bicoloripes: Ross 1932: 163.—Ross 1951: 7.—Smith 1978: 24.—Smith 1979: 10.

Female.—Length, 10–11 mm. Antenna black. Head black with clypeus and labrum white; apex of mandible and mouthparts brownish. Thorax mostly orange with pronotum, mesonotum, metanotum, upper corner of mesepisternum, upper half of mesepimeron, and upper corner of metapleuron black; tegula white. Abdomen black dorsally and laterally, orange ventrally; basal plates orange; segments with a narrow white posterior margin; sheath black with extreme apex dark orange. Legs orange



Figs. 7–11. Female sheaths. 7, *Megaxyela major.* 8, *M. aviingrata.* 9, *M. alisonae.* 10, *M. bicoloripes.* 11, *M. tricolor.*

with extreme apex of hind femur black on outer surface, hindtibia black, hindbasitarsus black with extreme apex white; and hind tarsal segments 2–5 white (segment 2 sometimes black at extreme base). Head, body and legs except tarsi with faint dark purplish tinge. Wings hyaline; veins and stigma black.

Antennal length about 1.9× head width; apical filament 9-segmented (in one specimen; others broken) and subequal in length to scape. Hindbasitarsus about 6.5× longer than broad and length about 0.6× length of remaining tarsal segments combined; hindtarsus about 0.7× length of hindtibia. Sheath (Fig. 10) length about 1.1× length of basal plate and about 0.8× length of hindtibia. Lance (Figs. 26, 28) with dorsal serration restricted to distal third; lancet (Figs. 27, 29) with fine serration on distal quarter.

Male.—Length, 9.5 mm. Coloration as for female; hypandrium black to dark orange. Antennal filament 9-segmented. Genitalia as in Fig. 34.

Specimens examined.—4 ♀, 1 ♂.

Distribution.—MICHIGAN: Washtenaw Co., Ann Arbor, IV-21-32. MISSISSIPPI: Agricultural College, 4-16-15 (holotype). MISSOURI: Boone Co., Columbia, 4-26-73; 4-25-73. PENNSYLVANIA: Spring Br., V-7-1945, H.K. Townes; Ross (1932) designated an allotype from "Penn."; we did not see this specimen. VIRGINIA: Arlington, VIII-21-51.

Holotype.—Female, USNM type no. 26040, labeled "Barbarin.AE., A&M.C, 4/6/15." Rohwer (1924) gave the type locality as "Agricultural College, Mississippi"; The collector is A.E. Barbarin

Host.—Unknown.

Discussion.—*Megaxyela bicoloripes* and *M. tricolor* form a group based on the shape of the sheath, lance and lancet, and slender hindtibia, as outlined in the introduction to the genus. The mostly orange legs, orange mesosternum and mesepisternum, and sheath shape distinguish *M. bicoloripes* from *M. tricolor,* which has the thorax entirely black. Furthermore, the sheath is shorter than the hindtarsus and about 3× longer than broad in *M. bicoloripes,* whereas that of *M. tricolor* is much longer than the hindtarsus and about 6.5× longer than broad (compare Figs. 10, 11).

Megaxyela major (Cresson)
(Figs. 4, 7, 18, 19, 33)

Xyela major Cresson 1880: 34.—Cresson 1916: 5 (lectotype).

Macroxyela major: Kirby 1882: 351.

Megaxyela major: Ashmead 1898: 214.—MacGillivray 1906: pl. 23, fig. 32 (wings).—Ross 1932: 162 (syn.: *ferruginea* Bridwell).—Ross 1951: 7.—Smith 1978: 25 (syn.: *langstoni* Ross).—Smith 1979: 10.

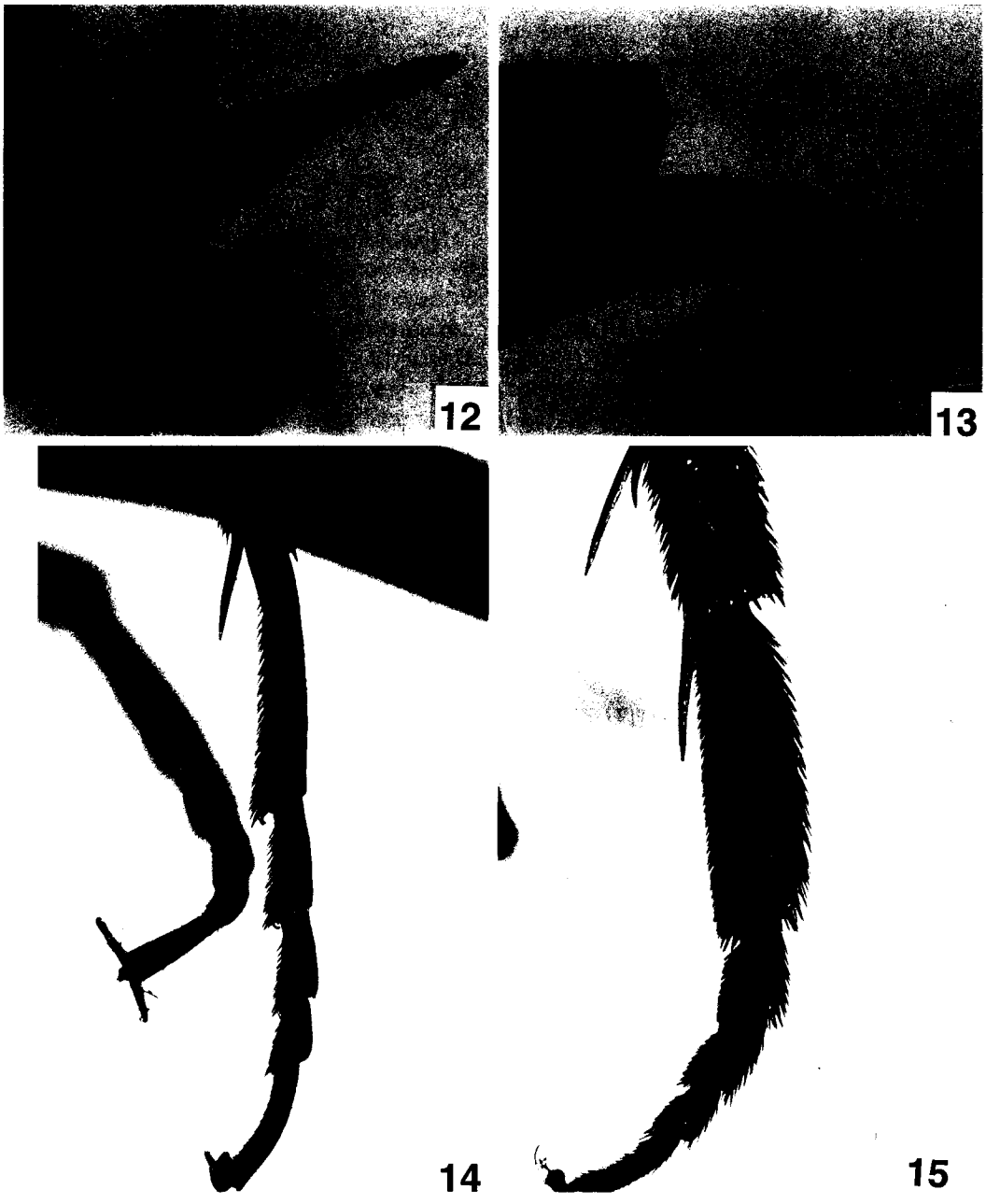
Odontophyes ferruginea Bridwell 1906: 94.

Megaxyela langstoni Ross 1936: 131.—Ross 1951: 9.—Webb 1980: 132.

Female.—Length, 9.5–11.5 mm. Mostly orange to reddish brown with yellowish and sometimes black markings, usually with following more yellowish: eye orbits, or much of head and mouthparts except for postocellar area; tegula; fore- and midlegs, hindtrochanter; basal third of hindtibia, hindbasitarus and sometimes two or more following segments; hind margin of abdominal segments; and sheath. Following may be blackish: frons; part of cervical sclerites; upper corner of mesepisternum; small spots anteriorly on mesoprescutum, lateral portions of mesonotal lateral lobes; small lateral spots on metanotum; hindcoxa except apex; apical half hindfemur and hindtibia; center of basal plates; terga 6–7. Wings hyaline to a slightly yellowish tinge; veins brown; forewing stigma black, sometimes with apical half yellowish.

Antennal filament 6–7 segmented, shorter than scape; antenna about 2.1× head width. Hindtarsus 0.7× length of hindtibia; hindbasitarsus about 0.9× length of remaining tarsal segment combined and and about 4.2× longer than broad. Sheath (Fig. 7) about 1.2× length of basal plate and 0.6× length of hindtibia. Dorsal margin of lance without teeth; lancet without discernible teeth (Figs. 18, 19).

Male.—Length, 9.0–10.5 mm. Coloration and variation similar to that of female, sometimes with slightly more extensive



Figs. 12–15. 12–13, Female sheaths. 12, *Macroxyela ferruginea.* 13, *M. aenea.* 14–15, Hindtarsus. 14, *Megaxyela bicoloripes.* 15, *M. alisonae.*

black marks at same spots and thoracic and abdominal dorsum. Genitalia as in Fig. 33.

Specimens examined.—32 ♀ and ♂; about 15 vials of larvae.

Distribution.—ALABAMA: Madison Co., VI-1962, pecan (larvae); Mobile Co., IV-8-1963, on pecan (larvae). ARKANSAS: Sheridan, IV-22-25, on pecan leaves (larvae). FLORIDA: Alachua Co., 9 mi. NW Gainesville, UF Hort. Unit, 19-III-1977; Monticello, IV-10-1963, on pecan (larvae). GEORGIA: Byron, 4-17-4-20-81,

IV-21-1977, on pecan (larvae); Thomson, McDuffie Co., IV-26-1960, ex pecan (larvae); Jasper Co., IV-30-1958, on pecan (larvae); Jonesboro, IV-29-1959, pecan trees (larvae); Ty Ty, IV-1-1964, on pecan (larvae). IOWA: Story Co., state nursery, April 6, 1978. KANSAS: Baldwin (holotype, *O. ferruginea*); Douglas Co., V-1933; Burlington, on pecan, V-2-25 (larvae). MISSISSIPPI: State College, Apr. 7, 1932 and March 24, 1932, reared from pecan, J.M. Langston (mostly paratypes of *M. langstoni*), 4-27-31, pecan L838B; 4-7-32; Lucedale, reared from pecan, emerged April 20, 1930, and March 28 and April 2, and April 9, 1931, H. Dietrich (some paratypes of *M. langstoni*); Ag. Coll. Miss., 4-10-1915, pecan. MISSOURI: St. Joseph, V-3-1939. NEW YORK: McLean, IV-26-1913. OKLAHOMA: Latimer Co., IV-1989; Cleveland Co., IV-8-1931; Madil, Marshall Co., IV-28-64, on pecan (larvae). PENNSYLVANIA: Huntingdon, VI-3-34; Dauphin Co., VI-8-34, on hickory (larvae). SOUTH CAROLINA: Clemson, IV-20-1975; Beaufort Co., IV-18-1959, on pecan (larvae). TENNESSEE: McNairy Co., V-13-71, on pecan (larvae). TEXAS: "Tex."; Concan, 4-14-49; Waco, on leaves of pecan, IV-21-1906 (larvae); Fredericksburg, IV-21-1960, pecan foliage (larvae). VIRGINIA: Miners Hill, on hickory, V-14-12 (larvae, identity ?). Records are for adults unless otherwise indicated.

Types.—*Xyela major* Cresson was described from a female and a male from "Texas (Belfrage)," The lectotype, chosen by Cresson (1916), is at ANSP, Type No. 330.

Odontophyes ferruginea Bridwell was described from one female. The holotype is in the USNM, with type labels and "Baldwin, Kansas," "Bridwell, Apr.," and "on early shrub willow." This is one of the darker specimens with blackish marks on the frons, mesonotum, and abdominal terga.

The holotype of *Megaxyela langstoni* Ross is at the INHS (Webb 1980). It is from State College Mississippi, April 7, 1932, coll. J.M. Langston, reared from pecan (*Carya pecan* A. & G.). Both sexes were described, and Ross (1936) also designated an allotype and 9 paratypes.

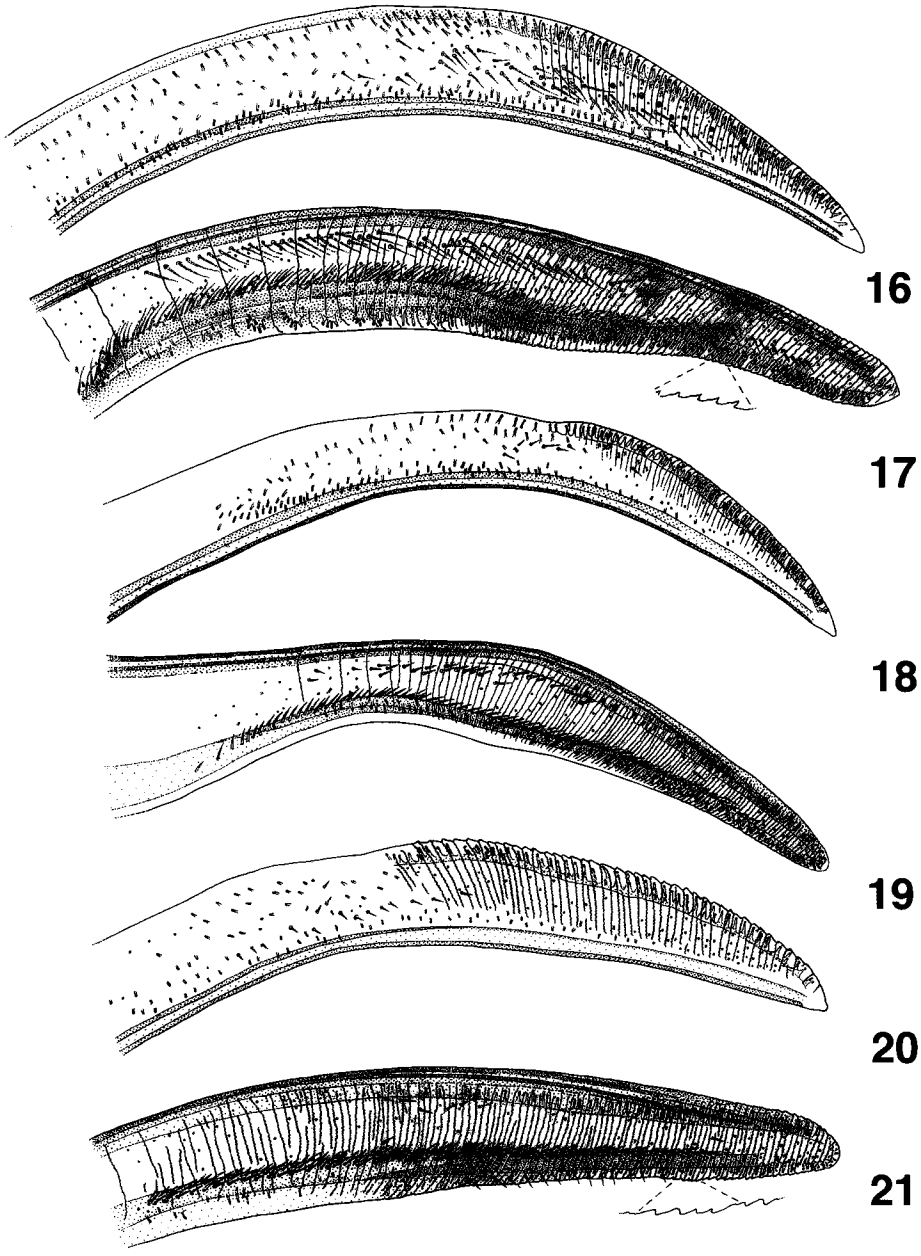
Hosts.—*Carya illinoensis* (Wang.) K. Koch (pecan). An adult was collected on "early shrub willow" (Bridwell 1906).

Discussion.—Ross (1936) stated that the larvae recorded by Dyar (1898b: 175) and Yuasa (1923) were *M. major*. Yuasa's "*Megaxyela* sp. 1" may also be *M. major*. *Megaxyela langstoni* larvae have a large dark area on the pronotum and penultimate abdominal segment. Yuasa's sp. 1 has these areas with a pair of black spots. Also, *M. major* appears to be a solitary feeder on pecan and some other hickories, whereas *M. langstoni* is gregarious. The dark areas on the pronotum and penultimate abdominal segment are variable and cannot be used for species separation. We cannot comment on the solitary vs. gregarious feeding habit.

Ross (1936) separated *Megaxyela langstoni* from *M. major* by the chestnut abdominal dorsum (not mostly black as in *M. major*), black area at base of the stigma, and less yellow at the base of the hindfemur and hindtibia. Examination of the specimens at hand show considerable color variation, and we believe Ross' *M. langstoni* is one of the paler color forms of *M. major*. Ross also stated that the sheath is shorter than the hindbasitarsus in *M. langstoni* (longer than in *M. major*). However, the sheath appears to be longer than the hindbasitarsus in the specimens Ross examined.

In summary, there seems to be behavioral, color and morphological variation within *M. major*, but, at present, it appears most likely that this is intraspecific variation rather than several cryptic species. Additional specimens, especially from intermediate localities, are needed to elucidate the full extent of this variation.

Dyar (1898b) attempted rearing some larvae under his code "7D." These were on hickory, Fort Lee, N.Y., Bronx Park, N.Y., and Bedford Park, N.Y. No adults were obtained, and thus the identity of his speci-



Figs. 16–21. Female ovipositors. 16, Lance of *Megaxyela aviingrata*. 17, Lancet of *M. aviingrata*. 18, Lance of *M. major*. 19, Lancet of *M. major*. 20, Lance of *M. alisonae*. 21, Lancet of *M. alisonae*. Figs. 16–21 drawn to same scale.

mens are unknown. Authors, e.g. Ross 1932, Smith 1987, recording Dyar's rearings as *M. major* may or may not be correct.

Megaxyela major belongs to the group of species with *M. aviingrata* and *M. alisonae* which have a thick hindbasitarus (Fig. 15) and similar sheath shape (Figs. 7–9). It can

be distinguished from those species by the nearly entirely orange-brown coloration, but with various degrees of black on the dorsum of the head, thorax, abdomen, femora, and tibiae.

Megaxyela tricolor (Norton)
(Figs. 11, 22–25, 35)

Xyela tricolor Norton 1862b: 144.
Macroxyela tricolor: Kirby 1882: 351.
Paraxyela tricolor: MacGillivray 1912: 294.
Megaxyela tricolor: Ross 1932: 162.—Ross 1951: 7.—Smith 1978: 26.—Smith 1979: 10.

Female.—Length, 10 mm. [Antennae missing.] Head and thorax black with a purplish metallic tinge; clypeus white except for black narrow margins and central spot; labrum white with apical half black; mandible brown to black at base underneath; mouthparts brown; and tegula white. Legs orange, spot on outer surface of mid- and hindcoxa, spot at base of outer surface of hindcoxa, extreme apex on outer surface of hindfemur black, all hindtibia and hindtarsus black. Abdomen black with white narrow posterior margin on each segment, basal plate of sheath brown to orange; and sheath black. Wings hyaline with veins and stigma black.

Hindbasitarsus slender, about 6.5× longer than broad and about 6× length of remaining tarsal segments together; length of hindtarsus about 0.8× length of hindtibia. Sheath (Fig. 11) unusually long and slender, about 1.6× length of basal plate and about 1.3× length of hindtibia. Lance (Figs. 22, 24) with dorsal serrations restricted to apical third or less; lancet (Figs. 23, 25) with distinct teeth only on ventral margin of apical quarter.

Male.—Length, 9.0–9.5 mm. Coloration mostly same as for female; antenna black; clypeus and mandible mostly whitish; hypandrium sometimes dark orange. Apical antennal filament 6–8 segmented with length subequal to length of scape; antennal length 2.1× head width. Otherwise similar to female. Genitalia as in Fig. 35.

Specimens examined.—1 ♀, 4 ♂.

Distribution.—CONNECTICUT: Storrs, May 1935. ILLINOIS: Algonquin; Urbana, April 12, 1891 (Ross 1932; specimen not seen). KANSAS: holotype, no further data. MISSOURI: Sapp, V-10-56. ONTARIO: Simcoe, 2-V-55. Locality unknown: One male labeled "16093" possibly from Illinois, at INHS.

Holotype.—At ANSP, male, labeled "Ks.," red label "Type No. 331," and "tricolor." Norton described the species from "One specimen from Kansas."

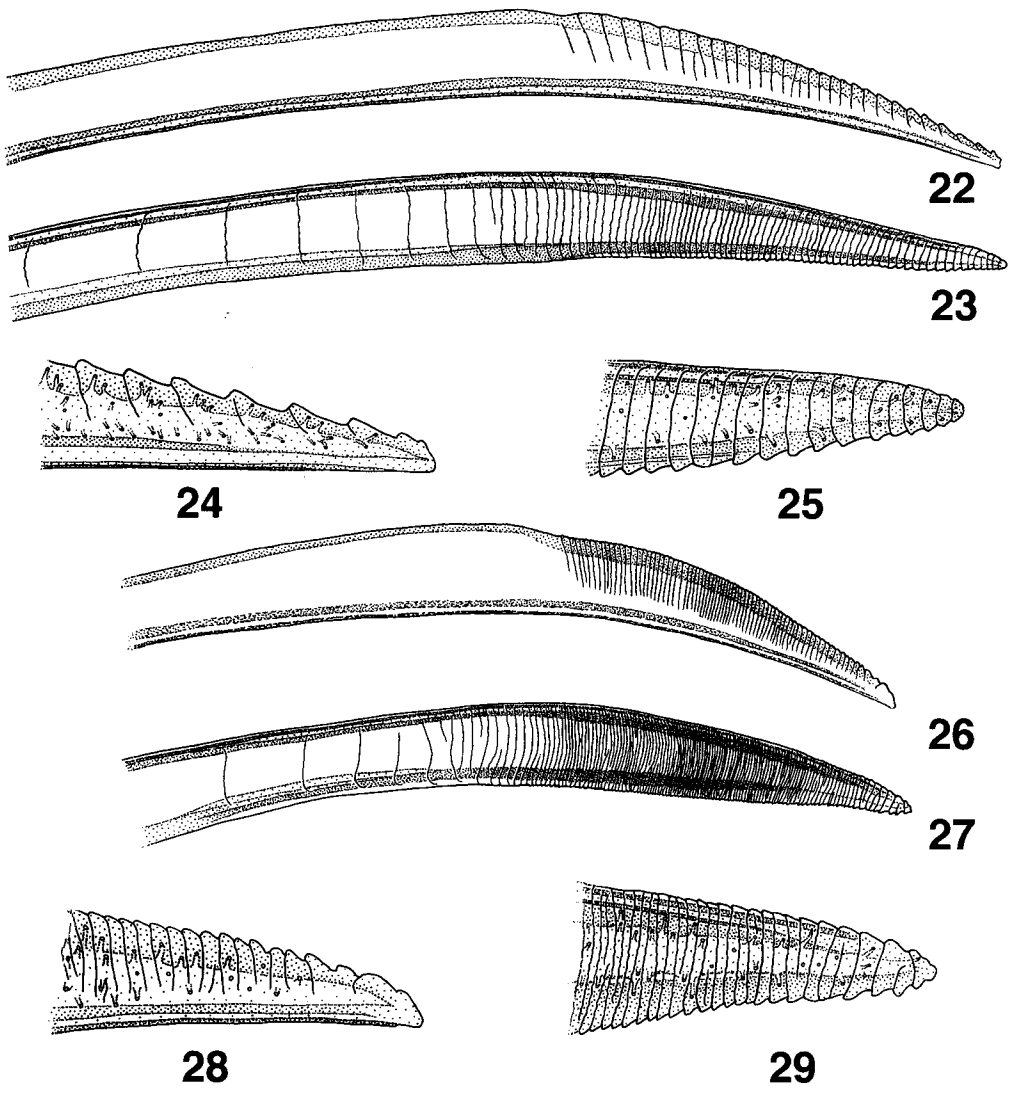
Host.—Unknown.

Discussion.—For separation from *M. bicoloripes,* see the preceeding key and discussion of that species. We have seen only one female (from Ontario), and this is associated with males only by the coloration. Previously, *M. tricolor* was known only from several males and *M. bicoloripes* only from females. Because of the similarity of *M. tricolor* and *M. bicoloripes,* Ross (1932) thought they may eventually be shown to be opposite sexes of the same species. Our studies show that there are two separate species involved.

Genus *Macroxyela* Kirby

Macroxyela Kirby 1882: 351.—Ashmead 1898: 214 (in key).—Ross 1932: 164 (revision; syn.: *Protoxyela* MacGillivray).—Ross 1951: 7 (N. Amer. catalog).—Smith 1978: 23 (world catalog).—Smith 1979: 10 (N. Amer. catalog). Type species: *Xyela ferruginea* Say. Orig. desig.
Protoxyela MacGillivray 1912: 295. Type species: *Xyela aenia* (!) Norton. Orig. desig.

Median lobe of clypeus notched medially, with two small round lobes, on each side of emarginated meson and labrum short, rectangular, nearly truncate anteriorly (Fig. 2). Labial palpus 3-segmented. Forewing with Sc short, Sc1 joining Sc + R1 very



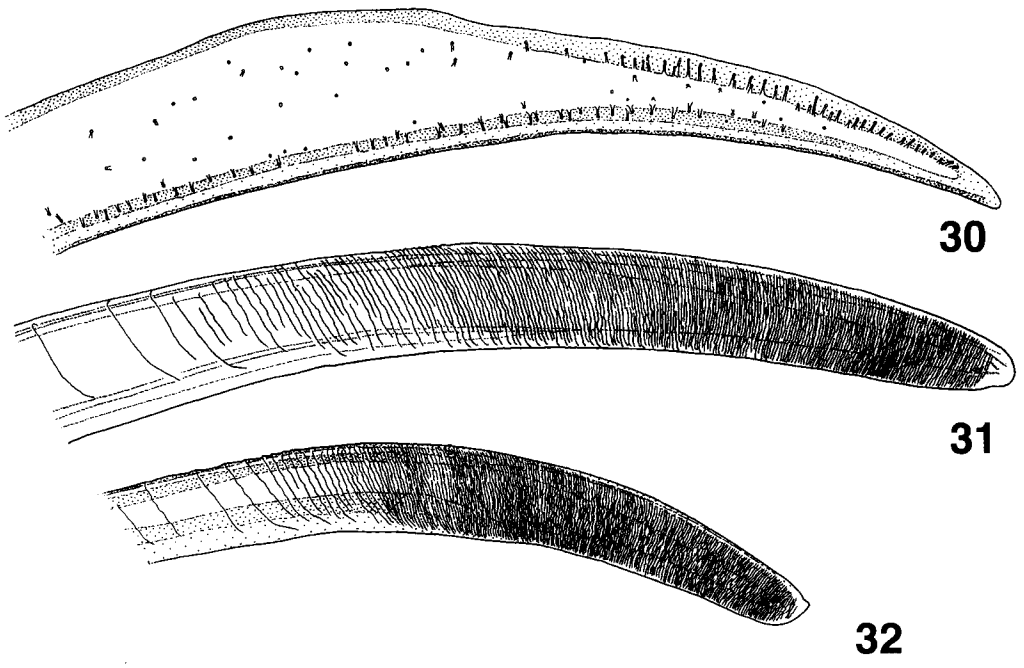
Figs. 22–29. Female ovipositors. 22, Entire lance of *M. tricolor*. 23, Entire lancet of *M. tricolor*. 24, Apex of lance of *M. tricolor*. 25, Apex of lancet of *M. tricolor*. 26, Entire lance of *M. bicoloripes*. 27, Entire lancet of *M. bicoloripes*. 28, Apex of lance of *M. bicoloripes*. 29, Apex of lancet of *M. bicoloripes*. Figs. 22–29 drawn to same scale.

slightly apical to juncture of Rs with Sc + R1 (Figs. 5, 6).

Two species are known for this exclusively North American genus. *Macroxyela ferruginea* is by far the most commonly collected species. The larva feeds on elm; further biological notes are given under that species.

Key to Species of *Macroxyela*

1. Sheath slender, about 4× longer than broad (Fig. 12); radial region of forewing with 3 cells (in 85% of specimens examined) (Fig. 5), if with 4 cells, then crossvein in cell Rs1 located toward distal portion of cell; female mostly reddish brown; male black or with abdomen partly to mostly reddish . . . . . *ferruginea* (Say)
– Sheath stouter, about 3× longer than broad



Figs. 30–32. Female ovipositors. 30, Entire lance of *Macroxyela ferruginea*. 31, Entire lancet of *M. ferruginea*. 32, Entire lancet of *M. aenea*. Figs. 30–32 drawn to same scale.

(Fig. 13); radial region of forewing with 4 cells, cell Rs1 divided by a crossvein at center of cell (Fig. 6); both sexes concolorous black to bronze . . . . . *aenea* (Norton)

Macroxyela aenea (Norton)
(Figs. 6, 13, 32, 37, 38)

Xyela aenea Norton 1872: 86.—Cresson 1928: 3.

Macroxyela aenea: Kirby 1882: 351.—Ross 1932: 165.—Ross 1951: 7.—Smith 1978: 23.—Smith 1979: 10.

Protoxyela aenea: MacGillivray 1912: 296.

Female.—Length, 7.5–9.0 mm. Black with antennal segments 1 and 2 dark orange, antennal filament brownish, and with following usually orange brown to orange: supraclypeal area, clypeus, labrum, mouthparts, anterior pronotum or all pronotum, mesoscutellum, sometimes mesosternum; legs (except hindtibia and hindtarsus usually blackish; sometimes venter of abdomen; and basal half or only apical margin of sheath; apical margins of abdominal segments yellowish. Abdomen with metallic bronze tinge.

Head and thorax finely punctate and shagreened; abdomen more shining with fine transverse microsculpture. Cell Rs1 of forewing divided into two cells (Fig. 6).

Male.—Length, 7.0–8.0 mm. Black, mostly like female, except thorax entirely black and hypandrium pale orange. Genitalia as in Fig. 37.

Specimens examined.—32 ♀ and ♂.

Distribution.—ILLINOIS: Pope Co., Burden Falls, April 20, 1960; Dixon Springs, IV-3-1948; Camp Point, Adams Co., IV-23-1960, on elm. INDIANA: Perry Co., T4S R1W S36, 21 April 1978. GEORGIA: Jones Co., 1–8 March 1994. LOUISIANA: Tallulah. MISSISSIPPI: Clarksdale, 3-10-55. MISSOURI: Webster Grove, 3-26-21, 3-31-25. NORTH CAROLINA: Orange Co., Chapel Hill, 8 Oct. 1963. OKLAHOMA: Latimer Co., in flight trap,

III-1986, IV-1987, III-1987, III-1989; Stillwater, 1948; Seminole Co., Wewoka, III-29-1966. TEXAS: types, no further data, as well as several other specimens labeled "Tex."; Harrison Co., 3 mi. E. Karnack, on pine, 6-III-1972. WISCONSIN: Dane Co., April 14, 1915. Ross (1932) recorded Staten Island, N.Y., a locality we were unable to verify.

Lectotype.—At ANSP, male, labeled "Tex." and red label "Type No. 332 Xyela aenea Norton." Norton described the species from "Texas. Five specimens." The one labeled as type is the lectotype as designated by Cresson (1928).

Host.—Unknown.

Discussion.—The division of cell Rs1 of the forewing is more consistent than in *M. ferruginea.* Of the 32 specimens examined, only 2 had this crossvein absent in one of the forewings and none in both forewings. Other distinguishing features of *M. aenea* are the shorter, stouter female sheath (compare Figs. 12, 13), and the concolorous black to bronze coloration in both sexes (usually reddish brown in *M. ferruginea*). Nothing is known of the habits of *M. aenea.* Records indicate a more southerly distribution than for *M. ferruginea* whose northernmost record is Madison, Wisconsin, although there is substantial overlap between the species.

Macroxyela ferruginea (Say)
(Figs. 2, 5, 12, 30, 31, 36, 38)

Xyela ferruginea Say 1824: 310.

Macroxyela ferruginea: Kirby 1882: 351, pl. 14, fig. 1.—Young 1899: 41 (larva, habits; syn: *infuscata* Norton).—MacGillivray 1906: pl. 23, fig. 33 (wings).—Garlick 1923: 256–257 (adult feeding habits).—Yuasa 1923: 41 (larva).—Ross 1932: 165 (syn.: *obsoleta* MacGillivray, *distincta* MacGillivray).—Smith et al. 1943: 382 (Kansas).—Ross 1951: 7.—Maxwell 1955: 17 (internal larval anatomy).—Smith 1967: 379–380 (larva).—Smith 1978: 23.—Smith 1979: 10.

Xyela infuscata Harris 1835: 583 (*nomen nudum*).—Rohwer 1920: 515.

Xyela infuscata Norton 1862a: 224.

Macroxyela infuscata: Kirby 1882: 351.

Macroxyela obsoleta MacGillivray 1912: 294.—Frison 1927: 234.

Macroxyela bicolor MacGillivray 1912: 294.—Frison 1927: 234.—Ross 1932: 166.—Ross 1951: 7 (syn.: var. *harti* Ross).—Smith 1978: 23.—Smith 1979: 10. **New synonymy.**

Macroxyela distincta MacGillivray 1912: 295.—Frison 1927: 234.

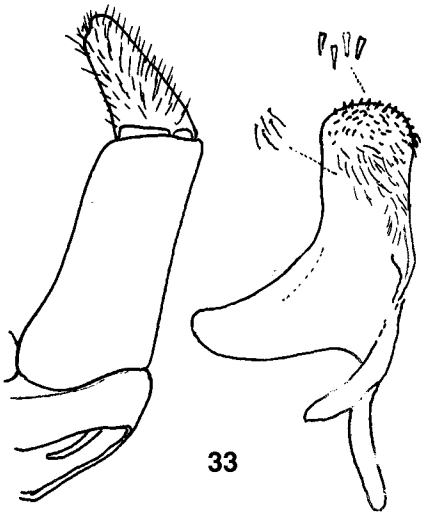
Macroxyela bicolor var. *harti* Ross 1932: 166.

Female.—Length, 7.5–9.0 mm. Mostly reddish brown; clypeus, labrum, and mouthparts sometimes more yellowish, mesosternum usually black; in darker forms, antennal flagellum, head between eyes, and ocellar area blackish; mesonotal lateral lobes, sometimes most or all of thorax ventrally and laterally, basal 3 to 5 abdominal segments, hindcoxa, hindtibia and apex of sheath sometimes black, with various combinations. Abdominal segments usually with yellowish apical margins, especially noticeable on venter. Wings hyaline to very lightly, uniformly infuscated, or rarely darkly infuscated.

Head and thorax finely shagreened; abdomen more shining, with fine transverse microsculpture. Apical antennal filament 5–6 segmented, slightly shorter than scape. Forewing with cell Rs1 not divided in most specimens.

Male.—Length, 7.0–8.0 mm. Mostly black with following reddish-brown to orange: most of clypeus, labrum and mouthparts; most of legs beyond coxae (inner surfaces of fore and mid tibiae, sometimes tarsi, and sometimes apical portion of hindcoxa paler); apical 3 or 5 abdominal segments on venter and sometimes laterally; genitalia. Some forms with almost entirely orange abdomen. Genitalia as in Fig. 36.

Specimens examined.—462 ♀ and ♂.



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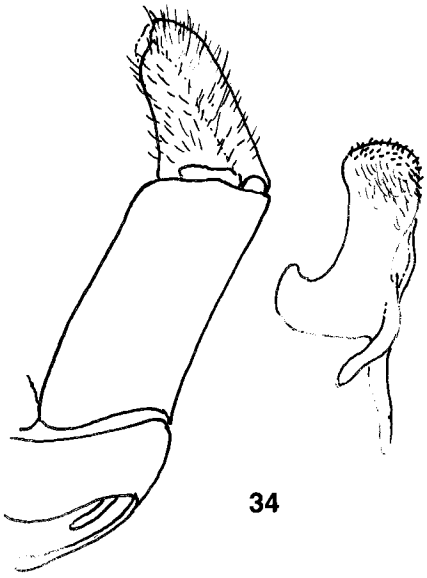

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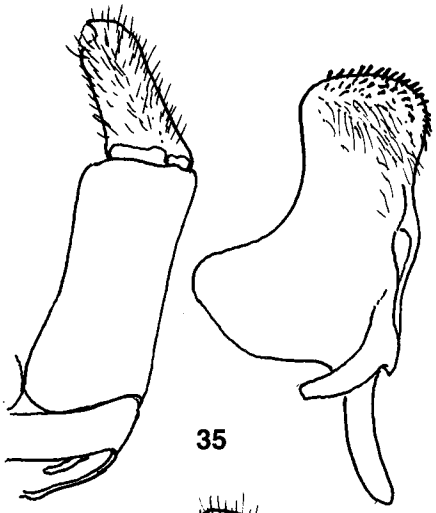

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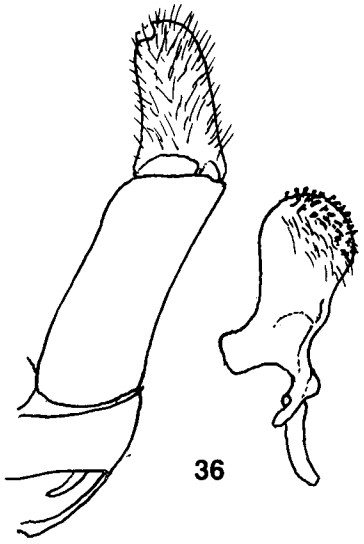

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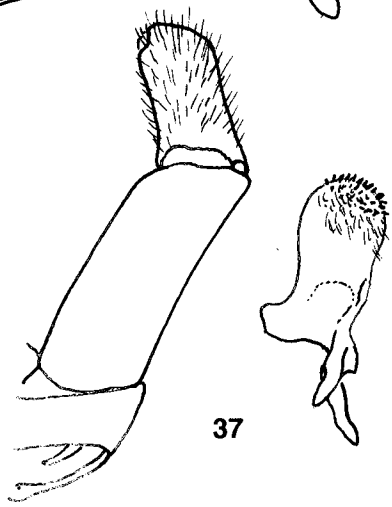

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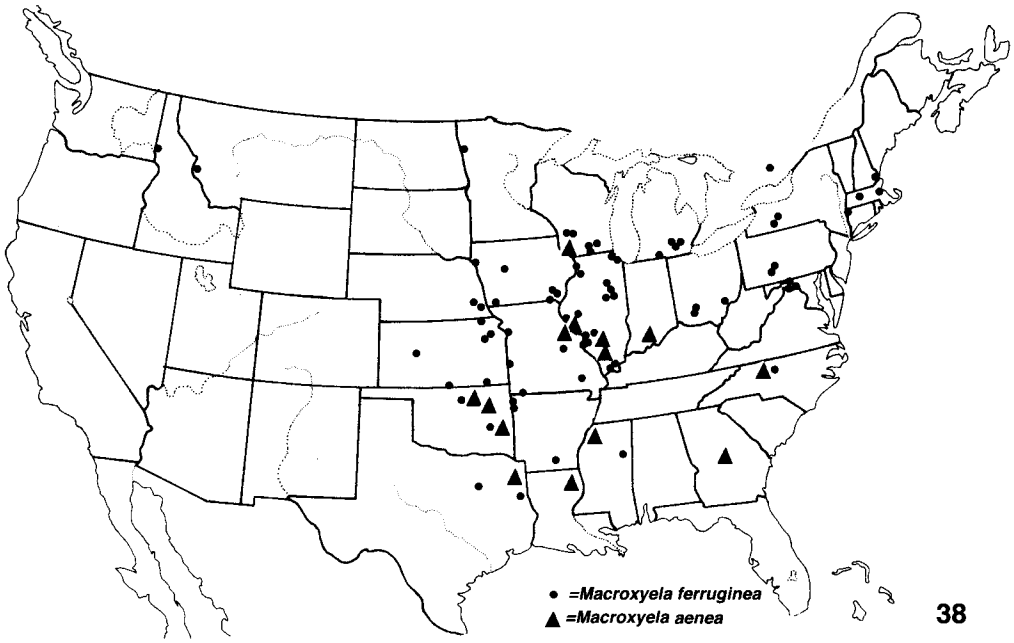

Fig. 38. Distribution of *Macroxyela*. Circles = *M. ferruginea*. Triangles = *M. aenea*.

Distribution.—Specimens examined from the following states and provinces, (Fig. 38): Arkansas, Connecticut, Idaho (Moscow), Illinois, Iowa, Kansas, Maine, Maryland, Massachusetts, Michigan, Minnesota, Mississippi, Missouri, Montana (Lost Horse, Ravalli Co., 7-2-49), Nebraska, New Hampshire, New York, North Carolina, Ohio, Oklahoma, Ontario, Pennsylvania, Texas,Virginia, West Virginia, Wisconsin.

Types.—The type of *Xyela ferruginea* Say is lost. Say described the female and stated "Inhabits Arkansa." The description agrees with the concept of this species.

Norton described Xyela *infuscata* from a male, "One specimen in Harris's Coll. Mass." Rohwer (1920) stated the type is no. 186 in the Harris Collection (MCZ), is in good condition, and, according to Harris' manuscript list, was collected April 25, 1827.

Macroxyela bicolor MacGillivray was described from a male, "Columbus, Ohio, Professor J.S. Hine, collector." It is at INHS (Webb 1980), labeled "947" and "Columbus, Ohio J.S. Hine."

Macroxyela obsoleta MacGillivray was described from a female labeled "Ithaca, N.Y., J.O. Martin, collector." It is at INHS (Webb 1980), labeled "Ithaca, N.Y., Apr. '97."

Macroxyela distincta MacGillivray was described from a female and a male from "Ithaca, N.Y, J.O. Martin, collector." The lectotype female, designated by Frison (1927) is at INHS (Webb 1980), labeled "Ithaca, N.Y., April 3, '97."

Macroxyela bicolor var. *harti* Ross, described from a male is at INHS (Webb

←

Figs. 33–37. Male genitalia, dorsal view, right half of genital capsule, and lateral view of penis valve with dorsal side to left. 33, *Megaxyela major*. 34, *M. bicoloripes*. 35, *M. tricolor*. 36, *Macroxyela ferruginea*. 37, *M. aenea*.

1980), labeled "Havana, Illinois, April 1896 (C.A. Hart)."

Hosts.—*Ulmus americana* L. (Young 1899, Garlick 1923); on elm (Yuasa 1923). We collected adults from *Ulmus carpinifolia* Gleditsch at the University of Virginia Blandy Experimental Farm and State Arboretum of Virginia, Clarke Co.; very few were on American elm, *U. americana,* and some exotic elms in the same vicinity in the Arboretum. Specimens collected in Malaise traps were in a nearby woodlot where slippery elm, *Ulmus rubra* Mühl., is present, but we cannot confirm this as a host. Most collection records from label data are from elm or *Ulmus* sp.

Biology.—The description of the larva and biological notes by Young (1899) are the first published on *M. ferruginea.* His classical observation of the active pupa phenomenon has not been reported since. According to Young "Larvae sit curled around the young leaves or terminal buds with the front part of their body free. They feed by eating a line across the bunch of leaves, thus truncating them all. A single brood each year, the adults appearing in April. A few days before the appearance of the adult the larva which has lain in the larval state in its cocoon until this time changes to an active pupa, which bursts its cocoon and comes forth without shedding its skin and exists then as an active pupa at the surface of the ground from twenty-four to forty-eight hours. It then sheds its skin and becomes the true imago. Larvae enter the ground about June 1st." He describes the cocoon as a light shell of sand held together by a few strands of silk.

Garlick (1923) reported on adult seasonality and feeding habits at Lawrence, Kansas. Adults were abundant in spring, March 30 to April 24, especially the week of April 10–17. The first specimen was found on March 30, and the last on April 24. They fed on buds of American elm and to a lesser extent buds of pear and plum. The buds are grown in length, but leaves hardly begun to show. Adults gnaw a hole in the side of the bud ⅔ up from the base and eat only the central part, working down and enlarging the hole as necessary. They left the bud an empty shell and so badly injured that no further growth of the bud was possible. About 200 specimens were netted, the sex ratio being 5 females to 1 male. Many of these voucher specimens are in the collection of the Snow Entomological Museum, University of Kansas.

Smith et al. (1943) reported that this is a common sawfly in Kansas and occurs only in early spring in April and May.

NMS collected adults and observed them in abundance on three elms at the Beltsville Agricultural Research Center, Prince George's Co., Maryland. Hundreds of individuals were netted while they flew from the ground to the branches of the trees above. However, diligent searching of the ground over several weeks failed to find "active pupae" as described by Young (1899). After continual observations, it became easy to distinguish *M. ferruginea* from other insects because of their slow flight, shiny wings, and because *M. ferruginea* would land on the twigs of the elm trees while other insects would hover near the branches, but seldom land. The elm trees where quite large (15 m) and only the lowest branches were attainable for collecting even with an extended net handle (3 m). Nonetheless, examination of the upper branches of the trees with binoculars revealed thousands of adults on two trees in 1994.

Specimens were netted during the following periods: 8–14 April 1993, 31 March–5 April 1994, and 16 March–15 April 1995. During these periods, NMS looked for individuals at least once a day. *Macroxyela ferruginea* only flew when it was warm and sunny. On cold or windy days, even in the middle of the flight period, no individuals were caught. Males emerged before females in 1995, the first male (followed by many others) was caught on 15 March and the first female not until 29 March. The sex ratio was notably biased

toward females after 1 April. Collections in 1993 and 1994 were not started prior to catching the first female specimens so presumably collections started in the middle of the flight period. Probably Garlick (1923) collected late in the flight period after males had flown. Sex ratio among (NMS) specimens (not necessarily a uniform sampling) is 124 m to 30 f (but at least 30 females were ground up for allozyme studies and a large number for sterol analysis). Rare individual males with red abdomens (formerly *M. bicolor*) were collected occasionally in the middle of the flight period (first part of April), and, since there were no associated females, we presume they are merely a sexually dimorphic color form of *M. ferruginea.*

Discussion.—Cell Rs1 of the forewing is not divided in most specimens examined. Of 461 specimens examined, 5 specimens had this cell divided in both forewings and 26 specimens had this cell divided in one of the two forewings. In most instances the division of this cell is not as uniform as in *M. aenea.* The cell may be smaller, or the crossvein dividing the cell may be partially atrophied; the crossvein is not centrally located as in *M. aenea* but toward the apex of the cell. For other characteristics, see the key to species and discussion under *M. aenea.*

About five specimens examined had rather darkly infuscated wings. They were from Missouri, Ohio, and Illinois. About ten males examined had a red abdomen. Some of these were collected in the same situation and at the same trees as the typically-colored black specimens, and we found no structural differences between the two. We examined red abdomen specimens from Maryland, Missouri, Illinois, Mississippi, Ohio, and Pennsylvania. NMS collected several red abdomen forms when making large collections in Maryland. This red form was described as *M. bicolor* by MacGillivray (1912). *Macroxyela bicolor* var. *harti* Ross (1932) is also this red form, but the wings are infuscated with deep brown and are strongly violaceous at the base. This is similar to the specimens with darkly infuscated wings as cited above. We regard these as color variants; thus, their synonymy above.

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Gainesville, FL; J.B. Whitfield, University of Arkansas, Fayetteville; and J.R. Wiley, Florida State Collection of Arthropods, Gainesville, FL. Other specimens are in the National Museum of Natural History, Smithsonian Institution, Washington, DC (USNM).

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