

Redescription of *Megamelus scutellaris* Berg (Hemiptera: Delphacidae), a Candidate for Biological Control of Water Hyacinth

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ABSTRACT To detect biocontrol agents of the invasive aquatic weed *Eichhornia crassipes* (Martius) Solms-Laubach (Pontederiaceae), surveys were conducted in the basins of the Paraná and Uruguay rivers in Argentina and the basin of the Amazon river in Peru and Brazil. Among the captured delphacids, *Megamelus scutellaris* Berg was the most abundant. Berg originally described this species on the basis of a macropterous female. In this contribution, the macropterous and brachypterous male and the brachypterous female are described, and the holotype female is redescribed. Some biological aspects are recorded.

KEY WORDS biocontrol, Delphacidae, *Eichhornia crassipes*, *Megamelus scutellaris*, water hyacinth

THE GENUS *Megamelus* Fieber 1866 is widespread throughout the world. Of 24 species found in the Americas (Asche 1985), only 5 are recorded from the Neotropical region: *M. bifurcatus* Crawford 1914 and *M. iphigeniae* Muir 1926 in Brazil, *M. electrae* Muir 1926 in Brazil, Puerto Rico, and Trinidad and Tobago (Caldwell and Martorell 1951, Cruttwell 1973), *M. timheri* Muir 1919 in Guyana, and *M. scutellaris* Berg 1883 in Argentina. Monocots, such as grasses and sedges (Poaceae and Cyperaceae), have been mentioned as host plants of many delphacid species (Denno 1978). However, the genus *Megamelus* is only associated with aquatic plants (O'Brien and Wilson 1985): *M. davisii* Van Duzee on *Nuphar advena* (Aiton) Aiton (Nymphaeaceae); *M. lobatus* Beamer on *Spartina patens* (Aiton) Muhlenberg (Poaceae); *M. metzaria* Crawford on *S. pectinata* Link (Poaceae); *M. notulus* (Germar) on *Carex laciocarpa* Ehrh, *C. riparia* Curtis (Cyperaceae), and *Juncus* sp. L. (Juncaceae); *M. palaetus* (Van Duzee) on *Pontederia cordata* L. (Pontederiaceae); *Megamelus* sp. on *Eleocharis* sp. (Cyperaceae), *Distichilis stricta* (Torrey) Rydberg, and *S. alterniflora* Loisel (Poaceae) (Au 1941, Wilson and McPherson 1979, 1981a, b, Wilson et al. 1994), and the only record for a Neotropical species, *M. electrae* on *Eichhornia crassipes* (Martius) Solms-Laubach (Pontederiaceae). *M. electrae* was preliminarily studied in Trinidad on its host plant as a candidate for biological control (Cruttwell 1973). *E. crassipes*, commonly called "water hyacinth" is an invasive aquatic weed native to Amazonia (South

America). In its adventive range, this weed clogs waterways, lakes, and channels in several countries of the tropical and subtropical regions (United States, Central America, Australia, Papua New Guinea, Southeastern Asia, Africa, and southwestern Europe) (Julien et al. 1999). Thus, the weed hinders navigation, fishing and recreation, and severely alters the ecology of the invaded areas (Gopal 1987). Chemical and mechanical controls have been used to combat water hyacinth. Because these are expensive and ineffective, biological control offers a better choice (Gopal 1987, Julien et al. 1999). Despite the fact that two weevils [*Neochetina eichhorniae* Warner and *N. bruchi* Hustache (Coleoptera: Curculionidae)] and two moths [*Niphograptus albigutalis* (Warren) (Lepidoptera: Pyralidae) and *Xubida infuselus* (Walker) (Pyralidae)] from South America are used to control the weed in its introduced range (Julien 2000), additional control measures are still required (Cordo 1995, Julien 2000).

In recent explorations in Argentina, Brazil, and the upper Amazon Basin, a large number of planthoppers were found; most were identified as *M. scutellaris*. This species was described by Berg in 1883 based on only one macropterous female specimen (holotype no. 1712) collected in Corrientes, Argentina, and stored in the collection of the Museo de La Plata (MLP), Buenos Aires. In this contribution, the two winged forms of the male and the brachypterous female are described, the holotype is redescribed, and further information on host plants and geographical distribution is added.

Materials and Methods

Adults and nymphs of *M. scutellaris* were collected in different provinces of Argentina in several sites on

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the Amazon River in Peru and in some sites in Brazil and Uruguay from 1997 to 2000. A few specimens belong to other collections, i.e., Facultad de Ciencias Exactas y Naturales, Universidad de Buenos Aires (FCEyN), División de Entomología del Museo de La Plata (MLP), and the USDA-ARS-South American Biological Control Laboratory (SABCL). All specimens were directly collected from the plant with insect aspirator, except the specimens from the FCEyN, which were collected with light-traps.

Approximately 200 adults and nymphs from Isla Talabera-Buenos Aires Province (December 1999 and February, November, and December 2000), 70 from Palo Santo-Formosa Province (November 2000), 150 from Pirané-Formosa (November 2000), and 60 from Formosa city (December 1999) were taken to the facilities of the USDA in Hurlingham (near Buenos Aires). Several generations were reared in outdoor conditions in three pools (2 m length by 1.4 m width by 0.5 m deep) containing different species of aquatic plants [Pontederiaceae: *E. crassipes*, *E. azurea* Kunth, *Pontederia cordata* L., *P. rotundifolia* L., *P. subovata* (Seubert) Lowden; Amaranthaceae: *Alternanthera philoxeroides* (Martius) Grisebach; Araceae: *Pistia stratiotes* L.; Alismathaceae: *Echinodorus grandiflorus* (Chamisso and Schlechtendal) Micheli, *Sagittaria montevidensis* Chamisso and Schlechtendal; Hydrocharitaceae: *Limnobium spongia* (Bosc) Steudel subsp. *laevigatum* (Humboldt and Bonpland ex Willdenow) Lowden; Limnocharitaceae: *Hydrocleys nymphoides* (Willdenow) Buchenau; and Menyanthaceae: *Nymphoides indica* L. Kuntze]. In addition, some of them were kept in two cages (61 by 61 by 61 cm) with only water hyacinth. Every week these plants were replaced with fresh ones.

The macropterous male was described in detail, but only major differences were described for females and the other winged forms. Both male and female genitalia were prepared for microscopic examination. The reported measurements come from 10 specimens of each sex and winged form and are given in millimeters. A series of 12 specimens, which were collected near the type locality, were considered as "reference specimens" and used for illustrations. In the female redescription, only the sixth sternite, the valvifer VIII outline, and the ovipositor length and coloration were recorded on the holotype; only the second valvula was dissected and described from the reference specimens so as to preserve the unique type specimen.

Abbreviations used here are as follows: L, total length; B.L., body length; t.l., tegmen length; v.l., vertex length; v. w., vertex width at base; M.f.w., maximum frons width; m.f.w., minimum frons width; a.I, first antennal segment length; a.II, second antennal segment length; p.l., pronotum length; m.l., mesonotum length; mti. l., metatibia length; mta., metatarsi length; mta.l, first hind tarsomere length; s.l., metatibial spur length; t.n., number of teeth on metatibial spur. Specimens were deposited at MLP and SABCL.

Results

Megamelus Fieber, 1866

Megamelus Fieber, 1866: 519

The genus is characterized by a narrow head, long vertex extending beyond the eyes, and the lobed appearance of male pygofer (Beamer 1955).

Megamelus scutellaris Berg, 1883

See Figs. 1–15.

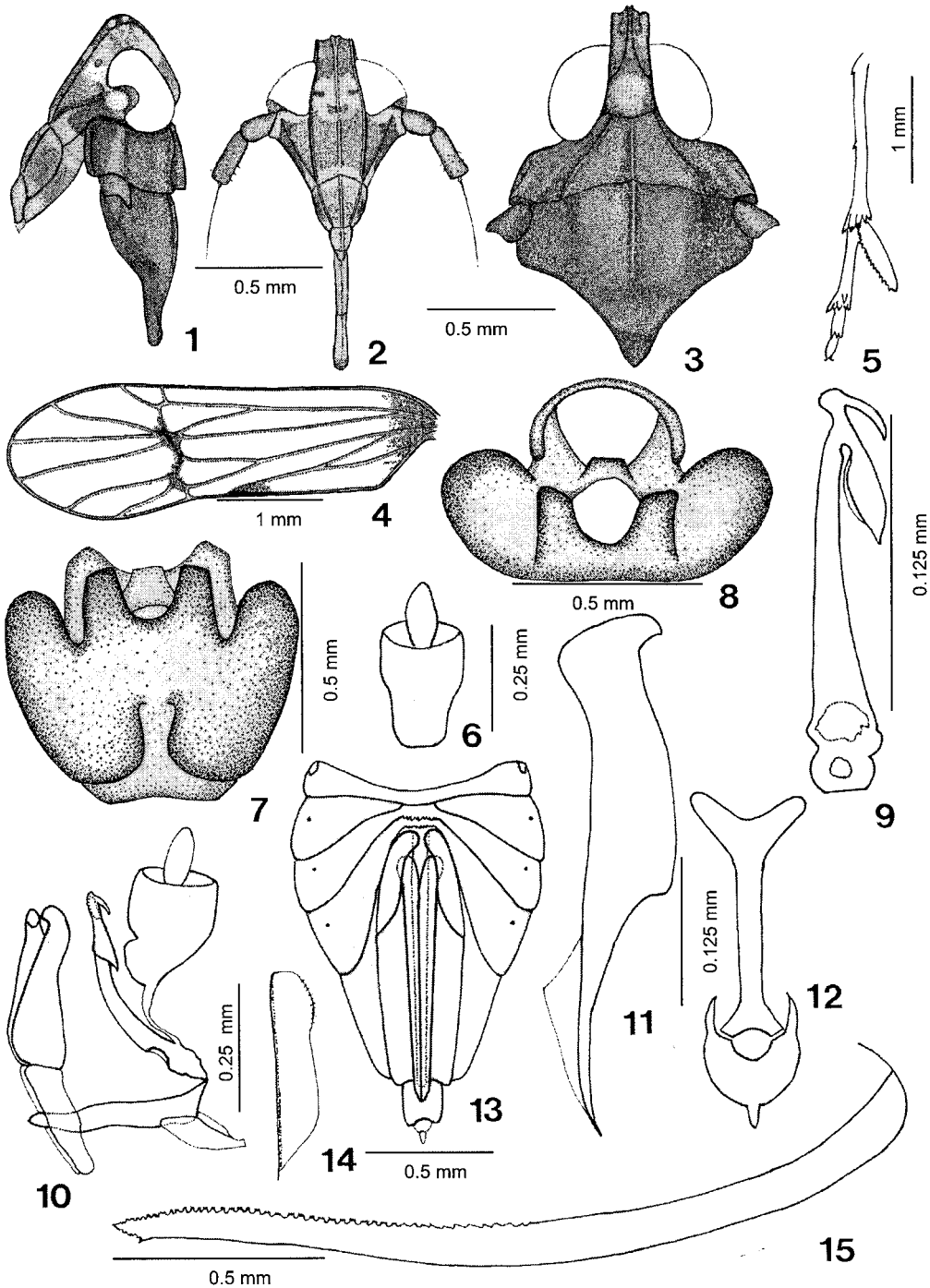
Megamelus scutellaris Berg, 1883: 23

Male Macropterous. Color: brown. Head, vertex lighter, lateral margin of basal compartment darker, small yellowish spots on apex of vertex and base of frons. Two lighter transverse stripes on frons, the broader one in the middle portion of frons and extending below the eyes, the other whitish, extending from the apex of frons and base of clypeus to the gena. Pronotum light brown, mesonotum dark brown, apex of scutellum blackish (Figs. 1–3). Legs light brown, annular dark brown stripes in the middle of pro and mesocoxa, base of trochanter, apical part of femur, basal and apical part of pro and mesotibia and base of metatibia. Tegmina hyaline, veins light brown, and fuscous area over axillar area, cross veins, and apex of clavus (Fig. 4). Abdomen brown, lighter at sides, and dorso lateral spots yellowish, VI segment and pygofer darker.

Head in dorsal view narrower than pronotum. Vertex rectangular, wider at base and slightly narrowing toward apex, lateral margin parallel, basal compartment approximately in the third basal, three times longer than wide and projecting beyond the eyes about one-half of its length (0.46:1), conspicuous medial carina forming a narrow triangular area that continues beyond the inflection point (Figs. 2 and 3).

Frons with lateral margins subparallel to convex, maximum width in the medial part, more than twice longer than wide (2.3:1), carinae well developed, median carina forked near the base at the same level of anterior edge of eyes. Clypeus subtriangular, as long as wide, lateral carinae joining to genal carinae, medial carina weaker. Rostrum short, reaching mesocoxa, basal segment longer than apical. Antennae, second segment 1.6 times longer than first segment, first twice longer than wide, second three times longer than wide (Figs. 1–3).

Pronotum with conspicuous, divergent, and straight to slightly convex lateral carinae, attaining hind margin. Mesonotum disc as long as vertex plus pronotum, median carina weak toward the apical part, lateral carinae absent (Fig. 3). Metatibial spur leaf-like, as long as first segment of metatarsi (0.98:1), 13–14 black-tipped teeth on the ventral margin, small and big teeth alternated on basal half, big teeth on apical half only, first hind tarsomere longer than second plus third (1.4:1; Fig. 5).



Figs. 1-15. *Megamelus scutellaris*. (1) Head and thorax, lateral view. (2) Head, frontal view. (3) Head and thorax, dorsal view. (4) Tegmina. (5) Apices of metathoracic leg. (6) Anal segment, caudal view. (7) Pygofer, ventro caudal view. (8) Pygofer, posterior view. (9) Aedeagus, posterior view. (10) Genitalia without genital segment. (11) Left style. (12) Connective. (13) Complete female genitalia, ventral view. (14) Left valvifer VIII. (15) Second valvula, right lateral view.

Genitalia. Anal segment without spine-like processes (Fig. 6). Pygofer subcylindrical, in caudoventral view. Outer lobes large, kidney-like, inner lobes

smaller, rectangular in outline, partially closing the ventral foramen, divergent truncated apices and concave area between their bases, a projected rectan-

gularly outline process in dorsal margin of diaphragm (Figs. 7 and 8). Aedeagus long, tubular narrowing toward apex and dorsally curved, two different apical processes on the right, the apical one finger-like and slightly curved and the other spoon-like much larger, phallosome on the left. Suspensorium short and lightly sclerotized. Connective short and straight (Figs. 9, 10, and 12). Styles long, widest at base with subparallel sides, truncate and convergent apically, broadly rounded outer corner and beak like inner corner (Fig. 11).

Measurements. L., 3.80–3.82, B.L., 2.47–2.94, t.l., 2.94–3.24, v.l., 0.38–0.40, v.w., 0.19–0.21, M.f.w., 0.24–0.28, m.f.w.: 0.17–0.18, a.l.I, 0.12–0.14, a.l.II, 0.24–0.26, p.l., 0.21–0.26, m.l., 0.51–0.59, mti.l.: 0.94–1.13, mta., 0.80–0.94, mta. I, 0.47–0.59, s.l., 0.49–0.59, t.n., 13–14.

Male Brachypterous. Color similar to macropterous form, tegmen amber, brown in the middle, four dark spots on apical margin. Abdomen lighter in the mid-part of tergites, lateral irregular whitish dots on tergites II, IV, V, and VII.

Mesonotum, three-median and lateral-well developed carinae reaching posterior margin, lateral carinae divergent near the median carina.

Measurements: B.L., 2.47–2.94, t.l., 0.87–0.94, v.l., 0.42–0.46, v.w., 0.20–0.24, M.f.w., 0.28–0.29, m.f.w., 0.17–0.22, a. l. I, 0.14–0.16, a. l. II, 0.24–0.26, p.l., 0.24–0.26, m.l., 0.35–0.38, mti. l., 1.01–1.55, mta., 0.82–0.87, mta. I, 0.54–0.59, s.l., 0.54–0.59, t.n., 12–13.

Female Macropterous. Structurally identical—pattern coloration and anatomical features—to the typical specimen and similar—color and morphology—to male. These diagnostic characteristics are considered relevant by the species's author as it is clearly shown in the original description.

Ovipositor dark brown, slightly overpassing the pygofer (Fig. 13). Margin of central part between the sclerites of sternite VII membranous, not always visible. Valvifer VIII regularly broad, slightly excavated on inner margin near the rounded and denticulated base (Fig. 14). Second valvula curved in the basal middle part and straight near the apex, numerous blunt teeth in the terminal half of dorsal margin and ventrally near the tip, one-half of them with a series of apical denticles (Fig. 15).

Measurements. L., 4.31–4.41, B.L., 3.06–3.69, t.l., 3.29–3.65, v.l., 0.40–0.48, v.w., 0.21–0.24, M.f.w., 0.26–0.29, m.f.w., 0.17–0.19, a. l. I, 0.14–0.17, a. l. II, 0.24–0.29, p.l., 0.24–0.29, m.l., 0.55–0.65, mti.l.: 1.06–1.29, mta., 0.96–1.16, mta. I, 0.58–0.66, s.l., 0.54–0.66, t.n., 13–15.

Female Brachypterous. Color and morphology similar to male. Genitalia similar to macropterous form.

Measurements. B.L., 3.35–3.50, t.l., 0.89–0.94, v.l., 0.42–0.47, v.w., 0.21–0.24, M.f.w., 0.31, m.f.w., 0.17–0.22, a.l.I, 0.14–0.16, a.l.II, 0.24–0.26, p.l., 0.24–0.26, m.l., 0.37–0.40, mti. l., 1.13–1.50, mta., 1.00–1.16, mta. I, 0.58–0.66, s.l., 0.54–0.66, t.n., 13–16.

Biological Aspects. *Megamelus scutellaris* was recorded in February, March, June, August, October, and December during the years 1997–2000 in Isla Talavera and only in summer in Resistencia, Palo Santo,

and Pirané. Several plants of the Pontederiaceae—*Pontederia cordata*, *P. rotundifolia*, *P. subovata*, *P. parviflora* Alexander, *E. crassipes*, and *E. azurea*—were sampled, but the only host plant recorded was water hyacinth. Similar results were obtained in the laboratory where *M. scutellaris* only reached very high densities on water hyacinth plants. This fact leads us to suggest the monophagy of *M. scutellaris*; therefore, host specificity studies were initiated. Adult and nymph feeding and oviposition punctures on water hyacinth leaves were frequently recorded between the distal portion of the petiole and the basal part of the lamina (on both sides) in the field as well as in the laboratory. Nymphs and adults were parasitized by a unidentified Dryinidae and predated by ubiquitous Carabidae, Staphylinidae, and spiders. Eggs were also parasitized by *Kalopolytnema poema* (Triapitsyn and Berezovskiy 2002) (Himenoptera, Mymaridae).

Geographical Distribution. ARGENTINA: Buenos Aires, Chaco, Corrientes, Entre Ríos, Formosa and Santa Fe. BRAZIL: Rio de Janeiro, Sao Paulo, Paraná and Río Grande do Sul states. PERU: Iquitos. URUGUAY.

The geographical range of *M. scutellaris* must be wider in the neotropical region. At present, it is found only in these four countries, although it is likely to be found wherever water hyacinth is naturally present. Studies are in progress to elucidate this geographical association.

Material Examined. HOLOTYPE: 1 ♀ (macropterous), ARGENTINA: Corrientes, XII-1876, Berg col., (MLP) No 1712. Reference specimens: ARGENTINA: Chaco, 4 ♀♀ brachypterous, 4 ♀♀ macropterous, 4 ♂♂ brachypterous, 4 ♂♂ macropterous, Traffic circle, junction Rt 16 and Rt 11, 13-XII-98, Sosa and Cordo col. (SABCL), Additional Specimens examined: ARGENTINA: Buenos Aires, 2 ♀♀ brachypterous, 4 ♂♂ brachypterous, Baradero, Baradero river, 26-XII-98, Hernández col. (SABCL), 2 ♀♀ macropterous, 6 ♂♂ macropterous, INTA Delta, 15-I-82, collected on lights traps, Bachman col. (FCEyN), 2 ♀♀ brachypterous, 3 ♂♂ brachypterous, 18-XI-99, Sosa, Cordo and Hernández col. (MLP), 1 ♀ brachypterous, 09-XI-99, Sosa and Cordo col., 5 ♀♀ brachypterous, 4 ♂♂ brachypterous, San Pedro, 29-X-99, Sosa and Cordo col. (MLP), 2 ♀♀ brachypterous, 2 ♀♀ macropterous, 2 ♂♂ brachypterous, 10 ♂♂ macropterous, Hurlingham, 04-II-2000, Sosa col. (MLP), Chaco, 16 ♀♀ brachypterous, 13 ♂♂ brachypterous, Traffic circle, junction Rt 16 and Rt 11, 13-XII-98, Sosa and Cordo col. (SABCL), 80 ♀ brachypterous, Rt 5, seven km Southwestern Río Bermejo, 15-VII-98, Sosa and Cordo col. (SABCL), 1 ♀ macropterous, Resistencia, 7-XI-52, Whaet leg. (MLP), Entre Ríos, 2 ♂♂ brachypterous, 1-XI-99, Villa Paranacito, Sosa and Cordo col. (MLP), Formosa, 3 ♀♀ brachypterous, 1 ♀ macropterous, 4 ♂♂ brachypterous, 2 ♂♂ macropterous, Comandante Fontana, Rt 81, 16-XII-98, Sosa and Cordo col. (MLP), 80 ♀♀ brachypterous, 1 ♀ macropterous, 26 ♂♂ brachypterous, 6 ♂♂ macropterous, Palo Santo, Rt 81, 16-XII-98, Sosa and Cordo col. (MLP), 7 ♀♀ brachypterous, 10 ♂♂ brachypterous, Riacho He He Chico,

26-XI-95, Cordo col. (MLP), Santa Fe, 2 ♀♀ brachypterous, 1 ♂ brachypterous, Rt 168, nine km East Río Colastiné, 31-X-2000, Sosa and Cordo col. (MLP), PERÚ: Iquitos, 18 ♀♀ brachypterous, 2 ♂♂ brachypterous, Muringo Cocha, 27-IV-99, Cordo col. (MLP), BRAZIL: Paraná, 4 ♀♀ brachypterous, 1 ♀ macropterous, 2 ♂♂ macropterous, outskirts of Foss do Iguacu, road to international border with Argentina, 22-IV-2000, Sosa and Cordo col. (MLP), Rio Grande do Sul, 5 ♀♀ brachypterous, 4 ♂♂ brachypterous, BR 116 outskirts of Guaiba, 9-IV-2000, Sosa and Cordo col. (MLP), Rio do Janeiro, 2 ♀♀ brachypterous, 1 ♂ brachypterous, Cabo Frio, 16-IV-2000, Sosa and Cordo col. (MLP), Sao Paulo, 1 ♀ macropterous, 2 ♂♂ brachypterous, SP 55, four km Western Humaita, 13-IV-2000, Sosa and Cordo col. (MLP), 4 ♀♀ brachypterous, 1 ♂ brachypterous, SP 55, Jaquehy, 13-IV-2000, Sosa and Cordo col. (SABCL), URUGUAY: San Jacinto, 3 ♀♀ brachypterous, 1 ♀ macropterous, 2 ♂♂ macropterous, Rt 1, 18-I-2000.

Remarks. Among South American *Megamelus*, the male genitalia of *M. scutellaris* is easily distinguished by the following character combination: anal segment without spines (Fig. 6), pygofer without process between inner lobes (Figs. 7 and 8), rectangular diaphragm process (Figs. 7 and 8), two different apical processes in the aedeagus—in shape and size—(Fig. 9), and convergent styles (Fig. 11). According to the species key from Beamer 1955, *M. scutellaris* is intermediate to *M. falcatus* Beamer 1955 and *M. coronus* Beamer 1955 because of the two apical processes in the aedeagus (Fig. 9), but it differs from these species in that the pygofer lacks processes between the inner lobes (Figs. 7 and 8).

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References Cited

Asche, M. 1985. Zur phylogenie der Delphacidae Leach, 1815 (Homoptera Cicadina Fulgoromorpha). Marburger Entomol. Publ. 2: 1-910.

Au, S. H. 1941. *Megamelus davisii* infesting water lily in Hawaii. J. Econ. Entomol. 34: 415.

Beamer, R. H. 1955. A revision of the genus *Megamelus* in America North of Mexico (Homoptera, Fulgoroidea, Delphacidae). J. Kansas Entomol. Soc. 28: 29-46.

Berg, C. 1883. Hemiptera Argentina. An. Soc. Ci Entomol. Arg. 16: 235.

Cordo H. A. 1995. Recommendations for finding and prioritizing new agents for biocontrol of waterhyacinth, pp. 181-185. In R. Charudattan et al. (eds.) Strategies for waterhyacinth control. Report of panel of experts meeting. Fort Lauderdale, FL.

Caldwell, J. S., and L. F. Martorell. 1951. Review of the Auchenorrhynchois Homoptera of the Puerto Rico Part II. The Fulgoroidea except Kinnaridae. J. Agric. Univ. Puerto Rico. 34: 133-269.

Crawford, L. 1914. A contribution toward a monograph of the homopterous insects of the family Delphacidae of North and South America. Proc. U.S. Nat. Museum. 46: 557-641.

Crutwell, R. E. 1973. Preliminary investigations on some insects causing minor damage to water hyacinth, *Eichhornia crassipes*. Report West Indian Station, CIBC.

Denno, R. F. 1978. The optimum populations strategy for planthoppers (Homoptera: Delphacidae) in stable marsh habitats. Can. Entomol. 110: 135-142.

Fieber, F. X. 1866. Grudzüge zur generischen Theilung der Delphacini. Ver. Zool. Bot. Ges. Wein. 16: 517-534.

Gopal, B. 1987. Water hyacinth. Aquatic plant studies 1. Elsevier, Amsterdam.

Julien, M. H. 2000. Biological control of water hyacinth with arthropods: a review to 2000. Biological and integrated control of water hyacinth *Eichhornia crassipes*, pp. 8-19. In M. H. Julien, M. P. Hill, T. D. Center, and D. Jianqing (eds.), Proceeding of the Second Meeting of the Global Working Group for the Biological and Integrated Control of Water Hyacinth. ACIAR, Canberra, Australia.

Julien M. H., M. W. Griffiths, and A. D. Wright. 1999. Biological control of water hyacinth. ACIAR monograph series, Canberra, Australia.

Muir, F. 1919. Some new American Delphacidae. Can. Entomol. 51: 36.

Muir, F. 1926. Contributions to our knowledge of South American Fulgoroidea (Homoptera). Part I. The family Delphacidae. Bull. Hawaiian Sugar Planter's Assoc. (Entomol. Ser.). 18: 1-51.

O'Brien, L. B., and S. W. Wilson. 1985. Planthopper systematics and external morphology, pp. 61-101. In: L. R. Nault and J. G. Rodrigues (eds.), The leafhoppers and planthoppers. Wiley, New York.

Triapitsyn, S. V., and V. V. Berezovskiy. 2002. Revision of *Kalopolynema*, with notes on *Platypolynema* (Hymenoptera: Mymaridae). Fla. Entomol. 58: 611-619.

Wilson, S. W., and J. E. McPherson. 1979. The first record of *Megamelus palaetus* in Illinois (Homoptera; Fulgoroidea; Delphacidae). Great Lakes Entomol. 12: 227.

Wilson, S. W., and J. E. McPherson. 1981a. Ontogeny of the tibia spur in *Megamelus davisii* (Homoptera: Delphacidae) and its bearing on delphacid classification. Great Lakes Entomol. 14: 49-50.

Wilson, S. W., and J. E. McPherson. 1981b. Life history of *Megamelus davisii* with descriptions of immature stages. Ann. Entomol. Soc. Am. 74: 345-350.

Wilson, S. W., C. Mitter, R. F. Denno, and M. R. Wilson. 1994. Evolutionary patterns of host plant used by delphacid planthoppers and their relatives, pp. 7-113. In R. F. Denno and J. Perfect (eds.), Planthoppers—their ecology and management. Chapman & Hall, New York.

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