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A new species of the genus *Cicadatra* from Iran (Hemiptera: Auchenorrhyncha: Cicadidae)

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Abstract. A new species *Cicadatra barbodi* sp. nov. was collected from Lorestan province in western Iran and its morphology and calling song are described. The new species sings with the head downward and its song is comprised of a continuous series of steady phrases with short interecheme intervals. The average of duration for phrases and interecheme intervals was 1.442 and 0.047 seconds and the peak frequency was determined to be 9.562 kHz (n = 2). The average rate at which phrases were produced was 1.5 per second and the duration of pulses within phrases was 0.001 second. The diagnosis of morphological and acoustic characters of the new species from other closely related cicada species are also given. *Cicadatra cataphractica* Popov, 1989 is transferred to *Psalmocharias* Kirkaldy, 1908 to become *Psalmocharias cataphractica* (Popov, 1989) comb. nov.

Key words. Cicadidae, new species, calling song, Iran, *Psalmocharias cataphratica*, new combination

Introduction

The fauna of cicadas of Iran has been subjected to some researches during the past 110 years. Melichar (1902) was the first person who studied Iranian cicadas: he described *Cicadatra ochreata* Melichar, 1902 and reported *C. alhageos* (Kolenati, 1857) and *Melampsalta musiva* (Germar, 1830) from southeastern Iran. Gardenhire (1958) is the next reference which mentioned the presence of *Cicadatra* spp. in western Iran. However, the most significant progress in identifying the fauna of cicadas in Iran was made by J. Dlabola who published several papers on the fauna of Auchenorrhyncha of Iran, including descriptions and records of species of the family Cicadidae (Dlabola 1960, 1970, 1979, 1981, 1987). Babaii (1967), Mirzayans et al. (1976), Mirzayans (1995), Shekarian & Rezvani (2001), Schedl (2003), Gogala & Schedl (2008), Gogala et al. (2008), Mozaffarian (2008), Mozaffarian et al.

(2010), Mozaffarian & Sanborn (2010, 2012), and Mol et al. (2013) further extended the knowledge on Iranian cicadas. A total of 42 cicada species (15 of which belong to the genus *Cicadatra* Kolenati, 1857) have been described and recorded from Iran. About 10 of them are mentioned as pests in agricultural and wood ecosystems (Abaii 2000, Shekarian & Rezvani 2001). The calling songs of only a few of the species occurring in Iran (13) have been described (Gogala & Schedl 2008, Mozaffarian & Sanborn 2010, Mozaffarian et al. 2010). The present study describes morphology and the calling song of *Cicadatra barbodi* sp. nov. collected from Lorestan province in western Iran.

Material and methods

The specimens were collected in Lorestan province in western Iran during summer 2009. Terminology for the description of the morphology follows Moulds (2005a). Measurements were made using Vernier callipers. Type material was deposited in the Hayk Mirzayans Insect Museum, the Iranian Research Institute of Plant Protection, Tehran (HMIM) and the Allen Sanborn collection, Miami Shores, Florida, USA (AFSC).

Calling songs were recorded on 23 July 2009 from two specimens on the edge of an oak wood in Zangolvar (ambient temperature was not recorded), using a Zoom Handy Recorder H4, at a sampling rate of 96 kHz and 24 bit resolution. The recorder and microphone have a ±3 db sensitivity to about 11–12 kHz whereupon the frequency response decreases. Recorded songs were analysed using Adobe Audition 2.0. Pulse repetition rates and echeme duration averages were determined by counting individual pulses and duration of 10 echemes in the song of each individual. The average of the values for the 10 echemes were then used as the representative values for each individual. Reported averages are the means of the two individuals.

Taxonomy

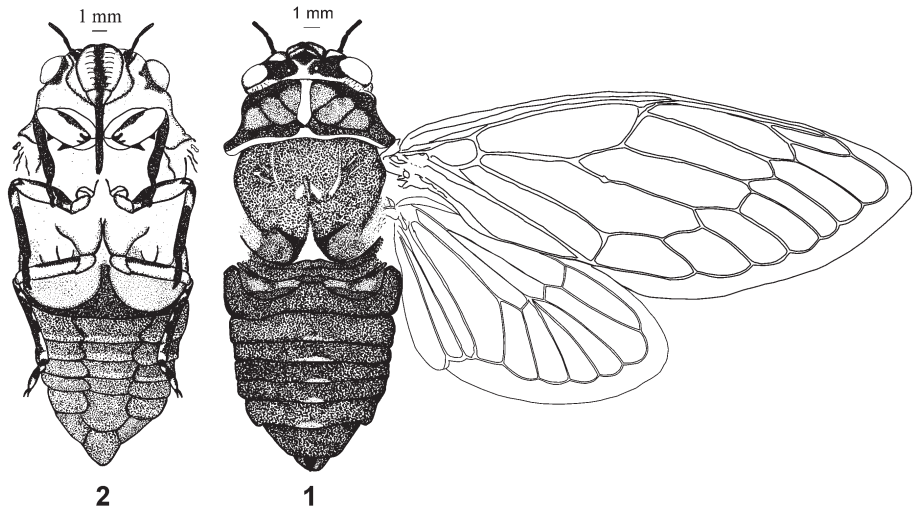
Cicadatra barbodi sp. nov.

(Figs 1–14)

Type material. Holotype: ♂, **IRAN: Lorestan:** Girit, Zangolvar, 23.vii.2009, Mozaffarian and Nematian leg. (HMIM). Paratypes: 1 ♂ 4 ♀♀ (HMIM), 1 ♂ 1 ♀ (AFSC), same data as holotype.

Description. General colour of body dark brown and black.

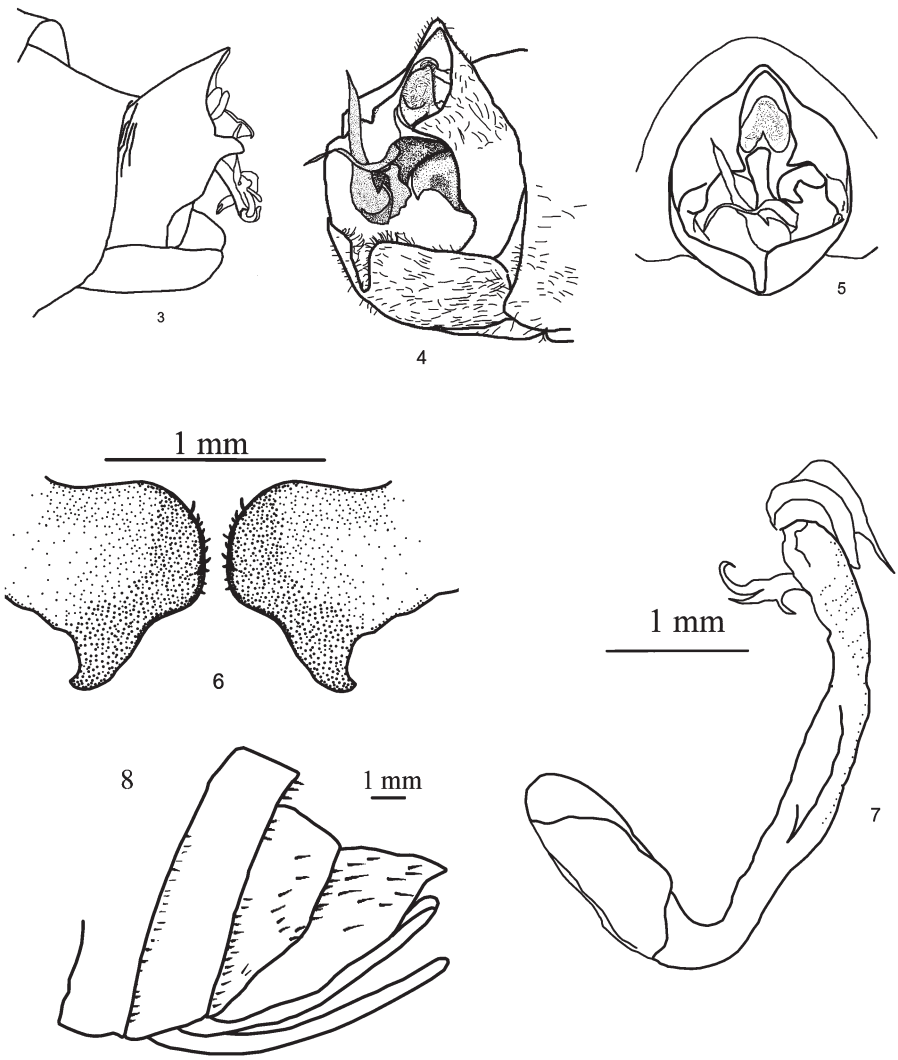
Head including eyes narrower than pronotum and mesonotum (Fig. 1). A longitudinal light fascia present on epicranial suture and its anterior arms extending to anterolateral surface of the vertex. Supra-antennal plates and most of anterior vertex yellow, dark brown next to eye and postclypeus. The sizes of dark and light areas on supra-antennal plates vary in paratypes. Vertex with black areas around ocelli, extending laterally towards compound eyes. Posterior edge of vertex yellow, white pile scattered on vertex, denser near the compound eyes. Yellow areas on vertex reduced in a male and a female paratype to a posterior fascia at junction with prothorax and the basal half of epicranial suture. Ocelli orangish brown with cream parts in holotype and some paratypes. Eyes brown with light irregular lines appearing in holotype and some paratypes. Distance between lateral ocelli nearly equal to their distance to compound eyes. Frons black surrounded by yellow anterior arms of epicranial suture.



Figs 1–2. *Cicadatra barbodi* sp. nov. 1 – dorsal view; 2 – ventral view.

Antennae with dark brown pedicel and light brown flagellum, totally dark or lighter in some paratypes. Postclypeus yellow with a median longitudinal dark brown fascia covering median longitudinal suture. Transverse grooves of postclypeus dark brown, fading laterally, brown areas vary in darkness and size in paratypes. Sparse white pile present on lateral edges of postclypeus. Anteclypeus yellow with dark or light brown median fascia and dense white pile laterally. Lorum and genae yellow with long white pile, gena black around eye. Mentum yellow, labrum and labium brown. Rostrum reaching basisternum III.

Thorax (Fig. 1). General colour of pronotum yellow and dark or light brown with scattered short white pile. A yellow median fascia present on pronotum widening on posterior one third and pointing apically. Pronotal collar black or dark brown with a yellow band posteriorly, incomplete in some paratypes, extending towards the median fascia on the midline. The size of the yellow areas varies in paratypes. Lateral angles of pronotal collar black or dark brown, with a posterior yellow band in some paratypes. Lateral parts of pronotal collar black or dark brown with narrow yellow margins laterally. Pronotal disc black or dark brown, lightened over a range to yellow in paratypes, with lighter irregular areas on both sides of longitudinal median fascia, on and between paramedian and lateral fissures. The light areas vary in darkness and size from ambiguous light pattern to large yellow discs. Mesonotum shiny black or dark brown with light brown to yellow pattern on parapsidial suture curving towards median axis, continuing with two tear-shaped marks lateral to a short light median line. Two to three short, oblique, light lines present laterad to parapsidial suture, absent or reduced in some male paratypes, attaching to another narrow light line, nearly parallel to parapsidial suture in some paratypes. Dense white pile present on mesonotum laterally and anterior to crucial elevation covering scutal depression. Additional sparse white pile present anteriorly in some paratypes. Cruciform elevation yellow,



Figs 3–8. *Cicadatra barbodi* sp. nov. 3 – lateral view of male pygopher; 4–5 posterior view of male pygofer; 6 – male claspers; 7 – male aedeagus; 8 – female terminal segments.

medially with black arms. Metanotum exposed and dark brown. Ventral sclerites of thorax light yellow, covered with dense white pile.

Legs (Fig. 2). General colour of legs yellowish with brown markings and fasciae covered with white pile giving a creamy white appearance to the legs. Darkness and size of markings vary in different specimens. Fore coxae yellow or whitish with a brown basal edge and two light or dark brown longitudinal fasciae on outer lateral surface. Middle coxae yellow, brown

at base in some paratypes. Hind coxae yellow. Fore trochanter yellow with brown patch at base on outer lateral side, extending narrowly towards the apex. Middle and hind trochanters yellow with brown irregular brown patches, absent in some specimens. Fore femur yellow with wide brown edges on outer lateral surface and brown fasciae along the inner lateral surface. Three brown femoral spines present, angled, darkening towards the apex, decreasing in size from primary to tertiary spine. An additional small spine present near the apex of fore femora in some paratypes. Middle and hind femora with extended longitudinal fasciae on dorsal and lateral surfaces and one short longitudinal fascia ventrally. The brown fasciae reduced in number and size in female paratypes, fasciae fused in one male paratype forming a wide dark area on dorsal and both lateral surfaces. Fore tibia brown, lighter in female paratypes. Middle and hind tibiae with brown dorsal surface with a yellow patch at base and yellow ventral surface. Dark areas on hind tibia extended in the male paratype and mostly yellow in a female paratype. Tibial spurs and comb brown, darkening towards the apex. Tarsus brown, yellow ventrally, totally dark brown in a male paratype, mostly yellow in a female paratype. Claws brown, darkening towards the apex.

Operculum. Male opercula (Fig. 2) light yellow, covered with white pile, short, broader than long, reaching anterior margin of sternite III but not meeting each other medially. Opercula do not extend to posterior of sternite II in some paratypes. Lateral and posterior margins strongly curved, rounded medially. Female opercula short, light yellow, tending to brown laterally, with rounded posterior margin. Meracanthus yellow, triangular, pointing posteriorly, brown spot at base in some paratypes.

Wings (Fig. 1). Fore wing hyaline with whitish basal membrane, eight apical cells and pentagonal fore wing radial cell. Fore wing venation yellow and brown, darkening distally with narrow infuscation around radial and radiomedial cross veins. Hind wing hyaline with six apical cells, venation yellow and light brown. Anal vein 3 dark brown, surrounding with a white plaga from base to near the apex. Narrow infuscation around ambient vein at the apex of cubital cell 2 and anal cell 1 and distal anal vein 2. Radius posterior and median veins fused at base.

Abdomen (Figs 1–2). Abdominal tergites brown, lighter in small areas on posterior edge, lighter lateral patches in tergites 3–6 in some paratypes. Rather dense white pile present on posterior edge of tergites, denser laterally. Timbal covers incomplete, exposing the timbals anteriorly with 10 ribs. Abdominal sternites light brown, lighter laterally, covered with white pile, denser towards the terminal sternites. Sternite VIII short, completely covered with white pile. Density of white pile reduced in some paratypes. Epipleurites light brown with dense white pile on anterior edge, scattered pile on the other parts.

Male genitalia (Figs 3–7). Male pygofer short, covered with white pile. Dorsal beak short, slightly longer than anal styles, at an approximate right angle to upper lobe of pygofer. Upper lobe of pygofer extended into a finger-like projection. Uncus short and globate with radiating golden pile. Claspers broad with round disc shaped bodies, not meeting each other medially and with a narrow triangular projection posteriorly, pointing postero-laterally. Aedeagus with a broad basal part and two curved spine like appendages at apex. A smaller tri-fold appendage present near the apex of aedeagus oriented at an approximate right angle to the stem.

Female genitalia (Fig. 8). Female abdominal segment 9 dark brown, lighter along ventral

margin in some specimens, covered with white pile. Dorsal beak extending beyond anal styles. Ovipositor sheath brown with white pile, extending beyond anal styles but not to dorsal beak. Ovipositor ocher brown, darkening towards the apex.

Measurements (3 ♂♂ 5 ♀♀, mean (range) in mm). Length of body, male: 26.3 (25.2–26.9), female: 26.9 (24.8–28.0). Length of fore wing, male: 32.7 (31.8–33.4), female: 32.3 (29.7–34.2). Width of fore wing, male: 12.8 (12.2–13.3), female: 12.7 (11.9–13.3).

Differential diagnosis. *Cicadatra barbodi* sp. nov. is one of a group of large *Cicadatra* species but can be distinguished from other large species relatively easily. The new species can be distinguished from *C. shaluensis* China, 1925 by the lack of heavy infuscation forming a zig-zag pattern on the fore wings and hind wings. The narrow fore wings of *C. erkowitensis* Linnavuori, 1973 and *C. longipennis* Schumacher, 1923, and the shape of ulnar cell 2 in the fore wing of *C. persica* Kirkaldy, 1909 distinguish these species from *Cicadatra barbodi* sp. nov. The narrower fore wings and black abdomen distinguish *C. bistunensis* Mozaffarian & Sanborn, 2010. The pronotal discs and ventral abdomen are ferrugineous in *C. aceri* (Distant, 1888) and *C. anoea* (Walker, 1850), the entire pronotum is flavotestaceous in *C. flavicollis* Horváth, 1911, and the pronotum is black except for a midline stripe in *C. kermanica* Dlabola, 1970. The wider pronotum, the lack of marking on the posterior pronotal collar, and black abdomen distinguish *C gingat* China, 1926. Finally, *C. zahedanica* Dlabola, 1970 can be distinguished by its monochromatic tawny coloration.

The other *Cicadatra* species from the collection region can be separated by the much smaller body size (about 16 mm) of *C. lorestanica* Mozaffarian, Sanborn & Phillips, 2010, the smaller body length (20 mm) and green or tawny coloration of *C. alhageos* (Kolenati, 1857), and finally, *C. hyalina* (Fabricius, 1798) can be distinguished by sternite VIII being about 1.5 longer than broad, the upper pygofer lobe being very small and not finger-like, the more rounded medial region of the claspers which meet medially, the multiple spines on the aedeagus in males or the rounded rather than angulate posterior margin of the female sternite VII. The genitalia as illustrated are unique to the new species and can be used to distinguish the species from any other *Cicadatra* species.

Song. During the field collection, male specimens were singing, head downward, on the stem of *Echinops* sp., in oak (*Quercus* spp.) woods (Fig. 9). The song of *C. barbodi* sp. nov. was also heard from the branches inside the oaks. The song (number of specimens recorded = 2) consisted of a continuous train of steady echemes separated by short pauses (interecheme intervals) (Figs 10–13). The echemes had a duration of 0.661 to 2.644 seconds, with the average of 1.442 seconds and the interecheme interval lasting between 0.033 to 0.057 seconds with the average of 0.047 seconds. The mean rate of echeme production was 1.5 per second. The echemes were comprised of repeating sound pulses of 0.001 second duration without interechemes. Peak energy (peak frequency) for both recorded animals was determined to be 9.562 kHz (Fig. 14). Blowing wind did not influence sound production or the length of phrases and silences in recorded sounds. No wing clicks were observed.

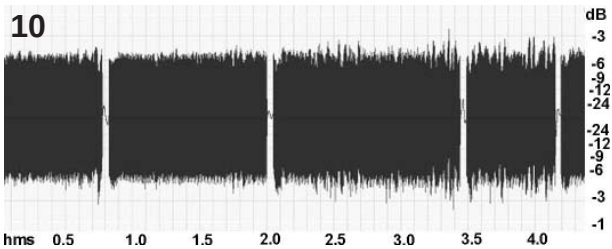
The head down posture during singing in this species is rather rare in cicadas (Boulard & Mondon 1996, Moulds 2005b, Sanborn & Phillips 2012). It has been described in *Cicadatra atra* (Olivier, 1790) (Boulard & Mondon 1996), which has also been recorded from Iran (Mozaffarian & Sanborn 2010) and was documented also in *C. hyalina* (Gogala 2009).

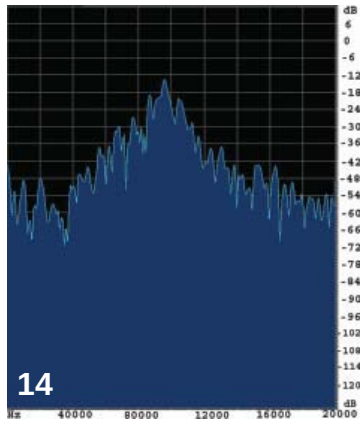
Fig. 9. Male specimen of *Cicadatra barbodi* sp. nov. singing on *Echinops* sp.

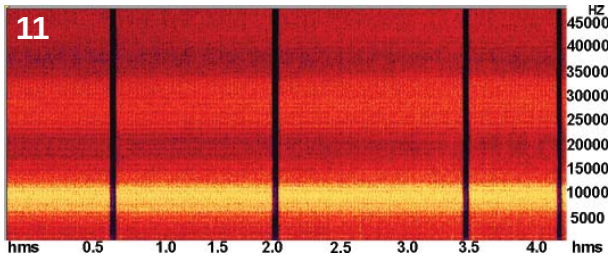
The wing click behaviour, described for *C. atra* (Gogala & Trilar 2003) and *C. platyptera* Fieber, 1876 (Gogala et al. 2005) was not observed in the new species. The song of *C. atra* is similar in frequency to the new species which would be expected based on the similarities in the body size of the species (Bennet-Clark & Young 1994) but this species has more types of songs (continuous, calling, courtship: Gogala 2009) and the temporal patterns of the songs differ (Popov 1975, Boulard 1995). Further observation may show that the new species also has additional song types.

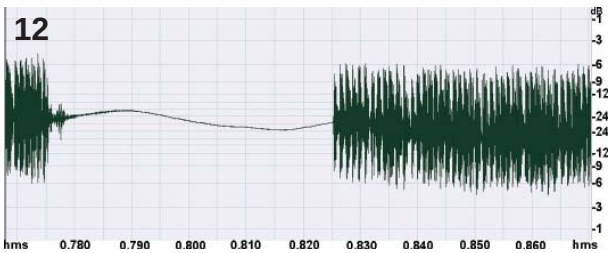
At least four other *Cicadatra* species have been recorded from Lorestan province (Mozaffarian & Sanborn 2010, Mozaffarian et al. 2010): *C. lorestanica*, *C. alhageos*, *C. hyalina*, and *C. persica* Kirkaldy, 1909. The song of the new species can be distinguished from *C. lorestanica* by the lack of the short buzzy pulses at the beginning and the termination of the song and lower frequency of the call (Mozaffarian et al. 2010). The duration of the phrases in the new species is much shorter than in *C. alhageos* (which was observed to have similar continuous steady phrases, up to 14 seconds in duration) and much longer than in *C. hyalina* (which is about 0.02 seconds: Popov 1985 and personal observation). The call of *C. hyalina* also begins with an amplitude modulated component and lacks the echemes of the new species (Boulard 1995). Gogala (2009) provides a calling song for *C. hyalina* that is continuous with a rumbling sound that is broken into echemes. The new species can also be distinguished from *C. persica* by the higher peak frequency, lack of an amplitude modulation pattern at the beginning of the song and the lack of the calling song with wing clicks as described in Gogala & Trilar (1998, 2003) for *C. persica*. The song of *C. alhageos* is most similar in its characteristics but has a higher peak frequency but the echemes range from 1.16 to 4.29 seconds with interecheme intervals of 0.04 seconds (Zamanian et al. 2008).

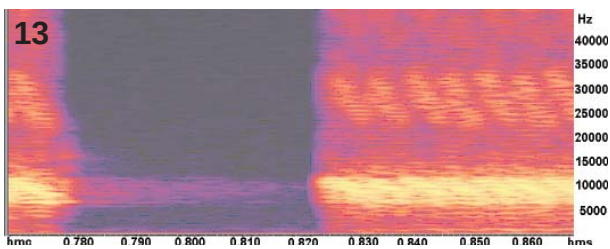
Tibicen esfandiari Dlabola, 1970, *Chloropsalta smaragdula* Haupt, 1920, *Cicadatra bistunensis* Mozaffarian & Sanborn, 2010, *Cicadatra shapur* Dlabola, 1981, *Psalmocharias flava* Dlabola, 1970, and *Psalmocharias querula* (Pallas, 1773) are other species recorded from western Iran, while only the song of the last species has been described. The song of *P. querula* is a continuous buzzing with peak frequency of 5–7 kHz and phrases of calling











Figs 10–14. Song of *Cicadatra barbodi* sp. nov. recorded in Zangolvar on 23 July 2009. 10 – waveform of a 4.2 second section; 11 – spectrogram of a 4.2 second section; 12 – a 0.865 second expansion of waveform of the same song; 13 – a 0.865 expansion of the spectrum of the same song; 14 – the peak energy in the audible range of frequency in the song.

song that are amplitude modulated at the beginning of each phrase (Popov 1975, Gogala 2009) and is easily distinguishable from the new species.

Etymology. The species is named for the Iranian musician Barbod (590–627 A.D.) who introduced his music to the king Khosroparviz while he was hidden in a tree so the king thought the music came from heaven.

Habitat and distribution. The new species was collected in oak (*Quercus* spp.) woodlands on *Echinops* sp. in western Iran. It is currently only known from the type locality and distributional data are therefore limited.

***Psalmocharias cataphractica* (Popov, 1989) comb. nov.**

Comments. While eliminating potential *Cicadatra* species in determining the status of the new species, it came to our attention that *Cicadatra cataphractica* Popov, 1989 is not a member of *Cicadatra*. The wing characteristics, particularly the ratio of width to length of the forewing and the position and infuscation on the radial and radiomedial crossveins of the forewings and hindwings, suggest the species is actually a member of the genus *Psalmocharias* Kirkaldy, 1908. Further evidence is the comparison by Popov (1989) to *Cicadatra querula* Pallas in the original description, a species also classified in *Psalmocharias*. As a result, we transfer *Cicadatra cataphractica* to *Psalmocharias* to become *Psalmocharias cataphractica* (Popov, 1989) comb. nov.

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