



Contribution to the planthopper fauna of Iran: Cixiidae, tribe Cixiini (Hemiptera, Auchenorrhyncha, Fulgoromorpha)

Fariba Mozaffarian

Insect Taxonomy Research Department, Iranian Research Institute of Plant Protection, Agricultural Research, Education and Extension Organization, P.O. Box 1454, Tehran 19395, Iran.

✉ mozaffarian@iripp.ir

<https://orcid.org/0000-0003-0163-7997>

Hannelore Hoch

Leibniz-Institute for Evolution and Biodiversity Science, Museum für Naturkunde, Humboldt-Universität zu Berlin, Invalidenstr. 43, 10115 Berlin, Germany.

✉ hannelore.hoch@mfn.berlin

<https://orcid.org/0000-0001-6439-9645>

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ABSTRACT. In this study, the Iranian specimens of the cixiid tribe Cixiini (genera *Cixius* Latreille and *Tachycixius*, Wagner) housed in Hayk Mirzayans Insect Museum (HMIM) were examined. The examined specimens were collected and deposited in HMIM since 1970 including our recent studies and collecting trips since 2007. *Cixius remotus* Edwards, 1888 is a new record for the fauna of Iran. An Identification key to the genera and species, and distribution maps for the species in the tribe Cixiini present in Iran are provided and zoogeographic implications are discussed.

Key words: Fulgoroidea, Fauna, Faunistics, taxonomy, Persia

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INTRODUCTION

With ca. 2.600 described species worldwide (Bourgoin, 2022), the Cixiidae are the largest family of the Fulgoromorpha. While adults of cixiid species usually live above ground feeding on the green parts of grasses, herbs, shrubs and trees, nymphs dwell in leaf litter or in cracks and crevices within the soil where they feed on plant roots. Female cixiid planthoppers lay their eggs on or into the soil, sometimes covered in wax filaments exudated by the female (Müller, 1942). Several lineages have evolved facultatively or obligately cavernicolous species (for a synopsis on the present knowledge concerning the morphology, ecology and diversity of the Cixiidae (see Holzinger et al., 2002; Bourgoin, 2022 and references therein).

The tribe Cixiini in Iran comprises two genera, *Cixius* Latreille, and *Tachycixius* Wagner. The type genus, *Cixius* is one of the large genera, if not the largest genus, currently comprising 298 species (Bourgoin, 2022). Species accommodated in *Cixius* are characterized by several, however mostly plesiomorphic features: mesonotum with three longitudinal carinae, hind tibia laterally with 1-3 spines, tergite IX in females with wax plate and tegmina (forewings) translucent, their distal margin without granula (bases of setae) between apical veins while the less species-rich genus *Tachycixius* displays granula between the apical veins of the forewing (Holzinger et al., 2003). Like other Cixiidae, nymphs of Cixiini species feed on plant roots, and their adults live on the green parts of plants only for a few weeks (Bressan et al., 2008). Some species are known to be vectors of plant pathogens, e.g. *C. wagneri* China which is known to transmit ‘*Candidatus* Phlomobacter fragariae’ causing the marginal chlorosis disease on strawberry (Danet

Corresponding author: Mozaffarian, F., E-mails: mozaffarian@iripp.ir and faribamozaffarian@gmail.com

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et al., 2003; Bressan et al., 2008; Salar et al., 2010). Cavernicolous *Cixius* species have been documented from Mexico, the Azores, the Canary Islands, and the Balears (see references in Bourgoïn, 2022).

The genus *Cixius* was recorded from Iran for the first time by Melichar (1902) who described *C. longipennis* (now *C. persicus* Distant, 1907: see below) from the eastern part of the country. The first official efforts for preparing insect collections in 1923 which led to the foundation of Hayk Mirzayans Insect Museum (HMIM) in 1943 marks the beginning of studies on the taxonomy of insects inside Iran. Since 1967, Jiri Dlabola (National Museum Prag, Czech Republic) identified the Auchenorrhyncha specimens in HMIM in the course of his collaboration with the museum. Subsequently, three expeditions of a Czech scientific team to Iran during 1970s in collaboration with scientists from the Iranian Research Institute of Plant Protection were performed. Up to now, only very few voucher specimens of species which were collected and described by Dlabola from Iran have been deposited in HMIM which impedes direct comparison, and thus unambiguous identification of subsequently collected specimens. The results of Dlabola's studies on the genus *Cixius* in Iran comprised the description of a new subspecies (*C. adornatus iranicus* Dlabola, 1979) and the addition of 4 new records (*C. stigmaticus* (Germar, 1818), *C. simplex* (Herrich-Schäffer, 1835), *C. rufus* Logvinenko, 1969 and *C. pallipes* Fieber, 1876) to the known fauna of the country (Dlabola, 1979, 1981, 1985). Subsequently, Mirzayans (1995) mentioned 3 *Cixius* species in his list of Auchenorrhyncha deposited in HMIM including a new record (*C. cunicularius* Linnaeus, 1767). The mentioned seven species were listed in an annotated checklist of Iranian planthoppers by Mozaffarian & Wilson (2011). The genus *Tachycixius* Wagner, 1939 is represented in Iran with one species, *T. desertorum* (Fieber, 1876) (Dlabola, 1981, 1985). In the present study, *Cixius remotus* Edwards, 1888 is added to the existing list of the tribe Cixiini and an illustrated key is provided to facilitate identification of the native fauna and to further promote studies on the tribe.

MATERIAL AND METHODS

The specimens examined were collected since 1970 and deposited in Hayk Mirzayans Insect Museum (HMIM) including recent collecting trips during our studies. The specimens were generally collected by sweeping net and only a few by light and malaise traps. A Canon 650D Camera connected to an Olympus stereomicroscope, model SZH and CombaineZP were used for preparing photographs of the species' habitus. Distribution maps were generated using ArcMap 9.3, based on the data of the examined specimens and published data. The terminology used for morphological characters follows the conventional vocabulary for Fulgoromorpha (adopted from Ossiannilsson, 1978; Holzinger et al., 2003). Due to the absence of voucher specimens of some species in HMIM, photos and illustrations of the habitus and male genitalia of *C. simplex* and the male genitalia of *C. stigmaticus* were prepared from specimens deposited in Zoological Institute, Russian Academy of Science in Saint Petersburg (ZIN) and the habitus of *C. persicus* from the syntype in the Moravian Museum Brno, Czech Republic (MMBC).

RESULTS

Taxonomic hierarchy

Class Insecta Linnaeus, 1758

Order Hemiptera Linnaeus, 1758

Suborder Auchenorrhyncha Duméril, 1806

Infraorder Fulgoromorpha Evans, 1946

Superfamily Fulgoroidea Latreille, 1807

Family Cixiidae Latreille, 1804

Subfamily Cixiinae Spinola, 1839

Tribe Cixiini Spinola, 1839

Key to the genera of the tribe Cixiini in Iran

- 1 Apical margin of fore wing without tubercles between apical veins. *Cixius* Latreille, 1804
- Apical margin of forewing with tubercles between apical veins; male genitalia with aedeagus apically endowed with two movable spines, and female genitalia with a large, undivided wax plate (tergite IX).
..... *Tachycixius* Wagner, 1939

Key to the species of the genus *Cixius* in Iran (not included: *Cixius persicus*, for explanation see below)

- 1 Tegmina brown. 2
- Tegmina hyaline or whitish. 3
- 2 Tegmina with coloration homogenous. Male genitalia: apical appendage of anal tube in lateral view narrowing apically, aedeagus with an apical spine on flagellum; habitus as Fig. 3A.
..... *C. cunicularius* Linnaeus, 1767
- Tegmina with conspicuous pattern. Male genitalia: apical appendage of anal tube in lateral view not narrowing apically, aedeagus without an apical spine on flagellum, habitus as in Fig. 2A–B.
..... *C. adornatus iranicus* Dlabola, 1979
- 3 Male genitalia as in Figs 4A–D. Phallobase of aedeagus with three moveable subapical spines (subgenus *Acanthocixius*). *C. stigmaticus* (Germar, 1818)
- Phallobase of aedeagus with two moveable subapical spines. 4
- 4 Habitus and male genitalia as in Figs 3D, 4M–P. Phallobase of aedeagus with a rigid dorsal acute spine. *C. simplex* (Herrich-Schäffer, 1835)
- Phallobase of aedeagus without a dorsal acute spine. 5
- 5 Curvature of moveable subapical spines of phallobase different; habitus and male genitalia as in Figs 3C, 4I–L. *C. remotus* Edwards, 1888
- Curvature of moveable subapical spines of phallobase similar. 6
- 6 Left lateral spine of aedeagus double S-shaped. *C. rufus* Logvinenko, 1969
- Left lateral spine of aedeagus simple; habitus and male genitalia as in Figs 3B, 4E–H.
..... *C. pallipes* Fieber, 1876/*C. wagneri* China, 1942

Genus *Cixius* Latreille, 1804

Type species: *Cicada nervosa* Linnaeus, 1758.

Cixius persicus Distant, 1907 (Figs 1A–C & 6A)

Cixius persicus Distant, 1907:284; *C. longipennis* Melichar, 1902:86, nec *Cixius longipennis* Walker, 1851 (South Africa: Natal), *nomen preoccupatum*, replaced with *C. persicus* by Distant (1907:284).

Remarks. There is no information on the male genitalia of *C. persicus* so that this species is not included in the key. According to the original description (Melichar, 1902), the species description is based on 2 females. *Cixius persicus* can be recognized by the elongate hyaline forewings which extend beyond the tip of the abdomen with more than one third of their total length, and the median longitudinal carina of the mesonotum which fades towards apex (Figs 1A–C).

The species was originally collected from “Nehibandan” in the east of Iran (Fig. 6A) by N.A. Zarudny, ornithologist, and described by Melichar as *C. longipennis*. Due to the preoccupation of the name, it was replaced with *C. persicus* by Distant (1907). According to the available information, the species is endemic to Iran, Khorasan mountains region which was shown to be an endemic zone for planthoppers in the country (Mozaffarian, 2013). The mountains in the south of Khorasan are surrounded by central Iranian deserts to the west and lowlands in Afghanistan to the east. Thus, it is conceivable that geographic separation has facilitated the origin of endemic species.

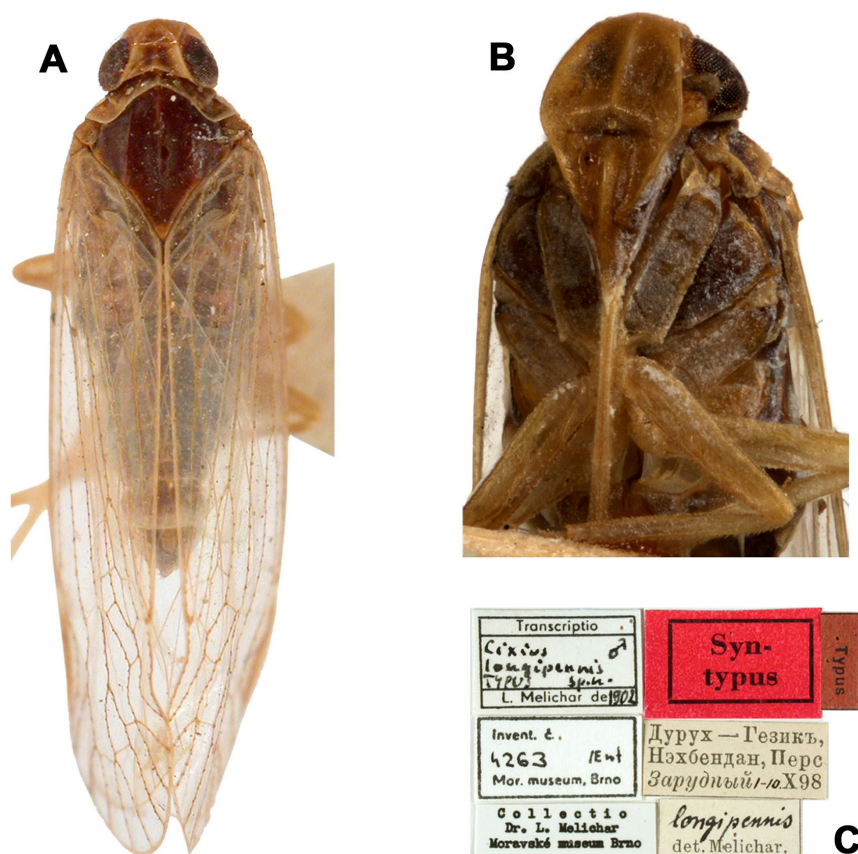


Figure 1. *Cixius persicus* Distant, 1907 (Syntype). **A.** Dorsal view; **B.** Ventral view; **C.** Type labels (*C. longipennis* Melichar, 1902). Specimen from Iran, Nehibandand (MMBC).

Cixius (Acanthocixius) stigmaticus (Germar, 1818) (Figs 4A–D & 6B)

Flata stigmatica Germar, 1818:199 [presumably Germany]; *Cixius stigmaticus* Curtis, 1829:194; *Cixius stigmaticus reuteri* Metcalf, 1936:219, replacement name for *Cixius stigmaticus albipennis* Reuter, 1880:194, [Finland] nec Stål, 1855:92 <Achilidae>; *Cixius (Sciocixius) stigmaticus* Wagner, 1939:89, 108; *Cixius (Acanthocixius) stigmaticus* Holzinger, Kammerlander & Nickel, 2003:101.

Remarks. The species is distributed in western, eastern and southern Europe (Nast, 1972) and Turkey (Tezcan & Zeybekoglu, 2001). It was recorded only once from Iran in southern slope of Alborz mountain (Fig. 6B) by Dlabola (1985). The specimen was deposited in National Museum of Prague. According to the available published data, this is the easternmost record of the species distributional range. Since it was not collected and housed in HMIM, the illustration in Figs 4A–D was prepared from identified specimens deposited in ZIN.

Cixius (Ceratocixius) adornatus iranicus Dlabola, 1979 (Figs 2A–C & 6C)

Cixius adornatus iranicus Dlabola, 1979:235 [Iran].

Material examined. IRAN • 1 ♂, Mazandaran province/6 km E. Zirab; 24–26.vi.1977; Mirzayans/Abaii leg.; (Paratype).

Remarks. Dlabola (1979) described the subspecies according to the specimens collected from southern coasts of Caspian Sea from northwest to northeast of Iran (Fig. 6C). According to Dlabola (1979), the type specimens are deposited in National Museum of Prague and National Science Museum of Budapest. The collecting data of the above specimen (which is labeled as paratype in HMIM) is mentioned for paratypes in the original description but the deposition in HMIM is missed to mention.

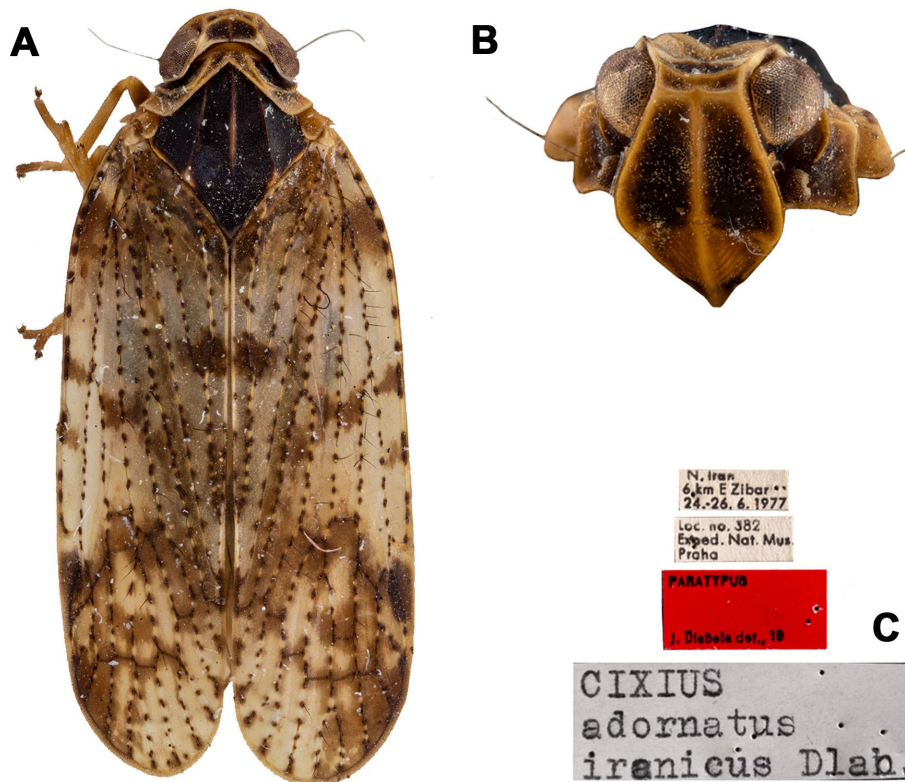


Figure 2. *Cixius adornatus iranicus* Dlabola, 1979: **A.** Dorsal view; **B.** Ventral view of head; **C.** Type labels. Specimen from Iran, Zirab (HMIM).

Considering the occurrence of *C. adornatus* Logvinenko, 1944 in Azerbaijan, it is conceivable that its range of distribution extends into Iran. However, Dlabola (1979) recognized it as an “independent subspecies” based on the difference in the longer left moveable subapical spine of the aedeagus and the different shape of the stylus distal dilated portion as well as of the apex of the anal tube. Whether or not *C. adornatus iranicus* should indeed be assigned subspecies status cannot be decided on the basis of the material available for study.

***Cixius (Ceratokixius) cunicularius* (Linnaeus, 1767) (Figs 3A & 6D)**

Cicada cunicularia Linnaeus, 1767:711, [Denmark]; *Cicada nervosopunctata* De Geer, 1773:182, [no type locality given]. Syn Germar 1818:195; *Cicada cynosbatis* Fabricius, 1775:686, [Denmark]. Syn Fallén, 1826:72; *Cercopis dionysii* Panzer, 1796:24, [Germany]. Syn Germar, 1818:195; *Cixius cunicularia*: Latreille 1807:166; *Cixius dorsalis* Hardy, 1850:430, [England]. Syn Scott, 1870:122; *Cixius eurypterus* Kirschbaum, 1868:46, [Germany]. Syn Fieber 1872:3; *Cixius cunicularius vulgaris* Fieber, 1876:189; *Cixius cunicularius fusca* Fieber, 1876:190; *Cixius (Ceratokixius) cunicularius* Wagner, 1939:88, 102.

Material examined. IRAN • 1 ♀ Gilan province, Asalem, Parehsar, 950 m a.s.l.; 14.viii.1974; Mirzayans/ Abaii leg.

Remarks. Regarding the recorded overall distribution of the species, which is from north Africa to Europe, Turkey, to northern and central Asia (Nast, 1972, Tezcan & Zeybekoglu, 2001), the occurrence of the species in northwest of Iran (Fig. 6D) is within the known range for the species.

***Cixius (Ceratokixius) pallipes* Fieber, 1876 [*Cixius wagneri* China, 1942 – group] (Figs 3B, 4E–H & 6E)**

Cixius (Ceratokixius) pallipes Fieber, 1876:191 (Italy, Corsica, southern France); *Cixius intermedius* Scott ssp. *pallipes* sensu Wagner, 1939 (partim); *Cixius pallipes wagneri* China, 1942:88 (Greece); *Cixius (Ceratokixius) wagneri* China, 1942; Nast, 1972.

Material examined. IRAN • 1 ♂, 1 ♀, Alborz province, Karaj, 29.v.1971 & 6.vi.1971, Sabzevari leg.; 1 ♀, Karaj, Arangeh, Sarziarat, 1750 m a.s.l., 10–11.vii.1996, Barari/ Badii leg.; 1 ♂, 1 ♀, Ardebil province, 4 Km W. Aslandouz, near Aras river, 39°29'42.1"N 48°03'2.2"E, 101 m a.s.l., 28.vi.2017, Light trap, Naserzadeh/ Mozhdehi, leg.; 1 ♂, Meshkinshahr, 5 km Parsabad Rd, 38°25'26.9"N, 47°41'20.8"E, 1298 m a.s.l., 23.vii.2009, Manzari/Hajiesmailian leg.; 1 ♂, S.W. Aslandouz, near Aras river, 38°57'9.7"N 47°01'17.3"E, 775 m a.s.l., 26.vi.2017, Naserzadeh/ Mozhdehi leg.; 1 ♂, W. Azarbaijan province, Piranshahr, Mahabad Rd., 35 Km Mahabad, 36°44'33.8"N 42°27'20"E, 1638 m a.s.l., 30.viii.2007, Mozaffarian leg.; 2 ♂, Sardasht, Kalle Gavi, 36°22'6.2"N 45°35'19.9"E, 1683 m a.s.l., 28.viii.2008, Mozaffarian leg.; 1 ♂, E. Azarbaijan province, N. Kaleybar, Arasbaran Conserved area, 5 km N. Asheghlu, Ainanluz station, 38°53'44.4"N 46°48'49.8"E, 1848 m a.s.l., 23.vi.2015, Naserzadeh/ Hajiesmailian/ Montreuli leg.; 1 ♂, 1 ♀, Chahar Mahal & Bakhtiari province, Ardel, Gahro, Tang-e Zeverdegan, 31°59'10.3"N 50°51'23.3"E, 2347 m a.s.l., 23.vii.2009, Mozaffarian leg.; 1 ♂, Esfahan province, Frizhand, 33°31'2.4"N 51°41'29.3"E, 2419 m a.s.l., 16.vi.2011, Mozaffarian leg.; 1 ♂, Golpaigan, 33°13'14.4"N 50°19'2.6"E, 1888 m a.s.l., 20.vii.2009, Mozaffarian leg.; 2 ♀♀, Gilan province, Asalem, Kom, 150 m a.s.l., 4.viii.1975, Mirzayans leg.; 6 ♂♂ 18 ♀♀, Asalem, Parehsar, 750 & 950 m a.s.l., 14.viii.1974, Mirzayanx/ Abaii leg.; 18 ♂♂, 12 ♀♀, Asalem, Pissason, 220 m a.s.l., 30.viii.1975, Mirzayans leg.; 6 ♀♀, 1300 m a.s.l., 17–16.viii.1980, Pazukki/ Baourmand leg.; 2 ♂♂, 2 ♀♀, Asalem, Shandol, 950 m a.s.l., 9.viii.1974, Mirzayans/Farahbakhsh leg.; 1 ♀, Bandar-Anzali; 8.viii.1974, Mirzayans/ Farahbakhsh leg.; 1 ♂, 29.ix.1970, Abaii leg.; 1 ♀, Hashtpar, Asalem; 1250 m a.s.l.; 30.vii.1976; Borumand/ Pazuki leg.; 6 ♂♂, 10 ♀♀, Hashtpar, Rek, 15 Km Hashtpar, 570 m a.s.l., 31.viii.1975, Mirzayans leg.; 1 ♂, Golestan province, Park-e Melli-e Golestan, Koylar, 1250 m a.s.l., 23.vi.1996, Ebrahimi/ Nazari v. leg.; 1 ♂ Ghom province, 13 Km Ghom, Ghomroud, Selfabad village, 35°47'1.8"N 51°23'33.4"E; 912 m a.s.l., 18.viii.2007, Alipanh leg.; pomegranate orchard. 1 ♂, Ghom, 27.vi.1974, Farzaneh leg.; 1 ♂, Hamedan province: Nahavand, Sarabe-e Gamasian, 34°5'56.2"N 48°25'20.5"E, 1813 m a.s.l., 11.vii.2014, Afsarian leg.; 1 ♂, Hormozgan province, Isin, 130 m a.s.l., 28–30.iv.1977, Pazuki/ Hashemi leg.; 1 ♂, N. Kuh-e Geno, Bge-Tang, 410 m a.s.l., 7–8.v.1977, Pazuki leg.; 1 ♀, Khuzestan province, 40 Km N. Andimeshk, Bidruyeh, 650 m a.s.l., 3.v.1976, Pazuki/ Abaii leg.; 1 ♂, 8 ♀, Ahvaz, Mollasani, 20 m a.s.l., 16.v.1975, Pazuki/ Borumand leg.; 2 ♂, Dez National Park, Mianroud, 32°6'23.6"N 48°26'17.2"E, 13.iv–14.vi.2014, 54 m a.s.l., Parchami Araghi leg.; near marsh, Malaise trap. 25 ♂♂, 20 ♀♀, Dezful, Haft-Tappeh, 20 m a.s.l., 13.v.1975, Pazuki/ Borumank leg.; 3 ♂♂, Shoush, Kardheh National Park, 32°4'36.5"N 48°14'15.8"E, 67 m a.s.l., 10.v.–10.vii.2015, Gilasian leg.; near swamp, Malaise trap. 1 ♂, Kordestan province, Sanandaj-Farah, 1–15.vii.1974, Hashemi leg.; Light trap. 1 ♂, Mazandaran province: Chalakrud, Ekrsar, 1560 m a.s.l., 11.ix.1990, Ebrahimi/ Badii leg.; 1 ♂, Tehran province: Robot Karim, Ovrin, 1050 m a.s.l., 24–25.v.1993, Parchami/ Badii leg.; 1 ♀, 1 ♂, Tehran, Evin, 32.vi.1975, Light trap.

Remarks. Problematic taxon, likely to concern at least two, if not more species. *Cixius pallipes* was originally described from Italy (type locality), Corsica and Southern France, and subsequently has been recorded in Afghanistan, Armenia, Azerbaidjan, Bulgaria, Corsica, Cyprus, France, Georgia, Greece, Hungary, Iran, Iraq, Israel, Lebanon, Moldova, Romania, Sardinia, Serbia, Slovakia, Switzerland, Tadzhikistan, Turkey, former Yugoslavia (Nast, 1972, 1987; Lodos & Kalkandelen, 1980; Kalkandelen, 1987; Dlabola, 1977, 1981; Drosopoulos, 1980; Demir, 2008; Picciau et al., 2016). However, records of *C. pallipes* from the Eastern Mediterranean region, Near- and Middle East are doubtful and probably refer to different species. Those from Eastern Europe are likely to concern *C. wagneri* China (M. Asche, Berlin, pers. comm., see also Holzinger et al., 2003; Mozaffarian & Wilson, 2011; Vadell & Hoch, 2009) or other yet undescribed species. Thus, all geographical records of both species need confirmation. According to the figures of the male genitalia given by different authors (e.g., Wagner, 1939, Emeljanov, 2015; Picciau et al., 2016) for *Cixius "pallipes"*, there is remarkable geographic variation among populations which may or may not point to separate species. A revision of the entire group would be highly desirable.

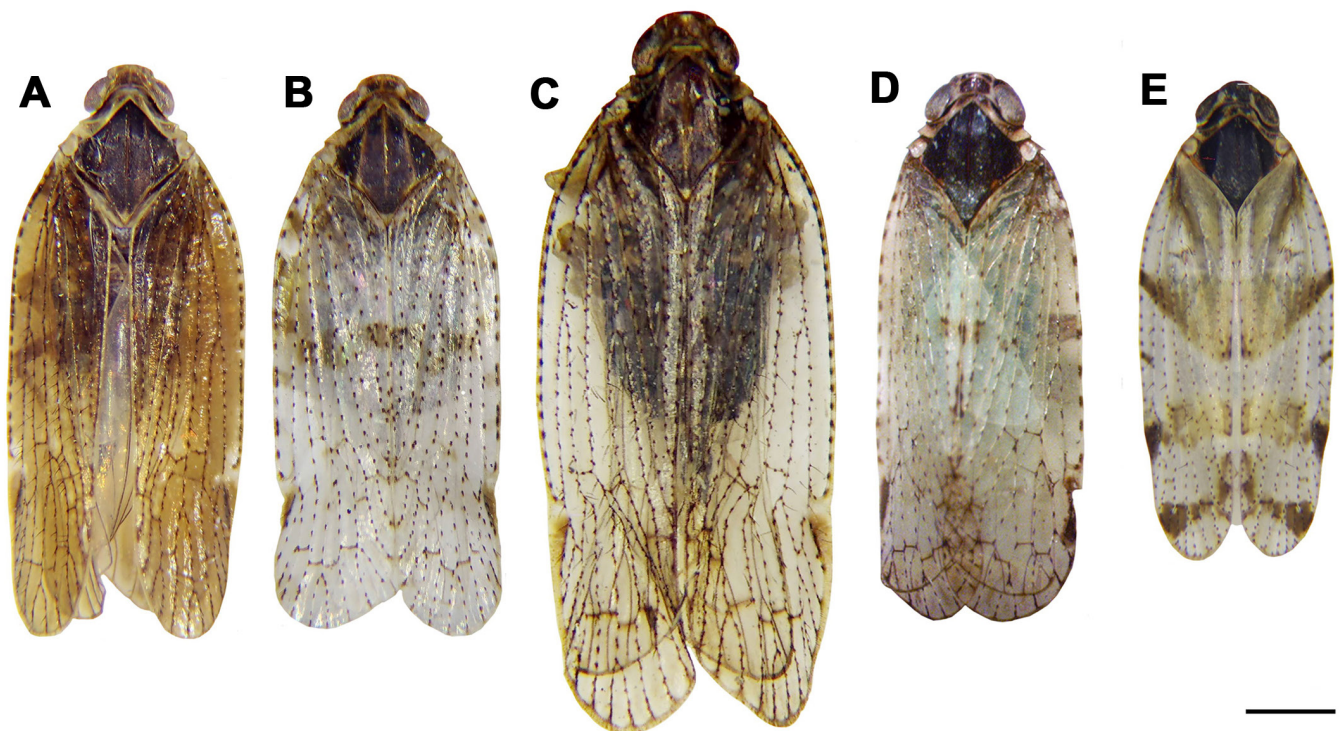


Figure 3. *Cixius* species, dorsal views: **A.** *Cixius cunicularius* Linnaeus, 1767 (Specimen from Iran, Parehsar, ♀ HMIM); **B.** *Cixius* cf. *pallipes* Fieber, 1876 (specimen from Iran, Karaj, ♀ HMIM); **C.** *Cixius remotus* Edwards, 1888 (specimen from Iran, Ash-mahalleh, ♀ HMIM). **D.** *Cixius simplex* (Herrich-Schäffer, 1835) (specimen is not from Iran, but from Azerbaijan ZIN); **E.** *Tachycixius* cf. *desertorum*. Specimen from Iran, Gorgan-Agh Ghala Road (HMIM). scale bars= 1 mm.

***Cixius* (*Ceratocixius*) *remotus* Edwards, 1888 (Figs 3C, 4I-L & 6F) new record**

Cixius remotus Edwards, 1888:100 [England]; *Cixius* (*Ceratocixius*) *remotus* China, 1942:97.

Material examined. IRAN • 1 ♂, E. Azarbaijan province; Jolfa, Asiab Kharabe, 38°51'30.5"N 45°51'24.1"E, 980 m a.s.l., 4.ix.2007, Mozaffarian leg.; 1♀, Chahar Mahal & Bakhtiari Province, Farsan, Heidarabad, 32°21'35"N 50°23'44.3"E, 2373 m a.s.l., 22.vi.2009, Mozaffarian leg.; 8 ♂♂, 6 ♀♀, Fars province, Sepidan, Sheshpir, 2200 m a.s.l., 25–26.v.1995, Hashemi/ Sarafrazi/ Badii leg.; 1 ♂, 1 ♀, Gilan province, Rasht, 0 m a.s.l., 29.viii.2001, Manzari/ Mofidi leg.; 6 ♂♂, 1♀, Kohkiluyeh & Boirahmad province, Kakan, Hoseinkhani, 2100 m a.s.l., 26.v.1995, Hashemi/ Badii/ Sarafrazi leg.; 2 ♂♂, Yasuj, Tang-e sorkh, 30°26'14.2"N 51°45'49.2"E, 2057 m a.s.l., 15.vi.2009, Mozaffarian leg.; 1 ♂, Yasouj, Tolegorgi, 2000 m a.s.l., 4.v.1985, Mirzayans/ Hashemi leg.; 1 ♀, Mazandaran province, Marzanabad, 400 m a.s.l., 6.vii.1995, Badii/ Sarafrazi/ Linnvuori leg.; 4 ♀♀, Marzanabad, Kotir Forest, 1220 m a.s.l., 12.iv.1990, Ebrahimi/ Badii leg.; 1 ♂, 5 ♀♀, Tonekabon, Sehezar, Ash-mahalleh, 760 m a.s.l., 7.ix.1990, Ebrahimi/ Badii leg.

Remarks. The species has been recorded from Europe (Nast, 1972), Turkey (Önder et al., 2011) and Lebanon (Picciau et al., 2016). This is the first record of *Cixius remotus* from Iran. The collecting sites in Iran (Fig. 6F) are in the western half of the country in various elevations (from sea level to 2057 m a.s.l.): in lowland coastal biotopes of the Caspian Sea to the more northern and mountainous areas such as humid part of the Zagros mountain in northwest as well as the dry parts of the Zagros mountain in southwest, and the hyrcanian forests on the northern slopes of Alborz mountain in north of the country). Thus it is safe to say that *C. remotus* shows a broad geographical and ecological distribution in Iran.

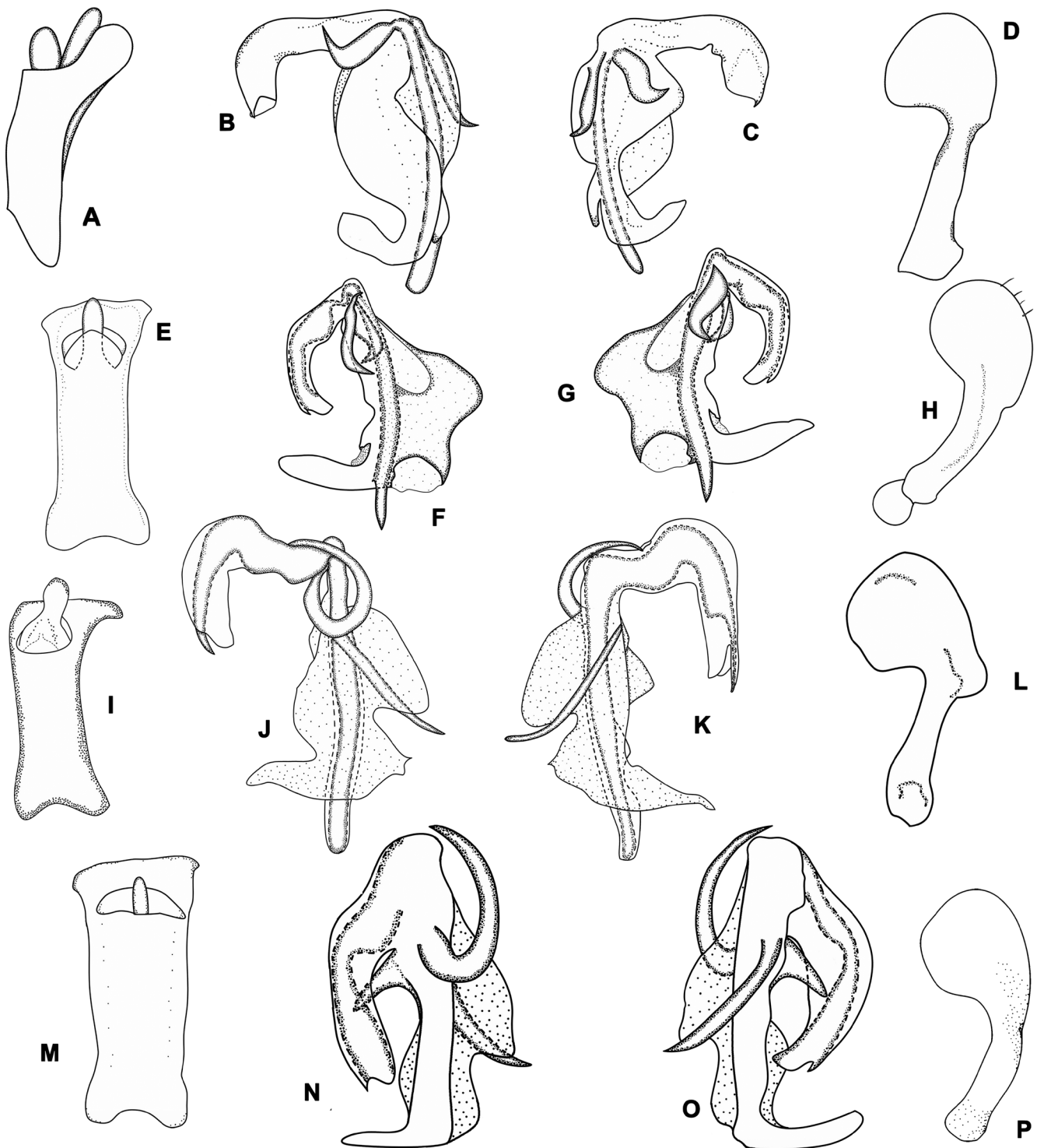


Figure 4. Male genitalia of genus *Cixius* species. **A-D.** *C. stigmaticus* (Germar, 1818): **A.** Anal tube, lateral view; **B.** Aedeagus, left lateral view; **C.** same, right lateral view; **D.** Left gonostyle, left lateral view. Specimen is not from Iran, but from Belgorod Province, Eastern Russia (ZIN). **E-H.** *C. cf. pallipes* Fieber, 1876: **E.** Anal tube, dorsal view; **F.** Aedeagus, left lateral view; **G.** same, right lateral view; **H.** Left gonostyle, left lateral view; Specimen from Iran, Arasbaran (HMIM). **I-L.** *C. remotus* Edwards, 1888: **I.** Anal tube, dorsal view; **J.** Aedeagus, left lateral view; **K.** Same, right lateral view; **L.** Left gonostyle, left lateral view. Specimen from Iran, Sheshpir (HMIM). **M-P.** *C. simplex* (Herrich-Schäffer, 1835): **M.** Anal tube, dorsal view; **N.** Aedeagus, left lateral view; **O.** same, right lateral view; **P.** Left gonostyle, left lateral view. Specimen is not from Iran, but from Azerbaijan (ZIN).

Cixius (Ceratocixius) rufus* Logvinenko, 1969 (Fig. 6G)Cixius rufus* Logvinenko, 1969:53 [S. Russia]

Remarks. The Iranian specimens used for recording this species (Dlabola, 1985) were deposited in National Museum of Prague. Dlabola (1985) considered *C. rufus* as a Hyrcanian element in Caucasus mountains and neighboring forests. He recorded this species in four locations in the north, along the coasts of Caspian Sea, and northeast (Fig. 6G) which show the eastern and southern borders of the overall distribution of the species. The coasts of the Caspian Sea in the north of Iran is a part of the Caucasian-Euxino-Hyrcanian province of Euro-Siberian region as considered by Frey & Probst (1986). The distribution of the species in this zone is consistent with Dlabola's zoogeographic comment of the species. The Caspian Zone is restricted to Caspian Sea in north and wall-like Alborz mountain in south, and is connected to the Khorasan zone in the east. The two zones were shown to have the highest degree of similarity based on the number of common endemic species (Mozaffarian, 2013). It is conceivable that the distribution of the species in the east is the result of dispersal after ending the barrier of the Alborz mountain chain to the east.

***Cixius (Ceratocixius) simplex* (Herrich-Schäffer, 1835) (Figs 3D, 4M-P & 6H)**

Cicada bifasciata Schranck, 1776:73 [no type locality given], primary homonym; Syn Wagner, 1939:100; *Flata simplex* Herrich-Schäffer, 1835:64 [Germany]; *Cixius simplex* Schaum, 1850:68; *Cixius minor* Kirschbaum, 1868:47 [Germany]; Syn Wagner, 1939:100; *Cixius vitripennis* Kirschbaum, 1868:48 [Germany]; Syn Wagner, 1939:100; *Cixius scotti* Edwards, 1888:100 [England]; Syn Wagner, 1939:100; *Cixius (Ceratocixius) simplex* Wagner, 1939:88, 100.

Remarks. The species was recorded from Northern Africa, Europe, Turkey and Central Asia (Nast, 1972, Önder et al., 2011). It was recorded from Iran (Dlabola, 1985) just once from west of the country in Lorestan province (Fig. 6H). The specimen was deposited in National Museum of Prague and not available for study so illustrations (Figs 3D, 4M-P) were prepared from a specimen deposited in ZIN.

Genus *Tachycixius* Wagner, 1939Type species: *Fulgora pilosa* Olivier, 1791***Tachycixius spec. cf. desertorum* (Fieber, 1876) (Figs 3E, 5A-D & 6I)***Flata desertorum* Fieber, 1876: 172 (Russia: Sarepta); *Tachycixius (Eupalame) desertorum* Emeljanov, 2015 (T. subg.)

Material examined. IRAN • 10 ♂♂, 4 ♀♀ Golestan province; Gorgan-Agh Ghala Road, 36°54'20.84"N 54°25'28.95"E; 3 m a.s.l.; 29.v.2009; Lashkari leg.; 2 ♂♂, Gorgan-Agh Ghala Road, 36°55'59.33"N 54°26'46.6"E; -4 m a.s.l.; 29.v.2009; Lashkari leg.

Remarks. *Tachycixius desertorum* is widely distributed in the central and eastern Mediterranean, eastern Europe and Asia Minor (Holzinger et al., 2003). The species is apparently associated with steppe biotopes, often on saline soils (see information in Holzinger et al., 2003).

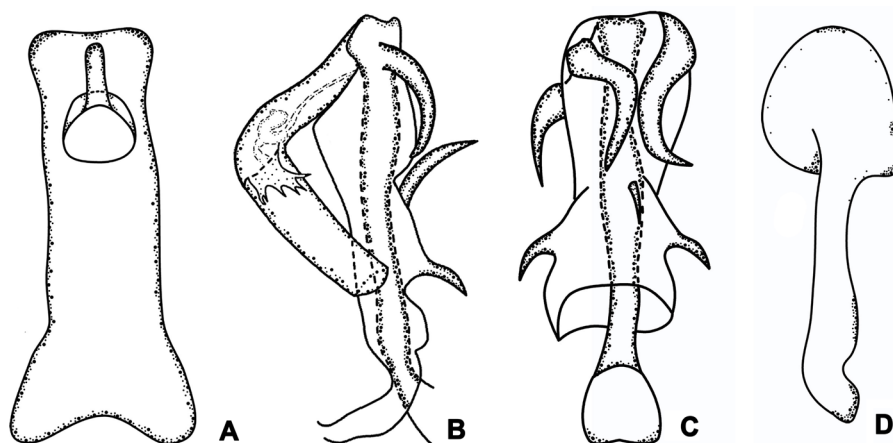


Figure 5. Male genitalia of *Tachycixius cf. desertorum*: **A.** Anal tube, dorsal view; **B.** Aedeagus, left lateral view; **C.** Same, ventral view; **D.** Left gonostyle, left lateral view. Specimen from Iran, Gorgan-Agh Ghala Road (HMIM).

The species shows a high geographic variability, especially in certain characters of the male genitalia, such as configuration of aedeagus spinulation and shape of the flagellum appendage (M. Asche, personal information, used with permission). It cannot be excluded that *T. desertorum* consists of more than one reproductively isolated unit, and may in fact be a complex of several independent species. *T. desertorum* was already recorded from Iran (black dots in Fig. 6I) by Dlabola (1981 & 1985). Unfortunately, duplicate specimens of Dlabola's studies have not been deposited in HMIM yet to be compared with the examined specimens (red dots in Fig. 6I). Thus, we here provide figures of the male genitalia of the species from Golestan Province, which we preliminarily identified as *T. desertorum*. Regarding the variation in flagellum appendage in *T. desertorum* group, illustrated by M. Asche (unpublished data, used with permission), the examined specimens are very similar to specimens collected from Turkey, Kurupelit.

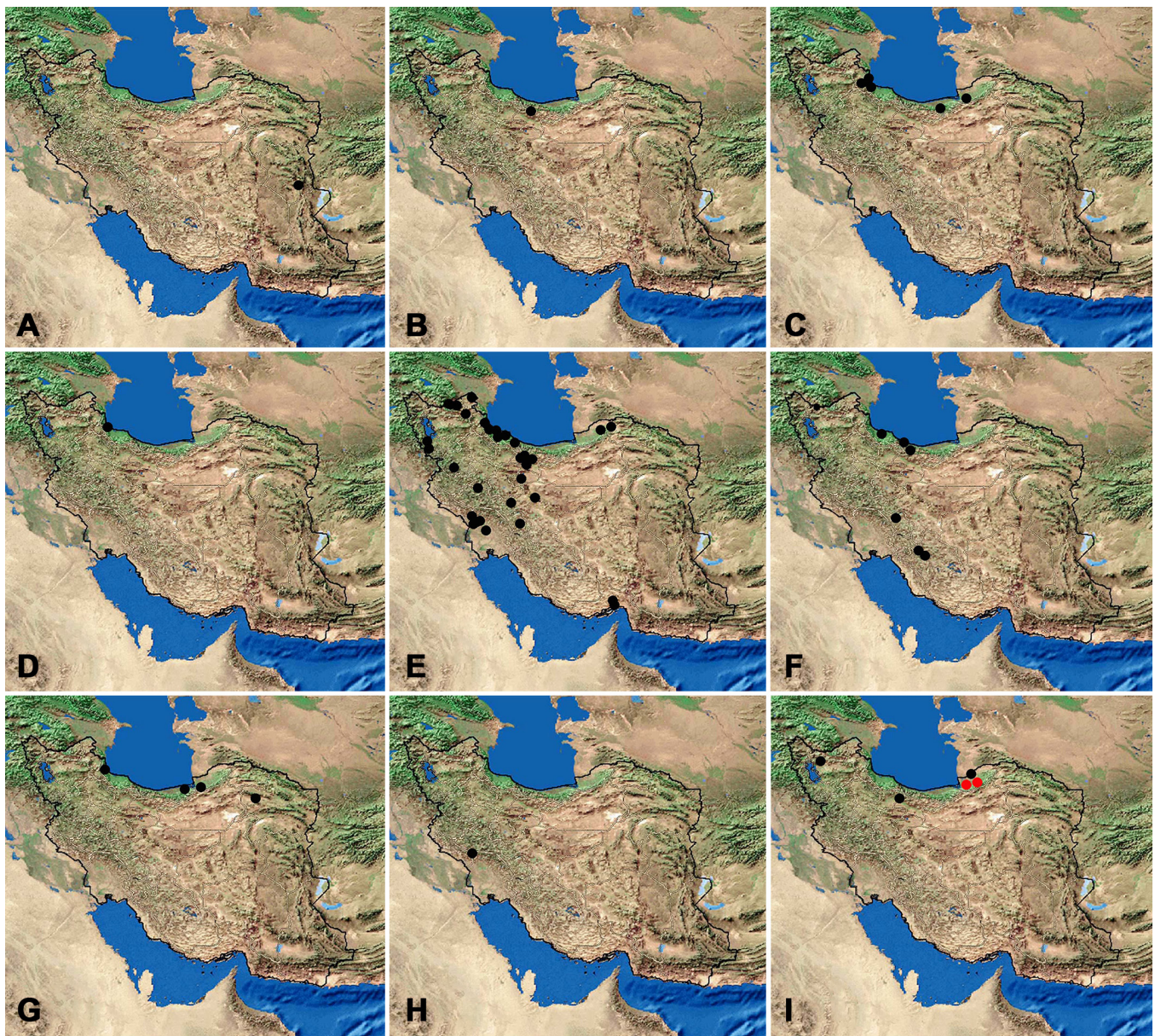


Figure 6. Distribution maps of tribe Cixiini in Iran: **A.** *Cixius persicus* Distant, 1907; **B.** *Cixius stigmaticus* (Germar, 1818); **C.** *Cixius adornatus iranicus* Dlabola, 1979; **D.** *Cixius cunicularius* Linnaeus, 1767; **E.** *Cixius* cf. *pallipes* Fieber, 1876; **F.** *Cixius remotus* Edwards, 1888; **G.** *Cixius rufus* Logvinenko, 1969; **H.** *Cixius simplex* (Herrich-Schäffer, 1835); **I.** *Tachycixius* cf. *desertorum*, black dots: published records of *T. desertorum*, red dots: examined specimens for *T. cf. desertorum* in this study.

DISCUSSION

The state territory of Iran is an extremely complex area with wide ranges of altitude, precipitation and temperature (Hedge & Wendelbo, 1978; Frey & Probst, 1986; Zohary, 1963). The diversity in geomorphology and climate is paralleled by the high biological diversity observed in Iran today which combines elements of the four ecozones of Palaearctic and Nearctic (by periodical connections of Bering Strait) from north, Afrotropical from southwest and Oriental from southeast (Madjnoonian et al., 2005). Regarding the known distribution of tribe Cixiini in Iran (Figs 6A–I), the species of the tribe are mainly distributed in North (northern slopes of Alborz mountain) and west (along Zagros mountain chain). The north of Iran has usually been considered as an independent biogeographic zone (Zarudny, 1911; Anderson, 1968) surrounded with Caspian Sea in the north and Alborz mountain chain in the south. The zone is characterized by hyrcanian forests with temperate deciduous broadleaved trees on the northern slopes of Alborz which extends to northwest and into some parts of Azerbaijan. The combination of the characteristics of the zone appear to be suitable for most of the species of tribe Cixiini in Iran; some species is limited to the zone (*C. adornatus iranicus*, *C. stigmaticus*, *C. cunicularius* and *T. cf. desertorum*) and some others (*C. cf. pallipes*, *C. remotus* and *C. rufus*) are adapted to other parts of the country as well.

The Zagros mountain chain extends from the northwest to the south of the country, which is considered to be the result of convergence between Iranian plateau and Arabian plate while the latter had detached from the Gondwana supercontinent and attached to Eurasia during Permian to late Miocene (Ghanbarian et al., 2021; Ghorbani, 2013). Due to the changes of latitude, different climatic zones can be recognized across the mountain belt (Ghasemifar & Naserpour, 2014). The mountains chain comprises of many discrete mountains increasing their distance with lower lands towards south. Anderson (1968) considered Zagros and the western foothills as a biogeographic zone. Three species of genus *Cixius* (*C. cf. pallipes*, *C. remotus* and *C. simplex*) are distributed across Zagros mountain chain, mostly in the northern part. The fact that shorter distances and lowlands in northern part of Zagros facilitates dispersion of the species explains this pattern of distribution. The lack of the known distribution of species of tribe Cixiini in the central and eastern lowlands of the country may indicate the preference of the species to forested and mountainous areas. The fauna of Auchenorrhyncha in northeast and east of Iran has been studied less than other parts of the country. Nevertheless, five endemic planthoppers reported from Khorasan mountains (*Adenissus zabolicus* Dlabola, 1980, *Kumlika mandrita* Emeljanov, 1997, *Phantia ovatospina* Dlabola, 1989, *Iranodus nishabur* Dlabola, 1982 and *C. persicus*) make this province a center of endemism. It is expected that intensified efforts of collecting in the undersampled areas could improve our knowledge (not only) of this tribe in Iran significantly.

AUTHOR'S CONTRIBUTION

The authors confirm their contribution in the paper as follows: F. Mozaffarian: conceived the project, identified the specimens, and generated taxonomic information (descriptions, drawings, photographs partim); H. Hoch: provided information on the taxonomic history of the species. FM and HH contributed equally to writing the introduction and discussion parts. The authors read and approved the final version of the manuscript.

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AVAILABILITY OF DATA AND MATERIAL

The specimens listed in this study are deposited in the Hayk Mirzayans Insect Museum (HMIM), the Zoological Institute, Russian Academy of Science in Saint Petersburg (ZIN) and the Moravian Museum Brno, Czech Republic (MMBC), and are available from the curators, upon request.

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

Not applicable.

CONSENT FOR PUBLICATION

Not applicable.

CONFLICT OF INTERESTS

The authors declare that there is no conflict of interest regarding the publication of this paper.

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مطالعه بخشی از فون زنجرک‌های ایران: خانواده Cixiidae، قبیله Cixiini (Hemiptera, Auchenorrhyncha, Fulgoromorpha)

فریبا مظفریان^{۱*}، هنلور هخ^۲

۱ بخش تحقیقات رده‌بندی حشرات، موسسه تحقیقات گیاهپزشکی کشور، صندوق پستی ۱۴۵۴-۱۹۳۹۵، تهران، ایران.
 ۲ انستیتو علوم تکاملی و تنوع زیستی، موزه تاریخ طبیعی، دانشگاه هامبولدت برلین، برلین، آلمان.

* پست الکترونیک نویسنده مسئول مکاتبه: mozaffarian@iripp.ir

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چکیده: در این تحقیق، نمونه‌های زنجرک‌های قبیله Cixiini از خانواده Cixiidae، شامل جنس‌های *Cixius* Latreille و *Tachycixius* Wagner در موزه هایک میرزایانس بررسی شدند. این نمونه‌ها از سال ۱۳۴۹ تاکنون به انضمام بررسی‌های ما از سال ۱۳۸۵، از نقاط مختلف کشور جمع‌آوری شده بودند. بر اساس نتایج این بررسی، گونه *Cixius remotus* Edwards, 1888 برای اولین بار از ایران گزارش شد. کلیدهای شناسایی مصور برای جنس‌ها و گونه‌های قبیله Cixiini در ایران تهیه و به همراه نقشه پراکنش و بحث‌هایی در ارتباط با جغرافیای جانوری آن‌ها ارائه شد.

واژگان کلیدی: زنجرک، فون، فونیستیک، تاکسونومی، پرشیا