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Caenidae (Insecta: Ephemeroptera) of Iran, with new records and re-description of the nymph of *Caenis kopetdagi* Kluge, 1985

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ABSTRACT

The present contribution gives a faunistic overview on the distribution of Caenidae in Iran. Four species have so far been reported, of which *Caenis macrura* Stephens, 1835 by far is the most abundant and most widely spread species. *Caenis kopetdagi* Kluge, 1985 was previously only known from three localities in the Kopet Dag Mountain range, which stretches along the border between Turkmenistan and Iran. We report this species from three further localities at the western border of the Zagros Mountains in southwest Iran, thus considerably expanding its distribution. The nymph of *Caenis kopetdagi* is re-described, its validity is confirmed, and modern diagnostic characters are added. Its CO1 sequence is provided and compared with sequences of other species of *Caenis* Stephens, 1835 occurring in the Middle East. The habitat of *C. kopetdagi* as well as the distribution of Caenidae in Iran and of *Caenis* in the Middle East is also discussed.

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Introduction

The mayfly fauna of Iran is still largely unexplored, although considerable progress has been achieved recently. Bojková et al. (2018) summarised the investigations on Iranian mayflies published to date, initiating a more systematic research on the topic. During extensive field trips between 2016 and 2018, new material of Ephemeroptera was collected throughout Iran. As first results from these efforts, a new species of Baetidae (Bojková et al. 2018) and two new species of Oligoneuriidae (Sroka et al. 2019) were recently described. In these field trips, also numerous specimens of the

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mayfly family Caenidae were collected. Previously, the mayfly family Caenidae was reported in Iran with four species (Bojková et al. 2018). Of these, the single record of the genus *Cercobrachys* Soldán, 1986, based on one unidentified species (Mahboobi Soofiani, Hatami, Hemami, and Ebrahimi 2012) since then could not be confirmed from Iran again. Nevertheless, the presence of this genus in Iran was considered possible by Bojková et al. (2018). Another species, *Clypeocaenis bisetosa* Soldán, 1978, is also known in Iran only from a single locality, where it had earlier been recorded and described (Soldán 1978). This species also could not been collected again despite our efforts. However, we encountered and confirmed another two species, namely *Caenis macrura* Stephens, 1835 (earlier records by Mousavi and Hakobyan 2017) and *Caenis kopetdagi* Kluge, 1985 (earlier report for Iran by Mohammadian 2005). While *C. macrura* is a common species in the West Palearctic, *C. kopetdagi* so far was only known from two localities in Kopet Dag Mountains in Turkmenistan (Kluge 1985) and only once reported from the Iranian province of Razavi Khorasan (Mohammadian 2005). Our own recent collections now prove *C. kopetdagi* from three sites in western Iran. One site is directly within the Zagros Mountains, south of Khorramabad, and two other sites are in the alluvial plains of River Karun, west of Zagros Mountains. The availability of this new material of *C. kopetdagi* led to the present contribution, which re-describes the nymph of this hardly known species.

Material and methods

Collecting

During extensive field trips between 2016 and 2018, new material of Ephemeroptera was collected at more than 200 collecting points throughout Iran. Swarming adults were obtained by aerial netting. Nymphs were obtained by kick sampling and preserved in 96% EtOH. Environmental variables (pH, conductivity, salinity and temperature) were measured using a Hach Pocket Pro + Multi 2 Tester.

Material

The material is deposited in the collections of the Biology Centre CAS, Institute of Entomology, České Budějovice, Czech Republic (IECA), State Museum of Natural History, Stuttgart, Germany (SMNS), and the Natural History Museum and Genetic Resources, Department of Environment, Tehran, Iran (MMTT_DOE).

Line drawings and photography

Drawings were made using a Leitz microscope, equipped with a drawing tube. Serial habitus photographs were made with a Leica DMC5400 digital camera on a Leica Z16 APO Macroscope using Leica Application Suite Version 3.1.8 and Helicon Focus Pro to obtain stacked photographs with extended depth of field. All photographs were subsequently sharpened and adjusted in contrast and tonality in Adobe Photoshop™ CC2019.

SEM

For scanning electron microscopy (SEM), mouthparts, legs, and gills were dissected. All parts were subsequently dehydrated through a stepwise immersion in ethanol, dried by critical point drying (Leica EM CPD300), and mounted on SEM stubs. The mounted material was coated with a 5 nm Au/Pd layer (Leica EM ACE200) and subsequently examined and photographed with a Zeiss EVO LS 15 scanning electron microscope. All photographs were subsequently sharpened and adjusted in contrast and tonality in Adobe Photoshop™ CC2019.

DNA extraction, PCR amplification and sequencing

For DNA extraction, the entire specimen was crushed and the tissue processed with Thermo Scientific Phire Tissue Direct PCR Master Mix Kit following the manufacturer's instructions for dilution and storage protocol. The resulting supernatant was used in a PCR reaction with a primer cocktail of CLepFolF (LCO1490 with LepF1) and CLepFolR (HCO2198 with LepR1) for CO1 targeting (see Hernández-Triana et al. 2014), utilising a Qiagen AllTaq Master Mix Kit. The PCR amplification was performed using touch down PCR as follows: Initial heat activation at 93°C for 3 min and 10 cycles of denaturation at 93°C for 0:15 min, annealing was performed at 51–0.5°C/Cycle for 0:30 min and elongation at 68°C for 1:00 min, followed by 30 cycles of denaturation at 93°C for 0:15 min, annealing at 46°C for 0:30 min and elongation at 68°C for 1:00 min. Finally, the PCR product was cooled down to 8°C. The PCR products were enzymatically purified using ExoI/FAP. The purified product was sequenced via the EZ-seq single direct service by Macrogen (Amsterdam, Netherlands). Resulting chromatograms were assembled and final sequences were error checked using Geneious suite version 10.2.3. A CO1 sequence of 687 base pair length was deposited at Barcode of Life Data Systems (http://www.boldsystems.org), see below.

DNA sequence analysis

The CO1 sequences of following species of *Caenis* Stephens, 1835 occurring in Levant, Caucasus, Minor and Central Asia were obtained from Barcode of Life Data Systems: *C. beskidensis* Sowa, 1973; *C. horaria* (L., 1758); *C. lactea* (Burmeister, 1839); *C. luctuosa* (Burmeister, 1839); *C. macrura*; *C. martae* Belfiore, 1984; *C. pseudorivulorum* Keffermüller, 1960; *C. rivulorum* Eaton, 1884; and *C. robusta* Eaton, 1884. To investigate the affinities of these taxa to *C. kopetdagi*, pairwise Kimura 2-parameter (K2P) distances were calculated in Mega X version 10.1 (Kumar, Stecher, Li, Knyaz, and Tamura 2018) under default settings.

Results

In 108 collecting points (for details see Appendix) in our field trips between 2016 and 2018, nymphs and adults of Caenidae were collected. In all of these locations, the prevailing species was *Caenis macrura* (see also Bojková et al. 2018). In three of these

Figure 1. Collection sites of *C. kopetdagi* Kluge, 1985: (A) at Cholhul River (right tributary of Kashkan River), W of Chameshk, Zagros Mountains, Lorestan Province and (B) in the alluvial plain of Karun River, SW of Shooshtar, Khuzestan Province.

locations, it occurred together with *Caenis kopetdagi* (see Figures 1, 10, and below). The nymph of the latter species was only briefly described by Kluge (1985) from Turkmenistan, but with the newly collected material, a thorough re-description was possible.

Caenis kopetdagi Kluge, 1985

(Figures 2–9)

Caenis kopetdagi Kluge 1985: 1586, figures 2.1–11 (description; male imago and subimago, nymph; distribution in Turkmenistan).

Caenis kopetdaghi [sic!] Kluge, 1985: Mohammadian 2005: 220 (distribution in Iran).

Type material studied

1 ♂ imago (holotype), 1 subimago (removed from last instar nymph), 4 nymphs, Turkmenistan, Kopet Dag Mountains, River Ay-Dere, 4.VII.1981, Sumbar at Kara-Kala River; 3 nymphs, 23.VI.1981, all leg. N. Kluge.

Additional material studied

18 nymphs, Iran, Lorestan Province, Cholhul River (right tributary of Kashkan River), W of Chameshk, 33°12′58.6″N, 48°09′05.2″E, 1310 m above sea level (a.s.l.), 26. IV. 2017, leg. J. Bojková, T. Soldán, J. Imanpour Namin (IECA: 10 specimens; MMTT_DOE: 3 specimens; SMNS: 3 specimens, 1 DNA voucher specimen SMNS_EPH_007481_V, 1 SEM specimen SMNS_EPH_007481_R).

3 nymphs, Iran, Khuzestan Province, Balarud River, S of Hoseyniye, 32°35′17.8″N, 48°17′19.4″E, 230 m a.s.l., 26. IV. 2017, leg. J. Bojková, T. Soldán, J. Imanpour Namin. (IECA: 2 specimens EtOH, SMNS: 1 SEM specimen SMNS_EPH_007722_R).

6 nymphs, Iran, Khuzestan Province, Karun River, SW of Shooshtar, 32°02′01.6″N, 48°49′17.9″E, 35 m a.s.l., 28. IV. 2017, leg. J. Bojková, T. Soldán, J. Imanpour Namin.

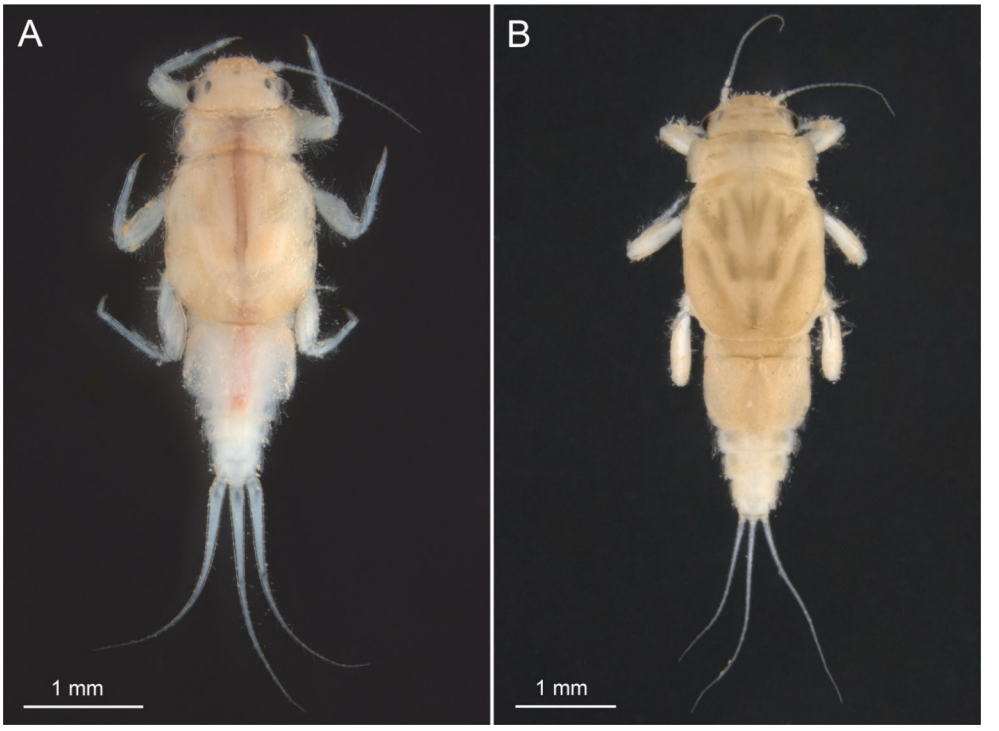

Figure 2. *Caenis kopetdagi* Kluge, 1985: habitus of (A) male and (B) female nymph in dorsal view under light microscope.

(IECA: 3 specimens EtOH, SMNS: 1 CO1 specimen SMNS_EPH_007721_E, 2 SEM specimens SMNS_EPH_007721_R).

Re-description of nymphs

Measurements. Male nymph, body length 3.5 mm, cerci 2.3 mm. Female nymph, body length 3.5 mm, cerci 2.7 mm.

Colouration of cuticle. A pale species (Figure 2A, B); mesonotum light brownish with two pale dashes along inner margin of wing buds and two other ones in front of them forming a V-shaped pattern. Other parts yellowish white or white.

Epidermal pigmentation. No pigments present.

Head. Short and broad, width about 2.3 times length, genae not bulged, eyes relatively small and flat (Figure 2A, B). Lateral sides of labrum diverging anteriorly forming broadly rounded corners; anterior part of dorsal surface with short and moderate pinnate bristles, often bifurcated (Figure 4A). Apical third of epipharynx (i.e., ventral side of labrum) in each half with a field of stronger, bowed bristles directed medially, bristles of left and right sides similar in shape and length, left field with slightly fewer bristles, both fields medially well separated from each other. Basal two thirds of epipharynx with single, medially contiguous large field of densely arranged, very fine

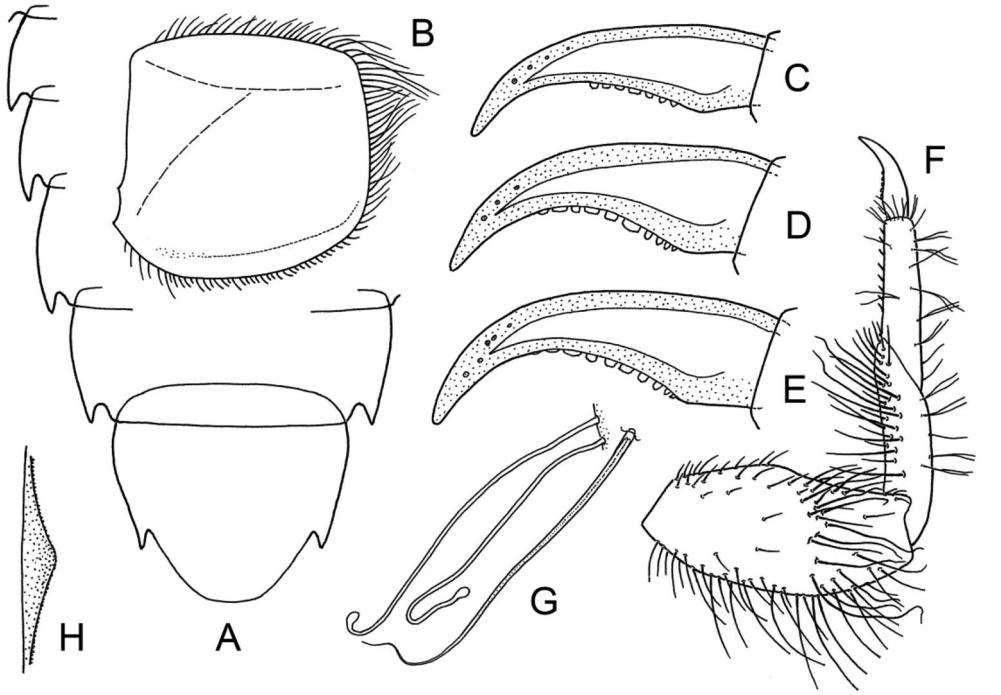

Figure 3. Line drawings of *Caenis kopetdagi* Kluge, 1985, nymph: (A) outline of abdomen in ventral view, (B) operculate gill, (C) fore claw, (D) middle claw, (E) hind claw, (F) fore leg in dorsal view, (G) bristles with apical knob and bristle with pointed tip, (H) posteromedian process on abdominal tergum II.

bristles. Basally to this field, there is a single longitudinal row of very thick bristles asymmetrically on left side only (Figure 4B). Mandibles (Figure 4C, D) anterolateral with a group of about 12 bristles of moderate length. Apical incisivus of left mandible with 4 denticles, subapical incisivus with 3 denticles; apical incisivus of right mandible with 3 denticles, subapical incisivus with 2 denticles; all incisivi posteriorly with a dense row of 10–15 apically directed bristles. Palpomeres of maxillary palp subequal in length, basal palpomere a little longer than the others (Figure 5A). Palpomere 2 of labial palp 1.4 times as long as palpomere 3 (Figure 5B).

Thorax. Sides of pronotum parallel, slightly convex or medially straight, with very small denticles and numerous thin bristles, often with end knobs. Those bristles also on sides of mesonotum. Groups of moderately thin bristles anteriorly from coxae on ventral side. Coxal processes inconspicuous. Fore femur on dorsal side with an irregular transverse band of very long, thin bristles (Figure 3F). All femora with thin long or very long bristles on hind margin and shorter ones on outer margin, with and without terminal knobs (Figures 3F and 6A–C). Very long bristles also on dorsal side of middle and hind femora, sometimes only few. Tibiae marginally with similar, somewhat shorter bristles. Femora ventrally each with a longitudinal oval field (in SEM, in light microscope scarcely visible) more or less surrounded by shorter blunt bristles (Figure 6A, B). All claws regularly bowed, with 7–10 denticles; most of them

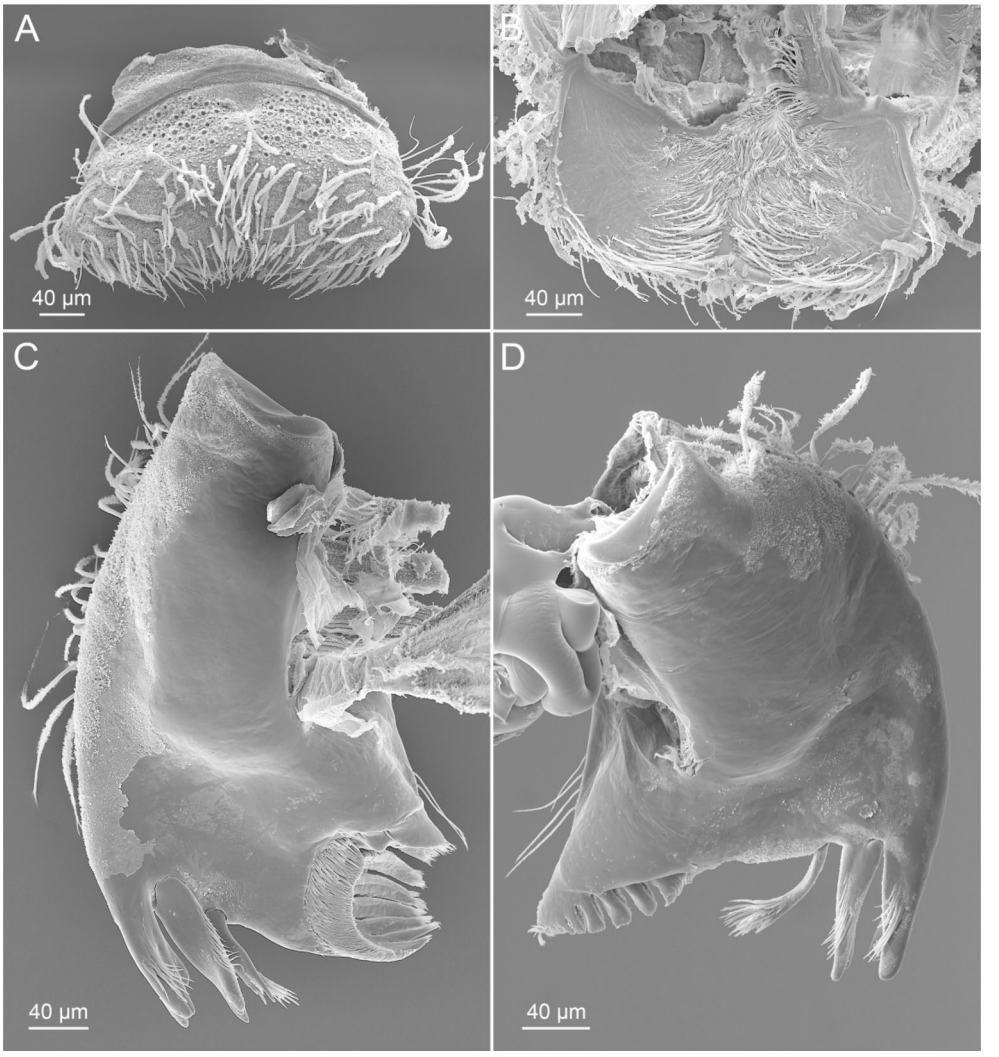

Figure 4. SEM of mouthparts of *Caenis kopetdagi* Kluge, 1985, nymph: (A) labrum, (B) epipharynx, (C) left and (D) right mandible in posterior view.

are apically cut and more or less rectangular (Figures 3C–E and 7A, B); subapically a row of about 5 sensillae can be observed (Figure 7A, C).

Abdomen. Posterolateral processes on abdominal segments VII–IX short to moderate (Figures 2 and 3A); lateral margins provided with moderate thin bristles. Posteromedian process on tergum II inconspicuous, forming a very short and broad protrusion nearly invisible in dorsal view (Figures 2 and 3H). Hind margin of terga VII–X with hair-like bristles of different length; with 35–50 bristles on tergum VII, 20–25 on tergum VIII, 15–20 on tergum IX and 10–15 on tergum X; tergum X additionally with denticles, tergum IX sometimes medially with few very small denticles or without. Surface of abdominal terga and sterna denticulated (Figure 9B, C).

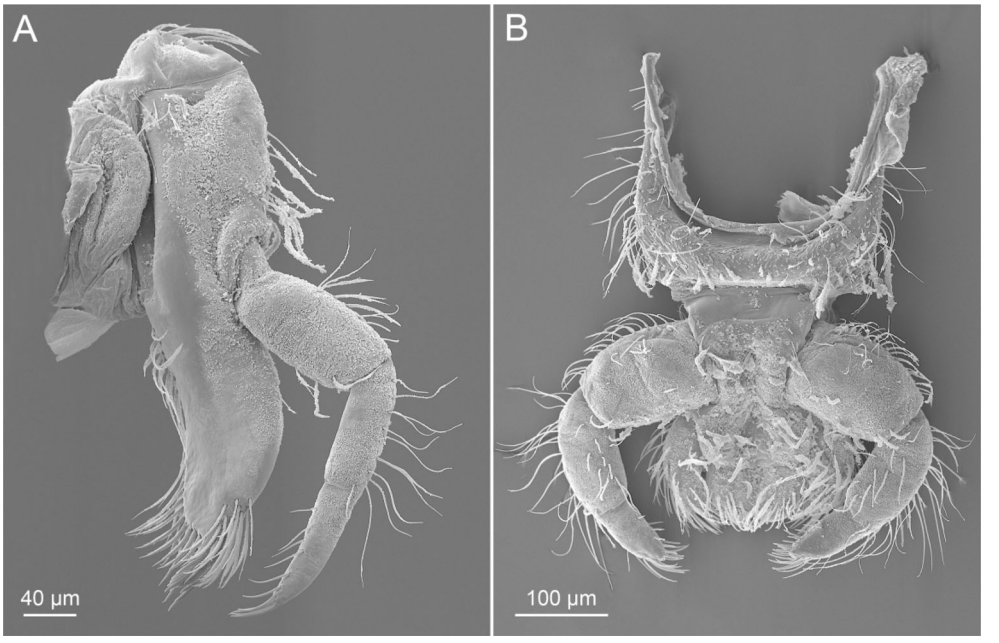

Figure 5. SEM of mouthparts of *Caenis kopetdagi* Kluge, 1985, nymph: (A) right maxilla and (B) labium in posterior view.

Sternum IX apically rounded (Figure 3A), hind margin with moderate, frayed bristles, the apical ones shorter and strongly bent medially. Shagreen not visible. Operculate gill (Figures 3B and 8A–G) rounded square; inner margin with moderate to long acute bristles, hind margin with long and very long thin bristles, lateral margin with short to moderate blunt bristles, thin and longer ones between them. Y-shaped ridges well developed (in SEM, in light microscope scarcely visible), inner ridge meets outer in the middle (Figures 3B and 8A), both with few long knobbed bristles, few also on the surface; about 5 short to moderate, blunt bristles on base of inner ridge. Surface with honeycomb microstructure (Figure 8B, C). Row of microtrichia on ventral side close to lateral margin, not continuing on hind margin (Figure 8D); shape of microtrichia very variable (Figure 8E–G): in basal half, rectangular or rounded and more or less irregularly arranged, long and very thin in apical half, deeply frayed. Other specimens show nearly all microtrichia very thin or most of them short, rectangular, or rounded. Third gill semicircular, with relatively short filaments, about 25 of them one or two branched, about 17 with 3 or more branches (Figure 9A). Gill I 0.4 times as long as gill II.

Differential diagnosis

Caenis kopetdagi can be distinguished from all other *Caenis* species by the following combination of characters:

Male. (1) base of antennal flagellum dilated (Kluge 1985, fig 2.2); (2) genital sclerites, forcipes and lateral parts of sternum IX coloured brownish (Kluge 1985, fig 2.1); (3)

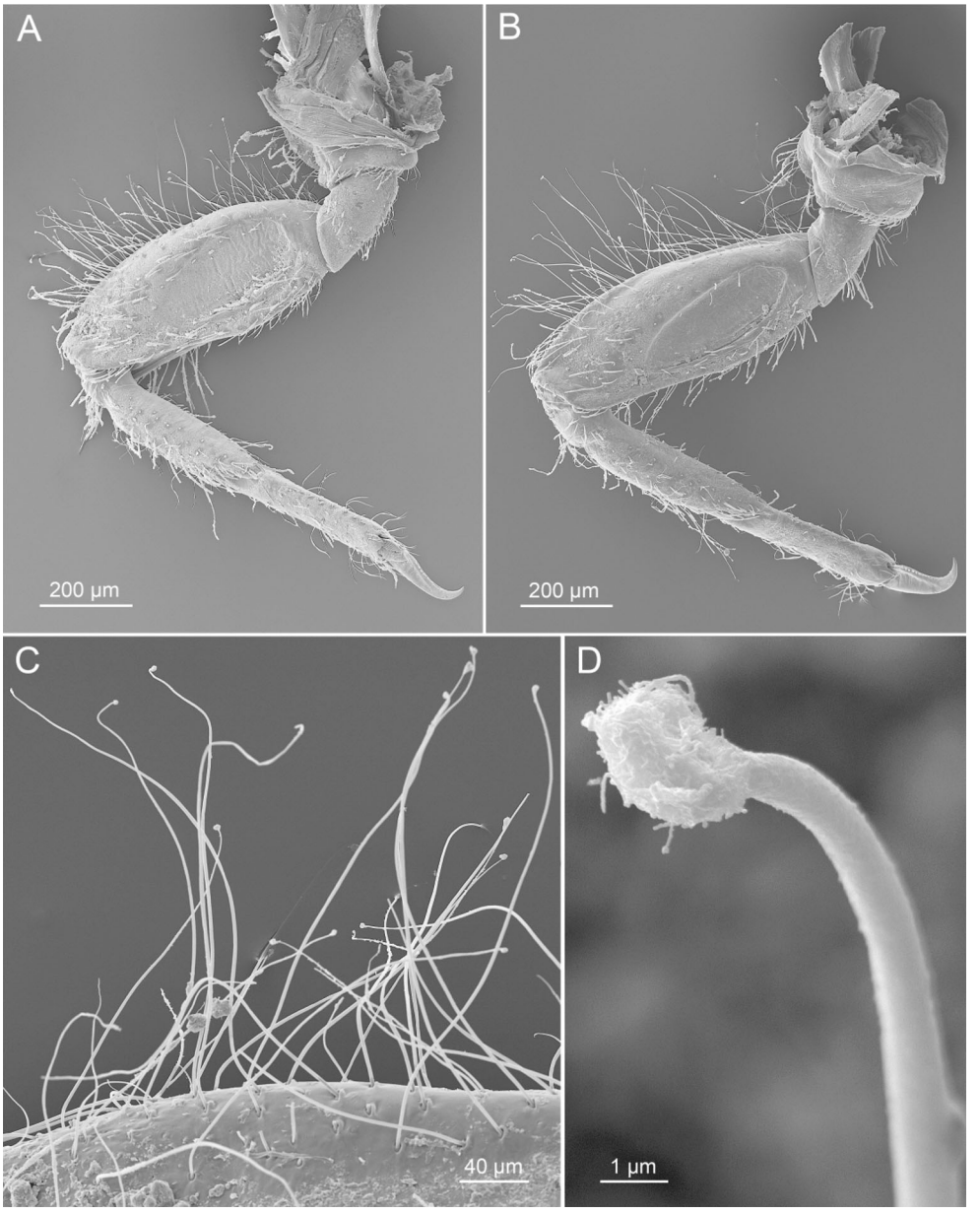

Figure 6. SEM of legs of *Caenis kopetdagi* Kluge, 1985, nymph: (A) fore leg and (B) middle leg in ventral view, (C) bristles with apical knobs on outer margin of middle leg, (D) apical knob of bristle with short processes.

penis lobes short and rounded (Kluge 1985, fig 2.1); (4) forceps with an apical spine (Kluge 1985, fig 2.4).

Nymph. (5) palpomere 2 of labial palp 1.4 times as long as palpomere 3 (Figure 5B); (6) fore femur on dorsal side with an irregular transverse band of very long thin bristles (Figure 3F); (7) claws regularly bowed, with 7–10 denticles;

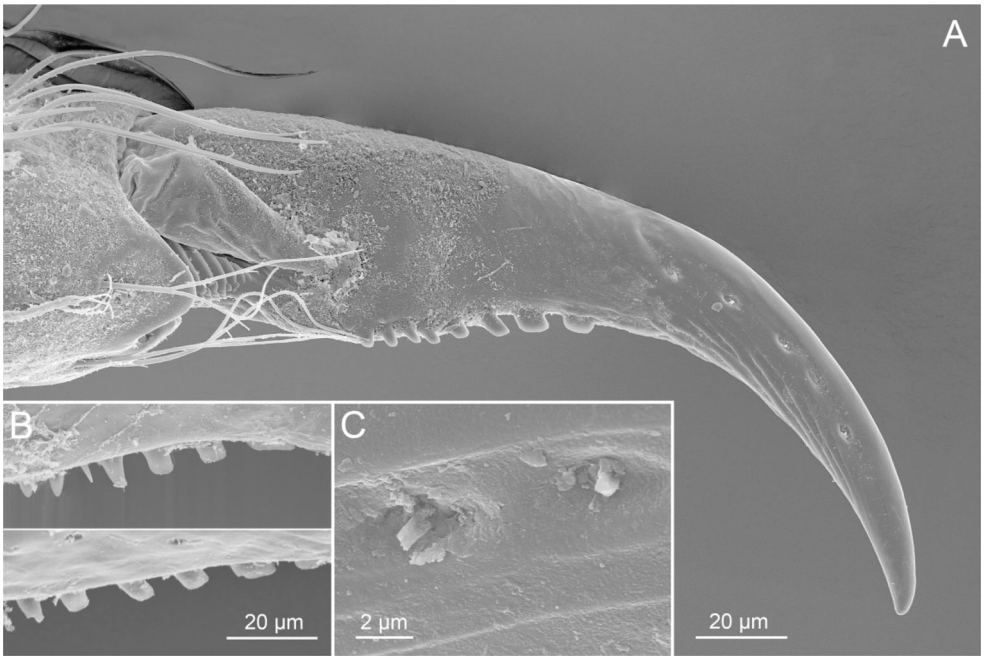

Figure 7. SEM of fore claw of *Caenis kopetdagi* Kluge, 1985, nymph: (A) in total view, (B) variability of dentition in different specimens, (C) enlarged view of subapical sensillae.

most of them apically cut and more or less rectangular (Figures 3C–E and 7A, B); (8) hind margin of terga VII–X with hair-like bristles of different length, tergum X additionally with denticles; (9) shagreen on dorsal side of sternum IX not visible. (10) Most characteristic for this species are long setae with apical knobs (Figures 3G, 6A–D, and 8A, B), which can be found, together with apically pointed bristles, on sides of pro- and mesonotum, femora, and operculate gills. SEM in high magnification shows that the terminal knobs are provided with short processes (Figure 6D).

CO1 sequence

A CO1 sequence of *C. kopetdagi* collected in Iran is available online at Barcode of Life Data Systems (http://www.boldsystems.org) under the process ID EPHIR015-19. Out of 21 different species of *Caenis* distributed in Levant, Caucasus, Minor and Central Asia (see Table 1), CO1 sequences are available for 10 species (including the newly provided sequence of *C. kopetdagi*). Within this dataset, *C. kopetdagi* differs from remaining species within the range 0.19–0.26 (mean K2P distance, see Table 1); the most similar species represents *C. horaria*.

Discussion

Habitat of C. kopetdagi

Despite considerable sampling efforts including also streams in the northeast of Iran, we were only able to collect *C. kopetdagi* in the Zagros Mountains and west thereof,

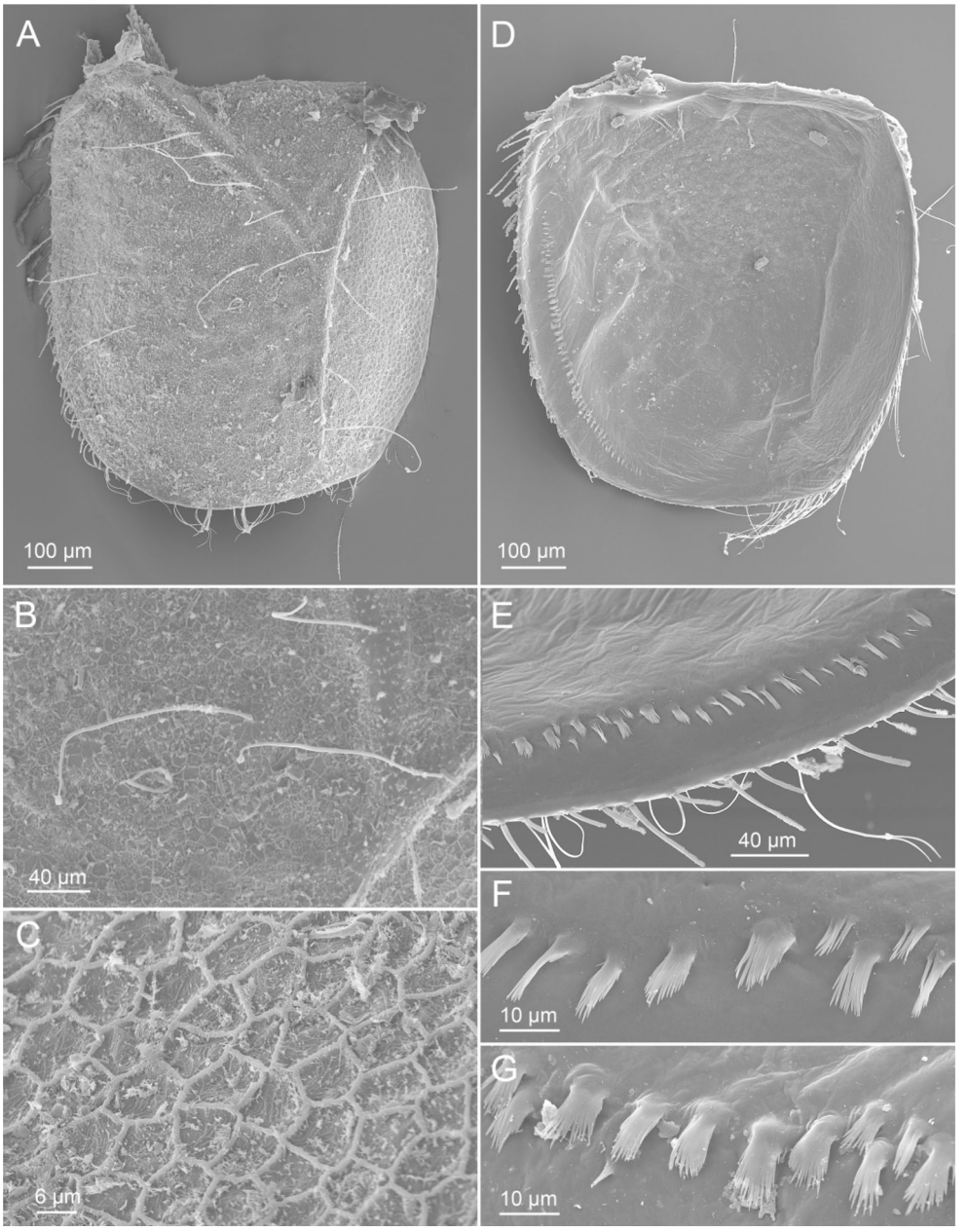

Figure 8. SEM of gill cover of *Caenis kopetdagi* Kluge, 1985, nymph: (A–C) left gill cover in dorsal view, (A) total view, (B) enlarged view of bristles with apical knob, (C) surface microsculpture, (D–G) right gill cover in ventral view, (D) total view, (E) sublateral row of microtrichia, (F–G) variability of microtrichia in different specimens.

far from its previously known occurrence. The three stream sections, where it was collected, considerably differ from each other, which precludes any generalisation about its habitat preference. Nymphs of *C. kopetdagi* were found in the mountainous stretch of Cholhul River, flowing in a deep, V-shaped valley in the southern slopes of

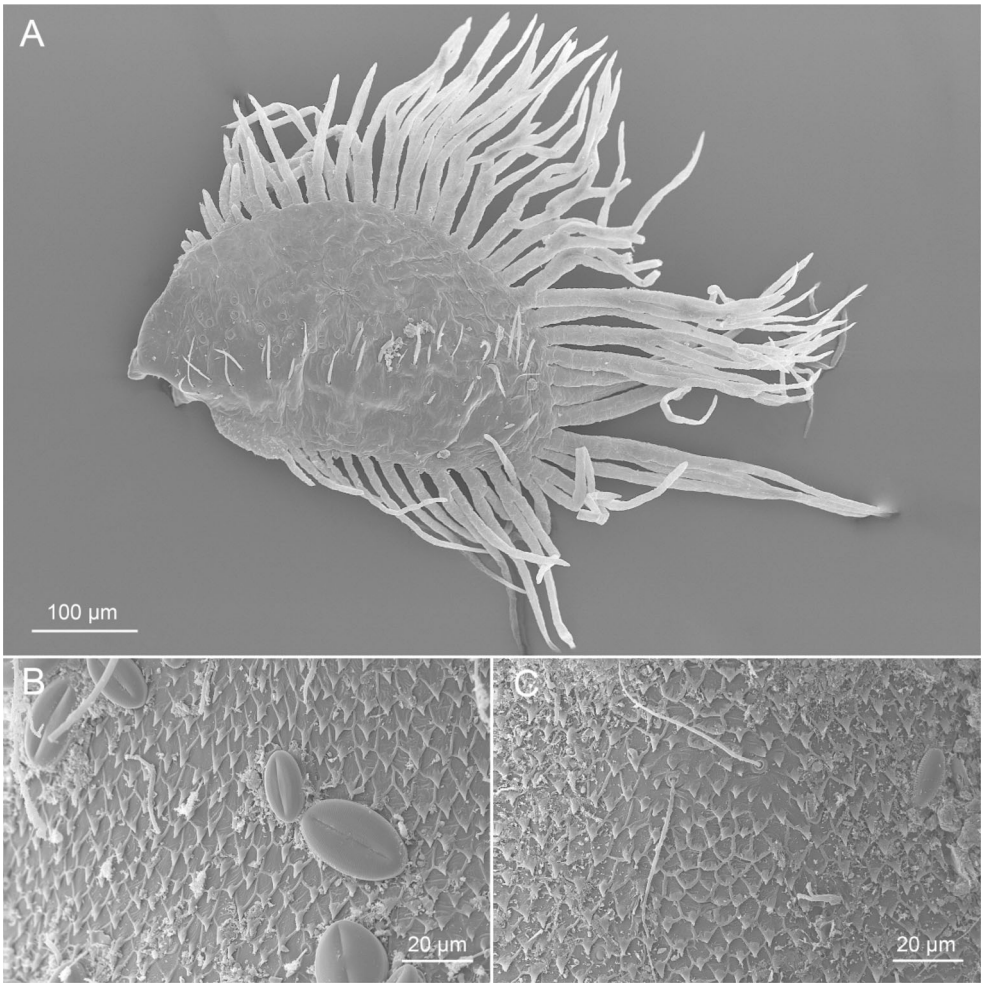

Figure 9. SEM of *Caenis kopetdagi* Kluge, 1985, nymph: (A) right abdominal gill III in dorsal view, (B) cuticular microsculpture with denticulation on abdominal tergite VIII, (C) sternite IX.

Zagros Mts. at an altitude of 1310 m a.s.l. (Figure 1A). It was a fast flowing stream of 8–10 m width with turbulent flow, slightly turbid water and coarse bed substrate (stones and boulders 55%, coarse gravel 25%, and silt 20%). There were only few accompanying mayfly species present like *Baetis braaschi* Zimmermann, 1980 and *Choroterpes* sp., both in low abundance. Water temperature was 16°C, conductivity 1168 µS cm^{-1} and salinity 0.58 ‰. Lowland Balarud River (230 m a.s.l., figure 10C in Sroka et al. 2019) and Karun River (35 m a.s.l., Figure 1B) on the other hand were clear, slow flowing streams with slightly turbulent to laminar flow. They had similar bed substrate with prevailing coarse gravel (coverage about 60%), and stones and fine gravel (20–30% and 10–20%, respectively). They differed in stream type, size, and water quality. Karun River was a large stream of about 130–180 m width, meandering in a large alluvium intensively used for agriculture. Compared to other streams in the region, its water had relatively low temperature (19°C), conductivity (1165 µS cm^{-1}) and salinity (0.58 ‰). Karun River was otherwise dominated by *Rhithrogena*

Figure 10. Presently known distribution of Caenidae in Iran.

(*Epeiron*) sp. and *Baetis* sp., both in high abundances. These species were accompanied by *Baetis braaschi*, *Labiobaetis balcanicus* (Müller-Liebenau and Soldán, 1981), and *Nigrobaetis* sp. in lower abundances. Balarud River was a sinuous stream of 5–6 m width with smaller gravel (but its channel was 15–20 m wide, indicating large seasonal discharge fluctuation), flowing in a deep, rocky valley without vegetation. It was warmer (27°C) than Karun River and had lower conductivity and salinity (760 µS cm^{-1} and 0.38 ‰). The accompanying species were somewhat similar to Karun River with dominating *Rhithrogena* (*Epeiron*) sp., *Nigrobaetis* sp., and *Choroterpes* (*Euthraulus*) sp., and less abundant *Oligoneuriopsis villosus* Bojková, Godunko, and Staniczek, 2019, *Baetis* sp., and only with few specimens of *Baetis braaschi*.

Based on the limited data, it is difficult to assess the preferred environmental parameters of *C. kopetdagi*, but given the fact that in all three sampling sites the river beds were to a considerable degree composed of coarse gravel, this may be the preferred substrate for the nymph.

Table 1. K2P distances among CO1 sequences of *Caenis kopetdagi* Kluge, 1985 and geographically closely distributed species of *Caenis* Stephens, 1835.

	1.	2.	3.	4.	5.	6.	7.	8.	9.
1. *C. beskidensis* (5)									
2. *C. horaria* (11)	0.250 (0.236–0.260)								
3. *C. lactea* (5)	0.232 (0.220–0.248)	0.231 (0.222–0.251)							
4. *C. luctuosa* (10)	0.285 (0.277–0.291)	0.228 (0.214–0.239)	0.281 (0.264–0.321)						
5. *C. macrura* (5)	0.251 (0.237–0.258)	0.221 (0.214–0.236)	0.243 (0.228–0.270)	0.232 (0.220–0.249)					
6. *C. martae* (1)	0.278 (0.256–0.292)	0.241 (0.239–0.244)	0.265 (0.261–0.270)	0.211 (0.208–0.219)	0.205 (0.199–0.210)				
7. *C. pseudorivulorum* (1)	0.149 (0.141–0.167)	0.216 (0.211–0.219)	0.236 (0.223–0.256)	0.244 (0.238–0.249)	0.232 (0.228–0.237)	0.255 (0.255–0.255)			
8. *C. rivulorum* (5)	0.297 (0.278–0.310)	0.225 (0.216–0.233)	0.255 (0.236–0.288)	0.214 (0.206–0.220)	0.225 (0.217–0.234)	0.235 (0.233–0.240)	0.253 (0.246–0.257)		
9. *C. robusta* (8)	0.177 (0.160–0.254)	0.236 (0.207–0.245)	0.232 (0.215–0.246)	0.277 (0.243–0.290)	0.233 (0.201–0.240)	0.266 (0.226–0.274)	0.128 (0.108–0.253)	0.282 (0.249–0.292	
10. *C. kopetdagi* (1)	0.229 (0.225–0.240)	0.213 (0.207–0.214)	0.240 (0.235–0.253)	0.257 (0.248–0.260)	0.231 (0.225–0.237)	0.246 (0.246–0.246)	0.235 (0.235–0.235)	0.271 (0.267–0.277)	0.246 (0.244–0.250)

Each cell contains mean distance (top) and range (bottom, in brackets). Number in brackets next to species name denotes number of analysed sequences.

Distribution of Caenidae in Iran

In their check list, Bojková et al. (2018) summarised literature data on Ephemeroptera in Iran. Except of numerous records of unidentified species of *Caenis*, there are four species of Caenidae reported from the country, three of which were only singularly collected, namely *Cercobrachys* sp., *Clypeocaenis bisetosa*, and *Caenis kopetdagi*. *Cercobrachys* sp. was reported by Mahboobi Soofiani et al. (2012) from Zayandeh Roud River, Isfahan Province. As the single described Palaearctic species within this genus, *Cercobrachys minutus* (Tshernova, 1952), has a wide Transpalaearctic distribution with records in France (Chovet and Brulin 2016), Lithuania (Kovács, Ambrus, Juhász, Olajos, and Szilágyi 2008), Hungary (Kovács 2009), Bulgaria (Russev 1971), Mongolia (Soldán, Enkhtaivan, and Godunko 2009), and Russian Far East (Tiunova 2009 et al.), its presence in Iran cannot be ruled out. Also possible might be the presence of a so far undescribed new species of *Cercobrachys*. *Clypeocaenis bisetosa* has been described by Soldán (1978) from Alborz Mountains. It is the only known record of the species from Iran. *Caenis kopetdagi* was described from Kopet Dag Mountains in Turkmenistan by Kluge (1985) and for the first time reported from the Iranian side of Kopet Dag Mountains in Razavi Khorasan Province by Mohammadian (2005). With our present records from three localities in western Iran, we considerably expand the distribution of the species, although it remains rare with unclear distributional range. Specimens of both western and eastern populations showed no obvious morphological differences. The most common and most abundant species of Caenidae in Iran is by far *Caenis macrura*, which was found in most of our collection sites throughout the country (for details see Appendix). Notably, it was also present in all three collection sites of *C. kopetdagi*. At these sites, *C. macrura* was more abundant and the dominant species compared to *C. kopetdagi*. A summary of our own collections of *Caenis* in Iran together with earlier data on Caenidae in literature gives Figure 10.

Distribution of Caenis in the Middle East and adjacent regions

Although there are only two identified species of *Caenis* present in Iran, in the surrounding countries of the Middle East the diversity of *Caenis* is much higher (Table 2). The taxonomical composition of the genus *Caenis* in Levant consists of both Afrotropical and Palaearctic species. While the Turkish and Caucasian fauna of *Caenis* includes seven species with European or Palaearctic distribution (Salur, Darılmaz, and Bauernfeind 2016), a few local species were described from Egypt, Israel, Lebanon, Jordan, United Arab Emirates, and Saudi Arabia. For a summary of distributional information see Table 2.

Based on male adults, *Caenis ulmeri* Brodsky, 1930 was described from Uzbekistan (Brodsky 1930), but later synonymised with *C. robusta* Eaton, 1884 by Malzacher (1993). Kluge (1995) confirmed this synonymy by studying syntypes. Kluge (1985) described two species of *Caenis* based on nymphs and reared imaginal material. *Caenis kopetdagi* was described based on limited material from Turkmenistan, and *C. hissari* Kluge, 1985 was established based on nymphs and adults of both sexes from Western Tajikistan. Additionally, *C. pseudorivulorum* Keffermüller, 1960, *C. macrura*, *C. luctuosa* (Burmeister, 1839), and C. *lactea*

Table 2. Distribution of *Caenis* Stephens, 1835 in Levant, Middle East, Caucasus, Minor and Central Asia (incl. neighbouring region of Pakistan): ● – reliable record; ? – questionable record.

	LEVANT						MIDDLE EAST					CAUCASUS				CENTRAL ASIA			
Species	EG	IL	JO	SY	LB	TR	IQ	IR	AE	SA	PK	AM	AZ	GE	RU	TM	TJ	UZ	KZ
C. antoniae Malzacher, 1992		●	●																
C. beskidensis Sowa, 1973												●		●					
C. corana Thomas and Sartori, 1989										●									
C. carloi Thomas et al., 2000					●														
C. gilbonensis Malzacher, 1992		●																	
C. haywardi Navás, 1926	●																		
C. hissari Kluge, 1985																	●	●	
C. horaria (Linnaeus, 1758)	●					●													
C. kimminsis Ali, 1967											●								
C. kopetdagi Kluge, 1985								●								●			
C. lactea (Burmeister, 1839)																			●
C. luctuosa (Burmeister, 1839)				●		●			?	●				●	●			?	●
C. mabroukii Hassan and Amer, 2007	●																		
C. macrura Stephens, 1835		●			●	●	?	●		●		●	●	●	●			●	●
C. malzacheri Sartori and Gattolliat, 2008									●										
C. martae Belfiore, 1984						●													
C. parabrevipes Malzacher, 1992		●	●																
C. pseudorivulorum Keffermüller, 1960						●						●		●				●	
C. rivulorum Eaton, 1884						●						●							
C. robusta Eaton, 1884	●	?				●												●	

Levant.

EG – Egypt, Hassan and Amer (2007): no details on *Caenis* distribution within country; original description of *C. mabroukii* based on adults and nymphs from Maadi suburb of Cairo City; superficial description of imaginal *C. haywardi*, without clarification of the origin and sex of material investigated.

IL – Israel, Malzacher (1992): original description of *C. gilbonensis* based on nymphs from Nahal Gilbon and Nahal Daliyyot; original description of *C. antoniae* based on adults of both sexes and nymphs from Nahal Arugot (Dead Sea Area); original description of *C. parabrevipes* based on nymphs from Lower Jordan River and Nahal Zippori; *C. robusta* was mentioned as species, which can be detected in the fauna of Israel.

JO – Jordan, Gattolliat, Vuataz, and Sartori (2012): *C. antoniae* was recorded from the Dead Sea River-basin as common and widely distributed within country; *C. parabrevipes* distributed in the same area as previous species, but less common and abundant; Alhejoj, Salameh, and Bandel (2014) cited the species *C. antoniae* as a possible indicator for the water quality evaluation of the Jordan River-basin; Ramadan and Katbeh-Bader (2018) published a summary on the distribution of *C. antoniae*.

SY – Syria, Puthz (1973: 18): *C. macrura* reported based on a single nymph from District of Tartus City; for distribution of *C. luctuosa*, see Koch (1988).
LB – Lebanon, Marie et al. (2001): original description of *C. carloi* based on nymphs from the Orontes River-basin; see Dia (2006) and Dia and Thomas (2005) for information about distribution of *C. macrura* in the Aouali et Damour River-basins, and Dia and Thomas (2007) for distribution in the Aarqa River-basin.
TR – Turkey, see Koch (1988) for *C. macrura* records from Antakya town and Urfa (officially Şanlıurfa City); see Salur et al. (2016) for the summary of distribution of the genus *Caenis* within country.

Middle East.
Abdu and Shaumar (1985: 218) reported *Caenis* sp. from Madinat Khalifa District of Doha City, Qatar; this record was also mentioned by Gattolliat and Sartori (2008: 47).
IQ – Iraq, Al-Zubaidi, Braasch, and Al-Kayatt (1987) cited a single taxon under the name '*Caenis* ex gr. *Macrura*' based on nymphs only, with a remark about the inability of a precise species identification.
IR – Iran, based on summarised data published by Bojková et al. (2018); *C. kopetdagi* hitherto was recorded for the country based on Mohammadian (2005) and N.J. Kluge (2018, personal communication); see also for data on distribution of *Caenis* within Levant Region.
AE – United Arabian Emirates, Gattolliat and Sartori (2008): original description of *C. malzacheri* based on nymphs from the Wadi Wurayah stream; '*Caenis* spec. cf. *Caenis luctuosa* (Burmeister, 1835)' was reported based on adult males and females, with some differences in structure of penis lobes and length of posterolateral abdominal spines compared to typical *C. luctuosa*.
SA – Saudi Arabia, see Thomas and Sartori (1989) for original description of *C. corana* based on nymphs from Makkah City.
PK – Pakistan, see Ali (1967, 1970) for superficial species description and record of *Caenis kimminsis,* a doubtful species.

Caucasus.
Caenis macrura is the most abundant species in the Caucasus, distributed within all countries of the region (for details see Kasymov 1972; Puthz 1978; Cherchesova 2004; Chertoprud and Peskov 2007; Martynov, Godunko, and Palatov 2016; Sokolova and Palatov 2016; Hrivniak et al. 2018). Puthz (1978) mentioned *C. luctuosa* and *C. robusta* for Caucasus without any specification of country or region.
AM – Armenia, see Kluge (1987) and Palatov and Sokolova (2016) for details of *C. beskidensis* and *C. rivulorum* distribution; see Hrivniak et al. (2018) for the first record of *C. pseudorivulorum* and additional locality of *C. rivulorum*.
AZ – Azerbaijan, see Sokolova and Palatov (2016) for the record of *C. macrura* from Talysh Mountains.
GE – Georgia, see Martynov et al. (2016) for the first record of *C. pseudorivulorum* from the Autonomous Republic of Adjara; see Kasymov (1972) for a single record of *C. luctuosa* (under *C. moesta*).
RU – Russian Federation, see Kasymov (1972) for the records of *C. luctuosa* from Republic of Adygea and Krasnodar Krai (under *C. moesta*).

Central Asia.
Kluge (1997) reported *C. macrura* and *C. robusta* from Central Asia without any specification of country or region. There are no reliable published data about diversity and distribution of the genus *Caenis* in Kyrgyzstan.
TM – Turkmenistan, Kluge (1985): original description of *C. kopetdagi* based on adults and nymphs from Kopet Dag Mountains.
TJ – Tajikistan, based on Kluge (1985).
UZ – Uzbekistan, Shukurov, Mitropolsky, Talsky, Zholdubaev, and Shevchenko (2005) reported three representatives of the genus *Caenis* from the protected area of the Western Tian Shan, i.e., *C. macrura* from rivers, streams and lakes of the Ugam-Chatkal National Park and Chatkalskiy State Nature Reserve, and Sary-Chelek Nature Reserve; *C. hissari* was recorded from the Chatkal Range within the territory of protected areas; the taxon 'C. sp. (*moesta* ?)' was collected in the rivers of the Ugam-Chatkal National Park and lakes of the Sary-Chelek Nature Reserve; see Kuchkarov et al. (2018) for additional distributional data; *C robusta* reported by Ulmer (1930) under the name *C. ulmeri*; the species *C. pseudorivulorum* was collected at several sites of the Amudarya River-basin by D. Palatov (2018, personal communication).
KZ – Kazakhstan, based on Kluge (1997) and Epova (2002).

(Burmeister, 1839) were reported in faunistical contributions and taxonomical keys (Kluge 1997; Epova 2002), or in unpublished reports, like for the Amudarya River-basin (see Cherniak 2017).

Caenis kimminsis Ali, 1967 was described from the Rawalpindi District in north-eastern Pakistan (Ali 1967). However, the description of this species was very superficial with almost non-informative drawings. Nevertheless, it was recorded from the Tamirabarani River of South Western Ghats, India by Selva Kumar, Sundar, and Arunachalam (2012); however, the true identity of this record remains unclear. There are no published data available on the distribution of *Caenis* in Afghanistan.

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Appendix. Collection sites of *Caenis macrura* Stephens, 1835 in our field trips to Iran 2016–2018

Appendix Table. List of localities of *C. macrura* Stephens, 1835 collected in Iran in 2016–2018.

Province	Name of Stream	Locality	Nearest town/village	Latitude	Longitude	Altitude (m a.s.l.)	Sampling date	Collector	No of specimens
Alborz	Kordan	2 km N Kordan	Kordan	35°57′15.6″N	50°50′25.4″E	1431	10.V.2017	AHS, MP, FN	15
Ardabil	unnamed pond	below of Jomadi (E of Vakilabad)	Vakilabad	38°16′55″N	48°06′14″E	1592	18.V.2016	TS, JB, JIN	69
Ardabil	Bulakhlar Chayi	above Nir	Nir	38°02′09″N	47°58′55″E	1634	17.V.2016	TS, JB, JIN	4
Ardabil	Bulakhlar Chayi (LT of Balikhli Chay)	in Nir	Nir	38°02′09″N	47°58′55″E	1634	17.V.2016	TS, JB, JIN	2
Ardabil	UB	in Sardabe (W of Vakilabad)	Vakilabad	38°17′03″N	48°02′10″E	1935	18.V.2016	TS, JB, JIN	83
Ardabil	Hakim Geshlaghi chayi (RT of Qareh-Su)	SW Almas / SW of Ardabil)	Ardabil	38°08′27″N	48°10′36″E	1434	18.V.2016	TS, JB, JIN	117
Chaharmahal and Bakhtiari	UB	SW of Gahru	Gahru	31°59′13.9″N	50°51′26.2″E	2215	30.IV.2017	TS, JB, JIN	5
Chaharmahal and Bakhtiari	UB	near Godar Kabk	Gandoman	31°43′24.9″N	51°15′06.9″E	2143	02.V.2017	TS, JB, JIN	23
Chaharmahal and Bakhtiari	Wanak (RT of Kuhrang)	Cheshme Ali	Gandoman	31°37′19.3″N	51°14′38.3″E	2064	02.V.2017	TS, JB, JIN	168
Chaharmahal and Bakhtiari	Sudejan	6 km NW Sudejan	–	32°32′23.2″N	50°20′43.9″E	2147	05.V.2017	AHS, MP, FN, RJG	12
Chaharmahal and Bakhtiari	Farsan	3 km E Nisirabad	–	32°23′17.3″N	50°20′04.1″E	2328	05.V.2017	AHS, MP, FN, RJG	16
Chaharmahal and Bakhtiari	Beheshtabad	17 km N Ardal	–	32°04′08.1″N	50°40′06.8″E	1960	06.V.2017	AHS, MP, FN, RJG	1
Fars	Cheshmegolabi	20 km W Darab		28°47′15.4″N	54°22′18.4″E	1103	01.V.2017	AHS, MP, FN, RJG	15
Fars	Kor	2,5 km SE Dorodzan	–	30°11′36.4″N	52°28′01.0″E	1622	03.V.2017	AHS, MP, FN, RJG	3
Fars	Ghadamgah	1 km S Dashtak	–	30°16′55.7″N	52°27′53.7″E	1927	03.V.2017	AHS, MP, FN, RJG	2
Fars	Kor	2 km S Cham-e-riz	–	30°26′39.3″N	52°07′11.7″E	1768	03.V.2017	AHS, MP, FN, RJG	11
Gilan	Khara Rud (RT tributary of Sefid Rud)	S of Paein mahale Khara Rud / S of Pashaki	Pashaki	37°05′01″N	49°46′25″E	83	12.V.2016	TS, JB, JIN	3
Gilan	Eshkaraab (RT of Khara Rud)	S of Paein mahale Khara Rud / S of Pashaki	Pashaki	37°02′29″N	49°47′52″E	200	12.V.2016	TS, JB, JIN	5
Gilan	Kalardeh Rukhan (LT of Khara Rud)	S of Paein mahale Khara Rud /S of Pashaki	Pashaki (Madarsara)	37°04′12″N	49°46′36″E	106	12.V.2016	TS, JB, JIN	2
Gilan	UB (RT of Khara Rud)	S of Paein mahale Khara Rud /S of Pashaki	Pashaki (Golestansara)	37°02′20″N	49°47′27″E	190	12.V.2016	TS, JB, JIN	18
Gilan	Zilaki (RT tributary of Sefid Rud)	Mush Bijar (E of Shahrbijar)	Shahr-e Bijar	37°00′28″N	49°40′24″E	130	13.V.2016	TS, JB, JIN	5
Gilan	Chulak [waterfall] (LT Reshte Rud)	NE of Khulak (W of Oskolak)	Oskolak	37°00′11″N	49°29′49″E	205	13.V.2016	TS, JB, JIN	2
Gilan	Sangdeh (LT of Shafa Rud)	W of Punel	Punel	37°31′47″N	49°00′52″E	231	15.V.2016	TS, JB, JIN	33
Gilan	Shafa Rud	W of Punel (ca 15 km from its inflow to the Caspian Sea)	Punel	37°31′47″N	49°00′52″E	231	15.V.2016	TS, JB, JIN	1
Gilan	Kak Rud (LT of Polrud)	Gheshlagh (SW of Deylaman)	Deylaman	36°51′44″N	49°52′52″E	1385	16.V.2016	TS, JB, JIN	63

(*continued*)

Appendix Table. Continued.

Province	Name of Stream	Locality	Nearest town/village	Latitude	Longitude	Altitude (m a.s.l.)	Sampling date	Collector	No of specimens
Gilan	UB (Lunak waterfalls)	Lunak waterfalls / S of Siahkal)	Siahkal	37°00′31″N	49°51′51″E	487	16.V.2016	TS, JB, JIN	20
Gilan	Bala Rud Shamrood (RT of Sefid Rud)	S of Tushi / S of Siahkal	Siahkal	37°03′00″N	49°53′54″E	260	16.V.2016	TS, JB, JIN	19
Gilan	Choshal	S of Lahijan	Lahijan	37°07′33″N	49°56′39″E	137	16.V.2016	TS, JB, JIN	15
Gilan	Chelavand (2.5 km from its outlet to the Caspian Sea)	upstream of Chelvand (S of Lavandvil)	Lavandvil	38°17′20″N	48°51′35″E	−5	19.V.2016	TS, JB, JIN	45
Gilan	UB (LT of Shalman Rud1	SW of Amlash	Almash	37°02′46.0″N	50°05′42.0″E	221	21.V.2016	TS, JB, JIN	6
Gilan	UB (RT of Shalman Rud)	in Bolurdekan	Amlash	37°01′09.0″N	50°03′51.0″E	345	21.V.2016	TS, JB, JIN	2
Gilan	UB (LT of Shalman Rud2)	SW of Amlash	Amlash	37°02′13.0″N	50°04′57.0″E	283	21.V.2016	TS, JB, JIN	4
Gilan	Semoosh (RT of Pol Rud)	upstream of Rahimabad	Rahimabad	37°00′11″N	50°18′06″E	89	21.V.2016	TS, JB, JIN	8
Gilan	Rudkhan	downstream of Masuleh (50 km from its outlet to Caspian Sea)	Masuleh	37°10′02″N	49°05′03″E	382	22.V.2016	TS, JB, JIN	7
Gilan	Karganrud	in Talesh (ca 7 km from its outlet to the Caspian Sea)	Talesh	37°48′22″N	48°54′27″E	39	22.V.2016	TS, JB, JIN	8
Golestan	Gorganrud	in Saribachsh	Saribachsh	37°13′29.7″N	55°01′33.2″E	24	28.IV.2018	TS, JB, JIN	73
Golestan	Cheshmesaran	below Mehdiabad	Azadshahr	36°56′17.8″N	55°22′04.2″E	720	28.IV.2018	TS, JB, JIN	18
Golestan	Aliborde	above Galikash	Galikash	37°15′14.6″N	55°27′24.3″E	263	29.IV.2018	TS, JB, JIN	32
Golestan	Goggol	in Qoli Tappeh	Galikash	37°14′55.2″N	55°25′01.8″E	214	30.IV.2018	TS, JB, JIN	13
Golestan	Madarsu	E of Tangrah	Tangrah	37°22′05.1″N	55°56′16.8″E	711	30.IV.2018	TS, JB, JIN	24 (n) 1 (a)
Hormozgan	Haji Abad	Haji Abad	Haji Abad	28°17′42.6″N	55°53′37.9″E	905	29.IV.2017	AHS, MP, FN, RJG	94
Hormozgan	Cheshme Bar Aftab	12 km N Tarom	–	28°17′42.6″N	55°53′37.9″E	891	29.IV.2017	AHS, MP, FN, RJG	3
Hormozgan	Roudan	5 km N Dehbarez		27°28′27.4″N	57°15′16.9″E	217	30.IV.2017	AHS, MP, FN, RJG	1
Hormozgan	Shamil	Shamil	Shamil	27°29′40.0″N	56°52′15.1″E	63	30.IV.2017	AHS, MP, FN, RJG	17
Hormozgan	–	40 km SE Ghoreh	–	27°39′32.1″N	56°14′38.7″E	439	01.V.2017	AHS, MP, FN, RJG	37
Hormozgan	–	5 km W Gahkom	Gahkom	28°11′18.4″N	55°46′39.9″E	712	01.V.2017	AHS, MP, FN, RJG	7
Isfahan	Chehel Cheshmeh	5 km SW Azadegan	–	32°38′56.5″N	50°27′01.4″E	2087	05.V.2017	AHS, MP, FN, RJG	77
Kerman	Mahan	4 km S Mahan	Mahan	30°01′05.5″N	57°16′45.2″E	2047	28.IV.2017	AHS, MP, FN, RJG	2
Kerman	UB (RT of Baft)	50 km S Bardsir		29°35′56.9″N	56°40′06.0″E	2466	28.IV.2017	AHS, MP, FN, RJG	7
Kerman	UB (RT of Baft)	24 km N Baft	Baft	29°21′12.1″N	56°38′39.7″E	2542	29.IV.2017	AHS, MP, FN, RJG	22
Kerman	Zardasht	8 km W Baft	Baft	29°15′29.9″N	56°25′22.0″E	2242	29.IV.2017	AHS, MP, FN, RJG	7
Kerman	Kheirabad	40 km W Baft		29°17′49.0″N	56°13′54.6″E	2094	29.IV.2017	AHS, MP, FN, RJG	2
Kermanshah	UB	E of Cheshmeh Godar	Cheshmeh Godar	34°46′37.0″N	46°23′16.3″E	1180	17.IV.2017	TS, JB, JIN	6
Kermanshah	UB (RT of Zrêbar)	S of Zalkeh	Biakara	35°23′16.1″N	46°13′41.0″E	1180	18.IV.2017	TS, JB, JIN	1
Kermanshah	Marjan (RT of Alwand Rud)	N of Gur Sefid	Gilan-e Gharb	34°13′42.2″N	45°50′51.8″E	663	19.IV.2017	TS, JB, JIN	151
Kermanshah	UB (LT of Alwand River)	SW of Shelin	Gilan-e Gharb	34°17′08.9″N	45°54′34.6″E	708	19.IV.2017	TS, JB, JIN	21
Kermanshah	Gamasiab	SW of Mir Azizi	Sahneh	34°28′04.2″N	47°36′49.0″E	1296	20.IV.2017	TS, JB, JIN	5
Kermanshah	Gaveh (LT of Sirwan Rud)	SE of Bavaleh	Songhor	34°53′03.8″N	47°43′32.6″E	1821	20.IV.2017	TS, JB, JIN	3
Kermanshah	Kangarshah (RT of Gamasiab Rud)	S of Mian Rahan	Miyan Rahan	34°34′32.8″N	47°26′27.6″E	1338	20.IV.2017	TS, JB, JIN	33
Kermanshah	Zarawar (LT of Qarasou)	N of Darchadman	Kamyaran	34°42′37.0″N	46°53′18.8″E	1346	21.IV.2017	TS, JB, JIN	46
Khuzestan	Balarud	S of Hoseyniye	S of Hoseyniye	32°35′17.8″N	48°17′19.4″E	230	26.IV.2017	TS, JB, JIN	54

(*continued*)

Appendix Table. Continued.

Province	Name of Stream	Locality	Nearest town/village	Latitude	Longitude	Altitude (m a.s.l.)	Sampling date	Collector	No of specimens
Khuzestan	Shavur	–	Hosseinabad	32°03′07.3″N	48°17′51.8″E	58	27.IV.2017	TS, JB, JIN	13
Khuzestan	channel from Karoun	N of Sherafat	Shooshtar	32°10′09.8″N	48°44′07.3″E	78	28.IV.2017	TS, JB, JIN	1 (a)
Khuzestan	Karun	SW of Shooshtar	Shooshtar	32°02′01.6″N	48°49′17.9″E	35	28.IV.2017	TS, JB, JIN	15
Khuzestan	Gragar	in Shahrake Andishe	Shooshtar	32°01′08.9″N	48°51′04.6″E	35	28.IV.2017	TS, JB, JIN	3
Khuzestan	Sur	N of Kuhzar	Kuhzar	32°06′25.9″N	48°56′48.8″E	65	28.IV.2017	TS, JB, JIN	320
Khuzestan	UB (LT of Sur)	NE of Akbah	Batvand	31°58′34.8″N	49°04′30.8″E	111	29.IV.2017	TS, JB, JIN	4
Khuzestan	Sur River (RT of Karoun)	SW of Batvand	Batvand	32°00′04.3″N	49°06′41.1″E	97	29.IV.2017	TS, JB, JIN	129
Khuzestan	UB (LT of Sur)	N of Mahsonboli	Masjed Soleyman	31°41′33.8″N	49°24′19.9″E	282	29.IV.2017	TS, JB, JIN	107
Khuzestan	UB (RT of Marun Rud)	W of Bagh Malek	Bagh Malek	31°31′14.0″N	49°49′18.7″E	586	29.IV.2017	TS, JB, JIN	28
Kohgiluyeh and Boyer-Ahmad	Yasuj	4 km E Yasudsch	Yasudsch	30°40′34.7″N	51°37′35.7″E	2078	04.V.2017	AHS, MP, FN, RJG	1
Kohgiluyeh and Boyer-Ahmad	Dehno-Beshar	1 km SE Yasudsch	Yasudsch	30°38′50.1″N	51°37′05.2″E	1800	04.V.2017	AHS, MP, FN, RJG	60
Kohgiluyeh and Boyer-Ahmad	Mehrian	15 km E Yasudsch	–	30°41′41.7″N	51°41′00.2″E	2456	04.V.2017	AHS, MP, FN, RJG	1
Kohgiluyeh and Boyer-Ahmad	Beshar	14 km NW Yasudsch	–	30°44′53.0″N	51°28′32.9″E	1669	04.V.2017	AHS, MP, FN, RJG	134
Kohgiluyeh and Boyer-Ahmad	Marbor	Kata	Kata	31°10′42.5″N	51°15′46.7″E	1562	04.V.2017	AHS, MP, FN, RJG	15
Kurdistan	UB (LT of Zrêbar)	SE of Kani Dinar	Biakara	35°26′42.4″N	46°13′42.8″E	1290	18.IV.2017	TS, JB, JIN	6
Lorestan	UB	NE of Hezar Khani	Harsin	34°12′52.7″N	47°48′51.4″E	1818	22.IV.2017	TS, JB, JIN	8
Lorestan	UB	in Eyvandar	Robatnemeki	33°42′41.9″N	48°14′10.3″E	1564	22.IV.2017	TS, JB, JIN	4
Lorestan	UB (RT of Khorramabad)	S of Robatnemeki	Robatnemeki	33°35′46.4″N	48°17′43.6″E	1269	22.IV.2017	TS, JB, JIN	18
Lorestan	UB (RT of right fork of Khorramabad)	SW of Halandasht	Khorramabad	33°30′14.7″N	48°30′15.0″E	1438	23.IV.2017	TS, JB, JIN	31 (n) 100 (a)
Lorestan	Marbureh (RT of Dez)	E of Tian	Azna	33°25′19.3″N	49°17′59.8″E	1735	23.IV.2017	TS, JB, JIN	8
Lorestan	Harrud (Kashkan River source)	in Polero	Zagheh	33°31′11.5″N	48°46′19.0″E	1748	23.IV.2017	TS, JB, JIN	7
Lorestan	Khorramabad	near Chahargoosh	Khorramabad	33°28′37.9″N	48°07′48.2″E	1030	24.IV.2017	TS, JB, JIN	2 (n) 45 (a)
Lorestan	unnamed spring	in Doab	Khorramabad	33°29′48.7″N	47°57′56.8″E	952	24.IV.2017	TS, JB, JIN	5
Lorestan	UB	in Doab	Khorramabad	33°29′49.8″N	47°57′59.5″E	950	24.IV.2017	TS, JB, JIN	15
Lorestan	UB (RT of Dez)	NW of Pasil	Bisheh	33°21′48.5″N	48°50′06.8″E	1674	25.IV.2017	TS, JB, JIN	12 (n) 5 (a)
Lorestan	UB (RT of Khorramabad)	in Khorramabad	Khorramabad	33°28′52.4″N	48°21′01.4″E	1179	25.IV.2017	TS, JB, JIN	47
Lorestan	Sarab-e Gamasyab	4,5 km SW Varayeneh	Varayeneh	34°02′46.2″N	48°22′32.6″E	1836	25.IV.2017	AHS, MP, FN, AA	34
Lorestan	Cholhul River (RT of Kashkan)	W of Chameshk	Chameshk	33°12′58.6″N	48°09′05.2″E	1310	26.IV.2017	TS, JB, JIN	87
Markazi	Band Chai	25 km SW of Saveh	Saveh	34°54′23.4″N	50°08′55.0″E	1086	24.IV.2017	AHS, MP, FN, AA	38
Markazi	UB (LT Band Chai)		Jalayer	34°52′57.1″N	50°02′15.0″E	1208	24.IV.2017	AHS, MP, FN, AA	1
Markazi	Band Chai		Jalayer	34°53′14.1″N	50°02′11.9″E	1174	24.IV.2017	AHS, MP, FN, AA	7
Mazandaran	UB (LT of Tajan)	NE of Kiasar	Kiasar	36°16′33.7″N	53°34′09.3″E	948	07.V.2018	TS, JB, JIN	1
Mazandaran	right fork of Tajan	near Chachkan	Sari	36°21′32.3″N	53°17′19.1″E	374	07.V.2018	TS, JB, JIN	32

(*continued*)

Appendix Table. Continued.

Province	Name of Stream	Locality	Nearest town/village	Latitude	Longitude	Altitude (m a.s.l.)	Sampling date	Collector	No of specimens
Mazandaran	left fork of Tajan	below Tangeh dam	Sari	36°18′09.8″N	53°10′56.4″E	314	07.V.2018	TS, JB, JIN	25
Mazandaran	UB	E of Vastan	Sari	36°20′17.2″N	53°10′31.5″E	258	07.V.2018	TS, JB, JIN	26
Mazandaran	Telar	above Ghaem Shahr	Ghaem Shahr	36°23′04.5″N	52°51′08.6	111	07.V.2018	TS, JB, JIN	6
Mazandaran	Chai Bagh	below Chai Bagh	Ghaem Shahr	36°20′58.7″N	52°51′38.0″E	157	07.V.2018	TS, JB, JIN	240
Mazandaran	Telar	in Javarem	Shirgah	36°13′31.4″N	52°54′46.8″E	328	08.V.2018	TS, JB, JIN	3
Mazandaran	UB (RT of Telar	in Javarem	Shirgah	36°13′36.4″N	52°54′32.6″E	343	08.V.2018	TS, JB, JIN	12
Mazandaran	Babol	NE of Alam Kola	Ghaem Shahr	36°15′09.3″N	52°47′19.6″E	203	08.V.2018	TS, JB, JIN	25
Mazandaran	Chai Bagh	E of Andar Koli	Ghaem Shahr	36°20′30.5″N	52°54′03.7″E	186	08.V.2018	TS, JB, JIN	15
Mazandaran	UB	NW of Zarrin Abad Sofla	Sari	36°32′09.6″N	53°10′09.6″E	124	10.V.2018	TS, JB, JIN	3
Mazandaran	UB	above Darab Kola	Neka	36°33′10.3″N	53°15′32.2″E	128	10.V.2018	TS, JB, JIN	6
Mazandaran	UB	in Zarandin	Neka	36°35′49.0″N	53°20′31.5″E	94	10.V.2018	TS, JB, JIN	10
Mazandaran	UB	NE of Estahr Posht	Neka	36°27′44.5″N	53°29′11.2″E	561	10.V.2018	TS, JB, JIN	89
Mazandaran	UB	in Momey Khal	Ghaem Shahr	36°04′24.3″N	52°58′19.6″E	742	11.V.2018	TS, JB, JIN	9
Mazandaran	UB (LT of Palang Darreh)	SE of Shirgah	Shirgah	36°16′30.2″N	52°56′51.3″E	303	11.V.2018	TS, JB, JIN	1
Mazandaran	UB (RT of Palang Darreh)	SE of Shirgah	Shirgah	36°16′41.2″N	52°56′49.3″E	327	11.V.2018	TS, JB, JIN	4
Mazandaran	Pol sefid	Pol-Sefid	Pol-Sefid	36°05′30.1″N	53°04′13.0″E	619	11.V.2017	AHS, MP, FN	15
Mazandaran	Sangdeh	2 km W Dadu Kola	Dadu Kola	36°05′42.7″N	53°10′31.9″E	1109	11.V.2017	AHS, MP, FN	160
Mazandaran	Shirinroud	1,5 km S Kola	Kola	36°09′02.5″N	53°20′58.1″E	758	11.V.2017	AHS, MP, FN	1
Mazandaran	Kiasar	1 km N Chachkam	Chachkam	36°21′32.2″N	53°17′18.6″E	381	12.V.2017	AHS, MP, FN	9
Mazandaran	Abbas Abad	4 km E Behschahr	Behschahr	36°40′34.9″N	53°35′18.9″E	158	12.V.2017	AHS, MP, FN	1
Mazandaran	Kashpel	1 km W Chamestan	Chamestan	36°28′19.3″N	52°05′54.1″E	134	13.V.2017	AHS, MP, FN	22
Mazandaran	Kashpel	8 km SW Chamestan	–	36°25′31.4″N	52°03′38.4″E	387	13.V.2017	AHS, MP, FN	2
North Khorasan	UB	below Darkash	Shahrabad-e Kord	37°27′07.5″N	56°43′13.9″E	948	01.V.2018	TS, JB, JIN	46
North Khorasan	Atrek	near Borj-e Zaganlu	Pish Qaleh	37°41′46.9″N	56°55′04.8″E	548	01.V.2018	TS, JB, JIN	220 (n) 7 (a)
North Khorasan	UB (LT of Atrek)	in Sarivan Tapeh	Pish Qaleh	37°36′00.9″N	57°02′44.3″E	725	01.V.2018	TS, JB, JIN	54
North Khorasan	UB	below Firuzeh	Kacharanlu	37°21′53.7″N	57°15′12.4″E	1266	02.V.2018	TS, JB, JIN	172 (n) 320 (a)
North Khorasan	UB	S of Araqi	Araqi	37°11′09.1″N	57°25′27.4″E	1386	02.V.2018	TS, JB, JIN	110
North Khorasan	UB	in Chenaran	Chenaran	37°24′21.2″N	57°32′31.1″E	1199	02.V.2018	TS, JB, JIN	186
North Khorasan	UB	in Golian	Golian	37°14′13.1″N	57°54′21.3″E	1313	03.V.2018	TS, JB, JIN	2
North Khorasan	UB	in Chalow	Skirvan	37°21′21.0″N	57°55′32.9″E	1111	03.V.2018	TS, JB, JIN	7
North Khorasan	UB	below Ostad	Maiva	37°10′33.3″N	58°00′45.3″E	1427	03.V.2018	TS, JB, JIN	7
North Khorasan	UB	in Jartudeh	Quchan	37°05′01.1″N	58°17′20.7″E	1421	03.V.2018	TS, JB, JIN	33
Razavi Khorasan	Drongar	in Dorbadam	Bajgiran	37°29′47.4″N	58°27′51.1″E	1522	04.V.2018	TS, JB, JIN	87 (n) 1 (a)
Razavi Khorasan	Drongar	in Mohammad Taghi Beyg	Nokhandan	37°36′59.1″N	58°38′32.1″E	986	04.V.2018	TS, JB, JIN	38
Razavi Khorasan	UB (RT of Drongar)	W of Zeyd	Nokhandan	37°36′31.5″N	58°45′30.0″E	913	04.V.2018	TS, JB, JIN	3
Razavi Khorasan	Drongar	in Nokhandan	Nokhandan	37°31′07.7″N	58°59′20.2″E	604	04.V.2018	TS, JB, JIN	1
Razavi Khorasan	UB	above Abgad	Golbahar	36°29′59.5″N	59°02′09.6″E	1432	05.V.2018	TS, JB, JIN	4
Tehran	Namroud	1 km NW Herandeh	Herandeh	35°42′49.6″N	52°39′57.0″E	1808	11.V.2017	AHS, MP, FN	6

UB – unnamed brook; RT – right tributary; LT – left tributary; TS – Tomáš Soldán; JB – Jindřiška Bojková; JIN – Javid Imanpour Namin; AHS – Arnold H. Staniczek; MP – Milan Pallmann; RJG – Roman J. Godunko; FN – Farshad Nejat, AA – Ashgar Abdoli. Numbers of specimens generally refer to nymphs unless specified as: (a) – adults, (n) – nymphs.