



Description of a new species of *Eucypris* Vávra, 1891 (Crustacea: Ostracoda) from a hot spring in western Türkiye

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Abstract

A new freshwater ostracod species, *Eucypris kulkoyluoglu* **sp. nov.**, is described from a low-temperature geothermal rheocene spring in western Türkiye based on detailed morphological examination of female and male specimens, and is distinguished from its congeners by a unique combination of diagnostic characters (e.g., natatory setae exceeding the antennal claw tips; mandibular terminal segment with three long and one short smooth claws; maxillule terminal segment with four well-developed smooth setae; first thoracopod endopod two-segmented; *d2* seta absent on the second thoracopod). *Eucypris kulkoyluoglu* **sp. nov.** shows notable morphological similarities to the recently described Cypriot species *E. denktasi* and *E. lefkosaensis*, including the absence of the *d2* seta on the second thoracopod. These shared features may suggest a possible affinity among these species and could reflect regional biogeographic patterns. In males of the new species, the presence of distinctive clasping organs, hemipenes with triangular outer processes, and a reduced number of whorls in the Zenker organ distinguishes them from other *Eucypris* males. In addition to this, a strongly female-biased sex ratio could be associated with a mixed reproductive system combining sexual and parthenogenetic reproduction. The occurrence of *E. kulkoyluoglu* **sp. nov.** in an environmentally extreme yet stable geothermal spring suggests notable thermal tolerance and ecological specialization, highlighting geothermal freshwater systems as overlooked reservoirs of ostracod diversity.

Key words: Cyprididae, new taxa, geothermal habitat, thermal tolerance, Anatolia

Introduction

Ostracods (Crustacea: Ostracoda) are bivalved crustaceans belonging to the meiofauna and constitute an important group of invertebrates across a wide range of aquatic environments. They possess a long evolutionary history (Siveter *et al.* 2014), inhabit diverse freshwater, brackish, and marine habitats (Meisch 2000), and exhibit variable responses to environmental and climatic change (Mesquita-Joanes *et al.* 2012).

With respect to extant non-marine ostracods, the most recent global checklist recognizes 2,420 species as currently valid (Meisch *et al.* 2024). Among these, the family Cyprididae Baird, 1845, one of the most widespread and morphologically diverse groups, includes the genus *Eucypris* Vávra, 1891, which is represented by 54 species in this checklist. However, subsequent taxonomic studies published shortly thereafter indicate that the number of recognized species within *Eucypris* has increased substantially. Külköylüoğlu and Özdilek (2024) described two new species from Northern Cyprus—*Eucypris denktasi* Külköylüoğlu & Özdilek, 2024 and *Eucypris lefkosaensis* Külköylüoğlu & Özdilek, 2024—representing the first records of the genus from the island Cyprus. Likewise, Batmaz *et al.* (2024) described *Eucypris dorlionensis* Batmaz, Yavuzatmaca & Külköylüoğlu, 2024 from Eskişehir Province in central Türkiye.

Türkiye has been identified as a key region for *Eucypris* diversity, with ten species recorded to date (Batmaz *et al.* 2024), due to its biogeographical position between Europe and Asia (Hu *et al.* 2025), and its pronounced topographic and climatic heterogeneity further suggests that the country harbours additional, as yet undescribed taxa, as evidenced by the continued expansion of regional ostracod inventories and the new *Eucypris* species record reported in the present study. Collectively, these findings highlight the ongoing potential for cryptic and undescribed

diversity in Türkiye and adjacent regions, and indicate that the region represents an active frontier for taxonomic and phylogenetic research on the genus.

This study describes a new species of *Eucypris* from Türkiye and compares it with closely related taxa based on diagnostic morphological characters. Ecological and biological notes are provided, including habitat characteristics and observations on reproduction, and discusses morphological traits that may suggest the new species, together with the recently described Cypriot taxa, could represent a potential new taxon.

Materials and methods

Sampling and measurements

Sediment samples were collected on 02 May 2023 from a rheocene hot spring habitat by using a hand net with a mesh size of 150 μm ., and fixed in 70% ethanol in labeled plastic containers in the field. The sampling site is located in the eastern part of Manisa Province (Türkiye) at 38°37'52"N, 28°43'08"E with an elevation of 380 m.a.s.l., and characterized by a Mediterranean climate (see details in Yavuzatmaca *et al.* 2026, station no: 78; Fig. 1 in this study). The physicochemical characteristics of the habitat, including pH, water temperature (T_w , °C), dissolved oxygen (DO, mg L^{-1}), oxygen saturation (%DO), electrical conductivity (EC, $\mu\text{S cm}^{-1}$), salinity (PSU), total dissolved solids (TDS, mg L^{-1}), and oxidation–reduction potential (ORP, mV), were measured with a HANNA HI-9829 multiparameter probe. Air temperature (T_a , °C) and relative humidity (Moist, %) were recorded using a Kestrel-3000 anemometer (Table 1).

Species identification

The collected material was washed under running tap water and sieved through a series of mesh sizes (1.5, 1.0, 0.5, and 0.25 mm) to remove coarse sediment in the laboratory. Ostracods were subsequently sorted from the remaining material under a stereomicroscope (Meiji, EMZ13) and preserved in 70% ethanol. Selected individuals were dissected in lactophenol using fine needles.

Species identification was based on the morphology of the carapace and soft body parts, following relevant taxonomic literature on freshwater ostracods (e.g., Meisch 2000; Karanovic 2012). The valves of dissected ostracod specimens were mounted on micropaleontological slides and examined using a scanning electron microscope (SEM) (Carl Zeiss EVO-50 type SEM–EDX, Germany), at Hacettepe University, Ankara. (Figs. 2-3). Morphological observations and measurements were performed using a light microscope (Olympus CX-41). Line drawings of soft body parts and carapace structures were prepared with the aid of a camera lucida attached to the microscope and later digitized using vector-based Adobe Illustrator CC 2024 graphic software (Figs. 4-5). All dissected material and voucher specimens are deposited in the Zoology Research Laboratory, Department of Biology, Marmara University, Istanbul, Türkiye.

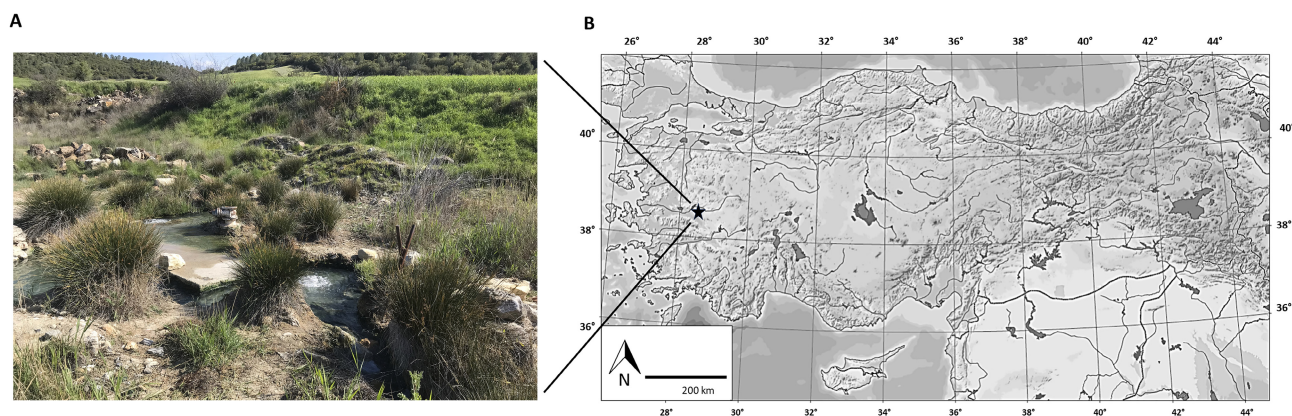


FIGURE 1. A. The photograph of the rheocene hot spring habitat. B. Map of Türkiye showing the location of the sampling site, indicated by a star symbol (<https://www.harita.gov.tr/>).

Abbreviations used in the text:

m.a.s.l.: meter above sea level, **LV:** Left valve, **RV:** Right valve, **A1:** Antennule, **A2:** Antenna, **Md:** Mandible, **Mx1:** Maxillule, **T1:** The first thoracopod (maxilliped), **T2:** The second thoracopod (walking leg), **T3:** The third thoracopod (cleaning leg), **UR:** Uropod.

Results

Taxonomic treatment

Class Ostracoda Latreille, 1802

Subclass Podocopa Sars, 1866

Order Podocopida Sars, 1866

Suborder Cypridocopina Baird, 1845

Superfamily Cypridoidea Baird, 1845

Family Cyprididae Baird, 1845

Subfamily Eucypridinae Bronstein, 1947

Genus *Eucypris* Vávra, 1891

Type species *Eucypris virens* (Jurine, 1820)

Eucypris kulkoyluoglu sp. nov.

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(Figs. 2–7)

Type material. All specimens from the type locality. *Holotype*: dissected female (Code: DA-P-45:01, Fig. 4A–C, Fig. 5A–E, Fig. 6A, D). *Allotype*: dissected male (Code: DA-P-45:02, Fig. 7A–D). *Paratypes*: dissected females (Code: DA-P-45:03, :06, Fig. 6B, C).

Other material examined. All specimens from the type locality. Dissected females (Code: DA-P-45:04 and 05), and male (Code: DA-P-45:07).

Type locality. A rheocene hot spring habitat (38°37'52"N, 28°43'08"E; 380 m.a.s.l.), Manisa Province in western Türkiye. Samples collected from the type locality by Mehmet Yavuzatmaca, Alper Ataman, and Ahmet Aytegin.

Derivation of name. The species epithet is named *kulkoyluoglu* in honour of Prof. Dr. Okan Kulköylüoglu, in recognition of his significant contributions to the taxonomy and ecology of freshwater ostracods. The specific name is a masculine patronym formed from his surname *Kulköylüoglu* with the Latin genitive ending *-i*.

Dimensions. Female (n=3) Length (L): 0.92–1.07 mm, Height (H): 0.52–0.63 mm, Width (W): 0.39–0.48 mm. Male (n=2) L 0.90–0.92 mm, H: 0.51–0.53 mm, W: 0.40–0.41 mm. H/L: 0.57 mm in both females and males.

Depository: All dissected material is deposited in the Zoology Research Laboratory, Department of Biology, Marmara University, Ýstanbul, Türkiye, and is labelled with individual specimen codes. Voucher specimens (102 females, 23 males, and 16 juveniles) are preserved in 70% ethanol under a single collection code (DA-P-45:08).

Diagnosis: Carapace is elongate-elliptical in lateral view, with broadly rounded anterior and posterior margins. Calcified inner lamella broad in both valves anteriorly, narrow posteriorly. LV slightly longer and more elliptical than RV in the same individual; LV exceeds RV both anteriorly and posteriorly and overlaps it ventrally. Carapace

surface is moderately hairy. No wart-shaped elevations (*Porenwarzen*) on surface. Natatory setae on A2 exceeding the tips of the distal claws. Terminal segment of Md rectangular, bearing three long and one short smooth claws. The second segment of Md bears four similarly sized and thick setae, together with an additional seta, and a short, hairy *beta* (β) seta. Terminal segment of Mx1 longer than broad, with four well-developed smooth setae. Palp (endopod) of T1 with two segments. T2 lacking *d2* seta, with a short *d1* seta. Distal lobe of hemipenis bluntly pointed with a distinct triangular shape. Right clasp organ cylindrical throughout its length, without any distal triangular expansion. Zenker organ elongated and cylindrical, with well-developed 20 + 2 chitinous rings.

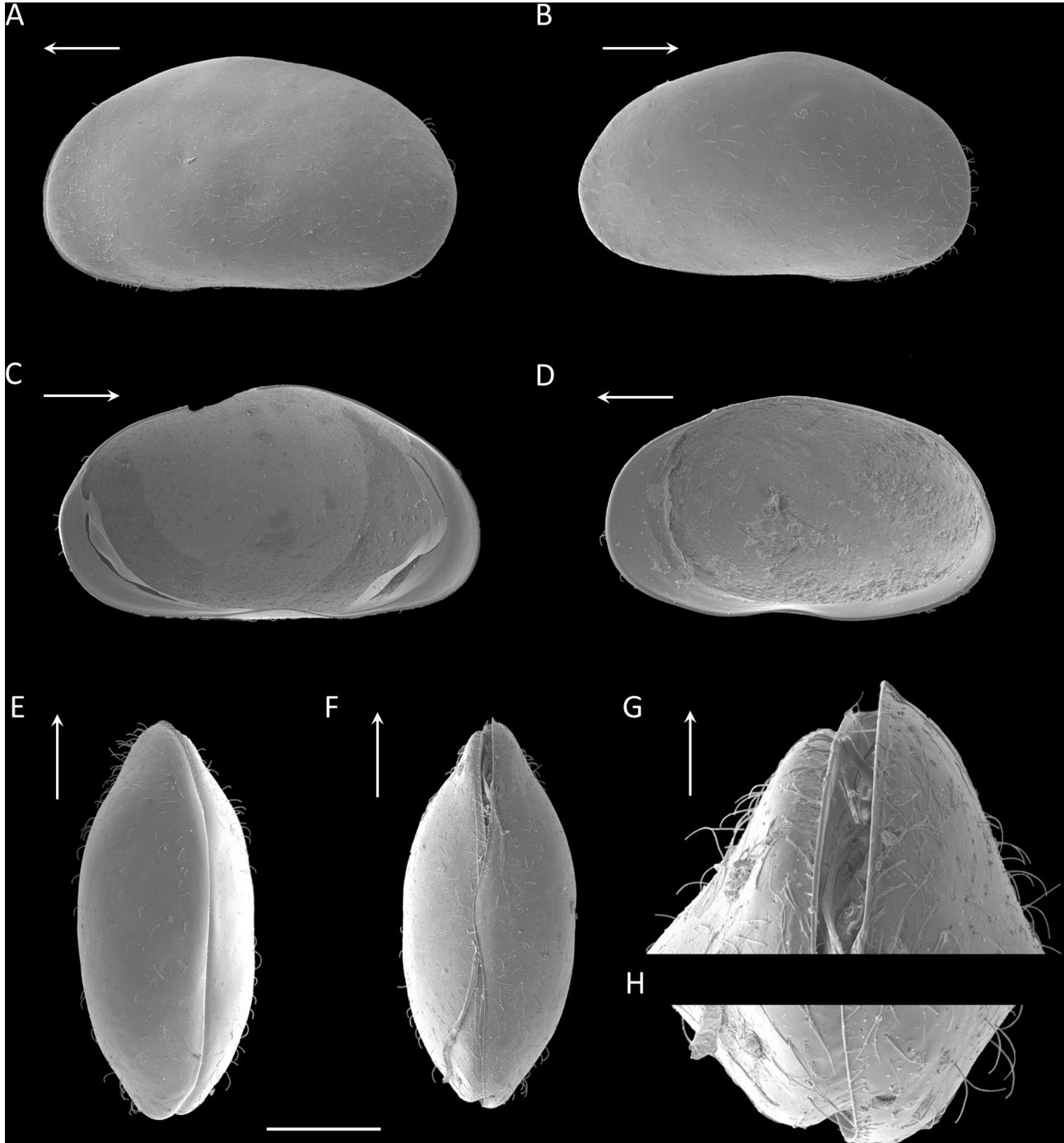


FIGURE 2. *Eucypris kulkoyluoglu* sp. nov. Female. **A.** LV external view. **B.** RV external view. **C.** LV internal view. **D.** RV internal view. **E.** Dorsal view. **F.** Ventral view. **G.** and **H.** Anterior and posterior details of carapace from ventral, respectively. Scale bar: 200 μ m for **A–F**, 50 μ m for **G–H**. Arrows show anterior.

Description

Female (Figures 2, 4, 5, 6)

Carapace (Fig. 2) rounded anteriorly and posteriorly in lateral view. Maximum height on the middle. Dorsal margin slightly convex. Ventral margin vaguely concave, almost straight. Dorsally, valve margins parallel; anterior end slightly pointed and beak-shaped. In ventral, LV overlaps RV anteriorly and posteriorly. Selvage absent. Hinge adont. Valve surface with fine hairs, and no warts on the surface.

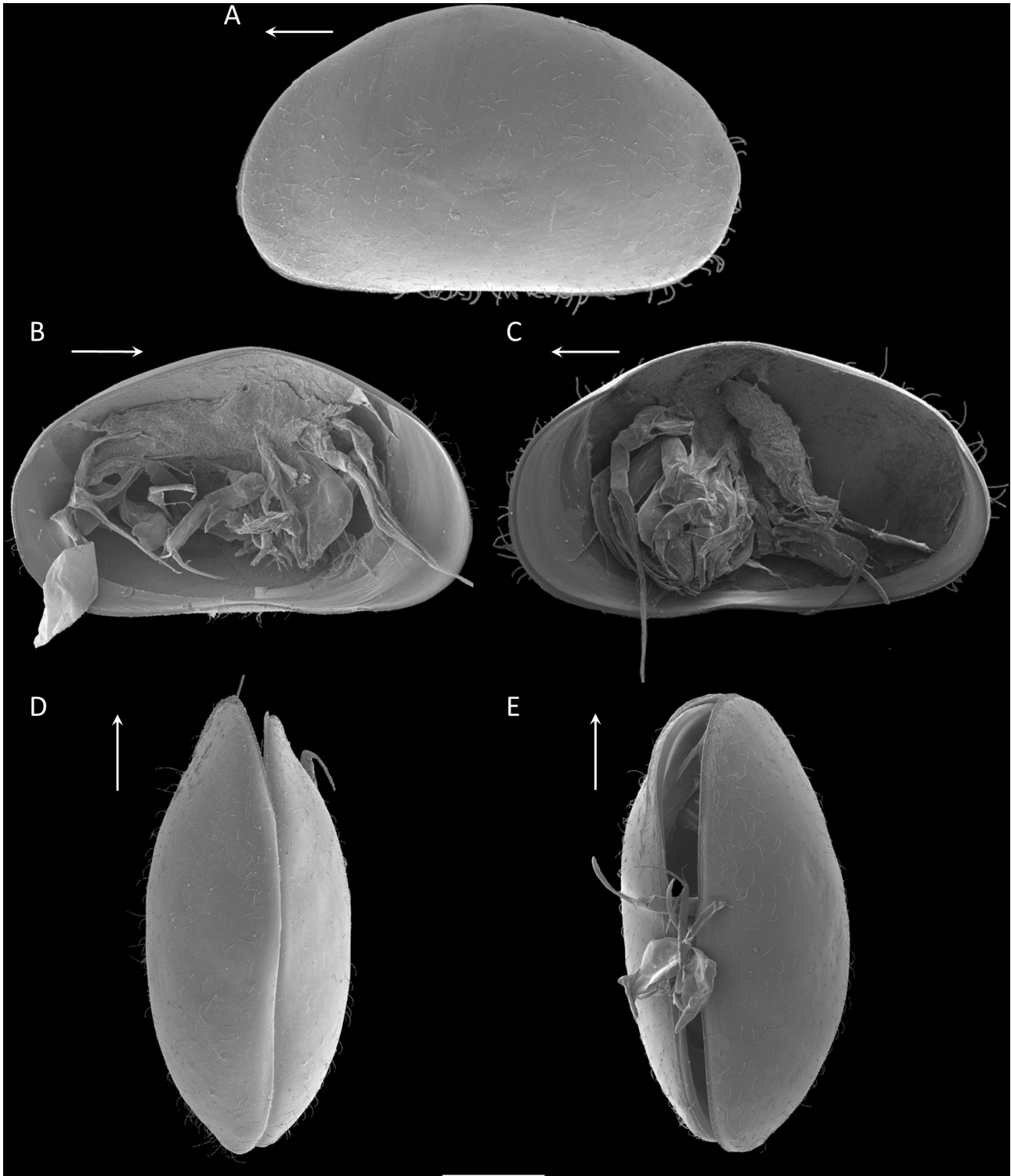


FIGURE 3. *Eucypris kulkoyluoglu* sp. nov. Male. A. LV external view. B. LV internal view. C. RV internal view. D. Dorsal view. E. Ventral view, with hemipenises. Scale bar: 200 μ m. Arrows show anterior.

A1 (Fig. 4A) seven-segmented. Rome organ present, Wouters organ absent. Basal segment with a short smooth dorsal seta, and two long ventro-apical setae. The second segment almost quadrate with a dorsal seta. The third segment 1.5 times longer than the second segment (elongated) with one dorso-apical seta and one ventro-apical seta. The fourth segment with two long and smooth dorso-apical setae and two short (one slightly plumose) ventro-apical setae. The segment five with two long and smooth dorso-apical seta and, two slightly shorter ventro-apical setae. The segment six with four long setae. Terminal segment with three long smooth setae and aesthetasc *ya*.

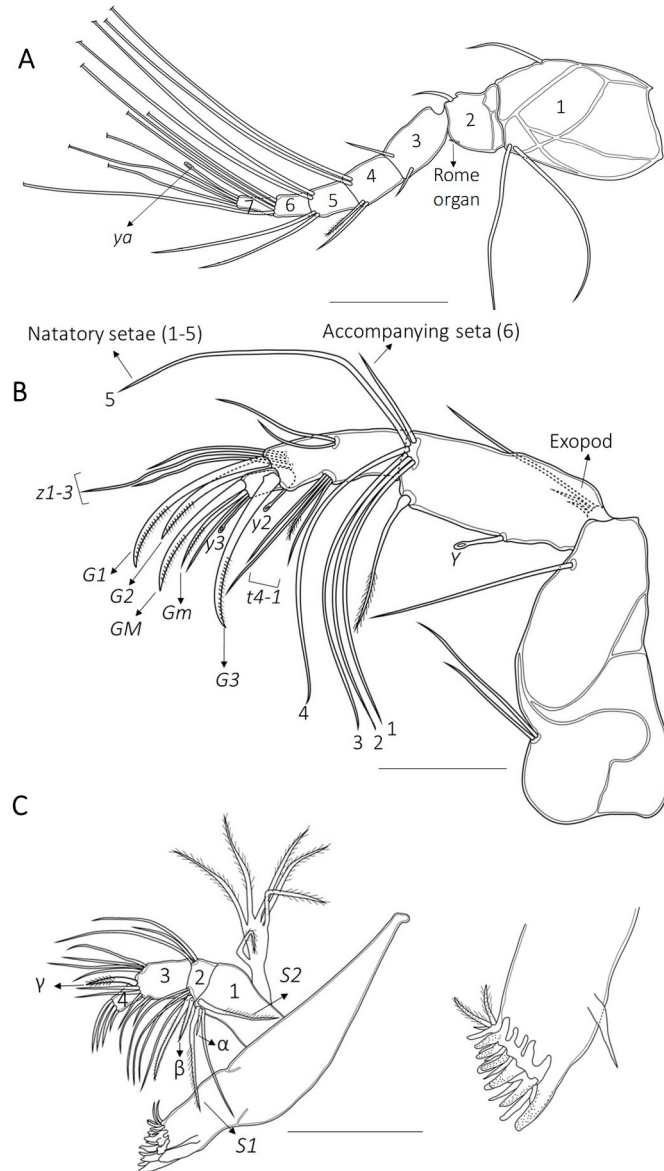


FIGURE 4. *Eucypris kulkoyluoglu* sp. nov., female. **A.** A1. **B.** A2. **C.** Md, and detailed view of teeth on mandibular coxa. Codes for A-C: DA-P-45:01. Scale bars: 100 μ m.

A2 (Fig. 4B) with two-segmented protopod (coxa + basis), three-segmented endopod, and single-segmented exopod; penultimate endopod segment undivided. Protopod bearing two unequally long basal setae and one long ventro-apical seta distally. Small exopod plate with one long and two short setae. First segment of endopod carrying aesthetasc *Y* and five natatory setae, exceeding the tips of the distal claws, accompanied by a short seta, and one long plumose seta present ventrally. Penultimate segment with mid-inserted two smooth setae dorsally, and setae *t* ventrally. Setae *t1–t4* unequally long, *t2* shortest and plumose. Setae *z* situated dorsally at the distal end. Setae *z1–z3*, subequal and smooth; *z2* longest; *y2* minute, located ventrally. Three well-developed, strongly serrated claws (*G1*, *G2*, and *G3*) anteriorly on the penultimate segment. Length of claws: *G*: $G1 > G3 > G2$. Terminal segment short, bearing two claws (*GM* and *Gm*) along with seta *y3* and *g*.

Md (Fig. 4C). Mandibular coxa with 6 well-developed teeth; each tooth is followed by a thick seta and three normally structured distal-setae. One additional short seta toward the dorsal side, reaching the base of the teeth. Mandibular palp with four segments. First segment with three long setae (one unnamed smooth, unequally long plumose *S1* and *S2* setae) and a thin and short *alpha* (α) seta. The second segment bears four similarly sized and thick setae, together with an additional seta, and a short, hairy *beta* (β) seta, and three dorsodistal setae. The third segment with four dorsodistal setae, two ventrodistal setae, three smooth setae in inner region, and a stout and feathery *gamma* (γ) seta extero-distally. Terminal segment rectangular, bearing three long and one short, smooth claws. Vibratory plate on the first segment with one short, and five long plumose setae.

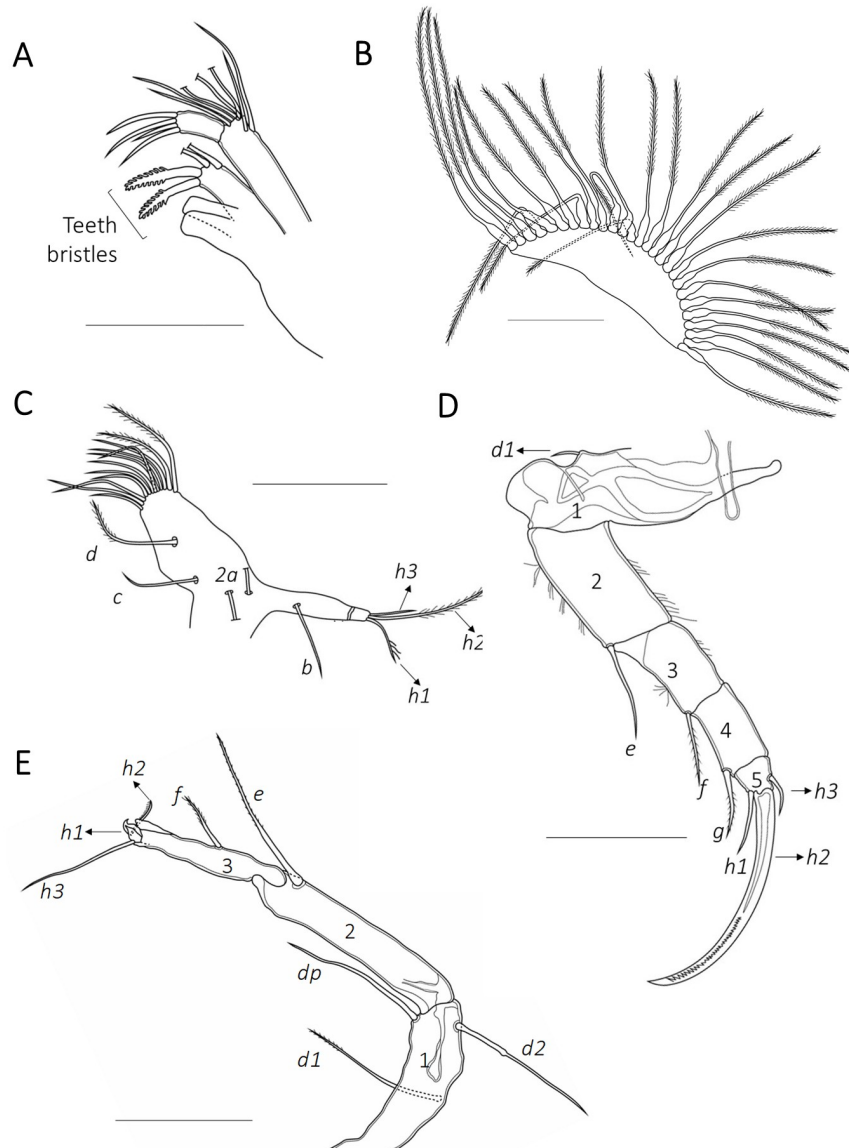


FIGURE 5. *Eucypris kulkoyluoglu* sp. nov., female: **A.** Mx1. **B.** Vibratory plate of Mx1. **C.** T1. **D.** T2. **E.** T3. Codes for A-E: DA-P-45:01. Scale bars: 100 μ m.

Mx1 (Fig. 5A) two-segmented. First palp segment with 5 + 2 setae. Distal palp segment cylindrical, longer than broad with four well developed smooth setae; teeth bristles (*Zahnborsten*) of 3rd masticatory lobe serrated. Mx1 vibratory plate with 27 rays (heavily feathered setae) (**Fig. 5B**).

T1 (Fig. 5C). Palp (endopod) with two segments. Two *a* setae and *b*, *c*, *d* setae present. Length of setae *h*: $h2 > h1 > h3$. Vibratory plate of T1 with six long and well developed setose setae.

T2 (Fig. 5D) five segmented (penultimate segment divided). Basal segment with one short seta (*d1*), *d2* absent. The second segment four times longer than terminal segment. Seta *e* smooth, setae *f* and *g* slightly plumosed. Length ratio of them: $e > f > g$. Setae *e* and *f* slightly longer than distal end of the third and the fourth segments, respectively.

Seta *g* two times longer than segment five. Terminal segment bearing a well-developed claw (*h2*) with anterior serrations. Seta *h1* almost same in size with seta *g*. Seta *h3* short.

T3 (Fig. 5E) Three segmented, penultimate segment not divided. Basal segment (protopod) with three long setae (*dp*, *d1*, *d2*). *d1* and *dp* almost similar in size, and shorter than *d2*. *d1* slightly plumose, *dp* and *d2* smooth. Second segment elongated with the long, plumose seta *e*. Seta *e* longer than terminal (third) segment. Seta *f* slightly plumose, in size half of the third segment. Terminal segment bearing a pincer organ. Seta *h3* almost three times longer than seta *h2*. Seta *h1* short and hook-shaped.

UR (Fig. 6A) well-developed, uropodal ramus almost straight/weakly curved. Claws (*Ga* and *Gp*) weakly serrated. *Ga* long, slightly exceeding 2/3 of rami, and *Gp* ca. 3/4 of *Ga*. Both anterior (*Sa*) and posterior setae (*Sp*) present. *Sa* ca. 3/4 of *Sp*. Uropodal attachment slightly curved with a short ventral branch. Triebel loop and, basal triangular structure absent.

Hypostome (Fig. 6B–C) elongate and moderately robust with chitinous framework. Broad basal region with thin setae along its margins. Rake-shaped organ with 8-9 well developed teeth.

Genital lobes (Fig. 6D) prominent, rounded, well chitinized, with spermatozoa inside.

Male (Figs. 3, 7)

Carapace (Fig. 3) similar to female but slightly smaller. Imprints of testes on the valves not visible.

A2 (Fig. 7A). Seta *z1* and *z3* smooth, seta *z2* transformed into claw. Claw *G2* well developed and as long as claw *G1*. *Gm* on terminal segment seta-like, and shorter than claw *GM*.

Clasping organs (Prehensile palps) (Fig. 7B, protopod not shown) similar in size, differ in shape. The distal process (finger) of the right clasping organ larger and more robust than that of the left, while its proximal part (body) stout. In contrast, the finger of the left clasping organ smaller and more strongly curved, and its proximal part narrower and elongate. Proximal parts of clasping organs with two blunt balbs distally.

Hemipenis (Fig. 7C) proximally expanded, narrowing distally; outline subtriangular in lateral view, with two angles strongly rounded and the remaining margin tapering slightly narrow to a pointed distal edge. Distal lobe bluntly pointed with a distinct triangular shape.

Zenker Organ (Fig. 7D) elongated and cylindrical, bearing well-developed 20 + 2 chitinous rings.

Reproduction

In the population of *Eucypris kulkoyluoglu* sp. nov., the sex ratio is markedly biased towards females, with males being rare (107 females, 23 males). On the other hand, the presence of spermatozoa in the spermathecae of examined adult females reflects successful recent mating. In addition to that, the co-occurrence of two generations (juveniles and adults) within samples collected from the type locality.

Ecology

The habitat in which *E. kulkoyluoglu* sp. nov. was collected is characterized by warm to hot, slightly acidic to circumneutral waters with moderate salinity and high mineral content (Table 1). Elevated water temperature (approximately 38 °C) and negative oxidation–reduction potential indicate reducing conditions, while moderate dissolved oxygen levels suggest hypoxic to moderately oxygenated waters typical of thermally influenced systems. High electrical conductivity and total dissolved solids reflect strong mineralization.

TABLE 1: The physicochemical characteristics of the type locality of *E. kulkoyluoglu* sp. nov.. For abbreviations, see “Material and Methods”.

pH	T _w	DO	%DO	EC
6.96	37.88	4.12	65.9	5171
Sal	TDS	T _a	mvORP	Moi.
2.72	2586	27.8	-54.7	46.2

Accompanying ostracoda fauna: No other ostracod taxa were recorded.

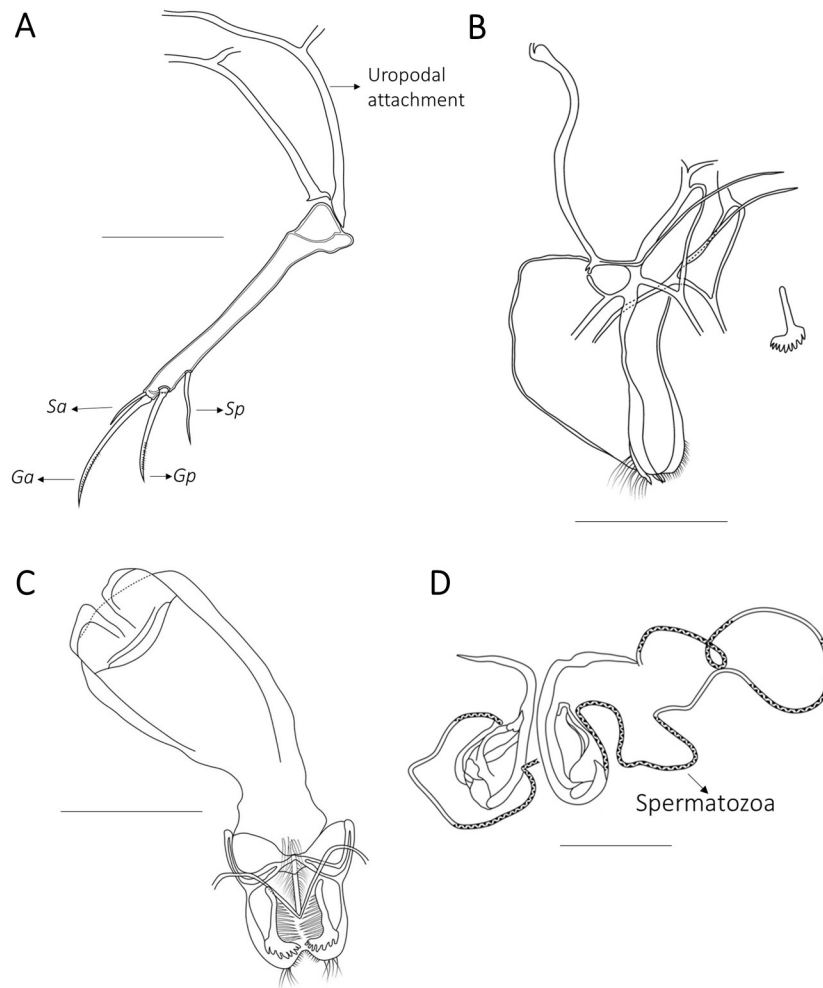


FIGURE 6. *Eucypris kulkoyluoglui* sp. nov., female: **A.** UR. **B** and **C.** Hypostome and rake shaped organs from dorsal and lateral view, respectively. **D.** Genital lobes with spermatozoa. Codes for A and D: DA-P-45:01, for B and C: DA-P-45:03 and :06. Scale bars: 100 μ m.

Discussion

Morphological comparisons and taxonomic remarks

Eucypris kulkoyluoglui sp. nov. shows notable morphological similarities to the recently described Cypriot species *E. denktasi* and *E. lefkosaensis*. These similarities are reflected in a combination of characters, although each species remains clearly distinguishable based on its diagnostic features. In contrast, *E. dorlionensis* exhibits a comparatively greater degree of morphological differentiation. Such patterns may reflect regional biogeographic relationships, as Cyprus and southern Anatolia formed parts of the southeastern margin of the Neo-Tethyan realm prior to their tectonic separation during the late Cenozoic (Yılmaz 2021), which may provide a broad historical context for the occurrence of related taxa in these areas.

The absence of the seta *d2* on the T2 distinguishes *E. kulkoyluoglui* sp. nov. from most other species within the genus *Eucypris*. However, this rare feature has also been observed in the recently described *E. denktasi*, whereas *E. lefkosaensis* lacks both *d1* and *d2* setae. The shared absence of the *d2* seta in *E. kulkoyluoglui* sp. nov. and *E. denktasi* may reflect retention of an ancestral or transitional character state, while the complete loss of both setae in *E. lefkosaensis* likely represents a further derived condition within the Cypriot lineage. Notably, the absence of the *d2* seta on the T2 is not observed in *E. dorlionensis*.

Although the presence of both setae *d1* and *d2* on the T2 is traditionally considered an important character for species identification and delimitation in the separation of Eucypridinae (Meisch 2000; Karanovic 2012), this

character alone is not always sufficient. Klkylođlu and zdilek (2024) discussed this issue in detail for the Cypriot *Eucypris* species, demonstrating that despite the absence of the *d2* seta, those taxa share a suite of other morphological characters that are consistent with the genus *Eucypris*. Following the same rationale, *E. kulkoyluoglu* sp. nov., despite lacking the *d2* seta on the T2, shows a closer overall morphological affinity to *Eucypris* than to other related genera. Therefore, in accordance with the arguments presented by Klkylođlu and zdilek (2024) for the Cypriot species, and considering the combination of diagnostic characters rather than a single seta, I place the new species within the genus *Eucypris*. My findings further support the view of Klkylođlu and zdilek (2024) that the genus *Eucypris* should be subdivided into two or more genera.

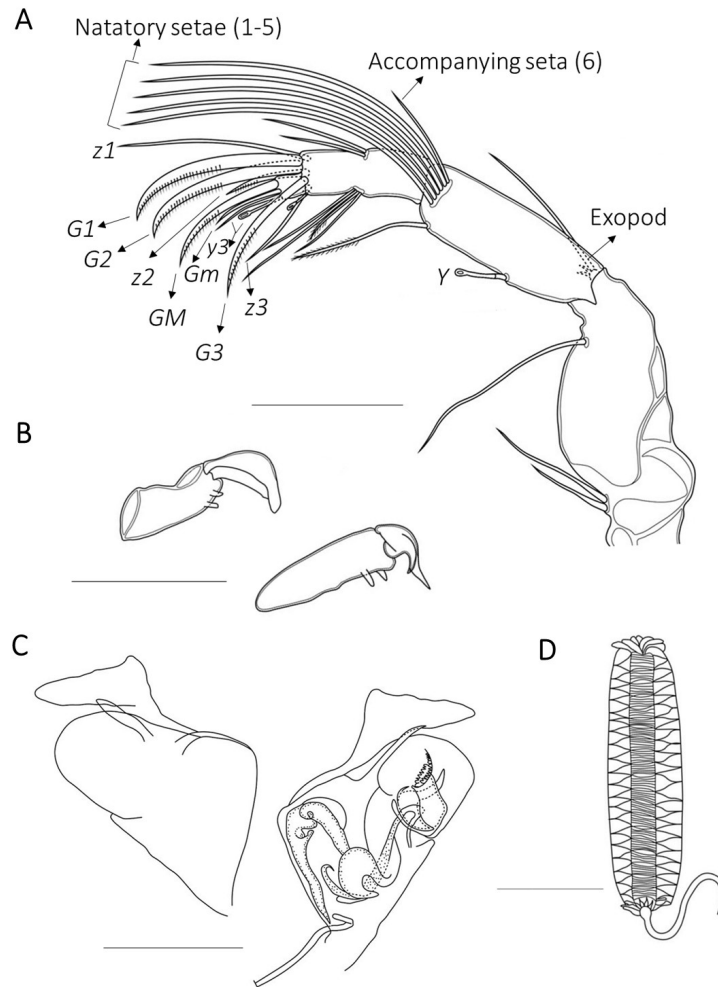


FIGURE 7. *Eucypris kulkoyluoglu* sp. nov., male: **A.** A2. **B.** Right and left clashing organs. **C.** Hemipenes. **D.** Zenker organ. Codes for A-D: DA-P-45:02. Scale bars: 100 μ m.

Unlike typical Cyprididae, which possess six claws or setae on the Md and Mx1 terminal segments, respectively, *Eucypris kulkoyluoglu* sp. nov. exhibits a reduced number, providing a clear distinction from these general family traits. While the newly described species *E. dorlionensis* reflects the typical family pattern in this respect, *E. denktasi* and *Eucypris lefkosaensis* also display deviations in the setation of these segments, yet the pattern observed in *E. kulkoyluoglu* sp. nov. differs from both of these species. In the new species, the terminal segment of the mandible bears three long and one short smooth claws, whereas *E. denktasi* has three claw-like smooth setae and *Eucypris lefkosaensis* possesses two claws and two smooth setae on the same segment. Furthermore, the terminal segment of the Mx1 in *E. kulkoyluoglu* bears four well-developed smooth setae, while *E. denktasi* has six setae (two claw-like and four smooth), and *Eucypris lefkosaensis* bears four well-developed claw-like setae on the terminal palp segment. Considering these traits, the species presented in this study may be placed within a new (sub)genera together with the Cypriot species. However, the inclusion of molecular data for these species would provide more robust support for this classification.

On the other hand, the presence of a palp (endopod) composed of two segments on the T1 is a unique diagnostic character of *E. kulkoyluoglu* sp. nov. and clearly distinguishes it from all other known members of the genus *Eucypris*, including *E. dorrionensis*, *E. denktasi*, and *E. lefkosaensis*. This subdivision of the endopod is therefore interpreted as a species-specific, secondary modification rather than the plesiomorphic (ancestral) condition.

Male morphology and reproductive traits

The occurrence of male individuals and the presence of a sexual population in the new species is a noteworthy feature for the genus *Eucypris*, which is mostly known for parthenogenetic populations (Horne & Martens 1998).

In males of the new species described herein, the carapace is slightly smaller than that of females, as observed in males of *Eucypris afghanistanensis* Hartmann, 1964, *Eucypris pigra* (Fischer, 1851), and *Eucypris persica* Klie, 1937. As the carapace surface lacks a distinct gonad impression, no clear external sexual dimorphism can be recognized. Examination of the internal morphology shows that, although the soft body parts are generally similar to those of the female, the structure of A2, with the transformation of the seta z2 into claw, a seta-like *Gm*, and more developed *G2* exhibits clear differences than females.

In terms of the clasping organs, males of *Eucypris kurtdiebeli* Petkovski & Keyser, 1997, *Eucypris pagasti* Schäfer, 1952, *Eucypris virens* (Jurine, 1820), and *E. persica* exhibit a distinct asymmetry: the right clasping organ is characterized by a relatively short proximal part and a markedly expanded distal part (distal process), whereas the left clasping organ has a smaller proximal part and a curved distal process.

The clasping organs of *E. kulkoyluoglu* sp. nov. generally resemble this configuration, particularly with respect to the right clasping organ. However, unlike the aforementioned species, the left clasping organ in *E. kulkoyluoglu* sp. nov. is distinctly cylindrical and does not show the distal triangular expansion observed in the others.

In addition, male reproductive morphology provides reliable diagnostic characters for *E. kulkoyluoglu* sp. nov. The hemipenis differs markedly from that of *E. kurtdiebeli*, *E. persica*, *E. pagasti*, and *E. virens* by the presence of a triangular outer process. Furthermore, the Zenker organ in *E. kulkoyluoglu* sp. nov. consists of 22 whorls, whereas it bears approximately 26 rings of chitinous spines in *E. pagasti* and about 30 rings in both *E. persica* and *Eucypris caralitana* Tagliasacchi Masala, 1969.

Despite the presence of males, the strongly female-biased sex ratio as observed in the studied population is commonly reported in Türkiye in taxa with mixed populations (e.g., Akdemir *et al.* 2020). In these populations, males coexist with both sexually reproducing and parthenogenetic females (Schmit *et al.* 2013). This pattern may reflect a flexible reproductive strategy that combines the demographic advantages of parthenogenesis (e.g., rapid population increase and population continuity) with the evolutionary benefits of sexual reproduction (e.g., genetic recombination and adaptive potential) (Horne & Martens 1998). On the other hand, female-biased sex alone does not constitute evidence for mixed reproduction, as males may be rare or occur only periodically.

In freshwater ostracods, overlapping generations and asynchronous population structures are well documented (Meisch 2000). With respect to permanently warm thermal springs, reproductive activity is not expected to be seasonally constrained as temperatures remain constant, and egg production can occur throughout the year. The simultaneous occurrence of juveniles and adults within the samples, together with the presence of spermatozoa in the genital fields of adult females, suggests the occurrence of more than one reproductive pulse (probably a bivoltine life cycle) within a single year for *E. kulkoyluoglu* sp. nov.

Overall, the combination of functional sexual reproduction, strongly female-biased sex ratios, and the presence of overlapping generations indicates that *E. kulkoyluoglu* sp. nov. possesses a flexible reproductive system. Such flexibility likely enhances both short-term population persistence and long-term evolutionary potential, representing an important reproductive trait within the genus *Eucypris*.

Ecological context

Species of *Eucypris* are typically associated with temporary or hydrologically unstable freshwater habitats, such as ephemeral ponds and floodplains (Meisch 2000). However, occasional records from moderately stable environments, such as cold springs (e.g., *Eucypris rava* Furtos, 1933 (Furtos 1933)), suggest that the ecological amplitude of the genus may be broader than generally assumed.

In the present study, the habitat in which *E. kulkoyluoglu* sp. nov. was collected corresponds to a low-temperature geothermal rheocrene spring. Thermal springs represent environmentally extreme yet temporally stable habitats, characterized by persistently elevated water temperatures and, in many cases, reduced dissolved oxygen levels and increased ionic content (Brues 1927; Springer & Stevens 2008; Pop *et al.* 2023). Geothermally influenced springs therefore differ markedly from surrounding freshwater habitats due to pronounced thermal and chemical gradients, which strongly influence aquatic community structure (Wickstrom & Castenholz 1985; Kreiling *et al.* 2022). These conditions act as strong ecological filters, resulting in communities structured primarily by niche-based processes rather than stochastic colonization, particularly when compared to cold spring systems (Kreiling *et al.* 2022). Consistent with the strong filtering typical of geothermal systems, no accompanying ostracod fauna was recorded at the sampling site. This low taxonomic diversity further emphasizes the ecological distinctiveness of the habitat and suggests a high degree of tolerance or specialization in *E. kulkoyluoglu* sp. nov.. As a result, such systems often function as ecological islands supporting thermotolerant or specialized taxa.

The occurrence of *E. kulkoyluoglu* sp. nov. under these physicochemical conditions indicates a notable ecological tolerance within the genus. When considered alongside earlier reports of ostracods from thermal waters (e.g. Klkylođlu *et al.* 2003), this tolerance suggests an adaptive capacity for persistence in thermally influenced freshwater environments and highlights the importance of geothermal freshwater systems as habitats for ostracod diversity.

Conclusions

The description of *Eucypris kulkoyluoglu* sp. nov. expands our understanding of the morphological diversity and evolutionary history of the genus *Eucypris* in the Eastern Mediterranean and Anatolian regions. The new species is clearly distinguished from its congeners by a unique suite of characters. First, the reduced number of claws or setae on the terminal segments of the Md and Mx1 - compared to the six claws or setae typically present in Cyprididae - clearly separates *Eucypris kulkoyluoglu* sp. nov. from the general family traits. Most notably, the absence of the *d2* seta on the T2 accompanied by a short *d1* seta, is a shared diagnostic feature that distinguishes both *E. kulkoyluoglu* sp. nov. and *E. denktasi* from all other species within the genus *Eucypris*. However, the presence of a two-segmented palp (endopod) on the T1 uniquely separates the new species from *E. denktasi*, further establishing its status as a distinct taxon. In addition, the bluntly pointed, triangular distal lobe of the hemipenis, the right clasping organ being cylindrical along its entire length without any distal triangular expansion, and a Zenker organ with 22 well-developed chitinous rings differentiate *Eucypris kulkoyluoglu* sp. nov. from other males of the genus.

Beyond its taxonomic distinctiveness, *Eucypris kulkoyluoglu* sp. nov. likely represents an ecologically specialized lineage adapted to a low-temperature geothermal spring environment. The combination of diagnostic morphological traits, ecological specialization, and shared characters with eastern Mediterranean congeners supports the recognition of *E. kulkoyluoglu* sp. nov. as a distinct taxon with potential biogeographic significance. Moreover, *E. kulkoyluoglu* sp. nov., together with the Cypriot congeners, may represent a distinct lineage that may indicate the need for recognition as a separate (sub)genera in future studies.

Conflict of interest

The authors report no financial or other conflicts of interest in connection with this work.

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