The Recent non-marine ostracods of Tunisia: an updated checklist with remarks on their regional distribution patterns and ecological preferences

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ABSTRACT

Different lines of investigation have recently contributed to increasing the available knowledge about the invertebrates inhabiting inland waters of north Africa, but a comprehensive synopsis on Tunisian Ostracoda is missing to date. An updated checklist of Recent non-marine ostracods from Tunisia and data on their distribution is thus offered here, representing the most extensive survey on this crustacean group ever carried out in inland waters throughout the country. One-hundred-five sites covering various climate zones, from Mediterranean to desert areas, were sampled between 2002 and 2012. Most of the considered water bodies were temporary or ephemeral habitats, but a few permanent sites were sampled as well. Overall, 18 genera and 32 taxa of putative species rank were collected in the frame of this survey, among which nine species and five genera were new to Tunisian fauna. As a result of this study and based on previous investigations, nine families (Candonidae, Cyprididae, Cytherideidae, Darwinulidae, Ilyocyprididae, Leptocytheridae, Limnochirostidae, Loxoconchidae, Paradoxostomatidae), 29 genera and at least 45 species of non-marine ostracods are currently known for Tunisia, which thus prove to host the most diverse ostracod fauna among north African countries. The number of species occurring in a single sample varied from 1 to 4. The *Eucypris virens* complex was the most widespread taxon (58 records), followed by *Heterocypris barbara* (30 records), *Heterocypris incongruens* (22 records), and *Sarscypridopsis aculeata* (16 records). For some ostracod species, clear distributional gradients associated with different climatic conditions were observed. The affinities with adjacent Maghrebian ostracod faunas are discussed. This study confirms the crucial role played by marginal aquatic habitats for the conservation of biodiversity, in particular in arid and semi-arid regions.

INTRODUCTION

Ostracods are a class of small bivalved crustaceans occurring in almost all aquatic ecosystems (Smith et al., 2015). In inland surface waters, both characterised by temporary and permanent hydroperiods, they abound in the benthic and periphytic habitats. According to Meisch et al. (2019), there are presently 2330 subjective species of non-marine ostracods in 270 genera.

Until a few years ago, information on non-marine ostracods of the Maghreb was largely based on the contributions by Gurney (1909), Gauthier (1928a, 1928b, 1928c), Klie (1943) and, to a lesser extent, on scattered data in the literature. Only recently, new studies have contributed towards increasing the knowledge on their distribution in this area and with the description of new species (among them, Danielopol et al., 1990; Marmonier et al., 2005; Schmit et al., 2013a). Zaibi et al. (2013) reviewed the existing literature on the occurrence of non-marine ostracods in Tunisia and provided new data from a survey carried out in 15 sites from the central and southern part of the country. Overall, 30 non-marine species were recorded by these authors, including *Vestalenula* sp. B (Danielopol, 1980), and additional three taxa were identified at supra-specific level. Later on, Scharf et al. (2014) reported the non-native *Candonopsis novaeezelandiae*, a species previously unknown in Tunisia, from five sites located in the northern part of the country.

In addition to the above mentioned studies on ostracods, other lines of investigation have recently contributed to increasing available knowledge about invertebrates of Tunisian inland waters, such as aquatic beetles (Touaylia et al., 2011), erpobdellid leeches (Ahmed et al., 2013),
branchiopods and copepods (Turki and Turki 2010; Marrone et al., 2016; Stoch et al., 2016), freshwater brachyuran (Marrone et al., 2020), and epigean amphipods (Ayati et al., 2019).

The high diversity of Tunisian landscape and waterbodies (Morgan, 1982; Stoch et al., 2016), the strong gradient observed in its climatic conditions and its geographic position between the eastern and western basins of the Mediterranean, make Tunisia notably interesting as a study area, in particular for biogeographic researches on aquatic fauna.

Here we present an updated checklist of Recent ostracod fauna from Tunisia and data on taxa distribution, which are based on the most extensive survey on this crustacean group ever carried out in inland waters throughout the country.

**METHODS**

Sampling sites were selected in order to encompass all the climatic areas and the most representative types of natural inland aquatic habitats of Tunisia (Fig. 1; Tab. 1). Some examples of sampling sites investigated in this study are presented in Figs. S1 and S2.

Altogether, 106 ostracod samples were collected using a handnet with a mesh size of 200 µm from 103 sites between 2002 and 2012. *Ex situ* rehydration of sediment collected from dry temporary habitats, the so-called “Sars’ method” as described in Marrone et al. (2019), allowed to study the ostracod assemblages from further two sites (Tab. 1). Geographical coordinates were recorded with GPS. Each sampling site was identified by an alphanumeric code consisting of a letter followed by a number, and then assigned to one of the following Köppen-Geiger climate zones according to Beck et al. (2018): Csa (temperate, dry summer, hot summer); Bsk (arid, steppe, cold); Bsh (arid, steppe, hot); Bwk (arid, desert, cold); Bwh (arid, desert, hot). When possible, the following environmental features were recorded: habitat type, estimated hydroperiod, water temperature, water conductivity at 20°C, water turbidity, and macrophyte coverage. Water temperature and electric conductivity were measured *in situ* using portable digital meters. Arbitrary values ranging from 0 to 4 were considered to represent water turbidity (0 = crystal clear water; 4 = extremely turbid water or argillotrophic system) and macrophyte coverage (0 = total absence of vegetation; 4 = absence of open water). The maps were generated using QGIS v. 3.4.15 (QGIS Development Team, 2018).

Ostracods were sorted under a binocular microscope and then fixed in 90% ethanol. The taxonomic identification of the collected material was based on adult specimens. Both soft parts and valves were checked for the identification at the lowest possible level, using Danielopol et al. (1990), Meisch (2000), Rasouli et al. (2016) and Mazzini et al. (2014). Taxonomic nomenclature follows Meisch et al. (2019). Ostracod specimens are housed at the Department of Chemistry, Life Sciences and Environmental Sustainability, University of Parma, Italy. All species authorships are listed in Tab. 2.

Sample-based rarefaction curves (Gotelli and Colwell, 2001) were computed using EstimateS v. 9.1.0 software (Colwell, 2013) in order to evaluate if sampling effort was exhaustive enough to be representative of the Tunisian inland water ostracod fauna. The non-parametric species richness estimators ICE (Incidence Coverage-based Estimator) and Jack1 (first order Jackknife-based estimator) were calculated. Following the recommendation by Colwell (2013), the Bias-corrected formula of Chao2 estimator of species richness was excluded since the coefficient of variation of the incidence distribution was higher than 0.5, and in this case the estimator became imprecise. For
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this reason, the ICE estimator was preferred over the classical Chao2 estimator, giving higher values, as recommended by Colwell (2013). The rarefaction curve of the mean values of “uniques” (i.e., species present only in a single sample) was also calculated.

RESULTS

A total of 32 taxa belonging to 18 genera in 4 families (Candonidae, Ilyocyprididae, Cyprididae and Limnocytheridae) were identified. Nine species (Candona cf. muelleri, Cyclocypris laevis, Cypria ophthalmica, Eucypris mareotica, Heterocypris reptans, Isocypris beauchampi, Leucocythere cf. algeriensis, Potamocypris smaragdina, Potamocypris variegata) and five genera (Candona, Cy-clocypris, Cypria, Isocypris, Leucocythere) were new to Tunisia (Tab. 2). The number of species reported in a single sample varied from 1 (30 sites) to 4 (9 sites). Figs. 2-5 show the distribution of ostracods found in this study. The Eucypris virens complex was the most widespread taxon (in 58 sites, Fig. 4A), being very common in both Mediterranean and arid areas. It was characterised by a noteworthy morphological variability in the carapace shape, with three distinct morphotypes here annotated as “typical”, “elongate” and “subquadrate” forms, sometimes co-occurring in the same population. The “subquadrate” form was the most common (in 41 sites), followed by the “typical” (31 sites) and the “elongate” (15 sites) forms. The latter was distributed only in the northern part of the country (Fig. 4A). Other species that were commonly identified included Het-

Fig. 2. A) distribution map of Bradleystrandesia sp. (△), Bradleycypris obliqua (★), Cypris bispinosa (●) and Cypris pubera (○) and B) Cypridopsis cf. elongata (△), Cypridopsis hartwigi (★), Cypridopsis vidua (●), Cypridopsis sp. (○) and Plesiocypridopsis newtoni (◆).
erocypris barbara (30 sites), H. incongruens (22 sites), and Sarscypridopsis aculeata (16 sites) (Figs. 3A and 3B). On the other hand, 13 taxa were represented in one site only (Tab. 2). More diverse ostracod assemblages mostly correspond to habitats with a higher vegetation coverage. Heterocypris salina and S. aculeata showed a marked preference for low-turbidity systems.

Most of the taxa occurred in the more temperate parts of the country, where temperature and precipitation are more suitable for the formation and persistence of more predictable aquatic habitats, and 19 were exclusively present under a Csa climate. Potamocypris smaragdina and Potamocypris variegata were recorded only in the steppic and desert areas, respectively in Bsh and Bwk climatic zones (Fig. 3A). Other ostracods are adapted to cope with the physically harsh conditions that characterize the southern and inner part of Tunisia, among them Heterocypris barbara, Heterocypris incongruens, Heterocypris salina, Eucypris mareotica, Eucypris virens complex, Cypridopsis vidua and the only records of Cypria optalmica and Ilyocypris bradyi, all of them found in Bwh climatic zone (Figs. 2B, 3B, 4A, 5A and 5B). Five taxa (Eucypris virens complex, Heterocypris barbara, Heterocypris incongruens, Ilyocypris getica and Tonnacypris lutaria), in addition to Csa, were present in at least two other climatic zones (Figs. 4 A,B and 5B).

Fig. 3. A) distribution map of Potamocypris arcuata (△), Potamocypris smaragdina (★), Potamocypris variegata (●) and Sarscypridopsis aculeata (○) and B) Heterocypris barbara (△), Heterocypris incongruens (★), Heterocypris reptans (●) and Heterocypris salina (○).
Except for *Ilyocypris bradyi*, which was collected from permanent pools along river margins (F209), the other 10 taxa found in permanent sites were also present in temporary habitats. The sampled sites showed a wide range of salinity, from freshwater to hypersaline conditions (Tab. 1). Taking into account only the species found in at least four sites, those which solely occurred at low conductivity (<1 mS cm⁻¹) were *Ilyocypris getica* and *Tonnacypris lutaria*; other species seemed to prefer low to medium conductivity, as *Trajancypris clavata* and the “typical” morphotype of the *Eucypris virens* complex, or medium to high conductivity, as *Sarscypridopsis aculeata*. *Eucypris mareotica* and *Heterocypris salina* were exclusively found in sites with conductivity >4 mS cm⁻¹. The ostracods present in a wide range of salinity conditions were the “elongate” and “subquadrate” morphotypes of the *Eucypris virens* complex (between 0.3 and 11.5 mS cm⁻¹ and between 0.2 and 11.5 mS cm⁻¹, respectively), *Heterocypris barbara* (0.4-53.6 mS cm⁻¹) and *Heterocypris incongruens* (0.2-5.6 mS cm⁻¹).

Rarefaction and estimation curves are shown in Fig. 6. The rarefaction curve was increasing, and no plateau could be observed. The ICE curve showed a reduction of its slope above 75 samples, while Jack1 showed a continuous increase. Uniques (species present in a single site) means tended to stabilize their trends at about 14 species (Fig. 6).
DISCUSSION

The water bodies considered in this survey are mainly temporary or even ephemeral, with marked fluctuations in their environmental conditions (see Supplementary Material). The fauna detected is therefore made up of generally euryhaline, widely tolerant taxa that are capable of producing resting stages and tuning their life cycles according to the duration of the wet phase. Notwithstanding the constraints imposed by these severe conditions, the diversity of non-marine ostracod fauna of Tunisia, as revealed from data collected in this study and in previous ones, is rather high, consisting of nine families, 29 genera and at least 45 species (Tab. 2). Certainly the species diversity is still underestimated because in some cases the identification at species level was not achieved due to the preservation state of the collected material, its scarcity or the absence of adult stages. In addition, in some ostracod genera, as in *Eucypris*, there are ill-defined (morpho)species (Meisch, 2000), consequent to the high phenotypic plasticity observed in valve shape and size (Baltanás et al., 2002). *Eucypris virens* was the most frequently encountered ostracod in this study. Bode et al. (2010) indicated the existence of a species complex with more than 40 cryptic taxa, suggesting a revision of the single species status of *Eucypris virens*. More recently, Koenders et al. (2017) demonstrated that genetic species in the *Eucypris virens* complex cannot be recognized morphologically by valve shape. For these reasons, here we reported only the presence of different morphotypes into this species complex, to which no taxonomic significance must be attached; future investigation on genetic and morphological variation among these forms will hope-

**Fig. 5.** A) distribution map of *Candona cf. muelleri* (△), *Neglecandona neglecta* (●), *Cyclocypris laevis* (●), *Cypria ophtalmica* (○) and *Leucocythere cf. algeriensis* (+) and B) *Ilyocypris bradyi* (△), *Ilyocypris getica* (●), *Ilyocypris cf. getica* (●), *Ilyocypris gibba* (○) *Ilyocypris cf. gibba* (+) and *Ilyocypris sp.* (X).
fully shed light on their taxonomic position. For some ostracod species identified in this study, distributional gradients associated with different climatic conditions were observed. The presence of a large part of the ostracod diversity in the Csa climate zone may be due to less harsh environmental conditions, but it should also be taken into account that most of the samples were collected there. As for the occurrence of *Potamocypris smaragdina* and *Potamocypris variegata* in a single climatic zone (Bsh and Bwk, respectively), the finding of these species in a single site each prevents to draw sound conclusions about their habitat preferences. Gauthier (1928c) had already reported a progressive rarefaction of the ostracod fauna diversity in Tunisia passing from the rainy area (average precipitation >500 mm y⁻¹), to the sub-steppic zone (between 300- and 500-mm y⁻¹) and finally to the steppic zone (<300 mm y⁻¹). The species present in all three areas were *Eucypris virens*, *Ilyocypris getica* and *Tonnacypris lutaria*.

The relatively low number (26) of samples in which ostracods were present and the poor sampling coverage in the driest part of Tunisia in the Gauthier’s study (1928c) probably account for the limited concordance with our data on ostracod distribution in relation to climatic conditions. The 15 sampling sites selected by Zaibi *et al.* (2013) for a survey conducted in November 2010 did not include the rainiest part of the country, and lotic environments were mainly sampled, making a comparison with our data difficult. On the other hand, the results in Zaibi *et al.* (2013) show that Tunisian running waters host a rich ostracod diversity and species that are conceivably absent, or much rarer, in standing waters, such as *Darwinula stevensoni* and *Psychrodromus tunisicus*.

The only non-native ostracod species found in Tunisia is *Candonocypris novaezelandiae* (Zaibi *et al.*, 2013), first described for New Zealand and subsequently reported from different biogeographic areas (Scharf *et al.*, 2014). *Isocypris beauchampi*, a species of Afrotropical origin first reported for Tunisia in this study, has been also found in Canada, South America and several European countries (Meisch, 2000). According to the latter author, although *Isocypris beauchampi* is unrecorded from subsaharian Africa where the genus *Isocypris* is represented by several species, it has probably been introduced in Europe from this same area by migrating birds. Therefore its occurrence in Northern Africa could be seen as the natural expansion of the species’ range northward. Of particular biogeographic interest is the occurrence of two ostracod taxa. *Leucocythere* cf. *algeriensis*, recorded from a single site (F071, a temporary marsh) in the study area; *Leucocythere algeriensis* is currently known for its type locality only in southern Algeria (Danielopol *et al.*, 1990). *Ilyocypris* sp. from F198 shows affinities with *Ilyocypris biplicata anomala* described by Gauthier (1938) from North Africa. Although other related, possibly conspecific, specimens have been found in Italy (Mazzini *et al.*, 2014), Greece (unpublished data), and in several Spanish localities (Escrivà *et al.*, 2009; 2010; Schmit *et al.*, 2013b; Martínez-García *et al.*, 2019), its taxonomic position is still somewhat uncertain.

The sample-based rarefaction curve of mean species richness based on the collected data did not reach a
plateau, thus confirming that the species richness recorded is below the real ostracod diversity occurring in Tunisian inland waters. The trend of unique means is stable above 14 species; in this context, increasing sampling effort did not allow to increase species richness per site, maybe indicating a low sampling efficiency for single sites as a possible cause of the low overall non-exhaustiveness. The ICE and Jack1 means show an expected overall species richness between 48 and 52 species in the study area; these values are slightly higher than the cumulative species richness obtained by integrating all the ostracod occurrence data published to date for the country (Tab. 2), i.e., at least 42 species. Such results further stress the need for carrying out further sampling surveys that take into account the heterogeneity of Tunisian surface waters both at a regional scale and at a local (single site) scale.

To date, except for Algeria and Tunisia, few studies have been published on non-marine ostracods from Maghreb. The scant available information from other parts of north-western Africa derives from occasional surveys and often from dated literature. For example, Ghigi (1932), Masi (1932) and Ramdani (1982) collected material and described new ostracod species from Morocco, and Klie (1943) described new species from Morocco and Mauritania. The only meaningful comparison that can be carried out is between Tunisian and North Algerian (Danielopol et al., 1990; Ghouaci et al., 2017) ostracod faunas, being both relatively well known and resulting from commensurate sampling effort in a similar latitudinal range. Based on currently available data, the number of recorded genera is slightly higher in Tunisia than in Algeria (29 vs 25 genera), of which 21 are shared by the two countries; Martenscypridopsis, Notodromas, Physocypris and Prionocypris were found only in Algeria, whilst Bradleystrandesia, Candona, Cythereois, Cytheromorpha, Darwinula, Leptocythere, Psychodromus and Vestalenula exclusively occurred in Tunisia. Six families were recorded in both countries (Candoniidae, Cyprididae, Cytherideidae, Ilyocryptidae, Limnocytheridae, Loxoconchidae), Notodromadidae only in Algeria, and Darwinulidae, Leptocytheridae, Paradoxostomatidae only in Tunisia.

Tunisia is separated from Sicily and surrounding small islands, i.e. the southernmost part of Italy, only by a narrow sea strait (the distance between the coastlines of Tunisia and mainland Sicily is about 150 km, and those from Tunisia and Pantelleria and Pelagie Islands about 70 and 110 km, respectively). The non-marine ostracod faunas of these two areas show many similarities, but also some differences in their generic composition: 22 genera are in common, eight genera are exclusively found in Tunisia (Bradleystrandesia, Bradleycypris, Candona, Cythereois, Cytheromorpha, Leptocythere, Leucocythere and Loxoconcha) and seven only in Sicily (Fabaeformiscandona, Mistacandona, Notodromas, Physocypris, Prionocypris, Pseudocandona and Tyrrhenocythere) (Pieri et al., 2020; Mazzini et al., 2017). In both areas, typically temperate ostracods, possibly except for few isolated records (e.g., Negleandona neglecta in M034 in Tunisia), are absent even in the most humid and coolest parts of the investigated regions. A likely reason for this can be found in the scarcity of deep lakes and, in general, of permanent lentic waters. A similar pattern, as well as the close zoogeographic affinities with adjacent faunas of the Maghreb, were observed for Tunisian “large branchiopods” (Marrone et al., 2016) and diaptomid copepods (Marrone et al., 2017).

CONCLUSIONS

Although likely not exhaustive, this study is the most comprehensive survey ever conducted on non-marine ostracods of Tunisia. It contributes to update and significantly increase the knowledge on the diversity and distribution of this ecologically important invertebrate group in Tunisia and, more broadly, in the Maghreb. The obtained results show the presence of one of the most diversified ostracod fauna among North African countries. The number of taxa reported here for Tunisia is certainly underestimated, since in our study most of the sites were visited only once, and relatively few permanent or lotic aquatic habitat were sampled. In addition, a greater taxonomic detail is desirable, also using molecular techniques for those taxa whose identification is not conclusive when based on a morphological approach only. We hope that the newly collected data presented here will provide a reference for further comparative faunal studies aimed at investigating the distribution, affinities and origins of the circum-Mediterranean and north Africa inland water ostracod faunas.

Our results confirm the key role of temporary habitats and, more broadly, of marginal aquatic systems for biodiversity conservation in arid and semi-arid circum-Mediterranean areas. It is therefore essential to implement conservation measures for these systems that are seriously threatened by different types of impact, such as urban sprawl, the transformation of natural areas into cultivated land, and the effects of climate change (Zacharias and Zamparas, 2010).

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| Code   | Date     | Latitude  | Longitude | CZ   | Habitat type                        | H  | Cond | Temp | Turb | MC |
|--------|----------|-----------|-----------|------|-------------------------------------|----|------|------|------|----|
| F064   | 02/02/2005| 36.90177  | 10.49709  | Csa  | Canal                               | T  | 3710 | 15.2 | 0    | 0  |
| F065   | 09/02/2006| 36.90975  | 10.54716  | Csa  | Marsh                               | T  | 385  | 15.6 | 2    | 0  |
| F066   | 09/02/2006| 36.90729  | 10.54991  | Csa  | Roadside ditch                      | T  | 547  | 17.0 | 0    | 2  |
| F067   | 09/02/2006| 36.99492  | 10.461404 | Csa  | Marsh                               | T  | 11540| 16.1 | 0    | 0  |
| F071   | 13/02/2006| 35.796014 | 10.14636  | Bsh  | Marsh                               | T  | 2480 | 11.0 | 1    | 1  |
| F072   | 13/02/2006| 35.765742 | 9.982058  | Bsh  | Pool in a streambed                 | T  | 614  | 11.7 | 3    | 0  |
| F073   | 13/02/2006| 36.041103 | 10.058864 | Bsh  | Pool                                | T  | 347  | 11.2 | 0    | 1  |
| F074   | 13/02/2006| 36.040990 | 10.058329 | Bsh  | Pool                                | T  | 230  | 11.2 | 0    | 0  |
| F076   | 15/02/2006| 36.791206 | 10.274467 | Csa  | Marsh                               | T  | 1380 | 12.3 | 0    | 2  |
| F077   | 15/02/2006| 36.786548 | 10.275925 | Csa  | Marsh                               | T  | 9000 | 14.3 | 0    | 0  |
| F078   | 15/02/2006| 36.781577 | 10.273724 | Csa  | Roadside ditch                      | T  | 1880 | 13.1 | 0    | 3  |
| F079   | 15/02/2006| 36.769772 | 10.263266 | Csa  | Marsh                               | T  | 47800| 12.4 | 0    | 1  |
| F080   | 15/02/2006| 36.769772 | 10.263266 | Csa  | Marsh                               | T  | 31500| 14.1 | 0    | 1  |
| F081   | 15/02/2006| 36.769453 | 10.264426 | Csa  | Pool                                | T  | 7700 | 16.7 | 0    | 3  |
| F082   | 15/02/2006| 36.956236 | 10.220210 | Csa  | Marsh                               | T  | 1250 | 15.0 | 3    | 1  |

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Tab. 1. Continued from previous page.

| Code | Date       | Latitude   | Longitude  | CZ   | Habitat type         | H  | Cond | Temp | Turb | MC |
|------|------------|------------|------------|-----|----------------------|----|------|------|------|----|
| F208 | 28/12/2004 | 36.883036  | 10.302282  | Csa | Pool                 | T  | n.d. | n.d. | 2    | 1  |
| F209 | 26/07/2002  | 34.376482  | 7.912122   | Bwh | Lateral pools along river margins | P  | n.d. | n.d. | 1    | 2  |
| F210 | 31/12/2007  | 37.119058  | 9.673126   | Csa | Pool                 | T  | 133  | 15.0 | 2    | 1  |
| F231 | 01/01/2008  | 37.110325  | 9.697821   | Csa | Pool                 | T  | 400  | 14.8 | 2    | 2  |
| F232 | 01/01/2008  | 37.206117  | 9.520817   | Csa | Pool                 | T  | 270  | 16.2 | 4    | 2  |
| F233 | 31/12/2007  | 37.138077  | 9.375803   | Csa | Roadside ditch       | T  | 297  | 14.0 | 2    | 2  |
| F234 | 31/12/2007  | 37.138865  | 9.338640   | Csa | Marsh                | T  | 348  | 16.8 | 4    | 1  |
| F235 | 31/12/2007  | 36.967102  | 8.846171   | Csa | Marsh                | T  | 960  | 12.5 | 0    | 4  |
| F248 | 02/01/2012  | 37.086655  | 9.199651   | Csa | Marsh                | T  | 360  | 13.1 | 4    | 1  |
| F249 | 02/01/2012  | 36.936295  | 8.761124   | Csa | Marsh                | T  | 286  | 12.0 | 0    | 3  |
| M029 | 29/06/2004  | 37.154742  | 9.761400   | Csa | Roadside ditch       | T  | n.d. | n.d. | n.d. | n.d. |
| M034 | SRL        | 37.201350  | 9.258189   | Csa | Pool                 | T  | n.a. | n.a. | n.a. | n.a. |
| M053 | SRL        | 35.484819  | 10.643233  | Bsh | Pool in a streambed  | T  | n.a. | n.a. | n.a. | n.a. |

CZ, climate zone as in Fig. 1; H, hydroperiod (T = temporary, P = permanent); Cond, electric conductivity at 20°C (µS cm⁻¹); Temp, water temperature (°C); Turb, turbidity (see text); MC, macrophyte coverage (see text); SRL, sediment re-hydrated in the laboratory; n.d., not determined; n.a., not available.

Tab. 2. Updated checklist of Recent non-marine ostracod taxa from Tunisia based on Zaibi et al. (2013) and references therein, Scharf et al. (2014), and present study. For the taxa found in the present study (marked with an asterisk), the sites in which they occurred are also reported (codes as in Tab. 1). New species and genera for the Tunisian fauna are reported in bold. Cythere sp. listed in Zaibi et al. (2013) was omitted because it is regarded here as a marine taxon.

Class Ostracoda Latreille, 1802
Subclass Podocopa G.O. Sars, 1866
Order Podocopida G.O. Sars, 1866
Suborder Cypridocopina Baird, 1845
Superfamily Cypridoidea Baird, 1845
Family Cyprididae Baird, 1845
  Subfamily Cypricercinae McKenzie, 1971
    Tribe Bradleystrandesini
      Genus Bradleystrandesia Broodbakker, 1983
        * Bradleystrandesia sp.
          F171
    Tribe Cypricercini McKenzie, 1971
      Genus Bradleycypris McKenzie, 1984
        * Bradleycypris obliqua (Brady, 1868)
          F235
  Subfamily Cypridinae Baird, 1845
    Genus Cypris O.F. Müller, 1776
      * Cypris bispinosa Lucas, 1849
        F036, F096, F170, F171, F235
      * Cypris pubera O.F. Müller, 1776
        F084
  Subfamily Cypridopsinae Kaufmann, 1900
    Genus Cypridopsis Brady, 1867
      * Cypridopsis cf. elongata (Kaufmann, 1900)
        F232
      * Cypridopsis hartwigi G. W. Müller, 1900
        F103, F170
      * Cypridopsis vidua (O.F. Müller, 1776)
        F138, F170
      * Cypridopsis sp.
        F231, F235
    Genus Plesiocypridopsis Rome, 1965
      * Plesiocypridopsis newtoni (Brady and Robertson, 1870)
        F047, F053, F085
    Genus Potamocypris Brady, 1870
      * Potamocypris arctica (Sars, 1903)
        F104, F232

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Tab. 2. Continued from previous page.

*Potamocypris smaragdina* (Vávra, 1891)  
F073

*Potamocypris variagata* (Brady & Norman, 1889)  
F135

Genus *Sarscypridopsis* McKenzie, 1977  
*Sarscypridopsis aculeata* (Costa, 1847)  
F004, F033, F053, F059, F060, F061, F067, F071, F076, F077, F078, F084, F107, F110, M034

Subfamily Cyprinotinae Bronshtein, 1947  
Genus *Potamocypris* variegata (Brady & Norman, 1889)  
F135

Genus *Heterocypris* Claus, 1892  
*Heterocypris barbara* (Gauthier and Brehm, 1928)  
F004, F008, F016b, F017, F032, F037, F038, F047, F060, F064, F077, F078, F081, F084, F088, F094, F106, F107, F112, F114, F115, F119, F122, F124, F131, F153, F201, F233

*Heterocypris exigua* (Gauthier and Brehm, 1928)  
F001, F002, F022, F034, F053, F061, F063, F066, F071, F074, F078, F104, F129, F146, F196, F203, F208, F210, F233, M029, M053

*Heterocypris reptans* (Kaufmann, 1900)  
F009

*Heterocypris salina* (Brady, 1868)  
F021, F022, F024, F049, F067, F081, F195

Subfamily Eucypridinae Bronshtein, 1947  
Genus *Heterocypris* complex (Jurine, 1820)  
F001, F002, F003, F006, F008, F011, F032, F034, F053, F061, F063, F066, F067, F071, F072, F073, F074, F076, F077, F078, F081, F084, F085, F088, F091, F092, F096, F101, F103, F104, F106, F107, F108, F109, F110, F116, F139, F147, F160, F164, F166, F168, F171, F185, F196, F210, F231, F232, F233, F234, F248, F249, M034

Genus *Tonnacypris* Diebel and Pietrzeniuk, 1975  
*Tonnacypris lutaria* (Koch, 1838)  
F074, F136, F139, F210

Genus *Trowancypris* Martens, 1989  
*Trowancypris clavata* (Baird, 1838)  
F135, F153, F154, F206

Subfamily Herpetocypridinae Martens, 2001  
Genus *Herpetocypris* complex (Jurine, 1820)  
F135, F153, F154, F206

Genus *Herpetocypris* variegata (Brady & Norman, 1889)  
F135

Genus *Candonocypris* Sars, 1894  
*Candonocypris novaezelandiae* (Baird, 1843)

Genus *Herpetocypris* Brady and Norman, 1889  
*Herpetocypris chevreuxi* (Sars, 1896)

Genus *Herpetocypris* sp.  
F112

Subfamily Psychrodromini Martens, 2001  
Genus *Psychrodromus* Danielpol and McKenzie, 1977  
*Psychrodromus tunisicus* Zaibi et al., 2013

Subfamily Isocypridinae Hartmann and Puri, 1974  
Genus *Isocypris* G.W. Müller, 1908  
*Isocypris beauchampi* (Paris, 1920)  
F231, F232

Family Candonidae Kaufmann, 1900  
Subfamily Candoninae Kaufmann, 1900  
Genus *Candona* Baird, 1845  
*Candona cf. muelleri* Hartwig, 1899  
F234

Candona spp.

Genus *Neglecandona* Krstić, 2006  
*Neglecandona neglecta* (Sars, 1887)  
M034

Subfamily Cyclocypridinae Kaufmann, 1900  
Genus *Cyclocypris* Brady and Norman, 1889  
*Cyclocypris laevis* (O.F. Müller, 1776)  
F234

Genus *Cypria* Zenker, 1854  
*Cypria ophtalmica* (Jurine, 1820)  
F124, F129

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| Family Ilyocyprididae Kaufmann, 1900 |
|-------------------------------------|
| Subfamily Ilyocypridinae Kaufmann, 1900 |
| Genus Ilyocypris Brady and Norman, 1889 |
| *Ilyocypris bradyi* Sars, 1890 F209 |
| *Ilyocypris getica* Masi, 1906 F032, F047, F072, F092, F136, F206, F210 |
| *Ilyocypris cf. getica* Masi, 1906 F091 |
| *Ilyocypris gibba* (Ramdohr, 1808) F021, F081 |
| *Ilyocypris cf. gibba* (Ramdohr, 1808) F168 |
| *Ilyocypris spp.* F008, F059, F093, F147, F171, F198 |

Superfamily Darwinuloidea Brady and Robertson, 1885
Family Darwinulidae Brady and Robertson, 1885
Genus *Darwinula* Brady and Robertson, 1885
*Darwinula stevensoni* Brady and Robertson, 1870
Genus *Vestalenula* Rossetti and Martens, 1998
*Vestalenula* sp. B (Danielopol, 1980)

Superfamily Cytheroidea Baird, 1850
Family Cytherideidae Sars, 1925
Subfamily Cytherideinae
Genus *Cyprideis* Jones, 1857
*Cyprideis torosa* (Jones, 1850)
*Cyprideis* sp.

Family Leptocytheridae Sars, 1925
Genus *Leucocythere* Sars, 1867
*Leucocythere* cf. *algeriensis* Martens, 1990 F071

Tribe Limnoctherini Klie, 1938
Genus *Limnoctythere* Brady, 1867
*Limnoctythere* sp.

Family Loxoconchidae Sars, 1925
Genus *Cytheromorpha* Hirschmann, 1909
*Cytheromorpha fuscata* (Brady, 1869)
Genus *Loxoconcha* Sars, 1866
*Loxoconcha elliptica* Brady, 1868

Family Paradoxostomatidae Brady & Norman, 1989
Genus *Cytherois* G.W. Müller, 1884
*Cytherois* fischeri (Sars, 1866)

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