A review of the genus *Limnocythere* (Podocopida: Limnocytheridae) in the Pampean region (Argentina), with the description of a new species, *Limnocythere cusminskyae* sp. nov.

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Abstract

Occurrences of Quaternary and extant limnocytherids in the Pampean region of Argentina are reviewed, particularly in relation with their use as paleohydrological indicators in environmental reconstruction research. In spite of its spread occurrence, the systematic of the genus in the area is still little known, which results in most records being left in open nomenclature and paleoenvironmental inferences being made on the basis of general considerations of the genus. We describe a new species, *Limnocythere cusminskyae* **sp. nov.**, which we consider to be the taxon featured in several of these works, and discuss its morphological and ecological differences with coexisting *Limnocythere* species, particularly the proposed indicator species *L. rionegroensis* Cusminsky & Whatley.

Key words: Paleoecological reconstruction, hydrological preferences, Buenos Aires province

Introduction

In natural continental waters, both the solute composition and the ionic concentration (salinity) reflect the outcome of major hydrological processes affecting the water balance. Under evaporative conditions, salinity and solute composition will evolve through distinctive solute paths, depending on the waterbody's original characteristics (Hardie & Eugster 1970; Eugster & Hardie 1978). The result is the depletion or enrichment of the water in determined major ions simultaneously with an increase in salinity, such that variations along both of these gradients can be used to define a number of hydrochemical fields. Many ostracod species are known to respond to these solute differences, such that an adequate knowledge of their autoecology renders them very useful proxies for hydrochemical changes within lakes (e.g., De Deckker & Forester 1988; Smith & Horne 2002). In particular, the genus *Limnocythere* Brady is noted for the hydrochemical partitioning exhibited by some of its species, that is, their differential distribution within hydrochemical fields (e.g., Forester 1986; Forester *et al.* 2005a).

Although this phenomenon has been well documented for only Nearctic limnocytherids, there is evidence that the distribution of some Neotropical species of the genus conforms to a hydrochemically partitioned pattern as well. More specifically, two *Limnocythere* species found in the Patagonian region, *L. patagonica* Cusminsky & Whatley and *L. rionegroensis* Cusminsky & Whatley appear to be indicators of contrasting water types (Whatley & Cusminsky 1999; Ramón-Mercau *et al*. 2012). The former has been found in low salinity, bicarbonate-dominated waters, indicative of a positive hydrological balance, while the latter was collected in high salinity (mostly within the mesohaline range), sodium and chlorine-sulphate-dominated waters, indicative of evaporative enrichment. For its part, several paleoenvironmental studies concerning diverse proxies from Quaternary lacustrine and marginal marine sediments from the Pampean region mention the occurrence of limnocytherids, using them as indicators of broad salinity / ionic composition (e.g., Bertels & Martínez 1990; Laprida 1998; Fontana 2005; among others). In spite of such spread usage, the paleoenvironmental interpretability of these findings is hindered by the fact that the majority of records of limnocytherids in the region–in paleoenvironmental studies or otherwise–have been left in

open nomenclature. Furthermore, some of these interpretations are based partly or totally on extrapolations of the ecology of the better known Neartic species to which those specimens have been likened to, most prominently *L. staplini* Gutentag & Benson.

Recently, Laprida (2006) undertook a survey of extant lacustrine Pampean ostracods in order to determine their environmental preferences for paleoenvironmental reconstruction purposes. Given this objective, descriptions were based on hard parts morphology alone as the sole structures capable of overcoming the taphonomic barrier. A shortcoming of this approach was that the two limnocytherids recorded in the course of that investigation were left in open nomenclature. Thereafter, they were abundantly recorded as fossils in several lacustrine sediments (Laprida & Valero-Garcés 2009; Laprida *et al.* 2009; Plastani *et al.* 2012, Laprida *et al.* in press). The purpose of this report is to describe the soft parts of *Limnocythere* sp. aff. *L. staplini* / *Limnocythere* sp. sensu Laprida 2006, formally defining it as a new species, and to discuss the records of the genus in the Pampean area, especially with regards to its use in paleoenvironmental studies.
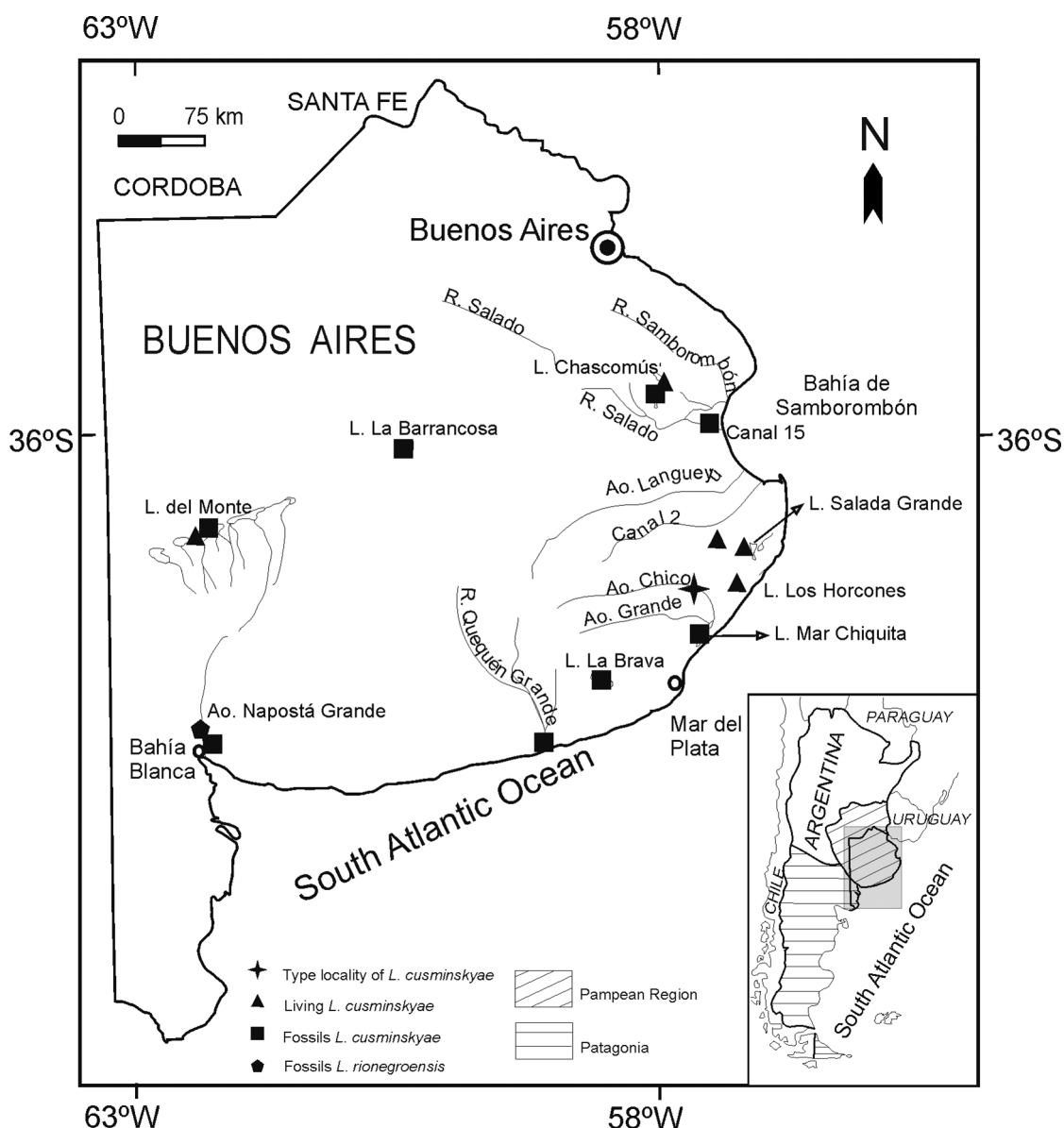

FIGURE 1. Location map of the study area, including sites where *Limnocythere cusminskyae* **sp. nov.** and *L. rionegroensis* have been recorded.

Material and methods

In October of 2012 the small stream Arroyo Chico, located in Buenos Aires province (Fig. 1), was sampled with a Surber Sampler equipped with a removable Dolphin bucket of 100 µm sieve opening. The sample recovered in the bucket was poured into plastic bags and preserved in situ with 96% ethanol. Once in the laboratory, the samples were washed with tap water on a standard sieve of 63 µm sieve opening and screened for ostracods under a stereomicroscope. The collected specimens—approximately 100 individuals belonging to at least six species - were stored in 70% ethanol. Several adult males and females of *Limnocythere* sp. aff. *L. staplini* sensu Laprida 2006 were dissected with entomological needles for soft part analysis; the following description is based on the examination of seven females and ten males plus the hemipenes of another three males. Valves were stored dry in micropaleontological slides, while soft parts were mounted on glass slides with Hydromatrix® (Micro-Tech-Lab, Austria) mounting medium and covered with a cover slip. For comparison, several Holocene male and female valves of the same species were studied. These fossils were recovered from a sedimentary core taken from the shallow lake La Barrancosa (37°19'40'' S; 60°06'51''W; Fig. 1) (Plastani *et al.* 2012; 2013).

Soft parts were analyzed under a Carl Zeiss Axiostar binocular light microscope, while valves were observed and photographed with a Carl Zeiss SUPRA 40 scanning electron microscope. The holotype, paratypes and the additional (fossil) material are stored at the Micropaleontological collection of the School of Exact and Natural Sciences of the University of Buenos Aires, under the collection numbers LM—FCEN 3200 to 3202.

For higher level taxonomy, the system proposed by Martens (1992) is used, while lower level taxonomy is based on Meisch (2000). The nomenclature for appendage description follows Meisch (1996, 2000), while description of the hemipenis follows Martens (1990). As for hingement classification, we follow Danielopol *et al.* (1989).

Abbreviations: A1: antennula; A2: antenna; cp: copulatory processus; cs: caudal setae; dl: distal lobe; hp: hook-like processus (of lower ramus of clasping organ); lp: lateral processus (of lower ramus of clasping organ); LV: left valve; Md: mandibula; MH: maximum height; ML: maximum length; mt: movable trabecule; Mx: maxillula; pl: proximal lobe; RV: right valve; T1: first thoracopod; T2: second thoracopod; T3: third thoracopod; ur: upper ramus of clasping organ; ve: vesica ejaculatoria; x1, x2: internal parts of labyrinth.

Systematic description

Class OSTRACODA Latreille, 1802

Subclass PODOCOPA Müller, 1894

Order PODOCOPIDA Sars, 1866

Suborder PODOCOPINA Sars, 1866

Infraorder CYTHEROCOPINA Gründel, 1967

Superfamily CYTHEROIDEA Baird, 1845

Family LIMNOCYTHERIDAE Klie, 1938

Subfamily LIMNOCYTHERINAE Klie, 1938

Tribe Limnocytherini Klie, 1938

Genus *Limnocythere* Brady, 1867
(Type species: *Cythere inopinata* Baird, 1843)

Diagnosis. Carapace laterally elongated and sexually dimorphic, with the females being stouter and shorter than

the males. When viewed dorsally, the anterior end of the carapace is usually beak-shaped, while the LV overlaps the RV posteriorly. Valves with marginal pore canals unbranched and often with tubercles of variable development. Flagellated claws present on the antennules of a number of species. Hemipenis with three uropodal setae, a movable trabecule, and a clasping organ with two rami; the lower ramus, consisting of a lateral process and a hook-like process, and the upper ramus, either reduced to an elongated tentacle or absent.

Limnocythere cusminskyae **sp. nov.**

1990. *Limnocythere* sp. n. Bertels & Martínez, Fig. 11
1996. *Limnocythere staplini*. Ferrero, Fig. 4, 1a–1d
1997. *Limnocythere* sp. Bertels & Martínez, Plate V, Fig. 2–3; Plate VI, Fig. 16–17
1998. *Limnocythere* sp. 1. Bertels-Psotka & Laprida, Fig. 1
1998. *Limnocythere staplini*. Laprida, Fig. 14
2006. *L.* aff. *L. staplini*. Laprida, Fig. 3, J–L. *Limnocythere* sp. Laprida, Fig. 3, H
2009. *L. staplini*. Ferrero, Fig. 10, 5–6

Type material. Holotype: One dissected male from the Arroyo Chico creek; soft parts mounted in a permanent slide with Hydromatrix® mounting medium, valves stored dry in a micropaleontological slide. Collection number: LM–FCEN 3200.

Paratypes: One dissected male (LM–FCEN 3201.1) and two dissected females (LM–FCEN 3201.2 and LM–FCEN 3201.3) from the same sample as the holotype; soft parts mounted in permanent slides with Hydromatrix® mounting medium, valves stored dry in a micropaleontological slide. Supplementary material: One male (LM–FCEN 3202.1) and one female (LM–FCEN 3202.2) from depth 0–1.5 cm of La Barrancosa core; one male (LM–FCEN 3202.3) and one female (LM–FCEN 3202.4) from depth 4–5 cm of La Barrancosa core; valves stored dry in a micropaleontological slide.

Type Locality: Arroyo Chico creek, Municipalidad de Balcarce, Provincia de Buenos Aires, Argentina (37° 23' 01" S–57° 09' 48" W).

Diagnosis. Small to medium-sized, elongated limnocytherid of approximately 600 μm in length. Males with straight dorsal margin and evident cardinal angles, females with variably arched dorsal margin, clearly discernible anterior cardinal angle and variably expressed posterior cardinal angle; ventral margin markedly concave at mid-length; dorsal and ventral margin subparallel. Overall shape of carapace in lateral view reniform (in males) to subreniform (in females). A sulcus and two or three smooth, poorly developed tubercles occur slightly anteriorly of mid-length; valve external ornamentation is weak. The hinge is modified antimerodont, consisting of one anterior small, smooth tooth, a central groove and a small, crenulated posterior tooth in the RV; LV with central bar smooth. A1 with subapically flagellated setae on the third and fourth segments. Strong sexual dimorphism in thoracopod length: in females, the apical claws of T2 and T3 are of similar length, with that of T1 being approximately ¼ shorter; in males, the apical claws of T1 and T2 are subequal while the apical claw of T3 is approximately 2.5 times longer than either. The hemipenis has a well-developed distal lobe. The upper ramus of the clasping organ is a tentacle-like processus. The x2 segment of the labyrinth is characteristically elongated and Y-shaped, with the bifurcated extreme adjacent to the vesica ejaculatoria.

Derivatio nominis. In honor to Dr. Gabriela Cusminsky, in acknowledgment of her contributions to the knowledge of Quaternary Patagonian ostracods.

Description. *External view.* In lateral view, the carapace is elongated; the anterior and posterior margins are simetrically rounded, with the latter more acuminate. The carapace of the male is reniform, with the posterior end slightly higher than the anterior one; MH situated approximately at anterior 1/4 of ML. The dorsal margin is straight, with marked cardinal angles, and subparallel to the ventral margin (Fig. 2a–b). The female carapace is more compressed, with overall subreniform shape; the dorsal margin is slightly to broadly arched and sloping, with a well-defined anterior cardinal angle and posterior cardinal angle evident to weakly discernible; the ventral margin is broadly sinuous. MH occurs approximately at anterior 1/3 of ML (Fig. 2c–d). In dorsal view, the anterior end is beak-shaped and the posterior end is rounded, with the LV overlapping the RV. External valve ornamentation is weak, presenting a light primary reticulation of muri and secondarily pitted fossae. A sulcus and two or three smooth, poorly developed tubercles occur slightly anteriorly of mid-length. Two rows of minute, similarly sized

and shaped denticles occur in the anterior and posterior margins of both valves (only visible through SEM); the first row is located just over the free margin (Fig. 2h). The valve surface presents scattered sieve-type normal pores.

Internal view. The dorsal margin is straight, with the anterior cardinal angle marked. Muscle scars as for the genus with a vertical row of four scars. The hinge is modified antimerodont, consisting of one anterior small, smooth tooth, a central groove and a small, crenulated posterior tooth in the RV (Fig. 2e–f); LV central bar smooth. The marginal zone is more developed anteriorly, approximately twice as broad anteriorly compared with the posterior margin, with few straight, unbranched marginal pore canals.
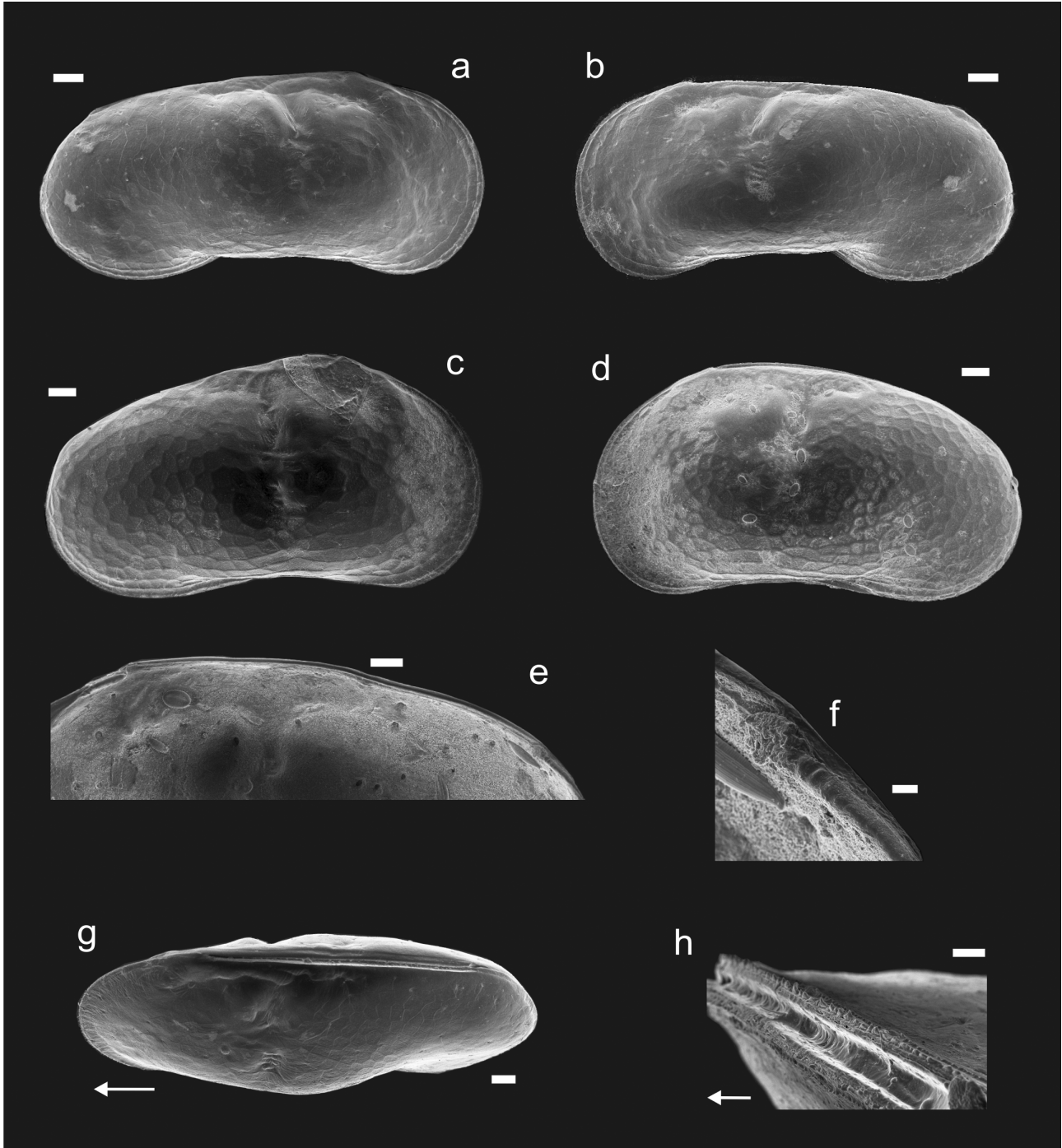

FIGURE 2. Carapaces and valves of *Limnocythere cusminskyae* **sp. nov. a.** External view of male RV. Holotype (LM–FCEN 3200). **b.** External view of male LV. Paratype (LM–FCEN 3201.1). **c.** External view of female RV. Paratype (LM–FCEN 3201.2). **d.** External view of female LV. Paratype (LM–FCEN 3201.2). **e.** Internal view of female RV. Paratype (LM–FCEN 3201.2). **f.** Detail of (e). **g.** Dorso-lateral view of male carapace. La Barrancosa core, 4-5 cm depth. **h.** Detail of ventral margin (ext.view) of female carapace. Supplementary material (LM–FCEN 3202.2). Scales: a–e: 40 μm; g: 30 μm; f, h: 9 μm.
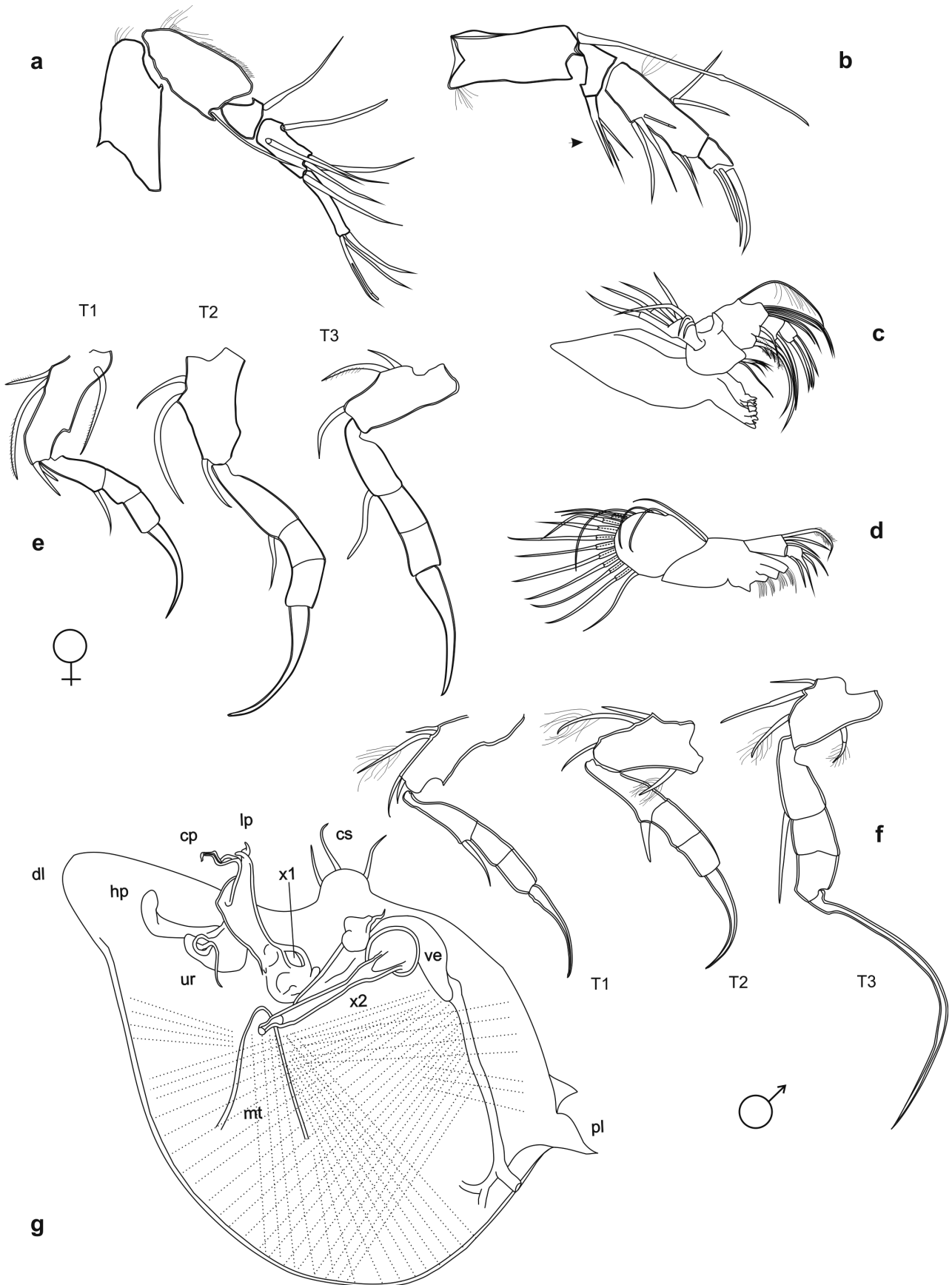
FIGURE 3. Appendages of *Limnocythere cusminskyae* **sp. nov. a.** Antennula. **b** Antenna. Arrow points to sexually dimorphic seta (see text). **c**. Mandibula. **d**. Maxilulla. **e**. Thoracopods of the female. **f**. Thoracopods of the male. **g**. Hemipenis.

Soft parts. The four anteriormost appendages are identical for both sexes, except for the morphology of a single seta in A2 (see below); the three thoracopods, for their part, present strong sexual dimorphism, both in relative size and the chaetotaxy of the basal segment.

The antennule (A1) is 5-segmented, with subapically flagellated setae on the third and fourth segments (Fig. 3a). The basal segment bears no setae; the second and third segments bear 1 seta each; the fourth segment presents 6 setae; the fifth segment has 3 setae, one of them proximally fused with an aesthetasc.

The antenna (A2) comprises 5 segments plus the exopod, which is a long, articulated seta (the spinneret seta) (Fig. 3b). The first four segments present bunches of setulae. The first segment is devoid of setae; the second presents the spinneret seta. The third segment bears 1 seta, smooth in the female and plumose in the male: its lower part is smooth, while the upper part presents numerous long flagella. The fourth segment presents 7 setae; 3 are plumose and 1, located medially, is an aesthetasc. The fifth segment bears 3 apical, unequally long claw-like setae.

The mandible (Md) presents a 4-segmented palp (Fig. 3c). The first segment bears a respiratory plate with 7 rays and 2 ventro-apically inserted setae; the second segment bears a long plumose seta dorsally, plus 5 smooth + 3 plumose + 2 smooth setae. The third segment presents 2 setae, while the fourth segment bears 4 setae apically.

The maxillule (Mx) presents 3 masticatory endites and bears a 2-segmented palp and a respiratory plate (Fig. 4d). The second segment of the palp is subrectangular and bears 4 setae.

Between Mx and the first walking leg is a so-called sternum, an elongated structure consisting of a central plate and lateral extensions, associated with the masticatory apparatus.

The first thoracopod (T1) is a 4-segmented limb which bears 6 setae + 1 apical claw in the female (Fig. 3e), and 5 setae + 1 apical claw in the male (Fig. 3f); the second seta of the basal segment is plumose in the male.

The second thoracopod (T2) is 4-segmented; the female presents 4 setae + 1 apical claw (Fig. 3e), while the male presents 5 setae + 1 apical claw (Fig. 3f), of which 2 are plumose. The apical claw is about a quarter longer than the apical claw of T1 in the female and subequal with the apical claw of T1 in the male.

The third thoracopod (T3) is 4-segmented as well, bearing 4 setae + 1 apical claw in the female (Fig. 3e) and 5 setae + 1 apical claw in the male (Fig. 3f), including 2 plumose setae. While in the female the apical claw of T3 is approximately as long as the apical claw of T2, in the male the apical claw of T3 is strikingly long ($\approx$ 2.5 x length of apical claw of T2), amounting to about half the total length of the appendage.

Genital lobe of the female without special features. The hemipenis (Fig. 3g) has a well-developed distal lobe. The upper ramus of the clasping organ is a tentacle-like processus. The x2 segment of the labyrinth is characteristically elongated and Y-shaped, with the bifurcated extreme adjacent to the vesica ejaculatoria.

Measurements. Holotype (male; LM–FCEN 3200): ML = 627 µm; MH = 273 µm

Paratype (male; LM–FCEN 3201.1): ML = 635 µm; MH = 283 µm

Paratype (female; LM–FCEN 3201.2): ML = 565 µm; MH = 295 µm

Paratype (female; LM–FCEN 3201.3): ML = 625 µm; MH = 330 µm

Distribution. The species has been recorded both living and fossil in Southeastern Pampa, mostly in locations close to the Atlantic coast (Fig. 1). As most of the research involving Quaternary microfossils that has been carried out in the Pampean area is related to past sea level fluctuations reconstruction, and therefore most of those studies included only seaside locations, the fact that *Limnocythere cusminskyae* **sp. nov.** has been found almost exclusively in the coastal area is quite probably a sampling bias artifact rather than a reliable indication of the species' (past) distribution. Laprida (2006) found live specimens of *L. cusminskyae* **sp. nov.** mostly in the shallow lakes Chascomús, Salada Grande, Los Horcones, Laguna del Monte and in the Arroyo Grande creek. Bertels & Martínez (1990; 1997) recorded the species in Holocene sediments from an exposed section along the margin of the Napostá Grande stream, at 2.5 km from its outlet to the ocean. The sediments, corresponding to the Bahía Blanca Formation, consist of shallow marine and transitional littoral-estuarine deposits. Ferrero (1996) reported it from a Holocene outcrop on the northern margin of the Quequén Grande river and in Late Pleistocene sediments ascribed to the Canal 5 Formation (Ferrero 2009) drilled near the Mar Chiquita Lagoon. Laprida (1998) found the species in samples taken from an outcrop on the right margin of the Canal N° 15 channel, corresponding to the early Holocene Destacamento Río Salado Formation, while Bertels-Psotka & Laprida (1998) recovered a single valve from Holocene sediments outcropping near that location (at the junction of Provincial Route N° 11 and Canal N° 15 channel), corresponding to the Cerro de la Gloria Member of Las Escobas Formation.

Remarks. Several limnocytherids recorded in the Pampean region have been likened to the well-known Neartic species *L. staplini* and, in one case, *L. bradburyi* Forester. Cusminsky& Whatley (1996) and Cusminsky *et*

al. (2005) considered the material described as *L.* aff. *L. bradburyi* by Bertels & Martínez (1990; 1997) to consist of juveniles of *L. rionegroensis*. This would be the northernmost record of the latter species, and the only one outside the Patagonian region. *L. rionegroensis* is known both after bisexual and parthenogenetic populations.

The valve outline of the male of *L. cusminskyae* **sp. nov.** differs from that of *L. rionegroensis* in the straight (*vs* curved) dorsal margin and from that of *L. bradburyi* in the ventral margin (reniform *vs* slightly curved). When comparing *L. staplini* and *L. cusminskyae* **sp. nov.**, both sexes are very similar in external morphology; perhaps the most important difference between them lies in the hinge, with the anterior tooth of the RV being crenulated in the former and smooth in the latter. Likewise, the valves of the females of *L. cusminskyae* **sp. nov.** and *L. rionegroensis* are very similar in external view. The hinge of *L. rionegroensis* is described as lophodont with a smooth bar; this would imply that the teeth are smooth, in contrast with the crenulated posterior hinge tooth of *L. cusminskyae* **sp. nov.** Lastly, *L. cusminskyae* **sp. nov.** differs from *L. bradburyi* in having a smooth hinge bar (*vs* crenulated in the latter species). This suggests that careful examination of hingement details might allow distinction between the valves of these similar taxa.

With regards to soft parts morphology, presently it is only possible to compare *L. cusminskyae* **sp. nov.** with *L. staplini*, whose appendages were described by Delorme (1971). This author makes no mention whatsoever of sexual dimorphism in thoracopod length; therefore, both species can be easily distinguished on the basis of soft parts analysis.

Lastly, it can be mentioned that Kihn & Pall (2013) report a limnocytherid left in open nomenclature, *Limnocythere* sp., from a small shallow lake in the inland Pampean region; while the line drawings of valves illustrating their work show a certain resemblance to *L. cusminskyae* **sp. nov.**, their poor quality and lack of description of the material prevent further comparisons.

Discussion

Most Quaternary and modern limnocytherids recorded in the Pampean region have been left in open nomenclature, with only five being determined up to species level. *Limnocythere paranaensis* Ferguson, which constitutes the earliest record of the genus in the area (Ferguson 1967), is too poorly described and illustrated to allow recognition or comparison, and no subsequent record has been published ever since. *Pampacythere multiperforata* Whatley & Cholich and *P. solum* Whatley & Cholich were recorded from fossil sediments ascribed to the Querandinense Stage of Late Pleistocene–Early Holocene age, sampled from the shallow lakes Salada Grande and Chascomús, and in the area around Canal Nº 15 channel (Whatley & Cholich, 1974). Laprida (1998), who considered *Pampacythere* to be a junior synonym of *Limnocythere*, recorded *L. solum* in Late Quaternary sediments, as did Laprida *et al.* (2009) and Ferrero (2009). Mechaly *et al.* (2003) claimed to have found living specimens of *L. solum* in a playa lake near the locality of Bahía Blanca; no description was made of the appendages. Individuals identified as *L. staplini* were reported in Ferrero (1996; 2009) and Laprida (1998).

L. staplini was first described from Pleistocene deposits from the central North American prairies (Gutentag & Benson 1962); subsequently it was found living throughout North America (Brouwers, 1990). Besides those records in the Pampean region which we consider to be conspecific with *Limnocythere cusminskyae* **sp. nov.**, the species has not been found in South America. The valve of *Limnocythere* sp. 1 illustrated by Bertels-Psotka & Laprida (1998) is described as having an adont hinge with the central groove located on the LV. Similarly, Bertels & Martínez (1997) mention that the individuals of *Limnocythere* sp. n. featured in that work and in their previous paper (Bertels & Martínez 1990) have an adont hinge. Nevertheless, we consider that this characterization of the hingement might be due to a taphonomic artifact: Bertels-Psotka & Laprida (1998) clearly stated that the *Limnocythere* sp. valve studied was poorly preserved, while Bertels & Martínez (1997) observed that *Limnocythere* **sp. n.** was left in open nomenclature due to the poor preservation of their material. In such taphonomic state, detailed observation of the hingement is difficult and thus we tentatively assign both taxa to *Limnocythere cusminskyae* **sp. nov.** in virtue of their great external resemblance.

The fifth limnocytherid species mentioned for the Pampean region is *L. rionegroensis*, by synonymy with *L.* aff. *L. bradburyi* sensu Bertels & Martínez (1990; 1997) (Cusminsky & Whatley, 1996; Cusminsky *et al.*, 2005). In the original description of *L. rionegroensis* from Quaternary Patagonian lacustrine sediments, Cusminsky & Whatley (1996) considered *L.* aff. *L. bradburyi* sensu Bertels & Martínez (1990) to consist of juveniles of *L. rionegroensis*. Subsequently, Bertels & Martínez (1997) published a paper including a description of their material,

including the hinge, which consists of two small teeth and an intercardinal groove on the RV, with the corresponding elements–the bar being smooth–on the LV; no changes were made in its identification. Nevertheless, Cusminsky *et al.* (2005) once more assigned *L.* aff. *L. bradburyi* sensu Bertels & Martínez to *L. rionegroensis*. Since both taxa share a great resemblance in external morphology and hingement, we agree with Cusminsky & Whatley in their synonymization. It is worth mentioning that the locality from which the material under question was obtained is situated close to the limit between the Pampean and Patagonian regions. Ultimately, sampling of extant populations from both regions and subsequent soft parts analyses will corroborate or disprove this criterion.

With regards to ecological affinities, presently there is evidence that the host waters of two coexisting limnocytherids of the Pampean region, namely *L. cusminskyae* **sp. nov.** and *L. rionegroensis*, lie within different hydrochemical fields. The former has been collected in permanent environments with oligo- or mesohaline, sodium-dominated alkaline waters (Laprida 2006), while the latter has been found exclusively in meso or polyhaline, sodium and chlorine–sulphate-dominated waters (Cusminsky *et al.* 2005; Ramón-Mercau *et al.* 2012). These preferences would also constitute a difference between *L. cusminskyae* **sp. nov.** and *L. staplini*, which occurs in bicarbonate-depleted waters mostly in the oligo—mesohaline range, as reported in the NANODe database (Forester *et al.* 2005b).

This has strong implications for several works dealing with paleoenvironmental reconstructions in the area involving limnocytherids. The earliest of these is the paper of Bertels & Martínez (1990) who, based on the findings of several researchers working elsewhere, considered the genus to be an indicator of high alkalinity resulting from an anion enrichment of the water, and interpreted their material accordingly. Ferrero (1996) interpreted her material, which we assign to *L. cusminskyae* **sp. nov.**, to be an indicator of high alkalinity and high salinity conditions. In a later work, Ferrero (2009) recorded the species again and considered it an indicator of high alkalinity, calcium and sulphate enriched waters. Laprida and collaborators have found *L. cusminskyae* **sp. nov.**, in a number of recent and current paleolimnological studies performed on sedimentary cores from Pampean continental shallow lakes (Lagunas Chascomús, del Monte, La Brava and La Barrancosa), with the species often occurring as (co)dominant in the total assemblage (Laprida & Valero-Garcés 2009; Laprida *et al.* 2009; Plastani *et al.* 2012; 2013; Irurzún *et al.*, in press).These authors concurred with their predecessors in considering the species an indicator of high alkalinity; however, they interpreted its presence as evidence of bicarbonate-dominated, low-salinity waters. This discrepancy is due to the fact that they based their inferences on records of the selfsame species in the area (including the same lakes under study) rather than on general considerations on the genus' hydrochemical affinities.

Lastly, a number of paleoenvironmental studies performed in the area have been published which feature, among other bioproxies, limnocytherids; (García 1999; Fontana 2005; Ferrero *et al.* 2005; Cusminsky *et al.* 2006; Stutz *et al.* 2010) however, they are not included in this review since those records are left in open nomenclature and no images of the taxa are provided. In two of them, a *L. staplini*-like species—quite probably, *L.cusminskyae* **sp. nov.**—is reported as the dominant member of the ostracod assemblage. Fontana (2005) found *Limnocythere* cf. *staplini* in all the samples of a sediment sequence of Holocene age from the south coast of Buenos Aires Province (Laguna Sauce Grande). The author interpreted the paleoenvironmental significance of this record in terms of the ecology of *Limnocythere staplini* as discussed by several authors; the only work in Argentina mentioned is that of Laprida (1998). Stutz *et al.* (2010) studied a sediment core recovered from Nahuel Rucá, a shallow lake located in the southeast of Buenos Aires province (37º37' S, 57º26' W), spanning the late Holocene. The ostracod assemblage was dominated by *Limnocythere* cf. *staplini*, which was considered by the authors as an indicator of brackish to saline, shallow-water environments.

Conclusions

The genus *Limnocythere* has been abundantly recorded in Late Quaternary and modern environments of the Pampean region, often for use as indicator in paleoenvironmental reconstructions. In most cases, such usage has not been entirely appropriate, since it requires further knowledge of the systematic and ecology of the taxa involved than it is currently available. Presently, two proposed indicator species with different hydrochemical preferences - *L. cusminskyae* **sp. nov.** and *L. rionegroensis*— are known to occur in the area. While the former has been found in several locations, and frequently as a numerically important component of the ostracod assemblages, at the best of our knowledge the latter has only been found once yet in the Pampean region, in Holocene sediments. Additionally,

due to the great external resemblance of the female valves of these species, distinction between them on the basis of valve morphology alone relies heavily on the presence of males. Since *L. cusminskyae* **sp. nov.** occurs in amphimictic populations but *L. rionegroensis* is known from both amphimictic and parthenogenetic populations, the distinction by valve morphology might be problematic in case of coexistence of both species. On the other hand, the soft part morphology of *L. rionegroensis*, *L. solum* and *L. multiperforata* is still unknown—no extant record of the latter has, in fact, been published yet.

This suggests that a reevaluation of the *Limnocythere* material left in open nomenclature recovered in diverse studies carried out in the region, coupled with further sampling of current populations, would allow a better identification of both Quaternary and fossil limnocytherids through assessment of their intra- and interspecific variability, as well as a more accurate characterization of their ecological requirements. In turn, this would lend a more solid basis for their use as indicator species, thus enhancing their use in paleoecological reconstructions.

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