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CONSERVATION STATUS OF AND THREATS TO *LYNCEUS HUENTELAUQUENSIS* (BRANCHIOPODA, LAEVICAUDATA): AN ENDEMIC CRUSTACEAN FROM THE SEASONAL POOLS OF SEMI-ARID CHILE

BY

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ABSTRACT

The species *Lynceus huentelauquensis* is an endemic crustacean with a restricted habitat in ephemeral coastal pools in the "Norte Chico" (Near North) zone of Chile. This species is classified as endangered ("En Peligro", EN) under Chilean legislation, due to its restricted distribution and the specificity of its habitats. The present study consists of a review of the potential risk in order to prepare a conservation strategy for *L. huentelauquensis*. The study was carried out in habitats used by *L. huentelauquensis* that present threats from human intervention, caused by poultry-rearing, vehicle traffic, water extraction and pollution, as well as the presence of feral species such as dogs and cats. The species diversity of the study sites was found to differ markedly from other similar sites in Chile, where copepods and/or cladocerans predominate. Ecological and conservation topics are discussed.

Key words. — Crustacean conservation, clam shrimps, seasonal pools, aquatic biodiversity, environmental threats, temporary ecosystems, inland water crustaceans

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RESUMEN

La especie *Lynceus huentelauquensis* es un crustáceo endémico con un hábitat restringido a pozas costeras de la zona del norte chico de Chile. Esta especie es clasificada como amenazada ("En Peligro", EN) según la legislación chilena, debido a su distribución restringida y la especificidad de sus hábitats. Este estudio consiste en una revisión del riesgo potencial en orden de preparar una estrategia de conservación para *L. huentelauquensis* que presenta amenazas por intervención humana como crianza de ganado, tráfico de vehículos, extracción y contaminación de agua, presencia de especies asilvestradas como perros y gatos. Se encontró que la diversidad de especies en el sitio en estudio fue marcadamente similar a otros sitios en Chile, donde predominan los copépodos y/o cladóceros. Se discuten tópicos de ecología y conservación.

Palabras clave. — Conservación de crustáceos, camarones almeja, pozas estacionales, diversidad acuática, ecosistemas temporales, crustáceos de aguas continentales

INTRODUCTION

There are few studies of Laevicaudata and Spinicaudata in Chile, and reports are restricted to ephemeral coastal pools in the Norte Chico (Near North) of the country (32-33°S). Only two species are reported: *Leptestheria venezuelica* Daday, 1923 is distributed along the South American Pacific coast; while *Lynceus huentelauquensis* Sigvardt, Rogers, De los Ríos, Palero & Olesen, 2019, is endemic to Chile (Rogers et al., 2021; Sigvardt et al., 2021). Both species are called "clam shrimps"; they have a restricted distribution and are particularly adapted to the habitats of ephemeral pools on coastal plains in the Coquimbo Region (Sigvardt et al., 2019). *Lynceus huentelauquensis* is an example of the endemic biodiversity found in ephemeral pools in Chile, which originates during the rainy season and provides a unique habitat for highly specialized organisms (De los Ríos-Escalante et al., 2019).

In this context, in 2021 — for the first time — it was proposed to include the clam shrimp species *Lynceus huentelauquensis* (Branchiopoda, Laevicaudata) (fig. 1) as a protected species in Chile in the 18th Wild Species Classification (Exempt Resolution N° 1529/2021, MMA (Ministerio del Medio Ambiente/Ministry of the Environment, Chile)), on the grounds that it is an endemic element of ephemeral pools in the coastal plains of the southern Coquimbo Region (fig. 2). In mid-2023, this species was classified as "endangered" by the Classification Committee through Supreme Decree 2/2023 of the Ministry of the Environment (Political Constitution of Republic of Chile, Law 19300), due to its restricted range (distribution area and occupation area less than 100 km^2 and 30 km^2, respectively), and to the pressure of human activities on the habitats of the reduced populations (Pizarro-Araya & De los Ríos-Escalante, 2022).

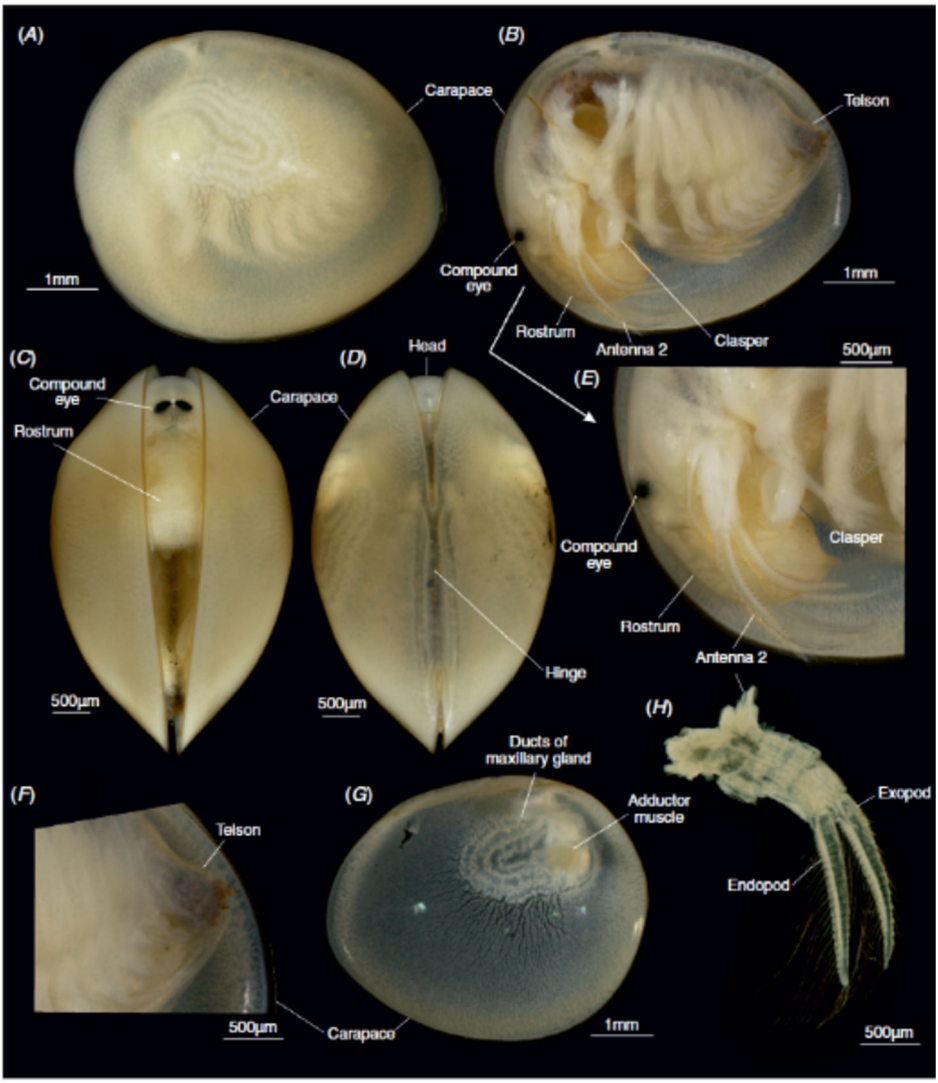

Fig. 1. Habitus of *Lynceus huentelauquensis* Sigvardt, Rogers, De los Ríos, Palero & Olesen, 2019 (Branchiopoda, Laevicaudata). [From Sigvardt et al., 2019.]

In the present study, we present a brief review of the systematics and distribution of *L. huentelauquensis*, as well as of the factors on which the proposal is based. We also discuss potential management procedures for the conservation of this species, with the object of mitigating the threat of environmental modification of its habitat.

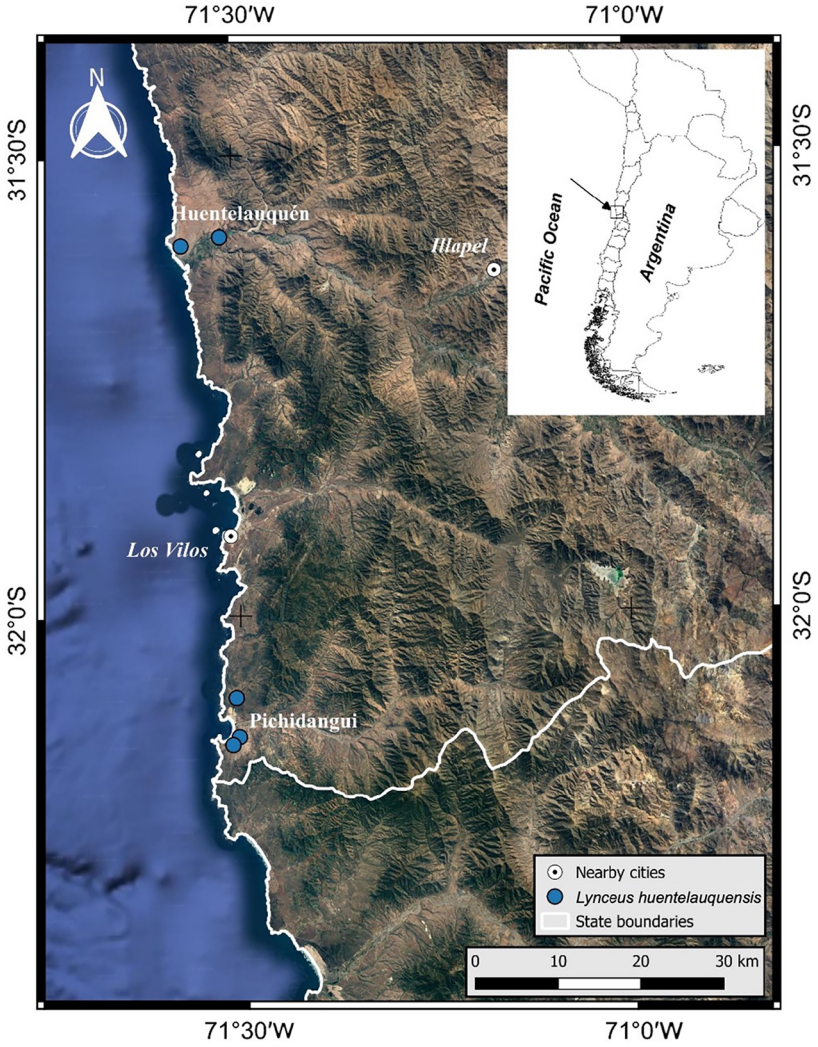

Fig. 2. Geographic map showing the locations of ephemeral pools in Huentelauquén and Pichidangui (Coquimbo Region, Chile), where *Lynceus huentelauquensis* Sigvardt, Rogers, De los Ríos, Palero & Olesen, 2019 populations have been recorded. Please note the latitude is "S" for South, while the longitude is "O" for West.

LYNCEUS HUENTELAUQUENSIS — AN ENDEMIC ELEMENT OF EPHEMERAL POOLS IN THE "NORTE CHICO" OF CHILE

This species has been reported for ephemeral pools in Huentelauquén; there are few studies on the biota of inland waters of this area (De los Ríos-Escalante et al., 2021). The pools are seasonal, with low species numbers and no structured patterns of species association. Previous studies have reported the presence of other crustaceans, such as *Daphnia ambigua* Scourfield, 1947, *Simocephalus serrulatus*

(Koch, 1841), *Boeckella gracilipes* Daday, 1901, and unidentified ostracods; however, this is the first record of the presence of the clam shrimps *Lynceus huentelauquensis* and *Leptestheria venezuelica* in Chile (De los Ríos-Escalante et al., 2021). The specific characteristics of these species raised many questions as to the adaptation strategies that have affected their life cycles, particularly in view of the seasonal conditions of their habitats, as well as other aspects of their life history.

Conservation status

The conservation status of *L. huentelauquensis*, classified as endangered ("En Peligro" — EN) under the Chilean Wild Species Classification Regulation (RCE), is based on the vulnerability of its habitats. These consist of ephemeral pools, which are highly sensitive to drying out due to climate change and water pollution caused by human activities. The limited geographical distribution and the specialized conditions of these pools increase the threat of extinction. Habitat preservation is important not only for the survival of these species, but to sustain the ecological integrity of ephemeral ecosystems of the region, which are biodiversity hotspots and play an important ecological role. Understanding the biology and ecology of this endemic species can offer valuable lessons on species conservation in ephemeral habitats, and contribute to more effective environmental management in the Coquimbo Region and other, similar areas.

Systematics and taxonomy

Lynceus huentelauquensis is distinguished by morphological characteristics that differ from those of other species of *Lynceus*, such as a bifurcated rostral carina in males and a weakly curved rostrum. These morphological adaptations are not only of taxonomic interest; they also reflect the evolution of the species to its native environment (Sigvardt et al., 2019). The ephemeral pools that form the habitat of this species are exposed to cycles of flooding and drying, creating a dynamic and challenging environment for aquatic organisms (Pizarro-Araya & De los Ríos-Escalante, 2022).

Distribution and habitat

Currently, there are only two localities where this species has been reported: Huentelauquén (31°33′16.82″S 71°33′23.72″W) and Pichidangui (32°6′10.38″S 71°30′18.59″W) (fig. 2). These are coastal habitats in a transition area between steppe with shrubby vegetation to the north, and vegetation including both shrubs and trees further south (Chang et al., 1989; Gajardo, 1993; Pizarro-Araya &

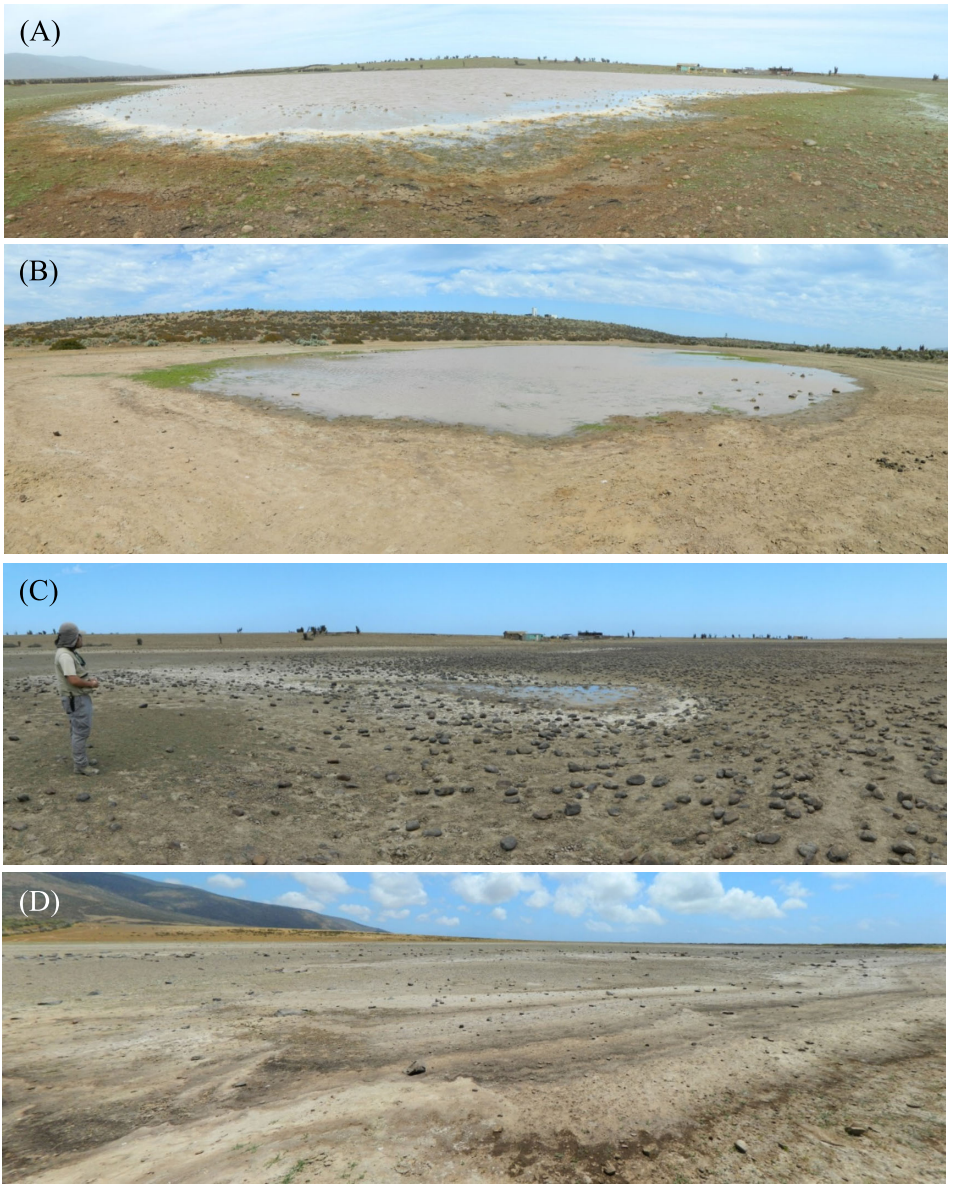

Fig. 3. Panoramic views of ephemeral pools in Huentelauquén (Coquimbo Region, Chile). A and B, Showing active pools during the rainy season; whereas C and D are depicting dry pools during the dry season, thus illustrating the extreme seasonal variability of these habitats.

Cepeda-Pizarro, 2013). The specific habitats are shallow, ephemeral pools that form during the rainy season in the southern hemisphere winter and spring (July-September) (fig. 3).

Vulnerability and threats

There are numerous threats to the survival of *Lynceus huentelauquensis*. The presence of poultry during the period when the seasonal pools appear can destroy these fragile habitats, as well as alter the soil structure in such a way as to threaten the survival of aquatic species (figs. 4-5). Urbanization, and the consequent spread of urban areas, implies the destruction and fragmentation of natural habitats, severely reducing the availability of space for *L. huentelauquensis* and associated species.

Furthermore, vehicle traffic close to the ephemeral pools can cause soil compaction and pollution, affecting the habitat conditions needed for the survival of this species. Waste and debris affect both the water and the soil, causing the habitat quality to deteriorate. Water extraction for agricultural and urban uses can reduce the water level and availability in ephemeral pools, resulting in drying out and a reduction of the space available for *L. huentelauquensis*. Division and occupation of the land by local people is another threat, because it reduces the space available to this species. Feral dogs and cats present in the area may indirectly impact *Lynceus huentelauquensis* and its habitat by disturbing the margins of ephemeral pools, trampling vegetation, and altering the substrate. These disturbances can degrade habitat quality, affect water retention, and disrupt the ecological interactions within the pools. Additionally, predation on small vertebrates and large invertebrates by these animals may alter local food webs, potentially influencing the ecological balance of these fragile aquatic ecosystems (fig. 4).

Conservation proposal

To mitigate the threats identified and to protect *Lynceus huentelauquensis*, it is fundamental to implement conservation management procedures. Habitat protection and restoration are essential, through the creation of protected areas to preserve the ephemeral pools and surrounding areas, and restoration of the degraded habitats to enhance living conditions for the species. It is also necessary to establish regulations to control urbanization and land division in critical areas, promoting the sustainable development of the region.

The control of poultry and vehicle traffic is likewise important. It is necessary to create regulations and/or physical barriers to prevent poultry and vehicles from entering the areas of seasonal pools, providing alternative routes as well as alternative poultry feeding grounds far from sensitive habitats. Waste management must be planned and rigorously implemented to prevent waste and debris from polluting ephemeral pools. The public must be made aware of the importance of keeping these habitats free of pollution.

Fig. 4. Threats to the habitat of *Lynceus huentelauquensis* Sigvardt, Rogers, De los Ríos, Palero & Olesen, 2019. A, Presence of individuals of *Capra hircus* Linnaeus, 1758, grazing on the native vegetation of Huentelauquén ephemeral pools; B, feral dogs (*Canis familiaris* Linnaeus, 1758), in areas surrounding the ephemeral pools; C, humans on motorized vehicles transiting around the ephemeral pools; D, house building and other human habitat modification in the natural areas that form the habitat of the threatened Laevicaudata.

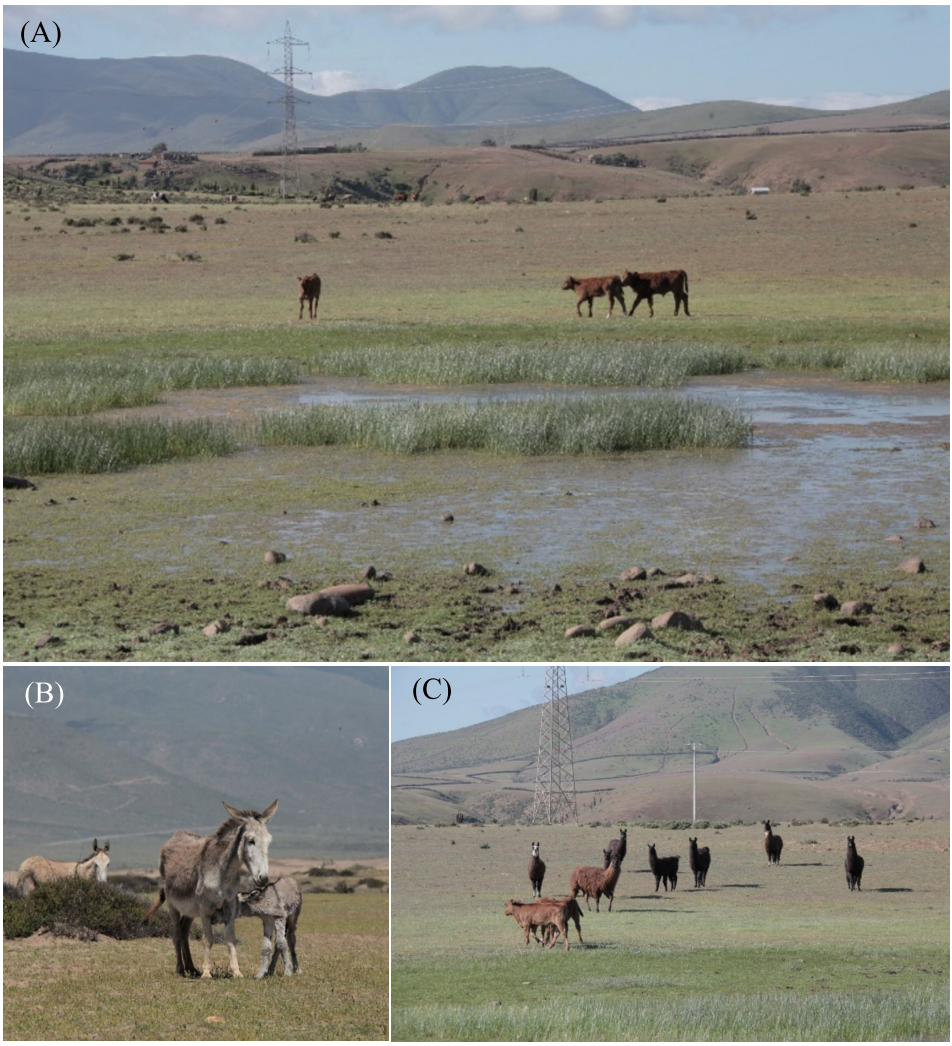

Fig. 5. Threats to the habitat of *Lynceus huentelauquensis* Sigvardt, Rogers, De los Ríos, Palero & Olesen, 2019. Grazing by: A, *Bos taurus* Linnaeus, 1758; B, *Equus asinus* Linnaeus, 1758 (donkey); and C, *Lama glama* (Linnaeus, 1758) (llama); poses a significant threat to the native vegetation surrounding the pools, directly impacting the fragile ecosystem where this branchiopod species thrives.

Water extraction in the area needs to be regulated to ensure that the ephemeral pools maintain adequate levels during the critical season; this will also enhance efficient, sustainable water use. Environmental education campaigns are important to inform the local communities about the importance of *Lynceus huentelauquensis* and the ephemeral pools, getting the community involved in conservation and monitoring activities.

Control programmes of invasive species, mainly feral dogs and cats, must be implemented to reduce their populations in the area of ephemeral pools and to minimize their impact on the native fauna. Future studies will be needed on the ecology and distribution of *L. huentelauquensis*, as well as monitoring of the populations and their habitat conditions in order to evaluate the effectiveness of conservation practices and adjust them if necessary. These procedures are not only important for protecting *Lynceus huentelauquensis*, they will also help to conserve the ecological integrity of ephemeral pools and the exclusive diversity that they sustain.

Ecological importance

Lynceus huentelauquensis plays a crucial role in the ecological equilibrium of ephemeral pools in the Coquimbo Region. As an endemic species adapted to ephemeral pools, it makes an important contribution to local biodiversity; it also serves as a biomarker of the environmental condition of these unique ecosystems. Its presence and survival depend on the specific conditions of its habitat, reflecting water and soil quality as well as the ecosystem's general functioning. *Lynceus huentelauquensis* forms part of the trophic chain as a prey for aquatic birds and other predators, and participates in the regulation of microorganisms and algae in these ephemeral pools. Conservation involves not only protecting this species, but also sustaining the biodiversity and ecological functioning of these ephemeral pools that are crucial for the semiarid ecosystems of Chile.

DISCUSSION

Recent studies at Huentelauquén have revealed that the crustacean communities in these ephemeral pools are unstructured and present low species diversity. The dominant presence of *Lynceus* and *Leptestheria* suggests an ecological dynamic different from that recorded in other parts of Chile, where cladocerans and copepods predominate (De los Ríos-Escalante & Woelfl, 2023). This difference may be due to the resistance of the eggs of both clam shrimp species, and the ease with which they are dispersed, enabling them to colonize and dominate these ephemeral pools (De los Ríos-Escalante et al., 2021). The low species diversity at Huentelauquén may be related to the extreme environmental conditions and the ecological variability characteristic of these habitats (Zuleta et al., 2019). The fluctuations in water availability, and factors like salinity and temperature, create a highly selective environment in which only the best-adapted species can survive. *Lynceus huentelauquensis* and *Leptestheria venezuelica* enjoy an adaptative advantage in this environment due to their reproductive strategy, which

includes the production of eggs that can survive long periods of drought (Rogers et al., 2021).

The predominance of these taxa may also be influenced by the absence of certain competitors and predators found in other kinds of permanent water bodies, enhancing the proliferation of *L. huentelauquensis* and *L. venezuelica* (cf. De los Ríos-Escalante et al., 2019). Anthropogenic factors, such as habitat alterations and pollution, may also affect crustacean community structure, favouring species with greater resistance and capacity for colonization (De los Ríos-Escalante & Woelfl, 2023).

Crustacean community dynamics in the ephemeral pools at Huentelauquén not only provide information on the ecology of these environments, they can also be applied for conservation. The dominance of species such as *L. huentelauquensis* highlights the need to protect these specific habitats, which are important not only for the survival of this species, but also for sustaining the ecological functionality of the region. Future studies should be directed towards improving understanding of the factors determining the composition and structure of crustacean communities in ephemeral pools, as well as evaluating the anthropogenic and climatic threats to these ecosystems.

CONCLUSIONS

The classification of *Lynceus huentelauquensis* as endangered highlights the need to implement conservation strategies to protect the ephemeral pools that form its habitat. Further studies are required on the ecology and distribution of this species, as well as crustacean community dynamics in ephemeral pools of the region. Conservation of these ecosystems will not only help to preserve *Lynceus huentelauquensis* but will also protect the unique diversity that inhabits the ephemeral pools. This endemic species can also be used as a biomarker for the environmental conditions of the ephemeral pools it inhabits, allowing more precise evaluation of the impact of anthropogenic activity and climate change on these habitats. Involving the local communities in conservation efforts is crucial, to enhance sustainable practices and increase awareness of the importance of these ecosystems. The survival of *Lynceus huentelauquensis* and the preservation of ephemeral pools in the Coquimbo Region can only be ensured by an integrated and collaborative approach combining scientific research with environmental management and community education.

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REFERENCES

CHANG, A., P. DROULLY, S. PALMA, M. RODRÍGUEZ & Y. VILINA, 1989. Prospección de áreas de concentración de fauna entre la I a VII Región. (FAO-CHI, Santiago, Chile).

DE LOS RÍOS-ESCALANTE, P., J. PIZARRO-ARAYA, F. M. ALFARO & J. PÉREZ-SCHULTHEISS, 2021. A preliminary observation of a terrestrial isopod (Crustacea, Isopoda) in the transitional coastal desert of Chile (24-29°S). Crustaceana, **94**(5): 519-528. DOI:10.1163/15685403-bja10097.

DE LOS RÍOS-ESCALANTE, P., J. PIZARRO-ARAYA, F. M. ALFARO & C. ZULETA, 2019. First descriptions of aquatic crustaceans in coastal plains in northern Chile (Huentelauquén, 31°S, Coquimbo region, Chile). Crustaceana, **92**(1): 73-81. DOI:10.1163/15685403-00003825.

DE LOS RÍOS-ESCALANTE, P. & S. WOELFL, 2023. A review of zooplankton research in Chile. Limnologica, **100**: 126079. DOI:10.1016/j.limno.2023.126079.

GAJARDO, R., 1993. La vegetación natural de Chile. Clasificación y distribución geográfica: 1-165. (Editorial Universitaria, Santiago).

PIZARRO-ARAYA, J., F. M. ALFARO & P. DE LOS RÍOS-ESCALANTE, 2024. Insects associated to ephemeral pools in Huentelauquén (29°S Coquimbo Region, Chile). Brazilian Journal of Biology, **84**: e254095. DOI:10.1590/1519-6984.254095.

PIZARRO-ARAYA, J. & J. CEPEDA-PIZARRO, 2013. Taxonomic composition and abundance of epigean tenebrionids (Coleoptera: Tenebrionidae) in the Chilean coastal matorral. Idesia, **31**(4): 111-118. DOI:10.4067/S0718-34292013000400015.

PIZARRO-ARAYA, J. & P. DE LOS RÍOS-ESCALANTE, 2022. *Lynceus huentelauquensis* Sigvardt, Rogers, De los Ríos, Palero & Olesen, 2019 (Diplostraca: Lynceidae). In: Ficha Inicial de 18° Proceso de Clasificación de Especies. (Ministerio del Medio Ambiente, Chile). https://clasificacionespecies.mma.gob.cl/wp-content/uploads/2022/04/Lynceus_huentelauquensis_18RCE_INICIAL.pdf.

ROGERS, D. C., F. SEVERO-NETO, M. V. VOLCÁN, P. DE LOS RÍOS-ESCALANTE, L. B. EPELE, A. O. FERREIRA & N. RABET, 2021. Comments and records on the large branchiopod Crustacea (Anostraca, Notostraca, Laevicaudata, Spinicaudata, Cyclestherida) of the Neotropical and Antarctic bioregions. Studies on Neotropical Fauna and Environment, **56**(1): 53-77. DOI:10.1080/01650521.2020.1728879.

SIGVARDT, Z. M. S., D. C. ROGERS, P. DE LOS RÍOS, F. PALERO & J. OLESEN, 2019. First molecular phylogeny of Laevicaudata (Crustacea: Branchiopoda) with description of a new species of *Lynceus* from Chile and an updated key to species in the Americas. Invertebrate Systematics, **33**(4): 597-617. DOI:10.1071/IS18073.

ZULETA, C., A. CEA, V. BRAVO, R. CASTILLO, M. ROBLES, J. PIZARRO-ARAYA, F. M. ALFARO, P. DE LOS RÍOS-ESCALANTE & C. PIÑONES, 2019. Charcas temporales de Huentelauquén (Canela, Región de Coquimbo). In: C. ZULETA & M. CONTRERAS-LÓPEZ (eds.), Humedales costeros de la Región de Coquimbo: Biodiversidad, vulnerabilidades & conservación: 148-188. (Ediciones Universidad de la Serena, La Serena, Chile).

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