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A new record of the non indigenous freshwater jellyfish *Craspedacusta sowerbii* Lankester, 1880 (Cnidaria) in Northern Patagonia (40° S, Chile)

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Abstract

A new record of the freshwater jellyfish *Craspedacusta sowerbii* in northern Chilean Patagonia is reported. The specimens were collected from Laguna Illahuapi, an oligotrophic shallow lake (15 m maximum depth) in early austral autumn, May 2013. This water body is located in the upper zone of the Rio Bueno basin, Province of Ranco, Region de los Ríos, Chile. The region is characterized by a great diversity of freshwater environments with minimal human pressure. This report confirms the presence of *C. sowerbii* in Chilean Patagonia and represents the southernmost range of distribution of this exotic medusa in South America. This study also contributes additional information on the limnological characterization of this water body.

Key words: *Craspedacusta sowerbii*; exotic species; freshwater jellyfish; medusa; Patagonia; Chile

Introduction

Craspedacusta sowerbii (Lankester, 1880) is a freshwater cnidarian native to the Yangtze valley in China (Kramp 1961). The life cycle of this organism is well known (De Vries 1992; Sasaki 1999; Lewis et al. 2012) including both benthic polyp and free- swimming medusa stages. Like many other freshwater organisms, *C. sowerbii* develops a resting stage under unfavorable environmental conditions, an adaptation conferring not only high potential of survival but also enhancing the capacity for dispersal. At present *C. sowerbii* is recognized as the most abundant and cosmopolitan freshwater cnidarian with a medusa stage (Dumont 1994; Jankowski et al. 2008; Fritz et al. 2009). During the last century *C. sowerbii* has invaded and successfully colonized practically all continents with the exception of Antarctica (Dumont 1994; Jankowski et al. 2008). *Craspedacusta sowerbii* exhibits an expansive ecological niche, being reported from streams, ponds, lakes, swamps and reservoirs (Boothroyd et al. 2002; Fritz et al. 2007; Lewis et al. 2012). Nevertheless, the medusa stage of this species seems to prefer temperate, stillwater, freshwater bodies of mesotrophic character (Jankowski 2001; Moreno Leon and Ortega- Rubio 2009; Jankowski et al. 2008) and water temperatures ranging from 12 to 33°C (Lewis et al. 2012). In these lentic aquatic ecosystems *C. sowerbii* medusa stage is basically planktivorous, and is capable of developing blooms, particularly during the warm seasons (Jakowski et al. 2005; Stefani et al. 2010; Gophen and Shealtiel 2012). Optimum growth temperature for sexually mature *C. sowerbii* medusae ranges from 19 to 25°C (McClary 1959; Pérez-Bote et al. 2006). The impact of this jellyfish on inland freshwater ecosystems is unclear and remains insufficiently studied (Oscoz et al. 2010).

There is a general consensus about human mediated introduction via the transplantation of fish and aquatic plants (Dumont 1994; Marsden and Hauser 2009). The northernmost limit of *C. sowerbii* in North America is reported from Canada at 46°N (McAlpine et. al. 2002), a biogeographically different zone compared to the U.S. distribution (De Vries 1992). For Meso-America, only the recent study by Moreno-Leon and Ortega-Rubio (2009) confirmed the establishment in Mexico. In contrast, the first reports of *C. sowerbii* in South American inland waters (Panama, Brazil, Uruguay, Argentina and Chile) date back to 1925 (Ringuelet 1950). The first reports of *C. sowerbii* from Chile date to 1942, when Porter and Schmitt (1942) collected and described free living medusae in “Tranque (dam) Marga-Marga”, located in the commune of Quilpué, province of Valparaíso, central Chile (32°S). In this same province, which hosts Chile’s principal international seaport for containers and passenger ships, large stable populations of *C. sowerbii* were later documented from Peñuelas reservoir (Schmid-Araya and Zúñiga 1992). The latter study reported that the highest abundance of free living medusa in the eutrophic waters of this water body occurred during February, the warmest month of the austral summer. More recently, Figueroa and De Los Ríos (2010) reported the presence of *C. sowerbii* in the Araucania Region, from Laguna Carilafquen (38 °S). In Argentina, *C. sowerbii* has only three published reports. The earliest record from General San Martin reservoir, Mendoza (31°S) was in 1950 (Ringuelet 1950). Later reports include a pond close to the La Florida dam, province of San Luis (33°S) in 1979 (Richard 1990) and from the Rio Tercero reservoir, province of Cordoba (32°S) in 1980 (Boltovskoy and Battistoni 1981). Currently there are no governmental monitoring programs aimed at studying the emergence of aquatic non-indigenous species in Chile. The generally scarce information on aquatic biological invasions in the country is mainly due to restrictions in the Chilean environmental legislation, which only allows funding of this kind of research when the exotic taxon is declared a pest. Such was the case of *Didymosphenia geminata*, detected forming blooms in different watersheds from Patagonia (Reid et al. 2012).

The presence of *C. sowerbii* in Laguna Illahuapi, Region de los Ríos (40 °S), constitutes a new record of this exotic freshwater jellyfish in Patagonia and represents the southernmost known distribution of the organism for the American continent (Figure 1 and Appendix 1).

Methods

On 5 May 2013 (early austral autumn) we conducted a limnological characterization of Laguna Illahuapi (40°16'16"S, 72°18'00", Figure 1 and 2), Province of Ranco, Region de los Ríos, Chile. This aquatic environment is located in a rural area very close to the large and deep (< 200 m) oligotrophic Lago Ranco (Campos et al. 1992). Laguna Illahuapi is located at 169 m a.s.l. and has a surface area of 14.1 ha, a maximum width of 365 m and a maximum length of 708 m. Tributaries are absent and water level fluctuates depending on precipitation. This lagoon is surrounded by a dense and diverse belt of submerged and emergent macrophytes, grading into forest cover dominated by *Nothofagus dombeyi*. The dominant submerged plants present in the littoral zone were *Myriophyllum* sp. and *Potamogeton* sp.

The sampling of this water body is part of a comparative study between large deep (>100 m) lakes and small shallower water bodies in North Patagonia (40-41°S) carried out by the Limnology and Aquatic Ecology laboratory from the Austral University, Valdivia, Chile. The sampling of Laguna Illahuapi was performed using a zodiac boat. An approximated bathymetric profile was constructed along the main longitudinal axis using echo-sounding (Garmin fishfinder 140) from the moving zodiac boat. A sampling station was established on the point of maximum depth (15.5 m), where limnological variables [dissolved oxygen (DO), temperature, conductivity, chlorophyll-a and pH] were measured every meter, from surface to a maximum depth of 14 m, using a YSI probe (model 6920 V2, USA). Water transparency was assessed using a Secchi disk (20 cm diameter). Based on the temperature profiles recorded *in situ* it was possible to assess where the thermocline was located. A single integrated epilimnetic water sample (Z_{mix} = 6 m) was later constructed by collecting 2 L of water at regular intervals of 2 m using a 5 L UWITEC bottle and a plastic container of 10 L. Sub-volumes of the integrated epilimnetic water sample were dark stored in plastic containers at 4°C for chemical and phytoplankton analyses. Chemical analyses [Total phosphorus (TP), soluble reactive phosphorus (SRP), total nitrogen (TN), nitrate (NO_3), nitrite (NO_2) and the major ions (Na^+, K^+, Ca^{++}, Mg^{++}, $SO_4^=$, $CaCO_3$, Cl^- and SiO_2)] were carried out according to standard methods (APHA 2005). Qualitative and quantitative zooplankton samples were collected by vertical hauls, from surface to 14 m depth, using a plankton net of 80 µm with flow meter (General Oceanics, USA). Samples were concentrated and narcotized with carbonated water prior to being fixed with buffered formalin solution at 4%. Phytoplankton was preserved in

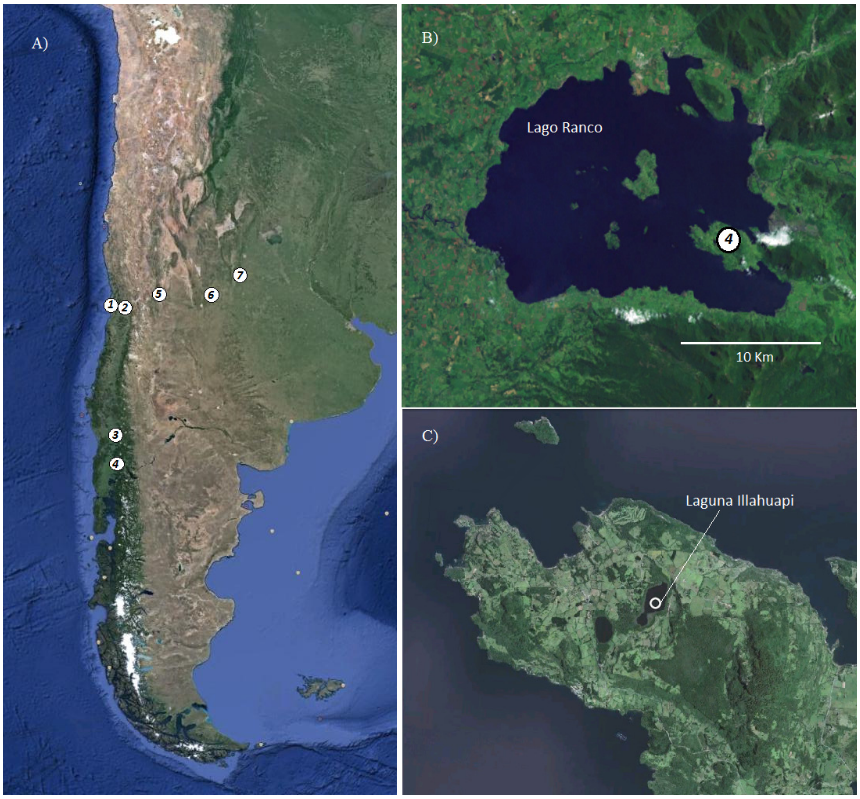

Figure 1. A) Distribution records of *Craspedacusta sowerbii* Lankester, 1880 in South America, shown on Google map. Numbers correspond to sites in Appendix 1. B) Lago Ranco with the specific location of Laguna Illahuapi (n° 4) and C) Detailed image of Laguna Illahuapi.

Figure 2. Sampling location, Laguna Illahuapi in May 2013.

plastic bottles with Lugol's iodine solution. Counting of cells was performed according to Utermöhl (1958). Zooplankton samples were analyzed under a compound microscope following the taxonomical guide for Chilean inland waters (Araya and Zúñiga 1985) and the taxonomic and systematic diagnoses for cnidarians described by Jankowsky (2001).

Results

Limnological characterization of Laguna Illahuapi

Based on the study of physical, chemical and biological attributes (Figure 3 and Table 1), Laguna Illahuapi is characterized as a temperate warm monomictic shallow lake (15 m depth) with oligotrophic status. At the time of sampling it was thermally stratified with a surface water temperature of 15.4°C. The epilimnetic waters (0–7 m deep) of Laguna Illahuapi were well oxygenated, but exhibited hypoxic condition in the hypolimnetic strata (Figure 3). Typical of most freshwater ecosystems in Central South Chile, Laguna Illahuapi has low ionic strength, with a conductivity of 45 µScm^{-1} and circumneutral pH of 7.36. In contrast with the Araucanian lakes (*sensu* Thommason 1963), Laguna Illahuapi has low transparency (Secchi Depth 4.5 m, Table 1), probably due to humic substances that commonly confers yellowish-brown water color. The maximum chlorophyll-a concentration (Chl-a) was 2.33 µg L^{-1} using *in situ* fluorimetry.

In terms of floristic composition, the phytoplankton in Laguna Illahuapi was composed of a total of 26 algal taxa, of which eight were Chlorophytes, nine Diatoms, three Dinoflagellates, three Crysophytes, two Cryptophytes and one was a Cyanobacterium (Table 2). The dominant phytoplankton species by biovolume were *Ceratium hirundinella*, *Gymnodinum* sp. and *Peridinium willei* (Dinoflagellates), *Dinobryon* sp. (crysophyte) and *Cyclotella glomerata* (Diatom), a phytoplankton assemblage that constitutes the functional group X2 according to Reynolds et al. (2002). The zooplankton assemblage consisted of 12 taxa (Table 3), including two copepod species (*Tumeodiaptomus diabolicus* and *Acanthocyclops* sp.), four cladocerans (*Bosmina longirostris*, *Ceriodaphnia dubia*, *Daphnia pulex*, and *Diaphanosoma chilensis*), four rotifers (*Polyarthra dolichoptera*, *Ascomorpha* sp., *Asplanchna* sp, *Keratella cochlearis*), one unidentified freshwater mite, and the medusa stage of the cnidarian (Limnomedusa) *Craspedacusta sowerbii* Lankester, 1880. This jellyfish (Figure 4) presented an umbrella diameter of 16 mm, and gonads were well defined. In addition, four types of tentacles were observed based on average lengths (n = 2 sexually mature medusae): primary (8.5 mm), secondary (4.0 mm), tertiary (1.5 mm) and quaternary (0.5 mm).

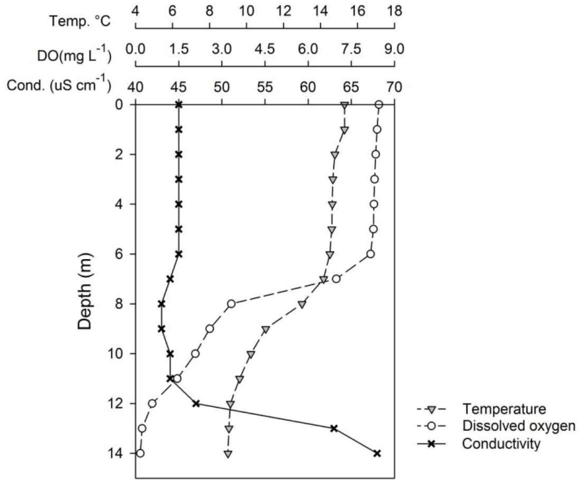

Figure 3. Temperature (Temp.), dissolved oxygen (DO) and conductivity (Cond.) vertical profiles in the water column of Laguna Illahuapi.

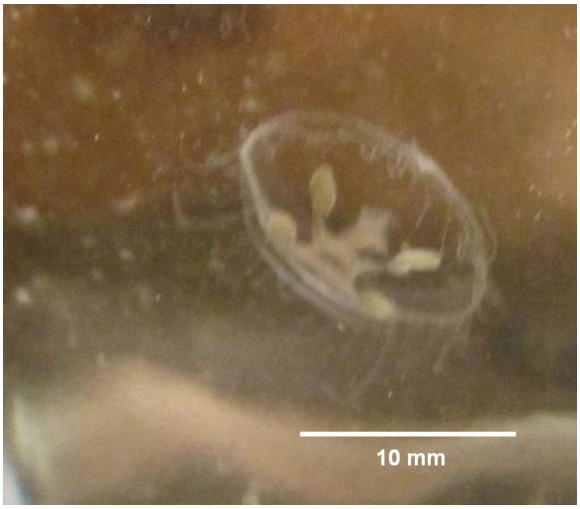

Figure 4. *Craspedacusta sowerbii* Lankester, 1880. A specimen collected in Laguna Illahuapi, Ranco basin, 5 May 2013.

Discussion

Laguna Illahuapi is characterized as oligotrophic (Carlson 1977), which is consistent with the phytoplankton functional group X2. The phytoplankton and zooplankton composition is similar to plankton communities from other temperate lentic inland water bodies where *C. sowerbii* has established large summertime populations (Stefani et al. 2010; Pérez-Bote et al. 2006).

Table 1. Chemical characteristics of the epilimetic water (Zmix= 6m) of Laguna Illahuapi measured in the early autumn, May 2013.

Parameter	unit	Epiliminion
Temperature	°C	15.4
Conductivity	μScm^{-1}	45
Secchi Disk	m	4.5
Chlorophyll-a (Chl-a)	μgL^{-1}	2.33
Total phosphorus (TP)	$\mu g\ L^{-1}$	12
Phosphate (P_PO_4)	$\mu g\ L^{-1}$	< 1
Nitrate (N_NO_3)	$\mu g\ L^{-1}$	43
Nitrite (N_NO_2)	$\mu g\ L^{-1}$	< 1
Silica (SiO_2)	mgL^{-1}	2.1
Alkalinity ($CaCO_3$)	mgL^{-1}	6
Chloride (Cl)	mgL^{-1}	1.02
Sodium (Na)	mgL^{-1}	1.55
Potassium (K)	mgL^{-1}	1.06
Sulphate (SO_4)	mgL^{-1}	< 0.112
pH		7.36

Table 2. List of phytoplankton species detected in Laguna Illahuapi. In parenthesis the relative percentage (biovolume) values are reported for those species contributing in more than 1 % to the total phytoplankton biomass.

Chloroficeae (Chlorophytes)	**Dinophyceae (Dynophytes)**
Botryococcus braunii Kutzing 1849	*Ceratium hirundinella* (Müller) Schrank 1882 (20)
Crucigeniella sp (1)	*Gymnodinium paradoxum* (Schilling 1891) (6)
Elakatothrix gelatinosa Wille 1898	*Peridinium willei* Huitfeldt-Kaas 1900 (8)
Eudorina sp.	
Gonatozygon sp.	**Chrysophyceae (Chrysophytes)**
Oocystis sp.	*Mallomonas* sp.
Staurastrum sp.	*Ochromonas* sp.
Volvox aureus	
Bacillariophyceae (Diatoms)	**Cryptophyceae (Cryptophytes)**
Aulacoseira granulata (Ehrenberg) Simonsen 1979	*Cryptomona* sp. (10)
Cyclotella glomerata Bachmann1911 (6)	*Rhodomonas* sp. (26)
Cyclotella sp. (3)	
Diatoma sp.	**Cyanophyceae (Cyanobacteria)**
Fragilaria sp.	*Anabaena* sp.
Gomphonema sp.	
Melosira varians Agardh 1827	
Tabellaria fenestrata Lyngbye Kützing 1844	
Tabellaria flocculosa Roth Kützing 1844	

Table 3. Zooplankton species abundance (vertical hauls, 0-14 m deep) recorded in Laguna Illahuapi in the early autumn, May 2013.

Species	Density (ind L^{-1})
Copepods	
Tumeodiaptomus diabolicus Brehm 1935	4.4
Acanthocyclops sp.	0.4
Cladocerans	
Bosmina longirostris Muller 1785	9.5
Ceriodaphnia dubia Richard 1894	5.1
Daphnia cf. *pulex* Leydig 1860	1.6
Diaphanosoma chilensis Daday 1902	0.2
Rotifers	
Polyarthra dolichoptera Idelson 1925	220
Ascomorpha sp	60
Asplanchna sp	n.d
Keratella cochlearis Gosse 1851	n.d
Freshwater mites	n.d
Cnidarians	
Craspedacusta sowerbii Lankester 1880	$6\ 10^{-3}$

Medium and large sized cladocerans such as *B. longirostris, C. dubia* and *D. pulex*, and the rotifer *P. dolichoptera*, which dominated the zooplankton community in our study, have been described as a suitable prey for the medusa stage of *C. sowerbii* (Davis 1955; Dodson and Cooper 1983; Spadinger and Maier 1999). Together with the warm stratified surface water (commonly reaching 24°C in midsummer at 40°S), conditions might be considered optimal for jellyfish blooms in this and other North Patagonian shallow lakes. In order to test this hypothesis, more intensive summer surveys must be conducted. Furthermore, we suspect that the distribution of *C. sowerbii* could be extensive in Chilean Patagonia, given the presence of many other small shallow lakes with similar characteristics (MMA 2012), and potentially considered an empty niche throughout Southern Chile. In agreement with Dumont (1994), we believe that N-S inter-valley dispersion of drought-resistant resting stages of *C. sowerbii* in Southern Chile (Patagonia) could be mediated mostly by aerial dispersal of migrating birds along the Andes Mountain corridor. In the current scenario of global climate change, and in a strong agreement with Rosenzweig et al. (2007), we also believe that the expansion of this freshwater jellyfish towards higher latitudes (poleward) in Chilean and Argentinean territory (Patagonia) would also be favored.

Even though our sampling does not consider the polyp stage of *C. sowerbii* in sediments of littoral-sub littoral strata, the finding of the medusae stage with developed gonads (sexually mature specimens) in the pelagic habitat of Laguna Illahuapi is in itself evidence that this exotic cnidarian has successfully bypassed physical and climatic barriers and has established in Chilean aquatic environments at this latitude. According to Oscoz et al. (2010), the impact of this jellyfish on freshwater ecosystems is unclear. However, alien species invading freshwater systems can commonly lead to loss and degradation at all levels of biological organization (Vilà and Garcia-Berthou 2010), with cascading effects on entire ecosystems. In conclusion, this report constitutes new evidence of an expansion of this non-indigenous cnidarian towards southern latitudes in Chilean Patagonia. More limnological studies, including the analysis of both medusa and polyp stages (Duggan and Eastwood 2012), are required in order to assess the current and potential distributional range of *C. sowerbii* in North Patagonian lakes, as well as possible effects on the functioning of freshwater ecosystems.

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References

American Public Health Association, APHA (2005) Standard Methods for the Examination of Water and Wastewater. 21st edn. Washington, DC, 1200 pp

Araya JM, Zúñiga LR (1985) Manual taxonómico del zooplancton lacustre de Chile. *Boletín Informativo Limnológico,* Universidad Austral de Chile 8: 1–110

Boltovskoy A, Battistoni PA (1981) La medusa *Craspedacusta sowerbyi* en el embalse Río III, Córdoba, Argentina. *Physis, Secc* B 39 (97): 78

Boothroyd IKG, Etheredge MK, Green JD (2002) Spatial distribution, size structure, and prey of *Craspedacusta sowerbii* in a shallow New Zealand lake. *Hydrobiologia* 468: 23–32, http://dx.doi.org/10.1023/A:1015206320300

Campos H, Steffen W, Agüero G, Parra O, Zúñiga L (1992) Limnological study of Lake Ranco (Chile). *Limnologica* 22: 337–353

Carlson RE (1977) A Trophic State Index for Lakes. *Limnology and Oceanography* 22(2): 361–369, http://dx.doi.org/10.4319/lo.1977.22.2.0361

Davis CC (1955) Notes on the food of *Craspedacusta sowerbyi* in Crystal Lake, Ravenna, Ohio. *Ecology* 36: 364–366, http://dx.doi.org/10.2307/1933253

De Vries DR (1992) The freshwater jellyfish *Craspedacusta sowerbyi*: a summary of its life history, ecology and distribution. *Journal Freshwater Ecology* 7: 7–16, http://dx.doi.org/10.1080/02705060.1992.9664665

Dodson SI, Cooper SD (1983) Trophic relationships of the freshwater jellyfish. *Craspedacusta sowerbyi* Lankester 1880. *Limnology and Oceanography* 28: 345–351, http://dx.doi.org/10.4319/lo.1983.28.2.03453

Duggan IC, Eastwood KR (2012) Detection and distribution of *Craspedacusta sowerbii*: Observations of medusae are not enough. *Aquatic Invasions* 7: 271–275, http://dx.doi.org/10.3391/ai.2012.7.2.013

Dumont HJ (1994) The distribution and ecology of the fresh- and brackish water medusa of the world. *Hydrobiologia* 272: 1–12, http://dx.doi.org/10.1007/BF00006508

Figueroa D, de los Rios P (2010) First report of *Craspedacusta sowerbii* (Cnidaria) (Lankester, 1880) for Patagonian waters (38 degrees S, Chile): a possible presence of invasive species and its potential ecological implications. *Brazilian Journal of Biology* 70: 227–228, http://dx.doi.org/10.1590/S1519-6984 2010000100032

Fritz GB, Pfannkuchen M, Reuner A, Schill RO, Brummer F (2009) *Craspedacusta sowerbii*, Lankester (1880) – Population dispersal analysis using COI and ITS sequences. *Journal of Limnology* 68(1): 46–52, http://dx.doi.org/10.4081/jlimnol.2009.46

Fritz GB, Schill RO, Pfannkuchen M, Brümmer F (2007) The freshwater jellyfish *Craspedacusta sowerbii* Lankester, 1880 (Limnomedusa: Olindiidae) in Germany, with a brief note on its nomenclature. *Journal of Limnology* 66: 54–49, http://dx.doi.org/10.4081/jlimnol.2007.54

Gophen M, Shealtiel L (2012) Record of the alien species *Craspedacusta sowerbyi* Lankester, 1880 (Cnidaria: Limnomedusae) in Lake Kinneret catchment area. *BioInvasions Records* 1: 29–31. http://dx.doi.org/10.3391/bir.2012.1.1.06

Jankowski T (2001) The freshwater medusae of the world: A taxonomic and systematic literature study with some remarks on other inland water jellyfish. *Hydrobiologia* 462: 91–113 http://dx.doi.org/10.1023/A:1013126015171

Jankowski T, Collins AG, Campbell RD (2008) Global diversity of inland water cnidarians. *Hydrobiologia* 595: 35–40, http://dx.doi.org/10.1007/s10750-007-9001-9

Kramp PL (1961) Synopsis of the Medusae of the world. Order Limnomedusae. *Journal of the Marine Biological Association of the UK* 40: 213–236, http://dx.doi.org/10.1017/S0025315400007384

Lankester ER (1880) On a new jelly-fish of the order trachomedusae, living in freshwater. *Science* 1: 34, http://dx.doi.org/10.1126/science.os-1.4.34

Lewis C, Migita M, Hashimoto H, Collins AG (2012) On the occurrence of freshwater jellyfish in Japan 1928–2011: eighty-three years of records of mamizu kurage (Limnomedusae, Olindiidae). *Proceedings of the Biological Society of Washington* 125(2): 165–179

Marsden JE, Hauser M (2009) Exotic species in Lake Champlain. *Journal of Great Lakes Research* 35: 250–265. http://dx.doi.org/10.1016/j.jglr.2009.01.006

McAlpine DF, Peard TL, Fletcher TJ, Hanson G (2002) First Reports of the Freshwater Jellyfish *Craspedacusta sowerbyi* (Hydrozoa: Olindiidae) from Maritime Canada with a Review of Canadian Occurrences, *Journal of Freshwater Ecology* 17(2): 341–344, http://dx.doi.org/10.1080/02705060.2002.9663904

McClary A (1959) The effect of temperature on growth and reproduction in *Craspedacusta sowerbyi*. *Ecology* 40: 158–162, http://dx.doi.org/10.2307/1929945

MMA - Centro de Ecología Aplicada (2012) Catastro ecosistemas acuáticos continentales, actualización Lic. N° 1588-28-LP10. Descripción metodológica actualización catastro de ecosistemas acuáticos continentales. Ministerio de Medio Ambiente, Santiago, Chile, 42 pp

Moreno-Leon MA, Ortega-Rubio A (2009) First record of *Craspedacusta sowerbyi* Lankester, 1880 (Cnidaria: Limnomedusae: Olindiidae) in Mexico (Adolfo Lopez Mateos reservoir), with notes on their feeding habits and limnological dates. *Biological Invasions* 11: 1827–1834, http://dx.doi.org/10.1007/s10530-008-9361-8

Oscoz J, Tomás P, Durán C (2010) Review and new records of non-indigenous freshwater invertebrates in the Ebro River basin (Northeast Spain). *Aquatic Invasions* 5: 263–284, http://dx.doi.org/10.3391/ai.2010.5.3.04

Pérez-Bote JL, Muñoz A, Morán R, Roso R, Romero AJ (2006) First record of *Craspedacusta sowerbyi* Lankester, 1880 (Cnidaria: Limnomedusae: Olindiidae) in the Proserpina Reservoir (Extremadura, SW Spain) with notes on their feeding habits. *Belgian Journal of Zoology* 136(2): 163–166

Porter C, Schmitt V (1942) The first free-living freshwater jellyfish from South America. *Science* 96 (2501): 515, http://dx.doi.org/10.1126/science.96.2501.515

Rayner NA (1988) First record of *Craspedacusta sowerbyi* Lankester (Cnidaria: Limnomedusae) from Africa. *Hydrobiologia* 162: 73–77, http://dx.doi.org/10.1007/BF00014334

Reid B, Hernández KL, Frangopulos M, Lorca M, Kilroy C, Spauldings S (2012) The invasión of the freshwater diatom *Didymosphenia geminata* in Patagonia: prospects, strategies, and implications for biosecurity of invasive microorganisms in continental waters. *Conservation Letters* 5: 432–440, http://dx.doi.org/10.1111/j.1755-263X.2012.00264.x

Reynolds CS, Huszar V, Kruk C, Naselli-Flores L, Melo S (2002) Towards a functional classification of the freshwater phytoplankton. *Journal of Plankton Research* 24(5):417–428, http://dx.doi.org/10.1093/plankt/24.5.417

Richard E (1990) *Craspedacusta sowerby*, la curiosa medusa de agua dulce. *Subacuática* 2(6): 28–29

Ringuelet R (1950) La medusa de agua dulce *Craspedacusta sowerbyi* Lank. en la Argentina. Notas Mus. La Plata, tomo xv, Zoologica 134, pp 135–50

Rosenzweig C (2007) Assessment of observed changes and responses in natural and managed systems. In: Parry ML, Canziani OF, Palutikof JP, van der Linden PJ, Hanson CE et al. (eds), Climate change 2007—impacts, adaptation and vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge Univ. Press, pp 79–131

Sasaki G (1999) Sexual reproduction in freshwater jellyfish (*Craspedacusta sowerbyi*). http://www.microscopy-uk.org.uk/mag/indexmag.html?http://www.microscopy-uk.org.uk/mag/artdec99/fwjelly2.html (Accessed 14 May 2013)

Schmid-Araya JM, Zúñiga LR (1992) Zooplankton community structure in two Chilean reservoirs. *Archiv für Hydrobiologie* 123: 305–335

Spadinger R, Maier G (1999) Prey selection and diel feeding of the freshwater jellyfish, *Craspedacusta sowerbyi*. *Freshwater Biology* 41: 567–573, http://dx.doi.org/10.1046/j.1365-2427.1999.00408.x

Stefani F, Leoni B, Marieni A, Garibaldi L (2010) A new record of *Craspedacusta sowerbii*, Lankester 1880 (Cnidaria, Limnomedusae) in Northern Italy. *Journal of Limnology* 69:189–192, http://dx.doi.org/10.4081/jlimnol.2010.189

Thomasson K (1963) Araucanian Lakes. Acta Phytogeographica Suecica, 139 pp

Utermöhl H (1958) Zur Vervollkommung der quantitativen Phytoplankton-Methodik. *Mitteilung International Vereinigung Limnologie* 9: 1–38

Vilà M, García-Berthou E (2010) Monitoring biological invasions in freshwater habitats. In: Hurford C, Schneider M, Cowx IG (eds), Conservation monitoring in freshwater habitats - a practical guide and case studies. Springer, Dordrecht, The Netherlands, pp 91–100, http://dx.doi.org/10.1007/978-1-4020-9278-7_10

Supplementary material

The following supplementary material is available for this article:

Appendix 1. Records of *Craspedacusta sowerbii* Lankester, 1880 in South America, Chile and Argentina.

Appendix 1. Records of *Craspedacusta sowerbii* Lankester, 1880 in South America, Chile and Argentina.

Site N° (Map. Ref.)	Site name	Habitat type	Location	Latitude, °S	Longitude, °N	Reference
1	Tranque Marga Marga	artificial dam	Chile	33°03'28.97"	71°29'11.82"	Porter and Schmitt 1942
2	Peñuelas reservoir	artificial lake	Chile	33°09'01.74"	71°31'57.31"	Schmid-Araya and Zúñiga 1992
3	Laguna Carilafquen	natural lake	Chile	39°00'56.27"	72°08'58.21"	Figueroa and De Los Ríos 2010
4	Laguna Illahuapi	natural lake	Chile	40°16'18.66"	72°17'59.63"	This study
5	San Martin reservoir	artificial lake	Argentina	32°53'39.56"	68°51'57.80"	Ringuelet 1950
6	Río Tercero reservoir	artificial lake	Argentina	32°12'51.47"	64°28'24.45"	Boltovskoy and Battistoni 1981
7	La Florida reservoir	artificial lake	Argentina	33°06'40.20"	66°01'40.96"	Richard 1990