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INTERACTION CHILEAN FLAMINGO (*Phoenicopterus chilensis*) AND ZOOPLANKTONIC CRUSTACEANS: A METACOOMUNITY VIEW POINT

SUMMARY

The Chilean flamingo *Phoenicopterus chilensis* is a migratory water bird that has as nesting and nidification area shallow ponds between Tierra del Fuego Island and Northern Andes. This species predate on crustacean zooplankton specifically Anostracans and Copepods. The aim of the present study is compare the spatial distribution of *P. chilensis* and with the crustacean communities among geographical gradient. In Southern latitudes specifically in Torres del Paine National Park and Tierra del Fuego Island the crustacean zooplankton is composed by brine shrimp *Artemia persimilis*, halophilic copepods *Boeckella poopensis* and large body copepods such as *Parabroteas sarsi, B. brasiliensis* and *B. poppei*, whereas in Central Argentina the main species are copepods such as *B. gracilis, B. pooopoensis,* cladocerans of *Daphnia* and *Moina* genus, finally, in the northern Andes the habitats have brine shrimps *A. franciscana* and halophilic copepods *B. poopoensis*. The geographical distribution of *P. chilensis* is similar to widespread crustacean species such as *B. poopoensis* and *B. gracilis* that would explain biogeographical patterns and would explain as metacommunity.

Keywords: *Phoenicopterus chilensis, Artemia, Boeckella,* zooplankton, saline lakes, metacommunity.

INTRODUCTION

The Chilean flamingo is a migratory aquatic bird that inhabits between Tierra del Fuego Island (53° S) and northern Andes (14° S) in shallow saline and subsaline lakes and lagoons (Hurlbert et al., 1986; Araya and Millie, 2005), this specie predate on zooplanktonic crustaceans of its habitats, mainly Branchiopods and Copepods (López, 1990). The main geographical distribution of this species are Andean Altiplano between 14-27° S (Hurlbert et al., 1986, Araya and Millie, 2005), shallow saline and subsaline lakes in Central Argentina (33° S; Romano et al., 2005; Battauz et al., 2013), and shallow lakes in Southern Chilean Patagonia between 51°-53° S (Soto, 1990; Araya and Millie, 2005), and occasionally in ephemeral pools between these main areas (Araya and Millie, 2005).

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If we considerate the migration route of *P. chilensis* and the diapause eggs capacity of branchiopods and cladocerans (Alekseev and Storobogatov, 1996), it would be probably that many biogeographical patterns of crustacean preys of *P. chilensis* are associated to migratory routes. On this scenario the *P. chilensis* geographical distribution can be explained under metacommunity theory because are many community interconnected with local colonization and extinction process (Leibold et al., 2004). In this scenario, the aim of the present study is do study the interactions between crustacean zooplankton communities with *P. chilensis* geographical distribution for understand the community characteristics of it, and potential biogeographical patterns.

MATERIAL AND METHODS

It was revised the literature about zooplankton and *P. chilensis* (Hurlbert et al., 1984, 1986; López, 1990; Parada, 1990; Soto, 1990; Williams et al., 1995; Caziani et al, 1990; ; Gibbons et al., 2007; De los Ríos and Gajardo, 2010; De los Ríos-Escalante, 2010; Echaniz and Vignatti, 2011; Vignatti et al., 2007; 2012; Battauz et al., 2013). If we considerate these third main regions on the basis of descriptions of De los Ríos-Escalante (2010): Andean Saline Lakes (14-27° S); Central Argentinean Plains (33°S) and Southern Patagonian plains (51-53° S). For each site was inventoried on the basis of literature the crustacean reported on literature.

RESULTS AND DISCUSSION

Andean saline lakes (14-27° S): these waterbodies are saline and subsaline shallow ponds associated to salt deposits called “salares” (Chong, 1988). These sites have nesting and feeding areas of *P. chilensis* (Hurlbert et al., 1984, 1986). The zooplankton assemblage in these sites is markedly regulated by salinity level (Hurlbert et al., 1984, 1986; Williams et al., 1995; De los Ríos and Gajardo, 2010; De los Ríos-Escalante, 2010). The zooplankton assemblage at salinity lower than 5 g/L has copepods such as *B. gracilis, Boeckella gracilipes, B. occidentalis,* or *B. calcaris* and cladocerans (Daphnidae and/or Chydoridae), whereas between 5 to 90 g/L the halophilic copepod *B. poopoensis* is the exclusive component in zooplankton, and at salinity upper than 90 g/L the anostracan *Artemia franciscana* is the exclusive component (De los Ríos-Escalante, 2010).

The scarce literature mention that *P. chilensis* predate on calanoids and branchiopods (Hurlbert et al., 1984, 1986; López, 1990), and it share habitats with Andean flamingo *Phoenicoparrus andinus* and James flamingo *Phoenicoparrus jamesi* both species grazing on diatoms and microalgae (López, 1990). These three species migrate in Northern Andes (Parada, 1990; Caziani et al 2007), and on a metacommunity view point it would have the main community joined by *Phoenicopterus chilensis* as main predator, that coexist with *Phoenicoparrus andinus* and *P. jamesi* that graze on phytoplankton (Table 1; Figure 1).

Table 1. Crustacean species composition in Andean saline lakes, Central Argentina and Southern Patagonia

	Andean Saline Lakes	Central Argentina	Southern Patagonia
Anostracan	*Artemia franciscana* Kellog, 1906	*A. franciscana*	*A. persimilis*
		*A. persimilis*Picinelli and Prosdocimi, 1968	
Cladoceran		*Ceriodaphnia dubia* Richard, 1894	*Ceriodaphnia dubia,*
	Daphnia sp. O.F. Muller, 1785	*Daphnia spinulata,*	*D. ambigua,* Scourfield, 1947
		D. obtusa Kurz, 1874	*D. pulex* Leydig, 1860
		D. menucoensis, Paggi, 1996	*D. dadayana* Paggi, 1999.
		Pleuroxus aduncus,(Jurine, 1820)	*C. sphaericus*
		Leydigia leydigi,(Schoedler, 1862)	
	Alona sp. Baird, 1850	*Alona diaphana,* King, 1863	
		Chydorus sphaericus (O.F. Müller, 1785)	
		Moina micrura Kurz, 1874	
		M. engeniae Olivier, 1954	
		M. macrocopa Straus, 1820	
		M. wierzejskii Richard, 1895..	
		Macrothrix sp.Baird, 1843.	
		Latonopsis occidentalis Birge, 1891	
		Simocephalus vetulus(Muller, 1776)	
Copepoda, Calanoida	*Boeckella calcaris*(Harding 1955)	*B. gracilis*	*B. brevicaudata,*
	B. gracilipes Daday, 1901	*B. poopoensis*	*B. gracilipes,*
	B. gracilis (Daday, 1902)		*B. meteoris* Kiefer, 1928
	B. occidentalis (Marsh, 1906)		*B. michaelseni* (Mrázek, 1901),
	B. poopoensis Marsh, 1906		*Parabroteas sarsi* (Ekman, 1905)
Copepoda, Cyclopoida		*Metacyclops mendocinus,* (Wierzejski, 1892)	*Metacyclops araucanus* Loffler, 1962
		Microcyclops anceps (Richard, 1897)	*Tropocyclops prasinus meridionalis* Kiefer 1927
		Acanthocyclops robustus(Sars, 1863)	

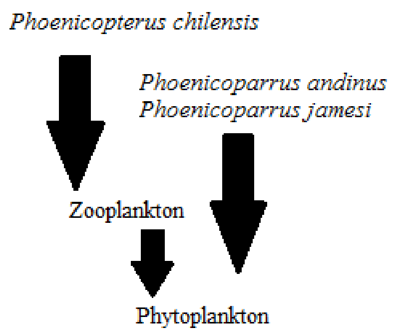

Figure 1. Trophic webs on Andean saline lakes

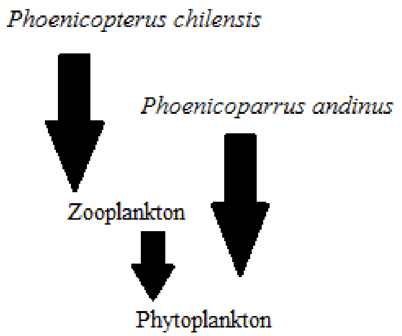

Figure 2. Trophic webs on Central Argentinean lakes

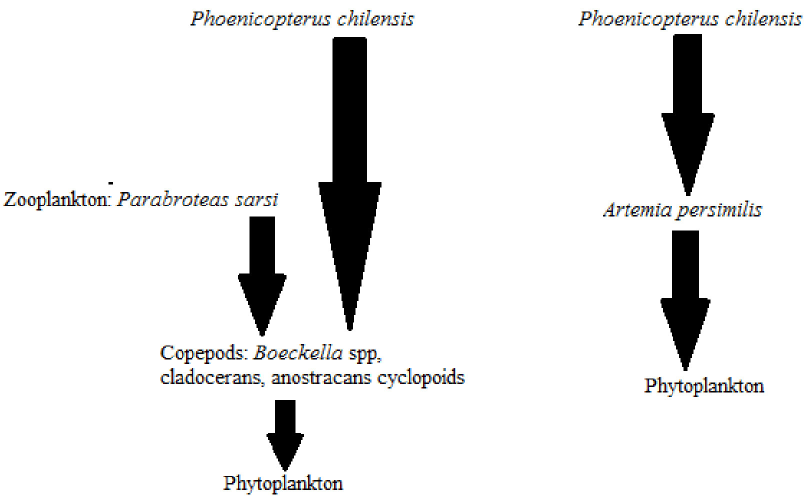

Figure 3. Trophic web in Southern Patagonian lagoons

If we considerate this zone and the zooplankton assemblage it would agree with descriptions of Menu-Marque et al., (2000) who mentioned a dispersion zone of crustacean species in Andes mountains.

Central Argentinean plains (33° S): In central Argentina, mainly Santa Fe, Córdoba, Mendoza and La Pampa provinces there are numerous shallow lagoons with a wide salinity gradient (Batauz et al., 2013). These lagoons have wide salinity gradient, and their aquatic crustaceans are branchiopods such as *Ceriodaphnia dubia, Daphnia spinulata, D. obtusa, D. menucoensis, Pleuroxus aduncus, Leydigia leydigi, Alona diaphana, Chydorus sphaericus, Moina micrura, M. engeniae, M. macrocopa, M. wierzejskii, Macrothrix* sp., *Latonopsis occidentalis, Simocephalus vetulus,* calanoids copepods such as *B. gracilis* and *B. poopoensis* and cyclopoids such as *Metacyclops mendocinus, Microcyclops anceps,* and *Acanthocyclops robustus* (Echaniz and Vignatti, 2011; Vignatti et al., 2007; 2012). Nevertheless, *B. poopoensis* in these habitats can coexist with other crustaceans because the salinities are lower than 15 g/L (Echaniz and Vignatti, 2011; Vignatti et al., 2007; 2012; Battauz et al., 2013). In these habitats it is possible coexistence the presence of *P. chilensis* with *P. andinus* (Battauz et al., 2013). In this scenario, the community would be different in comparison with the northern Andes, because *P. chilensis* is non-selective predator on zooplankton (Battauz et al., 2013; Table 1; Figure 2).

Southern Patagonian plains (51-53° S): this zone has numerous shallow permanent and ephemeral pools with a wide salinity gradient and high crustacean zooplankton species number (De los Ríos-Escalante, 2010), these water bodies are feeding areas for Chilean flamingo (Soto, 1990; Gibbons et al., 2007). In this scenario due that many of studied sites have low salinity, it is possible found high crustacean species such as cladocerans *Ceriodaphnia dubia, D. ambigua, D. pulex, D. dadayana, Chydorus sphaericus,* calanoids copepods *B. brasiliensis, B. brevicaudata, B. gracilipes, B. michaelseni, B. meteoris* and *Parabroteas sarsi*, cyclopoids such as *Metacyclops araucanus* and *Tropocyclops prasinus* (Table 1, Figure 3; De los Ríos-Escalante, 2010), whereas in saline lakes it is possible found *Boeckella poopoensis* and/or *Artemia persimilis* nevertheless these observations corresponds to rare saline lakes with salinities between 30-100 g/L (Table 1, Figure 3; De los Ríos-Escalante and Gajardo, 2010).

This zone has numerous seasonal water bodies that generate many habitats for aquatic invertebrate fauna and aquatic birds, (Soto, 1990, De los Ríos-Escalante, 2010), this scenario and the presence of migratory aquatic birds would explain the high crustacean zooplankton species in this region that would be the cause of a kind of spreading center of crustaceans to northern latitudes (Menu-Marque et al., 2000). In this scenario on a metacommunity view point, the main predator on trophic web would be the Chilean flamingo in spite that probably it is an occasional visitor (Soto, 1990, Gibbons et al., 2007).

Theoretical concepts associated: on a graphs view point (Fall et al., 2007, Fortin and Dale, 2010; Fortin et al., 2012; Thomas et al., 2014), we have tracks ways for crustacean cyst dispersion that would involve the dispersion centers such as Andean saline lakes, Central Argentina and Southern Patagonia, and the ways would connect these centers (Figure 4), on this view point we would explain the presence of widespread species such as *B. gracilipes, B. gracilis* and *B. poopoensis* in a wide geographical range (Table 1, Menu-Marque et al., 2000).

Figure 4. Map of studied zones and migration routes of *P. chilensis*

On this view point, we would agree with descriptions of Menu-Marque et al., (2000) who proposed two dispersion zones in Andean saline lakes and Southern South America for calanoids copepods. These components in these three main communities groups would be explained on the view point of groups theory, because we would have common components in all or two of these groups that would be in example the *B. gracilipes, B. gracilis* and *B. poopoensis* and *P. chilensis*. Also, on the view point of macrospatial scale, we would have one large common community that would have the three main groups (Andean saline lakes, Central Argentina and Southern Patagonia), and each group would have different subunities that would have specific characteristics, and all components would have the metacommunity system.

The role of waterbirds in aquatic flora and fauna dispersion was described by Green et al., (2008, 2013), and with emphasis in aquatic invertebrates that can involve large distances between different regions (Green and Figuerola, 2005; Green et al., 2005). This would have genetic implicances due genetic exchanges between individuals that colonizate the new habitats (Muñoz et al., 2013). In South America it has not studied the interactions between aquatic birds and invertebrate dispersion, nevertheless in comparative genetical studies South American *Artemia* populations the differences observed between populations would be caused due dispersion by water birds (Gajardo et al., 1995). On this view point it would be necessary more studies about water birds migratory routes and invertebrate dispersion hability for understand metacommunities process at different spatial scales, and their implicances at metapopulation level.

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