Limnetic zooplankton structure and abundance of Chilean lakes and reservoirs

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Considerations

- Patterns and interactions between freshwater planktonic organisms has been well studied
- Interactions between copepods and cladocerans (Branquiopoda) has received less attention
- Comparing natural and man made lakes may improve understanding these interactions

Methods

Bibliographic revision was from 28 ISI a non ISI publications from 1973-2009.

For a total of 63 sites in Chile.

Matrix of presence/absence per site (0,1), (updated from Oyanedel et al. 2008) in which species are columns and sites are rows.

ARID REGION ALTIPLANO

3 high Andean lakes

SEMI ARID- SUB HUMiD

10 reservoirs and 3 Andean lakes

HUMID

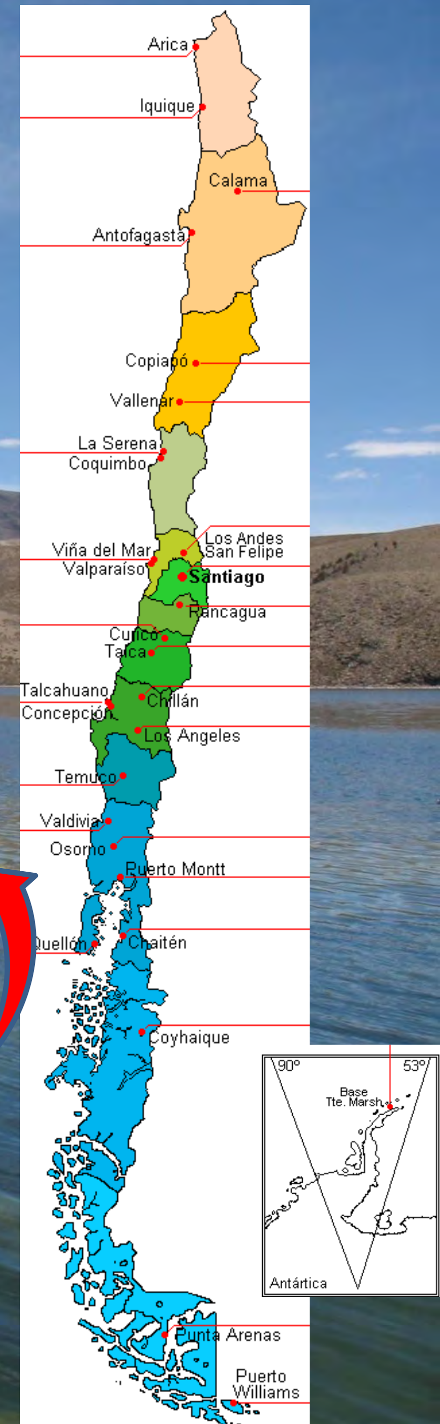
28 piedmont and 2 Andean lakes

NORDPATAGONIC

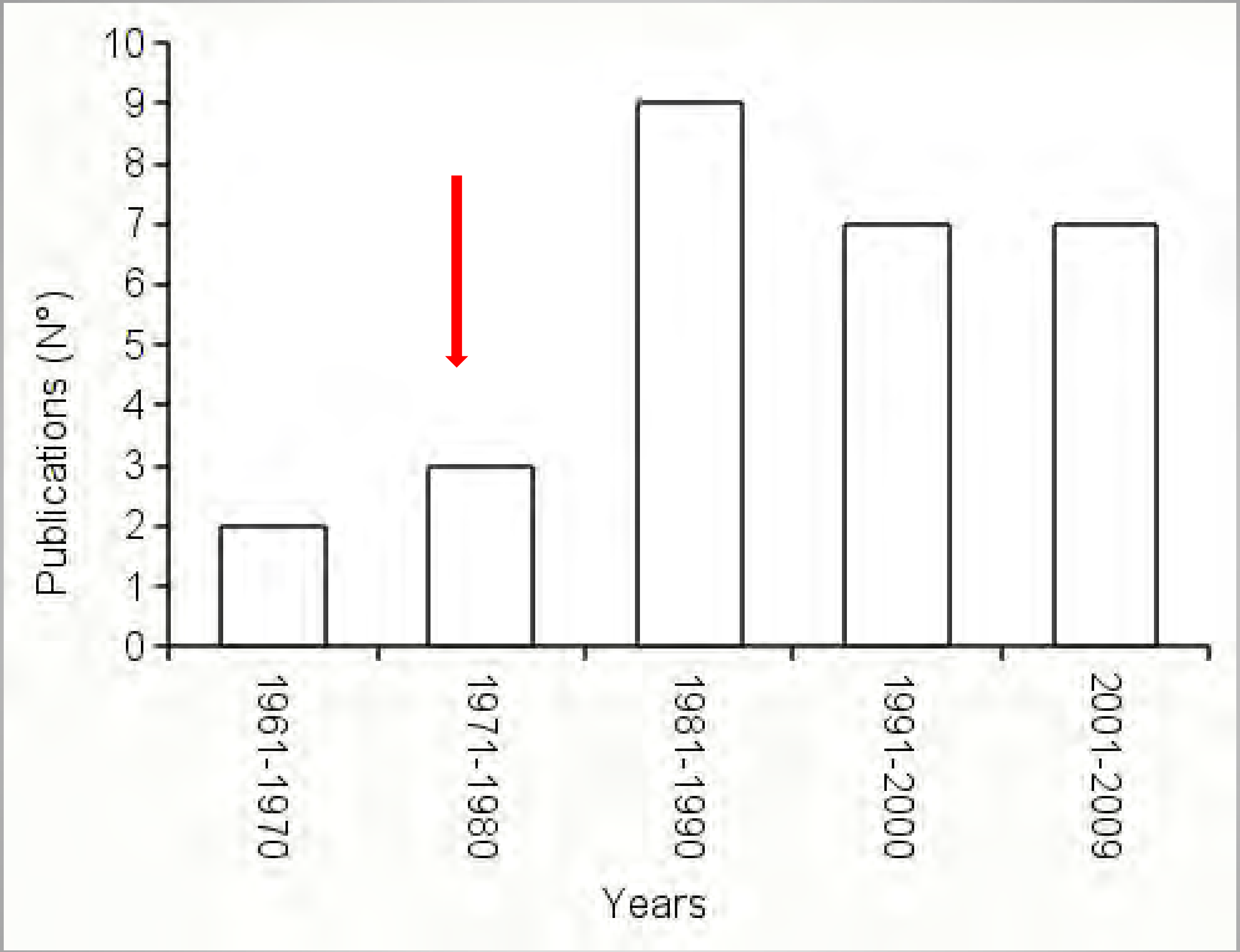
16 postglacial lakes

+ 1 Antarctic lake

Pacific Ocean

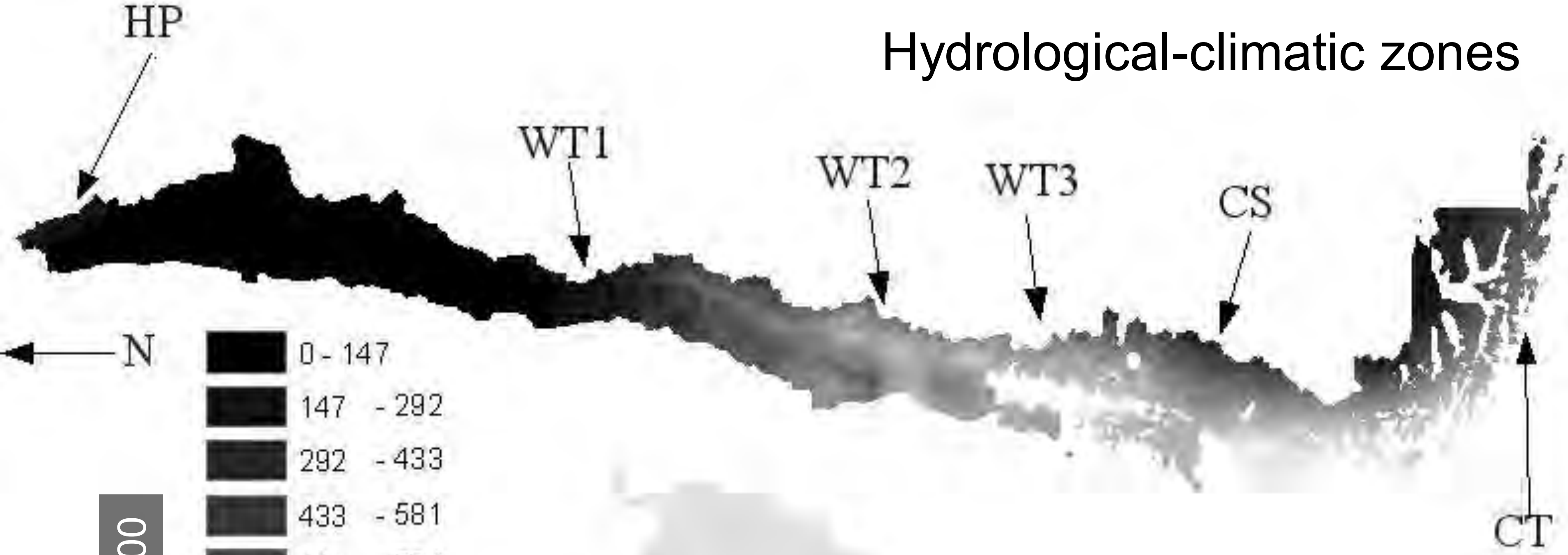


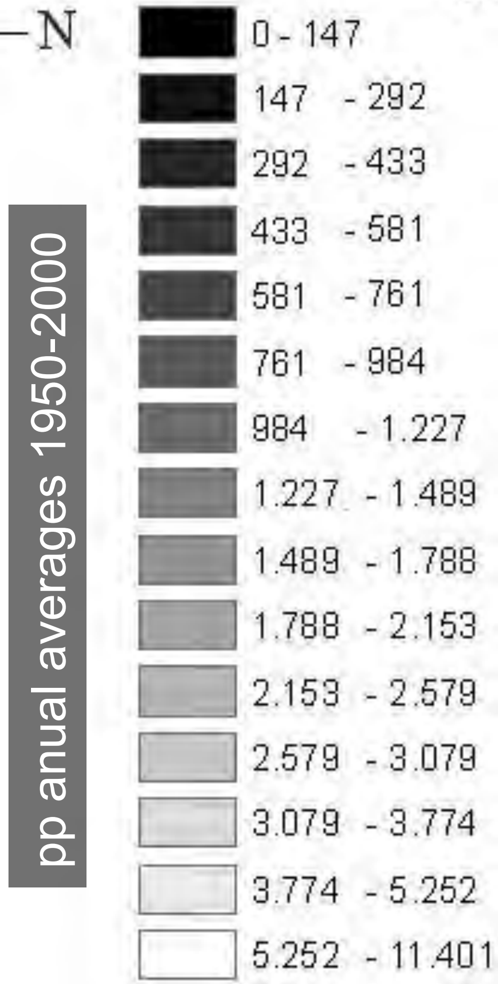
Advances after the development of the Man and Biosphere (MAB) - UNESCO Program, 1975



Chilean freshwater zooplankton knowledge and ecological understanding substantially accelerated after the 1971-1980 decade (1975 onwards).

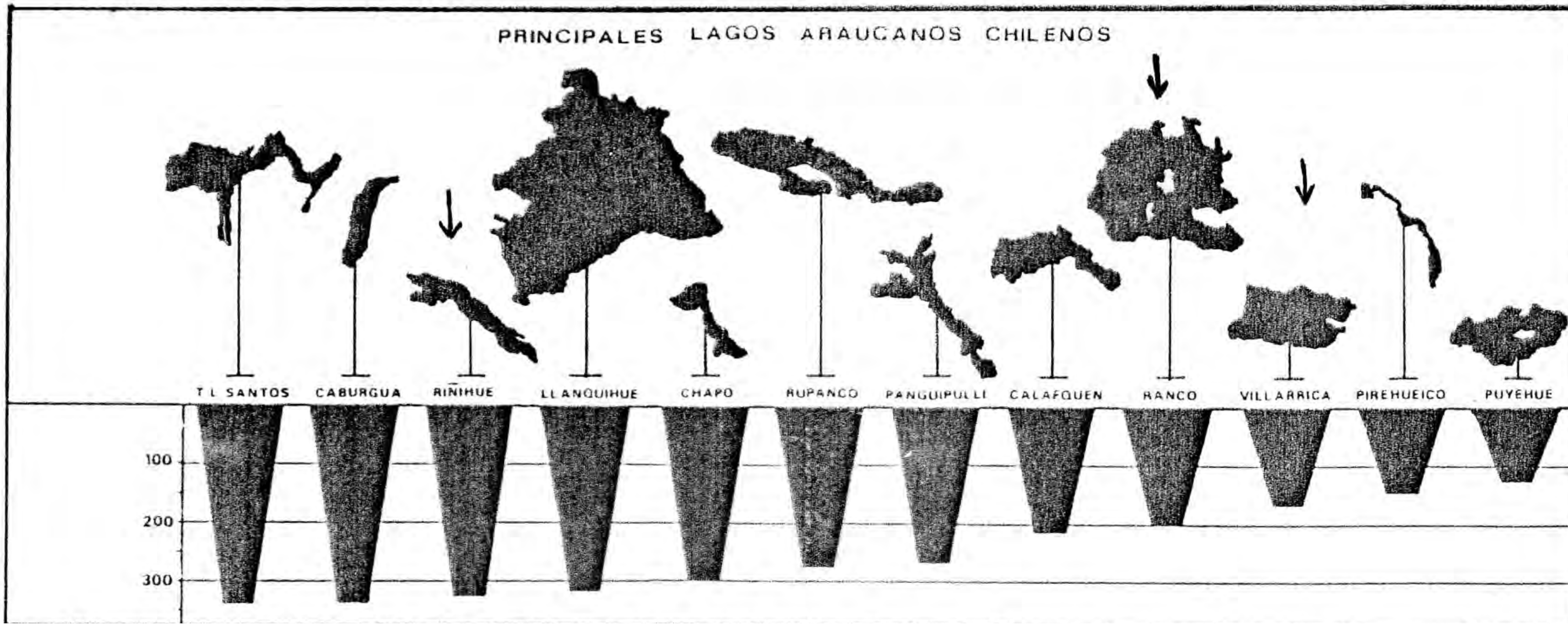
Hydrological-climatic zones





HP= High Plateau;
WT1 = Warm-temperate with winter rains;
WT2 = Warm-temperate with Mediterranean influence;
WT3 = Warm-temperate and rainy without dry season;
CS = Cold semi-arid with winter rains;
CT = Cold-temperate and rainy without dry season

ESTUDIOS LIMNOLOGICOS. Antecedentes de la Universidad Austral de Chile, Facultad de Ciencias, Instituto de Zoología (Campos & Steffen)



The assessment of total species richness of Copepoda and Branchiopoda among lakes and reservoirs is carried out with an analysis of covariance (ANCOVA), in order to minimise the effect of the area of each water-body on species richness. Non-homogenised variances were transformed by square root, according to Statistical 6.0, StatSoft, Tulsa, Oklahoma.

RESULTS & DISCUSION

33 Copepoda and 41 Branquiopoda species

Benthic taxa have been excluded from this classic classification

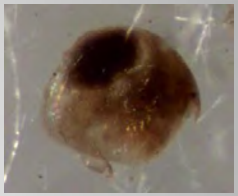
Phylum	Class	Order	Family	Genus	Species
Artropoda	Maxillopoda	Calanoida	Centropagidae	Boeckella	14
				Parabroteas	1
			Diaptomidae	Tumeodaptomus	2
		Cyclopoida	Cyclopinidae	Acanthocyclops	1
				Diacycops	1
				Eucyclops	4
				Macrocyclops	1
				Mesocyclops	1
				Metacyclops	1
				Microcyclops	2
				Paracyclops	3
				Tropocyclops	2
	Branchiopoda	Ctenopoda	Sididae	Diaphanosoma	1
				Latonopsis	1
		Anomopoda	Daphniidae	Daphnia	8
				Scapholeberis	2
				Simosa	3
				Ceriodaphnia	1
				Moina	1
			Bosminidae	Bosmina	3
			Macrothicidae	Macrothrix	6
			Chydoridae	Alona	5
				Alonella	1
				Leydigia	1
				Pleuxorus	3
				Chidorus	2
				Biapertura	1

(with the exception of Boeckella and Daphnia genera are constituted by few species)

Parabroteas sarsi (Cristian Correa)
(5-8mm)

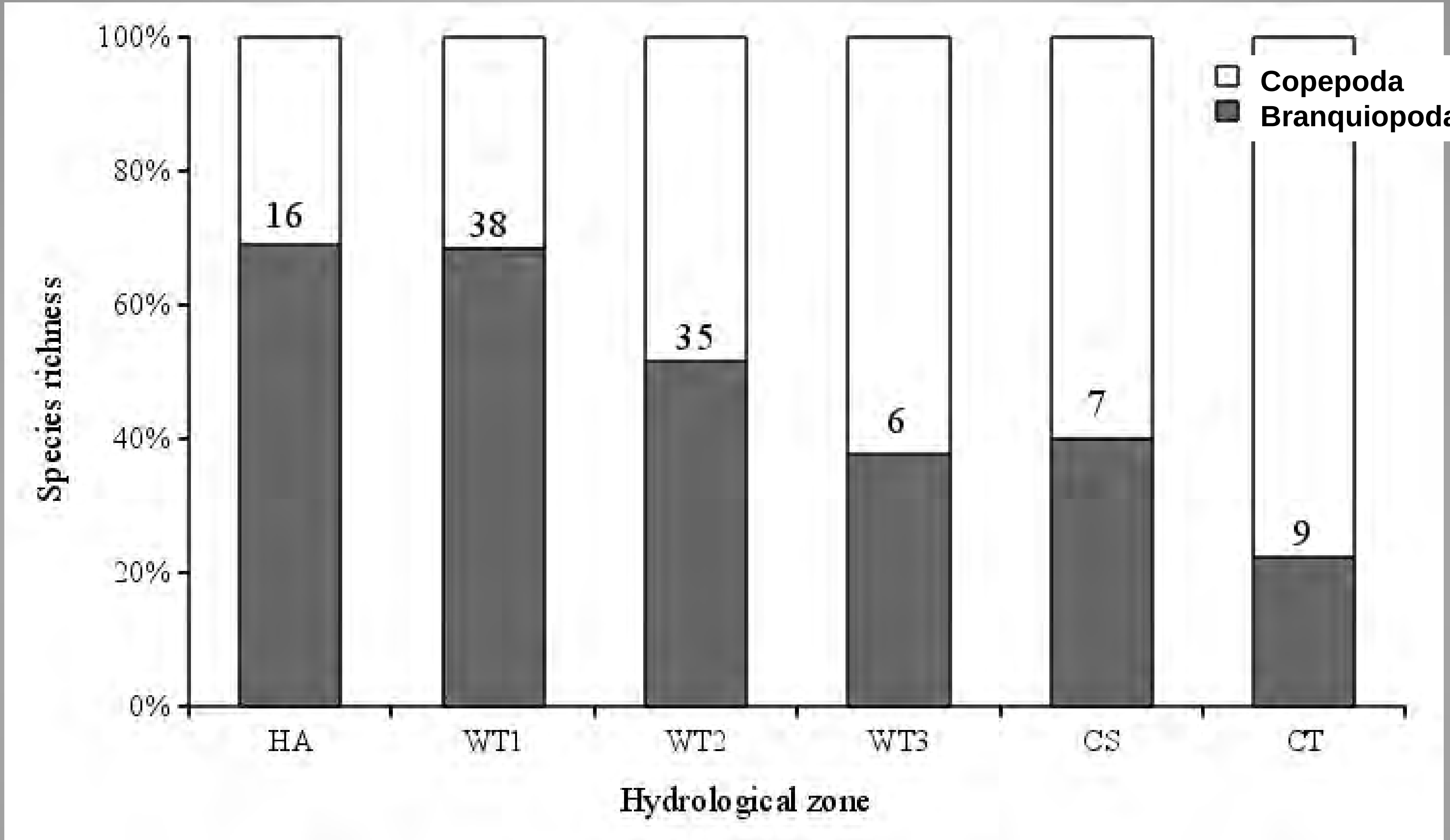
Boeckella gracilipes (JPablo Oyanedel)
(1,4mm app)

Chydorus sphaericus
(JPablo Oyanedel)
(0,25mm app)



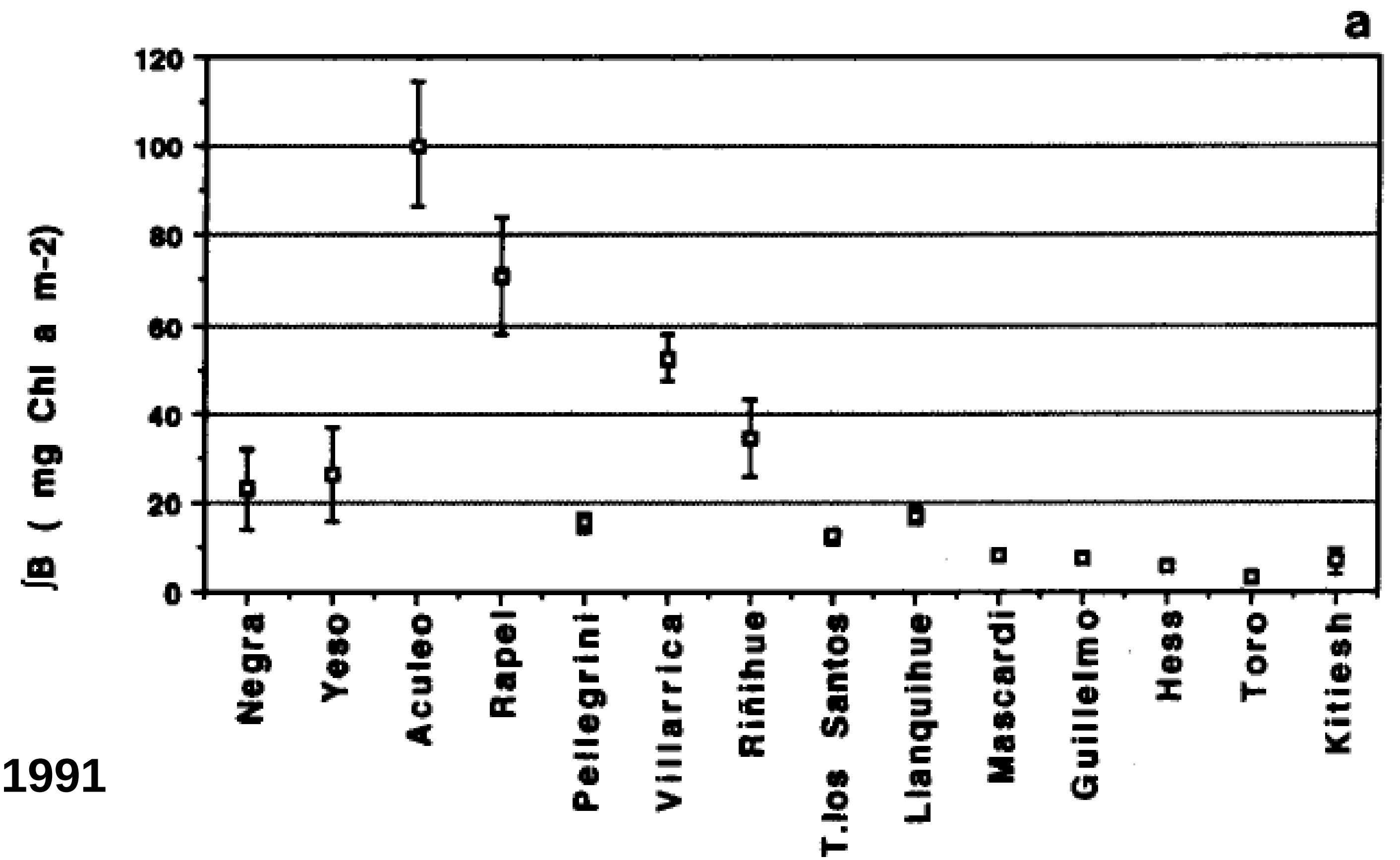
Bosmina longirostris (Graham Matthews)
(0.3mm app)

Daphnia pulex (Graham Matthews)
(1,9-2mm)



Maximum zooplankton species richness at approximately 40ºS, also encompasses a **higher percentage of copepods as latitude and the proportion of oligotrophic water bodies increase.**

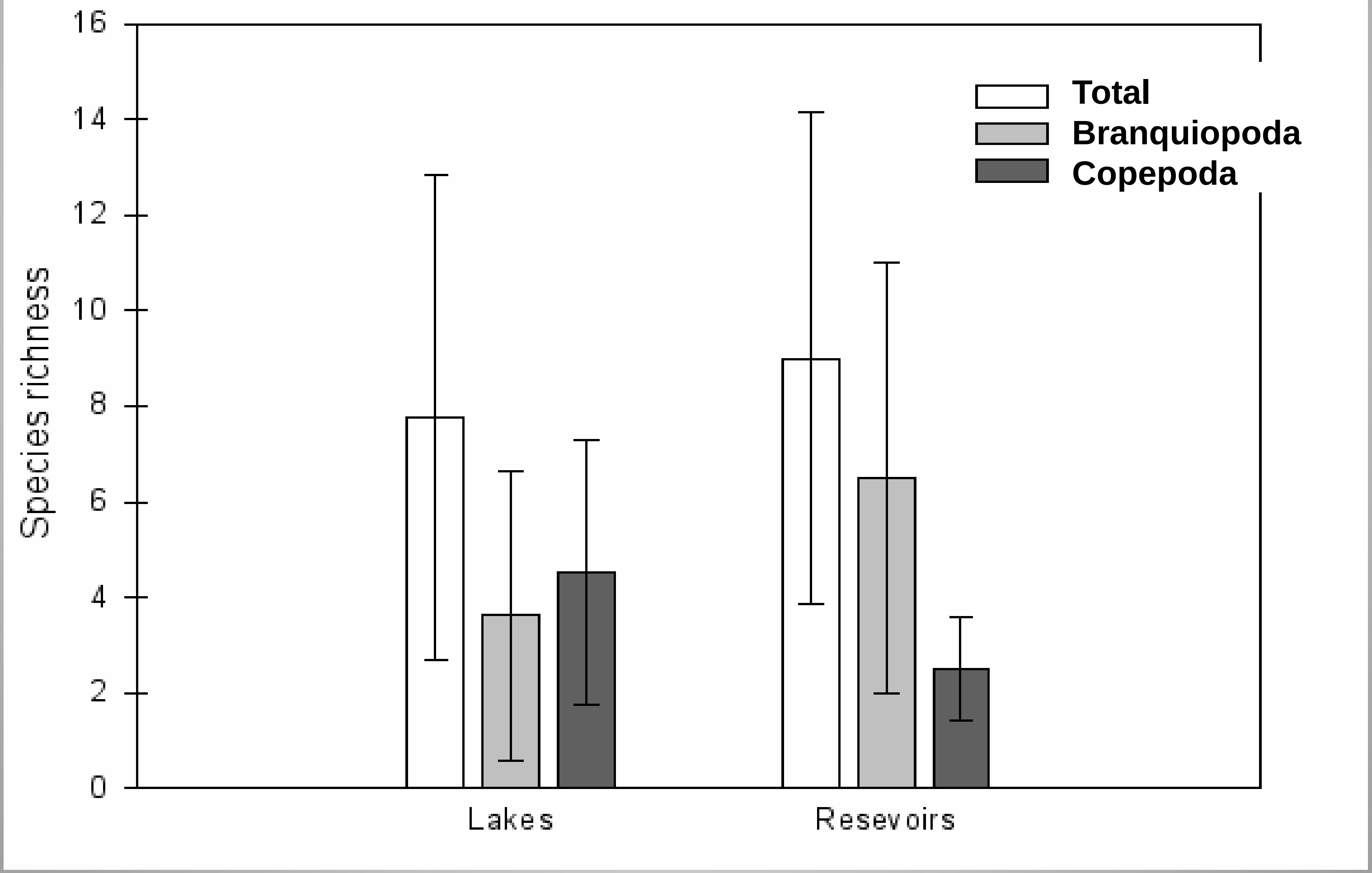
PRIMARY PRODUCTIVITY IN TEMPERATE S. AMERICA



Montecino 1991

Comparing the overall abundance of total crustacean zooplankton from lakes and reservoirs, there are no differences between them (ANCOVA F = 1.518 p = 0.23).

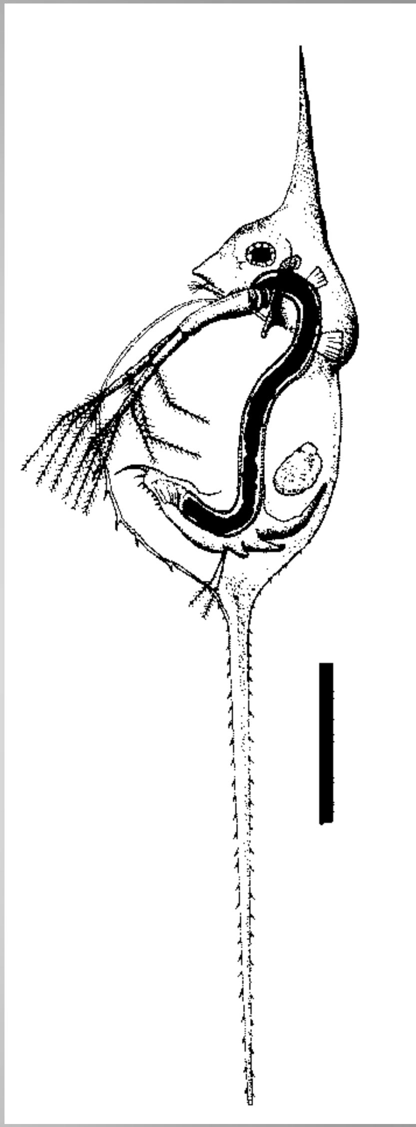
Nevertheless when Branchiopoda and Copepoda are treated separately, there is a **higher presence of Branchiopoda in man-made lakes** (ANCOVA F = 4.568 p = 0.046), whereas in the Copepoda no differences are found (ANCOVA F = 2.795 p = 0.111).

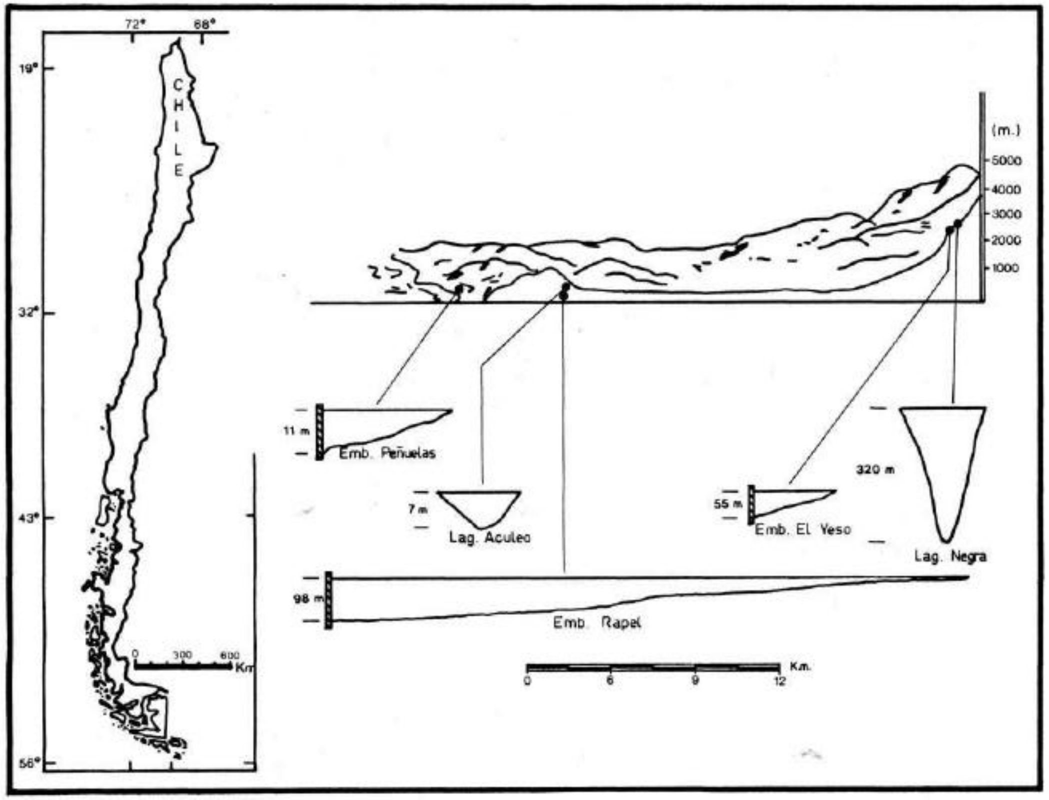


The comparison between natural and man-made lakes, and the differential responses for species richness observed in the present study, suggests that **the higher biological diversity in Branchiopoda is associated with their shorter life cycles and the greater environmental heterogeneity of impoundments** (Armengol 1980, Matsumura &Tundisi 2005).

Also, reservoirs are more readily invaded than natural lakes, because of their physiochemical properties, greater connectivity, and higher levels of disturbance (Havel et al 2005).

***no records of invasive species in Chile**





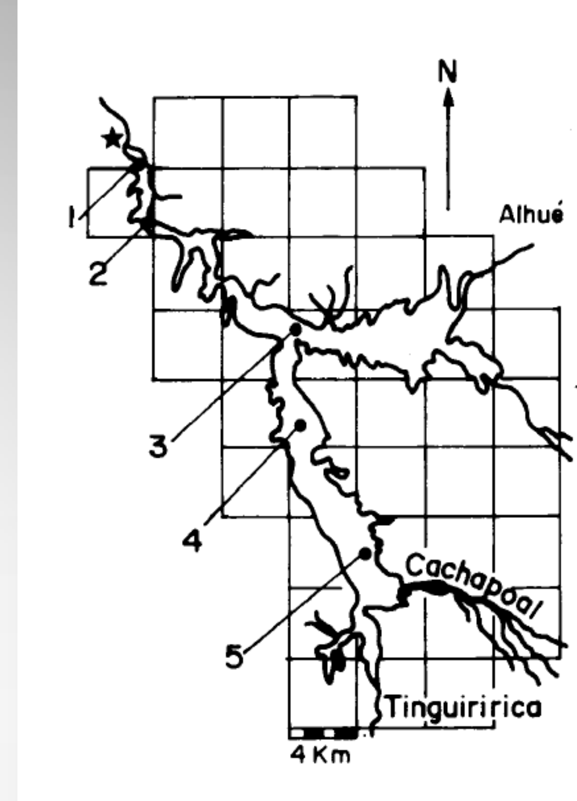
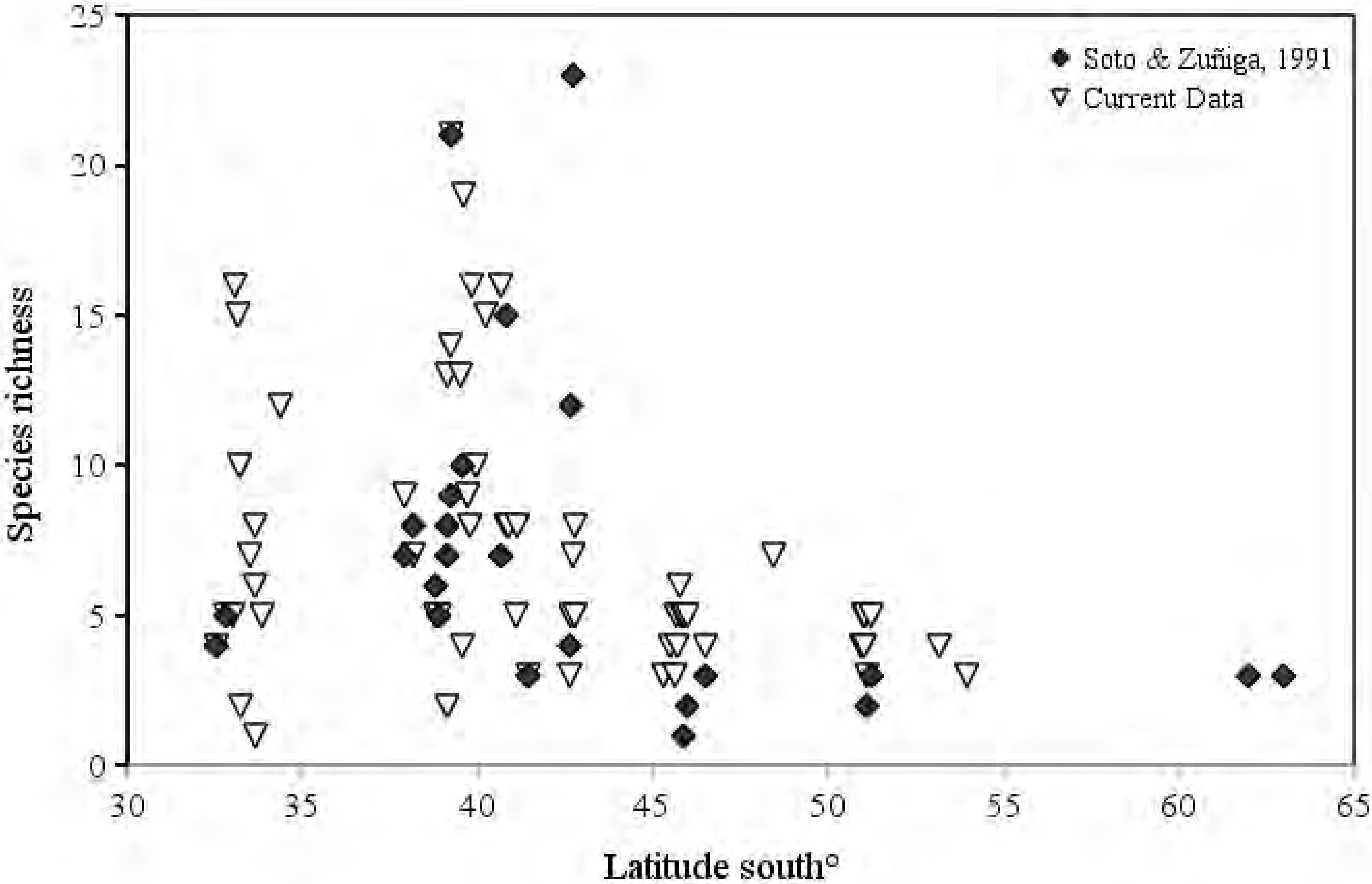


Table 1. Temperature and chlorophyll *a* fluctuations in the photic zone through different seasons in six natural and artificial lakes in Central Chile of different depth and altitudes.

Lake	Altitude (m)	Max. depth (m)	Chlorophyll *a* ($mg \cdot m^{-3}$) in the photic zone		Temperature (°C)	
			min	max	min	max
Negra	2688	320	0.06	5.6	6.5	16.1
Yeso	2500	55	0.44	2.3	5.0	15.1
Plateado	340	12	1.10	11.6	10.6	22.9
Rapel	200	90	2.70	58.4	11.6	25.9
Peñuelas	345	11	4.20	70.3	13.2	24.1
Aculeo	360	8	23.20	2039.9	10.7	30.4


Soto & Zuñiga, 1991
Current Data
Species richness
Latitude south°
0
5
10
15
20
25
30
35
40
45
50
55
60
65

The highest species richness is also promoted by the higher level of disturbance in specific lakes in the “Warm-temperate with winter rains” hydrological-climatic zone: i.e lake Riñihue

The decline in species richness farther south coincides with the fragmentation of the mainland at about 42º S (Soto & Zúñiga, 1991), paleo-climatic features and precipitation patterns (Hulton et al., 2002), and latitudinal decreasing temperatures and productivity (Zúñiga, 1988; Montecino, 1991).

This quantitative insight into freshwater systems components and the environmental relationships of the Chilean limnetic biota indicates that

Total number of species is low

Branquiopoda species richness is higher in reservoir

influenced by geographical isolation due to the desert, the ocean, and the Andes mountain range

Zooplankton patterns are controlled by physical variables since systems are largely influenced by climate, monomictic and polimictic mixing regimes, and oceanic modulation.

Questions:
Are specific traits selected for in reservoirs or in lakes?

This distribution is

Random?

Proximity?

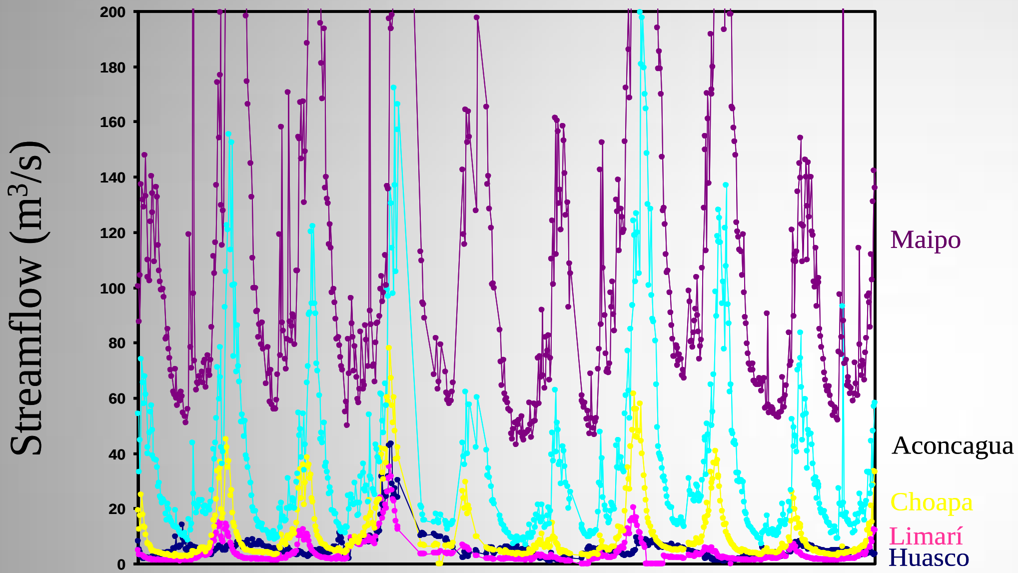
More work in Araucarian lake district?

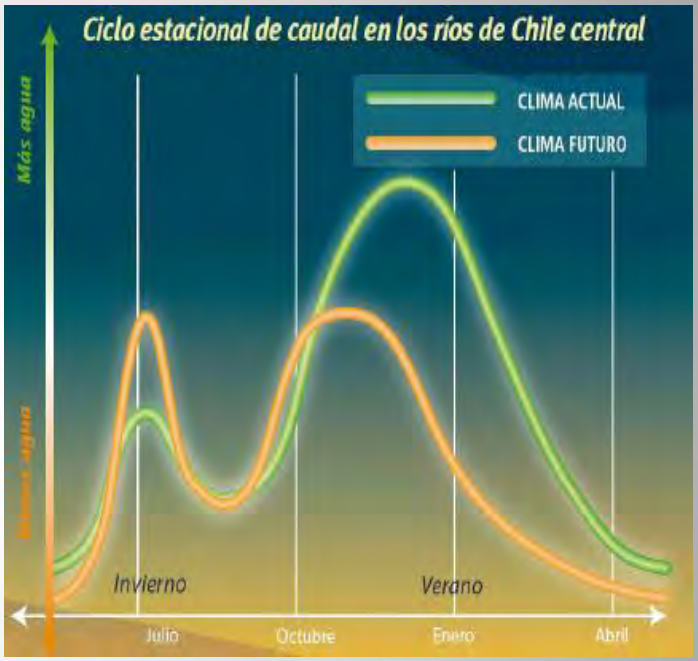
Phylogenetic diversification?

Top-down or bottom up ?

More reservoir in the Central zone of Chile?

Actual and future hydrological regimes under climatic change scenarios





DGA data, Véliz 2009

-Proyect ACT-19: "Climatic variability in Chile: evaluation, and projections"
(Geophysics Departament, U. Chile)

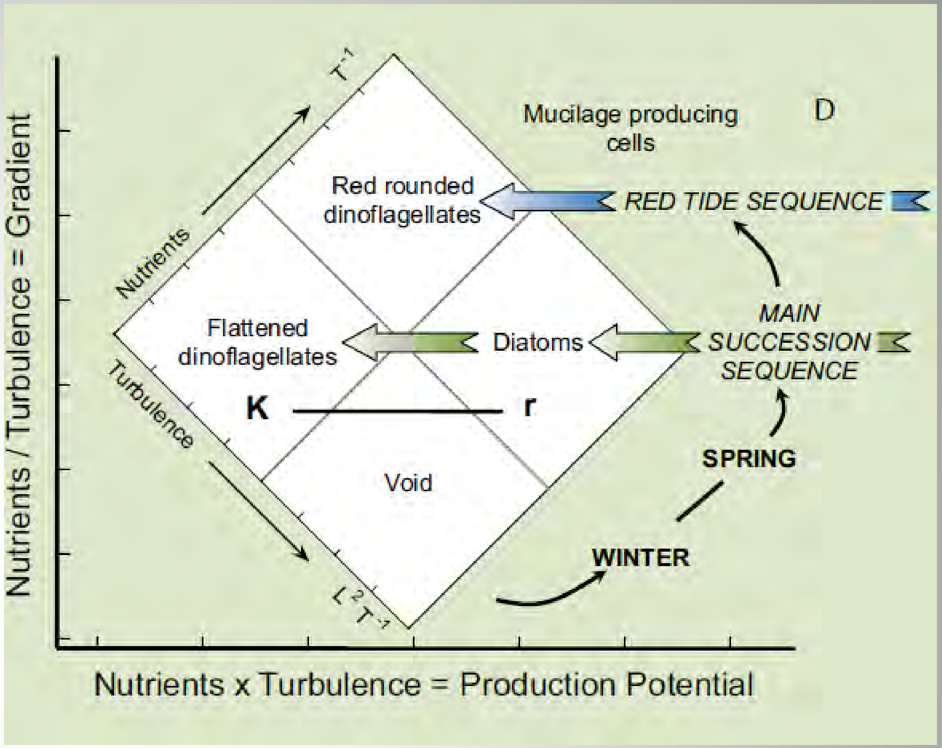
Lake shape and size

Temperature

Epilimnion depth

Irradiance

Nutrients



Hydrological regimes: salinisation/water clarity-turbidity

Phytoplankton succession, zooplankton life cycles and trophic relationships

Since we know the effect of lake shapes and sizes is significant, Climate Change research in Chile need to study with priority two most important facts: the changes in runoff and the changes in eutrophication.

This knowledge is basic because it will allow

-to determine the influence of changes in temperature, wind and radiation in the mixing regimes

-the evaluation of eutrophication process from the sub- humid to the humid regions of the country

-the quantification of salinisation (>>conductivity). Freshwater ecosystems in Chile are under high anthropic pressure since water management at the arid region is accelerating and because drying processes are worldwide affecting biodiversity.

-to analyze the impacts of cryospheric changes (glaciar meltwater), together with the effects of damming for hydropower generation.

CONCLUDING REMARKS

-We here provide significant new data and information regarding the status of limnetic zooplankton in Chile.

-We have to recognize that studies in the plankton systematic has been neither encouraged nor well supported.

-We should fill the taxonomical gaps, incentivate the continuity of descriptive studies, and encourage experimental work on biological interactions and ecosystem ecology approaches.

-Evolutionary ecology offers a conceptual framework to formulate hypothesis and it could be used to quantify and confirm these local and geographical patterns in Chile.

-We suggest to follow a phylogenetic perspective for these studies to establish also the circumstances about the origin and diversification of this taxa.

Acknowledgements: We acknowledge the early influence to these local studies of the European limnologist and freshwater copepodologist Bernard Dussart by presenting this contribution in his memory.

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