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LIMNOLOGICAL INVESTIGATION IN TIERRA DEL FUEGO _ ARGENTINA

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LA PLATA, AGOSTO 1987

Lentic environments belonging to Isla Grande of Tierra del Fuego stand as a field of particular, limnological interest. Some of the reasons for this are their austral location, the scarce influence they have received from man's action and the lack of information about them. Therefore, the main aim of this study is the preliminar characterization of some of said environments.

Information about eight lakes and eleven ponds is presented, these being considered as representative of different regions in the island;physical, geological,chemical and biological aspects are described as well as their geographical location.

By means of this work, the authors make an attempt to give origin to a research trend, aiming at achieving an exhaustive knowledge of all lentic bodies, the most important ones, lying on the austral sector of Patagonia.

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LIMNOLOGICAL INVESTIGATION IN TIERRA DEL FUEGO_ARGENTINA

por

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del INSTITUTO DE LIMNOLOGIA "Dr. RAUL A. RINGUELET"

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LA PLATA
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CONTENTS

RESUMEN

Se realizó un primer estudio limnológico en el Territorio Nacional de la Tierra del Fuego (Sector Argentino). Durante noviembre de 1983 se efectuaron relevamientos en 8 lagos glaciales y 11 lagunas. A lo largo de las diferentes regiones morfoestructurales, encontramos algunas propiedades particulares con respecto a las lagunas; aquellas de la zona norte Patagonia Austral Extraandina presentaron un elevado gradiente de salinidad y altísimos valores de fósforo y manganeso (3,8 mg P/1 y 2 mg Mn/1). Son cuerpos de agua poco profundos, con bajísima transparencia y elevada concentración de partículas en suspensión. Las lagunas cercanas a los lagos son poco profundas con aguas de color pardo y considerable concentración de clorofila. En algunas de ellas los valores de hierro fueron importantes.

En la zona sur, Cordillera Austral encontramos algunas lagunas húmicas, asentadas y rodeadas de potentes turbales, las mismas presentan elevada concentración de sustancias húmicas y el pH de las aguas estuvo alrededor de 5,8.

Los lagos tienen alta transparencia, homeotérmicos, bajos valores de clorofila y producción primaria, aguas blandas bicarbonatadas cálcicas. Presentan una situación de ultraoligotrofía.

Se efectuó un estudio cualitativo del fito y zooplancton y se caracterizaron las condiciones geoambientales de cada uno de los cuerpos de agua.

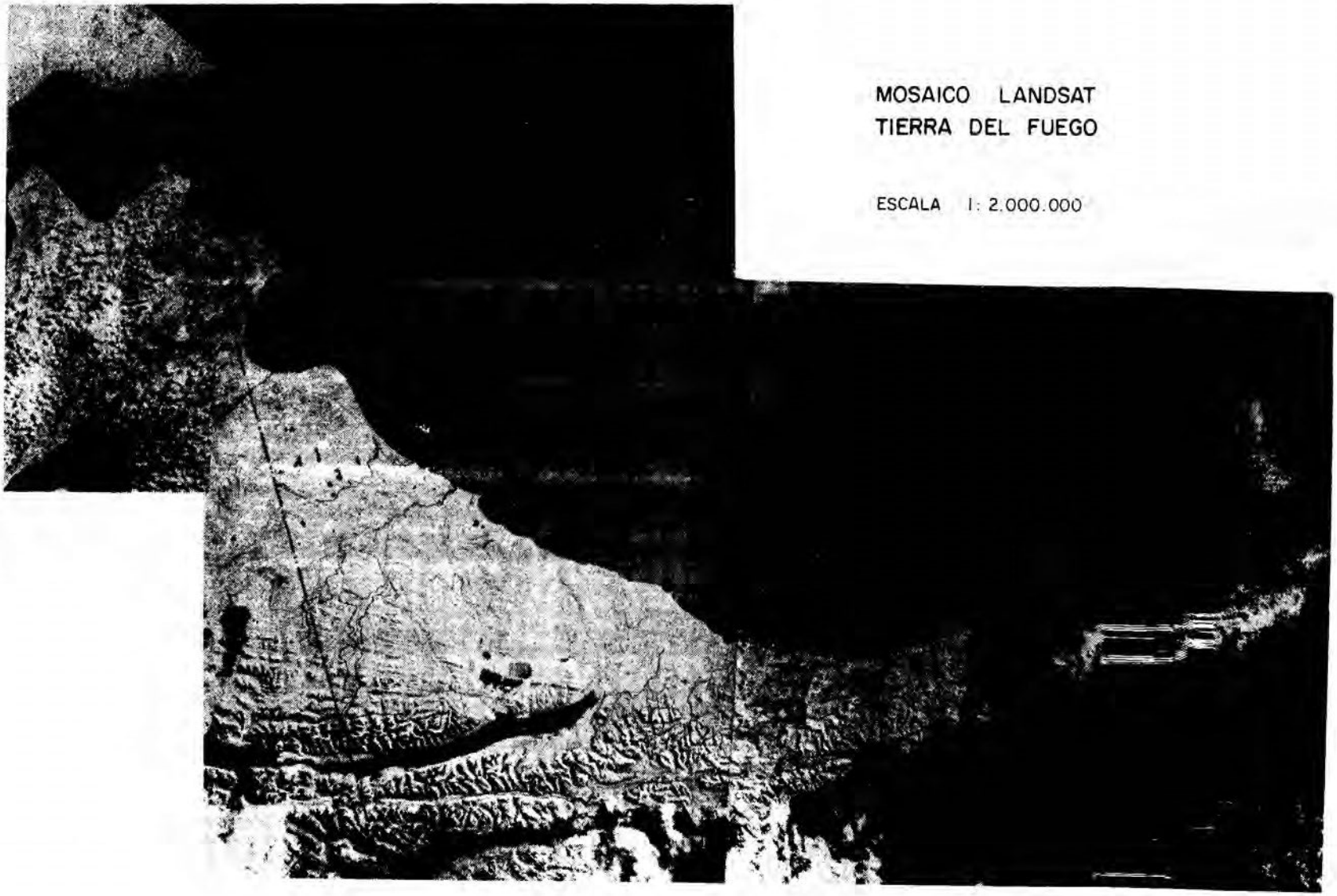
SUMMARY

A first limnological approach was made in the Territory of Tierra del Fuego (Argentina Sector). During November 1983, surveys were made in eight glacial lakes and in eleven ponds. Along the different morphostructural regions we found some particular properties with regard to ponds; those from the north Extra Andean Souther Patagonia, presented a high salinity gradient and very high values of phosphorus and manganese (3,8 mg P/1 and 2mg Mn/1).They are very shallow water bodies, with very low transparency and high concentration of suspended materials. Ponds surrounding lakes are shallow with brown waters and high chlorophyll values. In some of them, iron values were of importance.

In the southern region Fueguian Cordillera, we found some little bog ponds, settled and surrounded by very peat material. Such ponds have a high concentration of humic substances, and a water pH of about 5,8.

Lakes present high transparency, homeotermy, very low chlorophyll and primary production values, and soft waters with dominance of calcium bicarbonate, presenting a situation of ultraoligotrophy.

A qualitative study of phytoplankton and zooplankton was made and the geoenvironmental characteristics are described.



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INTRODUCTION

Lacustrine and lacunar aquatic environments in Isla de Tierra del Fuego cover an area of about 800km2, which is roughly equivalent to 4 % of the island area belonging to our country.

Such environments constitute actual potential reserves of possible use such as drinking water and also for fishing, industrial, touristic development, etc. In this way, it becomes inevitably necessary to carry out limno - logical research which could provide information about their condition and functioning. One of the purposes of this is to apply approppriate control and management measures in these environments which, fortunately, have not suffered the effects of pollution yet.

The schedule of activities centered our interest upon the sampling of all the lakes and on a series of ponds from different areas in the island. Material from the eight lakes and from eleven ponds was obtained.

According to laboratory chemical analyses, a very important feature was discovered, this being related to the high concentration of some elements such as phosphorus and manganese in Lagunas Grande and Am-Ki. This event gave place to a slight replanning of our suggestions, considering the potential conditions of profitable development concerning the aboved mentioned water bodies, provided a suitable technology is available.

The primary purpose of this work consisted in obtaining basic data as regards the most outstanding features of lacustrine and lacunar regions in the island.

SUBJECTS IN STUDY

Field and laboratory work have been carried out, covering the following subjects:

a) Geoenvironmental characteristics.
b) Physical and chemical factors.
c) Primary production and photosynthetic pigments.
d) Qualitative study of phytoplankton.
e) Qualitative study of zooplankton.

Water bodies surveyed	Order number
Lakes	
Lago Yehuin	I
Lago Chepelmuth	II
Lago Escondido	III
Lago Fagnano	IV

Lago Roca	V
Lago San Ricardo	VI
Lago Santa Laura	VII
Lago Yakus	VIII

Ponds

Laguna Pescado	IX
Laguna Antuk	X
Laguna Luz	XI
Laguna Asher	XII
Laguna Am-ki	XIII
Laguna Grande	XIV
Laguna San Luis	XV
Laguna Fuego	XVI
Laguna Blanca	XVII
Laguna Esperanza	XVIII
Laguna Verde	XIX

Despite the fact that data were punctually gathered, we achieved information enogh so as to develop a first characterization of environments, which could be taken into serious consideration for the correct planning of more detailed future research.

LOCATION

Isla de Tierra del Fuego is located in the south end of Argentina territory. It is separated from the continent by Magallanes Strait. The central coordinates of the sector in consideration are: parallel 54° south latitude and meridian 67° west longitude. According to the information provided by the Instituto Geográfico Militar, 20,912 km2 of the total area of the island belong to our country-Argentina.

The argentine sector is triangular in shape and its vertices are: in the north, Cabo Espíritu Santo; in the southwest, Hito XXV, and in the southeast, Cabo San Diego.

AREA CHARACTERIZATION

RELIEF: It is diverse, starting in approximately less than 10 metres in Bahía San Sebastián, then becoming higher towards the north where it is possible to find levations of about 160 metres, in the west end of San Sebastián ridge of mountains. From the bay's south border, topography slightly ascends southward. The main feature of this zone is a system of isolated hills, the height of which reaches its maximun value in Cerro Cañón-300 mt. high- quite near to

the Chilean frontier. From there, the relief gets lower until it reaches the sea-shore where hills do not exceed 20 metres high.

In the south section of Río Grande, the ascension becomes much more emphasized, changing from the soft hill zone of Estancias(Ranches) Ruby, Buenos Aires and La Catalana, with levations of scarcely 200mts. high, up to the shore - about 60 mts. high where Río Ewan flows into.From the above mentioned line towards Lago Fagnano, height values are certainly of importance; such is the case of Sierras de Beauvoir, showing a levation of about 1,000 mts. high, then descending up to 900 mts in the south of Lago Yehuin until it finally reaches 50mts. approximately in the shore. In the south of Lago Fagnano, the relief turns out to be more accentuated, even showing levations of up to 1,450mts, to be found in Vinciguerra ridge of mountains, and 1,490 mts. in Cerro Cornu belonging to Sierra de Alvear; 1,026 mts. in Cerro Atocha and 420mts in Cerro Real located in Península Mitre.

HYDROGRAPHY: It is relatively dense and is made up of rivers Cullen, Chico, Moneta, Grande, de la Turba, Mac Lennan, Candelaria, Ewan, San Pablo, Yrigoyen, Claro, Turbio, Lasifarshaj, Bueno, López, Suramérica, Olivia, etc.

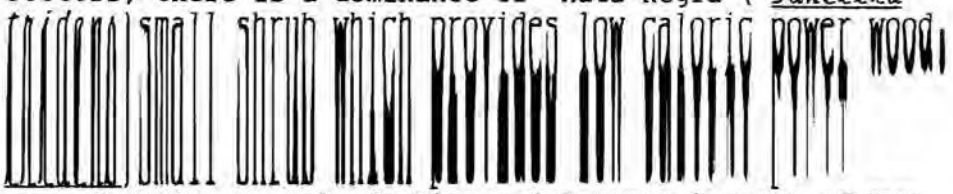
Water bodies of diverse shape and extent are scattered all over the territory, these being the main ones: ponds Am-ki, Asher, O'Connor, Grande, Los Flamencos, Carmen, Arturo, del Carbón, Peñas, Filaret, de la Pascua, Escondida, de la Suerte, Arcillosa, de la Vuelta, Miranda, de los Patos, Las tres Marías, Don Bosco, San Luis, Fuego,Okelkash, Antuk,Tap, Blanca, Verde, Luz and Bueno. Lakes Fagnano, Chepelmuth, Yehuin, Yakus, Escondido, San Ricardo, Santa Laura and Roca.

CLIMATE:In general , it is wet and cold in the south, presenting a slight variation towards the north where it becomes somewhat drier. In the south region, the absolute maximum and minimum temperatures are 25°C and -13°C in Ushuaia Station; 29°C and -14°C in Gallegos Station, located in the continent.

The average rain per year is 548 mm. in the south and 222 mm. in the north. Snowing is intense and it is most frequent in May and October. Cloudiness is also frequent, the covering being estimated in 6/8 during 75% of the year.

VEGETATION: in the south region there prevail forests, preferably made up of "Lenga"(*Nothofagus pumilio*) and "Ñire"(*Nothafagus antarctica*), surrounded by cinnamon trees, "Maitenes"(*Maytenus boaria*)and "Cohiues"(*Nothofagus dombeyi*); this constitutes an integrating part of the Subantartci province.The forest density and space distribution vary northward where the "Ñire" abunds. While the forest disappears when approaching the extreme northern regions,

there becomes dominant the herbaceous vegetation of the "meadow type". In this environment,"Coiron"(*Festuca gracillima*) is the prevailing floristic element. In certain sectors, there is a dominance of "Mata Negra"(*Junellia*



GEOLOGY: La Isla de Tierra del Fuego is part of two different geological provinces. In the northern part, that is to say, the region placed north Lago Fagnano, we identify the Province known as Patagonia Austral Extraandina or Cuenca Austral Magallánica, while in the southern region- that between Lago Fagnano and the shore of Canal de Beagle -we find the Province known as Cordillera Fueguina, which continues en Isla de los Estados. The first province constitutes a sedimentary basin, where a thick pile of sediment deposited, this belonging to Tertiary and Cretaceous times. As a whole, Tertiary lithological units display a greater horizontal development on the surface, while in the surroundings of Lago Fagnano there prevail those belonging to the high Cretaceous age.

The general aspect of the island is that of different and consecutive belts of sedimentary rock, of increasing age from north to south, adjusting themselves to the cordillera's direction. As a result, it describes a half moon arch which sticks to the cordillera bearing, this having an east-west direction in argentine territory, that is to say, parallel to Canal de Beagle. The cordillera breaks in LeMaire Strait and appears again in Isla de los Estados.

In the northeast sector of the island, between the atlantic shore and Río Grande, Tertiary beds are characterized by their marked horizontality. No folding is observed and the soft slopes that can be seen are mainly due to fracturating conditions. Undoubtedly, this is the region of greatest tectonic quiteness in the basin. As we advance towards the west-southwest region, it starts to become notorious an increasing disturbance of layers associated to compressing efforts. The folding directed east-west is soft, symmetrical and has a wide curvature ratius, in the outskirts of La Despedida ranch; it achieves a greater intensity as it approaches Lago Fagnano. It then gives origin to tight asymmetrical foldings, of short curvature ratius. When gaining depth, surface foldings constitute complex subsoil structures, with dominance of reverses faults. In the outskirts of Lago Fagnano, all this tectonic complexity turns out to be even more complicated because of the presence of strike slip faults, which are parallel to the folding direction.

In the second province, we distinguish the Cordillera Fueguina which is the natural prolongation of the Andes Patagónicos, these describing a concave arch towards the northwest. The oldest rocky units in the area emerge

in such cordillera. The sequence begins with rocks of metamorphic origin (Lapataia Formation) which consist of rocks of Paleozoic or Mesozoic age affected by a low grade regional metamorphism.The main integrating elements are phyllites and green schists. They out crop in the west of Ushuaia, in the surroundings of Lago Roca, where metamorphism intensity is greater, the progressively diminishing eastward. On the basement, the Formación Alvear rests in uncomformity;belonging to the Jurassic age, it is made up of a variety of volcanic and sedimentary rocks and consists of a succesion of shales and slates interbedded with basic rocks. Immediately after there follows the Formación Le Maire -middle to superior Jurassic age-, which appears in a saltuary way; it is formed by a group of volcanic and pyroclastic rocks of acid composition. On top of it, the Formación Yahgan lies. It corresponds to the inferior Cretaceous-superior Jurassic age and is characterized by black shale, ofhiolites, tuff and a turbiditic sequence, with interleaved intrusive bodies. There follow the acid plutonites -middle to superior Cretaceous age -which consist in reduced stocks of granitic and granodioritic composition, appearing quite separately. They give origin to hills of very particular shapes such as Cerro Huehuepan and the small hills placed north-northeast Río Olivia's Fishculture Station.

Showing an accentuated angular uncomformity, we find the Formación Río Claro's sediments of Tertiary age. Such formation is made up of conglomerates and sandstones of marine origin. Just upon this, there lay the deposits of Formación Slogget, of continental origin, formed by conglomerates, sandstones and coal thin layers.

The Quaternary deposit which affects the whole island and, completely or partially covers the above mentioned units in both provinces, is especially represented by glacial, fluvioglacial, fluvial, marine and eolic deposits thus constituting great plains. Such material covers almost the whole territory, scattering upon most of the previously mentioned formations. Glacial deposits reach their greatest development in the north end of the island, particulerly in the outskirts of Bahía San Sebastián. Fluvioglacial deposits are outstanding in large plains accompanying the main rivers. Peat material deposits reach their best development in the valleys descending from the Cordillera Fueguina and in Península Mitre.

Deposits of marine origin are most commnly found in the depression of Bahía San Sebastián, particularly in the surroundings of Río Chico or Carmen Silva, and along the whole coast in the mouth of atlantic rivers, thus giving place to arrows or spits of quite limited extent.

MATERIAL AND METHODS

A sampling station was settled in the studied lakes, in a central location. Water samples were obatined at different depths by using a pumping system. Dissolved oxygen, temperature and conductivity were determined with an oceanographic anular border. Transparency was measured with the Secchi disk, and the measurement of light attenuation in the water column was made by means of a LI-COR photometre (Lambda Instruments, Nebraska, U.S.A.)

Surface samples were taken from ponds in a zone neighbouring the shore, by using a Van Dorn bottle.

Plankton qualitative samples were obtained with a 25 µm

Dissolved oxygen was calculated through Winkler method modification by Alsterberg; volumetry was employed to determine calcium, magnesium, chloride, carbonate and bicarbonate; spectrophotometry was used to determine ortophosphate, total phosphorus, ammonia, nitrate, sulphate,reactive silica iron and manganese;sodium and potassium by atomic absorption according to techniques decribed in the Standard Methods for the Examination of Water and Wastewater (1971)-

Chlorophyll was determined in accordance with Lorenzen technique (1967), by filtering adequate water amounts through Whatman GF/C filters and removing the pigment with 90% acetone.

In relation to primary production measurements, samples were collected at different depths. Such samples were kept in the dark and were afterwards processed in the laboratory employing the ^{14}C method by Steeman Nielsen (1952). Light and dark bottles of the different depths were inocu - lated with 4 µ Ci of $Na^{14}CO_3$ H and later incubated in a thermostatized water bath during four hours. The source of light was obtained with a 500 watt photography lamp and bottles were placed at different distances so as to roughly get the same light intensity of the different depths.

Parallel to this, a sample was selected from each one of the lakes, at the depths of 2,5 metres,such sample being used to carry out an experiment of light-photosynthesis. This was accomplished by incubating the samples at different light intensities, namely: 500, 150, 45 and 13 µE $m^{-2}s^{-1}$. In ponds were primary production experiment was carried out, the work was only done with the surface sample, developing the light -photosynthesis experiment.

It is important to point out that data listed in Table 1 correspond to the maximum value, that is to say, production in the most favourable light intensity. Once primary production incubations were completed, samples were filtered trhough filters of 0,45 µm membrance. Filters were put in scintillation vials containing 10 milliliters of

scintillation solution with a p-dioxane base (Bray's fluor). The activity of samples was measured with a Beckman LS-100 liquid scintillation counter.

Geoenvironmental features were evaluated on the basis of field works and, essentially, by means of LANDSAT E 3038013120 image, dated March 2oth, 1979.

RESULTS AND DISCUSSION

According to physical, chemical and geoenvironmental characteristics, the systems which have been studied can be differentiated into three large groups.

The first group is made up of those water bodies located in the north region of the island, near Río Grande locality. Such water bodies are: Asher, Am-ki and Grande. The three of them present a north-south direction, determined by a geological/structural control. This zone shows a prevalence of fracturing giving origin to blocks, which, in turn, control the orientation of ponds. Geologically, they are placed upon a morphostructural unit defined by its flat/flat concave relief,scarce relief amplitude and heights not exceeding 300 meters above sea level. On the surface there prevail terrace shaped deposits of glacial, fluvioglacial origin, and peats in a minor proportion. All such material lies upon lithological units of superior Tertiary age, of marine origin; they are horizontally distributed and show evidence of faults mainly in the northeast -southwest direction.

The region fundamentally presents herbaceous vegetation. Some ponds, such as Am-ki, just to mention one we have studied, show spots of concentrated vegetation in the western border, these possibly indicating the area of feeding through underground waters. In this group of ponds, tints or colours are lighter (on Landsat colour IR image) than those in the rest of the island. We can appreciate a tint that ranges from a light bluish to a very soft light-blue. Most of these ponds display large shores of flat relief consist of cohesive material and a large saline aureole. The latter is most evident in Laguna Grande.They are bodies containing high turbidity because of quickly decantable suspended solids and an important salt concentration , especially chloride and sodium. There is also to be found in them a high content of phosphorus and certain other elements such as iron and manganese. The ionic balance shows a great discrepancy between cations and anions, something that leads us to consider the possible existence of other elements which have not been regarded in our analyses. Chlorophyll values are high enough and belong to mildly mature environments. The high concentration of

suspended sediments prevented us from carrying out primary production experiments.

The second group consists of a large amount of lakes and ponds located in the central section of the island, between Río Grande and a line passing somewhat south Lago Fagnano. The main water bodies which are part of this group are: Lakes Fagnano, Yehuin, Chepelmuth, Escondido, San Ricardo, Santa Laura, Yakus and ponds Pescado, Antuk, Luz, San Luis, Fuego, Blanca, Verde and Esperanza. Such these bodies are apparently distributed in a chaotic way: yet, they can be recognized as belonging to four different subgroups:

a) This subgroup includes those water bodies present-in a well-defined east-west orientaton due to structural control by folding. The following ones are considered: Fagnano, Yehuin, Chepelmuth, Yakus and Laguna Antuk, all of them being located north Lago Fagnano.

In broad line, they are placed on different morphostructural units.

The complete subgroup is settled in an area the surface of which is mainly covered with glacial, fluvioglacial and peat material. These materials stand upon rocky units of inferior Tertiary age, distributed in a sloping way as an effect of folding, which provides them with an east-west orientation. Relief is often on an outstanding amplitude.

All of them are embedded in a region of arboreal vegetation.

b) This subgroup is made up of those water bodies presenting a dominant southwest-northeast orientation, due to a structural control by fracture. They are the following ones: Lago Escondido, San Ricardo and Santa Laura, neighbouring the south shore of Lago Fagnano. The first of them-Lago Escondido- is placed in an area of accentuated relief while the other two lie in an area of soft, terrace-shaped relief. On the surface there prevail glacial, fluvioglacial and peat deposits, all resting upon Crestaceous age rocks.

The area is mainly covered with arboreal vegetation and, locally, quite near to the shore of lakes, peat material becomes of importance owing to its extent.

Lakes belonging to subgroups a) and b) share a series of features in common: first, a great transparency revealed by the values of Secchi disk and the coefficients of extinction. Their ionic composition is quite similar (Fig.1)' of the calcium bicarbonate type; their waters are also soft, poor in nutrients and organic matter. It is worthwhile to point out that, by comparison with the other ones, Lago Escondido has a higher nitrate concentration, this possibly being related to the fact that, because of its particular location, it receives the material coming from the mountains surrounding it. Thermal profiles, of oxygen and nutrients,

are very regular just like those of chlorophyll a (Table 1); primary production is low, not exceeding 0,4 mg. Cm^{-3} h^{-1}. According to the surveyed data, it is possible to state that we are in the presence of ultraoligotrophic water bodies.

c) It is made up of those water bodies showing neither a prevailing direction nor a regular shape, owing to the fact that they are located in areas of powerful, not consolidate covering, this diminishing the structural control which may exist on the subsurface. This subgroup is formed by ponds Blanca,. Verde, Pescado and Esperanza. The first three in particular are small in their dimensions and are all placed in the outskirts of the center-east sector of Lago Fagnano. As regards ponds Blanca and Verde, the base rock is of Cretaceous age. Yet, they have little or no contact at all with these surface rocks since the ponds fundamentally lie upon glacial deposits as in the case of Laguna Blanca - and upon fluviolacustrine and peat deposits -La guna Verde. The rest of them -ponds Pescado and Esperanza-, which lie upon deposits of glacial origin, rest on sedimentites of superior Tertiary age.

Absolutely all of them are placed in regions of flat to flat-soft undulating relief. Vegetation is mainly arboreal in ponds Blanca and Verde, and herbaceous in the other two.

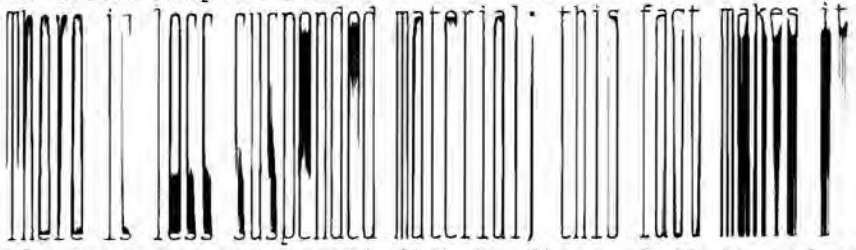
d) It is formed by those water bodies presenting a dominant west southwest- east northwest direction, near to the marine shore. They are the following ponds: San Luis, Fuego and Luz. Both ponds San Luis and Fuego lie upon a unit of flat to soft undulating relief with slow drainage. Considering its surface, the morphostructural unit is characterized by deposits of quaternary transport material, all of them spread upon rocks of middle and superior Tertiary age. Such rocky units are horizontally distributed and, in some cases, show soft warps.

Laguna Luz is thoroughly located upon large peat deposits which are placed on rocks probably belonging to Cretaceous age.

All bodies corresponding to this second group range from dark blue to black as regards their colour (when seen on Landsat colour IR image); except for bodies of irregular shape, the other ones have neither large shores nor saline aureole.

Ponds present a more neutral pH rank than those belonging to the first group; they also have less concentration of salt, and are softer. As regards their ionic composition, there is agreater prevalence of calcium and bicarbonate, evidenced by an increase in the divalent/monovalent cation ratio (Table 1). In particular,ponds Esperanza and Verde have ionic proportions which are similar to those to be

found in lakes (Figure 1). Laguna Luz is the exception to the recently mentioned rule since, despite the fact that it has low salinity and its waters are soft, its pH is acid and its ionic composition is sodium-chloride.



possible to carry out Secchi disk readings of 30 cm and apparently, most of these would be of organic nature, though it was not possible to make measurements.

The concentration of soluble organic matter originates a light brown tint in ponds; in Laguna Luz such tint is accentuated. Phosphorus is not so high as is the case of a chlorophyll and primary production. It is certainly outstanding the concentration of iron compounds appearing in ponds Antuk, Luz, San Luis, Fuego and Esperanza.

Lago Roca constitutes the third group. It consists in an atypical body on account of its glacial feeding. It is located in the west end of the territory and is also part of the Republic of Chile. The region where it is placed shows a large amplitude as regards its relief where metamorphic rocks prevail. Its orientation is northwest-south east, which could be a consequence of a structural control originated by the old folding structures, prior to the metamorphic process. While the shores of the lake are covered with arboreal vegetation mainly, peat material becomes more important towards the south. Its waters are less transparent when compared to those of the other alkes, this feature being the result of a fine suspended material produced by glacial activity.Its ionic composition is also different from that of the rest (Figure 1). Nitrate concentration turned out to be high, as in the case of Lago Escondido.

In so far as phytoplankton is concerned, net samples were analyzed in 12 of the 19 visited environments. The total amount of taxa observed was 102 and the best represented groups were those of Chlorophyta and Bacillariophyceae, with 42 and 35 taxa respectively.

Figure 2 shows the distribution of the different alga groups on the basis of the taxa number in each of them, considering the various environments in study.Basing our conclusions upon observation, we notice that ponds Antuk and Pescado, and lakes San Ricardo, Fagnano and Escondido were the environments with greater floristic resources. Besides, the quantitative importance of Chlorophyta and Bacillariophyceae is evident in all the ecosystems in consideration.

Table 2 presents a detailed report about the presence and relative frequency of each taxa in each environment where it has appeared. Thus, it can be deduced that the most frequent species were *Dinobryon* aff *sertularia*, *Asterionella formosa*, and a species of the *Mougeotia* genus, which were found in 7 of the 12 environments studied.

There follow *Dictyosphaerium pulchellum* and a species of the *Cymbella* genus, to be found in 6 of the ecosystems. We must also enhance the importance of *Staurastrum* and *Cosmarium* genera which were observed in 8 of the samples, presenting various species.

On the other hand, the species with higher relative frequency were *Dinobryon aff sertularia* in Lakes Yakus and Fagnano; in the latter, they shared importance with a species of *Staurodesmus* genus; similarly, *Asterionella formosa* became important in Lago Santa Laura and *Dinobryon divergens* in Laguna Blanca. All of these taxa in each of their environments became almost completely dominant with a high percentage of presence.

Results of the analyses of zooplankton samples are listed in Table 3 and Figure 3, 4 and 5.

If we do not consider those taxa having been identified through the found remains which, on the whole seem to come from shore sands, it can be stated that, in general, resources were poor. Certainly, we cannot ignore the feature of "punctual in time" of the analyzed samples; therefore, we can reasonably conclude that such circumstance leads to an underestimation of the actual number of species making up the zooplankton of the studied water bodies.

COMMENTS UPON THE IDENTIFIED TAXA

Boeckella michaelseni (Mrazek)

It turned out to be the most frequent species since it was found in all the samples in examination; it was also the most abundant, prevailing in all the cases (Figure 3).

According to bibliographical references Ringuelet 1957, the area of dispersion of such species is the south region of Southamerica, mainly in Tierra del Fuego, extending up to Georgias del Sur islands.

The structure of their populations was quite varying though we can distinguish certain trends so that lakes area generally dominated by nauplii stages while copepodites prevail in ponds. Figure 4 displays one graph per each water body which stands for 100% of the individuals of the population.

The differences and similarities to be noticed in the structure of populations could possibly be reflecting a response to certain environmental conditions which would characterize the different biotopes and would probably be related to the thermal system of each water body.

Fecundity, that is to say, number of eggs in each oviferous sack also showed differences in relation to the average fertility values in am increasing order.

It is important to point out that the null values of

Lago Santa Laura (VII) and Lagunas Blanca (XVII) and Esperanza (XVIII) would mainly be due to the scarce presence of adults in the samples though probably owing to different reasons. As regards the lake, its population was almost exclusively made up of nauplii, that is to say, in a particular stage to its dynamics; on the contrary, samples taken from ponds were very poor in specimens of any age.

Fertility in some species of calanoid copepods, as it has been verified (Czezuga 1960), would be associated with the trophic status of the water body.

Pseudoboeckella spp.

This genus was represented by two species: *P. brasiliensis* (Lubbock) and *P. poppei* Mrazek, both widely distributed in Patagonia, the latter also present in the Antártida Marí tima.

In the water bodies where they were found, the former in Lago Fagnano, the latter in Laguna Pescado, they were represented by a large number of individuals, the second species in particular.

The structure of their populations was dominated by larval stages, adults being proportionally scarce. Egg carrier females were only found in the population of *P. brasiliensis*.

It is also necessary to state that the sample from Lago Roca showed remains, apparently corresponding to a moult, which undoubtedly belonged to an individual of this genus; however, its state of conservation, apart from the fact that we were dealing with a specimen not yetmature, prevented us from identifying it at a species level.

Acanthocyclops spp.

This genus of the Cyclopidae family was present in the samples from three water bodies. The species that could be identified as *A. shottsbergi* Lindberg was represented only by larval stages, copepodites and probably nauplii, too; also male adults. Female specimens could not be found, at least in this first revision of the sample.

It is interesting to remark the fact that this species first found in a pond in the estuary of La Pera, south Chile (this is the second one), has its original description based upon male specimens, since female ones could not be found in that opportunity, either.

In Laguna Luz there appeared a copepodite IV specimen of this genus, but it was impossible to attribute this to any known species considering that, in this state of development, there is not yet a definition of all the diagnostic characters.

In reference to this genus, and to the most southern region of Patagonia, in this case Tierra del Fuego, it was also known the presence of A. *michaelseni* Mrazek, mentioned by Ekman 1905.

Tropocyclops Fischer

It is a species of cosmopolitan distribution whose presence in Tierra del Fuego was still recorded in the following registers: Lindberg 1954, Thomasson 1955 and Ringuelet 1957.

In the samples taken from Lakes Chepelmuth and Escondido, we have found a large number of specimens belonging to different development stages, while in the sample obtained from Lago San Ricardo there were only scarce adult specimens. In Lago Chepelmuth,we detected the presence of female individuals carrying small, rounded oviferous sacks with a limited number of eggs (3 or 4 in each sack).

Harpacticoideos

The only findings from this taxonomic group were remains of moults discovered in ponds Blanca and Luz, and a specimen of nauplia in Lago Chepelmuth.

Species of this group are typically of shore or bentonic type; that is why the presence of the above mentioned remains in samples is probably casual, just a result of the water turbulence caused by wind action, or the haulings carried out quite near to the shores.

Bosmina (Neobosmina) chilensis Daday

The identification of the specimens which were found was made by following the approach put forward in Paggi's revision 1980, in which there was a re- definition of *Bosmina* genus grouped in the *Neobosmina* Lieder sub-genus.

The distribution of this species,according to said approach, would be limited to the southwestern sector of Patagonia. Records made by Vavra 1901 and Thomasson 1953 and 1955, about *Bosmina obtusirostris* and *B. coregoni*,respectively, should be definitely attributed to *B. chilensis*.

Yet, we should notice that specimens belonging to some of the lakes in study, those of Lago Chepelmuth in particular, somewhat differ in their external look from what is considered typical in the species , specifically in what is related to "face" features.

We have provisionally included these specimens in the identification *B. chilensis* but it is still necessary to carry out more detailed observations which may lead us to throw light upon the problem, particularly complex in species

of high polimorphism such as those belonging to *Bosmina* genus.

Ceriodaphnia spp

The presence of specimens belonging to this genus turned out to be too frequent in the studied samples; this was verified in all samples taken from all lakes and that from Laguna Pescado.

The identified species, *C. dubia* Richard, has a roughly cosmopolite distribution and had already been discovered in Tierra del Fuego by Ekman 1905. It is also well represented in Lagos Araucanos, Thomasson 1959 and 1963, and Loffler 1961.

There were other specimens in Lakes Chepelmuth and Escondido and in Laguna Pescado, which were not attributed to any species in particular, since they were young individuals not bearing well-defined characters, specially the development of pectens of the caudal claws which are of basic importance in the genus taxonomy.

Daphnia midderddorffiana Fischer

Having been generally considered as a typically holartic representative, from water bodies neighbouring the North Pole and from highlands, this species was quite recently found in Andean lakes; Paggi 1973. In this work, and on the basis of some references to the specimen pigmentation, it was suggested that the identifications made by Ekman 1905 on material from Tierra del Fuego and Malvinas Islands, such as *Daphnia pulex* , actually belonged to *D. midderddorffiana*.

What has been found in the population of Laguna Luz and Pescado is to confirm the presence of the species in Tierra del Fuego and to reinforce the assumption of conespecificity with Ekman's specimens.

The population of the sample taken from Laguna Pescado in which specimens were more abundant, was made up of young and adult specimens of parthenogenetic female individuals; there was not any efipial male or female specimen. In Lago Santa Laura we found a very small, young specimen which was not identified at a species level. It may probably belong to the species here discussed since the way the middle pecten of caudal claws is developed undoubtedly places it in the "pulex" group, but we found no sign of pigmentation either in the dorsum of the cephalic shell or in the basis of feelers, this being a feature characteristic of *D midderddorffiana* .

Other cladocerous specimens

In all the samples from ponds, which proved to have been taken from zones with vegetation, probably covered with moss -basing this concept on the presence of pieces of "leaves" of such plants-, we discovered remains, particularly moults of valval and cephalic shells belonging to cladocerous of the Chydoridae family.

In such conditions, the level of approach of identifications that can be done depends upon the nature and state of conservation of the remains which have been found.

The mostfrequent remains were valves of *Chydorus* sp., and with a less frequency *Alona* sp., *Camptocercus* cfr *australis* -both in Laguna Luz- and *Biapertura affinis* in Laguna Blanca. Here we also found abundant remains of valves and some cephalic shields.

The sample from this pond also presented an "efipic" which surely belongs to some species of *Simocephalus* , member of the Daphnidae family, typical inhabitant of shore areas.

RECOMMENDATIONS

-To undertake a limnological study in a pilot lake, covering the most important aspects such as geomorphology, 
activity, phytoplankton, zooplankton,etc. Depending on the existing possibilities, to expand research to the rest of lakes.

-To implement a monitoring plan of basic limnological parametres in the most important aquatic ecosystems, to be obtained three or four times a year. Such plan will, in the short run, provide elementary information in any kind of undertaking some of the mentioned ecosystems may be involved in. Later, it would be possible to evaluate the origin and magnitude of potential pollution sources.

-In particular, to focus attention on the following themes:

- -Chemical analysis of the rest of ponds placed north Río Grande; Laguna Filaret; the ones near Puesto 22; Almirante O'Connor; Carmen; de la Suerte; Arturo; Las Tres Marías; de la Vuelta; Redonda; del Cañon; los Cisnes; Peñas, etc. To include in the analytical course techniques of lithium, aluminium, strontium, copper, vanadium and zinc detection.
- -Chemical analysis of the following rivers: Grande, Herminita, Moneta, Avilés and Chico.
  General hydrogeological research of the area and research focused on ponds.
- -Analysis of diagnostic vegetation.
- -Sampling of shore and deep sediments for the search of microfossils (diatoms).

Concerning the concentrations of phosphorus and manganese found in the northern ponds , it is not yet possible to determine their exact origin, owing to the scarce amount of information available. In order to overcome this difficulty, it is inevitable to start the above mentioned studies.

In order to achieve all that has been put forward, it is essential to constitute a permanent research team which could carry out their tasks in the Centro Austral de Investigaciones Científicas. Such team will rely on the advice and support of other research centres. CADIC has a series of facilities at its disposal, such as laboratories, instruments and logistic infrastructure devoted to the appropriate accomplishment of field work.

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No	WATER BODY	PH	CONDUCTIVITY µ MHO/CM A 20°C	TEMPERATURE °C	OXYGEN mg/l	OXYGEN % SATURATION	CARB./DIOXIDE mg. CO_2/l	CARBONATE mg CO_3^{--}/l	BICARBONATE mg CO_3H^-/l	SULPHATE mg SO_4^{--}/l	CHLORIDE mg Cl^-/l	CALCIUM mg Ca^{++}/l	MAGNESIUM mg Mg^{++}/l	SODIUM mg Na^+/l	POTASSIUM mg K^+/l	SALINITY mg/l	Mg /Ca	$\frac{Ca + Mg}{Na + K}$
I	YEHUIN	7,60	160	6,5	11,5	92,3	1,6	0,00	69,0	13,4	12,7	19,6	3,7	12,5	1,1	133,4	0,31	2,24
II	CHEPELMUTH	7,65	168	-	-	-	2,0	0,00	70,4	14,5	13,1	20,5	4,8	13,1	1,1	137,5	0,38	2,37
III	ESCONDIDO	7,15	88	6,2	11,3	90,8	2,0	0,00	40,6	9,5	2,3	13,6	2,1	3,9	0,3	71,6	0,25	4,81
IV	FAGNANO	7,00	74	5,7	11,9	95,6	2,0	0,00	32,7	5,6	7,2	10,2	1,1	3,4	0,4	60,6	0,18	3,80
V	ROCA	6,75	62	6,6	11,4	92,8	2,1	0,00	18,2	8,2	1,3	8,5	1,0	2,2	0,4	39,8	0,19	4,79
VI	SAN RICARDO	7,00	83	8,2	10,9	92,0	2,2	0,00	36,7	6,5	4,4	11,1	1,6	3,6	0,4	64,5	0,14	4,11
VII	SANTA LAURA	7,05	86	12	9,8	91,0	2,2	0,00	36,4	6,2	5,9	11,1	1,1	4,1	0,4	65,2	0,16	3,42
VIII	YAKUS	7,35	159	10,5	10,5	93,1	1,7	0,00	67,4	13,5	12,4	20,0	3,7	12,2	1,0	130,1	0,30	2,34
IX	PESCADO	7,15	112	9,5	10,3	89,2	1,5	0,00	72,7	0,7	7,8	15,3	1,6	10,2	0,3	108,6	0,17	1,99
X	ANTUK	7,80	112	12	10,4	96,6	0,7	0,00	52,8	0,8	10,8	11,9	1,1	13,1	0,5	110,9	0,15	1,18
XI	LUZ	5,80	90	9,2	9,4	81,4	2,2	0,00	11,7	3,7	29,8	4,3	1,6	12,6	0,8	64,5	0,61	0,61
XII	ASHER	8,30	776	6,5	9,8	78,7	0,0	6,9	216,8	51,7	160,0	54,6	17,3	139,0	17,2	663,5	0,52	0,64
XIII	AM-KI	8,45	3365	6,0	10,0	80,3	0,0	24,0	314,8	397,1	1.005,9	69,9	75,7	1030,0	28,8	2946,2	1,77	0,21
XIV	GRANDE	8,60	7682	11,5	7,3	66,2	0,0	65,5	501,1	841,0	5.029,6	85,3	369,7	3247,0	92,6	10231,8	7,10	0,24
XV	SAN LUIS	7,70	274	11,0	10,1	91,6	1,8	0,0	89,1	13,9	35,9	23,9	4,7	63,3	4,1	227,0	0,32	0,55
XVI	FUEGO	8,30	839	9,8	9,5	84,2	0,0	11,5	262,8	36,4	173,1	59,7	22,6	150,0	11,1	727,2	0,62	0,71
XVII	BLANCA	6,85	36	11,5	9,9	89,8	1,6	0,0	12,9	0,2	7,2	2,6	1,5	4,7	0,4	29,5	0,94	1,18
XVIII	ESPERANZA	7,55	194	11,5	9,5	84,2	2,1	0,0	95,0	14,3	13,7	29,0	3,7	12,4	1,7	169,8	0,20	3,01
XIX	VERDE	6,90	87	-	-	-	3,8	0,0	38,1	5,8	5,2	12,8	1,6	4,5	0,8	68,8	0,21	3,57

Table No 1

No	WATER BODY	AMMONIA µg at/l	NITRITE µg at/l	NITRATE µg at/l	ORTHOPHOSPHATE µg P/l	TOTAL PHOSPHORUS µg P/l	REACTIVE SILICON mg SiO_2/l	TOTAL IRON mg Fe/l	TOTAL MANGANESE mg Mn/l	DOO mg O_2/l	SECCHI METERS	CHLOROPHYLL mg/m³	PHAEOPHYTIN mg/m³	PRIMARY PRODUCTION mg C/m³.h
I	YEHUIN	20	5	5	5	28	8,0	0,243	0,00	4,4	12	0,51	0,00	0,36
II	CHEPELMUTH	32	5	5	8	29	10,2	0,006	0,00	6,2	5	0,42	0,11	
III	ESCONDIDO	10	5	5	5	14	5,0	0,006	0,00	3,7	5,5	1,01	0,00	0,40
IV	FAGNANO	10	5	5	5	12	3,8	0,006	-	3,4	9	0,27	0,03	0,44
V	ROCA	10	5	10	5	5	3,0	0,000	0,00	3,4	2	0,32	0,00	0,10
VI	SAN RICARDO	10	5	7	5	14	5,5	0,000	0,00	2,8	10	0,57	0,19	0,11
VII	SANTA LAURA	10	5	5	5	13	5,7	0,012	0,00	3,3	3	0,48	0,35	0,06
VIII	YAKUS	10	5	5	5	35	9,3	0,037	0,00	2,7	10	0,10	0,04	0,02
IX	PESCADO	10	5	5	7	25	35	0,092	0,00	3,6	1,4	2,94	0,00	0,11
X	ANTUX	10	5	5	13	43	0,8	1,746	0,15	11,1	0,5	9,33	6,40	0,59
XI	LUZ	10	5	5	-	19	0,8	1,746	0,00	24,2	0,25	3,17	0,24	0,94
XII	ASHER	31	5	5	13	360	10,0	0,839	0,00	-	0,05	38,41	0,00	0,28
XIII	AM-KI	10	5	5	498	3800	9,1	0,130	2,00	-	0,05	16,75	0,00	-
XIV	GRANDE	10	5	7	186	3100	10,5	0,399	2,00	-	0,05	15,49	1,71	-
XV	SAN LUIS	22	5	5	16	190	4,0	1,230	0,00	-	0,15	17,90	7,70	-
XVI	FUEGO	30	10	41	16	330	8,0	2,276	-	-	0,10	63,0	69,7	-
XVII	BLANCA	10	5	5	5	5	0,1	0,000	0,00	6,6	-	0,46	0,17	-
XVIII	ESPERANZA	192	5	40	10	70	4,5	1,746	0,00	7,2	0,15	23,50	0,00	-
XIX	VERDE	10	5	5	5	17	0,6	0,076	0,00	7,4	-	-		

Table 1. Continuation

WATER BODY	XI	II	XII	VIII	VI	III	X	VII	V	XVII	IV	IX
EUGLENOPHYTA												
Euglena sp							R-E					
CHRYSOPHYTA												
Monosiga sp.				R							MA (D)	
Mallomonas sp.	R											
Synura uvella	R											
Dinobryon sp.	E	R										
Dinobryon divergens						R		F-A	E	MA-D	F	
Dinobryon aff. acetularia	F	R		M-A/D	E	R	E				MA/D	
Tribonema sp.	F											
Melosira sp.			F									
Melosira granulata					F	R				R	E	
Melosira granulata var. angustissima f. spiralis						R						
Melosira italica	F				F	R		F-A				
Cyclotella sp.					E	E			R			
Cyclotella stelligera											R	
Cyclotella stelligera var. elpitica					E							
Cyclotella meneghiniana						R						
Rhizosolenia eriensis					MA	R		F	MA		F	
Asterionella formosa	E				E	R	MA	MA/D		F	A	
Diatoma aff. vulgaris	F	F		F			F					
Diatoma aff. elongatum					A			F-A			F-A	R
Tabellaria sp.							R		R			
Fragilaria aff. virescens			E									
Fragilaria crotonensis	F						R					
Synedra sp.					R	R		P			R	
Synedra ulna				E	E		E		F			R-E
Achnanthes sp.						R					R	
Cocconeis sp.							E					R
Gyrosigma sp.							R					
Fausulia sp.							E					
Naviculoides		R			E							E
Gomphonema constrictum							F					F-A
Gomphonema acuminatum var.coronata							F					R
Cymbella sp.			H		MA	R	F				A	E-F
Cymbella aff. affinis							E					
Cymbella cistula							F					R
Cymbella cistula var. guarrenae					MA					R		R
Pinularia sp.	R											R
Epithemia sorex							E					
Epithemia aff. argus							F					E
Rhopalodia gibba						R	R-F					R
Hantzschia sp.							R					
Nitzschia sp.					E							
Nitzschia sigma		F					P				R	E

Table 2: relative presence and frequency of phytoplankton in Tierra del Fuego.

R= rare
E= scarce (escaso)
F= frequent
A= abundant
MA= very abundant (muy abundante)
D= dominant (more than 75 % of presence)

WATER BODY	XI	II	XII	VIII	VI	III	X	VII	V	XVII	IV	IX
Cymatopleura solea		E					E					
Surirella sp.	R		R		R							
Surirella aff. robusta					R							R
PYRROPHYTA												
Cryptomonas sp.						E						
Hemidinium sp..							R			R		
Peridinium sp.					E							
CYANOPHYTA												
Chroococcus pascotti	R											
Aphanothece sp.						R						
Aphanocapsa litoralis				A								
Coelosphaerium sp.									E		R	
Coelosphaerium naegelianum		F										
Gomphosphaeria aponina					A			E				
Gomphosphaeria lacustris								E				
Microcystis sp.					R	E						
Merismopedia sp.			E			E					R	
Merismopedia elegans	R											
Oscillatoria sp.											E	E-F
Lyngbya sp.							P					F
Anabaena circinalis	R					E	MA					
Tolypothrix aff. limbata												R
CHLOROPHYTA												
Sphaerocystis schroeteri						E					A-MA	A
Oocystis sp.					R	R						
Oocystis parva			R				R					R
Oocystis aff. submarina											R	
Oocystis aff. crassa							R				R	
Coelastrum cambricum							R					
Planktosphaeria aff. gelatinosa												E
Ankistrodesmus spiralis												R
Ankistrodesmus falcatus							E					
Monoraphidium sp.			R									
Monoraphidium aff. contile											R	
Elakatothrix gelatinosa					R	F					R	
Scenedesmus sp.			E									
Scenedesmus quadricauda							E					
Scenedesmus arcuatus							R					
Crucigenia quadrata			A			E			R			
Crucigeniella rectangularis												E-F
Dictyochloropsella reniformis						A						
Dictyosphaerium pulchellum		A			E	E	E-F	R			R	
Scenedesmus alternans			E									
Pediastrum duplex		R	E						R			E-F
Pediastrum kawraiskyi		R	E			R		E			R	
Pediastrum boryanum	R		M-A					F	R			
Micractinium aff. pusillum									R			
Pauschulzia pseudovolvox		E		F	E			R	F			
Botryococcus braunii					R							
Pandorina morum				R		R						
Eudorina sp.						R						

Table 3 continuation

WATER BODY	XI	II	XII	VIII	VI	III	X	VII	V	XVII	IV	IX
Eudorina elegans					R							
Binuclearia exiensis						E						
Ulothrix sp.	F		F									
Mougeotia sp.	E					R	E	R		R	R	E
Spirogyra sp.												MA
Chaetophora sp.											R	
Staurodesmus spp.					E	R	R	R			MA-D	
Staurastrum spp.		E			R	R	E	R	E		A-MA	E-F
Cosmarium spp.		E			E	R	R	R	F	R	A	
Arthrodesmus sp.											R	
Closterium sp.	F		R			R						
Closterium aciculare											E	
Pleurotaenium aff. trabecula										R		
Gonatozygon sp.						R						
Gonatozygon aff. monotaenium										F		

Table 2 continuation

	II	III	IV	VII	VI	V	X	XII	XVIII	XI	I	IX
Boeckella michaelseni	+	+	+	+	+	+	+	+	+	+		+
Pseudoboeckella braziliensis			+									
Pseudoboeckella poppei												+
Pseudoboeckella sp.				r								
Acanthocyclops skottsbergi		+	+									
Acanthocyclops sp.										+		
Tropocyclops prasinus	+	+				+						
Harpacticoedeos	+								r	r		
Alona sp							r					
Biapertura affinis								r				
Bosminachilensis	+	+			+	+				+		
Camptocercus cfr. australis							r					
Ceriodaphnia dubia			+		+	+						
Ceriodaphnia sp.	+	+										+
Chydorus sp.								+	+	+		+
Daphnia middendorffiana										+		+
Daphnia sp.					+							
Simocephalus sp									e			

Table 3 : List of taxons of cruataceans identified in the samples of the different wate bodies ,indicated with Roman numerals.
(r=remains; e="efipio")

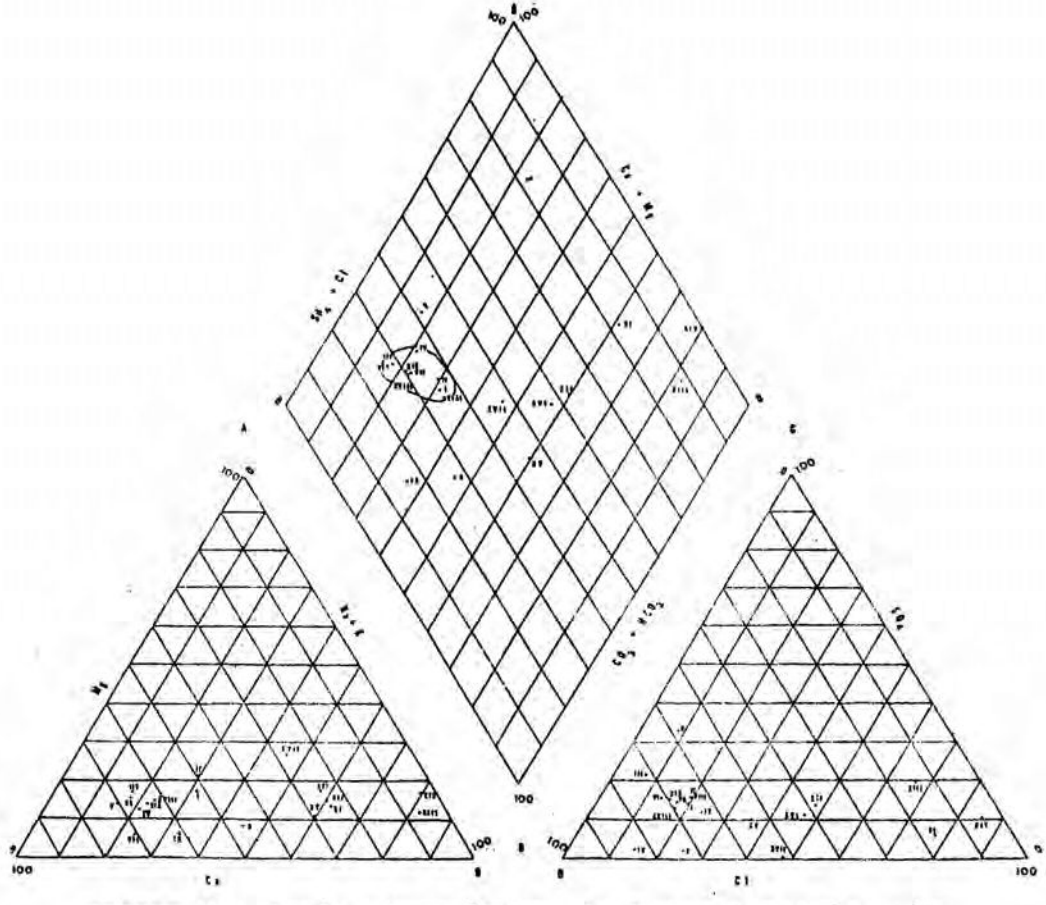

FIGURE 1 : Ionic composition. In Roman numerals, the water bodies which have been studied.

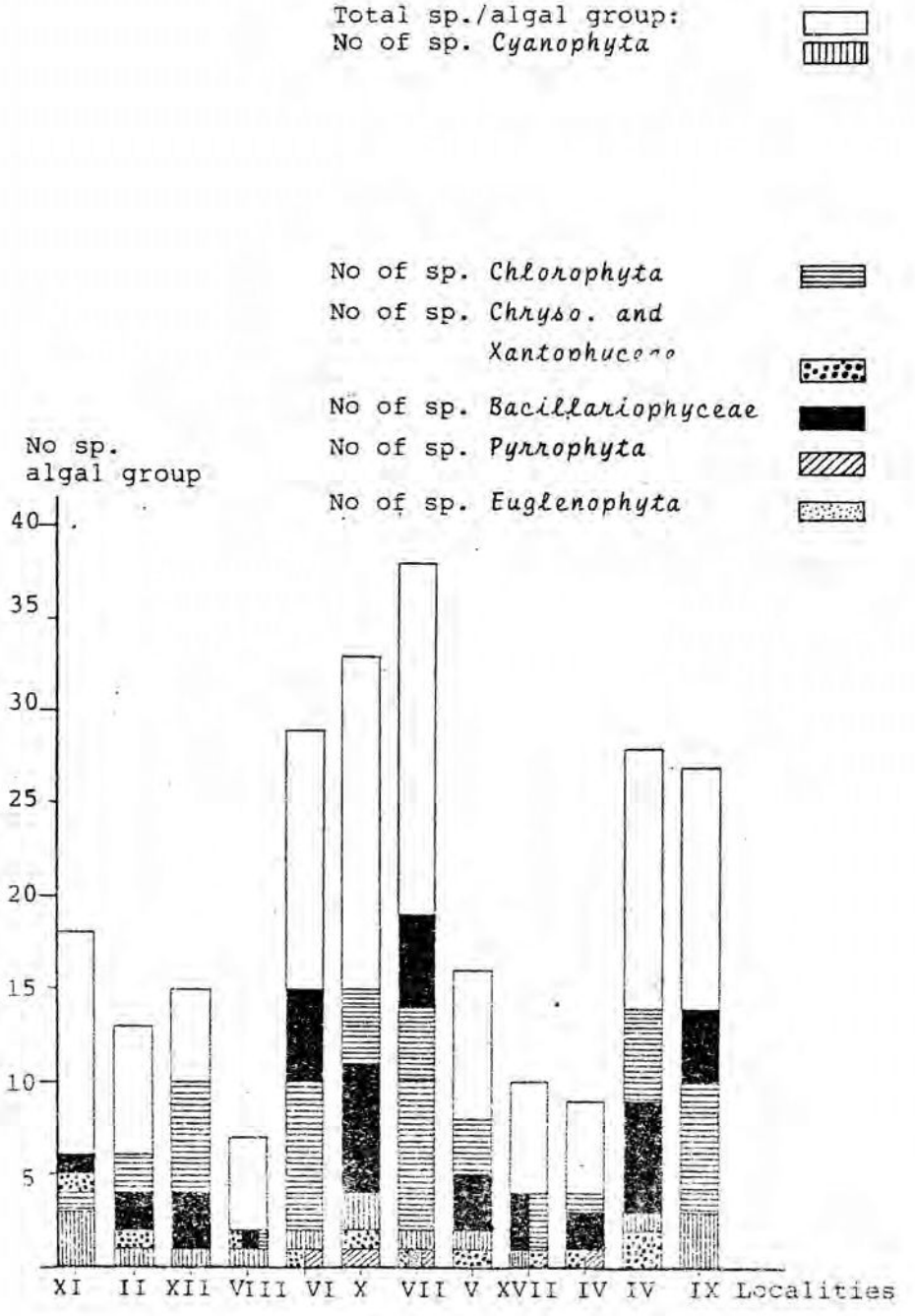

FIGURE 2: Variation of number of species in each algal group.

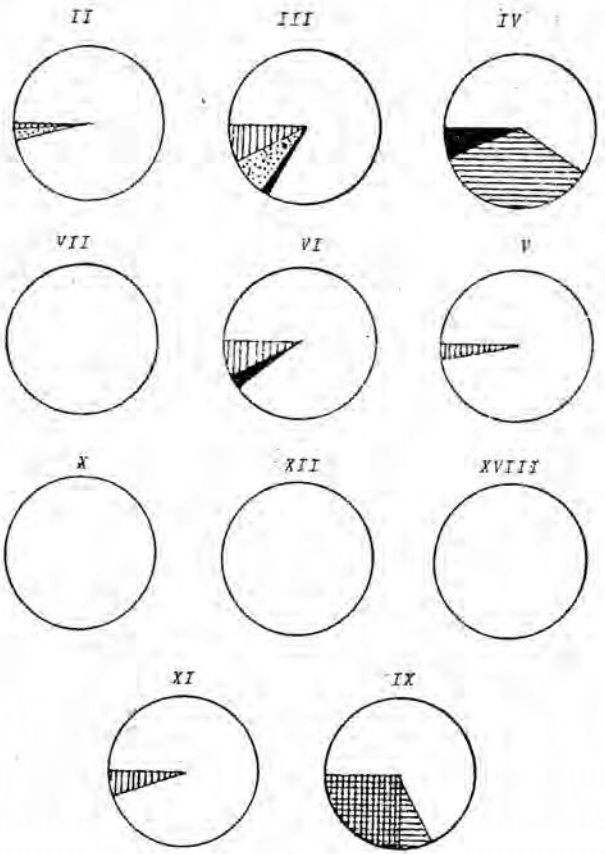

FIGURE 3: Composition of *taxocenosis* of zooplanktonick crustaceans in each water body. *Boeckella michaelseni*(white); *Pseudoboeckella poppei* (horizontal lines) ; *Tropocyclops prasinus* (dots) ;*Bosmina chilensis*(vertical lines) *Ceriodaphnia dubia* (black) ; *Daphnia midenddorffiana* (crossed lines).

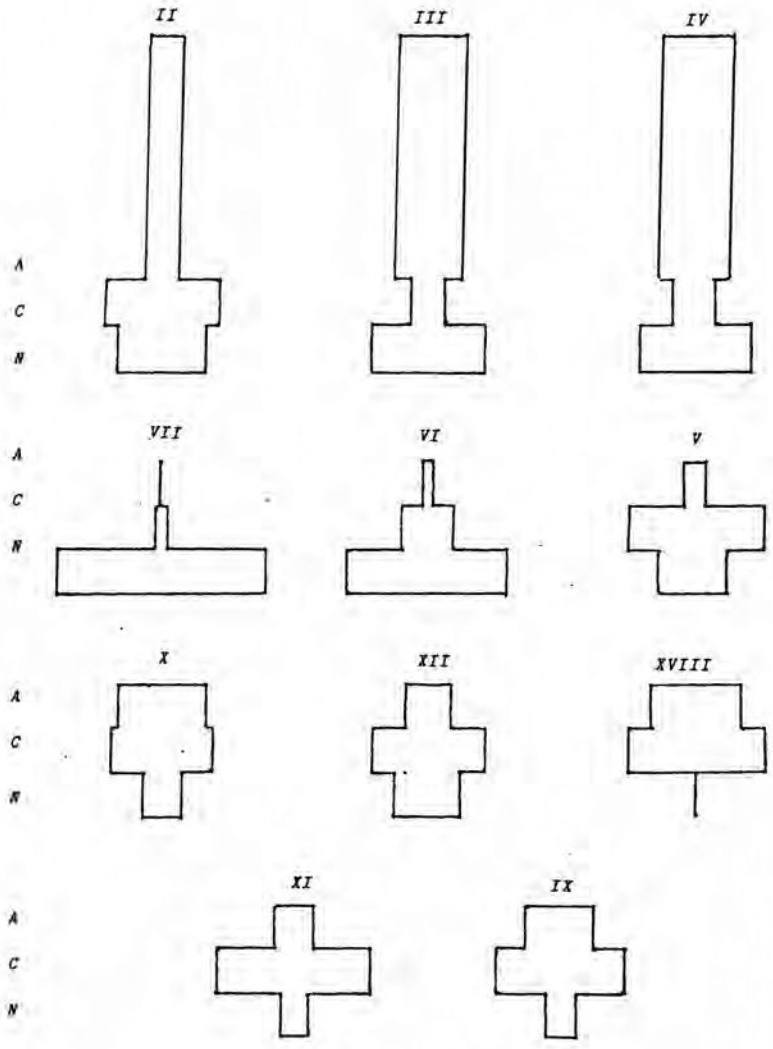

FIGURE 4: Structure of populations of *Boeckella michaelseni*.
Roman numerals indicate water bodies.
A: adults.
C: copepodites.
N: naupilii.

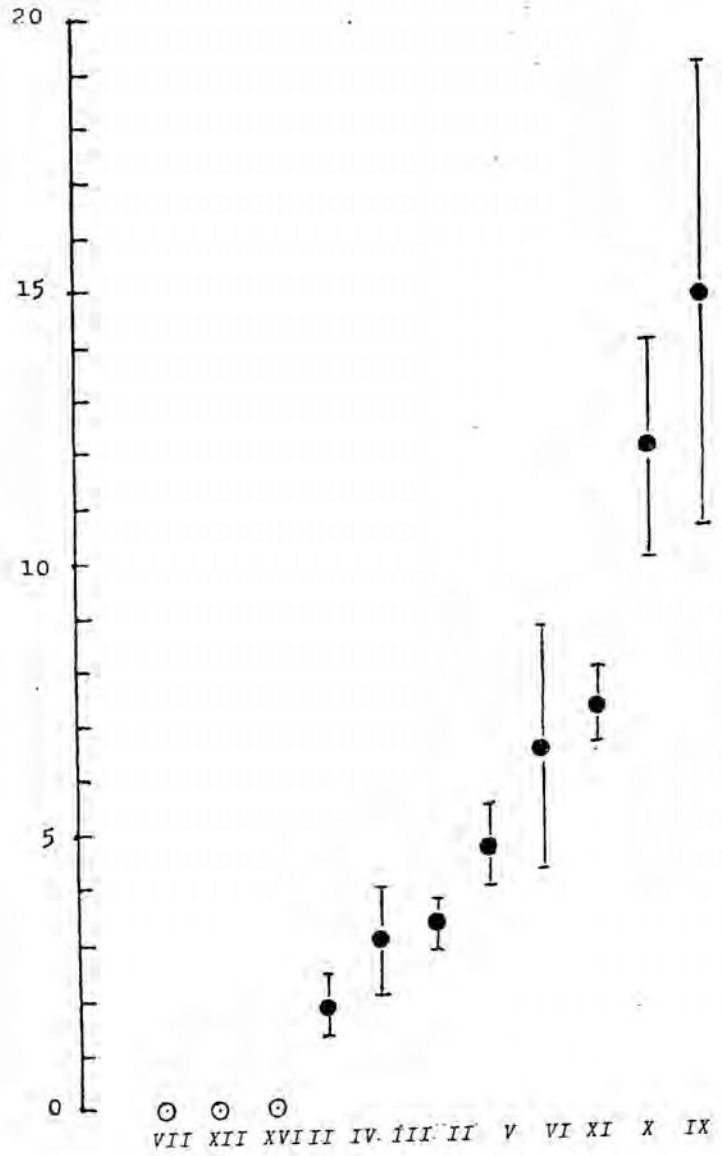

FIGURE 5 : Fertility of *Boeckella michaelseni*, number of eggs in each oviferous sack (vertical scale); average value (circle); typical deviation (vertical segment).
Roman numerals indicate water bodies.

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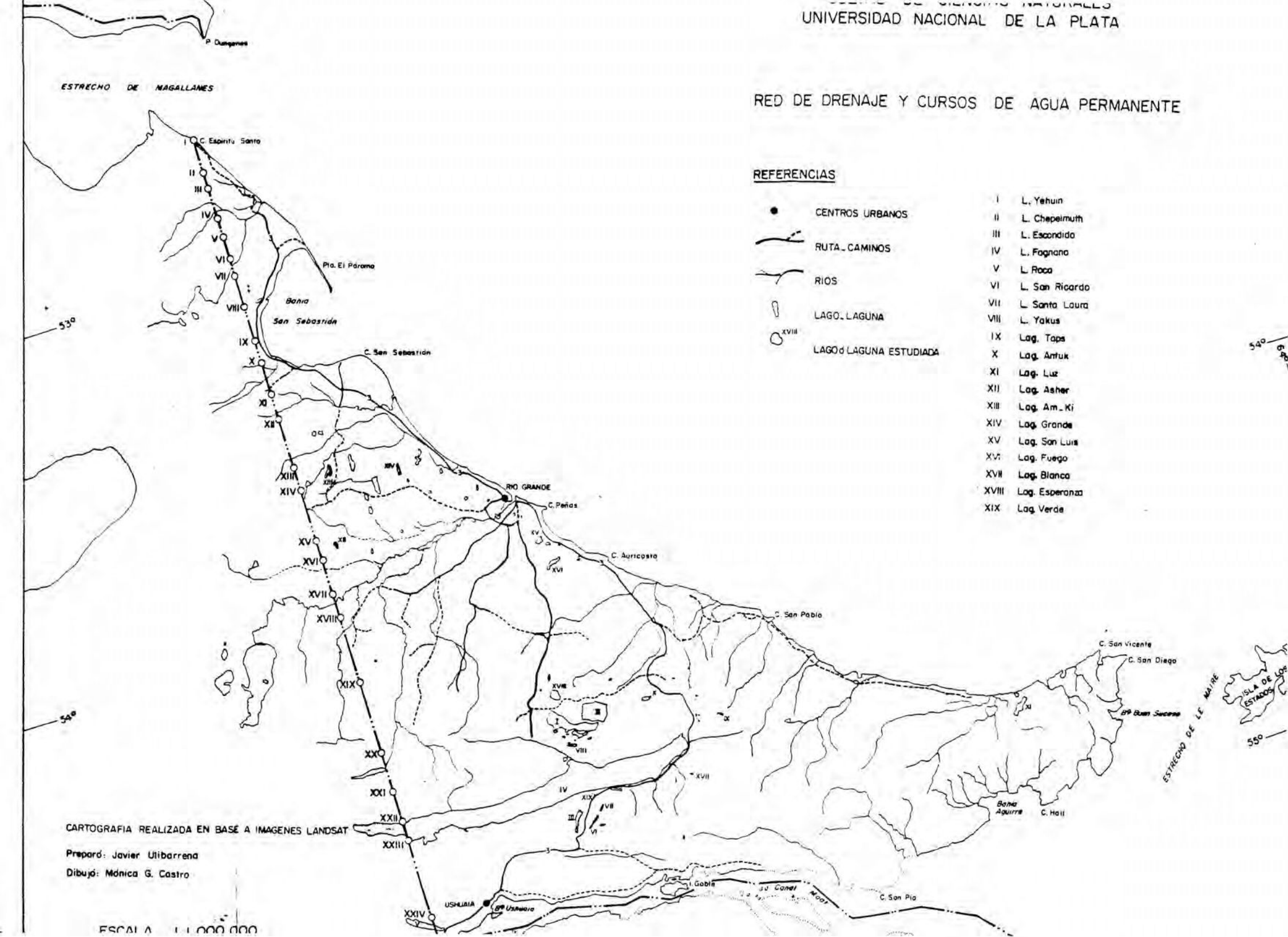
RED DE DRENAJE Y CURSOS DE AGUA PERMANENTE



REFERENCIAS

- CENTROS URBANOS
- RUTA_CAMINOS
- RIOS
- LAGO_LAGUNA
- XVIII LAGO d LAGUNA ESTUDIADA

I	L. Yehuin
II	L. Chepelmuth
III	L. Escondido
IV	L. Fagnano
V	L. Roca
VI	L. San Ricardo
VII	L. Santa Laura
VIII	L. Yakus
IX	Lag. Taps
X	Lag. Antuk
XI	Lag. Luz
XII	Lag. Asher
XIII	Lag. Am_Ki
XIV	Lag. Grande
XV	Lag. San Luis
XVI	Lag. Fuego
XVII	Lag. Blanca
XVIII	Lag. Esperanza
XIX	Lag. Verde

CARTOGRAFIA REALIZADA EN BASE A IMAGENES LANDSAT

Preparó: Javier Ulibarrena

Dibujó: Mónica G. Castro

ESCALA 1:1.000.000

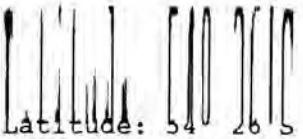
A P P E N D I X I

INDIVIDUAL RECORD OF LAKES

AND PONDS STUDIED

NAME: LAGO YEHUIN (Yehuin lake)

Geographical location: (approximate)



Latitude: 54° 26'S
Longitude:67° 44'W
Altitude :241m.
Easy access along H complementary route.
Average rain per year: 600mm.

Physical characteristics:

Shape: half moon
Total area: 53 km2
Maximum length : 16,500 m. Maximum width: 4,500m.
Shore line length: 45 km

Type of shore: presenting marked gullies; clearly defined, quite winding south border.
Main tributaries : several small tributaries coming from the surrounding ranges of hills.
Main effluents

Characteristics on the colour IR image:

Colour of water: dark blue to black.
Saline aureole : no presence.
Vegetation : arboreal up to the lake border, with peat material.

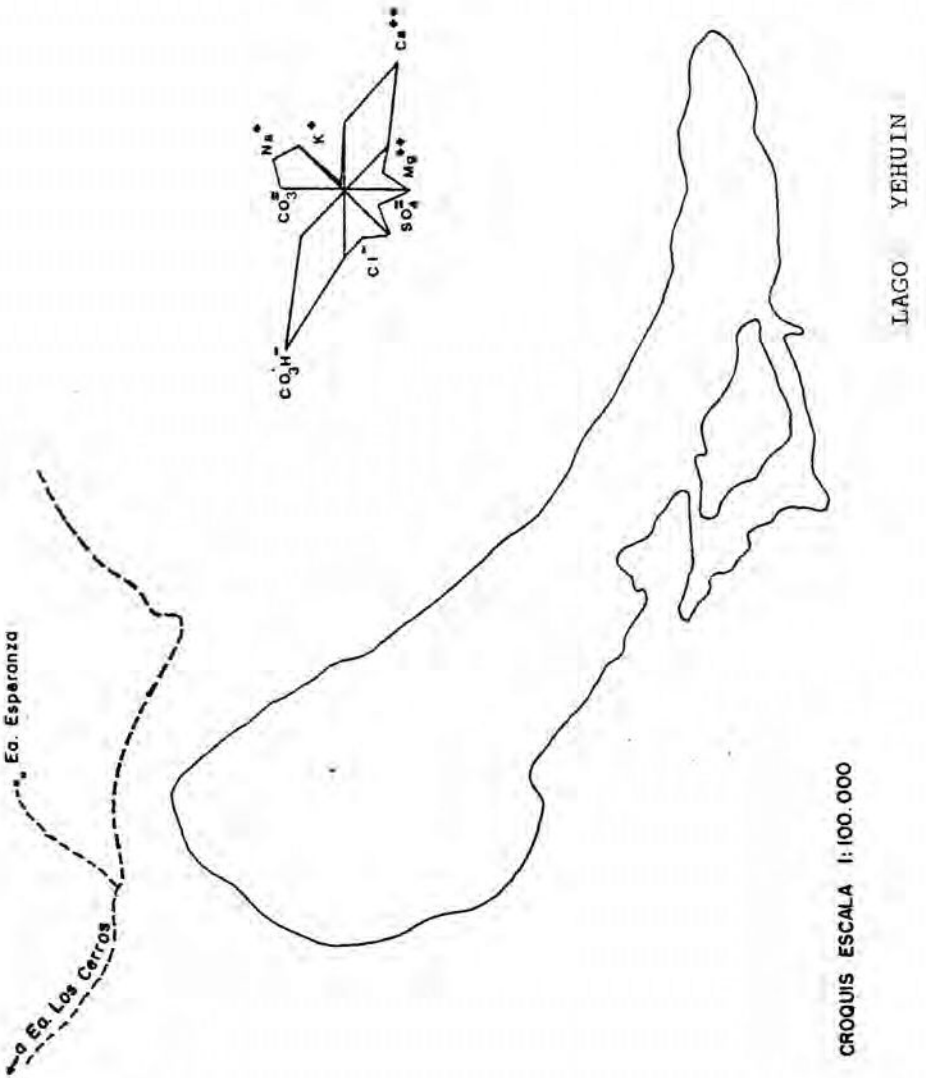
Local geology:

Placed upon glacial and peat deposits; on subsurface, rocky units of inferior Tertiary age. Highlander relief.

Limnological parameters:

Light penetration through these waters is quite high and it is reflected in the values of the coefficient of extinction of the water column 0,145m^{-1} and in the Secchi disk value, 12 meters.
Salt concentration is low and is in the rank of hipohalines (solid residue inferior to 500 mg/l). Ionic composition reveals the prevalence of bicarbonate and calcium, and pH is slightly alkaline, Table 1.
Inorganic nitrogenated nutrients present a low concentration and, among them, ammonia is most dominant. Phosphorus content is scarce while that of iron is relatively high. Soluble silicon is the most abundant inorganic nutrient. The values of chlorophyll and primary production are low, table 1, which makes it

possible to characterize this lake as belonging to the oligotrophic category.



NAME: LAGO CHEPELMUTH (CHEPELMUTH lake)

Geographical location: (approximate)

Latitude : 54° 24'S

Longitude: 57° 34'W
Altitude : 259 m.
Easy access along H complementary.
Average rain per year: 600 mm.

Physical characteristics:

Shape: circular
Total area: 46 km 2.
Maximum lenght: 8,500m Maximum width:6,500m.
Shore line length: 25km.

Type of shore: abrupt in the west and north.
Large plain in the east. Regular border.
Main tributaries: It receives several small streams.
Main effluents:

Characteristics on the IR colour image:

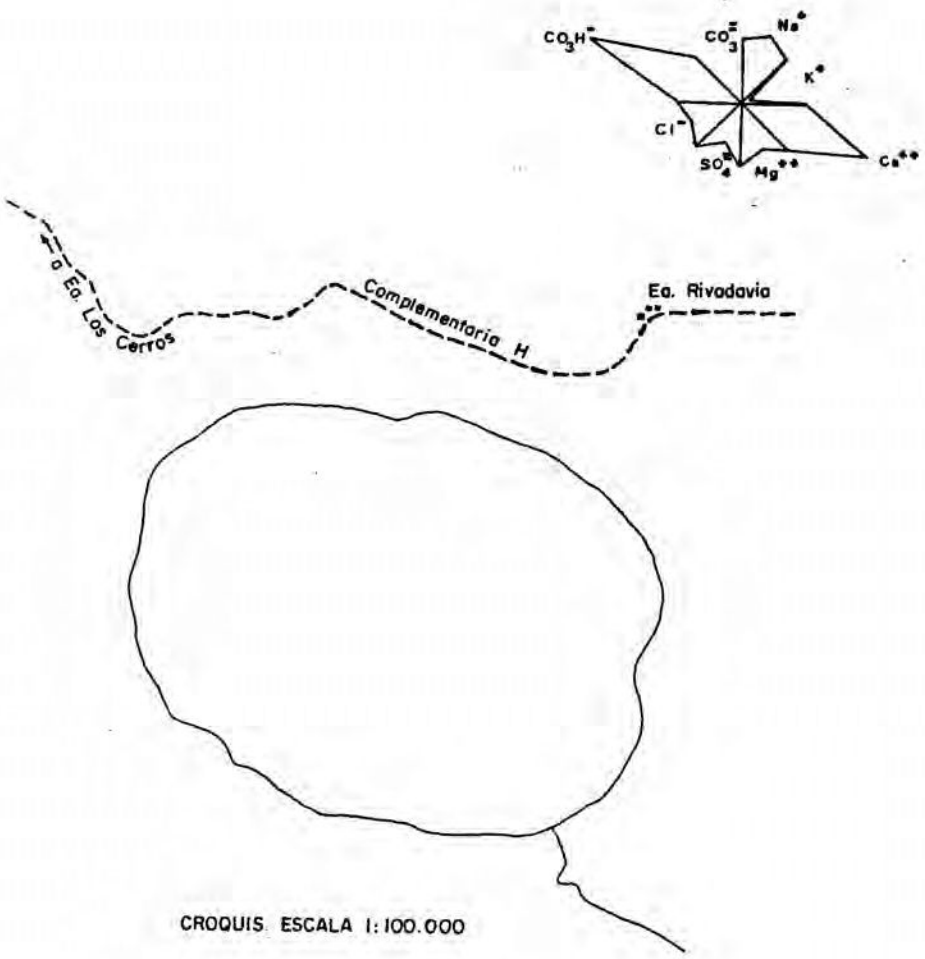
Colour of water: dark blue to black.
Saline aureole: no presence
Vegetation: arboreal almost up to the border;peat material.

Local geology:

Placed upon glacial and peat deposits. Rocks of inferior Tertiary age on the subsurface, Abrupt relief.

Limnological parameters:

When compared to Lago Yehuin, its waters are less transparent. Secchi disk reading, 5 mts.,though it shares its chemical characteristics, that is to say, hipohaline, calcium bicarbonate, pH is slightly alkaline and there is a low content of nutrients, except for soluble silica. Primary production and chlorophyll show low values. Table 1.

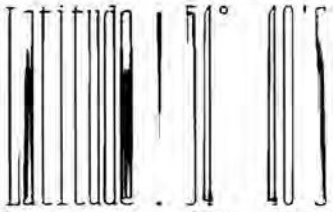


CROQUIS ESCALA 1:100.000

LAGO CHEPELMUTH

NAME: LAGO ESCONDIDO (ESCONDIDO lake)

Geographical location:



Longitude: 67° 48'W
Altitude : 140 m.
Easy access along route 3, Garibaldi path.
Average rain per year : 600 mm.

Physical characteristics:

Shape: lengthened, dominat southwest-northeast axis.
Total area: 7,5 km^2
Maximum lenght:17 km Maximum width: 1,500m.

Type of shore: running among highlands. Regular, not winding borders.
Main tributaries:
Main effluents: it drains along the northeast end towards the plain of Lago Fagnano.

Characteristics on the IR colour image:

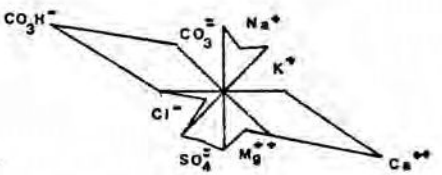
Colour of water: dark blue to black.
Saline aureole: no presence.
Vegetation: arboreal up to the border of the lake. There are peats, specially in the north end.

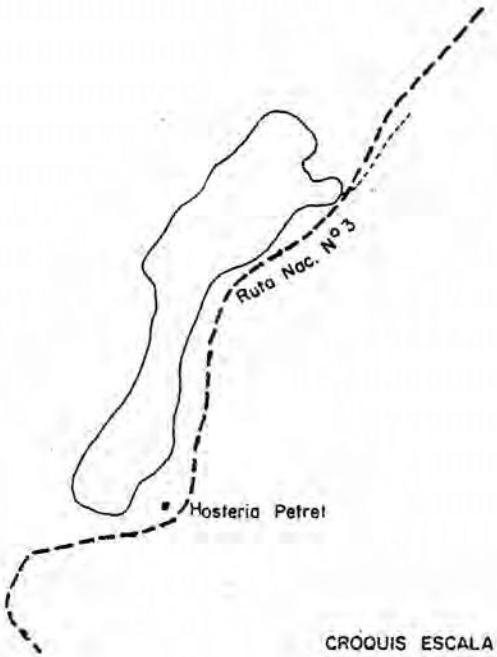
Local geology:

It is essentially placed upon glacial, fluvioglacial and peat deposits. In the south end, there is a greater influence of underlying rock of Cretaceous age.

Limnological parameters:

It shows a transparency of 5,5 metres; the coefficient of extinction is 0,345 m ; it has a low salt concentration (hipohaline), of calcium bicarbonate composition, and pH is near to neutrality.
As regards nitrogen, nitrates are more abundant than ammonia; phosphorus concentrations are low.
Chlorophyll, though it is low, is the highest in the surveyed lakes. Primary production values are low.
Table 1.





CROQUIS ESCALA 1: 100.000

LAGO ESCONDIDO

NAME: LAGO FAGNANO (FAGNANO lake)

(Argentine section)

Geographical location: (approximate)

E end latitude : 54° 32' W end 54° 30'
E end longitude: 67° 12' W end 68° 35'
Altitude : 140m.
Access along national route No 3 which borders on its shore.
Average rain per year: 600mm.

Physical characteristics:

Shape: rectangular and lengthened, in east-west direction.
Total area: 500 km2
Maximum length: 87,5 km. Maximum width:10,500km
Shore line length: 194 km.

Type of shore: regular, not winding north border; irregular south border, festooned west end.
Main tributaries: Ríos Claro, Molina, Valdéz, Turbio.
Main effluents: Río Azopardo (In Chile).

Characteristics on the IR colour image:

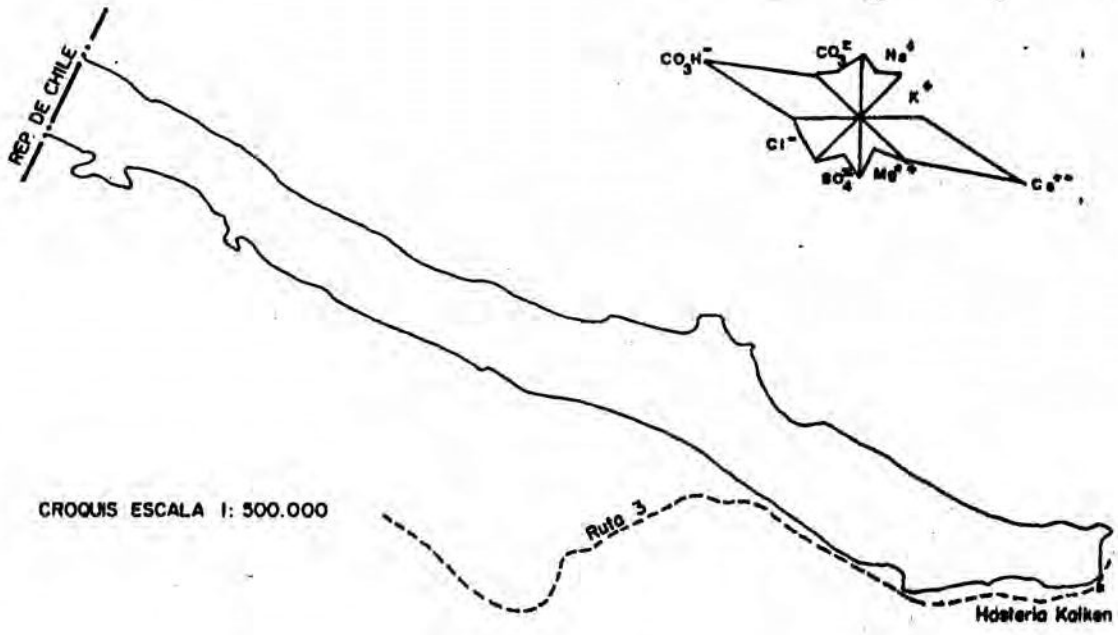
Color of water: dark blue to black
Saline aureole: no presence.
Vegetation: arboreal, presenting peats.

Local geology:

Placed upon fluvioglacial and peat deposits lying on rocky units of Cretaceous age. It is a high relief zone.

Limnological parameters:

Transparency is high; reading of Secchi disk, 9 mts. Chemical characteristics are similar to those corresponding to Lago Escondido, even the concentrations of the different components share the same order. Concentrations of chlorophyll and primary production values are quite low. Table 1.



LAGO FAGNANO

NAME: LAGO ROCA (ROCA lake)

(Argentine sector)

Geographical location:

Longitude: 68° 36'W
Altitude :
Easy access along route 3, up to Alakush Inn.
Average rain per year:

Physical characteristics:

Shape: lengthened. Prevalence of northwest-southeast direction
Total area: 5,5 km^2
Maximum length: 4,200 m Maximum width: 2,500m
Shore line length: 30Km

Type of shore: clearly marked, net borders.
Main tributaries: glacial feed, mainly.
Main effluents: in the south end, it flows into the Canal de Beagle.

Characteristics on the IR colour image:

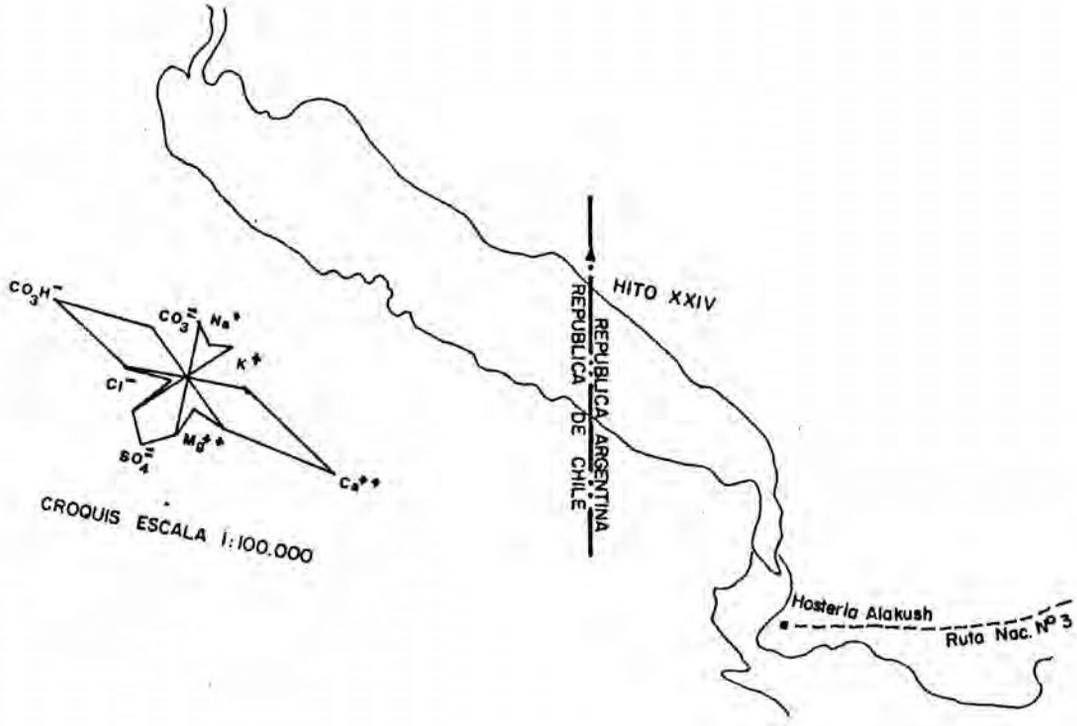
Colour of water: dark blue to black.
Saline aureole: no presence.
Vegetation: arboreal and with peats, particularly in the south-east end.

Local geology:

Settled upon glacial, peat deposits and there are low rank metamorphic rocks on the subsurface. Its sources are located in a considerably high cordillera region, exceeding 1,000 mts. high.

Limnological parameters:

Within lakes, the characteristic of having a larger amount of suspended material leads to a low reading of Secchi disk, 2 mts. and to the highest coefficient of extinction obtained (0,387 m^{-1}). Similarly, saline content is inferior and the ionic composition gets separate as it can be noticed in the figure.



CROQUIS ESCALA 1:100.000

LAGO ROCA

NAME: LAGO SAN RICARDO (SAN RICARDO lake)

Geographical location: (approximate)

Latitude : 54° 40'S
Longitude: 67° 43'W
Altitude :
Easy access along track going southward; from Bronsovich sawmill, it runs along 5,300 mts.
Average rain per year:

Physical characteristics:

Shape: rectangular and lengthened, dominant southwest northeast direction.
Total area: 4 km2
Maximum length: 5,500 m. Maximum width: 900m
Shore line length:12,500m

Type of shore: regular, net, not winding.
Main tributaries: In its south end, it receives feed from the mountain area.
Main effluents: It drains towards Lago Santa Laura placed in a more north location.

Characteristics on the IR colour image

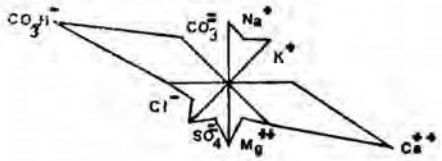
Colour of water: dark blue to black.
Saline aureole: no presence.
Vegetation: arboreal, presenting peats.

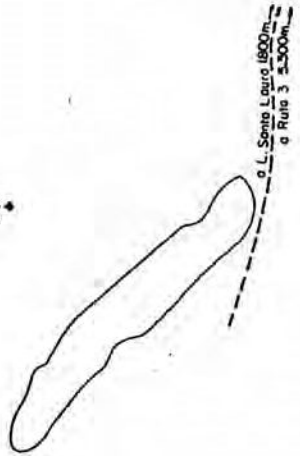
Local geology:

Placed on glacial and peat deposits, its north end in particular. Its south sector is influenced by the underlying rocky units of Cretaceous age. Flat un--- dulating relief

Limnological parameters:

Its waters are very transparent: disk reading, 10m; coefficient of extinction, 0,301 m.
Saline characteristics are similar to the rest of lakes and nutrients are scarce in all their forms.
Primary production and chlorophyll are quite low.
Table 1.





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LAGO SAN RICARDO

NAME: LAGO SANTA LAURA (SANTA LAURA lake)

Geographical location: (approximate)

Latitude : 54° 38'S

Longitude: 67° 40'W
Altitude :
Easy access along track going southward ; from Bronsovich sawmill, follow track along 3,500m; turn west.
Average rain per year:

Physical characteristics:

Shape: lengthened, dominant southwest-northeast direction .
Total area: 1,75 km2
Maximum length: 6,500 m. Maximum width: 850m
Shore line length: 6,500m.

Type of shore:relatively straight, net borders.
Main tributaries: small flow comimng from Lago San Ricardo.
Main effluents: it drains northward to Río Milna.

Characteristics on the IR colour image:

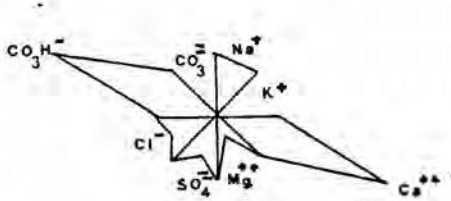
Colour of water: dark blue to black.
Saline aureole: no presence.
Vegetation: arboreal with peats,mainly.

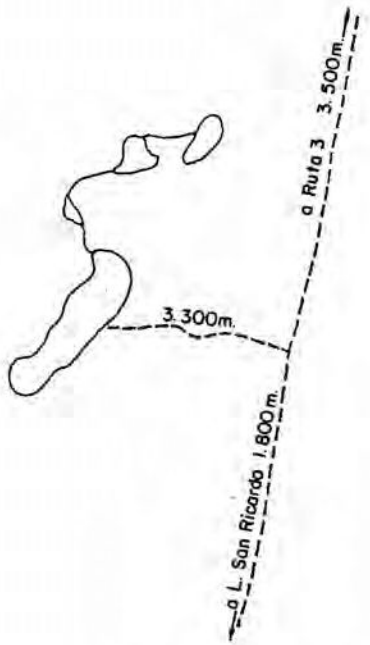
Local geology:

Placed upon glacial, fluvioglacial and peat deposits.
Flat relief.

Limnological parameters:

Chemical features are similar to those of Lago San Ricardo. Transparency, 3mts.; a-chlorophyll and primary production values are quite low. Table 1.





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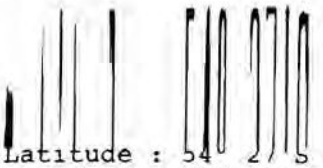
LAGO SANTA LAURA

NAME: LAGO YAKUS (YAKUS lake)

Geographical location: (approximate)



Latitude : 54° 2[illegible]'S
Longitude: 67° 43'W
Altitude :
Difficult access along track coming from El Carmen ranch.
Average rain per year:

Physical characteristics:

Shape: irregular.
Total area: 1,5 km2
Maximum length: 2,500m. Maximum width: 1,000m.
Shore line length: 6,000m.

Type of shore: net; irregularly festooned.
Main tributaries:
Main effluents: it drains towards plain of Río Claro.

Characteristics on the IR colour image:

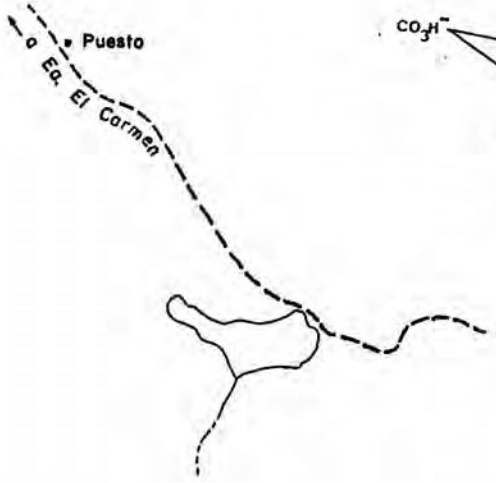
Colour of water: dark blue to black.
Saline aureole: no presence.
Vegetation : arboreal, presenting peats.

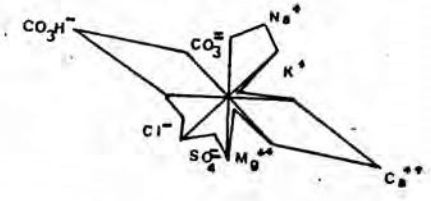
Local geology:

Placed on glacial and fluvioglacial deposits, mainly. On subsurface, there prevail rocks of inferior Tertiary age. Relief of soft hills.

Limnological parameters:

It is one of the most transparent lakes; reading of Secchi disk, 10m.; chemical characteristics as regards saline content are thoroughly similar to the rest of lakes.
Concerning nutrients, they are not detected in any of their forms.





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LAGO YAKUS

NAME: LAGUNA PESCADO (PESCADO pond)

Geographical location:

Latitude : 54° 27'S

Longitude: 67° 02'W
Altitude :
Easy access along track going from Kami aerodrome up to Las Lengas sawmill.
Average rain per year:

Physical characteristics:

Shape: irregular.
Total area: 1 km2.
Maximum length: 1,700m. Maximum width: 1,200m.
Shore line length: 5,000m.

Type of shore: irregular; festooned border, with no gullies.
Main tributaries:
Main effluents: Río San Pablo which flows into the Atlantic Ocean near the homonymous cape.

Characteristics on the IR colour image:

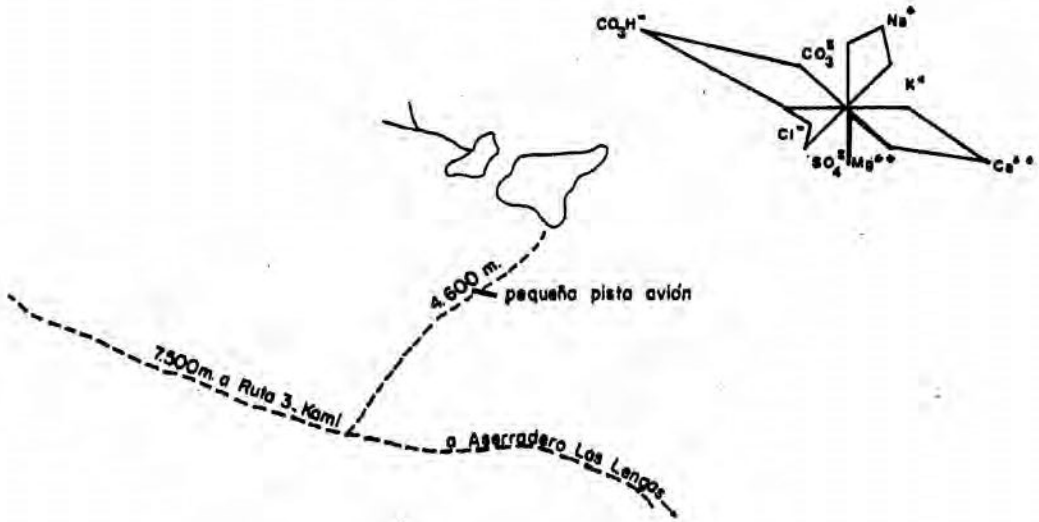
Colour of water: dark blue to black.
Saline aureole: np presence.
Vegetation: prevalence of peat vegetation.

Local geology:

Placed upon glacial, fluvioglacial material, and peat deposits, which prevail. It is located in a large plain.

Limnological parameters:

Saline content is low and the most abundant ions are bicarbonate, calcium and sosium. Ph is near to neutrality. It is poor in phosphorus and nitrogen nutrients; silicon is reletively abundant.



CROQUIS ESCALA 1:100.000

LAGUNA PESCADO

NAME: LAGUNA ANTUK (ANTUK pond)

Geographical location: (approximate)

Latitude : 54° 24'S

Longitude: 67° 20'W
Altitude :
Easy access along route 3, approximately 30km. from Kaiken.
Average rain per year:

Physical characteristics:

Shape: irregular; dominant east-west direction.
Total area: 3,5 km2.
Maximum length: 4,000. Maximum width: 1,400m.
Shore line length: 11,500 m.

Type of shore: net border, winding and irregular.
Main tributaries: it receives several ones from the surrounding mountain region.
Main effluents: in its western end, it drains towards Río Ewan,

Characteristics on the IR colour image:

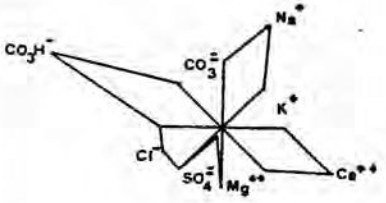
Colour of water: bluish. (medium blue).
Transparency/ turbidity: suspended material next south border.
Saline aureole: no presence.
Vegetation: arboreal, presenting peats.

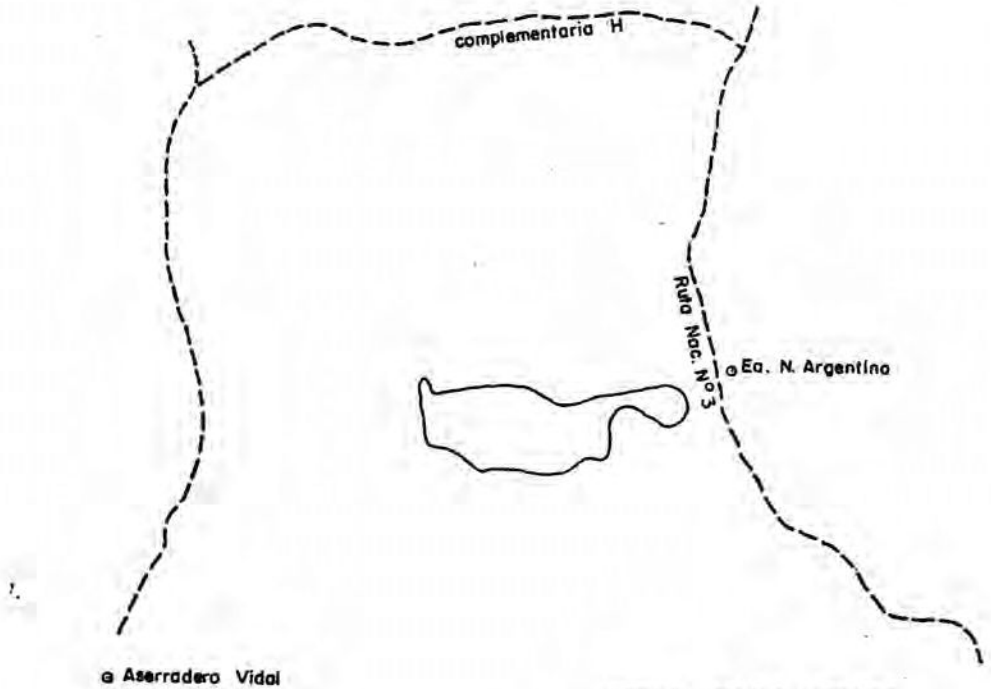
Local geology:

Placed on glacial and peat deposits distributed in turn on rocky sloping units belonging to inferior Tertiary age. Relief: soft hills.

Limnological parameters:

According to its salt concentration, it can be placed in the hipohaline rank; ionic composition indicates a revelance of bicarbonate, sodium and calcium ions, in such order. Ph is slightly alkaline. Concerning nutrients, it is poor in nitrogen, phosphorus and silicon; on the contrary, the iron content is high. Chlorophyll concentration reached 9,3 mg/m^3



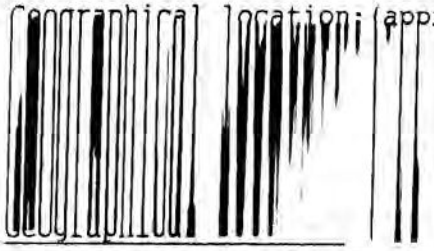


CROQUIS ESCALA 1:100.000

LAGO ANTUK

NAME: LAGUNA LUZ (LUZ pond)

Geographical location: (approximate)



Latitude :54° 42'S
Longitude:65° 40'W
Altitude :
Difficult access only along the sea or by helicopter.
Average rain per year: 700 mm.

Physical characteristics:

Shape: lengthened. Dominant southwest-northeast direction.
Total area: 8 km2
Maximum length: 6,100 m. Maximum width: 2,700 m.
Shore line length: 17,500 m.

Type of shore: irregular, winding border.
Main tributaries: it receives a small river in the southeastern end.
Main effluents: it flows into the Atlantic Ocean.

Characteristics on the IR colour image:

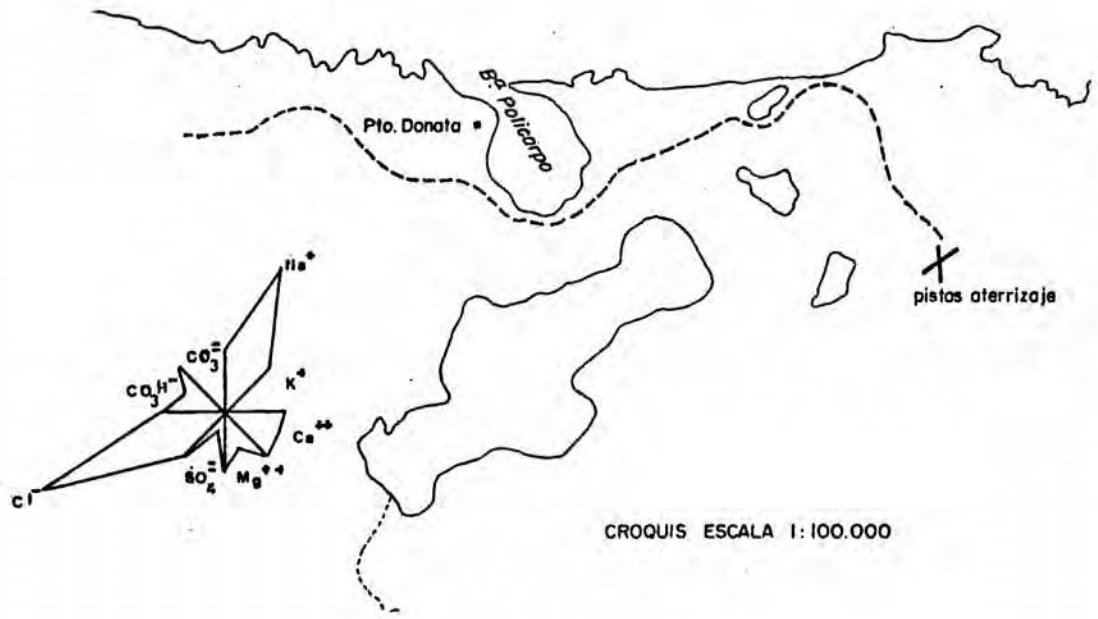
Colour of water: dark blue to black.
Saline aureole: no presence.
Vegetation: peat vegetation, mainly.

Local geology:

Placed upon peat deposits; slow darinage.
Relief: large plain.

Limnological parameters:

It belongs to humic water bodies; that is to say, the drainage basin is made up of peat soils. Consequently, soluble organic matter is quite abundant and humic acids which are present finally provide waters with a characteristic brown colour and an acid pH. It is poor in salt though the majority ions are sodium and chloride. It has a low concentration of nitrogen, phosphorus and silicon but a high iron value.



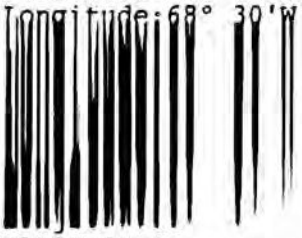
CROQUIS ESCALA 1:100.000

LAGUNA LUZ

NAME: LAGUNA ASHER (ASHER pond)

Geographical location:

Latitude: 53° 47'S
Longitude: 68° 30'W



Altitude :
Easy access along track coming from the police station of Sec. Castillo southward.
Average rain per year:

Physical characteristics:

Shape: lenghtened, irregular shape. Slight prevalence of N-S direction.
Total area: 2,750 km2
Maximum length: 2,500 m. Maximum width:1,500m.
Shore line length: 7,200 m

Type of shore:even, regular border; more abrupt gully in the northwest end.
Main tributaries: it receives tributaries in its south and west sides.
Main effluents: it drains towards Moneta river.

Characteristics on the IR colour image:

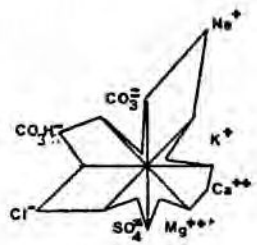
Colour of water: medium bluish.
Transparency/ turbidity: important charge of suspended material.
Saline aureole: no presence.
Vegetation: herbaceous.

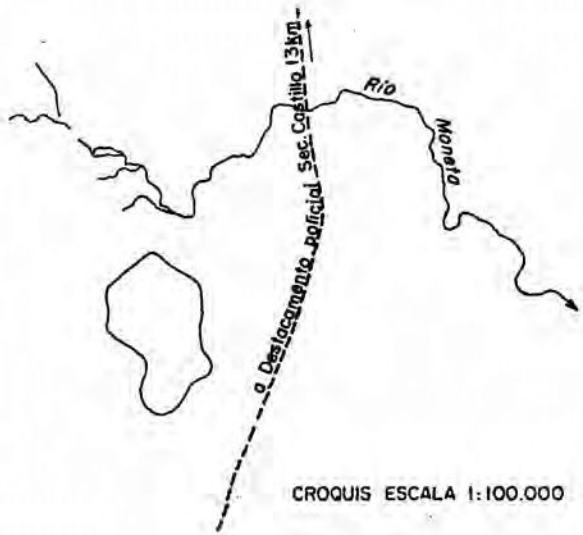
Local geology:

Placed upon glacial and fluvioglacial deposits lying on horizontal sedimentites of middle Tertiary age. The surrounding relief is reletively flat or undulating flat.

Limnological parameters:

It has a large amount of suspended sediment, evidenced by the minimum transparency it presents (0,05m.). They are sodium-chloride, clacium bicarbonate waters, and have a saline content which makes it possible to classify it as oligohaline (solid residue from 0,5 up to 5,0 g. per litre); and they are hard waters as regards their calcium and magnesium content. pH is alkaline in correspondence with the presence of carbonates. Referring to nutrients, it contains a high phosphorus concentration as well as other elements such as iron and manganese. The phytoplankton biomass is relatively high if considering the chlorophyll value (38,4 mg/m^3).



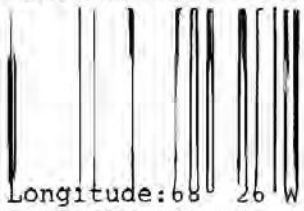


LAGUNA ASHER

NAME: LAGUNA AMKI O AMALIA (AMKI or AMALIA pond)

Geographical location:

Latitude :53° 35'S



Longitude:68° 26'W
Altitude :81 mts.
Easy access along C complementary route and a track going northward, next San Julio Ranch.
Average rain per year:

Physical characteristics:

Shape: triangular.
Total area: 7 km2.
Maximum length: 5,000m. Maximum width: 2,700m.
Shore line length: 14,500 m.

Type of shore: east shore is net and straight, west shore is winding.
Main tributaries: large plain of reception in its south end.
Main effluents: in the north, it drains towards Río Aviles.

Characteristics on the IR colour image:

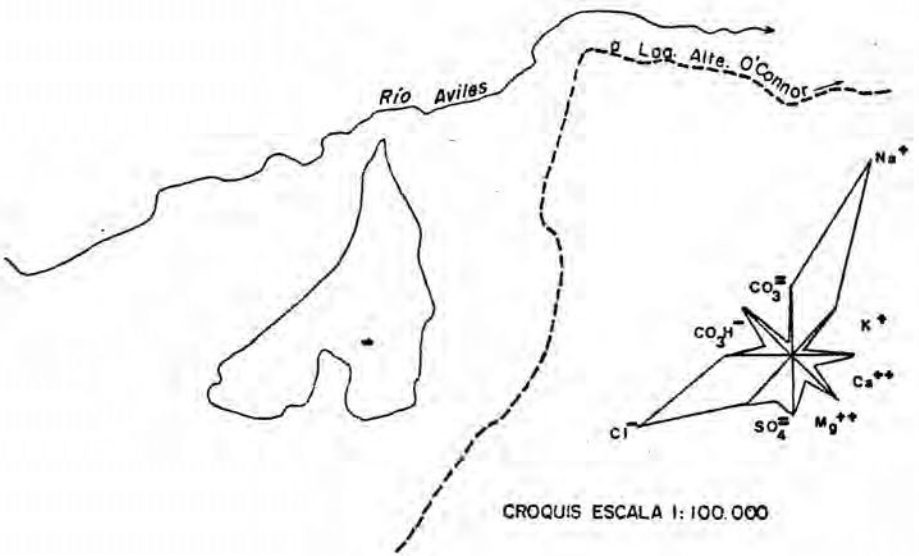
Colour of water: light bluish.
Saline aureole: important in the west border.
Vegetation: vegetation spot in the west border which could indicate the existence of a spring.

Local geology:

Placed on glacial and fluvioglacial deposits which, in turn, lie upon horizontal units of superior Tertiary age.
It is located on a large plain.

Limnological parameters:

It is alkaline with a larger amount of solid residue and greater hardness than the preceding one. It also has suspended sediment. Its ionic composition indicates that it is sodium chloride. Phosphorus is very high not only in its soluble form(orthophosphate) but also in its particle form. Its concentration of chlorophyll would correspond to that of a water body with certain degree of maturity. It is quite noticeable the high concentration of manganese, but iron is also important. See Table 1.

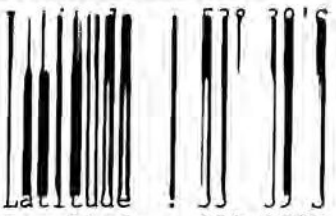


CROQUIS ESCALA 1: 100.000

LAGUNA AMKI O AMALIA

NAME: LAGUNA GRANDE (GRANDE pond)

Geographical location:



Longitude : 68° 08'W
Altitude : 10 m.
Easy access along C route and deviation along Miranda section track.
Average rain per year: 400 mm.

Physical characteristics:

Shape: rectangular, lengthened; prevailing north-south direction
Total area: 3,5 km2
Maximum length: 3,800 m. Maximum width: 1,500m.
Shore line length: 9,000 m.

Type of shore: regular and straight in the eastern shore and very festooned in western shore.
Main tributaries:
Main effluents:

Characteristics on the IR colour image:

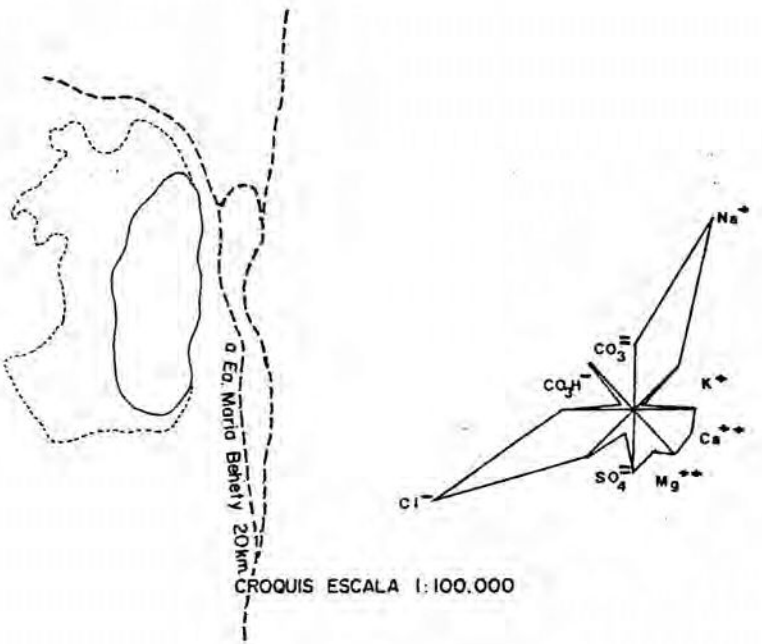
Colour of water: very light bluish.
Transparency/ turbidity: large amount of suspended material.
Saline aureole: it presents a quite large saline shore.
Vegetation: herbaceous.

LOcal geology:

Located upon glacial and fluvioglacial deposits lying on horizontal Tertiary sediment. Relief is very flat where only low hills emerge; area of slow drainage.

Limnological parameters:

This pond shares the caharacteristics of Laguna Am-Ki; in particular, it is more saline, owing to a larger presence of calcium, magnesium and sulphate.



CROQUIS ESCALA 1:100.000

LAGUNA GRANDE

NAME: LAGUNA SAN LUIS (SAN LUIS pond)

Geographical location:

Latitude : 53° 55'S
Longitude: 67° 37'W
Altitude :
Easy access along track which, from Río Grande, goes to San Luis section.
Average rain per year:

Physical characteristics:

Shape: half moon.
Total area: 6 km 2
Maximum length: 4,200 m. Maximum width: 2,500m.
Shore line length: 16, 500m.

Type of shore: net and regular in its eastern side.
Net and winding in its western shore.
Main tributaries: it receives them in its western side.
Main effluents: it drains towards the Atlantic ocean by means of canalized shoals.

Characteristics on the IR colour image:

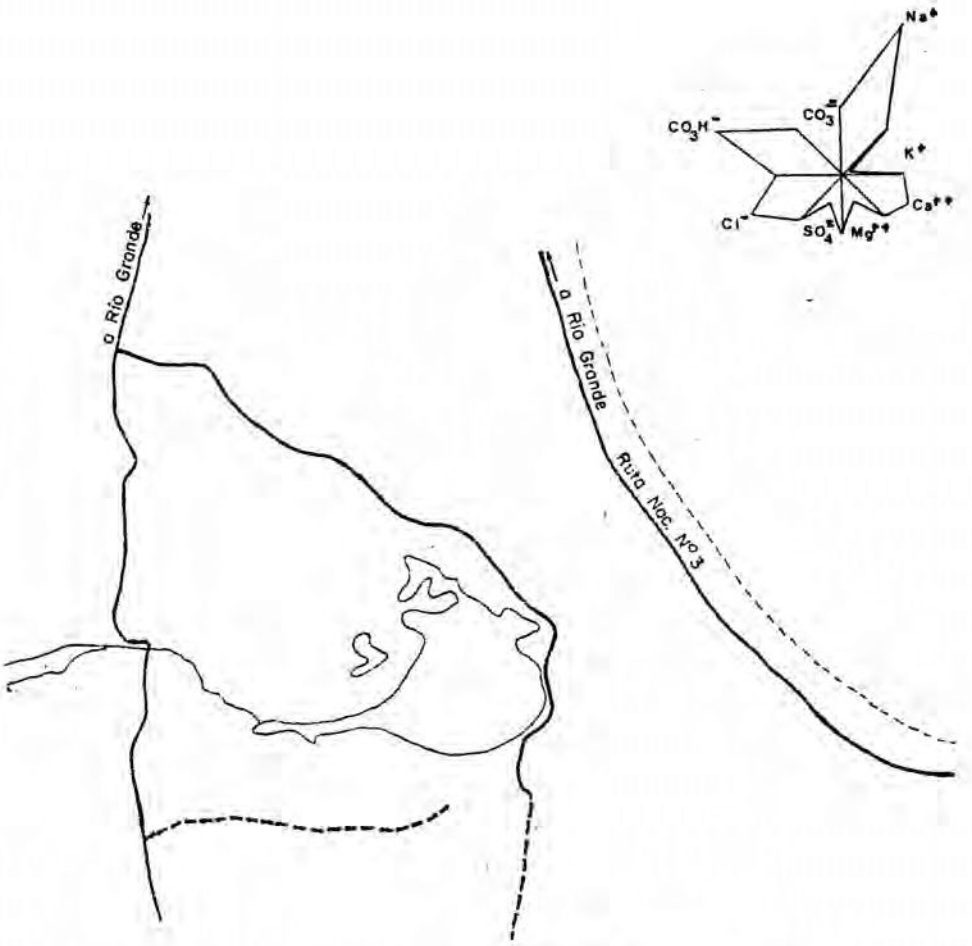
Colour of water: light bluish.
Saline aureole: no presence.
Vegetation: large peat on western shore.

LOcal geology;

Placed upon modern deposits, transport material upon horizontal sedimentites of superior Tertiary age.
Relief: large plain easily to be flooded.

Limnological parameters:

It has a low saline content(hipohaline) and its ionic composition reveals bicarbonate and chloride prevalence in anions; and sodium and calcium in cations.
Its pH is lightly alkaline. Nitogenated nutrients are scarce, being ammonia the most outstanding one. It is rich in phosphorus and iron compounds and silicon is reletively abundant.



CROQUIS ESCALA 1:100.000

LAGUNA SAN LUIS

NAME: LAGUNA FUEGO (FUEGO pond)

Geographical location : (approximate)

Latitude : 54° 00'S
Longitude : 67° 96'W
Altitude : 20 m.
Access is only possible by approaching along route 3 and following track in the west.
Average rain per year:

Physical characteristics:

Shape: rectangular, lengthened; dominant southwest-northeast direction.
Total area: 6 km2
Maximum length: 5,000 m. Maximum width: 5,000 m.
Shore line length: 12,500 m.

Type of shore: regular, straight border.
Main tributaries: Río Fuego.
Main effluents: Río Fuego which flows into the Atlantic Ocean.

Characteristics on the IR colour image:

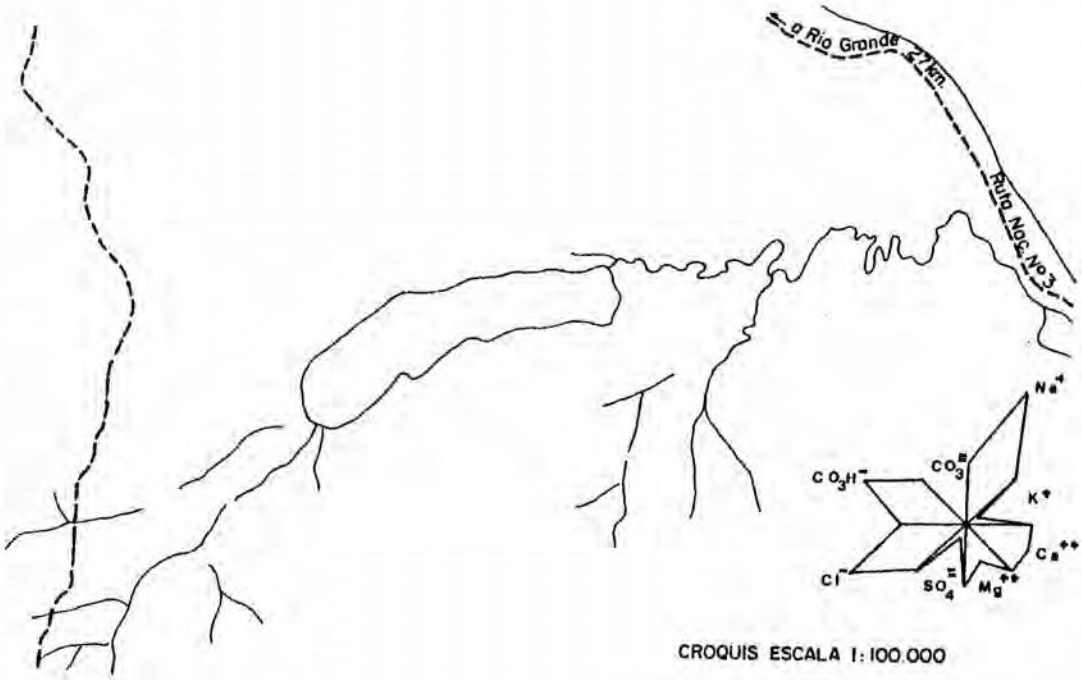
Colour of water: bluish(middle blue).
Transparency/ turbidity: it presents a charge of suspended material.
Saline aureole: no presence.
Vegetation: peat vegetation. Thre are trees in bounding hills.

Local geology:

Placed upon fluvioglacial and fluvial deposits. It occupies Río Fuego plain; outside this zone, the relief becomes markedly undulating.

Limnological parameters:

Its waters are alkaline, hard and of sodium chloride, calcium bicarbonate composition. It is rich in phosphorus, nitrogen silicon and iron nutrients,which probably regulate the chlorophyll concentration that is high and corresponding to a mature water body (63 mg/m^3).



CROQUIS ESCALA 1: 100.000

LAGUNA FUEGO

NAME: LAGUNA BLANCA (BLANCA pond)

Geographical location:

Latitude : 54° 37'S

Longitude : 67° 15'W
Altitude :
Easy access along track coming out of the route, next to Kaiken Inn towards Cerro Huehuepan.
Average rain per year:

Physical characteristics:

Shape: half moon.
Total area: 0,500 km2.
Maximum length: 1,000 m. Maximum width: 600 m.
Shore line length:2,800 m.

Type of shore: regular, even border.
Main tributaries:
Main effluents:

Characteristics on the IR colour image:

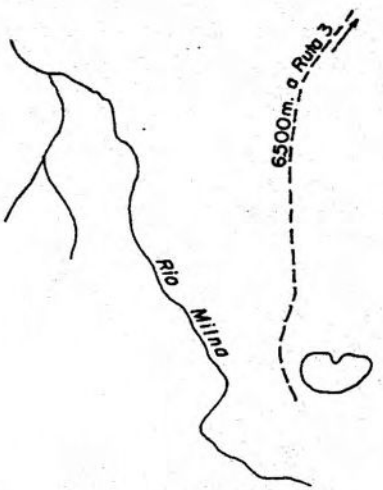
Colour of water: dark blue to black.
Saline aureole: no presence.
Vegetation: arboreal.

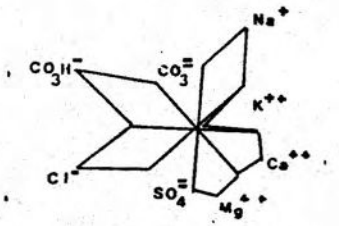
Local geology:

Placed upon glacial and fluvioglacial deposits.

Limnological parameters:

Very low saline content; outstanding ions are bicarbonate; chloride, sodium and calcium, in the mentioned order of importance. pH is near to neutrality; it is scarce as regards all surveyed nutrients.



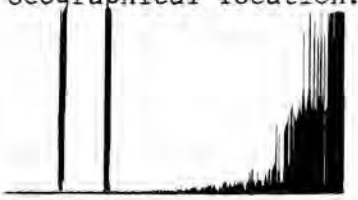


CROQUIS ESCALA 1:100.000

LAGUNA BLANCA

NAME: LAGUNA ESPERANZA (ESPERANZA pond)

Geographical location:



Latitude : 54° 20'S
Longitude: 67° 43'W
Altitude : 100 m.
Access is possible by approaching it along H complementary up to Estancia La Eaperanza.
Average rain per year: 500 mm.

Physical characteristics:

Shape: oval shape; dominant southeast-northwest axis.
Total area: 6,5 km2.
Maximum length: 3,200 m. Maximum width: 2,400m.
Shore line length: 9,800 m.

Type of shore: western south western border is festooned while south western border is regular and even.
Main tributaries:
Main effluents:

Characteristics on the IR colour image:

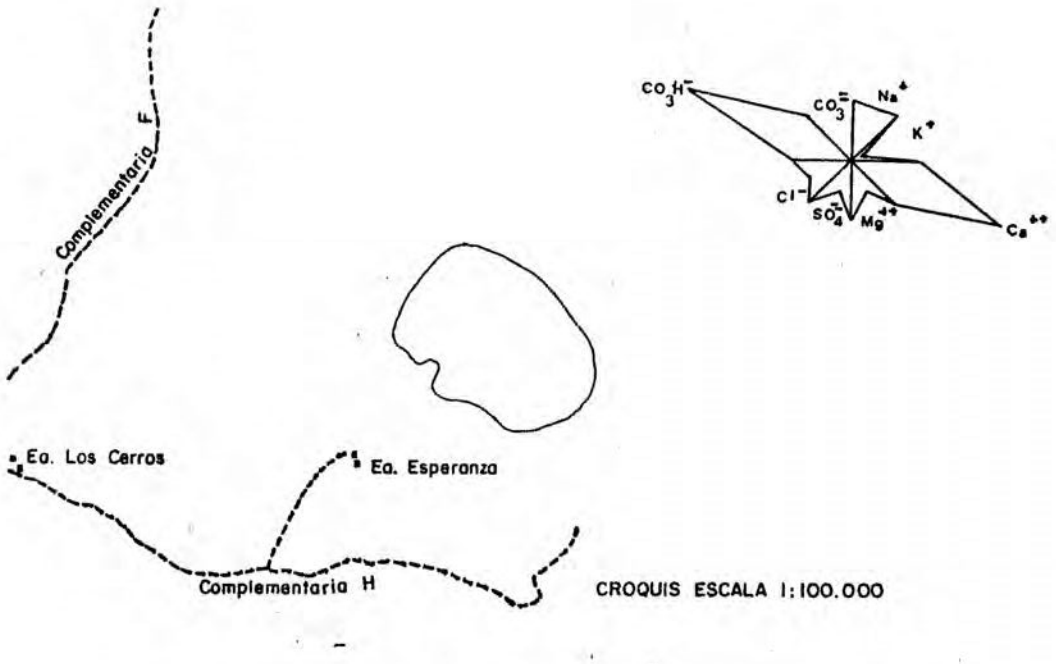
Colour of water: bluish (medium).
Saline aureole: no presence.
Vegetation: covered with peats.

Local geology:.

Placed upon fluvioglacial and peat deposits.
Relief: large plain.

Limnological parameters:

Low saline content; the outstandig ions are bicarbonate and calcium; pH is lightly alkaline. Nutrients indicate a high value of ammonia, nitrate concentration also being of importance. It shows a moderate concentration of phosphorus and silicon; it is quite rich as regerds iron. Table 1.



LAGUNA ESPERANZA

NAME: LAGUNA VERDE (VERDE pond)

Geographical location:

Latitude : 54° 36'S

Longitude: 67° 35'W
Altitude :
Easy access along route 3 at approximately 63 km from Ushuaia up to Kaiken.
Average rain per year:

Physical characteristics:

Shape: rectangular.
Total area: 0,0625 km2.
Maximum length: 600 m. Maximum width: 270 m.
Shore line length: 1,600 m.

Type of shore: net and regular, not winding.
Main tributaries:
Main effluents:

Characteristics on the IR colour image:

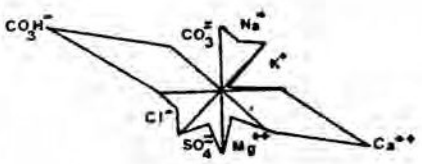
Colour of water: dark blue to black.
Saline aureole : no presence.
Vegetation : arboreal, presenting peats.

Local geology:

Placed upon glacial and limnological deposits.
Terraced-shaped flat relief.

Limnological parameters:

Its waters are neutral, with low salt concentrations and scarce nutrient content.



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