THE REPUBLIC OF CHILE

THE STUDY

ON

THE DEVELOPMENT OF WATER RESOURCES

IN

NORTHERN CHILE

PROGRESS REPORT

SUPPORTING REPORT E

ENVIRONMENT

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JAPAN INTERNATIONAL COOPERATION AGENCY

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Chapter I. GENERAL

This project aims to supply municipal water to Arica and Iquique cities by exploiting groundwater in the surrounding areas of the cities.

The potential groundwater acquifers are located in the Lower Lluta Valley, Pampa del Tamarugal and Salar del Huasco. However, groundwater development of these acquifers may draw down the existing water level, causing adverse effects on the natural and social environments in the neighbouring areas.

The following environmental factors were identified, by the initial field reconnaissance, as the major ones which might be affected by the groundwater development.

a) Plants, specially Tamarugo forest in Pampa del Tamarugal
b) Existing groundwater uses in Pampa del Tamarugal
c) Ecological and social environments in Salar del Huasco.

The other environmental factors are considered minor.

Existing groundwater uses in Pampa del Tamarugal are studied in Supporting Report B and C. Hence, the remaining two (2) major environmental factors are discussed in this report.

Chapter II. TAMARUGO WOODS IN PAMPA DEL TAMARUGAL

2.1 Tamarugo Forest Area

Natural Tamarugo forest had covered a wide area of Pampa del Tamarugal in old days. However, they almost disappeared during the last century since they were cut to use as the fuel of saltpeter mining. (A photograph of Tamarugo is shown in Photo. E,2.1).

Thereafter, planting of Tamarugo trees started with fodder and fuel production purposes in the 1930's. According to the inventory study of the National Forest Corporation of Chile (CONAF), the planted Tamarugo forest consisting of Tamarugo, Algarrobo and mix plantation reached 19,715 ha in 1973. Further, 989 ha were planted during the recent 12 years of 1981 - 1993. Then, the existing total planted Tamarugo forest is 20,704 ha.

On the other hand, a natural Tamarugo forest has grown in a wide area since before 1930. It was estimated to be 3,241 ha by the Institute Forestal in 1981<1.

The existing Tamarugo area by species and planted area are summarized below.

Species	Planted Year	Area (ha)
Planted Tamarugo	Before 1960	1,005
Tamarugo	1966 - 1973	16,340
	1981 - 1993	989
Algarrobo	Before 1960	1,950
Mixed Plantation	Before 1960	420
Subtotal		20,704
Natural Tamarugo	Before 1930	3,241
Total		23,945

The above planted Tamarugo forest all exist in the National Reserved Area of Zapiga and Salar de Pintados / Salar de Bellavista. On the other hand, the natural forests are mainly located in the Pampa Yuri National Reserved Area and its surrounding lands.

For location of the planted tamarugo forest, see Fig. E,2.1 - Fig.E,2.3.

2.2 National Reserved Area

The Tamarugo forest of Pampa del Tamarugal was designated as National Reserved Area in 1984. The total existing reserved area reaches 100,650 ha, distributing over three (3) districts of Zapiga, Salar de Pintados / Salar de Bellavista and Pampa Yuri as follows:

Zapiga	: 17,750 ha
Salar de Pintados / Bellavista	: 77,675 ha
Pampa Yuri	: 5,225 ha
Total	:100,650 ha

For location of the National Reserved Area, see Fig. E,2.2 and Fig. E,2.3.

The National Reserved Area is managed by CONAF. However, the reserved area is all rented to the local people for cattle breeding.

2.3 Beneficial Effects and Uses

a) Cattle Breeding

A matured tamarugo tree of 14 - 22 year age yields 20 - 70 kg/year on an average. On the other hand, approximately 100 trees are usually planted in one (1) hectare. Then, average annual production of the leaves and fruits of Tamarugo is estimated to be 2,000 - 7,000 kg/ha.

As of 1993, local people of 57 families make their living by rasing 18,000 sheeps in the Tamarugo forest.

b) Wood Production

Tamarugo trees are used as a material of chacoal and handicrafts. They are also used for honey collection.

c) Recreational Use

The Tamarugo forest offers such recreational opportunities as camping and hiking to people. Approximately 7,000 people visited the Tamarugo forest in 1993.

d) Opportunities for Research

Tamarugo is one of the limited plant species which might be able to improve the deserts of Chile. The Tamarugo forest in Pampa del Tamarugal offers a valuable experimental field.

2.4 Characteristics and Features

2.4.1 General Features

Tamarugo trees of Pampa del Tamarugal grow on the flat plains of desert with an elevation of approximately +1,000m. The soils of the Tamarugo forest consist of sandy clay, mostly covered by a thick salt layer of 10 - 60 cm.

Usually, Tamarugo forest forms a group of pure species. However, in some few areas, they are mixed with other similar species such as Algarrobo adapted to salty soil and arid climate.

It comes into bloom in November, fruits fall down in February to March and leaves wither in winter.

It can usually grow up 8 to 18 m in height. It has many sharp and long thorns. Its leave is of bipinnated type and 3 cm long. The leave is composed of 15 foliages with 5 mm lentgh each.

2.4.2 Water Absorption Mechanism and Root Length

The mechanism of the water absorption of trees has been studied by many researchers since 1969<2. The results of such previous studies are summarized as below.

a) Tamarugo tree absrobs water through both roots and leaves. In the day time, roots absorb groundwater and leaves evaporate water. At night, leaves absorb water from atmosphere along with groundwater absorption by roots and the absorbed water is stored in roots.

This means that Tamarugo tree consumes less water than the other normal plants.

b) The tree forms a mat of roots in a depth of less than 1.0 m from where tap roots grow downward to extract groundwater.

c) Tamarugo of Pampa del Tamarugal usually grows in the areas where groundwater depth is 5 - 12 m.

d) It is reported that a root of Mesquite (similar species of Tamarugo) has grown downward to 50 m depth in Pampa del Tamarugal. However, it has not been confirmed yet by field survey.

According to the information from CONAF members, tap roots of Tamarugo were found two (2) times in the past during well drilling. In 1987, a tap root of 10 - 15 cm in diameter was found out at a depth of 12 m during well drilling by machine. Judging from the diameter of the tap root, its maximum depth is considered to be 25 - 30 m. Furthermore, in 1993, a tap root of 30 - 40 year age was found out at a depth of 14 m during well excavation by manpower. Considering the diameter of the root, the root is assumed to reach a depth of 25 - 30 m.

2.5 Transpiratory Water Consumption

2.5.1 Evapotranspiration of Tamarugo Forest

Evapotranspiration of Tamarugo tree increases as the tree grows. Evapotranspiration of the Tamarugo trees in Pampa del Tamarugal corresponding to tree age was estimated by Grill, Vidaly and Grain in 1986, as shown in Fig. E,2.4. In this estimation, planting density of the Tamarugo trees was assumed as 50 trees/ha.

Evapotranspiration of the Tamarugo tree reaches the maximum value of about 280 mm/year (=0.089 l/s / ha) when the tree become 50 years old. Even this maximum value is very little compared with the average evapotranspiration of agricultural plants. As an example, the evapotranspiration of the agricultural plants in Azapa Valley is shown below.

Fruit	: 1,236.8 mm/year
Vegetable	: 1,154.7 mm/year
Pasture	: 1,593.1 mm/year

For details of the evapotranspiration of the agricultural plants in Azapa Valley, see Supporting Report C.

2.5.2 Present Total Transpiratory Water Consumption

The Institution of Forest estimated the age distribution of the Tamarugo trees including both planted and natural trees in Salar de Pintados and Salar de Bellavista in 1981. The estimated age distribution as of 1981 was as shown in Table E,2.1.

The age distribution of the Tamarugo trees in the whole Pampa del Tamarugal as of 1993 is estimated by modifying Table E,2.1 as shown in Table E,2.2.

Then, the present total transpiratory water consumption of the Tamarugo trees in the whole Pampa del Tamarugal in 1993 is estimated to be 1,000 l/s by using Table E,2.2 and Fig. E,2.4.

2.5.3 Future Total Transpiratory Water Consumption

The future transpiratory water consumption of the Tamarugo trees in the whole Pampa del Tamarugal is estimated based on the following assumptions:

a) 350 ha of trees will be additionaly planted in 1994.

b) During the period of 1995 - 2015, an additional 50 ha will be planted every year.

c) Life of Tamarugo tree is 75 years.

d) Tamarugo tree will be replanted soon after its life expires.

The results are summarized as follows:

Year	Tamarugo Area (ha)	Water Consumption (l/s)
1993	23,945	1,000
2005	24,846	1,700
2015	25,346	1,500
2025	25,346	1,700

Reference

<1 : Modelo de Simulación Hidrogeológico de la Pampa del Tamarugal
Informe, 1988, DGA, Ingeniería Civil Universidad del Chile.

<2 : Absorción Foliar de Humedad Atmosférica en Tamarugo, *Prosopiis tamarugo*
Phil, 1969, Universidad de Chile.

Table E,2.1 Plantations' Ages

Plantation Year	Age (years)	Area (ha)
1974 - 1981	7	233.6
1973	8	544.3
1972	9	3242.2
1971	10	2631.1
1970	11	1265.0
1969	12	3011.2
1968	13	1595.4
1967	14	1327.2
1966	15	792.9
1960	21	11.8
1947	34	107.8
1932 - 1937	44 - 49	3380.5
1931 or before	50 or more	3240.8

Source: instituto Forestal (1981)

Table E,2.2 Distribution of Tamarugo in Pampa del Tamarugal

Year	Age (years)	Area (ha)
1993	1	5
1987	7	25
1985	9	300
1984	10	300
1983	11	125
1981	13	234
1973	21	617
1972	22	3,677
1971	23	2,984
1970	24	1,435
1969	25	3,415
1968	26	1,809
1967	27	1,505
1966	28	899
1960	34	12
1947	47	108
1934	60	3,255
1931 or before	63 or more	3,241

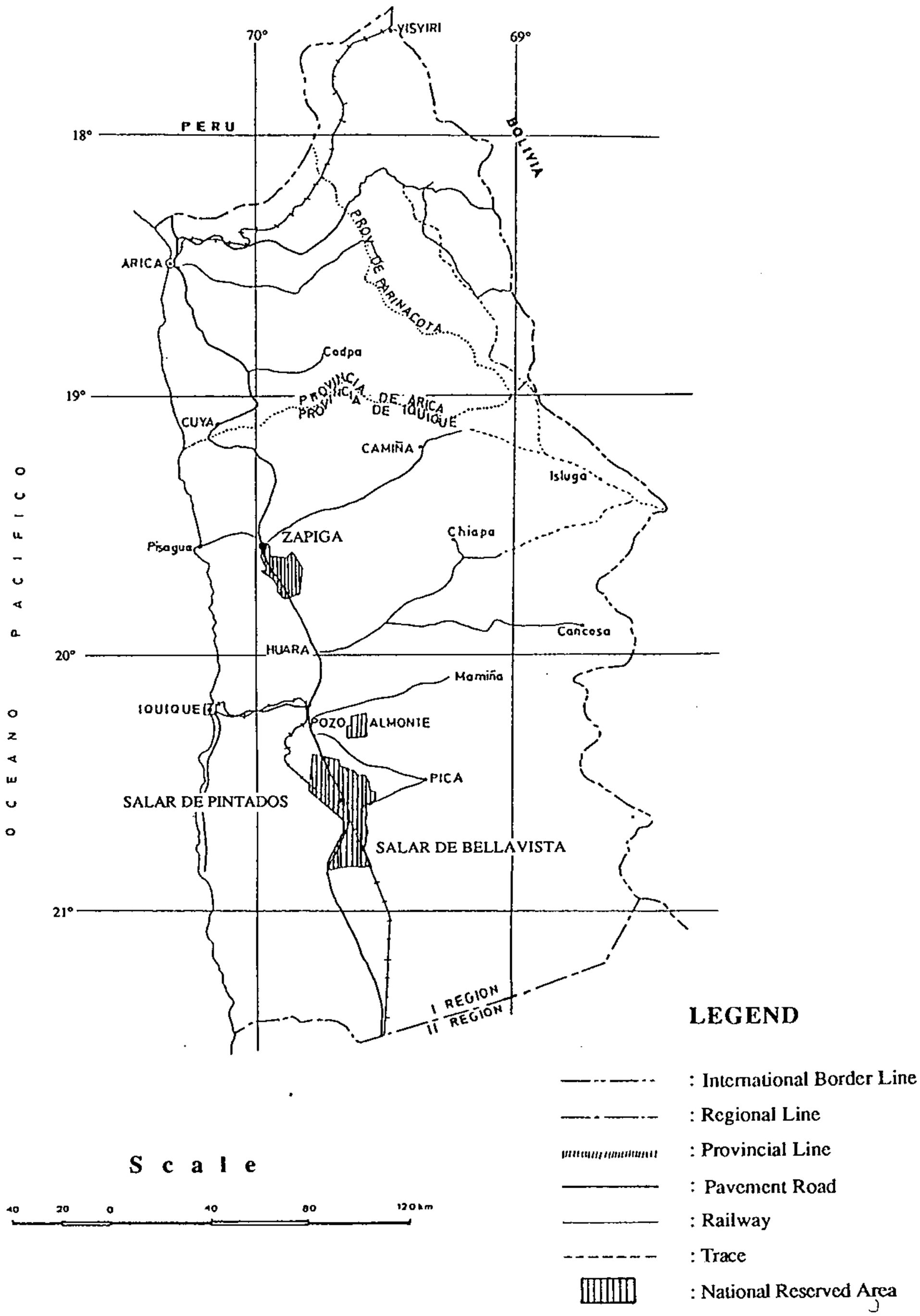

Fig.E.2.1 National Reserved Area of Pampa del Tamarugal

< Area de la Reserva Nacional Pampa de Tamarugal >

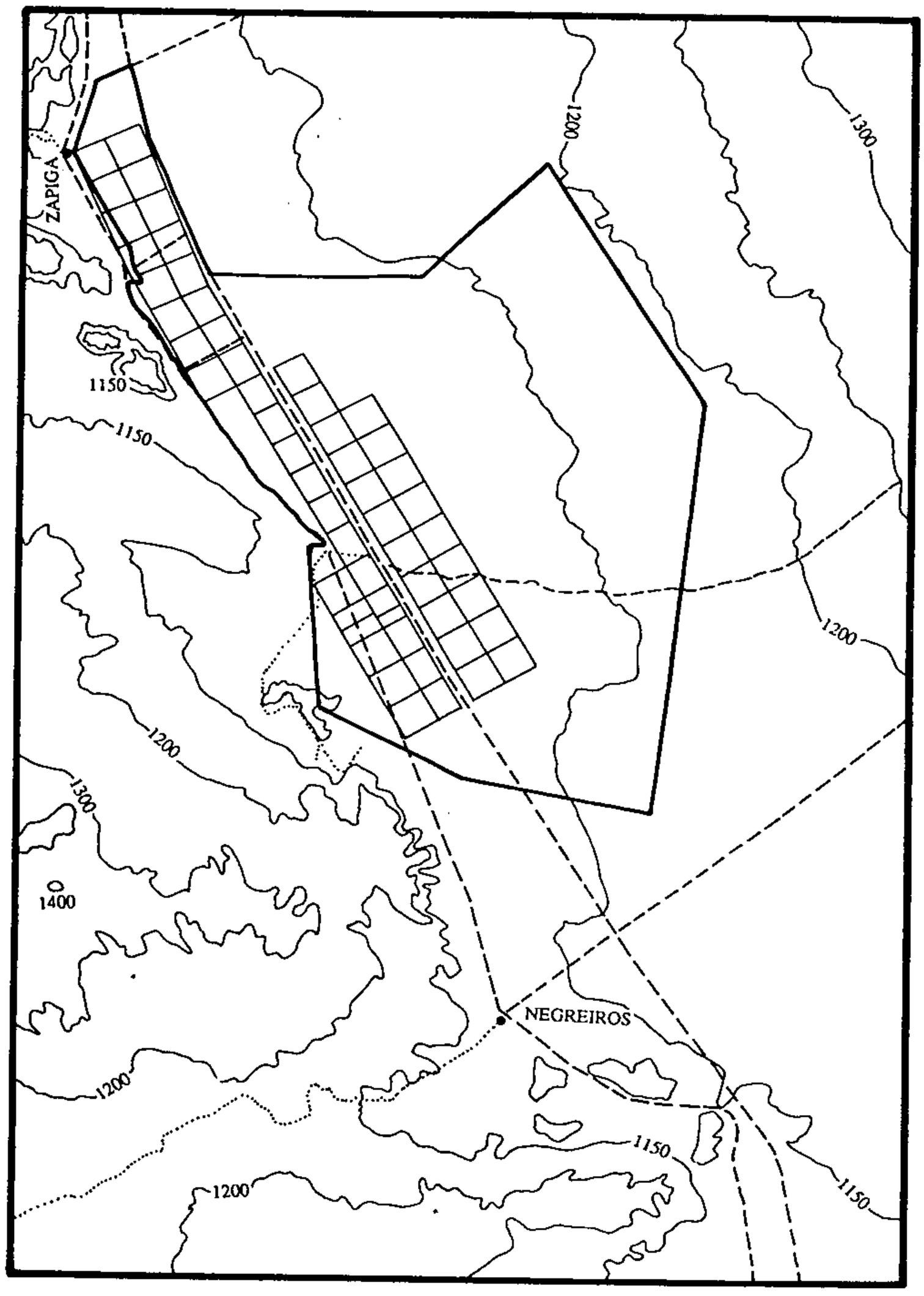

Fig. E.2.2 National Reserved Area of Zapiga

< Area de la Reserva Nacional, Zapiga >

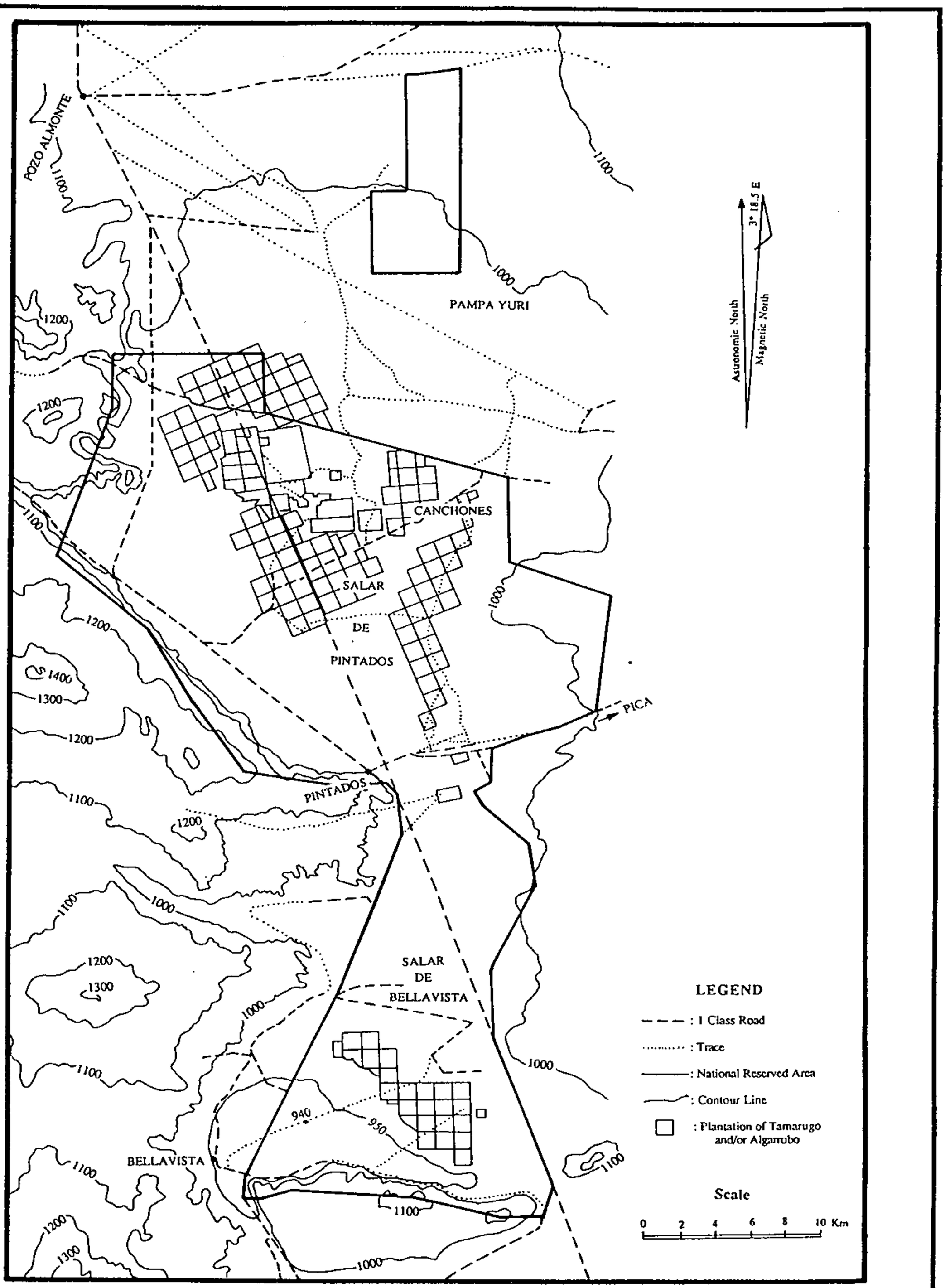

Fig.E.2.3 National Reserved Area of Salar de Pintados and Salar de Bellavista

< Area de la Reserva Nacional Salar de Pintados y Salar de Bellavista >

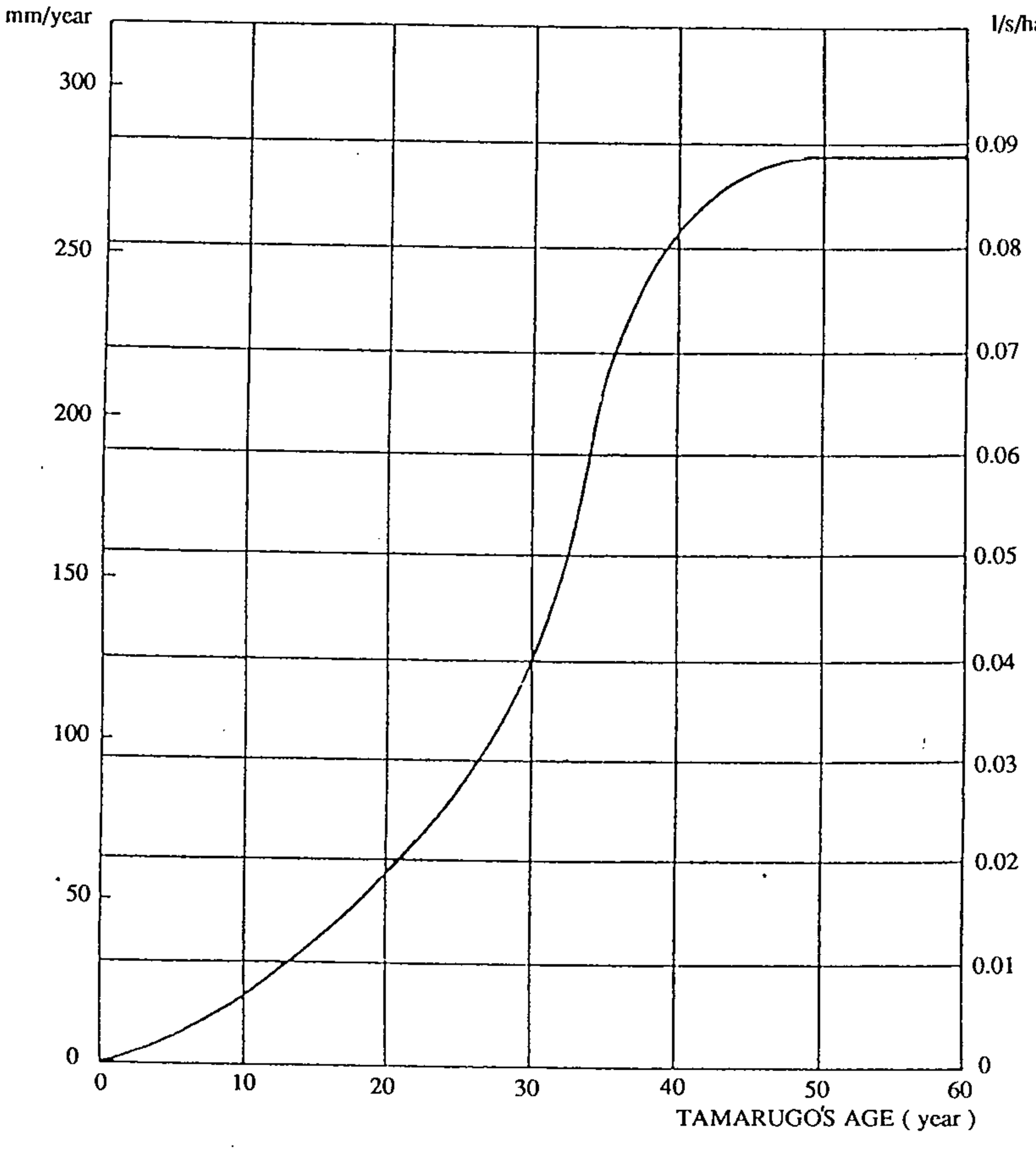

Fig. E,2.4 Transpiration by Tamarugo Plantations in Pampa del Tamarugal (Grill, Vidaly and Garin (1986))

< *Transpiración de las Plantaciones de Tamarugo en Pampa del Tamarugal* >

Photo E, 2.1 Tamarugo (Taken in Februaty 1994)

< Tamarugo (Tomada en Febrero de 1994) >

Chapter III ENVIRONMENTAL ASSESSMENT OF SALAR DEL HUASCO

3.1 Topographical Condition

3.1.1 Location

Salar del Huasco basin located in the Andes Highland in Iquique Province, has a total basin area of 1,712 km^2. The basin is closed and no river flows out from the basin. The precipitation in this area is about 100 - 200 mm/year. Salar del Huasco is situated at an altitude between 3,800 and 4,000 m.

3.1.2 Water Surface Area

Water surface area of Salar del Huasco, shown in Fig. E,3.1, was about 2km^2 (approximate maximum dimensions: width= 5km and length= 8.0km) on February 1994.

3.1.3 Water Depth

As shown in Fig. E,3.2, the water depth was 16 cm in the maximum; 4 cm in average on February 1994.

3.2 Water Quality

3.2.1 Introduction

The following major water quality elements of the lake were sampled and analyzed in order to know the relationship between the water quality and species of plankton, which were food for flamingos.

Temperature, pH, DO, Conductivity, NaCl, Turbidity, Na, K, Li, Ca, Mg, CO_3, SO_4, HCO_3, Cl, P, B, As, TDS, Dissolved Solid, Suspended Solid, Total Hardness.

The field investigation was conducted in November, December 1993 and January 1994.

The water sampling points are shown in Fig. E,3.3. This study was performed in corporation with the UNAP (Universidad Arturo Prat).

3.2.2 Results of Water Quality Analysis

1) Springs (H0 and H3)

There are two springs (H0 and H3) located around the westside of the Salar. The results of the water analysis are shown in Tables E,3.1 and E,3.2.

The values in milliequivalent per liter of the major elements of Ca, Mg, Na, K, CO_3, HCO_3, SO_4 and Cl are shown in Tables E,3.3 and E,3.4. The results indicate that the dominant cation is sodium and the dominant anion is bicarbonate; calcium and sulphates are abundant, as observed in Collins' diagram of Fig. E,3.4. They are classified as Sodium Bicarbonated Water. The water quality is compatively good. The water quality concentration is within the allowable limits of drinking water except turbidity. The phosphate concentration is in a low level, which will not cause an excessive growth of algaes.

2) Ponds

(1) Fresh Water Pond (H1)

A pond of H1 is located to the northwestern border of the Salar.

The results of the water quality analysis of this pond are shown in Table E,3.5. As observed in Collins' diagram, the sodium cation is for over the 60% (See Table E,3.6 and Fig. E,3.5); bicarbonate and sulphate anions show similar values as the spring water. They are classified as Sodium Bicarbonated Sulphated Water. The water quality is compartvely good. The water quality concentration is within the allowable limits of drinking water except turbidity.

(2) Lightly-Saline Pond (H6); Huasco Lipez

A pond of H6 is located in the southeast of the Salar and is enclosed by a zone of extensive "bofedal". In the surrounding area of this pond, domestic camelidae cattle are raised. It must be noted that no saline crust is identified in the surroundings of this pond. The results of the water analysis are given in Table E,3.7. The calculated values in milliequivalent per liter is shown in Table E,3.8. The dominant anion is sulphate, over 72% and the dominant cation is sodium, over 50%.

According to Collins' diagram (See Fig. E,3.5), the water is classified as Sodium Sulphated Water. The water quality is compartively good. The water quality concentration is within the allowable limits drinking water except turbidity and sulphate.

(3) Laguna Huasco (H2 and H4)

Laguna Huasco is the biggest pond of the Salar and occupies a great extension in the west and southwest part. Results of the water analysis are shown in Tables E,3.9 and E,3.10.

Water at H2 is much contaminated in all the observed water quality elements. Chloride is in the range of 10,774 mg/l and 16,323 mg/l. Boron is 110 mg/l and 145 mg/l. Arsenic is 12 mg/l and 18 mg/l.

Water at H4 is also much contaminated in all the observed elements. Chloride ranges from 23,079 mg/l to 69,768 mg/l. Boron is 203 mg/l and 515 mg/l. Arsenic is 36 mg/l and 66 mg/l.

Water at H2 is less contaminated than water at H4. This may be due to the dilution effects of the spring water. Tables E,3.11 and E,3.12 show the calculated values in milliequivalent per liter. Fig. E,3.6 shows Collins' diagrams for H2 and H4. The dominant cation is sodium, over 70%. The dominant anion is chloride, over 51%. The water is classified as Chlorided Sulphated Sodium one or Sulphated Chlorided Sodium.

(4) Brine Pond (H5)

A pond of H5 is located at the southwest of the Salar.. The water is highly saline in taste and shallow in depth. No recharge of surface water was observed in it. The substrate of the pond is very hard.

The result of water quality analysis are given in Table E,3.13. Table E,3.14 shows the calculated values in milliequivalent per liter. Fig. E,3.7 shows Collins' diagrams. The dominant cation is sodium, over 75%. The dominant anions are chloride and sulphate. They share more than 48% and 49% respectively. The water is classified as Chlorided Sulphated Sodium Water, similar to Laguna Huasco. Water at H5 is much contaminated in all the observed water quality elements. Chloride is in the range of 32,390 mg/l and 102,508 mg/l. Boron is 395 mg/l and 773 mg/l. Arsenic is 60 mg/l and 128 mg/l.

3.3 Ecology

3.3.1 Fishes, Amphibous and Mollusks

1) Fishes

Two fish species were found in the spring; they are:

a) *Trichomycterus* aff. *rivulatus* Valenciennes (Fam. Trichomyctaridae, Siluriformes).

b) *Orestias* aff. *agassizi* Valenciennes (fam. Cyprinodontidae, Atheriniformes)

These are not scarce species.

2) Amphibious

Three amphibious species were found in the fresh water.

a) *Telmatobius* aff. *peruvianus:*
This has been detected also previously in Pampa Lagunilla and Rio Collacagua, to the north of Salar del Huasco. This is not a scarce species.

b) *Pleuroidema marmorata*:
This species is typical one in the central and southern parts of Perú and northeast of Argentina. In Chile, it has only been found at Lago Chungará, Putre, Portezuelo de Putre, Parinacota and Chungara. The present species extends over 150 km in north-south direction in northern Chile. This shows the zoogeographic importance of Laguna Huasco.

c) *Bufo spinulosus*:
This is not a scarce species.

3) Mollusks

Three mollusk species are found in the fresh water. One is Bivalve and the others are snails. These are not scarce species.

a) *Pisidium* sp.:
This bivalve (Pelecypoda) is living in the subaquatic vegetation of the fresh water spring in the west part of the Salar.

b) *Tropicorbis* sp.:
This snail is living together with *pisidium* sp..

c) Indeterminatae sp.:
This species is a different from *Tropicorbis* sp. (probably *Littoridina*); and is limited in the "bofedal" and the effluents of Huasco Lipez spring.

3.3.2 Plankton

Plankton is one of the major foods of flamingos. The existing fitoplankton and zooplankton in the three ponds; Laguna Huasco, Huasco Lipez and Cerro Huasco, of Salar del Huasco were surveyed. Samples were taken from the column of water and sediment of bottom. The results of the survey are shown below.

a) Laguna Huasco

The analysis of the specific composition of fitoplankton in Laguna Huasco identified 15 species of Bacillariophyceae (diatoms) and four species of Cyanophyceae (See Table E,3.15) of which two species of diatoms; *Surirella* sp.1 and *Navicula* sp. (See Photo. E,3.1) are dominant. The zooplankton is represented by four species of Artropoda and one of Nematoda (See Table E,3.16) of which two species of Artropoda; Copepoda Calanoidea and Copepoda Ciclopoidea are dominant.

b) Pond of Huasco Lipez

The specific composition of fitoplankton in this pond is 15 species in total (See Table E,3.17): 11 Bacillariophyceae and four Cyanophyceae. The species of *Surirella* sp.1 and *Fragillaria* sp. are taken a notice of their abundance. The zooplankton are represented by four species of Artropoda and one of Nematode (See Table E,3.18). The species of Artropoda: Copepoda Calanoidea and Ciclopoidea are abundant as well as in Laguna Huasco.

c) Pond of Cerro Huasco

The specific composition of fitoplankton was confirmed by eight species of Bacillariophyceae and four species of Cyanophyceae (See Table E,3.19). The species of *Diploneis* sp.of Bacillariphyceae are taken a notice of their abundance. Zooplankton is represented by three species of Artropoda and one of Nematode of which Copepoda Calanoidea of Artropoda is dominant (See Table E,3.20).

The composition of the fitoplankton in the ponds of Salar del Huasco are characterized by a dominance of two species of Bacillariophyceae: *Surirella* sp.1 and *Navicula* sp.1. The composition of the zooplankton is represented mainly by two species of Artropoda: Copepoda Calanoidea and Copepoda Ciclopoidea .

A higher concentration of fitoplankton / zooplankton and a greater diversity of species are identified in Laguna Huasco. A lesser diversity is confirmed in Cerro Huasco, different from other ponds in biological components.

The water of Salar del Huasco is shaked by wind because of its shallow depth. The existing organic matters in the bottom are mixed with water, resulting in homogenization of fitoplankton and zooplankton in both stratum.

3.3.3 Plants

1) Around the Salar

(1) Formation of "Pajonales"

This formation is located around the Salar and dominates in the hills. This formation is dominated by tall gramineous genuses: *Festuca*, *Parastrephia* and *Stipa*.

(2) Formation of "Tolares"

This formation is characterized by a high cover of vegetation and an abundance of shrubs and subshrubs which are well known as "tolas" and "tolillas". The dominant genuses are *Baccharis*, *Fabians* and *Parastrephia*.

(3) Formation of "Bofedales"

This formations exists around the Salar, with marshy soil. This is a food of mammals during the dry periods. This formation is composed of *Oxychloe andina*, *Festuca* sp., *Lycium* sp., *Werneria* sp., *Azolla* sp. and *Deyeuxia* sp. "Bofedales" are preserved by the special law "Modifica Artículos 58 y 63 del Código de Aguas" since the year 1992.

2) Aquatic Plants

The following aquatic plants are identified in the surrounding area of fresh water.

Family	Specie
Salvinacea	*Azolla* sp
Zemnacea	*Zemna* sp.
Haloragacea	*Ruppia* sp.
Charophyceae	*Chra* sp.

3.3.4 Others

1) Bird

The number of birds in Salar del Huasco was surveyed during November 14th - 18th, December 14th - 17th 1993 and January 11th - 14th 1994. The identified bird species are listed in Table E,3.21. It should be noted that among the above, species given below are designated by CONAF as the endangered or vulnerable species to be conserved.

a) Endangered Species

Pterocnemia pennatas (d'Orbigny) (Fam. Rheidae, Lesser Rhea) (See Photo.E,3.2).

b) Vulnerable Species

Tinamotis pentlandii Vigors (Fam. Tinamidae, Puna Tinamou)
Phoenicopterus chilensis Molina (Fam. Phoenicopteridae, Chilean Flamingo)
Phoenicopterus andinus (Philippi) (Fam. Phoenicopteridae, Andean Flamingo)
Phoenicopterus jamesi (Sclater) (Fam. Phoenicopteridae, Puna Flamingo)
Chloephaga melanoptera (Eyton) (fam. Anatidae, Andean Goose)
(See Photo.E,3.3)
Fulica gigantea Eydoux & Souleyet (Fam. Rallidae, Gaiant Coot)

2) Reptilians

Liolaemus sp. (Fam. Iguanidae) is identified in the "Tolar" near the Laguna Huasco.

3.4 Flamingo

3.4.1 Population

Three species of flamingo were identified during November 1993 - January 1994. The maximum population during the period of survey was counted at 3,344 on December 16th 1993 (See Table E,3.22). The species and maximum counted population are shown below.

Species	Population
Phoenicopterus chilensis Chilean Flamingo	544
Phoenicopterus andinus Andean Flamingo	1,267
Phoenicopterus jamesi Puna Flamingo	1,533
Total	3,344

These are designated by CONAF as the vulnerable species and further authorized by CITES (Convention on International Trade in Endangered Species of Wild Fauna and Flora) as the endangered one.

3.4.2 Population Share in Northern Chile

1) *Phoenicopterus chilensis* (Chilean Flamingo)

The population of *Phoenicopterus chilensis* in the world were reported as 330,000 in 1993, all of which are living in South America. According to the survey of Corporation National Forest - U.S.A. in 1985 - 1987, number of this species was counted in the Northern Chile as below:

Season and Year	Population
Winter 1985	3,451
Summer 1986	15,464
Winter 1986	2,797
Summer 1987	6,450

The species migrates among mountanious area in Chile, Peru, Bolivia and Argentina, and the east coast of South America. The population in Salar del Huasco shares 3.5% (544/15.464= 0.035) of that in the Northern Chile.

2) *Phoenicopterus andinus* (Andean Flamingo)

The population of *Phoenicopterus andinus* in the world were reported as 130,000 in 1993, all of which are living in Andes. According to the above U.S.A. survey, number of this species in the northern Chile was counted as below:

Season and Year	Population
Winter 1985	4,216
Summer 1986	40,747
Winter 1986	11,109
Summer 1987	37,245

The species migrates among mountanious area in Chile, Perú , Bolivia and Argentina. The population of Salar del Huasco shares 3.1% (1267/40,747= 0.031) of that in the Northern Chile.

3) *Phoenicopterus jamesi* (Puna Flamingo)

The population of *Phoenicopterus jamesi* in the world were reported as 15,000 in 1973, all of which are living in Andes. According to the above U.S.A. survey, the number of this species was counted as shown below.

Season and Year	Population
Winter 1985	5,760
Summer 1986	17,268
Winter 1986	10,503
Summer 1987	12,802

The species migrates among mountanious area in Chile, Peru, Bolivia and Argentina. The population of Salar del Huasco shares 8.9% (1,530/10,268= 0.089) of that in Northern Chile.

3.4.3 Nesting Habit

As shown in Tables E,3.22 and E,3.23, chickens, nests and eggs of *Phoenicopterus jamesi* were found on December 1993 and January 1994 in Salar del Huasco (See Photo E,3.4). This fact is important because Salar del Huasco provides one of the nesting areas of the scarce species; *Phoenicopterus jamesi* of which population in the world was reported as 15,000 in 1973.

3.5 Land Use, Social and Cultural Aspects

According to CONAD (National Corporation of Indigenous Right), a part of the northwest area ("bofedal", spring and lagoon of fresh water) of Salar del Huasco, is considered as private property. All the other areas of Salar del Huasco are owned by Bienes Nacionales de Chile. However, four aymara families (16 persons) are living in this area at present time.

The "bofedales" of the Laguna Huasco is also used sometimes as feeding area for the Auchenid livestock of surrounding communities outside Salar del Huasco. For example, the sheperds of Colchane visit Salar del Huasco every 3 - 10 years, together with 1,000 - 1,500 animals.

Table E,3.1 Water Quality Analysis of Huasco 0

Item		Nov. 93	Dec. 93	Jan.94
Temperature	(° C)	17.0	16.1	15.0
pH	(U)	8.06	8.05	8.03
Dissolved Oxygen (DO)	(mg/l)	3.6	3.8	3.1
Conductivity (EC)	(mS/cm)	0.5	0.5	0.5
NaCl	(%)	0.02	0.02	-
Turbidity	(mg/l)	69	173	-
Sodium (Na)	(mg/l)	-	78.6	81.2
Kalium (K)	(mg/l)	-	7.5	7.7
Litium (Li)	(mg/l)	-	4.8	1.8
Calcium (Ca)	(mg/l)	-	47.6	47.0
Magnesium (Mg)	(mg/l)	-	13.0	9.8
Carbonates (CO_3)	(mg/l)	-	0.0	0.0
Sulphates (SO_4)	(mg/l)	-	98.66	95.9
Bicarbonates (HCO_3)	(mg/l)	-	109.7	109.8
Chloride (Cl)	(mg/l)	-	32.6	32.9
Phosphate (P)	(µg-at/l)	-	2.10	2.0
Boron (B)	(mg/l)	-	1.0	
Arsenic (As)	(mg/l)	-	0.06	
Total Solids (TDS)	(mg/l)	-	440	397
Dissolved Solids	(mg/l)	-	440	393
Suspended Solids (SS)	(mg/l)	-	0	3.4
Total Hardness	(mg/l)	-	171.4	157.3

Table E,3.2 Water Quality Analysis of Huasco 3

Item		Nov. 93	Dec. 93	Jan. 94
Temperature	(° C)	15.5	20.3	17.0
pH	(U)	8.34	7.88	8.77
Dissolved Oxygen (DO)	(mg/l)	3.4	5.2	4.8
Conductivity	(mS/cm)	0.5	0.5	0.5
NaCl	(%)	0.02	0.02	-
Turbidity	(mg/l)	70	18	-
Sodium (Na)	(mg/l)	76.6	76.0	75.9
Kalium (K)	(mg/l)	6.4	6.7	7.1
Litium (Li)	(mg/l)	1.5	1.5	1.5
Calcium (Ca)	(mg/l)	41.5	40.5	41.3
Magnesium (Mg)	(mg/l)	5.9	5.8	5.8
Carbonates (CO_3)	(mg/l)	0.0	0.0	0.0
Sulphates (SO_4)	(mg/l)	88.3	82.7	85.9
Bicarbonates (HCO_3)	(mg/l)	207.4	204.8	203.8
Chloride (Cl)	(mg/l)	40.0	36.4	36.6
Phosphate (P)	(µg-at/l)	1.4	1.5	1.4
Boron (B)	(mg/l)	1.2	0.9	
Arsenic (As)	(mg/l)	< 0.03	< 0.03	
Total Solids (TDS)	(mg/l)	421	390	400
Dissolved Solids	(mg/l)	393	380	398
Suspended Solids	(mg/l)	28	10	2
Total Hardness	(mg/l)	139.5	140.1	150

Table E,3.3 Parameters in Milliequivalent/l of Huasco 0

Item		Nov.93	Dec. 93	Jan.94
Calcium (Ca)	(meq/l)	-	2.4	2.4
Magnesium(Mg)	(meq/l)	-	1.1	0.8
Sodium (Na)	(meq/l)	-	3.4	3.5
Kalium (K)	(meq/l)	-	0.2	0.2
Carbonate (CO_3)	(meq/l)	-	0.0	0.0
Bicarbonate (HCO_3)	(meq/l)	-	3.5	3.6
Sulphate (SO_4)	(meq/l)	-	2.1	2.0
Chloride (Cl)	(meq/l)	-	0.9	0.9
Cations Total	(meq/l)	-	7.1	6.9
Anions Total	(meq/l)	-	6.6	6.5

Table E,3.4 Parameters in Milliequivalent/l of Huasco 3

Item	Nov. 93	Dec. 93	Jan. 94
Calcium (Ca)	2.1	2.0	2.1
Magnesium (Mg)	0.5	0.5	0.5
Sodium (Na)	3.3	3.3	3.3
Kalium (K)	0.2	0.2	0.2
Carbonate (CO_3)	0.0	0.0	0.0
Bicarbonate (HCO_3)	3.4	3.4	3.3
Sulphate (SO_4)	1.8	1.7	1.8
Chloride (Cl)	1.0	1.0	1.0
Cations Total	6.1	6.0	6.1
Anions Total	6.3	6.1	6.1

Table E,3.5 Water Quality Analysis of Huasco 1

Item		Nov. 93	Dec. 93	Jan. 94
Temperature	(° C)	20.0	19.6	18.0
pH	(U)	9.36	9.07	9.10
Dissolved Oxygen (DO)	(mg/l)	2.7	4.3	3.8
Conductivity (EC)	(mS/cm)	0.3	0.6	0.4
NaCl	(%)	0.01	0.02	-
Turbidity	(mg/l)	89	212	-
Sodium (Na)	(mg/l)	96.5	91.1	97.0
Kalium (K)	(mg/l)	9.2	8.8	9.9
Lithium (Li)	(mg/l)	1.8	1.8	2.1
Calcium (Ca)	(mg/l)	27.4	33.0	26.9
Magnesium (Mg)	(mg/l)	11.3	10.6	12.4
Carbonates (CO_3)	(mg/l)	23.4	21.0	28.0
Sulphates (SO_4)	(mg/l)	97.14	98.66	98.66
Bicarbonates (HCO_3)	(mg/l)	137.6	148.4	128.1
Chloride (Cl)	(mg/l)	44.3	41.9	45.3
Phosphate (P)	(µg-at/l)	1.5	1.30	0.9
Boron (B)	(mg/l)	1.1	1.0	
Arsenic (As)	(mg/l)	0.04	0.04	
Total Solids (TDS)	(mg/l)	473	480	465
Dissolved Solids	(mg/l)	413	460	433
Suspended Solids (SS)	(mg/l)	60	20	31.7
Total Hardness	(mg/l)	114.5	125.3	118.1

Table E,3.6 Parameters in Milliequivalent/l of Huasco 1

Item		Nov.93	Dec.93	Jan.94
Calcium (Ca)	(meq/l)	1.4	1.6	1.3
Magnesium (Mg)	(meq/l)	1.0	0.8	1.0
Sodium (Na)	(meq/l)	4.2	4.0	4.2
Kalium (K)	(meq/l)	0.2	0.2	0.3
Carbonate (CO_3)	(meq/l)	0.8	0.7	0.9
Bicarbonate (HCO_3)	(meq/l)	2.2	2.4	2.1
Sulphate (SO_4)	(meq/l)	2.0	2.1	2.1
Chloride (Cl)	(meq/l)	1.2	1.2	1.3
Cations Total	(meq/l)	6.8	6.6	6.8
Anions Total	(meq/l)	6.2	6.4	6.4

Table E,3.7 Water Quality Analysis of Huasco 6

Item		Nov. 93	Dec. 93	Jan. 94
Temperature	(° C)	14.0	14.0	10.0
pH	(U)	8.66	7.93	8.40
Dissolved Oxygen (DO)	(mg/l)	2.1	3.6	3.4
Conductivity (EC)	(mS/cm)	2.0	1.2	1.8
NaCl	(%)	0.1	0.8	-
Turbidity	(mg/l)	95	203	-
Sodium (Na)	(mg/l)	335	363	437
Kalium (K)	(mg/l)	113	116	95
Lithium (Li)	(mg/l)	9.1	9.3	9.6
Calcium (Ca)	(mg/l)	150	178	209
Magnesium (Mg)	(mg/l)	31.1	30.2	36.9
Carbonates (CO_3)	(mg/l)	12.6	0.0	0.0
Sulphates (SO_4)	(mg/l)	962	1040	1269
Bicarbonates (HCO_3)	(mg/l)	138	215.4	209.8
Chloride (Cl)	(mg/l)	167.7	184.7	235.8
Phosphate (P)	(µg-at/l)	12.3	17.4	19.1
Boron (B)	(mg/l)	5.0	5.4	
Arsenic (As)	(mg/l)	2.0	2.0	
Total Solids (TDS)	(mg/l)	1953	2190	2480
Dissolved Solids	(mg/l)	1872	2140	2327
Suspended Solids (SS)	(mg/l)	81	50	153
Total Hardness	(mg/l)	502.8	572.5	673

Table E,3.8 Parameters in Milliequivalent/l of Huasco 6

Item		Nov. 93	Dec. 93	Jan. 94
Calcium (Ca)	(meq/l)	7.5	8.9	10.4
Magnesium (Mg)	(meq/l)	2.5	2.5	3.0
Sodium (Na)	(meq/l)	14.6	15.8	19.0
Kalium (K)	(meq/l)	2.9	3.0	2.4
Carbonate (CO	(meq/l)	0.4	0.0	0.0
Bicarbonate (HCO	(meq/l)	2.3	3.5	3.4
Sulphate (SO_4	(meq/l)	20.0	21.7	26.4
Chloride (Cl)	(meq/l)	4.7	5.2	6.6
Cations Total	(meq/l)	27.5	30.2	34.8
Anions Total	(meq/l)	27.5	30.4	36.4

Table E,3.9 Water Quality Analysis of Huasco 2

Item		Nov. 93	Dec. 93	Jan. 94
Temperature	(° C)	19.0	23.7	28.0
pH	(U)	8.74	8.60	8.30
Dissolved Oxygen (DO)	(mg/l)	2.0	3.2	3.0
Conductivity (EC)	(mS/cm)	509.0	39.6	>
NaCl	(%)	3.21	2.39	-
Turbidity	(mg/l)	19	230	-
Sodium (Na)	(mg/l)	17250	11500	27081
Kalium (K)	(mg/l)	2558	1835	1429
Lithium (Li)	(mg/l)	245	234	408
Calcium (Ca)	(mg/l)	392.8	196.4	198.4
Magnesium (Mg)	(mg/l)	477.6	303.8	329.3
Carbonates (CO_3)	(mg/l)	110.0	138.4	168.0
Sulphates (SO_4)	(mg/l)	18541	12253	35965
Bicarbonates (HCO_3)	(mg/l)	575.8	245.2	216.0
Chloride (Cl)	(mg/l)	16323	10774	15925
Phosphate (P)	(µg-at/l)	230	212.5	243.4
Boron (B)	(mg/l)	145	110	
Arsenic (As)	(mg/l)	18	12	
Total Solids (TDS)	(mg/l)	52547	34290	66683
Dissolved Solids	(mg/l)	51143	34250	65348
Suspended Solids (SS)	(mg/l)	1404	40	1335
Total Hardness	(mg/l)	2948	1739	1852

>: Very High

Table E,3.10 Water Quality Analysis of Huasco 4

Item		Nov. 93	Dec. 93	Jan. 94
Temperature	(°C)	20.0	24.2	19.0
pH	(U)	8.64	8.22	7.92
Dissolved Oxygen (DO	(mg/l)	2.0	1.6	1.5
Conductivity (EC)	(mS/cm)	>	>	>
NaCl	(%)	>	>	-
Turbidity	(mg/l)	133	217	-
Sodium (Na)	(mg/l)	25471	68103	52210
Kalium (K)	(mg/l)	5565	13103	14414
Lithium (Li)	(mg/l)	898	1633	2449
Calcium (Ca)	(mg/l)	587	465	1275
Magnesium (Mg)	(mg/l)	695	1994	4726
Carbonates (CO_3)	(mg/l)	154.6	672.8	1056.0
Sulphates (SO_4)	(mg/l)	34590	58962	45204
Bicarbonates (HCO_3)	(mg/l)	637.4	637.4	358.6
Chloride (Cl)	(mg/l)	23079	69768	53973
Phosphate (P)	(µg-at/l)	226.3	361.6	321.4
Boron (B)	(mg/l)	203.0	515.0	
Arsenic (As)	(mg/l)	36	66	
Total Solids (TDS)	(mg/l)	96312	203420	176910
Dissolved Solids	(mg/l)	91698	180250	175273
Suspended Solids (SS)	(mg/l)	4614	23170	1637
Total Hardness	(mg/l)	4329	9373	11330

N. D. : Not Determined

> : Very High

Table E,3.11 Parameter in Milliequivallent/l of Huasco 2

Item		Nov. 93	Dec. 93	Jan. 94
Calcium (Ca)	(meq/l)	19.6	9.8	9.9
Magnesium (Mg)	(meq/l)	39.1	24.9	27.0
Sodium (Na)	(meq/l)	750.0	500.0	1,177.0
Kalium (K)	(meq/l)	65.4	46.9	36.5
Carbonate (CO_3)	(meq/l)	3.7	4.6	5.6
Bicarbonate (HCO_3)	(meq/l)	9.4	4.0	3.5
Sulphate (SO_4)	(meq/l)	386.2	255.3	749.0
Chloride (Cl)	(meq/l)	459.8	303.5	448.6
Cations Total	(meq/l)	874.1	581.6	1,250.4
Anions Total	(meq/l)	859.4	567.4	1,206.7

Table E,3.12 Parameters in Milliequivalent/l of Huasco 4

Item		Nov. 93	Dec. 93	Jan. 94
Calcium (Ca)	(meq/l)	29.4	23.2	31.9
Magnesium (Mg)	(meq/l)	56.9	163.4	193.8
Sodium (Na)	(meq/l)	1,327.0	2,961.0	2,270.0
Kalium (K)	(meq/)	142.3	335.1	368.6
Carbonate (CO_3)	(meq/l)	5.1	22.4	35.2
Bicarbonate (HCO_3)	(meq/l)	10.4	10.4	5.8
Sulphate (SO_4)	(meq/l)	720.6	1,228.3	941.8
Chloride (Cl)	(meq/l)	650.0	1,965.3	1,520.0
Cations Total	(meq/l)	1,555.6	3,482.7	2,864.3
Anions Total	(meq/l)	1,386.1	3,226.4	2,502.8

Table E,3.13 Water Quality Analysis of Huasco 5

Item		Nov. 93	Dec. 93	Jan. 94
Temperature	(°C)	27.5	32.5	-
pH	(U)	8.34	8.38	-
Dissolved Oxygen (DO)	(mg/l)	1.4	1.9	-
Conductivity (EC)	(mS/cm)	>	>	-
NaCl	(%)	>	>	-
Turbidity	(mg/l)	158	105	-
Sodium (Na)	(mg/l)	113022	31119	-
Kalium (K)	(mg/l)	17198	11958	-
Lithium (Li)	(mg/l)	2960	1878	-
Calcium (Ca)	(mg/l)	689.4	645.3	-
Magnesium (Mg)	(mg/l)	2908	1382	-
Carbonates (CO_3)	(mg/l)	0.0	N.D.	-
Sulphates (SO_4)	(mg/l)	130858	40697	-
Bicarbonates (HCO_3)	(mg/l)	N.D.	N.D.	-
Chloride (Cl)	(mg/l)	102508	32390	-
Phosphate (P)	(µg-at/l)	2.5	4.7	-
Boron (B)	(mg/l)	773.0	395.0	-
Arsenic (As)	(mg/l)	128.0	60.0	-
Total Solids (TDS)	(mg/l)	297128	119480	-
Dissolved Solids	(mg/l)	287485	112070	-
Suspended Solids (SS)	(mg/l)	9643	7410	-
Total Hardness	(mg/l)	13697	7301	-

N.D. : Not Determined
> : Very High

Table E,3.14 Parameters in Milliequivalent/l of Huasco 5

Item		Nov. 93	Dec. 93	Jan. 94
Calcium (Ca)	(meq/l)	34.0	32.0	-
Magnesium (Mg)	(meq/l)	238.0	113.0	-
Sodium (Na)	(meq/l)	4,988.0	1,353.0	-
Kalium (K)	(meq/l)	440.0	306.0	-
Carbonate (CO_3)	(meq/l)	-	-	-
Bicarbonate (HCO_3)	(meq/l)	-	-	-
Sulphate (SO_4)	(meq/l)	2,726.0	912.0	-
Chloride (Cl)	(meq/l)	2,888.0	848.0	-
Cations Total	(meq/l)	5,700.0	1,804.0	-
Anions Total	(meq/l)	5,614.0	1,760.0	-

Table E,3.15 Fitoplankton in the Laguna Huasco

(Unit: Num./l)

Square	35		46	
Month	Nov. 1993	Dec.1993	Nov. 1993	Dec. 1993
BACILLARIOPHYCEAE				
Surirella sp.1	1,533.333	1,713,333	3,200.000	2,383,333
Navicula sp.1	1,033.333	20,000	200.000	233,333
Amphora sp.	300.000	-	66.667	83,333
Surirella sp. 2	-	86,667	-	183,333
Nitzschia sp.1	266.667	6,667	-	66,667
Diploneis sp.	66.667	20,000	233.333	50,000
Navicula sp.2	66.667	-	-	-
Fragillaria sp.	166.667	6,667	100,000	266,667
Navicula sp. 3	133.333	-	33,333	-
Pinnularia sp. 1	-	3,333	-	66,667
Surirella sp. 3	-	-	-	150,000
Ophepora sp.	-	-	-	16,667
Nitzchia sp.2	-	-	-	16,667
Navicula sp.4	33.333	-	-	16,667
Coconeis sp.	-	-	33.333	-
CYANOPHYCEAE				
Anabaena sp. 1	66,667	-	-	-
Oscillatoria sp.1	-	10,000		16,667
Oscillatoria sp. 2	-	10,000		-
Oscillatoria sp. 3	-	-		33,333

Table E,3.16 Zooplankton in the Laguna Huasco

(Unit: Num./l)

Square	35		46	
Month	Nov. 1993	Dec. 1993	Nov. 1993	Dec. 1993
ARTROPODA				
Copepodos Calanoideos	22.00	4.00	18.00	-
Copepodos Ciclopoideos	189.00	2.40	8.00	2.00
Ostracodo	2.00	0.60	-	-
Insect larva (3)	-			2.00
NEMATODA				
Sp. Indeterminata	10.00			

Table E,3.17 Fitoplankton in Huasco Lipez

(Unit: Num./l)

Month	Nov. 1993	Dec. 1993
BACILARIOPHYCEAE		
Diploneis sp.	33,333	23,333
Fragillaria sp.	150,000	766,667
Navicula sp.1	116,667	50,000
Navicula sp.3	100,000	-
Surirella sp.1	916,667	506,667
Navicula sp.4	-	10,000
Amphora sp.	200,000	23,333
Pleurosigma sp.	-	13,333
Nitzschia sp.1	83,333	.6,667
Surirella sp.2	100,000	50,000
Navicula sp.6	-	16,667
Pinnularia sp.	-	26,667
CYANOPHYCEAE		
Anabaena sp.3	-	6,667
Anabaena sp.1	16,667	-
Oscillatoria sp.1	66,667	10,000
Oscillatoria sp.3	33,333	80,000

Table E,3.18 Zooplankton in Huasco Lipez

(Unit: Num./l)

Month	Nov. 1993	Dec. 1993
ARTROPODA		
Copepoda Calanoidea	17.00	2.40
Copepoda Ciclopoidea	3.30	2.00
Insect larvae (2)		0.40
Ostracoda		0.60
NEMATODA		
Sp. Indeterminatae	3.30	0.40

Table E,3.19 Fitoplankton in the pond of Cerro Huasco zone

(Unit: Num./l)

Month	Nov. 1993	Dec. 1993
BACILLARIOPHYCEAE		
Diploneis sp.	2,300,000	1,200.000
Navicula sp.1	83,333	6,667
Navicula sp.3	66,667	-
Surirella sp.1	400,000	506.667
Opephora sp.	16,667	-
Nitzschia sp.1	16,667	3,333
Navicula sp.4	-	13,333
Navicula sp.5	-	13,333
CYANOPHYCEAE		
Anabaena sp.1	916,667	363,333
Anabaena sp.2	16,667	-
Oscillatoria sp.1	50,000	13,333

Table E,3.20 Zooplankton in the Pond of Cerro Huasco

(Unit: Num./l)

Month	Nov. 1993	Dec. 1993
ARTROPODA		
Copepodos Calanoideos	15.00	14.00
Artemia sp.	2.00	3.60
Larvas de Insecto (3)	-	0.20
Ostracodo	10.00	-
NEMATODA		
Sp. Indeterminada	6.00	0.20

Table E,3.21 Bird Species in Salar del Huasco and Conservation Status

Fam. TINAMIDAE			
Tinamotis pentlandii Vigors	Puna Tinamou	V	v
Fam RHEIDAE			
Pterocnemia pennata (d'Orbigny)	Lesser Rhea	E	e
Fam. PODICIPEDIDAE			
Podiceps occipitalis (Garnot)	Silvery Grebe	X	x
Fam. PHOENICOPTERIDAE			
Phoenicopterus chilensis Molina	Chilean Flamingo	V	v
Phoenicoparrus andinus (Philippi)	Andean Flamingo	V	v
Phoenicoparrus jamesi (Sclater)	Puna Flamingo	V	v
Fam. ARDEIDAE			
Nycticorax nicticorax (Linné)	Black-crowned Night Heron	X	x
Fam. ANATIDAE			
Chloephaga melanoptera (Eyton)	Andean Goose	O	v
Lophonetta specularioides (King)	Crested Duck	X	x
Anas flavirostris Veillot	Chilean Teal	X	x
Anas georgica Gmelin	Brown Pintail	X	x
Ana puna Tschudi	Puna Teal	X	x
Fam. FALCONIDAE			
Phalcoboenus megalopterus (Meyen)	Mountain Caracara	X	x
Fam. RALLIDAE			
Fulica gigantea Eydoux & Souleyet	Giant Coot	V	v
Fam. CHARADRIIDAE			
Vanellus resplendens (Tschudi)	Andean lapwing	X	x
Charadrius alticola (B. & S.)	Puna Plover	X	x
Fam. RECURVIROSTRIDAE			
Recurvirostra andina (Phil. & Landb.)	Andean Avocet	X	x

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Fam. SCOLAPACIDAE			
Tringa flavipes (Gmelin)	Lesser Yellowlegs	X	X
Calidris bairdi (Coues)	Baird's Sandpiper	X	X
Gallinago andina (Taczanowski)	Puna Snipe	X	X
Phalaropus tricolor (Veillot)	Wilson's Phalarope	X	X
Fam. THINOCORIDAE			
Thinocorus rumicivorous Eschscholtz	Least Seedsnipe	X	X
Fam. LARIDAE			
Larus serranus Tschudi	Andean Gull	X	X
Fam. FURNARIIDAE			
Geositta cunicularia (Veillot)	Common Miner	X	X
Geositta punensis Dabbene	Puna Miner	X	X
Cinclodes fuscus (Veillot)	Bar-winged Cinclodes	X	X
Upucerthiaruficauda (Meyen)	Earthcreeper	X	X
Tripophaga dorbigny (Reichenbach)	Canastero	X	X
Fam. TYRANNIDAE			
Agriornis albicauda (Phil. & Landb.)	White-tailed Shrike-Tyrant	X	X
Muscisaxicola rufivertex d'Orb. & Lafr.	Rufous-naped Ground-Tyrant	X	X
Muscisaxicola juninensis Taczanowski	Puna Groud-Tyrant	X	X
Muscisaxicola flavinucha Lafresnaye	Creamy-naped Tyrant	X	X
Lessonia rufa (Gmelin)	Rufous-backed Negrito	X	X
Fam. HIRUNDINIDAE			
Hirundo rustica Linné	Barn Swallow	X	X
Fam. COLUMBIDAE			
Metriopelia aymara (Knip & Prevost)	Andean pigeon	X	X
Fam. MOTACILLIDAE			
Anthus correndera Veillot	Correndera Pipit	X	X
Fam. EMBERIZIDAE			
Sicalis uropygialis (Laf. & d'Orb.)	Bright-rumped Yellow-Finch	X	X
Fam. FRINGILLIDAE			
Phrygilus erythronotus (Phil. & Landb.)	White-throated Finch	X	X
Phrygilus unicolor (lafres. & d'Orb.)	Plumbeus Sierra-Finch	X	X
Carduelis atratus Lafres. & d'Orb.	Black Siskin	X	X

Remark - 1: Conservation Status in based of CONAF

Status	I. Region	Chile
Endangered	E	e
Vulnerable	V	v
Out of danger	O	o
Not defined	X	x

Table E,3.22 Number of Flamingos

SPECIE	Nov. 93	Dec. 93	Jan. 94
Phoenicopterus chilensis			
Chilean flamingo	145	544	181
Phoenicoparrus andinus			
Andean flamingo	951	1,267	579
Phoenicoparrus jamesi			
Puna flamingo	-	1,533	1,449

Table E,3.23 Nesting Flamingos, December 1993

SPECIE	Nests	Eggs	Chickens
Phoenicopterus chilensis			
Chilean flamingo	-	-	-
Phoenicoparrus andinus			
Big parina	-	-	-
Phoenicoparrus jamesi			
Small parina	287 Nos.	290 Nos.	-

Table E,3.24 Nesting Flamingos, January 1994

SPECIE	Nests	Eggs	Chickens
Phoenicopterus chilensis			
Chilean flamingo	-	-	-
Phoenicoparrus andinus			
Big parina	-	-	-
Phoenicoparrus jamesi			
Small parina	451 Nos.	350 Nos.	165 Nos.

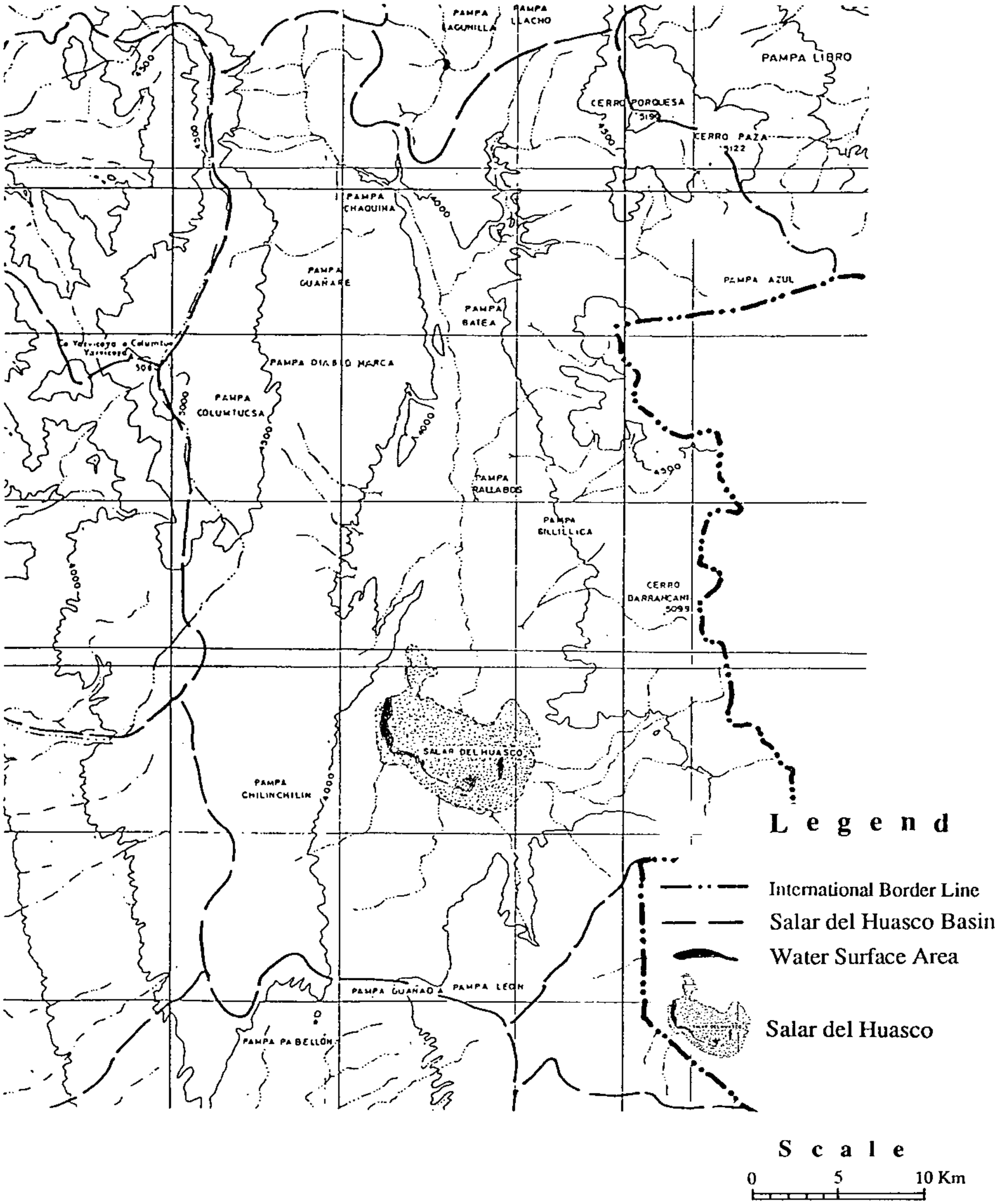
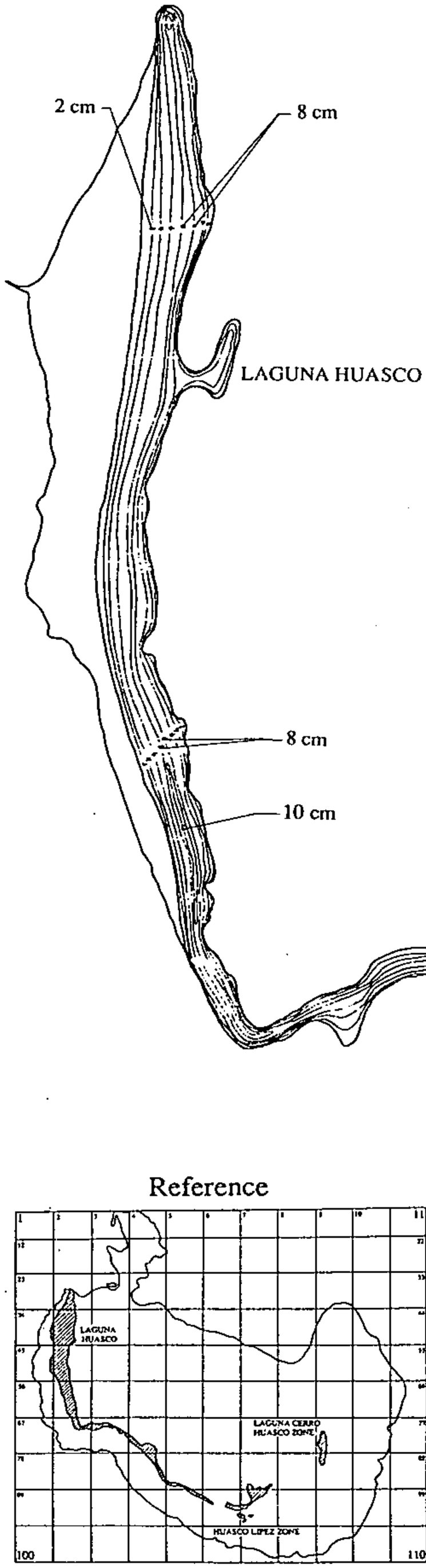
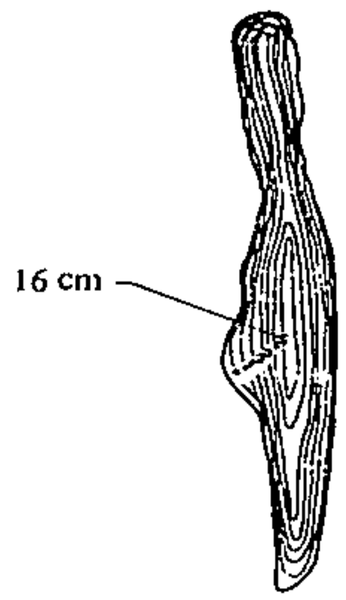


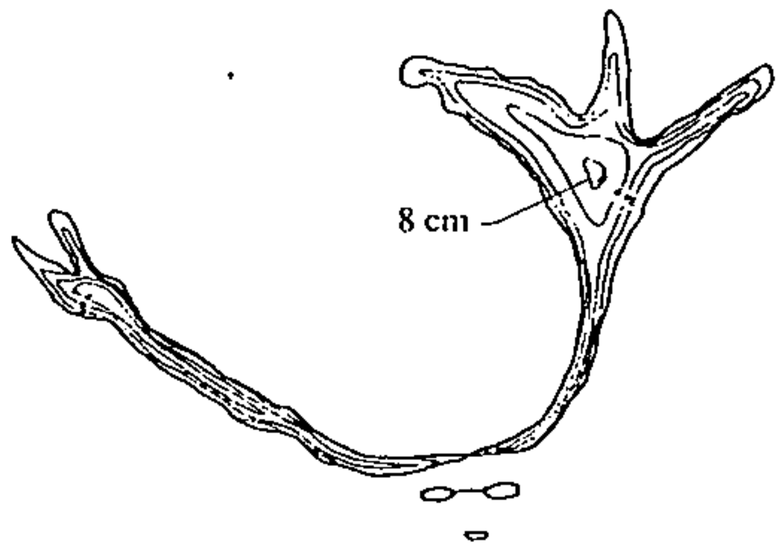
Fig. E.3.1 Salar del Huasco Basin and Water Surface Area

< *Cuenca del Salar del Huasco y Area de la Superficie de Agua* >

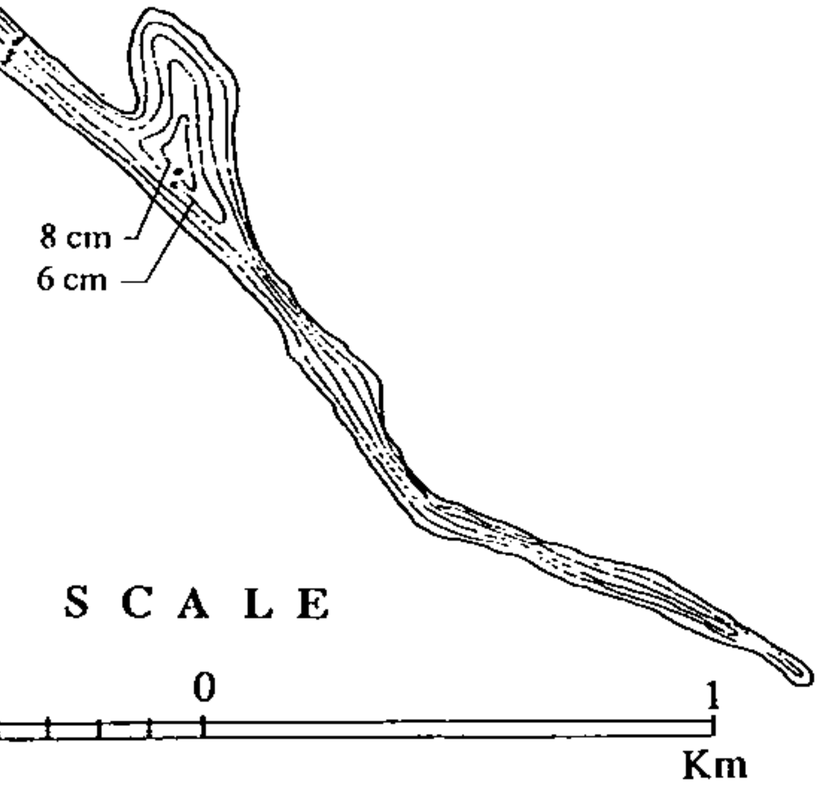




LAGUNA CERRO HUASCO ZONE



HUASCO LIPEZ ZONE



Reference

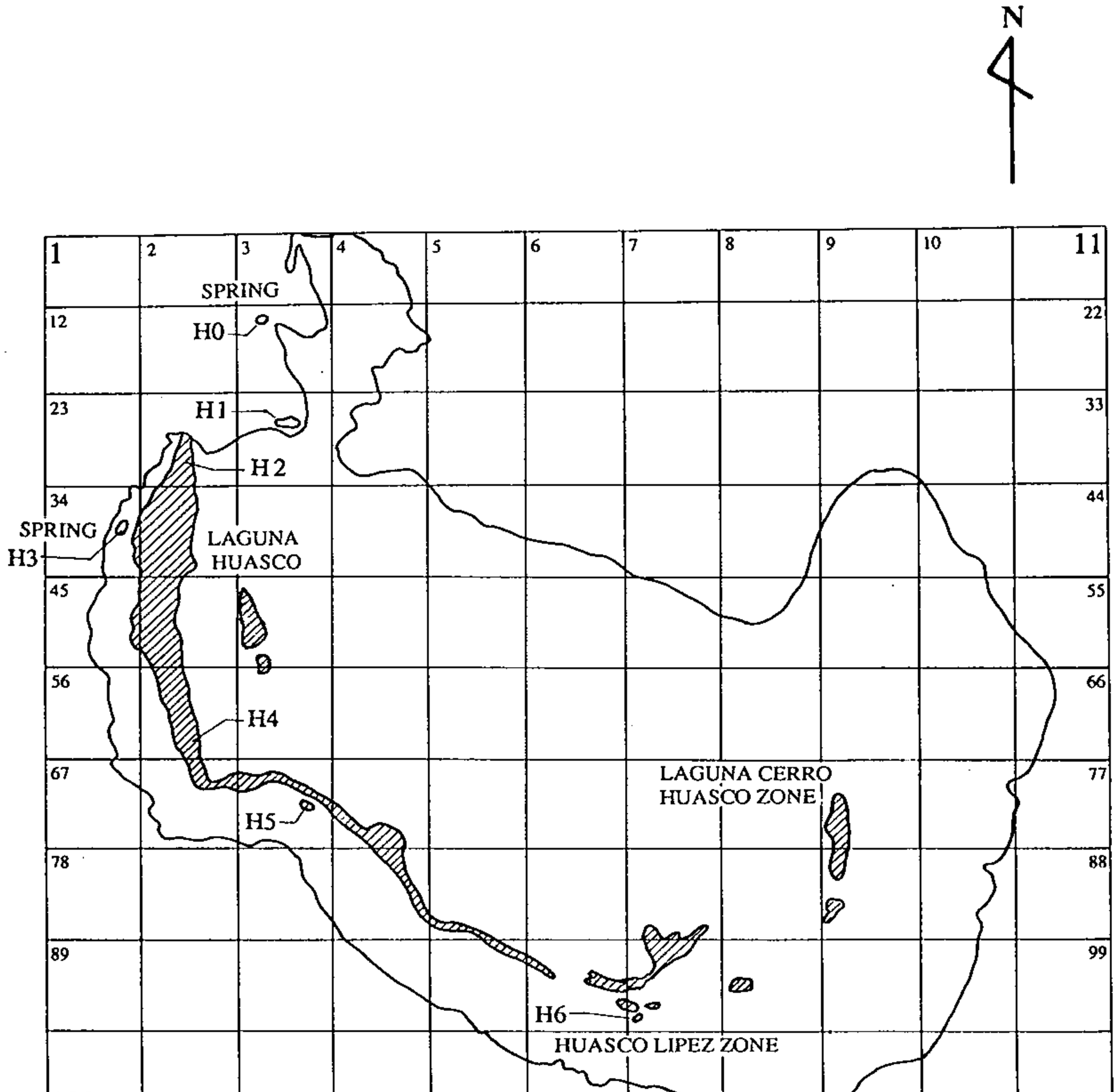
S C A L E

1 0 1

Km

Fig. E.3.2 Isobath of the Salar del Huasco

< Isóbatas del Salar del Huasco >



L E G E N D

: Water surface

H1 : Water samplig point H1

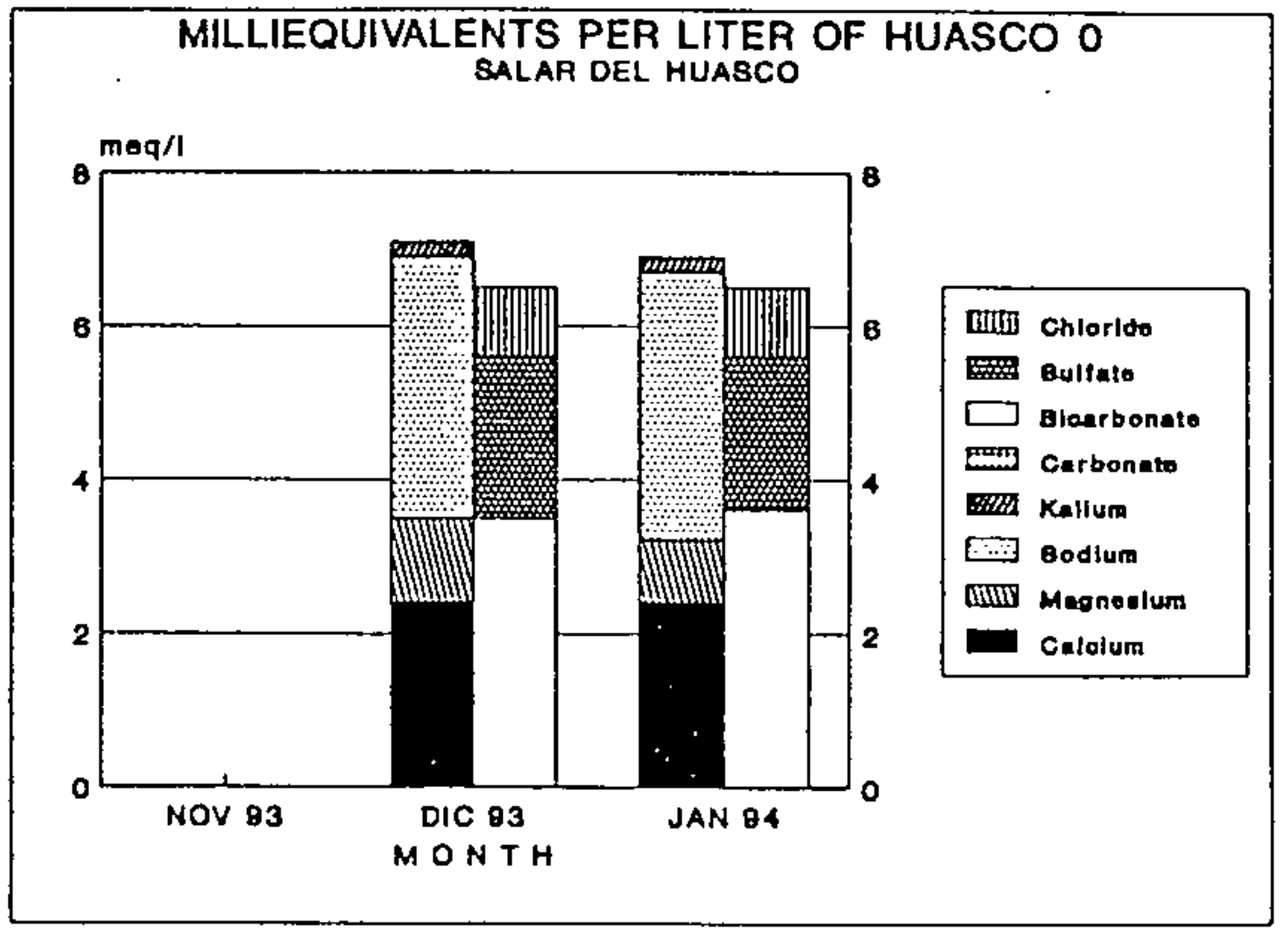
11 : Index 11

S C A L E

0 1 2 3 Km

Fig. E.3.3 Water Sumpling Points of the Salar del Huasco

< Muestreo de agua del Salar del Huasco >



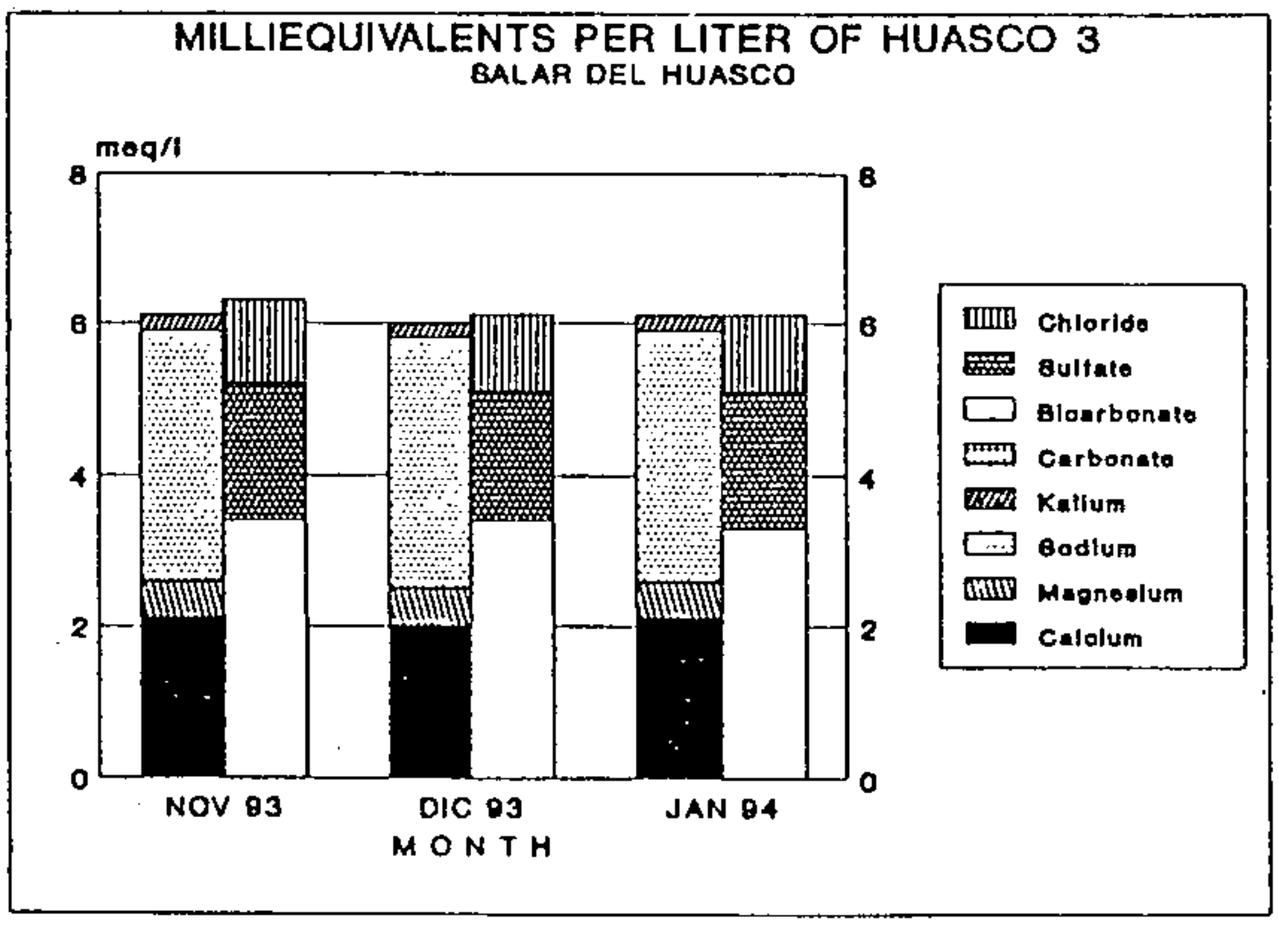
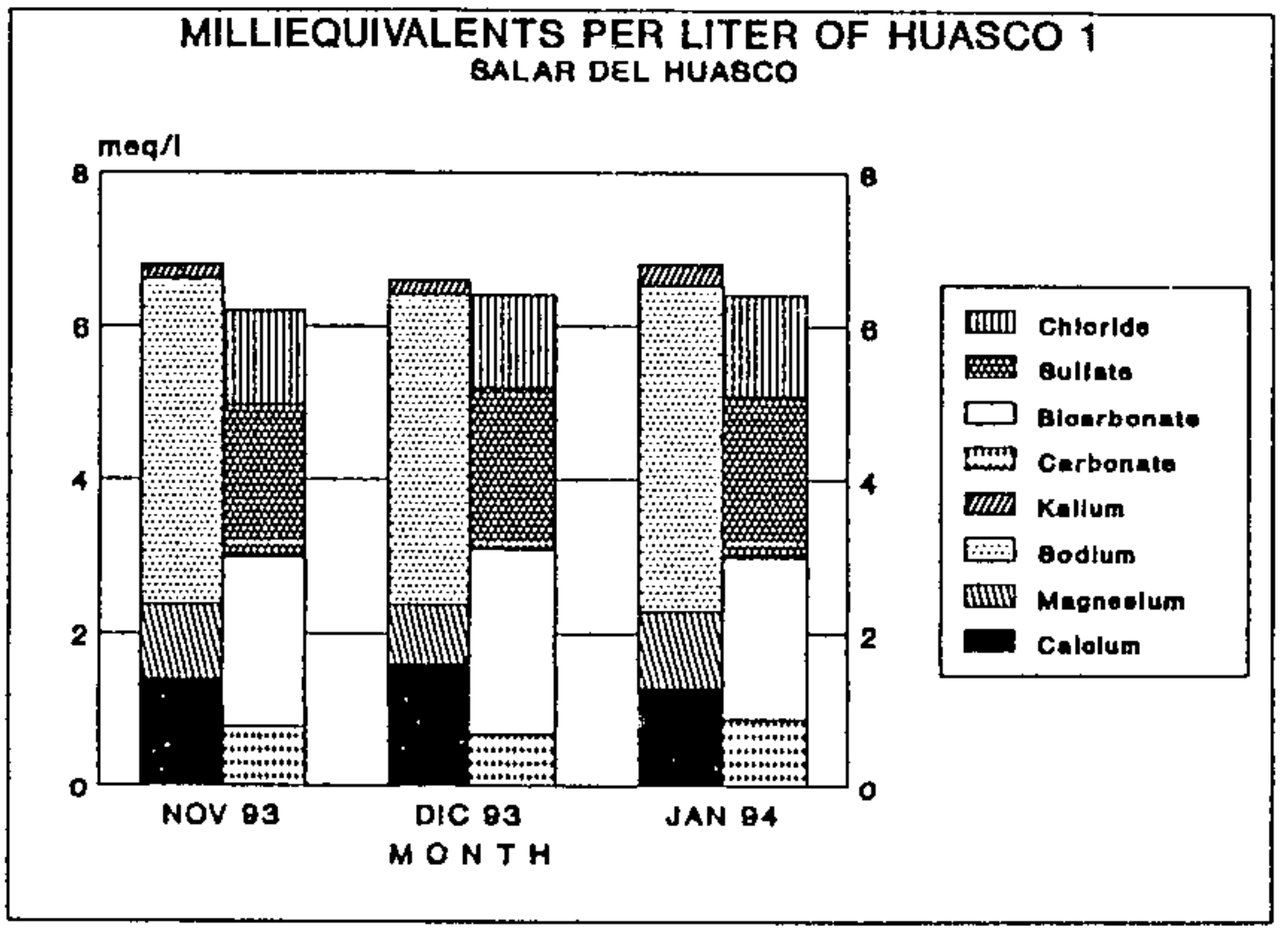


Fig. E, 3.4 Collins Diagram (H0 and H3)

< Diagrama Colins (H0 y H3) >



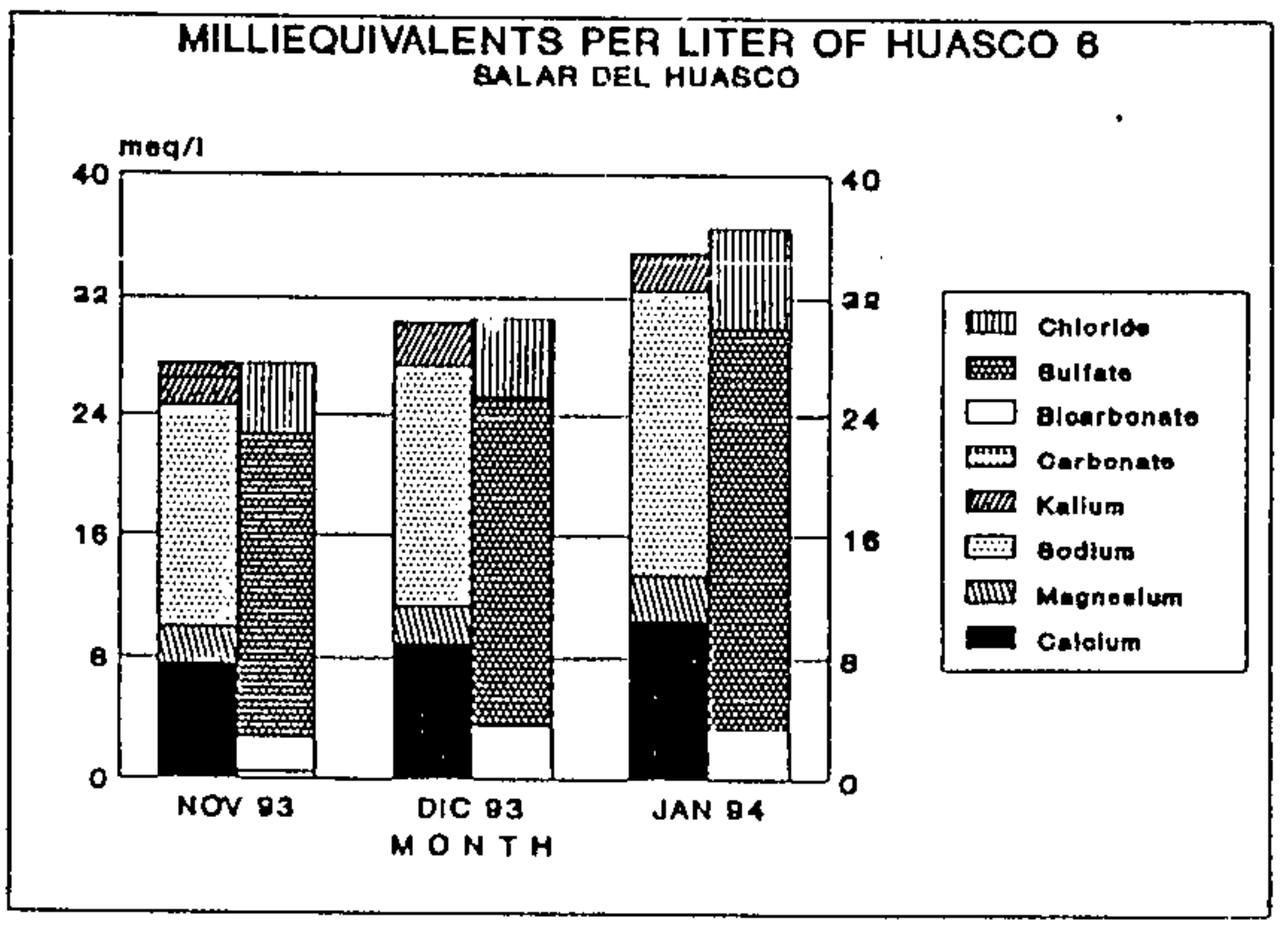
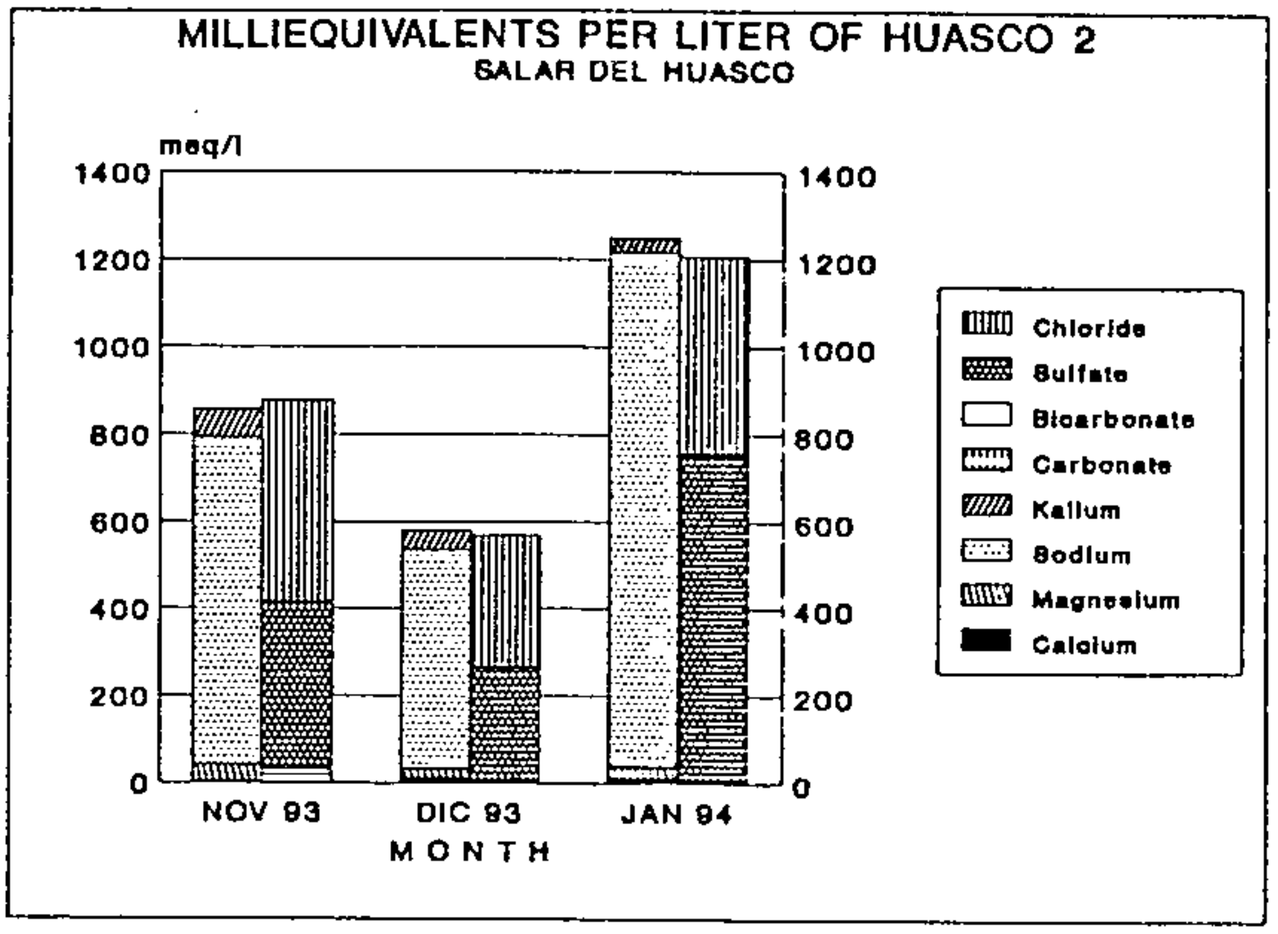


Fig. E, 3.5 Collins Diagram (H1 and H6)

< Diagrama Collins (H1 y H6) >



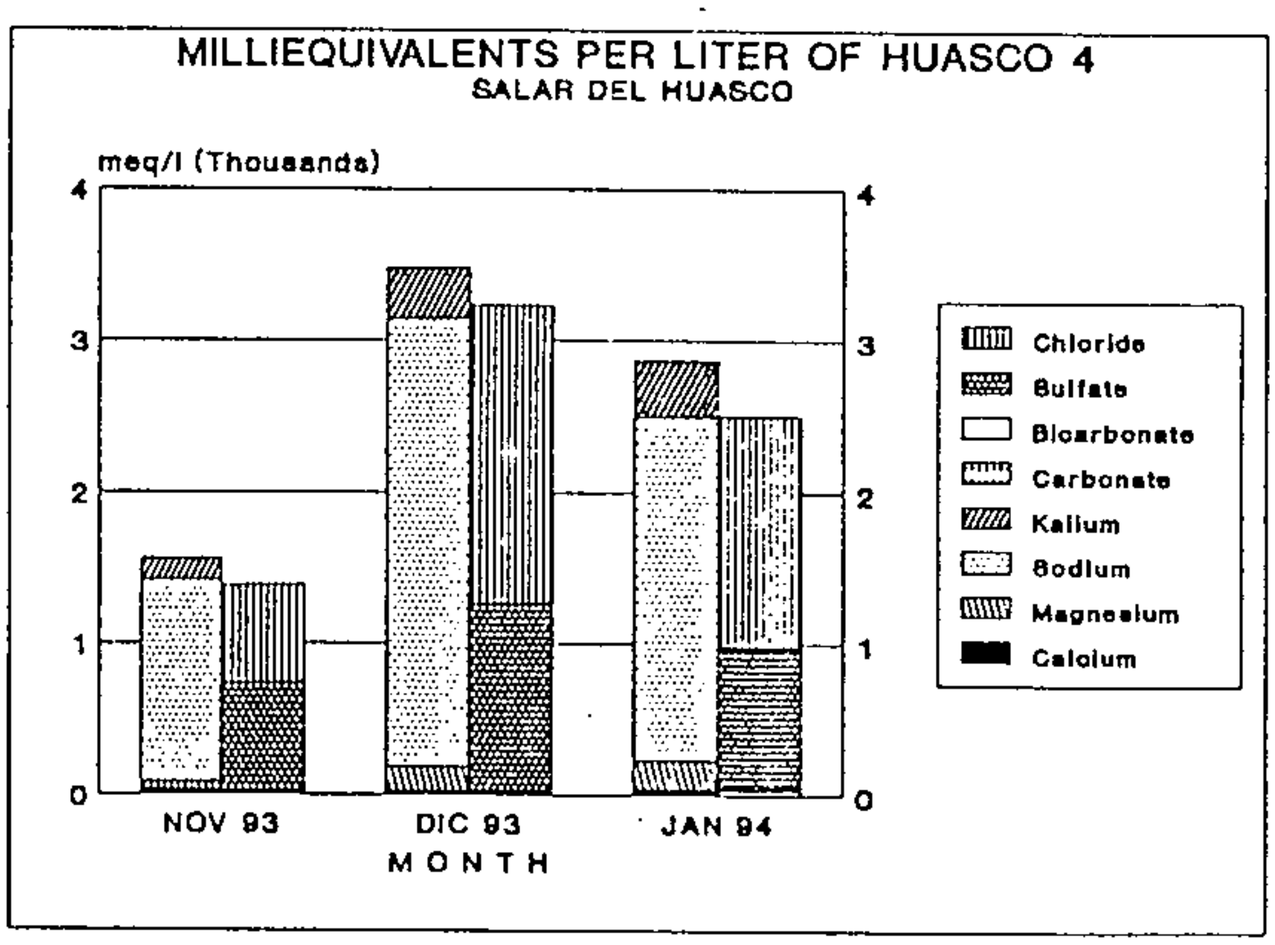


Fig. E, 3.6 Collins Diagram (H2 and H4)

< Diagrama Collins (H2 y H4) >

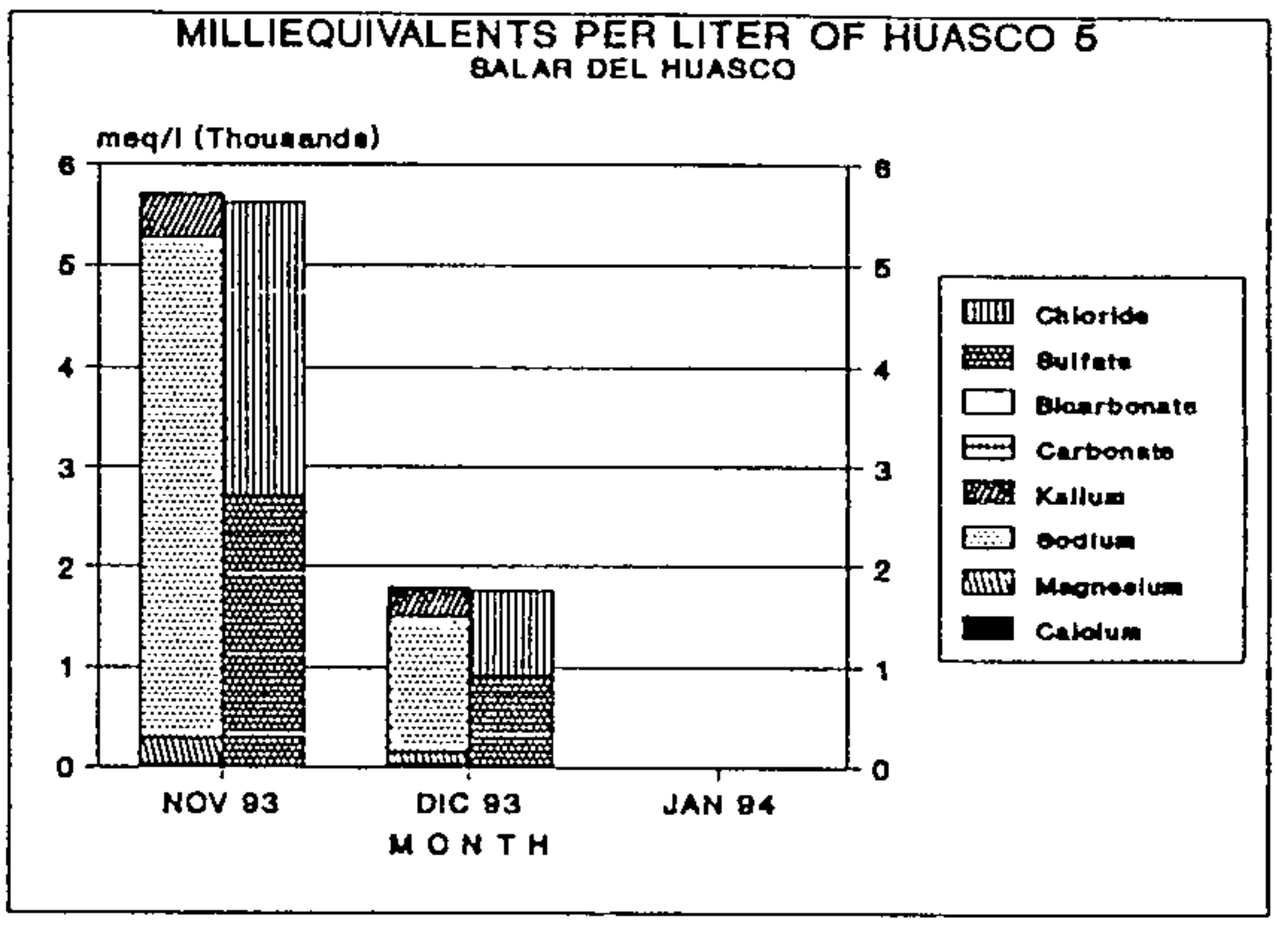
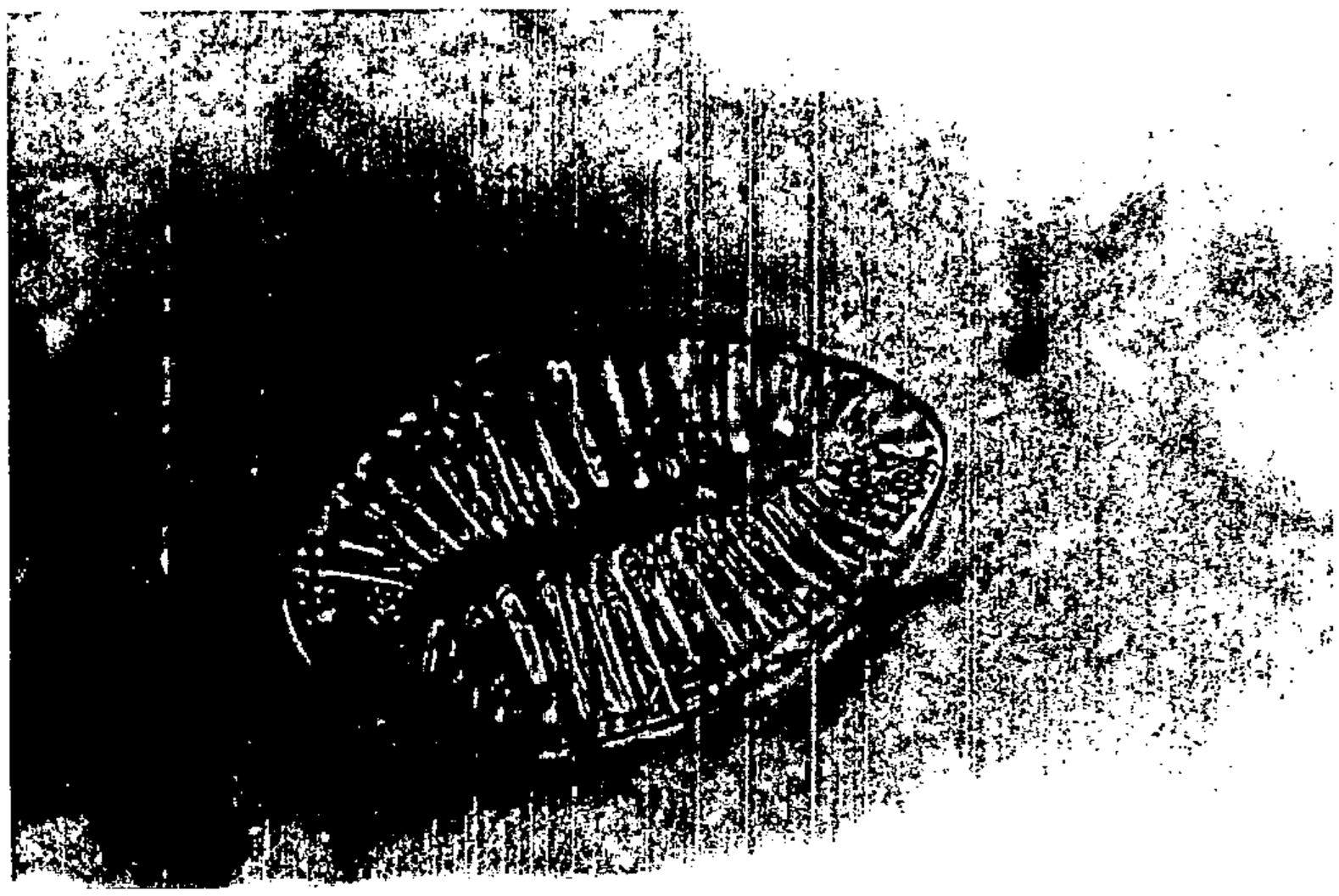
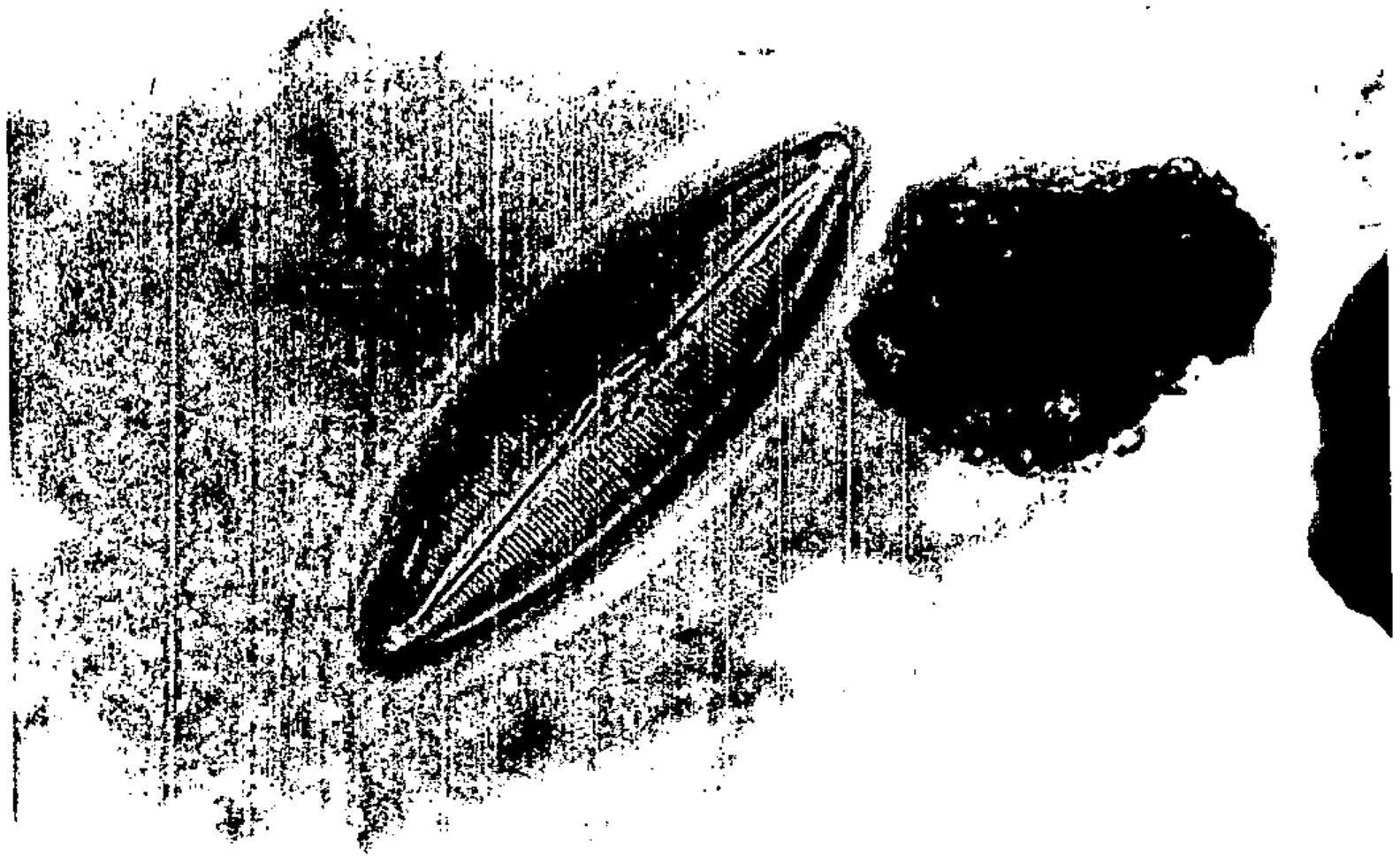


Fig. E, 3.7 Collins Diagram (H5)

< Diagrama Collins (H5) >



Microphotography of *Surirella* sp 1.



Microphotography of *Navicula* sp.

Photo E, 3.1 Plankton (*Surirella* sp.1 and *Navicula* sp.)
<*Plancton (Surirella sp1 y Navicula sp.)*>

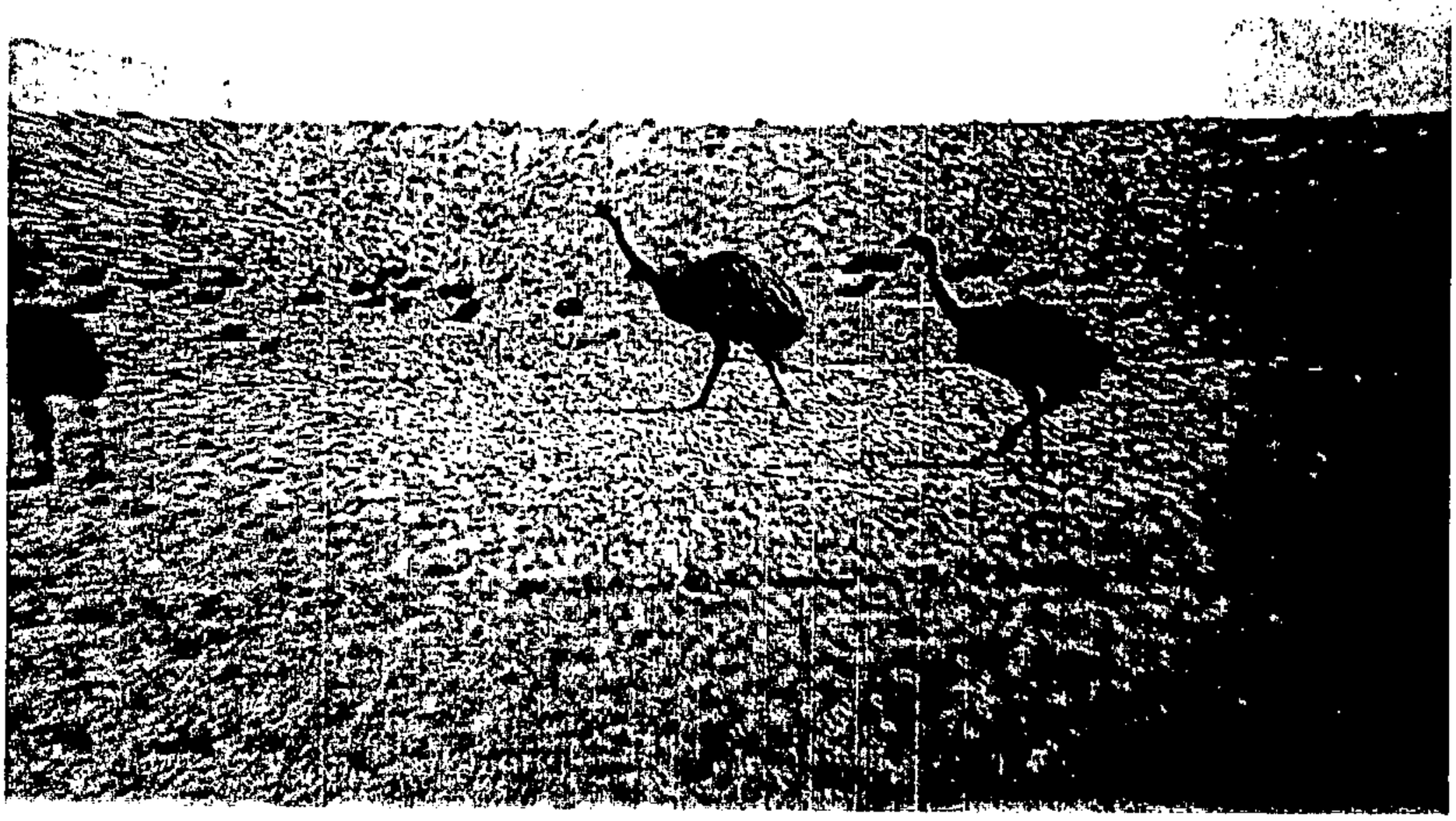
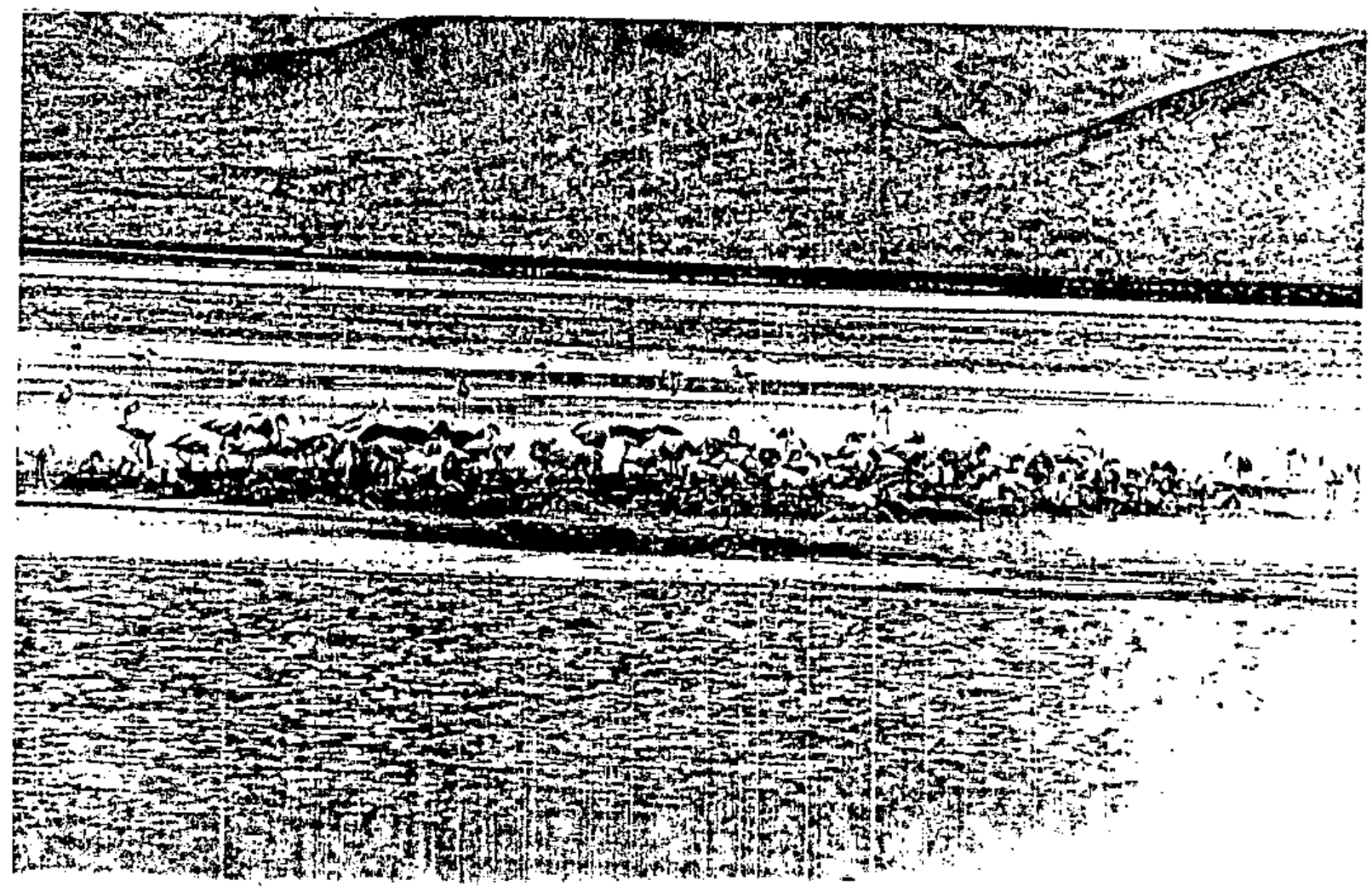


Photo.E, 3.2 *Pterocnemia Pennata* (Lesser Rhea)
< *Pterocnemia Pennata (Rhea Menor)* >

Photo.E, 3.3 *Chloephaga Melanoptera* (Andean Goose)

< *Chloephaga Melanoptera (Ganso Andino)* >



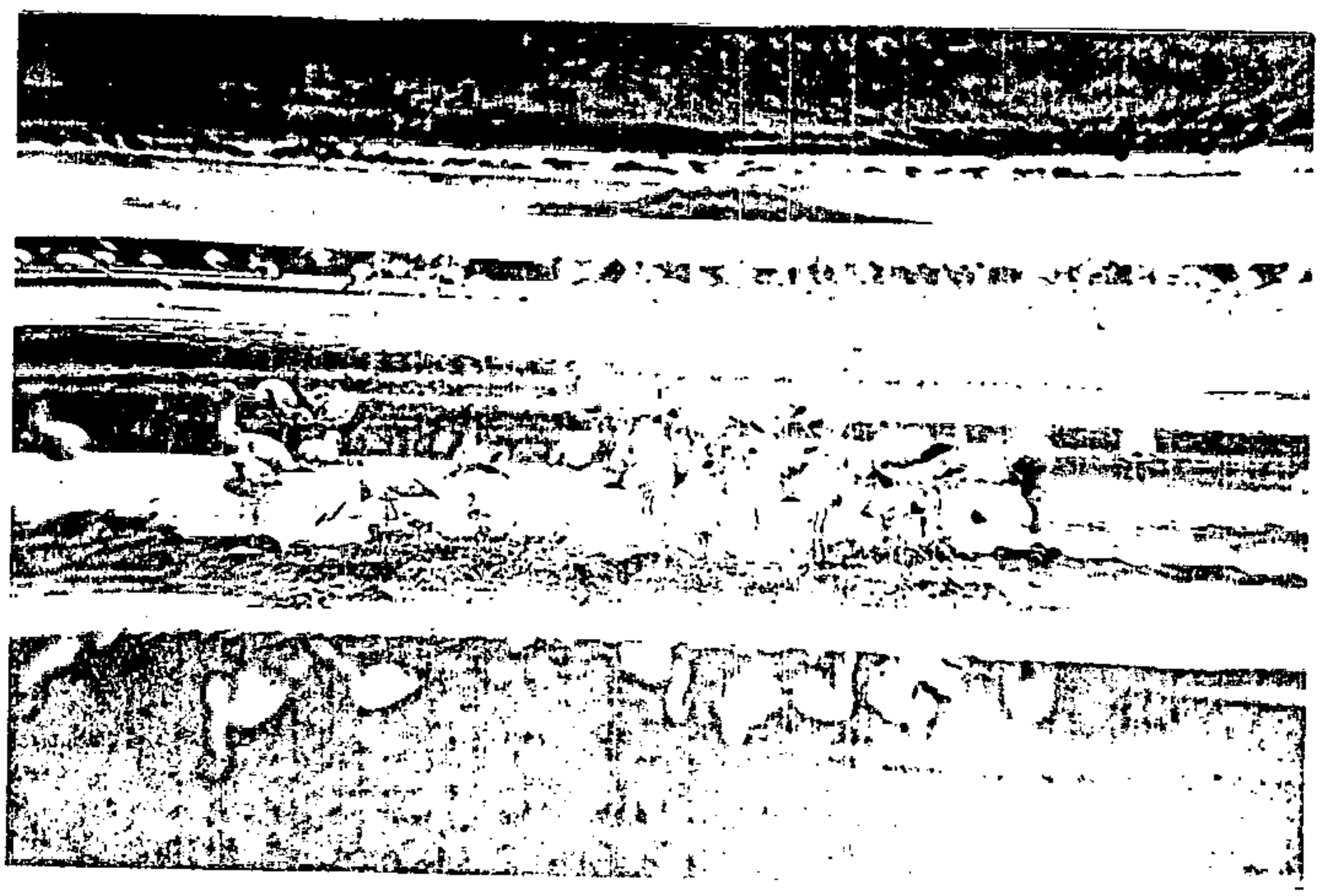


Photo.E, 3.4 Nests and Eggs of *Phoenicoparrus Jamesi* (Puna Flamingo)

< Nidos y Huevos de Phoenicoparrus Jamesi (Flamenco de la Puna) >