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Postilla

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RESULTS OF RESEARCH IN THE ANTOFAGASTA
RANGES OF CHILE AND BOLIVIA

I. Birds: LUIS E. PEÑA

II. Diatoms: RUTH PATRICK

Color Plate: ROGER TORY PETERSON

I

EXPLORATIONS IN THE ANTOFAGASTA RANGE,
WITH OBSERVATIONS ON THE FAUNA AND FLORA

LUIS E. PEÑA*

SANTIAGO, CHILE

About the middle of May, 1957, I began the initial steps towards the making of an expedition to the Antofagasta Range (Chile, S.A.), a region rich in scientific possibilities, yet relatively unknown.

The Curator of Vertebrate Zoology of the Peabody Museum of Natural History at Yale University, Mr. S. Dillon Ripley, commissioned me to make a study of the birds of this range and to locate one of the lesser flamingos called "parina chica," about which little is known.

Several persons have helped me with data and suggestions. Among them I am especially thankful to the following: Dr. Luis Sandoval, Director of the Centro de Estudios Antropologicos at the University of Chile; Mr. William E. Rudolph, engineer of the Chile Exploration Company; Dr. Rudolfo A. Philippi, Chief of the Ornithology Section of the Museo Nacional de Historia Natural de Santiago, who was kind enough to classify some of the birds and critically examine these notes; Mrs. Rebecca Acevedo of the Botanical Section of the Museum who classified the plant collection; Octavio Barrios Valenzuela, my good friend and President of the Sociedad Chilena de Etimologia, who has always encouraged me in this work; Juan G. Rojas and Luis A. Flores, employees of the Chile Exploration Company who helped by supplying me with much valuable information; and Pedro and Mario Soza, also employed by the above company, who were always ready to give me their help. I must especially mention my assistant, Gerardo Barria Peredes, who collaborated on this trip with great enthusiasm and earnestness.

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My main interest was to observe and, wherever possible, to collect the birds which pass the winter on the high ranges of the Andes in the interior of the province of Antofagasta. During the spring, summer, and part of the autumn months, the bird life of this region is numerous in species which disappear during the winter, migrating to warmer climates. My other mission was to recheck the presence of some insects which I had collected on earlier trips. These were little-known species which had been classified recently. Another object of this trip was to meet the expedition that the Centro de Estudios Antropologicos of the University of Chile had sent to the region of San Pedro de Atacama. I was to show them the exact location of certain archaeological discoveries made on my past explorations through these parts. This never took place, however, since we were unable to meet each other in the field.

These notes have been arranged in two parts. They are: firstly, a synopsis of the trip with observations on what I have seen in the regions visited in chronological order; secondly, a systematic list and a discussion of the birds collected.

I do not pretend to list here all the birds of the Antofagasta range, but I have tried to discuss only what I have accomplished in these two months of exploration (June and July) in a region of Chile so little known in general and even less known during this rugged period of the year.

PART ONE

SYNOPSIS OF THE TRIP

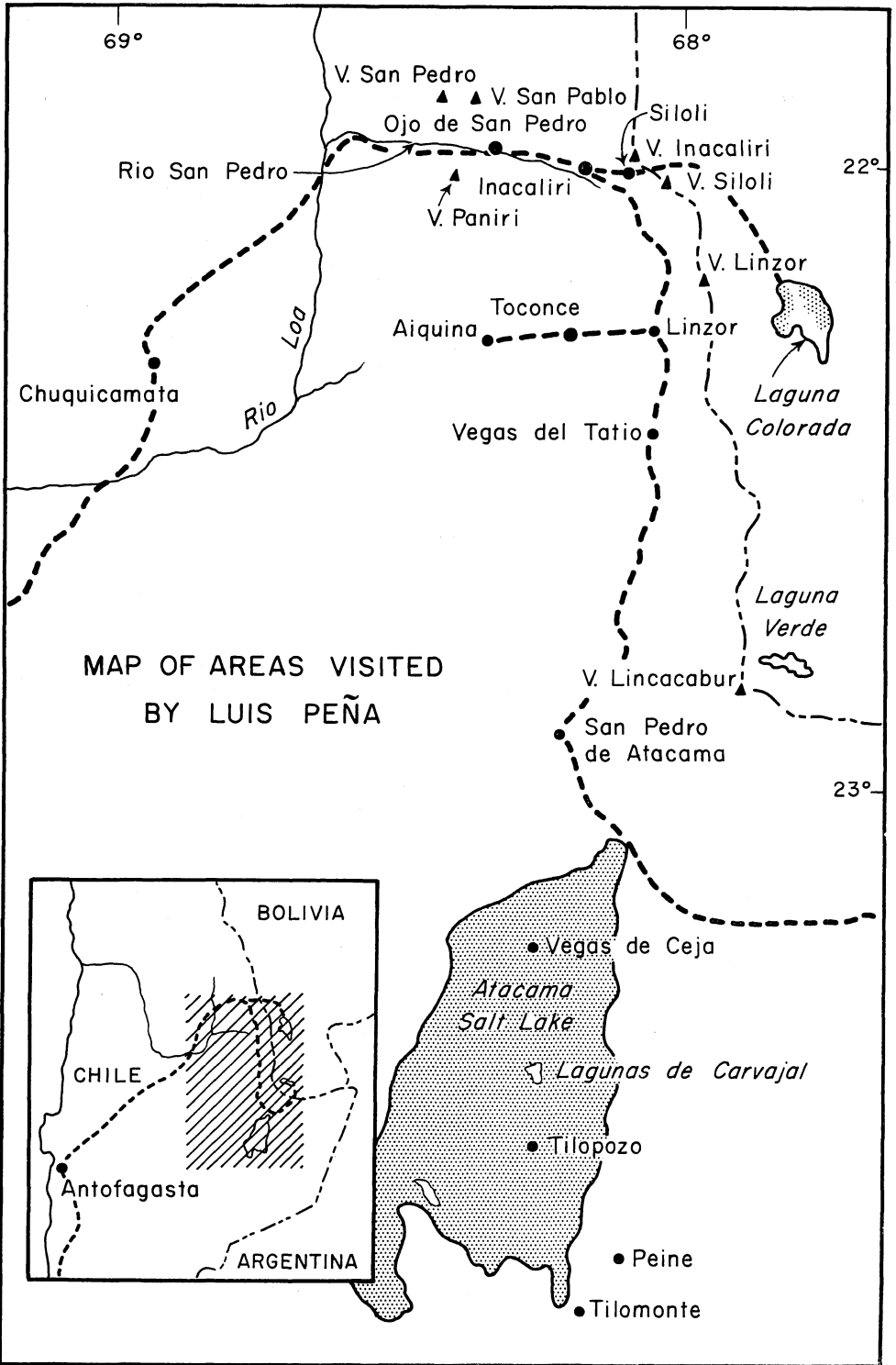
I left Santiago on July 6, 1957, in my jeep with a trailer provided by the Centro de Estudios Antropologicos of the University of Chile, and with my two assistants, Gerardo Barria Paredes and Herman Varas, for Domeyko, a little village located in the province of Atacama. Two days later I arrived at Chuquicamata where I was received by Mr. William E. Rudolph who arranged for everything I needed. Valuable information was obtained from Mr. Juan A. Rojas and Mr. Luis A. Flores about the roads and about the location of the



Phoenicopterus jamesi (Sclater)

flamingos which inhabit the mountains. I headed for Inacaliri from Chuquicamata where the Chile Exploration Company has some encampments. But on arriving at Lasana, a place located on the Loa River, I had more trouble with the trailer and had to return to Chuquicamata, leaving the encampment installed near Pucara de Lasana, one of the most important archaeological centers of the area. We finally left for Inacaliri on July 12. Before arriving at the San Pedro railroad station the road veers towards the south following the San Pedro River along the west bank. This river runs from south to north through the slope formed by the enormous San Pedro and San Pablo volcanoes. Just as I had feared, a heavy storm had broken out during the night in this region, and it was not too long before we ran into the first big patches of snow.

An enormous plain extends from the San Pedro railroad at 3,200 meters, going south in a gradual ascent until it reaches the Ojos del Rio San Pedro at 3,800 meters. This entire region is covered with "tolares," that is, fields in which the dominant plant is the "tola" (*Baccharis tola* Phil.). The drought had affected these fields enormously, and I tried without success to collect some insects from among the roots of the tola and the *Opuntia*. I found only the remains of some Tenebrionidae, of the genera *Praocis* and *Psectrascelis*, and some elytra of *Curculionidae*. A great many of the species of these groups spend the winter underground among the roots of the plants, waiting for good weather before coming out—a fact that has been proved on earlier trips to the Domeyko range and to the east of San Pedro de Atacama. In this entire stretch, I did not see a bird or any other living thing crossing our path. The Ojos del Rio San Pedro are fertile marshlands which begin at the foot of the San Pedro volcano. Generally speaking, the location of the source of a river or spring is called "ojo" (i.e., eye). Here in these lowlands I was able to observe many ducks and coots. I was not acquainted with the road, however, and hurried on, expecting to run into difficulties because of the previous night's snowfall. On arriving at Inacaliri, we were taken care of by the custodian of the dam which provides Chuquicamata with water. I spent several days in this place, establishing it



Map of areas visited by the author.

as a central point from which I planned to make trips to several diverse places: Ojos del Rio San Pedro, Cabana, Siloli, and Laguna Colorada (Bolivia).

INACALIRI: I stayed from June 12th to the 27th in this location, which is situated at an altitude of 4,000 meters. It is located in the neighborhood of the Inacaliri River and is flanked by a type of vegetation (*Festuca juncea* Phil.) used for pasture. On both sides there are thickish, vertically-cut stone palisades. These have an average height of some 40 meters and are inhabited by large quantities of rodents including vizcachas (*Lagidium viscacia*). It is not uncommon to find traces of the fox *Dusicyon* sp. as well. The tolas with their rounded hillocks are spread all over these walls.

In these surroundings one finds an undetermined species of *Opuntia* (Cactaceae) which forms very characteristic hemispheres and under which, on other occasions, I have found numerous examples of Coleoptera of various families. Some other plants which attract attention are: *Lampaya medicinalis* Phil., *Lepidophyllum quadrangulare* (Meyen) Benth. and Hook., and *Adesmia polyphylla* Phil. This last plant, when it blooms, is visited by species of Hymenoptera, and especially by bees of the family Megachilidae. There are also some species of grasses in these places, the most common of which is *Stipa venusta* Phil. As these plants dry, they leave an ever widening type of matting in the shape of a horseshoe, the edges of which are bordered by living plants.

This entire region is surrounded by volcanoes. To the north are the Colan peaks (5,500 meters) and the Inacaliri, more than 5,600 meters high, on the Bolivian frontier. Towards the south, one finds the Cerro del Leon, more than 5,700 meters high, and the open volcano Toconce with a height of almost 5,500 meters. To the east there is a chain of mountains over 5,500 meters in altitude which forms the frontier with Bolivia. Among them is the Silaguala string and the Cerro Silala, also called Siloli, 4,800 meters in height. To the west rises the majestic Paniri volcano. It borders on the Inacaliri River and, further on, the southern branch of the San Pedro. Close to 6,000 meters high, it is very similar in appearance to the

Toconce volcano. More towards the northeast are the brother volcanoes, San Pedro and San Pablo, each over 6,100 meters in altitude.

In spite of having looked diligently for insects, especially Tenebrionidae, I found nothing except some Circulionidae beneath the rocks. I was able to observe some Diptera flying among the few tolas in bloom. These were of the family Syrphidae belonging to the genus *Volucella*. The remains of Coleoptera were always found beneath stones and in the necks of plants. Close to 3,500 meters I found a species of *Praocis* (Tenebrionidae) in such bad condition that identification of species was impossible.



Inacaliri marshes and tolar region in the vicinity of my first base camp, 390 meters.

This entire region is uninhabited because of the extraordinary drought which had lasted for more than four years. As a result I was able to observe some birds, and examples of nearly all of these were collected. Close to the place of the same name, the Inacaliri River joins with the Cabana River

which comes from the south. Together they form extensive marshlands where llamas and burros may often be seen grazing. These marshes are almost permanently frozen and only on very hot days, so few during these months, can one see the water flowing. As in all the marshlands of the area, there is a hard and spiny grass here which forms a compact carpet occasionally broken by the water from small streams. This pasture grass is *Oxychloe andina* Phil. There is another species of plant called *Calamagrotis arundinacea* Phil. as well. Life in the water is meager. We found only some examples of Coleoptera of the family Elmidae. These constitute a part of the diet of the various species of birds which frequent these lowlands.

OJOS DEL RIO SAN PEDRO: As in the great majority of the origins of mountain rivers, the source of the San Pedro has formed swampy areas. The "ojos" of this river are at 3,800 meters altitude and are very near the base of the San Pablo volcano. Here are lagoons and stagnant backwaters bordered with vegetation. This growth is made up in particular of two kinds of plants. One of them is *Oxychloe andina* Phil., and the other is a fairly high straw-grass which forms little islands in places and is used by birds for nesting. To the north of these marshes there is a native settlement called Ojos de San Pedro. It is made up of a dozen houses constructed of stone, mud, and straw. On the outskirts of the village there is a large watershed of lukewarm water which is the actual source of the river. These people keep sheep, llamas, and burros. While the sheep graze on the banks, this is not so with the burros. They are often seen in the water, submerging their heads in order to bring up a type of water plant which grows there and which provides them with food.

Hunters have totally driven away the birds in this area. It is painful to see the quantity of cartridge cases of all calibers and kinds which one finds scattered over the landscape. The Ojos del Rio San Pedro is an ideal region for nesting ducks, coots, and flamingos. The south side of the marsh is very swampy and white in color like a salt marsh.

CABANA: This area is located on the eastern slope of the Cabana River just a few kilometers from the marshes of Inacaliri; that is, it is in the place where these rivers meet. The altitude is close to 4,000 meters, and the atmosphere is similar to that of Inacaliri which has the same plants but is much more open.

SILALA: Following the Inacaliri Pass towards the west, there is a place called Silala, or Siloli, close to the Bolivian frontier at an altitude of 4,250 meters. There is a sluice here and a hydraulic intake valve for all the waters which go as far as the city of Antofagasta. An expedition of the Chicago Museum of Natural History visited the place in 1924. Many interesting species of birds occur here.

LAGUNA COLORADA (BOLIVIA): I made a trip to this lagoon, one of the objectives of the expedition, since three species of flamingos inhabit the area. The Silala, or Siloli, Pass is nearby, at 4,550 meters. There is a fairly good vehicular road used



A view of the Laguna Colorada in Bolivia taken in a southwest direction from its extreme northeast, 4,400 meters above sea level.

by trucks which transport sulphur and esparta grass from Bolivia down to the railroad station at San Pedro for shipment by rail. This mountainous pass is guarded by two Bolivian policemen who live in decidedly bleak conditions. Past the frontier, the road leads south along the east side of the Silaguala chain. There are vast, smooth expanses there where herds of vicunas (*Lama vicugna*) graze. These animals are much persecuted locally by the Bolivian police as well as the native inhabitants, although Koford (1957), in his fine paper, feels that the vicuna population has remained relatively static recently.

Laguna Colorada, covering an area of nearly 20 kilometers square, owes its name to its coloration. We arrived and circled the lagoon until we came to a place where the water springs from the slope of the hill. The water is warm here as it flows into the lagoon, and I was able to wade barefoot. It was here that we observed and later captured some species of birds such as the "caiti" and the famous "parina chica." The warmer water was observed as a long and narrow strip which fades out towards the south end of the lagoon after a few miles. The lagoon itself is quite shallow. With my helper I went over the entire length of the warm water, and its greatest depth hardly reached 60 cm. The aquatic vegetation is notable where the water is warmest, that is, near the source at the slope of the hill. A small plant here, intensely green in color, covers the surface. Beneath the water there is a species of dark-green alga in which insects swarm. I saw a species of aquatic Hemiptera belonging to the family Notonectidae, very similar to and possibly of the same species which I collected in the Loyquis lagoon in a similar habitat. That lagoon is located deep in the interior of the range in the province of Antofagasta and is near the Argentine border. This hemipteran is under study at the University of Kansas. Thousands of Diptera were walking and flying over the water.

Laguna Colorada presents a fantastic spectacle difficult to describe. There are places where red-colored pools occur in the midst of sky-blue and gray water. The farther edge of the lagoon is red and white and has for a backdrop the snow-

covered mountains on the Chilean frontier. The periphery of the lagoon has all the aspects of a salt marsh, as do most of the Andean lagoons. It is formed from hundreds of little islands which are more or less one meter square and are surrounded by calm water. A straw-grass grows in these surroundings. The beauty of the place brings to mind the lagoon and even the salt marsh at Loyoquis, mistakenly called Quisquiro on our maps. I cannot be sure, but I believe that nearly all of the lagoon was frozen, with the exception of that part which was warmed naturally by the waters from the hot spring.

From Inacaliri, our first base camp, we continued towards the south, in part skirting the eastern side of the Cabana River and passing to the east of the Toconce volcano in order to reach our second base camp at Linzor. The entire region is identical, with tolas, ravines, marshes, and enormous hills, many of which had been very active volcanoes at one time. No living thing is discernible here except "llaretero" trucks which can be seen descending from time to time with their bulky loads.

After some hours of travel, we arrived at Linzor and reached the Chile Exploration Company's encampment. This was wonderfully fitted out for the studies which I had to make. We made several exploratory field trips from this base to Toconce, the Tatio Geysers, the Tatio Marshes, Ayquina, and the Turi Marshes. Everywhere we went we found traces of the expedition of Carl Koford, who had spent months with his family studying the fauna in the mountainous regions of Chile, Peru, and Bolivia.

LINZOR: The reservoirs which supply Chuquiámata with water are located at the source of the Toconce River, at some 4,100 meters altitude. The water is carried down by means of an aqueduct. The Government also takes advantage of the water in the ravine at this place, using the same type of pipeline transmission as the reservoirs to carry it down to some of the saltpeter refineries. Linzor is located southeast of the Toconce volcano. There is a good road from there to Chuquiámata passing near the outskirts of the village of Toconce and crossing the Turi Marshes.

The rivers which flow down from the mountains forming the Bolivian frontier have created marshlands in places. It is here that the birds gather, and it was here I especially came to look for them. The tolas are abundant everywhere in this region and "llareta," *Laretia compacta* (Phil.), was found in the vicinity of the camp. However, since they make excellent fuel, very few plants of this species are to be found that have not been used by man.

The proximity of the snow-covered mountains which separate Chile from Bolivia makes the climate rough. When I arrived at Linzor, I found a large part of the trail almost completely covered with snow. During my stay there the days were sunny, and the snow melted until there were only a few patches left in shady spots. Linzor is a splendid site for setting up a base camp. From here there are roads which go in all directions and paths which approach areas with special characteristics, whether they be valleys among the ranges and high peaks or marshlands and rivers. However, the flora cannot be appreciated in this weather, especially after such heavy droughts. This place has essentially the same characteristics as Inacaliri, except that there are llareta fields here. The river fauna is practically the same. Elmidae (Coleoptera) abound. My attention was attracted many times on seeing "naiads" of ephemeropterans in the waters of the river, and afterwards I was also able to see some examples of these primitive insects flying on their nuptial flight on a hot morning. This material is being studied by Dr. Demoulin of the Institut Royal des Sciences Naturelles of Belgium.

We still had hopes of returning to Inacaliri for a few days in order to revisit the Laguna Colorada of Bolivia, but it had snowed so much that it was impossible for me to attempt a new trip to that marvelous lagoon.

THE TATIO GEYSERS: The Tatio Geysers are located some 20 kilometers from Linzor and are at an altitude of 4,250 meters. On a plain surrounded by hills, dozens of steaming openings form part of the active crater of a volcano. These openings continue along the ravine and downwards, and all the spillways of salt and bitter waters join to form the Salado

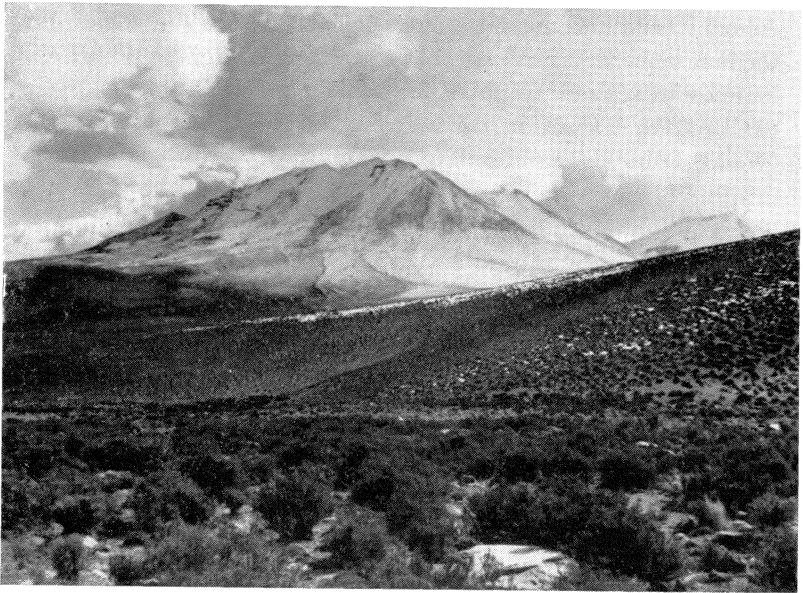
River which in turn meets the Loa River near the village of Chiuchiu.

We were able to visit this curious place three times, once staying the night in order to observe these fields at sunrise. At seven o'clock in the morning the scene is unforgettable. From hundreds of openings one may see columns of vapor rising to heights greater than 60 meters. This happens because of the intense cold at that hour (-14.5°C) which causes condensation. From time to time a breeze comes along and all the columns bend and undulate like serpents. As the sun comes out, the magnificence of the spectacle reaches its highest point, and little by little, as the sun rises, the columns of vapor disappear until at ten o'clock in the morning one may only see vapors coming from the most active openings.

On observing these escape valves close at hand, one may enjoy the sight of some very curious formations. The boiling waters in the interiors of the openings become activated in some cases every two to ten or more minutes to the point of leaping out to heights of a little more than half a meter. The salts in the waters form crusts of the most varied colors, in the shape of pearls in some cases or of superposed terraces in others. In many of the quieter openings beautiful lagoons have been formed, some of them up to 3 meters in diameter and quite deep. Their waters are of an extraordinary transparency, which contrasts with others where the water is muddy and from the interior of which slow bubbles of gas rise up. In many of these openings the plant and animal life is active enough. One can see fibrous aquatic plants and insects of the family Notonectidae which swarm inside. On top of the water one can see thousands of flies sliding around. The temperature in which life develops here is 30°C , in spite of reports of finding species there which live in waters of temperatures near boiling point. I also observed here larvae of the batrachian species, *Telmatobius halli edentatus* Capurro, 1954. It is very dangerous to approach these openings since the ground is liable to fissure, and one risks sticking a foot or leg into boiling water as has happened on past occasions. These geysers are in the middle of swampy fields. Birds were surprisingly scarce here.

On the first of these trips we had to return early, since on the trip up the snow drifted on the road, and twice we got stuck with our jeep. A species of "vizcacha" is very common in all these places, and several times they came out of their caves to within a few meters of where they were being observed.

TOCONCE: Coming down through the Linzor ravine through a winding road, we arrived at the village of Toconce, situated at 3,300 meters altitude. Enormous blocks of vertical volcanic



The Toconce volcano (5,500 meters), and to the right the Paniri volcano (6,000 meters). In the foreground may be seen a typical tolar which is made up of the tola plant (*Baccharis tola*, Phil.).

stones form immense walls full of cavities. All along the route one sees towers of a thousand forms—esplanades of stones which resemble great rivers of rock. The vegetation gradually changes until one arrives at the branch of the road which goes to Toconce. Between 3,500 and 3,800 meters I was able to collect the following dominant plants: *Verbena seriphioides* Gill. and Hook., *Fabiana squamata* Phil., *Baccharis tola* var. *lejia* (Phil.) Reiche, *Psila boliviensis* (Wedd.) Cabrera, *Ades-*

mia polyphylla Phil., *Lampaya medicinalis* Phil., *Fabiana denudata* Miers., and *Fabiana deserticola* Reiche.

The village is on the south slope of the ravine of the Toconce River and is not accessible by vehicle. In order to arrive there one must cross the river and then climb up a long, stony grade. At the bottom of the ravine there is an encampment which is occupied with the work involved in carrying the waters of this river to the city of Antofagasta. With this usurpation of their rights the cultivated fields of the natives will remain without sufficient irrigation, all of which has produced considerable quiet indignation.

The ravine is rich in botanical species. *Cortaderia atacamensis* Phil. grows in various places near the water. On the sides there are large quantities of Cactaceae. Among those which attract special attention there is a species of high spiny cactus which has been used from time immemorial for building, since its interior contains a rather hard and resistant wood. There are two or three species of *Opuntia* and a species of "sandillón" with red thorns. On the slopes the following plants are dominant: *Ephedra americana* Humb. Bon. ex Willd., *Baccharis rupicola* H.B.K., and *Atriplex axillaris* Phil. On the cultivated terraces there is an abundance of *Baccharis juncea* Desf., and *Fabiana deserticola* Reiche. There is also a rather common species of undetermined nettle whose flowers are visited very often by the only species of hummingbird that I saw. On the banks of the ditches one sees a very abundant species of graminaceous plant called *Bromus catharticus* Vahl.

In the enormous rocks which are in front of the village on the northern stream of the river, a waterfall has bored deeply and has formed a very narrow ravine which is shady and damp. There the ancient inhabitants of the village had constructed an aqueduct in the form of an arch. It was made of stones and the water ran on top, but nowadays it is not used. In this little ravine I collected a few plants which turned out to be: *Epilobium glaucum* Phil. var. *stenophylla* Reiche; a species of *Solanum*, undetermined because of being incomplete; *Polygonum australis*, Brongn.; and a variety (or possibly an undescribed species) of *Mutisia linearifolia* Cav.

The work which has been effected by the natives for making these lands workable is admirable. The construction of Inca-type terraces covers a large area. Corn, alfalfa, onions, garlic, and carrots are harvested, as well as a large variety of flowers. At this time there were gilliflowers and carnations.

From the archaeological point of view the outskirts of the village comprise one vast field of study. There are many dry stone walls, burial grounds, and granaries in the vicinity of the village. The granaries are still used to guard grain. They are circular constructions, approximately 1.5 to 2 meters high, made of stone, and with roofs of this material. On one side they have a little door about 30 x 30 cm.

Life abounds in the waters of the ravine. From beneath each stone lifted from the bottom of the river scurry dozens of naiads of Ephemeroptera and many larvae of Plecoptera. I was also able to observe other insect larvae, such as those of a micro-lepidopteran which makes its cocoon beneath the submerged stones. I have seen adults of this little moth on top of the stones of the river. I saw very few Coleoptera and the few that there were belonged to the family Elmidae. There are also great quantities of planarians on these submerged stones.

Among the few insects observed were the following: vespid wasps of the subfamily Eumeninae; some examples of adult Ephemeroptera; an abundance of flying Chironomidae (Diptera); some species of Silulidae (Diptera) which let themselves be seen from time to time circling around our faces. Only two examples of butterflies were observed: a lycaenid and a species of the family *Hesperiidae*, possibly of the genus *Hylephila*.

THE TURI MARSHES: Following the road which goes to Chiu-Chiu, one finds a large and extensive flat region which is bordered on the north by the Toconce and Paniri volcanoes and on the south by the Toconce ravine and the Salado River more to the north. This plain is called the Marshes of Turi. This flat land which is at an altitude of 3,100 meters is well-used by burros, sheep, and some mules.

On the eastern extremity of this plain the baths of Turi are to be found. Here a volume of warm water springs into a rustic pool and is used by the natives as a medicinal bath.

At the foot of the Paniri volcano there are three native ranches or groups of farms which are dedicated to agriculture. These are the villages of Cupo, Paniri, and Topain. In Paniri there are orchards, and corn, wheat, alfalfa, beans, and prickly pears are cultivated. In the others there are no orchards, probably because of the climate. In the vicinity of the Turi baths there is an interesting archaeological site perhaps more important than Toconce.

AYQUINA: From the heights of the ravine of the Salado River can be seen the ancient, picturesque village of Ayquina, elevated on the slopes of volcanic rocks at 3,000 meters altitude. Cultivation is carried out in fields constructed in the Incan manner; that is, on terraces equal to those in Toconce. Wheat, corn, alfalfa, and several species of vegetables and flowers are produced. The river has groups of typical Cyperaceae on its banks. In the marshy areas there is a type of compressed pasturage where llamas, goats, and burros graze. Some pear and pepper trees shade the village and the ravine.

The ravine contracts as it progresses east and is quite narrow, being sufficient only to let the small overflows through when they run during these months.

THE TATIO MARSHES: The waters which flow down from the heights such as the Tatio volcano, 5,300 meters in altitude, converge to form a ravine which is very wide at the beginning and very narrow afterwards. These waters flow from south to north and spill into the salt waters flowing out of the geysers forming the Salado River, which has a definitely volcanic origin. The wide area of the ravine is dotted by extensive marshes which are used by the inhabitants of Toconce, Ayquina, and Caspana as pastures. The situation is ideal for water birds, although only a limited number of species were seen, perhaps because this was the winter season. The waters of the marshes and the river were in large part covered with ice; nevertheless, many insects were found beneath the stones submerged in the river. I observed a large quantity of a species of beetle of the family Elmidae, perhaps the same which lives in Linzor. Some Diptera were flying over the surface of the water, and they

were found by the hundreds beneath the stones which were almost in contact with the water. I also observed some species of gammaridean amphipods.

From Linzor we continued south, following the road which runs parallel to the Bolivian frontier. We passed by the Tatio Geysers, the Tatio Marshes, to the west of the Putana volcano, and tried to reach San Pedro de Atacama on that same day, July 8. In the Tatio Marshes I observed a group of seven vicunas, normally so shy, grazing peacefully on the side of the road in spite of the fact that we passed them at a distance of scarcely 10 meters.

After several hours we reached the completely abandoned sulphur mines of Tatio. These mines are located in the marshes which are the source of the Putana River. Here we observed several flocks of ducks.

Then by mistake we took the wrong road, not a rare thing for those who do not know the region since there are dozens of tracks which were made by the workers of the sulphur mines and the "llaretales." We followed along the edge of the Putana River until we crossed one of its tributaries which came down from the east. From there we continued along the south side of the river and later began to go up an interminable hill. This was obviously an abandoned road, since we had to cross over landslides from time to time. It was impossible to turn back because the road was very narrow and bordered on the edge of a deep precipice. It was already night when we came to a small plateau in which enormous stones covered with the remains of llareta stood out everywhere. All the terrain was sandy and we saw dozens of tracks. We followed the trail which had been used most, but it ended, and, walking from one side to another, we found ourselves completely lost. This was at 4,200 meters and in the middle of the Llaretal del Carcanal. By luck there was plenty of dry llareta which served as excellent fuel, for it was bitterly cold. My assistant suffered a sharp attack of "puna," altitude sickness. On the following day, after heating the water from the radiator of the jeep, we retraced our steps to the marshes of the Putana River with the object of locating the road which would take us

towards San Pedro de Atacama, but once again we found ourselves on another llareta road with no possibility of turning around on the narrow path. After traveling several kilometers the road ended, and we were finally able to maneuver around in order to return. Around five o'clock in the afternoon and after crossing an enormous chain of snow-covered mountains at more than 4,300 meters, we succeeded in arriving at San Pedro de Atacama. We remained here from the 9th to the 14th of July. My intention was to explore some lagoons in the interior of the Atacama salt marsh with the object of studying the flamingos there which are absent at this season from the lagoons of the high ranges. We worked in Guatin, Laguna Verde (Bolivia), and the lagoons and marshes of Ceja in the interior of the Atacama salt marsh.

SAN PEDRO DE ATACAMA: To the north of the Atacama salt marsh and at an altitude of 2,440 meters there is a series of fertile oases among which the oasis of San Pedro stands out. This is a village of great historical importance which has always been one of the most attractive places for scientists who are especially interested in anthropological and archaeological studies. The soil of this oasis receives weak saline water which comes from the eastern hills.

One of the outstanding sights here is that of the immense chain of mountains and volcanoes which extends from north to south, and which serves as a background when, looking towards the east, the Putana volcano, 5,700 meters high, stands out, followed by the Sairekabar mountain with an altitude of 6,000 meters. There is also the marvelous volcanic cone called Licancabur, approximately 6,000 meters in altitude, where Inca ruins have been found at the summit and at the foot of which there are vast unexplored remains. Beyond lies the Juri-quez volcano, 5,700 meters; the Purico, Hekar, and Potor volcanoes; Laguna Verde; and the enormous Laskar volcano with its steaming crater. Farther to the south is the Tumisa volcano, 5,500 meters; the Miscanti mountain, 5,600 meters; Miniqui, 6,000 meters; and the immense Pular with a height of more than 6,200 meters. In the distance lie the snow-peaks of Socompa and Llullaiyaco. Towards the west the arid Do-

meypo range extends, with the single legendary peak of Cerro del Quimal, on the summit of which I have also found ruins.

As soon as we arrived at San Pedro de Atacama, I went to see Father Gustavo Le Paige, the parish priest of this area who has amassed valuable study material into a small archaeological museum.

LAGUNA VERDE: On the eastern side of the Licancabur volcano, to the north of Juriquez volcano, and at 4,100 meters altitude, the Laguna Verde spreads out. It owes its name to the beautiful emerald-green color of the water. It almost has the form of an isosceles triangle. Vegetation is very spare all over the area, consisting of bunches of straw-like grass, possibly of the species *Stipa venusta* Phil. As in all Andean lagoons, the shores are covered with a white earth giving the effect of a salt marsh.

Nearly all the lagoon was covered with a thick layer of ice with the exception of a part of its eastern side. At the extreme northeast of the lagoon there is a spring of hot water which prevents complete freezing. This place is used by some birds as a wintering area. I saw about 160 grebes as well as 36 horned coots. On a previous trip in February with my friend Gerardo Melcher from the University of Chile I had seen a quantity of flamingos which were now nearly absent except for one pair of immature specimens. This observation added to those made in the Laguna Colorada (Bolivia) and the data gathered from the inhabitants of the region supports my theory that the flamingos migrate to milder climates such as the Atacama and the Punta Negra salt marshes in the winter.

The wind from the northwest began to rise a little before eleven o'clock in the morning, and shortly after noon it was already unbearable, making big waves on the part of the lagoon which was free of ice. In this period (July) it snows intensely, and in order to succeed in reaching the lagoon it was necessary to cross huge patches of snow.

GUATIN: From San Pedro de Atacama, following the same route to the northwest, there is a place with cultivation located at about 3,500 meters above sea level and with waters originat-

ing from the Puritama baths not far distant. Guatin is an extension of artificially watered pastures which are used for the cultivation of a curious variety of corn of great yield and which has become acclimatized to these altitudes and to the saline waters. Alfalfa is also cultivated there. On the river bed there is an exuberance of vegetation. The entire area indicates ancient habitation, as has been proven by Father Le Paige with his archaeological discoveries.

On the slopes there is an abundance of tola and a large quantity of cactus of the genus *Opuntia*, as well as other types.

SALAR DE ATACAMA: Between the ranges of the Andes and those of Domeyko, and divided through the middle by the Tropic of Capricorn, extends the Atacama salt marsh. In area it is close to 2,700 square kilometers, and its appearance, observed from the air at an altitude of 2,000 meters, is that of an immense white plain dotted with occasional mounds. In its depressions there are lagoons of the most diverse colors, greenish blue being the dominant. From the air one perceives semi-circles which seem to be salt formations and give an appearance of snowdrifts.

On reaching the surface level the appearance is totally different from that observed from the air. Only an immense plain can be seen, bordered by mountains on all sides. Advancing towards the interior of the swamp, the trees disappear. The swamp is dominated in parts by a halophytic species of pasture grass. Here nitrous formations jut out of the ground in irregular shapes, making walking very difficult. Little by little the grass disappears. The salt excrescences have diverse forms. In some cases they are snow-white and form tiny spheres. In others the ground is like a checkerboard divided into polygons, the angles of which are made up of walls of salt crystals which stick out somewhat in the manner of chains no more than 10 cm high. These formations originate generally in the areas around the waters which are in the salt marsh. I observed the hard nitrous excrescences which jut out to 50 cm from the ground at the edge of the area of vegetation.

The lagoons are not very deep in general. The bottom is of a soft, smooth, slippery material which has been precipitated

very slowly. This is formed of layers of different colors: green, white, yellow, rose, and black, perhaps due to fungus and other vegetable matter which has found an ideal environment for growing. I noted that the bottom surface of these lagoons was always whitish in color. It seems probable that the guano of the birds which abound there plays an important part in the growth of certain material. There are tongues of saline structures below the surface of these lagoons which have the most capricious forms.

In January, February, and sometimes March, the waters of the salt marsh increase; they increase again during the season of snowfalls and rain in the range, i.e., June, July, and August. I believe that a study of the plankton of these waters will be very rewarding. The east side of this marsh has never been visited by a scientist. Here there are extensive unknown lagoons, grasslands, and strange salt formations.

MARSHES AND LAGOONS OF CEJA: With a very strong north wind blowing, my assistant and I, riding on mules, penetrated the northern Atacama salt marsh on July 13. Going in a southerly direction and in a straight line towards Socompa volcano which could be seen on the horizon, we should have arrived at a little path which would take us to our destination, the Tebenquiche lagoon. When we had once abandoned the tree area, we entered extensive fields. Everywhere were the burrowings of a rodent, possibly of the genus *Ctenomys* known in the region by the name "ucultur" or "tunduco." Here salt water lies about 5-10 cm below the surface.

With an unbearable heavy wind blowing behind us, we arrived, after two and a half hours of intermittent galloping, at the marshes and lagoons of Ceja. There we left our mounts, as the mules sank up to their hocks in very sticky, gray mud. The waters of these lagoons are quite salty, but in the neighborhood there are some wells opened by the inhabitants who from time to time pasture their cattle in these remote regions. This water, though not sweet, is potable.

Very few birds were observed. Some flamingos flew off at our arrival. Only one flamingo was captured, and it turned out

to be the common species which we know in the central zone of the country. The others flew off to adjacent lagoons.

It was impossible to get to Tebenquiche lagoon, the largest in the salt marsh, since we would have needed perhaps two more hours of walking. My greatest fear was to lose our way because of the dust and gravel clouds which hindered our sight. This nitrous dust cloud blasted our faces and the mules, sometimes making movement almost impossible. The gusts of dust would pass, losing themselves in the distance, only to return a few moments later. They could be seen coming as dark, dragging clouds, and at times it was difficult to have to put up with them. Our eyes suffered terribly, since we were not provided with adequate protection. All the plants collected disappeared in the midst of a series of gusts, and we did not have the spirit to get down and round them up again.

We arrived back at San Pedro de Atacama when it was completely dark and found that our helpers were preparing to set out to look for us.

On July 16 I left for Talabre, a ravine which runs parallel to the one at Hekar, beginning at the eastern base of the Laskar volcano in the marshes of Salta and Tumbre. In this ravine alfalfa is cultivated, and the family which lives there has flocks of sheep and llamas.

In Talabre I found my good old traveling companion, Fabio Soza, with whom I have explored these regions on several occasions; he is a man who knows all the corners of the Andes. He had some insects which he had collected for me, among which were species that were only recently described on the basis of specimens collected in those regions. All were Tenebrionidae and Curculionidae. Among the first were examples of *Entomochilus varius laevis* Kulzer, *Physogaster nitidus* Kulzer, and *Psectraselis intricaticollis* Fairm. Also among the insects collected by him were examples of vespid wasps and six examples of one of the most extraordinary species of Andean butterflies, already observed by me in the Salar de Pujsa in December, 1952. It is a subspecies of *Argyrophorus lamna* (Satyridae) which will be described by Dr. Ureta.

This butterfly flies from Pujsa to Aguada de la Perdiz, to

the east of the Salar de Aguas Calientes, a place near the Argentine Frontier. The species is very difficult to obtain since its flight is so rapid, and because of the height of its habitat, close to 4,300 meters, it is almost impossible to run in order to capture it.

With Fabio Soza as our guide, we returned to the camp left in Aguas Blancas and continued the trip south in order to visit the Carvajal lagoons situated in the Atacama salt marsh on its eastern side: Peine, Tilomonte, and Tilopozo.

CARVAJAL LAGOONS: Using the jeep, we entered the Atacama salt marsh on the east side as far as the muddy ground permitted and set up one kilometer from the Carvajal lagoons. On looking over the lagoons with binoculars, I could see hundreds of flamingos in the water. I could clearly see three different species, among which was a small white form which turned out to be a female "parina chica," *Phoenicoparrus jamesi*. On entering the lagoon we found the remains of the flamingo nests. There were dozens of mounds of white mud, already much worn but still sticking out of the water a few centimeters.

On the following day, we collected a pair of *Phoenicoparrus jamesi*.

PEINE: At an altitude of 2,300 meters on the western slope of the mountains which come down by the Atacama salt marsh is located the village of Peine. It is in the middle of very ancient, abandoned ruins. Surely some of them belonged to that culture and people known as Atacamena, who spoke the curious Kunsu language. This village lived in total isolation from the rest of the country, and the inhabitants were farmers. There is a profusion of "algarrobo" (Mimosaceae) here. The "chanares" (Papilionaceae) trees were slightly green as it was mid-winter. Corn, wheat, and alfalfa are cultivated principally. In the distance groups of flamingos were observed on the Peine lagoon flocking in large numbers to the center of the water. During the summer months this is the favorite place for nesting. The inhabitants of the village gather the flamingo eggs from miles around and pack them in boxes which are then



Male example of the "parina chica" (*Phoenicoparrus jamesi*, Sclater) collected at the Laguna Colorada (Bolivia).

carried on burros towards San Pedro and sold there. Last year it was calculated that they had extracted approximately 10,000 eggs. It is reported that the flamingos lay a single egg in each nest. When this is removed, the birds will lay a second and finally a third during the nesting months of December and February. It appears that flamingos do not nest here every year.

TILOMONTE: The oasis of Tilomonte is towards the south and in the middle of the desert, near Peine. It is a true forest of "algarrobo" and "chanares" in the middle of a plain where corn and alfalfa are cultivated, irrigated by the salt water of the ravine.

TILOPOZO: On the extreme south of the Atacama salt marsh there is a large area of marsh covered with grasses. We traveled as far as the Banos de Tilopozo which spring from a hot-water overflow. This place must be ideal for birds during the summer nesting season, but they are now absent. The

hurricane-force wind made continuing with the jeep impossible because of the hail of sand and rock which had already heavily scratched the windshield.

We returned to Santiago on July 26 after a fruitless visit to the salt marshes of Pedernales and Maricunga, more than 250 kilometers to the south of Atacama. Flamingos do nest on these marshes in the summer months.

PART TWO

ANNOTATED LIST OF BIRDS COLLECTED OR OBSERVED

The list of birds reported here includes observations made in December, 1957, and in January, 1958, on a second visit with Dr. Roger Tory Peterson. Specimens collected are now in the Peabody Museum at Yale University. A series of our material is also in the collection of the Museo Nacional de Historia Natural of Santiago.

Pterocnemia pennata tarapacensis Chubb

Several pairs were observed in Inacaliri at 3,900 meters, and on the Turi pampa (3,100 meters). One specimen was captured by persons from Inacaliri and carried to the San Pedro station with the object of removing its fat, since it is highly desired as a remedy for rheumatism and arthritis. Before this, however, I took the following measurements: length from the point of the bill to the end of the tail, 144 cm; wing, 50 cm; bill, 7.2 cm; tarsus, 33 cm.

On examining the contents of the stomach, I found it replete with roots and thick stems of the tola.

Tinamotis pentlandi Vigors

This species of "partridge" is somewhat frequent in the high regions of the Antofagasta range between 3,500 and 4,500 meters. A slightly wounded specimen attacked me by flying against my face as I approached to photograph it at a distance of 3 meters; later it fled, tossing off a large quantity of fetid excrement. An example was captured in Inacaliri at

4,000 meters altitude. A small flock was observed on the Tatio volcano at 4,400 meters.

Phoenicopterus chilensis Molina

The Chilean flamingo is common in the central zone of Chile. It is found in the lagoons of the north where it is known by the name of "tococo." The specimen taken came from the lagoons of the Ceja marshlands, situated in the interior of the upper sections of the Atacama salt marsh approximately 30 kilometers to the south of San Pedro de Atacama. It was a solitary bird.

Phoenicoparrus andinus (Philippi) Bonaparte

At Ojos del Rio San Pedro two immature specimens of this "parina" were captured, locally called "hiticti." Birds were observed in the Ceja lagoons and in those of Carvajal, situated in the interior of the Atacama salt marsh. At night they could be heard calling, and it is at that hour that they move from lagoon to lagoon. It is difficult to distinguish them from the "parina chica" (*Ph. jamesi*), when they are in their habitat, since it is impossible to approach them, and their coloration and size is very similar.

Phoenicoparrus jamesi (Sclater)

One of the objects of this expedition was to study this rare flamingo. No one has had recent news of this species. In 1957, Dr. Francisco Behn, in company with Mr. A. W. Johnson and Mr. Guillermo Millie, had traveled in these areas with the sole object of finding this bird and making studies of a biological character (Johnson, Behn, and Millie, 1958). They succeeded in capturing a female example and obtained several nests of eggs, all in the Laguna Colorada of Bolivia in the month of February, 1957. In the same place, situated a few kilometers from the frontier, I succeeded in capturing an adult male example and two immature specimens. The population was reduced. I was only able to see 7 adults and about 20 nestlings already old enough to fly. The adults were extremely shy; not so the young ones which walked about tranquilly scarcely

10 meters from us, as we, with the water a little bit below our knees, were exploring the lagoon in the region not affected by ice. Later on, in the lagoons at Carvajal to the east of the Atacama salt marsh and in front of the Hekar or Camar ravine, we succeeded in capturing another example.

This "parina," called "chururu" by the inhabitants, is probably not as rare as had been thought previously. Many times my attention was called to the fact that the mountain lagoons were almost completely deserted by birds, according to information received from the inhabitants. However, the flamingos were abundant in the Laguna Colorada during the summer and nested there. This was proved by Dr. Behn, although his calculation for the species was low, 6-8% of the total of 3,000 birds of 3 species seen (*tom. cit.* 1958: 296).

With the object of studying the possible movements of the species about the Atacama salt marsh area, I traveled among the lagoons of the interior observing an immense quantity of flamingos in a number almost impossible to calculate. But, in view of the quantity of little lagoons which exist in this vast region, I cannot make any firm estimate of this population. Unfortunately, I was not able to go as far as the Punta Negra salt marsh which is south of the Imilac railroad station. I was assured that flamingos nest there by the thousands during the months from December to February. It seems to me that the Atacama salt marsh is the nesting center and the place in which the majority of the flamingos spend the winter.

These flamingos are vagrants. The mountain lagoons freeze, though not entirely, since nearly all of them receive hot springs. But the influence of hot water is only felt in a limited space, as I had observed in the Laguna Colorada (Bolivia) and the Laguna Verde. These birds migrate to salt-water lagoons of a better climate such as the Atacama salt marsh. Some specimens maintain themselves in the Andean lagoons, but they are always isolated.

In the entire region the people who know about the "parinas," including the natives who spend the summer on the Laguna Colorada as well as the people from Toconao, Peine, and Socaire, who live for a part of the year on the eggs of these birds, distinguish four well-defined species of flamingos

and "parinas." They have a name for each, taken from the call which the birds emit. The first is the "tocoço" (*Ph. chilensis*), the common species which is also found in the central region of Chile. The second is the "hiticti" (*Ph. andinus*) which is more reddish in color than the first one and larger in size. Its call is very similar to its name: "hi-ri-ri-ri-ri-ri." The third one is the "chururu" (*Ph. jamesi*) which is the species that was thought to be the most scarce and turns out to be the most abundant. Its characteristic call is "chu-ru-ru-ru-ru-ru." The fourth is a species which we have not been able to locate. In my opinion it comprises young examples of *jamesi*. On various occasions I was able to hear its call of "huj-cha-ta-ta."

Upon observing the stomach contents of these birds (*Ph. jamesi*), I found only some mud of greenish-yellow color mixed up with fine sand. Under the microscope I could see that the contents represented a compact mass of diatoms, which agrees with the observations of Dr. F. Behn.

Phoenicoparrus jamesi is a common enough bird, as are all the "parinas" and flamingos of the Andes. It is very difficult to observe and capture, however, since it is very shy. It nests on the Laguna Colorada of Bolivia and almost positively on the Andean salt-water lagoons such as the Pujsa salt marsh and the Loyoquis salt marsh. According to the word of the people of the region, it lays eggs three times a year.

A second visit to Laguna Colorada made by Dr. Roger Tory Peterson and myself from December 20-27, 1958, adds to our knowledge of the relative abundance of the three flamingo species. During the second visit the observed ratio of flamingos was:

<i>Ph. jamesi</i>	no less than 7,000.
<i>Ph. adinus</i>	300.
<i>Ph. chilensis</i>	100.

This compares with the figures of Johnson, Behn, and Millie for January, 1957 (*tom. cit.* 1958):

<i>Ph. jamesi</i>	40 to 50.
<i>Ph. adinus</i>	1,500 approximately.
<i>Ph. chilensis</i>	1,500 approximately.

Chloëphaga melanoptera (Eyton)

I have observed this species always in pairs at altitudes of 3,500 meters (Ojos del Rio San Pedro) to 4,250 meters on the marshlands which are the sources of the Salado River; that is, the Tatio Geysers. It was not possible to capture examples.

Lophonetta specularioides alticola (Ménégaux)

This is perhaps the most common duck of the mountain marshlands which were explored. I observed it from 2,400 meters to 4,400 meters in Chile as well as in Bolivia. It nearly always travels in pairs and is rarely seen in flocks (the ravine of Pastos Largos, Atacama). It is known as the "pato rial" and is very much desired on account of its flesh and size. It is easily distinguished because it is much larger than the other ducks with which it lives.

Anas versicolor puna Tschudi

Rare in the region explored; I observed some examples only in the Ojos del Rio San Pedro (3,800 meters) and in the Laguna Colorada of Bolivia at 4,400 meters.

Anas flavirostris oxyptera Meyen

A common duck on the Inacaliri marshes and on the Ojos del Rio San Pedro. They were observed in flocks of from 15 to 30 examples. It was also seen on Laguna Colorada, Bolivia, at 4,400 meters; Tilopozo (2,400 meters); the Putana River; and the ravine of Pastos Largos, this last in the province of Atacama.

Fulica americana peruviana Morrison

Very common in the Ojos del Rio San Pedro where it is persecuted by hunters.

Fulica cornuta Bonaparte

This rare species is known only from the high ranges of the Andes. It is called "huari" or "socar" by the natives.

Very little is known about its habits. I observed 36 examples on the Laguna Verde at 4,100 meters. They were all swimming on the eastern side of the lagoon, since the water there is always temperate. The rest of the lagoon was frozen over with a thick cap of ice. It was very amusing to see these birds emerge from the water and try to walk on the ice, while attempting to fly. It was impossible for them to maintain their footing on the frozen surface. They lived there in common with a large group of *Podiceps occipitalis juninensis*, some pairs of *Lophonetta specularioides alticola* and *Anas flavirostris oxyp-tera*. Three examples were captured and were weighed as follows: ♀, 4 lbs.; ♂, 5 lbs. 12 oz.; ♂, 5 lbs. 5 oz.

The color of the bill is yellow, with greenish-olive tints. Towards the base it is somewhat reddish and the upper part of the culmen is black. The feet are greenish-black with some yellow. The iris is red.

All of the examples which were observed had fully developed caruncles. On opening their stomachs, I found little food, and this was made up of aquatic grasses which abound in the temperate parts of the lagoon. Most of the stomach contents consisted of volcanic sand.

In a little lagoon near the Laguna Verde (Bolivia) the remains of the nests of these *Fulica* were seen. For a description of the nests farther south see Ripley (1957 a and b), and Behn and Millie (1959).

Oreopholus ruficollis (Wagler)

Flocks with numerous specimens were observed in the marshlands of Turi at 3,200 meters. They were extremely shy. They flew in more or less compact groups and at a distance of more than 200 meters. They are known by the name of "chuchúri" or "tiutila."

Charadrius alticola (Berlepsch and Stolzmann)

A relatively scarce bird which was observed only in the Inacaliri marshes (4,000 meters). It was abundant at the Tatio volcano (4,250 meters) and was even more common in the

Atacama salt marsh, on the Carvajal lagoons, and the marshlands at Ceja.

This plover was seen running after food on the muddy little beaches which are formed at the shores of the salt marsh lagoons.

Phegornis mitchellii (Fraser)

It is known as "pijlulo" by the inhabitants of the Inacaliri region. Only two examples were observed in the Inacaliri marshes at approximately 4,000 meters.

Capella paraguaiiae innotata Hellmayr

Only one snipe was observed in the marshes of Inacaliri. It flew off at the moment my foot was about to crush it. According to what I was told, it is quite common during the summer months.

Recurvirostra andina Philippi and Landbeck

The "caiti," known in the region as "caichón," is frequently found in the salt-water lagoons and lowlands of the Andean region. The two examples obtained are immature and come from the Laguna Colorada. At that place there were small groups of three to seven specimens resting on the warm water of the lagoon, since the rest of the water was frozen. This friendly little bird was also observed in the lagoons of the marshes of Ceja and Carvajal in the interior of the Atacama salt marsh (2,400 meters).

Thinocorus rumicivorus rumicivorus Eschscholtz

Two examples were taken in June while the camp was being set up in the desert region in front of the village of Domeyko in the province of Atacama. It is a bird which abounds in the region.

Thinocorus orbignyianus orbignyianus

I. Geoffroy St. Hilaire and Lesson

The "puco-puco" or "poco-poco" is very common in all of the marshes explored; it was observed between 3,800 and 4,300

meters. It is always seen in little flocks of three to eight. It is elusive, hiding itself among the crevices where the water from the marshes runs, always with its head sticking up. As soon as it takes flight, it utters a characteristic cry.

Larus serranus Tschudi

The "gaviota" is frequently found in all weather in the lagoons of the high ranges of the Andes. An example was observed in the Laguna Colorada of Bolivia (4,400 meters) living with "caitis" and "parinas." Others were seen on the lagoons of Carvajal and the marshes of Ceja in the interior of the Atacama salt marsh (2,400 meters). All were wearing their faded winter plumage.

Zenaidura auriculata auriculata (Des Murs)

This dove, so common in the central zone of the country, had not been captured previously in Antofagasta. In San Pedro de Atacama it is extremely abundant during the winter months. Several flocks were observed in Toconce as well as in the high desert zone of Paposo (the southern coast of the province of Antofagasta). An example was secured from Toconce (3,030 meters).

Metriopelia melanoptera melanoptera (Molina)

An example was collected in Lasana on the banks of the Loa River.

Psilopsiagon aurifrons orbygnesi (Souancé)

Several flocks of "caturros" were observed in Inacaliri (4,100 meters), in Toconce (3,030 meters), and on the outskirts of the Talabre ravine (3,200 meters). It is a rather common little parrot which nests in the area.

Crotophaga sulcirostris sulcirostris Swainson

I was surprised to find an example of this bird in Peine because it had to cross so many kilometers of desert area to

arrive there. I observed it among the branches of a Bolivian pepper tree which is near the public square. According to what the natives told me, this bird had arrived there at the end of the month of March. It was not captured.

Oreotrochilus estella d'Orbigny and Lafresnaye

Common in Toconce where some examples were collected. They are to be seen in cultivated areas visiting the flowers of the nettle "ortiga."

Geositta isabellina (Philippi and Landbeck)

This species, so rare in collections, was observed on the outskirts of Potrerillos in the province of Atacama while I was on the road to the salt marshes of Pedernales. It has only been known previously from the province of Coquimbo further south.

Geositta punensis Dabbene

Very common in several places between 3,200 meters and 4,300 meters. It is found most frequently around houses and in the regions of the tolas. It is known by the name of "roilita" (Talabre). Some examples were taken on the outskirts of the Turi marshes (3,100 meters) and in the tolas of Inacaliri.

Upucerthia dumetaria hallinani Chapman

A rather common species which is difficult to capture because it is very shy. Examples were observed in Ayquina (3,030 meters), Guatin (3,500 meters), Peine (2,400 meters), and San Pedro de Atacama (2,400 meters). It is always seen traveling over the sown and cultivated terraces. It emits a strident and characteristic call. It is commonly known as the "lucho-lucho" (Toconce) or the "lichi-lichi" (Talabre).

Upucerthia ruficauda (Meyen)

This bird is quite rare. It frequents the tolas where a few examples were seen. It was observed in Linzor (4,100 meters) and Inacaliri (4,000 meters).

Asthenes modesta modesta (Eyton)

Common above 3,500 meters, it was observed among the tolas. It is frequently seen on rocks and on the ground searching out its food. It is very easy to capture since it allows one to approach to within a few meters. The vulgar names given to it in these regions are "pipo," "lucho-lucho," and "cacique" (Peine).

Leptasthenura aegithaloides berlepschi Hartert

Known as "tijerita" or "chiriviri" (Talabre) and as "quiron" in Peine, it is a very common little bird between 2,400 meters (San Pedro de Atacama) and 4,100 meters (Linzor). It frequents cultivated fields and the regions of the tolas. It is always seen among the shrubs searching out food.

Cinclodes fuscus albiventris (Philippi and Landbeck)

Very common in the marshes and rivers in Inacaliri (4,100 meters), the Ojos del Rio San Pedro (3,800 meters), Silala (4,200 meters), Vegas del Tatio (4,300 meters), Toconce (3,300 meters), Guatin (3,500 meters), Peine (2,400 meters), and the Laguna Colorada of Bolivia (4,400 meters). It is extremely tame; the natives call it "requete chico" (Toconce), "alcalde," and "itirico" (Peine), and "sapero" (Talabre). It lives in some places with the congeneric *C. atacamensis atacamensis*. In observing the stomach contents of some samples, we found insect larvae, possibly of Lepidoptera Heterocera, and many remains of aquatic vegetation.

Cinclodes atacamensis atacamensis (Philippi)

Less frequent than the previous species. Several examples were captured in Toconce (3,300 meters), Linzor (4,100 meters), and Silala or Siloli (4,300 meters). No examples were observed in Inacaliri (4,100 meters). In an example taken in Linzor, I found remains of coleopterous insects of the family Elmidae, so common beneath the stones submerged in the streams. There were also little stones and an uncountable number of little snails of the genus *Littoridina*.

Agriornis andicola albicauda (Philippi and Landbeck)

The "gaucho" is one of the rare species which with luck may be observed from time to time. It has only been found in Putre in the interior of the province of Tarapaca, Department of Arica. A specimen from Linzor was collected on the outskirts of the Ojalar River at an altitude of 4,100 meters.

Agriornis montana maritima (Lafresnaye and d'Orbigny)

Examples were observed in Inacaliri (4,000 meters) and in its immediate environs. In Linzor (4,100 meters) it seems to be more common, though not so in Toconce (3,300 meters) where it was rather scarce.

The stomach contents of one of the examples was composed of the seeds of the prickly grass (*Oxychloe andina* Phil.) which grows in the swamps and marshes, the remains of a chrysidid hymenopteran, and a species of Diptera (Syrphidae, genus *Volucella*). In a female example captured in Linzor I found its stomach full of the same seeds, water plants from the streams, and the remains of insects which were impossible to determine. In another male example I found seeds and a wing-bone of a small bird. In Peine I observed a "gaucho" in the process of killing a small mouse.

These birds frequent the tolas, the shores of streams, and marshes.

Muscisaxicola rufivertex pallidiceps Hellmayr

Known as "fraile" or "cura," it is one of the most characteristic birds of the traveled regions. It is quite common between 3,300 meters and 4,250 meters. It frequents the marshlands and streams in search of food.

Muscisaxicola capistrata (Burmeister)

As common as the previous species and with very similar habits. Examples were observed in all the places visited from 3,200 to 4,250 meters. This "fraile" dwells in Patagonia and in Tierra del Fuego and spends the winter in the ranges to the north. All of the examples had very faded plumage.

Muscisaxicola maculirostris maculirostris

Lafresnaye and d'Orbigny

Called the "fraile chico," it is very common in Ayquina (3,030 meters). It has been observed running on the cultivated terraces and on the shores of running waters. In San Pedro de Atacama (2,400 meters) ground-tyrants were observed in the fields cultivated with alfalfa.

Lessonia rufa oreas (Sclater and Salvin)

Only one example was captured at the Ojos del Rio San Pedro (3,800 meters), even though some pairs were observed in the marshes which form the streams which are the sources of the San Pedro River. Few examples were observed in the lagoons of Carvajal in the interior of the Atacama salt marsh.

Anthus correndera catamarcae Hellmayr

I observed this subspecies of "bailarin chico" in the marshlands of the Ojos del Rio San Pedro, 3,800 meters; also, in a lesser quantity, in the marshlands of Ceja, which are in the interior of the Atacama salt marsh at 2,450 meters; and in great abundance at the southern extremity of the same salt marsh at the location of the Tilopozo marshes. They are always found in humid places among the tall grasses where they hide, making their capture rather difficult. It is a rather shy little bird.

Troglodytes musculus atacamensis Hellmayr

Common in the thickets of San Pedro de Atacama between 2,400 and 3,300 meters.

Turdus chiguanco anthracinus Burmeister

This species of thrush, very common in Bolivia and Argentina, has been sporadically collected in Chile. Its nesting had never been observed before in Chilean territory. On this trip I was able to observe numerous examples in the valleys of the Loa (Lasana) River. In San Pedro de Atacama, where it is

known as "lachirachi," it is extremely abundant, as it is also in the oasis of Toconao (2,400 meters). According to information given by the natives, I was assured that they nest there.

Passer domesticus domesticus (Linnaeus)

The "gorrion" has now arrived at the village of San Pedro de Atacama, with its usual instincts of destruction towards the small autochthonous birds.

Phrygilus atriceps (Lafresnaye and d'Orbigny)

I found this beautiful fringilline in abundance in Toconce at 3,300 meters. Some examples were captured on the outskirts of Linzor (4,100 meters). They also abound in Guatin, a place located to the northeast of San Pedro de Atacama at more or less 3,500 meters altitude. They always travel in small flocks. The female is much rarer than the male, and we were able to capture only one example in Toconce. It is a harmful bird since it destroys vegetables and eats corn, wheat, and oats, especially when they have not yet matured. It is vulgarly known by the name of "comesebo." In Talabre it is called "chasca."

Phrygilus unicolor unicolor (Lafresnaye and d'Orbigny)

Only a few examples were observed, both in Siloli (Silala) at 4,200 meters and in Toconce (3,300 meters). An example was observed in the Laguna Colorada and another in the Laguna Verde, both in Bolivia.

Phrygilus dorsalis Cabanis

This rare little bird, known in Chile by only two or three examples found in these ranges, turns out to be extremely common and numerous specimens were observed and captured. The "sulte," as they call it in some places, was observed in Inacaliri (4,100 meters), Silala or Siloli (4,300 meters), the Tatio Geysers (4,200 meters), Linzor (4,100 meters), and Laguna Colorada in Bolivia (4,400 meters). I understand that

it abounds in Tumbre, a place to the northeast of the Laskar volcano at an approximate altitude of 4,000 meters, where I was assured that it nests. It is not a shy bird and frequently approaches to within a few meters. Numbers are seen in the surrounding areas of the small streams which form the marshes of the deep ravines. When chased, they fly toward the walls of the ravine, resting themselves on the rocks. From time to time they may be seen flying directly upwards where they remain immobile in the air by beating their wings. Later they let themselves fall again toward the earth. Their presence is revealed by a fine call which they express with a penetrating "pii."

Phrygilus fruticeti fruticeti (Kittlitz)

The "yale" is known in a large part of the country as a rather destructive and damaging little bird. It is frequently seen in Toconce (3,300 meters), Guatin (3,500 meters), and Talabre (3,300 meters) where I was able to observe it in flocks of about 20 birds.

Zonotrichia capensis antofagastae Chapman

This is perhaps the most characteristic bird of agricultural sites situated between 2,400 meters and 3,500 meters in the entire region visited. It is known by the name of "chincol" and is extremely common in the village of Toconce (3,300 meters), at Ayquina (3,030 meters), San Pedro de Atacama (2,400 meters), Tilomonte and Toconao (2,500 meters). It is observed in groups or alone.

Spinus atratus (Lafresnaye and d'Orbigny)

The "canario" is very much desired by the natives as it has a beautiful song. After capturing them by means of traps, they raise them in cages. They abound in the region of Siloli in the summertime. We were not able to obtain examples in spite of having seen some in the Toconce ravine (3,300 meters).

Sicalis uropygialis uropygialis (Lafresnaye and d'Orbigny)

I only observed two flocks of this "chirigue," both very numerous. One of them was at the Ojos del Rio San Pedro (3,800 meters) and the other at the Vegas de Inacaliri, a place close to 4,000 meters.

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II

DIATOMS (*BACILLARIOPHYCEAE*) FROM THE ALIMENTARY TRACT OF *PHOENICOPARRUS* *JAMESI* (SCLATER)*

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During December, 1957, *Phoenicoparrus jamesi* (Sclater) was collected by Señor Luis Peña from Laguna Colorado Puna de Atacama, Bolivia, at an elevation of 4,400 meters. Walcott (1925) describes this lake as strongly alkaline with springs at the north end. On the shores were salt deposits consisting of sodium and potassium carbonate, sodium chloride, and borax. In July, 1957, Señor Luis Peña collected this species in Salt Lake, Atacama, Chile and in Lagunas de Carvajal (salt), Atacama, Chile. Both collections were taken at an elevation of 2,400 meters.

An analysis of the contents of the alimentary tracts of these birds showed that they were mainly diatoms. The most common species were *Navicula carvajaliana* sp. nov., *Amphora atacamana* sp. nov., *Navicula luisii* sp. nov., and *Nitzschia accedens* var. *chilensis* var. nov.

These findings confirm the prediction of Jenkins (1957), based upon the type of filters of *Phoenicoparrus jamesi*, that this bird would feed on algae or diatoms. It is interesting to note that the more common diatoms in the alimentary tract have a similar size range.

At all three locations the commoner diatoms were the same. This is probably due to the fact that the areas in the lake which were favorable feeding grounds for these birds supplied ecologically similar habitats for diatoms. Also, since these strongly alkaline salt-water lakes represent a very specialized

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habitat for diatoms, the numbers of kinds of species which can grow under these conditions are relatively limited, and therefore the diatom floras of these lakes would be more similar than is generally the case in the more usual fresh or brackish water lakes. The two lakes in Chile are quite close together, but it is unlikely that the birds captured in Bolivia had previously fed in the Chilean lakes.

The fact that flamingos may feed on algae has been reported by various workers. Ridley et al. (1955) and Jenkins (1957) state that in East African Lakes, *Phoeniconaias minor* (Geoffroy) feeds almost exclusively on blue-green algae and on small diatoms. Usually diatoms are mixed with the blue-green algae and sometimes diatoms without the blue-green algae seem to be the main source of food.

According to a letter written by Dr. Robert P. Allen to Mr. Ridley (Jenkins, 1957), *Phoenicopterus ruber* Linné in the Bahamas feeds on mud rich in bacteria, blue-green algae and, to a lesser extent, diatoms.

A systematic list of the species identified in this study is given below. The slides on which these identifications are based are in the diatom herbarium of the Academy of Natural Sciences of Philadelphia. The type specimens are ringed on the slides.

Suborder MONORAPHIDINEAE

Family ACHNANTHACEAE

Genus Achnanthes Bory

Achnanthes brevipes var. *intermedia* (Kütz.) Cl.

Achnanthes brevipes var. *intermedia* (Kütz) Cl., K. Svenska Vet.-Akad. Handl., ser. 2, 27 (3): 193, 1895.

DISTRIBUTION: Chile, Atacama, Salt Lake, alt. 4,400 m, coll. Luis Peña, July, 1957 (A-G.C. 26098).

Achnanthes hauckiana var. *rostrata* Schultz

Achnanthes hauckiana var. *rostrata* Schultz, Bot. Arch., 13: 191, fig. 39, 1926.

DISTRIBUTION: Chile, Atacama, Salt Lake, alt. 4,400 m, coll. Luis Peña, July, 1957 (A-G.C. 26098a); Lagunas de Carvajal, alt. 2,400 m, coll. Luis Peña, July, 1957. (A-G.C. 26100).

Family NAVICULACEAE
Genus Navicula Bory

Navicula atacamana sp. nov. Pl. 1, Fig. 10

Valva lineari-lanceolata apicibus acutis apiculatis leniter. Area axiali angusta. Area media rectangularis latus distendens ad margines valvae. Striis lineatis, parallelis in media parte valvae et convenientibus ad apices. Striis, 10-11 in 10μ ; longitudo, 49-50 μ ; latitudo, 6-7 μ .

Valve linear-lanceolate with acute, slightly apiculate ends. Axial area narrow. Central area a broad rectangle extending to the margins of the valve. Striae lineate, parallel in the center of the valve and slightly convergent toward the apices. Striae, 10-11 in 10μ ; length, 49-50 μ ; breadth, 6-7 μ .

This species is similar in shape, striae structure and angle, and narrowness of axial area to *Navicula directa* (W. Sm.) Cl. It differs in the presence of a broad rectangular central area and in its smaller size.

TYPE LOCALITY: Bolivia, Puna de Atacama, Laguna Colorado, alt. 4,400 m, coll. Luis Peña, December, 1957.

SPECIMEN ILLUSTRATED: A-G.C. 26098a, Holotype.

DISTRIBUTION: KNOWN only from the type locality.

Navicula carvajaliana

var. **carvajaliana** sp. nov. Pl. 1, Figs. 1, 2, 3

Valva lineari ad linearem-lanceolatam. Apicibus mutabilibus in forma rotundis, cuneatis aut rostratis. Pseudosepta brevi distende supra apices. Area axiali distincta semper ferme minus quam uno quadrante latitudinis valvae. Area media mutabili, transversa formante fasciam saltem in uno latere valvae, altero latere saepe cum uno aut duobus striis positus late. Striis radiatis leniter in media parte valvae, parallelis aut conventis leniter ad apices. Angulo striarum inique facto valve concava leniter ad aream axialem. In formis angustis striis paene parallelis et valva non concava ad aream axialem. Striis fractis inaequaliter, punctis obscurissimis, si adsunt. Striis, 14 in 10μ in media parte valvae ad 18 in 10μ ad apices valvae; longitudo, 36-70 μ ; latitudo, 8-15 μ .

Valve linear to linear-lanceolate. Apices variable in shape, rounded, wedge-shaped or rostrate. A short pseudoseptum extending over each of the apices. Axial area distinct, usually less than one-fourth the width of the valve. Central area variable, transverse, forming a fascia at least on one side of the valve, the other side often with one or two widely placed striae. Striae slightly radiate in center of valve, parallel or slightly convergent at the apices. Angle of striae partially caused by the valve being slightly concave toward the axial area. In narrow forms the striae almost parallel and valve not concave toward axial area. Striae irregularly broken. Puncta if present very indistinct. Striae, 14 in 10μ in center of valve to 18 in 10μ at ends of valve; length, 36-70 μ ; breadth, 8-15 μ .

This taxon is highly variable as to the shape of the valve, and one would recognize some of the variations as separate subspecies or varieties if they did not intergrade into each other. On plate 1, figs. 1, 2, 3 are illustrations showing some of the extremes of variation of these intergrading populations. Some specimens have been found, that are not illustrated, in which the apices of the valve are not drawn out, but the valve simply narrows to a rounded end.

This species is a member of that group of taxa which are intermediate between *Stauroneis* and *Navicula*, that is, it seems to be closely related to *S. thermicola* (Peters.) Lund (New Phytol., 45(1): 61, figs. 3 K-AA, 1946) and *Navicula incomposita* Hagelstein (New York Acad. Sci., Sci. Surv. Porto Rico & Virgin Isl., 8(3): 286, pl. 7, fig. 2, 1939). This taxon resembles *Stauroneis* in that the specimens have a transverse hyaline area which in girdle view seems to be slightly thickened, particularly at the central nodule of the valve. However, it does not have striae which are radiate at the ends of the valve and resolvable into puncta, which characters are typically associated with species belonging to the genus *Stauroneis*. This species has a pseudoseptum at the ends of the valve which is found in species belonging to the genera *Stauroneis* and *Navicula*. Since I cannot be sure that the central area is a true stauros and since the striae, although breaking into irregular pieces, do not resolve into puncta and are slightly convergent at the ends, it seems wiser to place this species in the genus *Navicula*.

This taxon is also related to *Navicula allorgei* Manguin (Algues Guadeloupe, p. 58, pl. 3, fig. 51, 1952) but differs in the angle of the striae and the usual presence of a distinct fascia at least on one side of the valve. It is also larger and the shape is more variable.

TYPE LOCALITY: Bolivia, Puna de Atacama, Laguna Colorado, alt. 4,400 m, coll. Luis Peña, December, 1957.

SPECIMEN ILLUSTRATED: A-G.C. 26098a, Holotype, fig. 1; Cotypes, figs. 2, 3.

DISTRIBUTION: In addition to the type locality: Chile, Atacama, Carvajal Lake, alt. 2,400 m, coll. Luis Peña, July, 1957 (A-G.C. 26100); Atacama, Salt Lake, alt. 2,400 m, coll. Luis Peña, July, 1957 (A-G.C. 26099a, b).

***Navicula carvajaliana* var. *attenuata* var. nov. Pl. 1, Fig. 12**

Valva lineari lanceolata, apicibus rotundis attenuatis. Pseudoseptis praesentibus. Area axiali angusta, distincta. Area media fascia transversa interdum stria praesenti in ea in uno latere valvae. Striis radiatis leniter in media parte valvae, plus aut minus convenientibus ad apices. Striis intermissis inaequaliter sed non punctatis. Striis, 13 in 10μ in media parte valvae usque 16 in 10μ ad apices; longitudo, 44-60 μ ; latitudo, 6-11 μ .

Valve linear-lanceolate with attenuated, rounded apices. Pseudosepta present. Axial area narrow, distinct. Central area a transverse fascia sometimes with a stria present in it on one side of the valve. Striae slightly radiate in the center of the valve, more or less convergent at the ends. Striae irregularly interrupted but not punctate. Striae, 13 in 10μ in middle part of valve to 16 in 10μ at apices; length, 44-60 μ ; breadth, 6-11 μ .

This taxon is distinguished from the nominate variety by the narrow attenuated ends of the valve. No intergrades were found between this form and the other forms which are highly variable.

TYPE LOCALITY: Chile, Atacama, Salt Lake, alt. 2,400 m, coll. Luis Peña, July, 1957.

SPECIMEN ILLUSTRATED: A-G.C. 26099a, Holotype.

DISTRIBUTION: Known only from the type locality.

Navicula luisii sp. nov.

Pl. 1, Fig. 4

Valva lineari lanceolata, apicibus rotundis acutis. Pseudo-septo ad apices. Area axiali distincta circa unum quadrantem latitudinis valvae. Area media fascia transversa. Striis attinentibus aream crassioribus quam alterae striae. Striis radiatis leniter per magnam partem valvae, parallelis ad apices. Striis, 14-17 in 10μ ; longitudo, 63-89 μ ; latitudo, 9-14 μ .

Valve linear-lanceolate with acute, rounded ends. Pseudo-septum present at apices. Axial area distinct, about one-fourth the width of the valve. Central area a transverse fascia. Striae bordering the central area a little thicker than the other striae. Striae slightly radiate throughout most of the valve, parallel at the apices. Striae, 14-17 in 10μ ; length, 63-89 μ ; breadth, 9-14 μ .

This species is distinguished from *Navicula carvajaliana* by the striae bordering the fascia being distinctly thicker than the other striae and by its larger size. It is near *N. incomposita* Hagelstein (New York Acad. Sci., Sci. Surv. Porto Rico and Virgin Isl., 8(3): 386, pl. 7, fig. 2, 1939) but differs in the regularity of the striae which are a little coarser than in *N. incomposita*. The shape of the valve is also different and the axial area is broader.

This species is named for Señor Luis Peña who collected the flamingos which were examined for this study.

TYPE LOCALITY: Chile, Atacama, Salt Lake, alt. 2,400 m, coll. Luis Peña, July, 1957.

SPECIMEN ILLUSTRATED: A-G.C. 26099a, Holotype.

DISTRIBUTION: Known only from the type locality.

Navicula oppugnata Hust.

Navicula oppugnata Hust., Arch. Hydrobiol., 40(4): 925, pl. 42, fig. 1, 1945.

Our specimens differ from those illustrated by Hustedt in that the central area is a little larger and the striae in the middle of the valve are slightly curved. The central area of these specimens is similar to those illustrated by Foged (Folia Limnol. Scandinavica, no. 6, pl. 2, figs. 12-14, 1954).

This species was fairly common in Laguna Colorado.

DISTRIBUTION: Bolivia, Puna de Atacama, Laguna Colorado, alt. 4,400 m, coll. Luis Peña, December, 1957 (A-G.C. 26098a).

Navicula pseudosepta sp. nov.

Pl. 1, Fig. 5

Valva lanceolata, apicibus rostratis ad rostratis-capitatis. Pseudoseptis praesentibus. Area axiali angusta, distincta. Area media non dissimili areae axiali. Striis radiatis in media parte valvae et parallelis ad convenientibus leniter ad apices. Interdum striis in uno latere nodulis mediae crassioribus quam in latere altero. Striis non decernunt in puncta. Striis, 13-15 in 10μ ad mediam partem valvae usque 18 in 10μ ad apices; longitudo, 51-68 μ ; latitudo, 11-13 μ .

Valve lanceolate with rostrate to rostrate-capitate ends. Pseudosepta present. Axial area narrow, distinct. Central area not differentiated from axial area. Striae radiate in the center of the valve and parallel to slightly convergent at the apices. Sometimes striae of one side of the central nodule coarser than on the other side. Striae do not resolve into puncta. Striae, 13-15 in 10μ at center of valve to 18 in 10μ at apices; length, 51-68 μ ; breadth, 11-13 μ .

This species is most closely related to *N. carvajaliana* which is described in this paper. It differs in the lack of a central area which is a fascia on one or both sides of the valve. Also, the striae are not irregularly broken. It resembles in shape of valve and structure of axial and central areas *N. cuspidata* var. *ambigua* (Ehr.) Cl. It differs in the formation of the striae which do not resolve into puncta forming longitudinal lines. Nor are pseudosepta present in *N. cuspidata* var. *ambigua* (Ehr.) Cl.

TYPE LOCALITY: Chile, Atacama, Lagunas de Carvajal, alt. 2,400 m, coll. Luis Peña, July, 1957.

SPECIMEN ILLUSTRATED: A-G.C. 26100a, Holotype.

DISTRIBUTION: Known only from the type locality.

Navicula salinicola var. **boliviana** var. nov. Pl. 1, Fig. 11

Valva lineari attenuata ad apices acutos. Area axiali angusta, distincta. Fissuris terminalibus distinctis. Area media vix dissimili areae axiali. Striis lineatis parallelis in media parte valvae et conventis leniter ad apices. Striis, 10-12 in 10μ ; longitudo, 16-30 μ ; latitudo, 4-6 μ .

Valve linear, narrowed toward the acute apices. Axial area narrow, distinct. Terminal fissures distinct. Central area scarcely differentiated from axial area. Striae lineate, parallel in center of valve and slightly convergent at the apices. Striae, 10-12 in 10μ ; length, 16-30 μ ; breadth, 4-6 μ .

This taxon is very similar to the nominate variety *N. salinicola* Hust. (Abhandl. Naturwiss. Verein zu Bremen, 31: 638, figs. 61-69, 1939) in size, shape, structure of axial and central areas, and type and angle of striature. It differs in the number of striae, which are much coarser in this taxon.

TYPE LOCALITY: Bolivia, Puna de Atacama, Laguna Colorado, alt. 4,400 m, coll. Luis Peña, December, 1957.

SPECIMEN ILLUSTRATED: A-G.C. 26098a, Holotype.

DISTRIBUTION: KNOWN only from the type locality.

Family CYMBELLACEAE

Genus Amphora Ehr. emend. Kütz

Amphora atacamana sp. nov.

Pl. 1, Fig. 8

Margine dorso valvae convexo valide, margine ventrali concavo leniter. Raphe propiore ad marginem dorsum quam ad marginem ventralem. Area axiali angusta, distincta. Area media parva. Striis punctatis subtilissime. Striis, 26-28 in 10μ ; longitudo, 31-52 μ ; latitudo, 6-9 μ .

Dorsal margin of valve strongly convex, ventral margin slightly concave. Raphe nearer to dorsal margin than to ventral margin. Axial area narrow, distinct. Central area small. Striae very finely punctate. Striae, 26-28 in 10μ ; length, 31-52 μ ; breadth, 6-9 μ .

The valves of the frustules are very convex and therefore the shape varies greatly according to the angle at which they

lie on the slide. In some specimens the raphe appears very close to the dorsal margin. Sometimes, as in the illustration, a hyaline area is present near the ventral margin. One rarely finds this diatom in girdle view, but in such specimens as I have seen the intercalary zone is complex.

This species is distinguished by the convexity of the valve, the raphe which is fairly near the dorsal margin, and the very fine striae. The portion of the valve ventral to the raphe lies in a distinctly different plane from the portion dorsal to the raphe.

TYPE LOCALITY: Bolivia, Puna de Atacama, Laguna Colorado, alt. 4,400 m, coll. Luis Peña, December, 1957.

SPECIMEN ILLUSTRATED: A-G.C. 26098a, Holotype.

DISTRIBUTION: In addition to the type locality: Chile, Atacama, Salt Lake, alt. 2,400 m, coll. Luis Peña, July, 1957 (A-G.C. 26099a); Lagunas de Carvajal, alt. 2,400 m, coll. Luis Peña, July, 1957 (A-G.C. 26100).

***Amphora boliviana* sp. nov.**

Pl. 1. Fig. 9

Margine dorso valvae convexo valide, margine ventrali concavo leniter. Area axiali angusta. Area media lanceolata in forma in latere ventrali raphis, obscuro in latere dorso. Striis punctatis crasse in latere dorso raphis, punctatis obscure in latere ventrali. Striis 18 in 10μ in latere dorso raphis praeter ad apices ubi sint 20 in 10μ . Striis in margine ventrali 22-23 in 10μ , punctatis obscure; longitudo, 57-58 μ ; latitudo, 7-8 μ .

Dorsal margin of valve strongly convex, ventral margin slightly concave. Axial area narrow. Central area lanceolate in shape on ventral side of raphe, indistinct on dorsal side. Striae coarsely punctate on dorsal side of raphe, indistinctly punctate on ventral side. Striae 18 in 10μ on dorsal side of raphe except at the apices where they may be 20 in 10μ . Striae on ventral margin 22-23 in 10μ , indistinctly punctate; length, 57-58 μ ; breadth, 7-8 μ .

This species is characterized by the striae which are coarse and distinctly punctate on the dorsal side and fine and indistinctly punctate on the ventral side. The central area is

absent on the dorsal side of the valve and lanceolate in shape on the ventral side. This species does not seem to be very closely related to any species which I have seen. It belongs in the general group of species comprising *A. coffeaeformis* Ag. and *A. acutiuscula* Kütz.

TYPE LOCALITY: Bolivia, Puna de Atacama, Laguna Colorado, alt. 4,400 m, coll. Luis Peña, December, 1957.

SPECIMEN ILLUSTRATED: A-G.C. 26098a, Holotype.

DISTRIBUTION: Known only from the type locality.

***Amphora carvajaliana* sp. nov.**

Pl. 1, Fig. 7

Valva marginibus ventralibus concavis et margine dorso convexo valide. Apicibus valvae rostratis-capitatis. Raphe prope marginem ventralem valvae. Area axiali distincta, nulla area media in latere dorso valvae. Striis absentibus in latere ventrali valvae; in latere dorso punctatis crasse, radiatis leniter. Striis, 18 in 10μ ; longitudo, 10-28 μ ; latitudo, 4-5 μ .

Valve with ventral margin concave and dorsal margin strongly convex. Apices of valve rostrate-capitate. Raphe near ventral margin of valve. Axial area distinct, no central area on dorsal side of valve. Striae absent on ventral side of valve; on dorsal side coarsely punctate, slightly radiate. Striae, 18 in 10μ ; length, 10-28 μ ; breadth, 4-5 μ .

This species is characterized by the lack of striae on the ventral margin of the valve and the coarsely punctate striae on the dorsal side of the valve. This species, in size and shape, resembles *A. banyaiana* Greguss and Weber ? (Botanikai Kozlemenyek, 35: 287, pl. 3, fig. 55, 1938) but differs in that it does not have a broadening of the axial area into a recognizable central area on the dorsal side of the valve, and the striae are distinctly and coarsely punctate. It also resembles *A. turgida* Greg. (Trans. Roy. Soc. Edinb., 21(4): 510, pl. 12, fig. 63, 1857) but differs in the striae which are coarsely punctate and finer.

TYPE LOCALITY: Chile, Atacama, Lagunas de Carvajal, alt. 2,400 m, coll. Luis Peña, July, 1957.

SPECIMEN ILLUSTRATED: A-G.C. 26100a, Holotype.

DISTRIBUTION: In addition to the type locality: Chile, Atacama, Salt Lake, alt. 2,400 m, coll. Luis Peña, July, 1957 (A-G.C. 26099a).

Family NITZSCHIACEAE

Genus *Nitzschia* Hass

Nitzschia accedens var. *chilensis* var. nov. Pl. 1, Fig. 6

Valve linear with rounded ends. Keel puncta short, distinct, distinctis, 12-13 in 10μ ; striis distinctis, non decretis facile in puncta, 26-28 in 10μ ; longitudo, 56-90 μ ; latitudo, 5-6 μ .

Valve linear with rounded end. Keel puncta short, distinct, 12-13 in 10μ . Striae distinct, not easily resolved into puncta, 26-28 in 10μ ; length, 56-90 μ ; breadth, 5-6 μ .

This variety differs from the nominate variety (Hust., Abh. Naturw. Ver. Bremen, 31: 663, fig. 115, 1939) in the more rounded apices, size of the valve, and the fine keel puncta.

TYPE LOCALITY: Chile, Atacama, Salt Lake, alt. 2,400 m, coll. Luis Peña, July, 1957.

SPECIMEN ILLUSTRATED: A-G.C. 26099a, Holotype.

DISTRIBUTION: In addition to the type locality: Chile, Atacama, Lagunas de Carvajal, alt. 2,400 m, coll. Luis Peña, July, 1957 (A-G.C. 26100).

Nitzschia amphibia Grun.

Nitzschia amphibia Grun., Verh. Zool.-Bot. Ges. Wien, 12: 574, pl. 18, figs. 23 a-c, 1862.

This species was common in the collection.

DISTRIBUTION: Bolivia, Puna de Atacama, Laguna Colorado, alt. 4,400 m, coll. Luis Peña, December, 1957 (A-G.C. 26098a).

Nitzschia epithemoides Grun. in Cl. and Grun.

Nitzschia epithemoides Grun. in Cl. and Grun., K. Svenska Vet.-Akad. Handl., ser. 2, 17(2): 82, 1880.

This species was fairly common in the collections. It is a brackish to marine species.

DISTRIBUTION: Bolivia, Puna de Atacama, Laguna Colorado, alt. 4,400 m, coll. Luis Peña, December, 1957 (A-G.C. 26098a). Chile, Atacama, Salt Lake, alt. 2,400 m, coll. Luis Peña, July, 1957 (A-G.C. 26099a); Lagunas de Carvajal, alt. 2,400 m, coll. Luis Peña, July, 1957 (A-G.C. 26100).

Nitzschia hungarica Grun.

Nitzschia hungarica Grun., Verh. Zool.-Bot. Ges. Wien, 12: 568, pl. 18, figs. 31 a-b, 1862.

This is a brackish to fresh-water species. It was fairly frequent in the one collection.

DISTRIBUTION: Bolivia, Puna de Atacama, Laguna Colorado, alt. 4,400 m, coll. Luis Peña, December, 1957 (A-G.C. 26098a).

Nitzschia palea (Kütz.) W. Sm.

Nitzschia palea (Kütz.) W. Sm., Syn. British Diat., 2: 89, 1856.

This species can stand a great variety of water conditions and often develops in large masses in polluted water.

DISTRIBUTION: Bolivia, Puna de Atacama, Laguna Colorado, alt. 4,400 m, coll. Luis Peña, December, 1957 (A-G.C. 26098a).

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PLATE 1

- Fig. 1, 2, 3 *Navicula carvajaliana* sp. nov.
Fig. 4 *Navicula luisii* sp. nov.
Fig. 5 *Navicula pseudosepta* sp. nov.
Fig. 6 *Nitzschia accedens* var. *chilensis* var. nov.
Fig. 7 *Amphora carvajaliana* sp. nov.
Fig. 8 *Amphora atacamana* sp. nov.
Fig. 9 *Amphora boliviana* sp. nov.
Fig. 10 *Navicula atacamana* sp. nov.
Fig. 11 *Navicula salinicola* var. *boliviana* var. nov.
Fig. 12 *Navicula carvajaliana* var. *attenuata* var. nov.

