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Flamingos

Introduction by Sir Peter Scott

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From April 1972 to July 1973, I studied flamingos in the Department of Arica, Province of Tarapacá, in northern Chile. The altiplano of Arica consists of two parallel mountain ranges with an undulating intermediate plain extending from 17°30' to 19°S. Almost the whole of this 700,000 ha plain lies above 4000 m, with several volcanic peaks surpassing 6000 m and possessing permanent snow caps (296). To the west, lies a narrow xerophytic scrub formation which descends through the rainless Atacama Desert to the Pacific coast some 100 km away. To the east, lies the extensive Bolivian altiplano.

Three species of flamingo—the Chilean, Andean, and James'—are found in the Arica altiplano. Flamingos have also occurred at a small reservoir, Tranque de Caritaya, at 3500 m (19) and, as recently as ten years ago, were seen by local residents at the mouth of the Río Lluta, just north of the city of Arica. I found a Chilean carcass on the beach at Arica in May 1972 but, in general, the occurrence of flamingos at low elevations in this zone can be considered extremely rare.

HABITAT

Salt lakes are the preferred habitat for all three species and the largest lake, the Salar de Surire, harbours most of the birds and is the only known nesting site in the area. The 250 sq km salar has no outlet and receives drainage from the surrounding 570 sq km and the small, intermittent Río Surire (157). The smaller Laguna Blanca lies 150 km to the north and is 100 sq km with 150 sq km of watershed. This lake has shrunk drastically in recent years, concomitant with similar desiccation in Bolivia (201). When I visited it on 11–13 April 1972, I found only 14 flamingos—two adult and one immature Chilean, and three adult and eight immature James'.

Fresh water habitats midway between these salt lakes are also used. Lago Chungará, with a surface area of 21.5 sq km and a closed water-shed of 280 sq km, is one of the higher lakes in the world at 4520 m. Flocks of less than 50 flamingos have been observed here on several occasions. Nearby Lago Cotacotani has a surface of 6 sq km, with numerous small islands and disconnected ponds.

The third habitat utilized by flamingos is the spring fed, semi-bog pastureland, locally known as 'bofedale'. These peat bogs, in basin areas or on gently inclined slopes, are characterised by springs and meandering streams of freshwater (296). They provide grazing for the herds of llamas and alpacas maintained by the Aymara Indians, and are a common feature of the altiplano. They appear to be frequented by flamingos only near Parinacota

and Caquena (several hundred birds), and at Laguna Paquiza (up to 30) some 15 km north of Salar de Surire.

Salar de Surire (18°50'S and 69°5'W) lies only 40 km north of the type locality for *jamesi*, Laguna Parinacota. It is relatively small (18 × 15 km) compared to the Bolivian salars of Coipasa and Uyuni to the southeast. The basin is 4140 m above sea level and is surrounded by peaks up to 5590 m. The eastern edge is approximately 3 km from the Bolivian frontier. Most of the surface is composed of dry salt crystals capable of supporting a vehicle. The amount of surface water is variable, with large expanses of shallow (5–10 cm) water completely evaporating by the end of the dry season. There are several areas of permanent water in which flamingos wade belly-deep but only occasionally swim, so apparently even the deeper water is relatively shallow.

Precipitation and drainage are responsible for the increase in water area during the rainy season, but springs at the edge of the salar maintain a perma-

nent minimum level. These springs are of three types: (a) cold (10 °C) and sweet, supporting a variety of green aquatic plants; (b) cold (10 °C) and brackish, with no plant life; and (c) hot (40 °C) thermal springs and geysers. When the fresh water springs erupt some distance from the edge of the salar they frequently support 'bofedale' vegetation which is exploited by vicuñas, llamas, and alpacas, as well as by numerous passerine birds. Table 10 presents analyses of sweet water, a thermal spring, and the resultant mix surrounding the nest site several kilometres away near the centre of the salar.

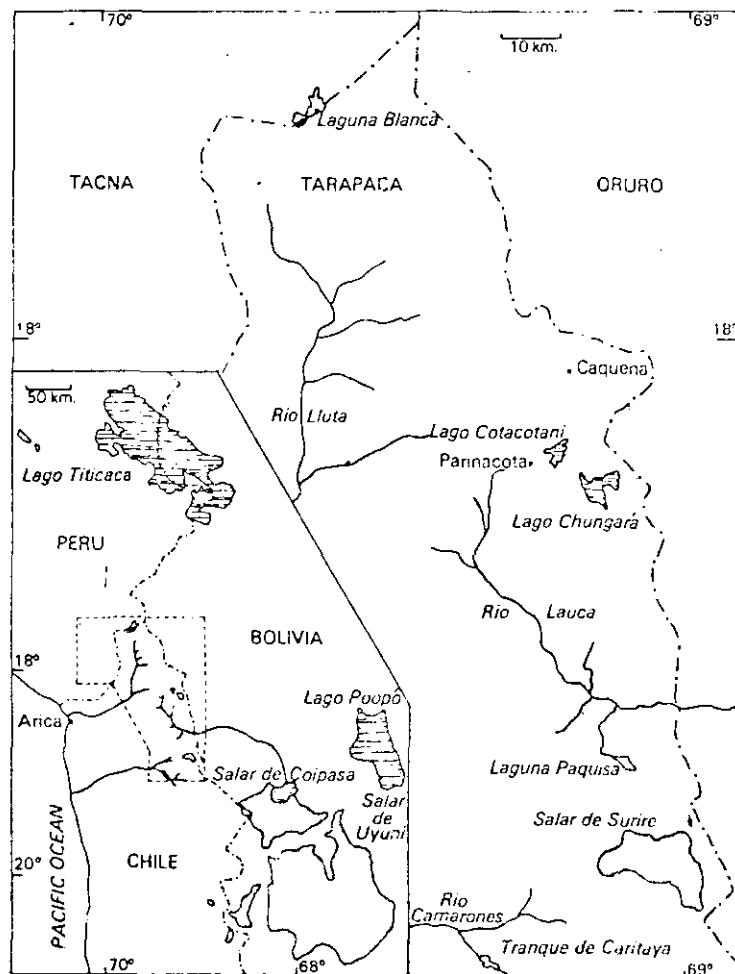
Climatic data for the altiplano are incomplete, but annual precipitation is estimated at 300–400 mm (157; 243). A new weather station at Surire recorded 281.3 mm of rain between November 1971 and March 1972, and unofficial information indicates 334 mm in the three months of summer 1972–73, which was an exceptionally wet year throughout the altiplano. There are distinct wet and dry seasons. While Parinacota has recorded rain during every month over a 37-year period, the normal pattern is for the rain to commence during November, with heaviest precipitation in January, and to cease by April. The remaining six months are virtually dry and, in exceptionally dry years, rain may be absent for eight months. Equally important is the evaporation rate. On a typical day, the wind commences about 1000 hrs and blows strongly until after sundown. During the rainy season, the skies are usually clear until noon and the afternoons are filled with scattered but violent electrical, snow and sleet storms. The higher peaks retain permanent snow caps but snowfall on the plain evaporates very quickly. In January 1972, the mean daily temperature was 5°C, and in July 1972, it was -2°C. The lowest temperature recorded was -26°C (26 August), and the highest 15°C (21 December).

The vegetation surrounding the salar is xeric puna, a *Stipa* tussock grassland with patches of *Baccharis* shrubs and as much as 30% of the soil surface is without vegetation. The higher slopes are a subalpine *Laretia* formation with *Stipa* (296).

It is clear that the habitat of these flamingos is rather severe and surface ice is a common feature of the open water much of the year. Flamingos resort to the warmer springs at dusk and remain there until the feeding areas are ice-free the following morning. However the nesting site was not near warm water, and on 10 May, after a temperature of -8°C, large expanses of the shallow flats were covered with ice up to 5–10 mm thick which persisted until 1100 hours. As this ice breaks up, large sheets are driven by the wind, exerting considerable force on objects standing in the water. Young flamingos still in the nests begin to shiver soon after an intruder forces the parent to abandon the nest.

REPRODUCTION

Positive evidence of nesting in Arica has been obtained only twice. When we visited Surire on 4–5 August 1972, J. Rottman located a crèche of some 200 fledglings believed to be James' and another group of 200 downy young which appeared to be Chileans, but only one dead Chilean was found to establish identification. The young of all three species appear similar from a dis-



16 Location of the Arica of Tarapachá

TABLE 10: Analyses of water samples from the Salar de Surire

	A	B	C
Temperature	10°C	60°C	variable
pH	7.0	6.2	8.7
Conductivity (mho)	1.65	5.96	10.4
CO ₃ = (m eq/litre)	—	—	3.0
HCO ₃ ⁻	7.4	2.4	1.2
Cl ⁻	6.56	42.92	91.79
SO ₄ =	1.67	17.3	11.98
Ca ⁺⁺	5.2	11.8	7.22
Mg ⁺⁺	7.15	2.03	5.32

No analysis for borates was made.

A = a sweet "bofedale" spring containing abundant green aquatic plants.

B = directly from the main boil of the thermal Baños de Polloquere.

C = from shallow water surrounding the nesting colony. There were large diurnal temperature fluctuations due to 10 cm depth.

tance and pursuit across the salar on foot is futile. The nest sites were not located, but apparently eggs were laid in late April and again in May or June. There were few grey immature birds present to indicate earlier nesting.

I visited the site again on 7–10 May 1973 and found about 4000 Chileans at a nesting colony with 1516 nests. Of these, 375 contained an egg and 60 had a chick in or near. Dr M. P. Kahl independently censused this colony on 11–12 May and estimated 200 chicks on or near the nests, suggesting considerable synchronous hatching in two days. There was also a large crèche of 800 birds, indicating that eggs had been laid from March to April or later.

Not all of the adult birds appeared to be of breeding age. There were no grey-plumaged birds flying in the area, but three age classes of 'adults': (a) almost white bodies without red in the wings; (b) pale pink bodies with red wing coverts; and (c) adults with strongly pink bodies and red wing coverts. The percentage of these presumed non breeding adults is unknown but substantial.

The nests were constructed in two groups about 30–40 m apart. Most appeared to be about 25 cm high and 35–40 cm broad at the top. The nest site was flat with a surface of fine grained grey mud. The area was covered with 2–10 cm of water, but much of that surrounding the inner nests was dry. This would greatly increase the survival rate of those chicks which fell from the nest before they were old enough to climb back. Nests without eggs seemed to lose their retaining wall quickly and completely, but empty nests were rare. The general impression was of rapid breakdown of nests, accelerated by wind

88 Northern Chile

driven wave action, with the need for constant repair. Twenty eggs measured 92.2 mm (84.0–106.0) × 51.7 mm (50.1–54.5) and the extreme eggs were 84.0 × 51.6, 106.0 × 50.7, 87.0 × 50.1, and 88.7 × 54.5 (Appendix 5).

While there is no evidence that 1500 nests were utilized, we can assume that they represented 1500 eggs and 3000 adults. There were 120 eggs lost but remaining in the immediate vicinity of the nests. Since they float, we have no idea how many had blown away, but egg loss may be a minimum of 10%. Few dead chicks were found. If we further assume 200 young at the nests and 800 in the crèche, we can conservatively estimate 70% or better reproduction. Potential predators like the Andean Wolf *Dusicyon cuplaxus*, Pampa Fox *Dusicyon griseus*, and Variable Hawk *Buteo poecilochrous*, and such scavengers as the Andean Condor *Vultur gryphus* and Andean Caracara *Phalcobuccus albogularis* all occur at Surire, but none has been observed taking flamingos. There is also no evidence that eggs or young are collected for human consumption.

In August, at the abandoned mining site of Chilcaya on the north shore of Surire, the birds were moulting contour feathers which were on the water and along the shore. Of 1089 flamingos counted (896 *jamesi*, 125 *andinus*, 35 *chilensis*, and 33 immatures), only the James' were seen with feathers detaching and blowing away, but it is possible that all species were moulting. There was no indication of moult in November but both contour and flight feathers were present at the same site the following May. Many James' and Andean possessed conspicuously new plumage and bright yellow bills, and the James' had bright red legs. The bulk of the Chilean population was segregated some distance away at the nesting colony and there was no indication of moulting there. Flightless adults have not been observed.

POPULATION ESTIMATES

The nomadic nature of flamingos is obvious here. Population estimates for Salar de Surire are presented in Table 11, and censuses in other Arica localities are equally irregular. Local residents at Surire indicate that few flamingos were present until early 1972. Large numbers of *jamesi* arrived and some of them are believed to have nested. Part of the increase from August to November represents more grey immature birds but they are not necessarily locally produced. The population of *chilensis* has steadily increased and they nested in 1972 and 1973. The number of *andinus* has increased at least twice but the species apparently retreats to Bolivia to breed.

TABLE 11: Flamingo population estimates for Salar de Surire

	<i>andinus</i>	<i>chilensis</i>	<i>jamesi</i>
February 1957 (147)	200	none	6
April 1969 (165)	very abundant	none	few
August 1972	125	110	2000–2500
November 1972	3500–5000	1000	2500–3000
May 1973	1000	4000	6000

FEEDING BEHAVIOUR AND ECOLOGY

Differences in bill morphology suggest differences in feeding behaviour and ecology between the three species (141). All exploit the food resources of the salt lakes and *jamesi* may be restricted to such habitats. Both *andinus* and *chilensis* have been observed at the freshwater lakes and bog areas but *chilensis* seems to frequent them more consistently and in greater numbers. Nothing is known about the food habits of either species in these areas. Not all bogs are utilised by the flamingos but the limiting factors are unknown. Laguna Paquiza has excellent 'bofedales' and several ponds, and here *chilensis* activity seems to be limited to the open water. The 'bofedales' at Parinacota lack pond areas but attract small numbers of flamingos. Both of these localities attract numerous other water bird species.

All three species can be observed feeding in mixed flocks in deep water at Surire and no differences in behaviour have been detected. All feed in belly-deep water with heads completely submerged. At Chilcaya on Salar de Surire, the birds can be observed feeding in deep water, shallow water, and on soft mud. Three basic techniques have been noted:

- (a) in *jamesi* and *andinus* the bill is lowered to the mud and pushed forward as the bird walks slowly, the upper mandible leading the way. The head is moved from side to side and as the direction is changed, the angle of the head is changed so that the upper mandible always leads. The resulting track does not indicate a regular pattern;
- (b) in *jamesi* and *chilensis*, the bill is placed directly down, picked up and placed down in selected spots. There is no pushing and no bill track formed with the footprints;
- (c) in *chilensis*, feeding in shallow water has been accompanied by active foot-stomping, which apparently stirs the water and upper mud layers. The bill is lowered and moved directly at the feet.

No species has been observed to walk backward while feeding (148), to feed at the surface of the water, or while swimming (220).

Both *jamesi* and *andinus* commonly drink fresh water at springs at the edge of the salar. The bill is dipped to the surface of the water for one to two seconds, and in *andinus* the head is moved sideways while barely touching the surface, then the head is raised and stretched upward until the bill tip is higher than the eyes and the rest of the head. The action is repeated a number of times before the birds walk off to resume feeding and are replaced at the spring by other individuals. As many as 50 birds may be lined up on both sides of the tiny stream, at a point before it enters the salar.

No birds or stomach samples have been collected during this study. In May, the mud covered a pink layer which was very widespread in the area, including the zone of *chilensis* feeding activity surrounding the nesting colony. In addition, widely scattered small (15–20 cm or less) clumps of dark brick-red organisms and green organisms penetrated the mud surface and were visible from above. Samples of all three types were collected for further analysis. These red and pink organisms may be the source of red pigment for the birds.

90 Northern Chile

A number of species of diatoms have previously been identified from stomach samples of *jamesi* (216).

CONSERVATION

All the major flamingo habitats in the Department of Arica are within the boundaries of Lauca National Park. Unfortunately, national parks in Chile are not inviolate areas and several government agencies are pursuing counter-productive schemes for development. These include the construction of an international highway for commerce and tourism, increasing the production of the already overgrazed llama and alpaca pastures, removing water for hydro-electric generation and irrigation of the coastal desert zone, and the exploitation of mineral deposits.

The completion of an all-weather highway to the Bolivian frontier will end an era of isolation and inaccessibility. The road will directly pass through the bog areas of Parinacota and follow the shoreline of Lago Chungará. This will not only increase disturbances but will allow easy access to other altiplano areas. This should affect other species, for example the Giant Coot *Fulica gigantea*, more adversely than the flamingos.

The Salar de Surire is one of the most inaccessible areas of the altiplano, especially during the rainy season. It has few human inhabitants and has enjoyed a rare isolation. The beneficial effects of this isolation are further attested to by the presence of the largest populations of Vicuña *Vicugna vicugna* and Rhea *Pterocnemia pennata* on the Chilean altiplano.

The scheme of the Corporación de Fomento de la Producción and the Junta de Adelanto de Arica to reestablish the commercial exploitation of borax at the Salar de Surire can only be to the detriment of wildlife. Test bores are under way and a laboratory-residence has been established at the salar. Studies to determine the limiting factors affecting flamingos are urgently needed to guide their future conservation.

To summarise, three species of flamingo live on the altiplano of northern Tarapacá, Chile. The Chilean Flamingo is known to have nested in 1972 and 1973, and James' probably nested in 1972. The Andean occurs in numbers but appears to retreat to Bolivia to breed. All exploit the salt lakes, and *jamesi* appears restricted to them. Fresh-water lakes and bogs are frequented by *chilensis* and, to a lesser extent, by *andinus*. Populations have been increasing in recent years, but developing projects may reverse this trend.

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