

THE PREDATION OF GUANO BIRDS ON THE PERUVIAN ANCHOVY (*ENGRAULIS RINGENS* JENYNS)

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INTRODUCTION

The Peruvian anchovy is regularly preyed upon by a variety of animals belonging to different orders of the animal kingdom. Among those that thrive on its abundance are invertebrates, such as medusae and squids, and a multitude of carnivorous fishes, birds and mammals. Two great industries owe their existence to the stock of anchovy: the guano industry, based on the collection of the bird droppings, which have served as a fertilizer of the soil from ancient times and the fishmeal industry, man's exploitation of the anchovy resource, a recent innovation.

Although the majority of the birds that inhabit the Peruvian islands and coasts prey upon the anchovy to some extent, the list of the principal predators is not extensive. The main species are the following:

- Family: Spheniscidae
Spheniscus humboldti Meyer—"Peruvian penguin"
- Family: Procellariidae
Puffinus griseus (Gmelin)—"Sooty shearwater"
- Family: Pelecanidae
Pelecanus occidentalis thagus Molina—"Peruvian pelican"
- Family: Sulidae
Sula variegata (Tschudi)—"Gannet"
Sula nebowxi Milne-Edwards "Blue-footed booby"
- Family: Phalacrocoracidae
Phalacrocorax bougainvillii Lesson—"Cormorant"
Phalacrocorax gaimardi (Lesson)—"Red-footed shag"
Phalacrocorax brasilianus (Humboldt)—"Bigua cormorant"
- Family: Laridae
Larus pipixcan Wagler (migratoria)—"Franklin's gull"
- Family: Sternidae
Larosterna inca (Lesson)—"Inca tern"

Three of these species, the "guanay" (cormorant), the "piquero" (gannet), and the "alcatraz" (pelican), are the main consumers, because of their great numbers. These are the species that transform the anchovy into the valuable fertilizer, which is de-

posited in more than 40 islands and headlands along the Peruvian coast.

Because of their overwhelming importance, the present discussion on the predation of birds on the stock of anchovy is limited to these three species.

SPECIES COMPOSITION AND GEOGRAPHICAL DISTRIBUTION OF THE MAIN POPULATION CENTERS

In the order of importance the main guano producers are cormorants, gannets, and pelicans. The epicenter of their distribution lies between lat. 6° S. and lat. 12° S. The birds occupy this zone during spring and summer, when they form their densest concentrations; subsequently, during autumn and winter, the birds are more dispersed and their area of distribution is greatly enlarged, extending from lat. 1° N. to lat. 38° S. The quantities and locations of the main bird colonies along the Peruvian coast are shown in Figure 1.

The number of adult birds, based on graphical censuses made in December, 1962 and February, 1963, was estimated as being about 18 millions (Jordán and Fuentes, 1964), with the following frequencies of species:

	<i>Millions Percent</i>	
Cormorant	14.89	82.4
Gannet	2.76	15.3
Pelican	0.42	2.3

During the last 20 years this relative frequency does not seem to have changed substantially.

FOOD AND FEEDING

The anchovy constitutes 96% of the food of the cormorant (Jordán 1959) and at least 80% of the food of the gannet and the pelican. During periods of low availability of the anchovy, due to changes in the oceanic climate of the Peru current or other causes, the birds suffer from malnutrition which eventually leads to cachexia and death. This is the reason why the birds are completely dependent on the availability of the anchovy.

The feeding habits of the three species differ, both as regards fishing methods and time of food collecting.

The cormorant dives and swims underwater in the pursuit of its prey to depths that exceed 12 m. The search begins at 6 AM during the reproductive pe-

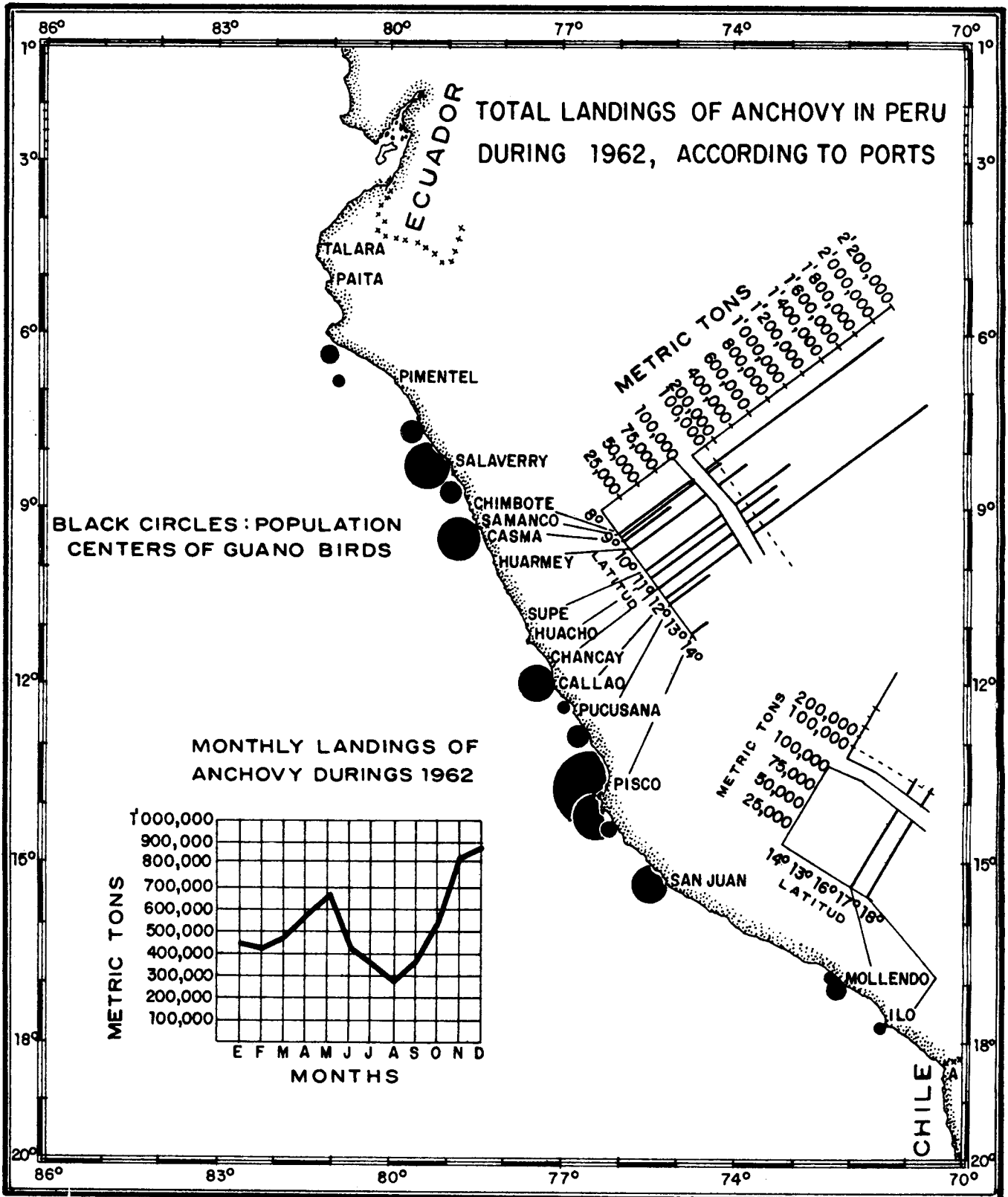


FIGURE 1. Geographical distribution of population centers of guano birds and anchovy landings during 1962.

riod and after 8 AM during the rest of the year. The fishing activity lasts until sunset.

The gannet dives from a certain air altitude to reach the depth required, probably not exceeding 15 m of depth. The feeding hours begin at dawn and continue during daylight.

The pelican dives from the air in a manner similar to that of the gannet, but rarely submerges the whole body. The sea depth reached is therefore limited to the length of its neck. This species feeds at different hours of the day and also during the night.

It has been stated that the operative range of these birds, with special reference to the cormorant, is between 30 and 40 nautical miles and they clearly prefer to seek their food near the coast rather than offshore. However, the gannets and the pelicans may be encountered more than 50 miles offshore.

Frequently the three species are found fishing in the same areas, competing with each other. On the other hand there also exists a kind of cooperation in detecting the fish schools. The flocks of cormorant are seen flying towards fishing areas first detected by gannets and pelicans, or vice versa.

A study of the sizes of anchovies devoured by the birds, based on examinations of the stomach contents of the cormorant, showed that they capture all size groups between 2 and 14.5 cm SL or 3 and 16 cm TL (Figure 2). This size composition demonstrated

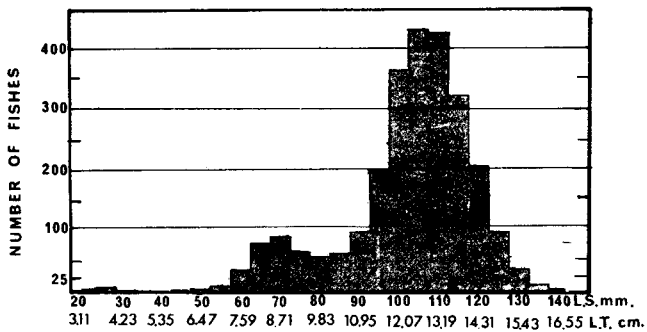


FIGURE 2. Size distribution of anchovies in the stomach contents of the guano. Material collected during 1954-1957.

that the birds can prey upon somewhat smaller fish than those generally caught in the purse seines of the fishermen. This shows that the birds are not selective as to size of the anchovy and are able to capture small sizes, down to 2 cm in length, if they are within their reach.

FOOD CONSUMPTION AND GUANO PRODUCTION

It is estimated that a cormorant, weighing 2 kilograms, consumes an average of 430 grams of food per day (Jordán 1959) and the minimal daily requirement seems to be 200 grams (Barreda 1959).

Different methods have been used to calculate the rate of transformation of food to guano. Gamarra (1941) concluded, from experiments on birds in captivity, that 1 ton of guano was produced from 31 tons of fish. However, more extensive observations

demonstrated that 1 ton of guano is produced by a smaller fish intake. Vogt (1942) found the rate of transformation from food to guano to be 7.3:1 and Hutchinson (1950), using biochemical analysis, suggests that the cormorant could produce 1 ton of guano from between 9.8 and 15.3 tons of anchovy. Avila (1954) found that the conversion factor is between 6.7 and 7.8 and recent experiments carried out by us indicate that an average of 8 tons of anchovy are needed to produce 1 ton of guano. It can be mentioned that the fishmeal factories use about 6 tons of anchovy to produce 1 ton of fishmeal.

According to available information each bird produces between 40 and 70 grams of guano per day.

During the last 54 years the average annual harvest of guano was 130,000 metric tons, with marked annual fluctuations, related mainly to high mortalities of guano birds during certain years when sources of food ran low. The great increase in guano harvesting between 1946 and 1956 is connected with better management of the bird colonies, primarily due to improvement of the nesting sites and protection of various headlands, where important centers of nesting were successfully established.

NUMBERS OF BIRDS AND THE ANCHOVY CATCH BY THE BIRDS

The guano birds and the fishermen are two of the main groups of predators on the anchovy stock. Therefore, it is of interest to establish the magnitude of the bird predation and define the pressure exerted on the anchovy population in different areas.

It was estimated that each bird (cormorant) consumes an average of 430 grams of anchovy per day. Annual bird censuses have yielded data from which we can estimate the quantity of anchovy consumed by the three species of guano birds each year (Table 1).

TABLE 1
ESTIMATED NUMBER OF BIRDS AND QUANTITIES OF ANCHOVY EATEN BY THE BIRDS PER DAY
(in metric tons)

Year	Estimated number of birds (census data)	Anchovy consumed per day in tons
1961-----	12 x 10 ⁶	5,000
1962-----	18 x 10 ⁶	8,000
1963-----	16 x 10 ⁶	7,000

An estimate, based on these values, leads us to the conclusion that annually the guano birds consumed between 1.8 and 2.8 million tons of anchovy during the period 1961-1963.

The geographical and quantitative distribution of the birds in the summer of 1962 is shown in Figure 1. This distribution has remained unchanged during the last years.

If we group the bird numbers according to the areas of two latitudinal degrees (data from the 1962 and 1963 censuses), it will be seen that the distri-

bution was rather uniform along the coast between lat. 8° S. and lat. 14° S. (Table 2). At both ends of the distributional range lower numbers are encoun-

TABLE 2
NUMBER OF GUANO BIRDS, IN THOUSANDS, IN THE COASTAL AREAS OF PERU, ACCORDING TO AREAS OF TWO LATITUDINAL DEGREES

Year	South Latitude					
	6° to 8°	8° to 10°	10° to 12°	12° to 14°	14° to 16°	16° to 18°
1962	1,141	2,027	3,700	5,539	4,309	296
1963	1,603	3,840	4,719	2,813	4,749	350

tered, because ecological factors exert their influence. We can conclude that, at least during spring and summer, the pressure on the anchovy stocks was rather uniform in the whole range between lat. 8° S. and lat. 14° S.

The situation is rather similar as regards the fishing zones exploited by the fishermen as will be seen from Figure 1 and Table 3.

TABLE 3
LANDINGS OF ANCHOVY (IN THOUSANDS OF TONS) DURING 1962-63 ACCORDING TO AREAS OF TWO LATITUDINAL DEGREES

Year	South Latitude					
	6° to 8°	8° to 10°	10° to 12°	12° to 14°	14° to 16°	16° to 18°
1962	--	2,501.8	1,446.3	2,045.5	--	274.2
1963	--	2,155.9	1,816.3	2,031.4	--	419.5

Two main centers of landing stand out: Chimbote (lat. 9° S.) and Callao (lat. 12° S.), which together account for about 50% of the total catch landed in Peru. Intermediate centers are developing rapidly as is also the area between lat. 12° S. and lat. 14° S. (Tambo de Mora and Pisco). Thus it will be seen that fishermen and birds exploit and exert heavy pressure on the anchovy stock in the whole area between lat. 8° S. and lat. 14° S.

There are some very densely populated bird centers, such as La Vieja Island (lat. 14° 17' S.) and the headland Punta Culebras (lat. 9° 57' S.), each of which is temporarily inhabited by about 3 million adult birds, which means that they have to fish about 1,200 tons of anchovy per day for their sustenance.

It was found possible to estimate roughly the great changes that have occurred in the population size during the last 54 years, using the annual harvesting of guano as a basis. Decreases during certain years coincide with changes in the oceanic climate of the Peruvian current. It has been shown (Jordán and Fuentes 1964) that during these abnormal years, the availability of the anchovy for the birds was greatly diminished, which resulted in the break-up of colonies and heavy mortalities.

The marked changes that have occurred in the population size of the guano birds during the period 1955 to 1963, are shown in Figure 3. The increased

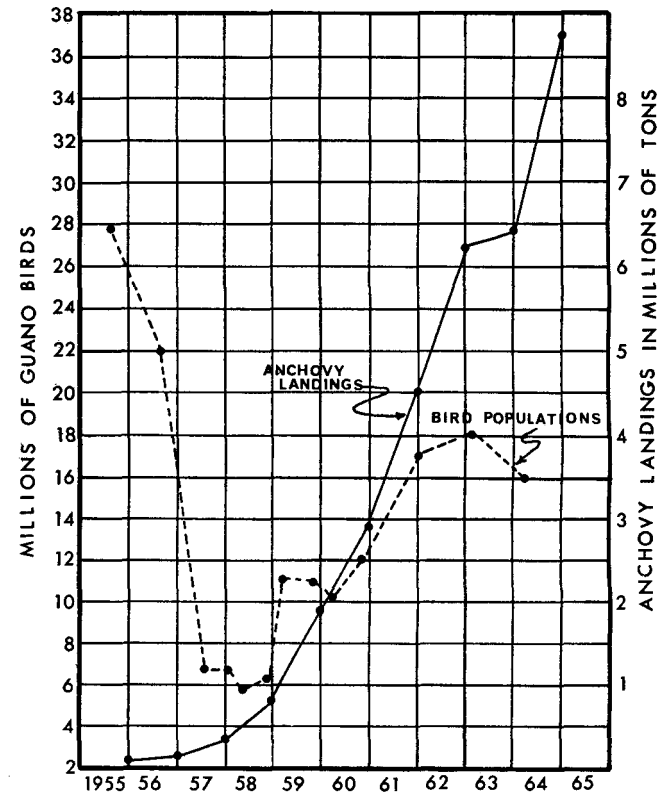


FIGURE 3. The population size of the guano birds and anchovy landings during 1955 to 1964.

anchovy catches by the fishing fleet during the same period are also shown.

The population estimate for 1955 (28 million birds) represents the highest peak ever reached during the last 54 years. During this year the birds may have taken some 4 million tons of anchovy out of the sea, while fishing was still at a low level.

After the great fall in bird numbers that occurred during 1957 and 1958, a steady increase was noted until the beginning of 1963, occurring simultaneously with an enormous increase in the yields of the fishery, which reached about 6 million tons in 1962. During this year the birds extracted some 3 million tons of anchovy out of the sea. A new wave of bird mortalities occurred in the autumn and winter of 1963 (June to September), which reduced the population size considerably at the end. The fishery caught 8.8 million tons of anchovy, apparently without having caused food shortages for the birds.

The future of the guano industry and the fishing industry is entirely dependent on the anchovy resource. From our study of the fluctuations in the population size of the guano birds it can be inferred that the anchovy stock is vulnerable when subjected to marked changes in the oceanic climate. A too heavy predation under such circumstances may have far reaching consequences for the delicate balance

existing in the autonomous regime of the fauna of Peru current.

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