

LOCATION AND CHARACTERIZATION OF NEW
NESTING SITES FOR GRAY GULLS, *LARUS*
MODESTUS, IN THE ATACAMA DESERT, NORTHERN
CHILE

Carlos G. GUERRA C., Lloyd C. FITZPATRICK, Roberto E. AGUILAR P.
and Guillermo S. LUNA J.

INTRODUCTION

Gray Gulls, *Larus modestus*, are found on the west coast of South America from 0° to 40°S latitude during the austral winter, but congregate in northern Chile during the spring-summer breeding season. Though Gray Gulls feed on the beaches they do not nest there. Instead, they nest in the Atacama (Goodall *et al.*, 1945; Howell *et al.*, 1974; Howell, 1982; Guerra and Cikutović, 1983; personal observation), one of the driest and most barren deserts, termed "biologically bankrupt" by Moffett (1969). Until Guerra (Guerra and Cikutović, 1983) discovered an active colony in 1980 at the base of Cerro Negro (aka Palestina Mountain) some 90 km inland, the only reported and studied nesting site was near the Cerros de Colupo in the Pampa del Miraje approximately 35 km inland (*e.g.*, Goodall *et al.*, 1945; Howell *et al.*, 1974; Howell, 1982).

The Colupo colony which was quite large (*ca.* 10,000 nesting pairs in 5.5 km²; Howell *et al.*, 1974; Howell, 1982) and probably composed of Gray Gulls from the sandy beaches between Mejillones and Tocopilla was reported by Devillers and Terschuren (1976) as having abandoned the site. According to local residents at Tocopilla (personal communication to Guerra) the gulls stopped nesting at Colupo as early as 1973-1974. Thus, as of 1980 the only known active nesting colony was the small one at Cerro Negro. Since the Cerro Negro colony probably was composed of gulls from the population inhabiting rocky beaches at Antofagasta, the question arose "Where had all the Mejillones-Tocopilla gulls gone to nest?"

In 1982 we began to address that question by systematically searching the Atacama with 4WD vehicles and a helicopter provided by the Chilean Air Force. Here we report the results of our desert surveys in terms of location and

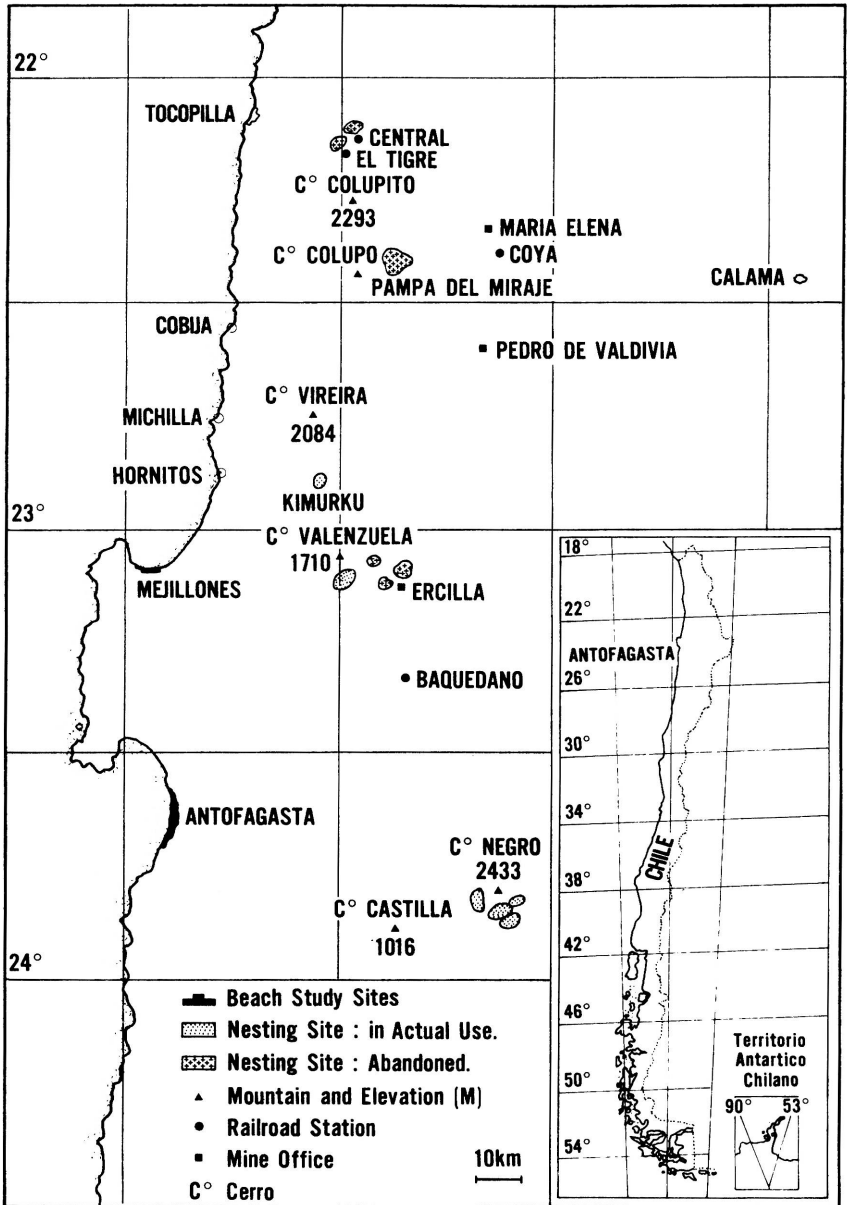


Fig. 1. Map locating active and inactive Gray Gull, *Larus modestus*, nesting sites in the Atacama Desert of northern Chile.

general description of newly discovered active and inactive nesting sites between 22° and 25°S latitude in the Atacama Desert (Fig. 1). Detailed physical and micrometeorological analyses of these sites, and studies of active nesting colonies are underway and will be reported as completed.

MATERIALS AND METHODS

From the breeding season (November-February) of 1982-1983 to that of 1985-1986 we explored a stretch of the Atacama using 4WD vehicles and a helicopter. Our search was based on reports of observations by miners, railway workers and long time residents of northern Chile, topographic maps, our familiarity with the terrain used by *L. modestus* for nesting, and our observations of directions taken by nesting gulls as they returned to the interior after daily foraging on the beaches.

RESULTS AND DISCUSSION

Fig. 1 provides the general location of the nesting sites which we discovered during our surveys (specific locations available by written request to the authors). During the 1982-1983 and 1983-1984 breeding-nesting seasons we found only unoccupied sites, though readily identified by excrement (guano) accumulations, shallow nest scrapes in the sand and bones or mummified remains. Later, we determined (Guerra *et al.*, 1988) that *L. modestus* failed to reproduce during the 1982-1983 and 1983-1984 as a consequence of the August 1982-April 1983 El Niño Southern Oscillation (see Tropical Ocean-Atmosphere Newsletter 1983). In 1984-1985 and 1985-1986 Gray Gulls nested and we located colonies in the Kimurku-Valenzuela area and at Cerro Negro (*ca.* 35 and 90-100 km, respectively inland. The 100 km colony at Cerro Negro is in addition to that reported by Guerra and Cikutović (1983) at 90 km from the coast.

None of the active colonies were as large or dense as the Colupo colony (*ca.* 10,000 pairs in 5.5 km²) studied by Howell *et al.* (1974). In marked contrast, gulls were nesting in small widely dispersed groups (*i.e.*, sub-colonies) at least several kilometers apart with individual nests frequently separated by several hundred meters. In both Kimurku-Valenzuela and at Cerro Negro we found subcolonies over 10 km apart. The hyperdispersed nesting pattern within and among subcolonies, and asynchronous laying (see Howell *et al.*, 1974) make it extremely difficult to find groups and individual nests, and impossible to accurately quantify density.

Though our observations are only preliminary and further field work necessary, we believe that *L. modestus* is evolving from nesting in large dense colonies close to the coast to smaller hyperdispersed groups deeper in the Atacama. We believe that predation, including egg exploitation by humans, is a major selective pressure (Howell *et al.*, 1974, noted predators, but did not consider them an important mortality source at Colupo). In January 1985 we observed intense egg predation at Kimurku (*i.e.*, 13 of 14 nests within 1 km² contained freshly eaten eggs) by five Turkey Vultures, *Cathartes aura*. We also saw a falcon (*Falco* sp.) flying over the nesting site. The following year (February 1986) we found freshly predated remains of 17 adults and a falcon pellet containing adult parts at the same site. We also observed a Turkey Vulture searching the site and one nest (the only active nest at the site that day) containing a freshly eaten egg. We have not observed any predators at Cerro Negro or evidence of predation.

Guerra received a report from a Tocopilla resident that Turkey Vultures and Condors (*Vultur gryphus*) began visiting the Colupo and El Tigre sites (Fig. 1) a few years before they were abandoned. The same resident who had been a dealer in "garuma" (local name for Gray Gulls) eggs recounted to Guerra stories of intensive egg harvests before Colupo was abandoned in 1973-1974. Thousands of eggs were removed and/or destroyed by egg hunters from Tocopilla.

The only Colupo-like densities which we found were in abandoned Kimurku-Valenzuela sites (Fig. 1). Density is reflected by guano deposits, nest scraps and mummified remains. At Kimurku we censused mummies in three randomly-selected quadrats (6272 m² each) and calculated densities of hatchlings, intermediate-sized chicks, fledglings and adults of 99, 38, 7.5 and 1.6 per ha, respectively. Obviously, mortality was integrated through time and the proportion due to predation impossible to determine. However, nowhere else have we observed such mortality.

All active and inactive nesting sites share certain physical characteristics as well as common general meteorological conditions (see Howell *et al.*, 1974, and Guerra and Cikutović, 1983). Gulls establish nests in areas where the sandy substrate is covered with small rocks. We have not discovered nesting sites in areas without rocks. At Cerro Negro the colonies nest on the alluvial slopes which are dissected by numerous dry channels. Elsewhere gulls nest more frequently on flatter areas in the pampas. The rocks and dry channels are used by chicks, principally as refugia from the cold dry northeast night wind and for shade in the morning. Examination of the rocks reveals guano accumulation almost always on the southwest or leeward (relative to the northeast nightwind) side (see Fig. 2), indicating years of use by chicks. Our preliminary micrometeorological measurements demonstrate considerable difference in wind velocity and surface/air temperatures among various sides of rocks, and marked difference from ambient conditions at 1 m above the desert floor. For example, on 28 January 1986 at 11:50 h we measured wind velocity (with a Datametrics 100 UT airflow metre), temperature and relative humidity (with a Digi-Sense Type K Thermocouple digital thermometer with psychrometer probe) around a

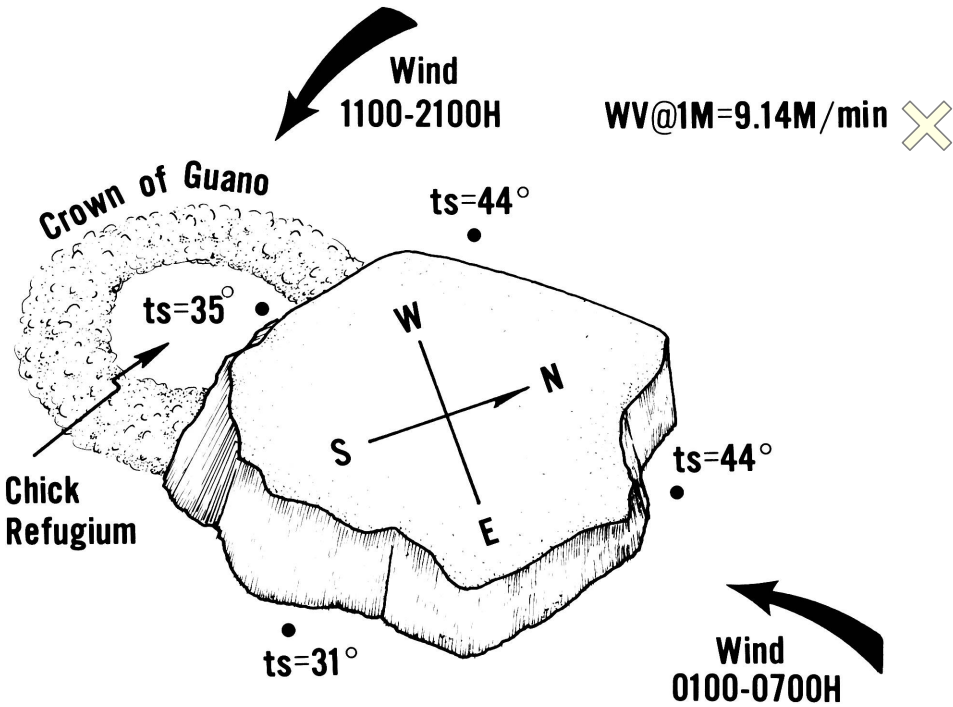


Fig. 2. Micrometeorological conditions at a rock shelter (25 x 27 x 16 cm) in Kimurku used by Gray Gull, *Larus modestus*, chicks measured at 11:50 h on 28 January 1986: ts = shaded surface temperatures, ta = air temperature at 1 m, WV = wind velocity at 1 m, wv = wind velocities immediately above surface next to rock.

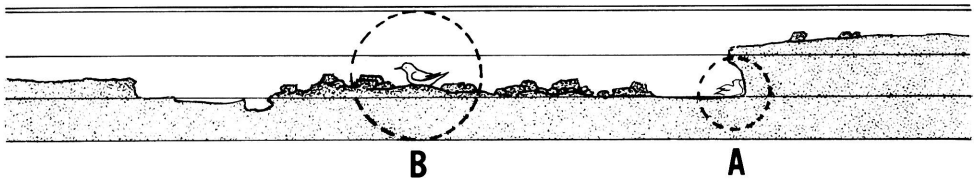


Fig. 3. Diagram showing relation of dry channel chick refugia (A) and open sites among rocks where adults construct nests (B).

Table 1. Diel micrometeorological conditions within a shallow dry channel refugium (CR) used by Gray Gull, *Larus modestus*, chicks compared with ambient conditions (ac) one meter above surface during 5-6 February 1986 in the Atacama Desert near Cerro Negro.

Time	Temperature				Relative Humidity		Wind Velocity*	
	Air		Surface		CR	AC	CR	AC
	CR	AC	CR	AC				
0851	18.0	18.5	18.0	17.0	67	69	0	0
0955	22.0	23.0	21.5	21.0	60	59	61	91
							122	122
1150	28.0	26.5	26.5	44.0	51	41	0	15
							6	21
1255	30.0	29.0	19.0	48.0	42	40	0	15
							6	30
1410	34.0	31.0	32.0	54.0	42	34	122	335
							213	609
1610	31.0	27.5	35.5	44.5	49	47	183	457
							366	670
1710	31.0	26.0	34.0	40.5	52	49	213	549
							427	732
1810	28.0	25.0	30.0	35.0	55	40	182	305
							207	549
1910	25.5	22.0	25.5	29.5	57	54	30	213
							61	366
2010	21.5	20.5	22.0	25.0	58	59	182	305
							305	610
2110	19.5	19.0	20.5	22.5	68	65	0	15
							15	30
2200	17.5	16.0	19.0	16.0	84	88	0	152
							15	183
2400	17.0	16.0	18.0	13.0	76	78	0	0
0200	14.0	12.0	17.0	10.5	90	94	46	73
							55	91
0400	13.5	12.5	15.0	10.0	90	89	15	30
							46	61
0600	13.0	13.0	14.0	10.5	77	77	46	122
							61	152
0800	14.5	14.5	15.0	11.5	71	77	9	61
							21	88

* given as Minimal/Maximal meters per minute at each recording because wind varies in velocity over short periods.

rock frequently used by chicks at Kimurku. Fig. 2 provides the results, general orientation and size of the rock, and wind direction chronology.

Table 1 is a comparison of the diel micrometeorological profile of one of the dry channel refugia for chicks with exposed ambient conditions at Cerro Negro made on 4-5 February 1986. As with measurements close to the rock (Fig. 3), conditions in the refugium differ markedly from those in an exposed area. Though rock and channel refugia offer protection to chicks, adults establish nests in which they incubate (see Howell *et al.*, 1974 for description of behavior) eggs in exposed areas which receive direct benefit of wind during the daylight hours. Without the daily wind, we believe that solar radiation would be too intense for gulls to survive. We have recorded surface temperatures as high as 61°C during the day (and as low as 2°C before dawn). During the hottest period of the day chicks are found in the exposed areas, benefiting from the wind.

We believe from our preliminary micrometeorological data, observations of chick-adult behavior and common characteristics among nesting sites, that specific site selection is based on thermoregulatory constraints in the Atacama. Furthermore, we believe that gulls begin flying to these nesting sites as early as September (personal observation; see Cikutović *et al.*, manuscript submitted), two months before the first eggs are laid (see Goodall *et al.*, 1945) to establish territories with the best micrometeorological characteristics commensurate with thermoregulation. We have observed territoriality among nesting adults at Cerro Negro. However, distance of the nesting sites from the coast may be more of a function of predation, including human exploitation of eggs than factors related to thermoregulation (*i.e.*, there are numerous potential nesting sites in the Atacama that are not used).

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SUMMARY

Nests sites of Gray Gulls, *Larus modestus*, in the Atacama Desert of northern Chile, between 35 and 100 km from the coast, are described in physiographic, micrometeorologic and ecologic terms. Nests are located only in areas of the dry desolate pampas strewn with small rocks and / or dissected

by small dry channels, both of which are important for behavioral thermoregulation of chicks. In actively-used sites, nests are widely dispersed within and among subcolonies; in marked contrast to old abandoned sites which had high densities of nesting gulls.

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RESUME

Les sites de nidification du Goéland gris, *Larus modestus*, établis dans le Désert d'Atacama au nord du Chili, entre 35 et 100 km des côtes ont été décrits en termes physiographiques, micrométéorologiques et écologiques. Les nids sont établis seulement dans les pampas sèches et désolées parsemées de petits rochers et/ou découpées de petits chenaux asséchés. Ces deux éléments jouent un rôle important dans le comportement de régulation thermique des jeunes. Dans les sites actuellement occupés, les nids sont largement dispersés au sein des colonies et en sous-colonies: ce qui contraste avec les anciens sites abandonnés qui présentaient de hautes densités de goélands nicheurs.

SAMENVATTING

De broedplaatsen van de Grijze Meeuw, *Larus modestus*, in de Atacama woestijn van noord Chili, tussen 35 en 100 km van de kust verwijderd, worden in fysiografische, microclimatologische en ecologische termen beschreven. Nesten bevinden zich uitsluitend in gebieden van de droge desolate pampas bezaaid met rotsblokken en doorsneden met door de natuur gevormde droge

kanalen; deze spelen beide een belangrijke rol in de thermoregulatie van de pulli. In de kolonies waar thans Grijsz Meeuwen broeden zijn de nesten wijd verspreid; dit is in tegenstelling met oude verlaten broedplaatsen waar de nestdensiteit hoog was.

Carlos G. GUERRA C., *Instituto de Investigaciones Oceanologicas, Universidad de Antofagasta, Antofagasta, Chile.*

Lloyd C. FITZPATRICK, *Department of Biological Sciences, University of North Texas, Denton, TX 76203, USA.*

Roberto E. AGUILAR P. and Guillermo S. LUNA J., *Instituto de Investigacions Oceanologicas, Universidad de Antofagasta, Antofagasta, Chile.*

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