tudes and breeds in lower latitudes. Therefore they only exhibit a mouth-open behaviour when they are in colder waters, not in warmer waters when they would be more likely to be thermally stressed. More work is needed to document all the potential functions of the baleen whale palate.

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Climate and cocaine

SIR — It is difficult to obtain information about the production of clandestine crops such as the coca (*Etythrozylum coca*) leaf. We have used production of coca leaf in Bolivia as a test of the effectiveness of remote climate analysis in obtaining such surveillance information. Bolivian coca production provides about 40% of the world's supply of illicit cocaine[1] but is difficult to monitor because of the severe restrictions on its sale.

We studied coca-leaf production influenced by fluctuations in rainfall at distant Bolivian stations. Monthly data (1976–81) of production for one of the two coca-producing regions of Bolivia, the Chapare (see figure), were correlated with the number of days of rain for 15 Bolivian stations. We restricted study to the high-Sun rainy season (November–February) which comprises 40–50% of the annual coca production period[1]. Our monthly coca production values were obtained from Bolivian government records compiled from the checkpoint on the single road to the Chapare region[2] and were standardized by month.

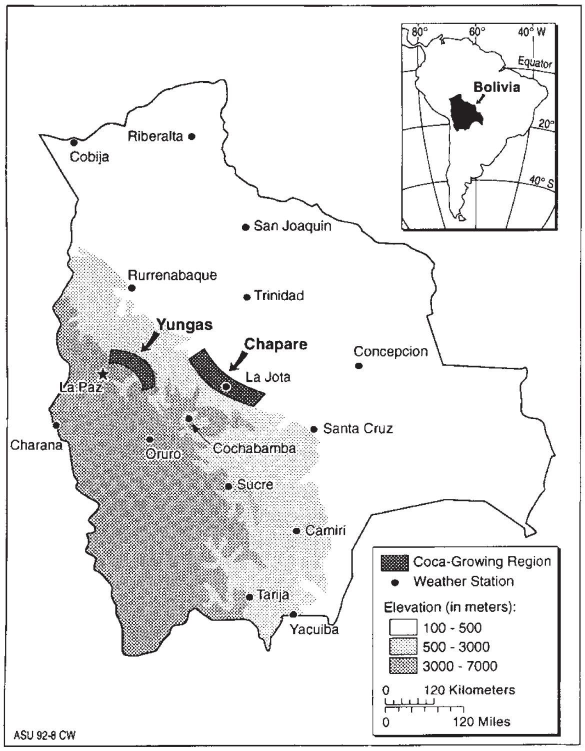
Climate was represented by (1) the total monthly rainfall and (2) the number of days with rainfall 1 mm or greater. As with the coca values, our climate data were standardized by month (1961–86) as documented in ref. 3 and from locally obtained data.

Although Bolivian monthly rainfall is significantly linked to coca production, the number of days of rain per month is more closely related to Chapare coca production (see table). Almost all major Bolivian stations demonstrate a strong inverse relationship between days of rain and coca production. Production decreases as the number of rain days increases, and this relationship is highly significant at seven locations. For example, the number of rain days at Rurrenabaque (approximately 150 km from the Chapare) explains 64% of the variance in coca production.

COCA PRODUCTION AND CLIMATE

Weather station	Geographical land type	Rainfall	Rain days
Camiri	Transitional	−0.59(20)†	−0.47(20)*
Charana	Altiplano	0.27(9)	−0.70(9)*
Cobija	Tropical lowland	−0.35(20)	−0.36(20)
Cochabamba	Altiplano	−0.37(20)	−0.46(20)*
Concepcion	Tropical lowland	−0.47(9)	−0.27(9)
La Paz	Altiplano	−0.55(20)*	−0.58(20)†
La Jota	Transitional	−0.68(14)†	−0.77(14)†
Oruro	Altiplano	−0.70(20)†	−0.54(20)*
Riberalta	Tropical lowland	0.30(20)	0.06(20)
Rurrenabaque	Tropical lowland	−0.03(19)	−0.80(19)†
Santa Cruz	Tropical lowland	−0.16(20)	−0.72(20)†
Sucre	Altiplano	−0.57(20)†	−0.70(20)†
Tarija	Transitional	−0.41(20)	−0.46(20)*
Trinidad	Tropical lowland	−0.02(20)	−0.63(20)†
Yacuiba	Transitional	−0.27(20)	−0.75(20)†

Correlation coefficients between high-Sun coca production in the Chapare region and two climate variables recorded at 15 Bolivian cities. Numbers in parentheses refer to the number of available months used to compute the coefficient. Asterisk, coefficient significant at $\alpha = 0.05$; dagger, coefficient significant at $\alpha = 0.01$.



Meteorological stations for this study, and the two primary coca-producing regions (the Chapare and Yungas regions) of Bolivia.

The relationship is not likely to be related to physiological growth factors. We propose that the number of rain days constrains the harvest by decreasing the time available to dry the picked coca leaves. In general, a two- to three-day drying time is needed to ensure a good harvest[4]. The greater the number of rain days, the fewer leaves are produced for market.

The effectiveness of this remote climate relationship between the number of rain days at various Bolivian cities and coca production is explained by the geography of the country. Cities where rain day totals are strongly linked to Chapare coca production are either geographically close to the coca-producing region (for example, La Jota, Trinidad); located in the climate region defined by the large transition zone between the lowland rainforests and the Altiplano region (for example, Santa Cruz, Rurrenabaque); or derive their precipitation from the same regional moisture flow as the coca-producing area (for example, La Paz, Sucre).

Unfortunately, the lack of recent coca harvest data[1] and on-site climate data prevents independent prediction of coca production. However, because of the strong inverse relationship described above, first-order approximations of coca production can be achieved by remote weather monitoring. In particular, the use of modern technology (such as satellite imagery) might substitute for the scarcity of on-site climate information for such sensitive regions. We suggest that the study of climate in this way may improve the monitoring, prediction and perhaps eventual control of the coca supply.

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1. Narcotics Intelligence Consumers Committee *The Supply of Illicit Drugs to the United States from Foreign and Domestic Sources in 1988–1989* (1990).
2. Orellana, A. C. & Zannier, J. C. C. *Bolivia: Coca Cocaina (Subdesarrollo y Poder Político)* (Los Amigos Del Libro, Cochabamba, Bolivia, 1982).
3. World Meteorological Organization *Monthly Climatic Data for the World* Vols 15–39 (NOAA, Asheville, North Carolina, 1962–1986).
4. Henkel, R. *The Chapare of Bolivia: a Study of Tropical Agriculture in Transition* (University of Wisconsin, 1971).