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California sea lions (*Zalophus californianus californianus*) have lower chlorinated hydrocarbon contents in northern Baja California, México, than in California, USA

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Results suggest that sea lion prey must also have lower hydrocarbons in Baja California than in California in the USA.

Abstract

Chlorinated hydrocarbons (CHs) were determined in blubber samples of 18 California sea lions (*Zalophus californianus californianus*) that stranded dead along Todos Santos Bay, Ensenada, Baja California, México, January 2000–November 2001. ∑DDTs were the dominant group (geometric mean 3.8 μg/g lipid weight), followed by polychlorinated biphenyls (∑PCBs, 2.96 μg/g), chlordanes (0.12 μg/g) and hexachlorocyclohexanes (0.06 μg/g). The ∑DDTs/∑PCBs ratio was 1.3. We found CH levels more than one order of magnitude lower than those reported for California sea lion samples collected along the California coast, USA, during the same period as our study. This sharp north–south gradient suggests that *Z. californianus* stranded in Ensenada (most of them males) would probably have foraged during the summer near rookeries 500–1000 km south of Ensenada and the rest of the year migrate northwards, foraging along the Baja California peninsula, including Ensenada, and probably farther north.

Keywords: Chlorinated hydrocarbons; Organochlorines; Pesticides; Polychlorinated biphenyls; *Zalophus californianus californianus*; Baja California

1. Introduction

Chlorinated hydrocarbons (CHs) including polychlorinated biphenyls (PCBs) and several chlorinated pesticides such as DDTs (i.e., DDT and its metabolites DDE and DDD) are contaminants distributed worldwide in the marine environment; it is estimated that all marine mammals alive today have been exposed to these persistent organic contaminants (Mössner and Ballschmiter, 1997; Marine Mammal Commission, 1999). Most CHs are highly fat soluble (lipophilic) and have low water solubility (hydrophobic), allowing them to bioaccumulate in fatty tissues of aquatic organisms (O'Shea, 1999). Given the affinity of CHs for fatty tissues, they preferentially accumulate (store) in marine mammal blubber (Aguilar and Borrell, 1991). For this reason, most of the published reports related to the monitoring of contaminants in marine mammals refer only to concentrations of PCBs and chlorinated pesticides in blubber (Le Boeuf, 2002; Marine Mammal Commission, 1999). Marine mammals have been proposed as global pollution indicators of these ubiquitous contaminants because many species have long lifespans, are in a high trophic level and store large amounts of fat in their blubber (Mössner and Ballschmiter, 1997).

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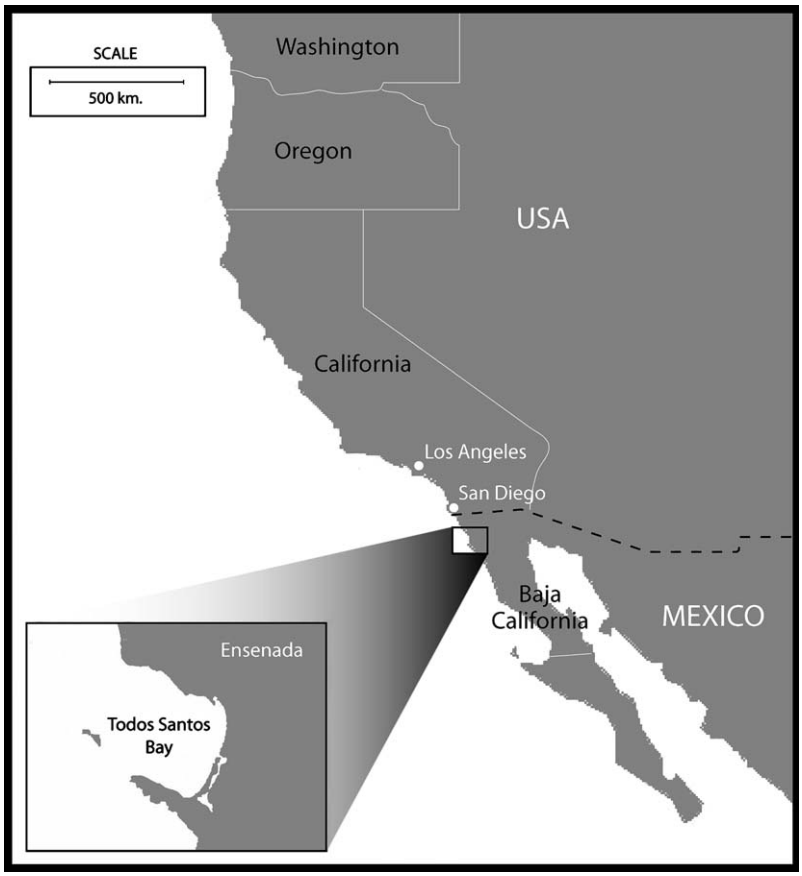

Fig. 1. Location of Todos Santos Bay, Ensenada, Baja California, México.

Given the potential adverse effects (e.g. depression of the immune system, reproductive impairment, lesions of the adrenal glands, etc.; see Aguilar et al., 2002; and references therein) that environmental levels of CHs may pose on marine mammal populations, many refereed articles (30–40 per year in the 1990s) reporting CH levels in different species of marine mammals appear every year in the literature (Aguilar et al., 2002). In spite of this, the amount of literature reporting CHs in California sea lions (*Zalophus californianus californianus*) is still limited. To our knowledge, there are less than a dozen refereed articles published between 1971 and 2004 on organochlorines in this species (see Le Boeuf and Bonnell, 1971; DeLong et al., 1973; Gilmartin et al., 1976; Lieberg-Clark et al., 1995; Hayteas and Duffield, 1997; O'Shea and Brownell, 1998; Kajiwara et al., 2001; Le Boeuf, 2002; Le Boeuf et al., 2002; Kannan et al., 2004) in spite of the extremely high concentrations ($>1000\ \mu g\ g^{-1}$ lipid weight) of DDTs reported for blubber of some specimens in the earlier studies (Le Boeuf and Bonnell, 1971; DeLong et al., 1973). Follow-up studies (Lieberg-Clark et al., 1995; Le Boeuf et al., 2002) indicated a decrease with time on DDT contamination in California sea lions; however, a recent study concluded that DDT and PCB levels in California sea lions stranded along the coast of California (USA) are still among the highest in marine mammal populations (Le Boeuf et al., 2002; Kannan et al., 2004). The recent observed levels remain above concentrations reported to cause inmunotoxicity or endocrine disruption (Kannan et al., 2004).

The present study was carried out because of the lack of reports on CHs in California sea lions inhabiting the Pacific coast of Baja California (México), and because of the relative proximity of the study site, Todos Santos Bay, Ensenada (located about 200 km south of San Clemente Island), to the rookeries in southern California (Fig. 1), where high concentrations of CHs have been reported (Le Boeuf and Bonnell, 1971; Kajiwara et al., 2001; Le Boeuf et al., 2002; Kannan et al., 2004). California sea lion strandings, particularly of male specimens, along the coast of Todos Santos Bay are common (Bravo, 2003; Bravo et al., in press). This provided the opportunity to study the environmental quality of their habitat through the analysis of CHs in their blubber.

2. Materials and methods

Blubber samples were collected from 18 dead California sea lions (15 males, two females, and one undetermined sex) stranded between January 2000 and November 2001 along Todos Santos Bay, Ensenada, Baja California, México. Todos Santos Bay is located between 31°43′ and 31°54′N and 116°36′ and 116°49′W. During sampling data were registered according to Geraci and Lounsbury (1993): location, sex, age group, total length, blubber thickness and carcass decomposition state (i.e., advanced, incipient or fresh; Table 1). Blubber samples (3 cm^3) were collected from the ventral area of the stranded animals, based on the method described by Dierauf (1994).