rowest boards attracted from only a few centimeters, whereas the widest ones attracted seedlings at distances up to 70 cm. Seedling mortality resulting from burial under falling debris, leaves, and branches is very high, and the growth of seedlings is very slow (less than 10 cm/month); therefore only those seedlings within a few decimeters are able to reach the host before being buried under dead leaves.

As skototropism might be dangerous for a photosynthesizing plant, we set up a dark cul-de-sac to see how far vine seedlings would grow into the dark. We placed a box with three sides and a top on the ground next to several seedlings. The open side of the box, 1 m wide and 15 cm high, was perpendicular to the growth direction of the vines. After 2 months the vines had grown into the box and in a sinusoidal pattern parallel to the open end. They were caught, oscillating just inside the mouth of the box. The vines apparently switch to positive phototropism when the light grows very dim, but switch again to skototropism when the light grows brighter. This switching could be homologous to the first positive and first negative phototropic responses found in taxa used in laboratory plant physiology. However, *Monstera gigantea* shows no second positive phototropic response. At all but minimal light levels these vines are skototropic, hence this response is distinct from those described by classical laboratory plant physiology (*6, 7*).

Skototropism ceases when the horizontally growing seedling meets a tall, vertical surface. In our experiments, seedling growth changes to positively phototropic within 1 month of meeting the tree. During this period leaf morphology changes into that of the second, saucer-leafed stage. The positively phototropic response of the second stage is demonstrated by the growth of seedlings that encounter the tree deep in a crotch between a pair of buttresses; growth in this case is upward but also distinctly outward into areas more exposed to sunlight. The first saucer leaves are small, about 1 cm in diameter, and are light green. During ascent the leaves darken; the highest saucer leaves can be 25 cm in diameter and are often dark green and covered with epiphyllae. The transformation from the saucer-leaf to adult stage occurs when the vine emerges into direct sunlight. We infer this from observations of the transition positions on the host trunk from saucer-leafed to adult *Monstera gigantea*. When the species ascends a trunk in unshaded sunlight it assumes adult morphology at only a few meters above the ground. Also, we have not found the adult morphology beneath understory canopy.

Skototropism is the only means yet proposed that will lead a vine directly to a host. Random searching (*2, 4*), negative geotropism (*3*), positive phototropism (*5*), or growth away from the light (*2, 8*) can only lead the seedling into an area where there may be a host, or into a light area where the vine can photosynthesize until it finds a host by random movement. Because of its obvious adaptive value skototropism may be a general mechanism for host location in ground-germinating arboreal vines (*9*). We can find only one previous author, though, with data that can be interpreted to indicate a whole-plant skototropic response. In this case an unidentified vine species is described as pursuing a stake that was moved daily to a different position relative to the sun's diurnal course. However the author offers this, not as evidence of skototropism, but as "proof" of the "consciousness of plants," "that they think," and that "plants belong to the philosopher class" (*10*).

DONALD R. STRONG, JR.
THOMAS S. RAY, JR.
Biological Science Department, Florida State University, Tallahassee 32306

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Brown Pelicans: Improved Reproduction off the Southern California Coast

Abstract. *Although still about 30 percent too low for population stability, productivity of California brown pelicans at their two northern colonies has improved significantly since 1971. Numbers of adults breeding probably reflect food supplies and recruitment from more successful colonies to the south, but improving fledging rates (up to 0.9 young per nest in 1974) reflect better egg survival and improving eggshell condition, with declining DDE contamination in anchovies, their major food source.*

In recent years, population declines in brown pelicans (*Pelecanus occidentalis*) have become symbolic of man's pollution of the oceanic environment. The reasons for these declines have been debated among conservationists and scientists. Our studies since 1970 have disclosed some of the major factors in the widely publicized decline of the northern populations of the California brown pelican (*P. o. californicus*) and indicate that this decline (*1, 2*) is now slowing or reversing.

The area where reproductive problems have been most severe is off the Pacific Coast of southern California and northwestern Baja California. This report summarizes data that we have gathered at the two breeding colonies in that area, Anacapa Island and Isla Coronado Norte (*3*).

Productivity at the two colonies has increased, from a total of four young fledged in 1969 to 1185 fledged in 1974 (Table 1). The high figure in 1974 partly reflected an increase in numbers of adults attempting to breed, most likely in response to an increase in the biomass of northern anchovies (*Engraulis mordax*) in southern California waters (*4–7*) (Table 1), plus some recruitment of first-breeders from the more successful populations to the south (*2*). However, since 1970, there has also been a steady increase in fledging success (Table 1). The fledging rates did not differ significantly between the two colonies and averaged 0.9 young per nest. This is about 30 percent below the fledging rate of 1.2 to 1.5 young per nesting pair estimated as necessary to maintain a stationary population in the eastern brown pelican (*P. o. carolinensis*) (*8*).

Eggshell thickness has gradually increased (Table 1), although the mean is still significantly less than the normal (before 1943) mean of 0.572 mm (*9*). In 1974, thickness of intact eggs at Anacapa and Coronado was 16 percent, and crushed or

Table 1. Recent history of brown pelicans breeding off the coast of southern California and northwestern Baja California; productivity totals include Anacapa and Santa Cruz Islands and Isle Coronado Norte (*3*). Abbreviation: C.L., confidence level.

Year	No. nests built	No. young fledged		Eggshell thickness*					Anchovy abundance†
				Crushed/broken		Found intact		Reference	
		Total	Per nest	No.	$\bar{X} \pm$ 95% C.L. (mm)	No.	$\bar{X} \pm$ 95% C.L. (mm)		
1969	1125	4	0.004	53	0.288 ± 0.016	12	0.402 ± 0.019	(*14*)	140
1970	727	5	0.007	72	0.286 ± 0.014	16	0.393 ± 0.021	(*28*)	70
1971	650	42	0.065	17	0.310 ± 0.030	6	0.460 ± 0.026		80
1972	511	207	0.405	25	0.294 ± 0.034	4	0.438 ± 0.024		195
1973	597	134	0.225	26	0.343 ± 0.033	4	0.510 ± 0.068		275
1974	1286	1185	0.922	27	0.378 ± 0.033	59	0.482 ± 0.016		355

*Arithmetic means are given. Normal eggshell thickness for this population is 0.572 ± 0.010 mm (N = 11) (*9*); eggshells were measured by standard techniques (*9*). Intact eggs included some destroyed by predators. Thickness data for 1969 to 1973 are from Anacapa and Santa Cruz only; those for 1974 also include samples from Isla Coronado Norte, which were not significantly different. †This is an estimate of biomass expressed as thousands of schools per census in a fixed area off southern California during January to June, as derived from figure 6 of Mais (*4*).

broken eggs were 34 percent, below this normal value. In eastern brown pelicans, a slow population decline was associated with a mean of 15 percent eggshell thinning (*10*), but a population with 9 percent thinning appeared stationary (*11*).

Levels of DDE and other DDT-related materials (*12*) in the southern California offshore environment have been among the highest known (*13, 14*). Concentrations of DDT materials in various samples taken from the mid-1950's to the early 1970's along the California coast showed significant increases in the vicinity of Los Angeles (*15, 16*). DDT materials were first detected in the sediments of the Santa Barbara Basin in the early 1950's and continued to increase in samples from that area at least through 1970 (*15, 17*). The major source of this contamination was found to be the discharge at a sewage outfall associated with a Los Angeles plant that manufactured technical DDT (*15, 18, 19*). After April 1970, this plant's liquid wastes were deposited in a sanitary landfill, and oceanic input of DDT began to decline rapidly (*15, 19*).

Low dietary levels of DDE, an environmentally stable metabolite of DDT, cause eggshell thinning in many species of wild birds (*20*). Data from separate studies on the east and west coasts of North America (*10, 11, 21*) indicate that DDE has been the major cause of shell thinning in brown pelicans. Suggestions that other factors were responsible (*22*) have not been supported (*23*).

Samples of northern anchovies, the major food of brown pelicans off the southern California coast during the breeding season (*6*), were collected from 1969 to 1974 at various locations in the southern California area and analyzed for organochlorine residues (*24*). Because of their relationship to the problems described here, only residues of DDT-related materials (*12*) are reported in Table 2. Other pollutants studied were not related to the problems of eggshell thinning (*21*). (Throughout, we express all combined residue values as geometric means to avoid skewness.)

The highest mean level of DDT plus TDE plus DDE in whole anchovies was 4.3 parts per million (ppm) (fresh weight) in 1969, although one fish in the collection contained 16.7 ppm. This mean probably represents the degree to which the food of pelicans breeding off southern California was contaminated during the period of severe eggshell thinning. After 1969, residues in pooled anchovy samples dropped steadily (Table 2). Residues consisting of DDE and DDT plus TDE were significantly higher in 1969 than in either 1970 to 1972 or 1973 to 1974 ($P < .001$ for both residues) and were significantly higher in 1970 to 1972 than in 1973 to 1974 ($P < .01$ for DDE and $P < .001$ for DDT plus TDE) (*25*). By 1974, the mean for DDE plus TDE plus DDT had dropped 28-fold, to 0.15 ppm.

During the same period, DDT-related residues in brown pelican eggs from Anacapa and Coronado decreased, although not as sharply as in anchovies (Table 2). This slow response is, however, consistent with experimental evidence reported by Haegele and Hudson (*26*). Residues in 1969 were extremely high, particularly in crushed eggs. Residues in bird eggs usually provide an index to residues in the females that laid them (*26, 27*); however, all eggs analyzed after 1969 were intact, so that their concentrations represent minimum levels in the pelican population. In intact eggs, DDE and DDT plus TDE were significantly higher in 1969 than in 1973 to 1974 ($P < .001$) (*25*). Between 1969 and 1974, the mean for DDE plus DDT plus TDE in intact eggs dropped ninefold, from 907 ppm to 97 ppm (lipid weight). In 1974, DDT was not detected in any of the 39 eggs analyzed, and TDE was detected, at very low levels, in only two.

We conclude that the most important reason for the recent improvement in brown pelican fledging rates at Anacapa and Coronado Norte has been the decrease of DDT contamination in the birds and their food. We cannot say whether residues

Table 2. Geometric mean residues of DDT and related compounds (DDE and TDE) (*12*) in anchovies and brown pelican eggs off the southern California and Baja California coasts. Abbreviations: Cr, crushed eggs; In, intact eggs; N.D., residues were not detected (< 2 ppm, lipid basis) (*24*).

Year	Anchovy whole bodies*				Brown pelican egg contents†				Reference
	Residue (ppm, fresh weight basis)				Residue (ppm, lipid weight basis)				
	No.	DDT plus TDE	DDE	Total	No.	DDT plus TDE	DDE	Total	
	Southern California and northwestern Baja California								
1969	11	1.03	3.24	4.27	73 (Cr)	49.0	1155.3	1204.3	(*14*)
					28 (In)	54.2	852.5	906.7	(*29*)
1970	15	0.56	0.84	1.40					
1971	6	0.47	0.87	1.34					
1972	8	0.38	0.74	1.12	10 (In)		220.9	> 220.9	
1973	4	0.11	0.18	0.29	4 (In)	6.5	174.9	182.9	
1974	4	0.03	0.12	0.15	39 (In)	N.D.	96.6	96.6	
	West-central Baja California								
1969	10	0.06	0.20	0.26	16 (In)	5.8	89.5	96.1	(*14*)

*Anchovies were collected from January to August each year. Individual fish were analyzed in 1969 and pools of 10 to 30 fish were analyzed thereafter; sensitivity was 0.01 ppm (*24*). The anchovies from west-central Baja California probably represent a different population (*5*). †Eggs from Coronado Norte were included only in 1969 and 1974. The pelican eggs from west-central Baja California were collected at Isla San Benito.

have been lose to deep sediments, transported out of the area by ocean currents, concentrated in other trophic layers, or metabolized. Brown pelican productivity is still too low for population stability, and continued monitoring and indefinite protection of these colonies will be necessary. Nonetheless, these data are encouraging; we believe they illustrate a significant response by a wild population to distant and largely unrelated antipollution measures.

DANIEL W. ANDERSON
U.S. Fish and Wildlife Service, Post Office Box C, Davis, California 95616

JOSEPH R. JEHL, JR.
Natural History Museum, Post Office Box 1390, San Diego, California 92112

ROBERT W. RISEBROUGH
Bodega Marine Laboratory, University of California, Bodega Bay 94923

LEON A. WOODS, JR.
California Department of Fish and Game, 987 Jedsmith Drive, Sacramento 95819

LAWRENCE R. DEWEESE
WILLIAM G. EDGECOMB
U.S. Fish and Wildlife Service, Denver Wildlife Research Center, Building 16, Federal Center, Denver, Colorado 80225

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Reduced Incidence of Spontaneous Tumors: Another Statistical Analysis

Lacour *et al.* (*1*) report a reduced incidence of spontaneous mammary tumors in C3H/He mice treated with polyadenylate-polyuridylate. They gave only a very crude statistical analysis of their data, and a more careful appraisal may be more enlightening.

The mice were observed for 380 days, with all survivors being killed at this time. Table 1 shows their data immediately before day 380 when the survivors were killed. The appropriate statistical analysis for ascertaining a difference in the incidence of tumors in the two groups up to this point is to calculate the mammary tumor rate, correcting for the intercurrent deaths; that is, deaths from causes other than mammary tumor. This cannot be done properly with the data as they are without making certain assumptions: (i) that on the average the animals dying of other causes were observed for half the observation period, and (ii) that the mammary tumors occurred at a constant rate during the observation period.

On these assumptions, the corrected mammary tumor rates may be calculated by dividing the total tumors by (the total animals observed minus one-half the number of intercurrent deaths). In this case, the rate for controls is $55/[127 - 0.5(29)] = 49$ percent; for treated mice it is $30/[83 - 0.5(31)] = 44$ percent, an obviously not significant difference.

The proper statistical methodology to use in analyzing such an experiment without making these assumptions requires knowledge of the actual times of intercurrent deaths and times of diagnosis of mammary tumors and is fully described by Peto (*2*). The major difference between the treated and control group was, as the authors note, in those mice still alive on day 380 (Table 2: 58 percent versus 23 percent; $P < .025$).

One may thus tentatively draw the conclusion that treatment appears to prevent tumors in a proportion of animals but not delay the appearance of the tumor in those mice it fails to protect completely. An

Table 1. Mammary tumors and total deaths observed up to day 380.

Group	Mammary tumors	Other deaths	Survivors	Totals
Control	55	29	43	127
Treated	30	31	22	83

Table 2. Mammary tumors discovered at autopsy of survivors.

Group	With mammary tumors	Without tumor	Total
Control	25	18	43
Treated	5	17	22