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Source: Journal of Wildlife Diseases, 10(4) : 335-340

Published By: Wildlife Disease Association

URL: https://doi.org/10.7589/0090-3558-10.4.335

RELATIONSHIP OF PULMONARY PARTICULATES IN ENGLISH SPARROWS TO GROSS AIR POLLUTION

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Abstract: English sparrows (*Passer domesticus*) were studied to assess the usefulness of this species as a relatively stationary air sampler and biological indicator of atmospheric pollutants significant to man. Histopathology of bird necropsy tissue revealed numerous granule-laden macrophages in the pulmonary stroma of birds taken from polluted atmospheres (inland sample) but not from unpolluted atmospheres (coastal sample). Electron microscopy demonstrated several different types of particles within pulmonary macrophages of inland birds but not in coastal birds. The results of this study suggest that the English sparrow might serve as a useful indicator of amospheric pollutants and as a model system for studying the effects of an adverse environment.

INTRODUCTION

The English sparrow is a non-migratory species of old-world Weaver finch introduced into North America in the last half of the 19th century.[13] The bird is found only near human habitations throughout most of North America. It is thus exposed to many of the same environmental agents which affect humans and domestic animals. Because of its proximity to human habitations, the species should be exposed to the same atmospheric pollutants which damage the lungs and other tissues of humans, domestic animals, and plants.[1,2,3,4,5,6,7,10,12,14,15] Therefore, in the present study the respiratory tissues of samples of free living English sparrows and the morphologic nature of the foreign contaminants which accumulate in these tissues were studied in order to see if the microscopic lesions could be correlated with gross atmospheric pollution.

MATERIALS AND METHODS

An inland sample of 45 English sparrows was collected by means of live traps in the vicinity of Davis and Sacramento, California, (an area included in the Sacramento Valley airshed, and known to be polluted). A coastal sample of 13 birds was also collected in the immediate vicinity of certain human habitations along the coast near Bodega Bay, California, (an area included in the North Coast airshed and swept clean by prevailing westerly winds).*

Birds were collected by using "Havahart" live traps or cylindrical hardware cloth traps of our own construction. Samples of brain, heart, lung, kidney, skin, liver, adrenal, pituitary and reproductive organs were fixed in 10% buffered formalin and embedded in paraffin in the usual manner for light microscopic examination. Tissue for electron microscopy was fixed in 1.6% glutaraldehyde, post-fixed with 1% Sorenson's buffered osmium tetroxide,[11] embedded in epon, sectioned, stained with Reynolds lead citrate and alcoholic saturated uranyl acetate,[9] and viewed with an AEI 801 electron microscope.

* According to nomenclature of California Air Resources Board.

RESULTS AND DISCUSSION

Histopathology of lungs from birds captured in Davis and Sacramento revealed an abundance of black granules in the cytoplasm of macrophages focally distributed in the subepithelial layers of the tertiary bronchi (Figs. 1 and 2). The granules resembled those commonly observed in the pulmonary macrophages of human city dwellers.[8] Granule accumulation did not occur within the air passage but was limited to the tertiary bronchi. Local accumulations of lymphocytes were also observed in the subepithelial stroma of the tertiary bronchi of some of the inland birds. These accumulations were sometimes but not always associated with the granule-laden macrophages. On the other hand, histopathology of lungs from the coastal collection near Bodega Bay revealed only occasional macrophages containing granules, (Figs. 3 and 4) and no lymphocytic infiltrates.

For each bird an attempt was made to quantitate the number of granules in the inland versus the coastal sample by counting the number of granule-laden macrophages per ten tertiary bronchial profiles as observed in microscopic slides. Table 1 shows the total number of pulmonary macrophages with granules, the range, the average number per bird for each sample, and the standard deviation. In almost every instance, inexperienced observers could correctly assign the lung sections to either the coastal or inland sample by brief examination under the microscope. The results indicate that the inland sample accumulated significantly more granule-laden macrophages than the coastal sample.

By electron microscopy, lung tissue from inland birds showed a variety of particle types within pulmonary macrophages. One common type is illustrated in figure 5. Many of the particles were similar if not identical to those seen in

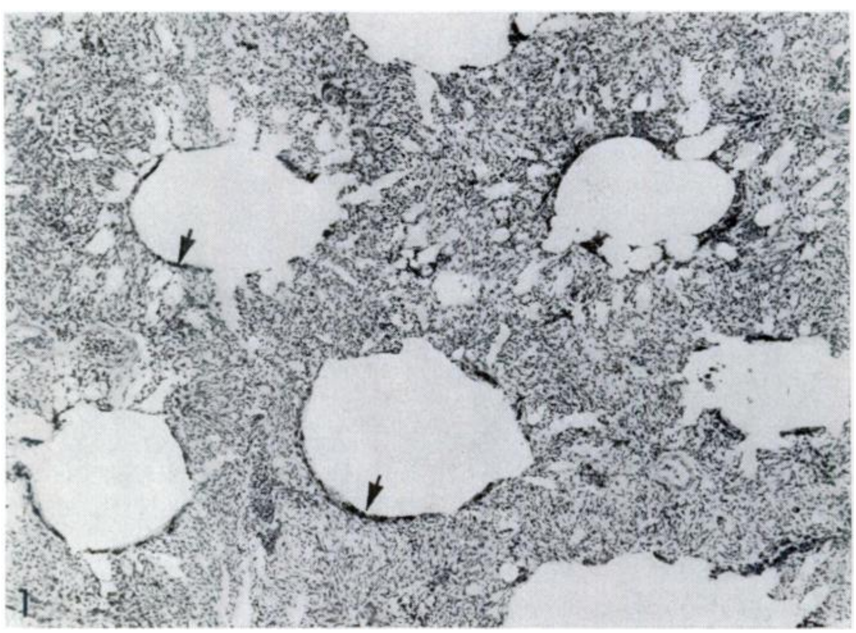

FIGURE 1. Inland sample. Histologic section of lung from English sparrow shows dark material in the subepithelial tissue lining the tertiary bronchi (arrows). The dark material represents macrophages containing black granules. x 100

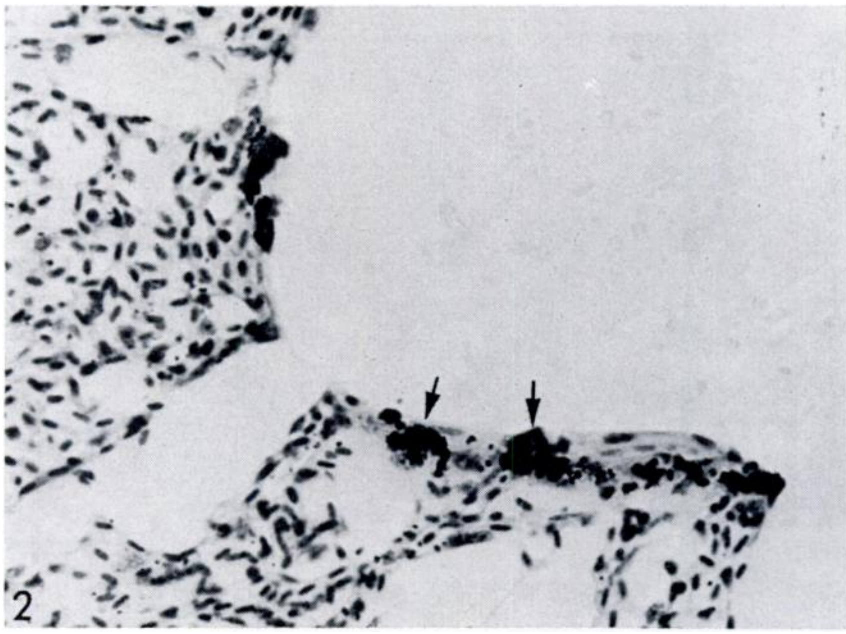

FIGURE 2. Inland sample. Higher power shows macrophages (arrows) containing black granules. x 600

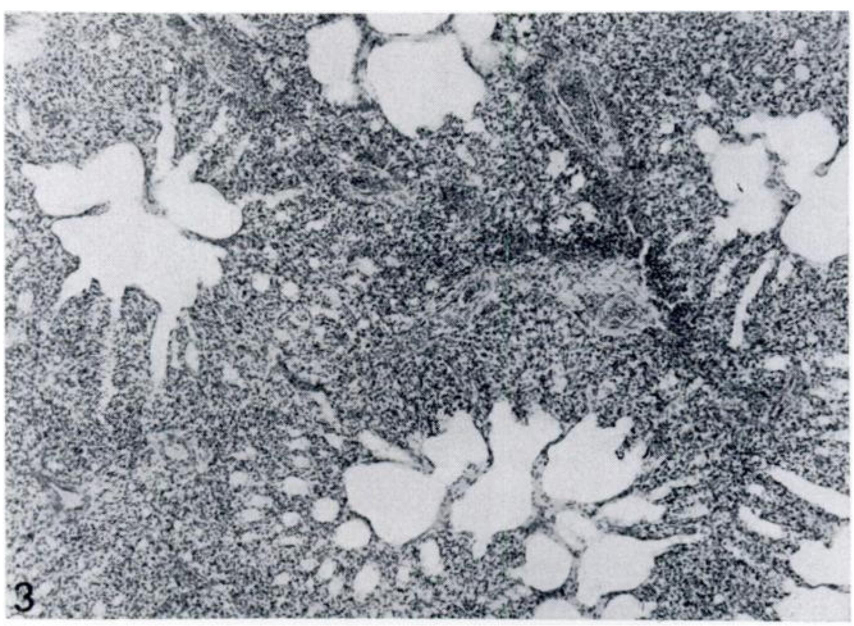

FIGURE 3. Coastal sample. Tertiary bronchi, cut at various angles, show no dark material in the subepithelial tissue at low power. Compare with Figure 1. x 100

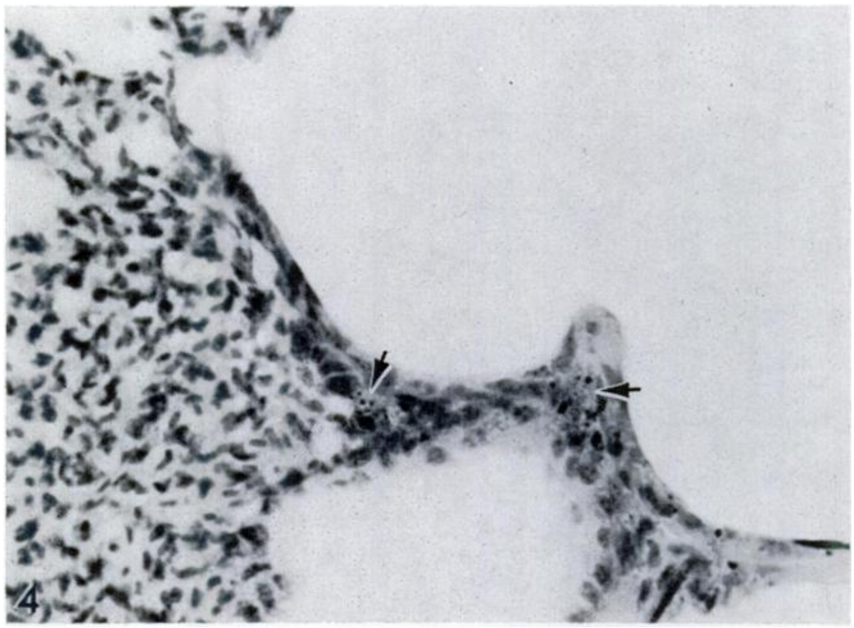

FIGURE 4. Coastal sample. Higher power shows small numbers of black granules, apparently located in macrophages. Compare with Figure 2. x 600

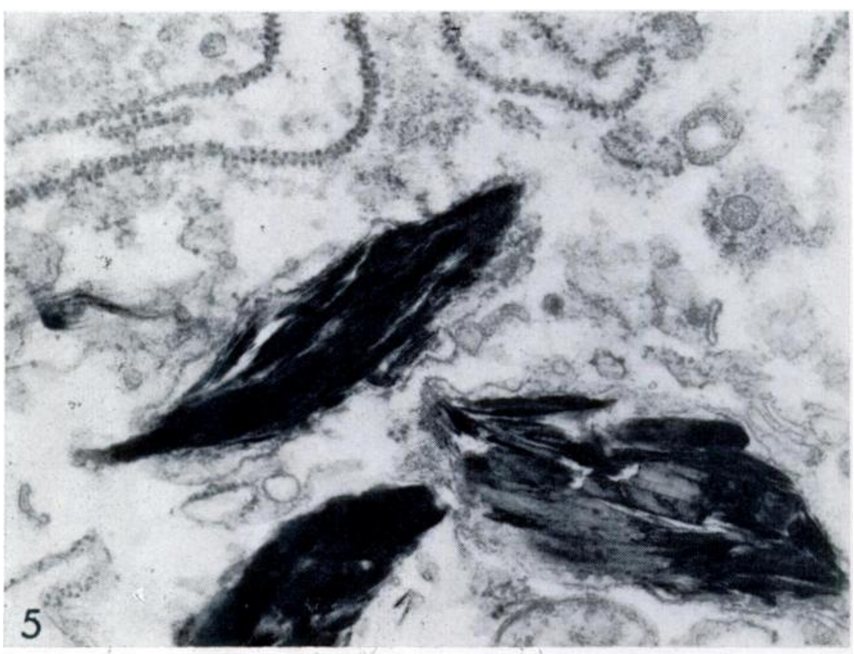

FIGURE 5. Electron micrograph showing three typical particles found in the cytoplasm of pulmonary macrophages of the inland sample. These are interpreted as clay particles. x 40,000

TABLE 1. Number of pigmented pulmonary macrophages in English House Sparrows in coastal and inland collecting sites

Collecting Site	No. of Birds	Total Pulmonary Macrophages with Black Pigment Granules	Range, Pulmonary Macrophages with Black Pigment Granules	Average Number of Pulmonary Macrophages with Black Pigment Granules	Standard Deviation
Sacramento Valley Airshed (Davis and Sacramento)	45	14474	1-1252	308	223.23
North Coast Airshed (Bodega Bay, Calif.)	13	50	0-26	4	7.4

pulmonary macrophages from human lungs of city dwellers in the Sacramento area. Many particles, including those illustrated in figure 5, were ultrastructurally similar to silicate particles described in various soils.[5]

Histopathology of brain, heart, kidney, skin, adrenal, pituitary and reproductive organs revealed no significant difference between the coastal and inland samples. However, most of the inland birds showed mild accumulations of fat droplets, confirmed by staining with Oil Red I, in the cytoplasm of hepatic parenchymal cells. Similar accumulations were not seen in the coastal sample.

A direct correlation between granule accumulation in pulmonary macrophages and the extent of atmospheric pollution is suggested by this preliminary study. It is hypothesized therefore that sparrow lungs accumulate chemical components from polluted air in much the same manner as human lungs, that the histopathology of the respiratory system of the English sparrow can be used as an indicator of atmospheric pollution, and that this species can serve as a model for studying the effects of atmospheric pollutants. The English sparrow is well suited for these purposes because it is common, non-migratory, and found near human habitations. A careful study of the histopathologic changes in pulmonary tissue and the nature of the accumulated contaminants in lungs may therefore be useful in establishing cause and effect relationships between environmental contaminants and resultant disease.

The significance of the fatty infiltration in liver cells and the chemical composition of the granules accumulated in the pulmonary macrophages is yet to be determined. In particular, the possibility should be investigated that toxic substances (e.g., heavy metals or hydrocarbons) enter the respiratory system absorbed on the granules which are phagocytized by macrophages.

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Received for publication 20 February 1974