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Coccidioidomycosis in Northern California

An Outbreak among Archeology Students near Red Bluff

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An outbreak of coccidioidomycosis occurred among 39 archeology students in the summer of 1972. The students excavated Indian ruins near Red Bluff in Tehama County, California, 20 miles north of the previously recognized northernmost limit of endemicity. At least 17 persons contracted an illness clinically compatible with a diagnosis of coccidioidomycosis. Coccidioidomycosis was documented by skin test conversion as well as by specific serologic reactions. Coccidioides immitis was also isolated from two soil samples taken at the excavation site. In light of its ecological requirements, it is doubtful that C. immitis will be recovered much farther north than Red Bluff. The occupational hazard of coccidioidomycosis to archeologists and others employed in known endemic areas remains a substantial threat to health.

COCCIDIOIDES IMMITIS, the fungal agent causing coccidioidomycosis, has never been isolated from soil obtained outside the Western Hemisphere.[1] In the United States, the disease is generally thought to be limited to the Southwest; and in California it is regarded as a problem of the southern half of the state and more particularly the San Joaquin Valley. Recently, however, outbreaks of coccidioidomycosis have been reported in Northern California, first in Yolo County[2] and then in Butte County.[3] This report discusses an outbreak of coccidioidomycosis which occurred some 20 miles farther north in Tehama County and now represents the most northerly endemic area for coccidioidomycosis known in California and the United States (Figure 1).

The Outbreak

A professor at California State University at Sacramento, who was leading an archeologic excavation on open, uncultivated land near Red Bluff, reported a suspected outbreak of coccidioidomycosis. The symptoms among his students were reminiscent of his own illness with coccidioidomycosis years previously. The outbreak involved at least 17 members of his party of 39 who partici-

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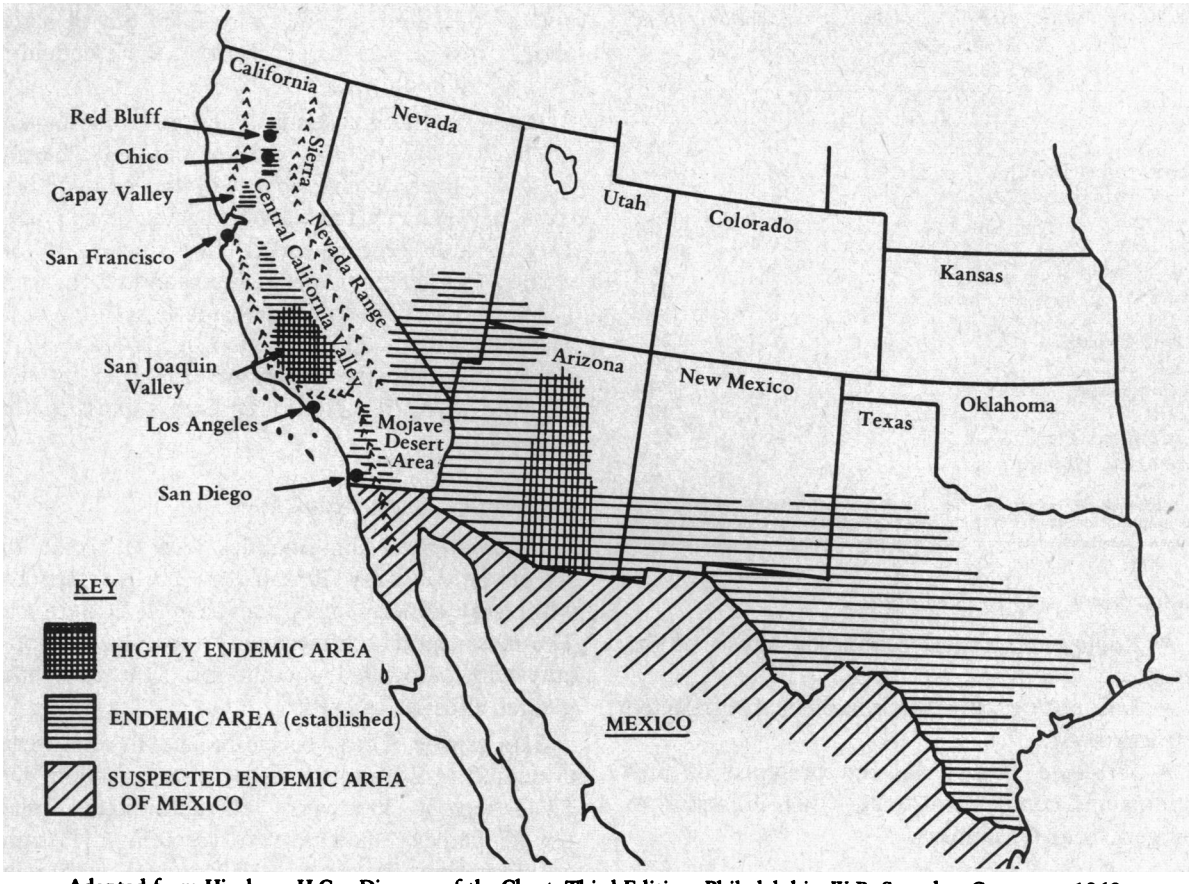

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Figure 1.—Areas endemic for coccidioidomycosis in the United States and Northern Mexico.

pated in a six-week summer course. Most students were from out-of-state colleges and many had never before been in areas endemic for coccidioidomycosis. Excavation began 19 June 1972 for Indian ruins of the Yana civilization which resided in the Red Bluff area until about 1870. The only area the party excavated was at Dye Creek Ranch, 14 miles southeast of Red Bluff in Tehama County in the foothills of the Southern Cascade Mountain range at an elevation of 300 feet. Students excavated to depths averaging six feet. The soil was riddled with rodent burrows. Human skeletal remains were recovered, as were grinding tools and projectile points.

The summer, as usual, was hot with Red Bluff's all-time high of 119.3°F recorded 15 July 1972. The year preceding excavation had been drier than normal, only 10 inches of rain having fallen between 1 July 1971, and 30 June 1972, as compared with a normal annual total of 22 inches. The soil was dry and dusty; no masks were used. Students ate and slept in tents near the dig sites. The class was informed about the risk of contracting coccidioidomycosis before excavation began and members were skin-tested with coccidioidin by Dr. Susan Snively, director of the college Student Health Service. On 13 July, after four weeks of field work, illness was first reported.

Materials and Methods

On 17 July all participants in the archeology course were asked to complete a questionnaire and undergo laboratory studies.

Histories. In addition to demographic data, participants were asked if they had ever before been in states endemic for coccidioidomycosis. Both the participants and the Student Health Service were asked about reactions to the coccidioidin skin test given before fieldwork began. Those who reported any illness were asked to indicate their signs and symptoms on a checklist that was provided. In September 1972, follow-up questionnaires were sent to class participants for interim clinical histories.

TABLE 1.—*Symptoms of Clinical Coccidioidomycosis* Among 17 Archeology Course Participants (Red Bluff, California, 1972)*

Symptoms	*Number*	*Percent*
Cough	16	94
Shortness of Breath	14	83
Chest Pain	13	77
Myalgia	12	71
Headache	10	59
Sore Throat	9	53
Phlegm	8	47
Fever	6	35
Night Sweats	6	35
Rash	5	29
Meningismus	4	24
Chills	2	12
Abdominal Pain	2	12
Erythema Nodosum	1	6

*Presence of cough or chest pain was arbitrarily designated as the minimal criterion for a diagnosis of clinical coccidioidomycosis.

Laboratory studies included:

- *Radiographs* (posteroanterior films) of the chest.
- *Skin testing* with Coccidioidin 1:100 injected intradermally.
- *Serologic studies* for the presence of precipitins and complement-fixing (CF) antibodies to antigen from C. immitis.

Other laboratory studies included:

- *Animal trapping* at the excavation site for culture of C. immitis from lungs and lymph nodes.
- *Soil studies* for the fungal pathogen. Multiple specimens were obtained at the excavation site from topsoil (to a depth of 10 cm) and from the linings of rodent burrows. Soil specimens were collected on 17 July, 11 October, and 28 November 1972 until C. immitis was finally isolated. The specimens were collected in sterile containers and studied in two ways: (1) Soil suspensions were treated with penicillin and streptomycin, and were then inoculated intraperitoneally into mice, and (2) soil suspensions were treated with cycloheximide and streptomycin, then cultured using a double pour plate method with yeast extract agar containing cycloheximide and chloramphenicol.[4] Suspicious colonies were inoculated intraperitoneally in mice for confirmation.

Results

Questionnaire data:

Of the 39 participants, questionnaires were completed by 34. All but one were white; there were 17 men and 17 women. Of the 34 completing the questionnaire, 21 were from out of state and 13 denied ever having been in areas endemic for coccidioidomycosis.

Based on the diagnostic criterion of chest pain or cough, 17 of the 34 (or 50 percent) had begun to have illness compatible with coccidioidomycosis between 15 days after digging began and 18 days after digging ended. The attack rate for women (59 percent) was higher than that for men (41 percent). The peak date for onset of illness was July 10 — 21 days after fieldwork began. Table 1 details the symptoms reported by the 17 who were ill. None required admission to hospital.

Laboratory study results:

Radiographs. Abnormalities were detected in six of the 32 x-ray films taken. The six persons with x-ray abnormalities had been ill (Chart 1). The most common abnormality was hilar adenopathy with associated pneumonitis. One case had pleural effusion as well.

Skin testing. Thirty coccidioidin skin tests were evaluated at 24 and 48 hours after injection. Of 17 ill persons skin-tested with coccidioidin, nine (or 53 percent) had positive reactions of 5 mm of induration or more, as compared with two positive reactions (or 15 percent) among 13 persons who did not have symptoms. Eight of the nine positive reactions among ill persons represent conversions from negative reactions recorded at the start of the course. One ill person with a positive reaction had not had a coccidioidin test before the course began. Two persons who had had positive coccidioidin reactions before excavation began remained well throughout the study period.

Serologic studies. Thirty-three had serologic studies. Of 17 ill persons tested, seven (or 41 percent) had serologic evidence for coccidioidomycosis compared with no positives among 16 well persons tested (Chart 1). Six persons had positive precipitin test reaction. Of these, five were also positive by CF. One person had a positive CF test but a negative precipitin test. No CF titer was greater than 1:8.

Results of animal trapping and culture. Four gray field mice were trapped alive and then killed for study. C. immitis could not be isolated from them.

Soil studies. Of a total of 22 specimens of soil collected, only two were positive. Both were col-

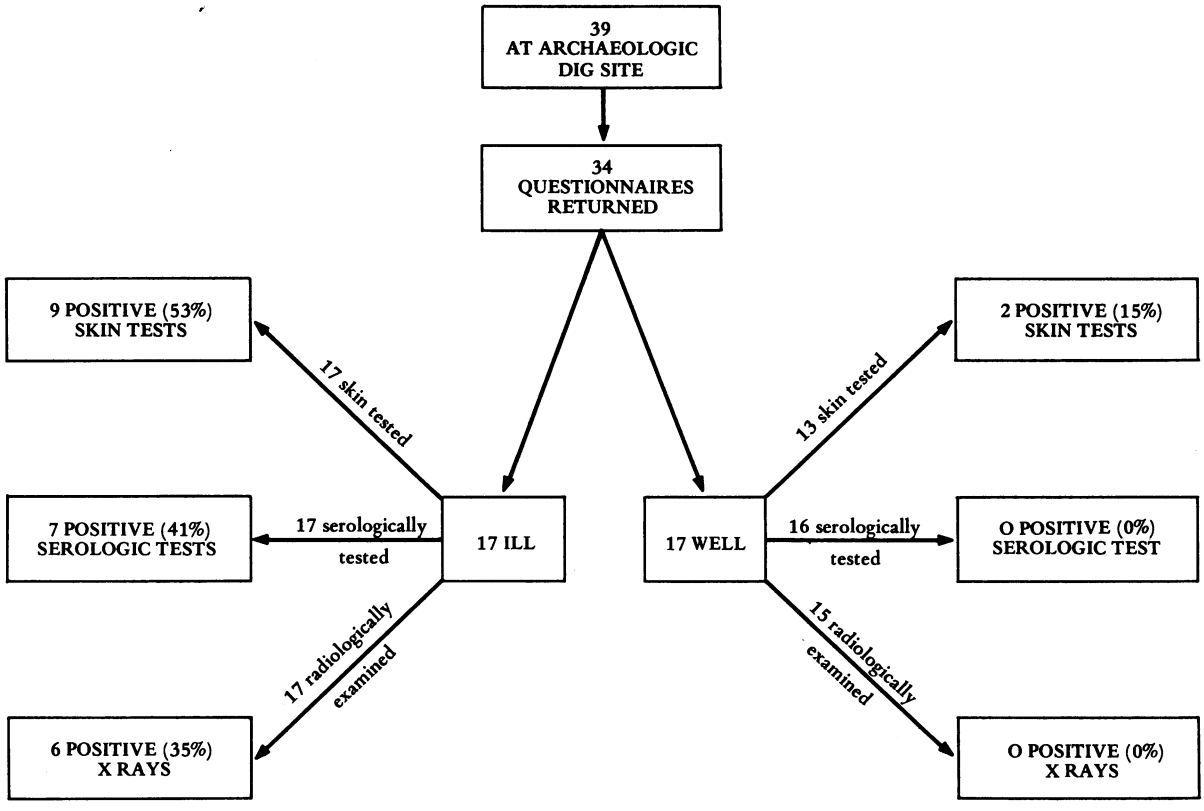

Chart 1.—Summary flow sheet of findings for coccidioidomycosis, Red Bluff, California, 1972.

lected on 28 November 1972. One of the positives resulted from direct mouse inoculation, with isolation of C. immitis from cultures of typical lesions. A direct soil culture was also positive; suspicious colonies were confirmed by intraperitoneal inoculation of mice with demonstration of endosporulating spherules in lesions of thoracic and abdominal cavities.

Discussion

This outbreak identifies a new area of endemicity for coccidioidomycosis in Northern California, farther north than ever before recognized. It emphasizes again the risk of coccidioidomycosis to susceptible persons with extraordinarily heavy exposure to contaminated soil.

Of 34 respondents, half reported illness clinically compatible with coccidioidomycosis. The laboratory data leave no doubt that the outbreak was due to coccidioidomycosis. Not only were there documented conversions of coccidioidin reaction among eight ill persons, but positive serologic tests to C. immitis were found exclusively among those who were ill. Finally, C immitis was isolated from soil taken from the excavation site.

Only ten of the 17 persons with illnesses clinically compatible with coccidioidomycosis had laboratory confirmation (positive coccidioidin test or serologic test). The other seven may have had some other respiratory disease or may have been tested too soon in the course of illness for results to be positive. The peak of the outbreak occurred on 10 July 1972, just seven days before skin test agents were injected and sera collected. Smith et al[5] reported that coccidioidin skin tests may not turn positive until two to three weeks after clinical onset. Smith also reported that demonstrable humoral antibodies may never develop in mild cases[6] and that when they do, CF antibodies are especially late to appear.[7] Less than one-third of patients with coccidioidomycosis in whom CF antibodies ultimately develop give evidence of the fact within the first month of illness.[8] Maddy suggested that C. immitis is limited to the geographic area of the lower Sonoran Life Zone which is characterized by arid and semi-arid climate, hot summers, few winter freezes, sparse flora, low altitude, and alkaline soil.[9] Red Bluff is representative of this zone, and indeed Grinnell stated in 1935 that this zone extends only as far north as Red Bluff.[10] In view of its ecologic requirements,

it is doubtful that C. immitis will be recovered much farther north than Red Bluff.

Influenza-like illness with concurrent rash provided the early clue that this archeology class was undergoing an outbreak of coccidioidomycosis. This combination of symptoms should bring coccidioidomycosis to mind in the differential diagnosis of disease in patients from areas known to be endemic and from areas nearby.[11]

The symptoms reported in this outbreak (Table 1) were comparable in type and frequency with those we reported in a larger outbreak.[3] Fortunately, morbidity was less in the present group and none of the patients needed treatment in a hospital. Indeed, CF titer did not exceed 1:8 in any case. Smith had previously noted that serious disease, such as dissemination, is associated with titers greater than 1:16.[8]

In an effort to acquaint archeology programs in California with the risk of acquiring coccidioidomycosis, letters were sent by the California State Department of Public Health in November of 1970 to every college in California with an archeology or anthropology program, and each was provided basic recommendations. However, as outbreaks continued to occur among archeology students, some of whom were quite ill and bringing litigation against their respective institutions, a more complete list of recommendations was distributed in September 1972 to the presidents of all California colleges for distribution to all departments (archeology, geology, anthropology, engineering, and others) in their institutions offering fieldwork. These recommendations are detailed elsewhere[12] and, if implemented, should reduce the incidence of coccidioidomycosis in future groups. The recommendations are summarized below:

1. No educational institution should require fieldwork in areas endemic for coccidioidomycosis.
2. Information should be provided on coccidioidomycosis (specific references were provided).
3. Coccidioidin skin tests should be performed to determine those at risk of illness.
4. Nonreactors should be advised not to participate in fieldwork in areas endemic for coccidioidomycosis.
5. Dust control should be exercised wherever feasible, including use of masks, working and sleeping upwind of excavation sites, and other measures deemed reasonable after assessing the specifics of each situation.

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