U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES ■ Public Health Service
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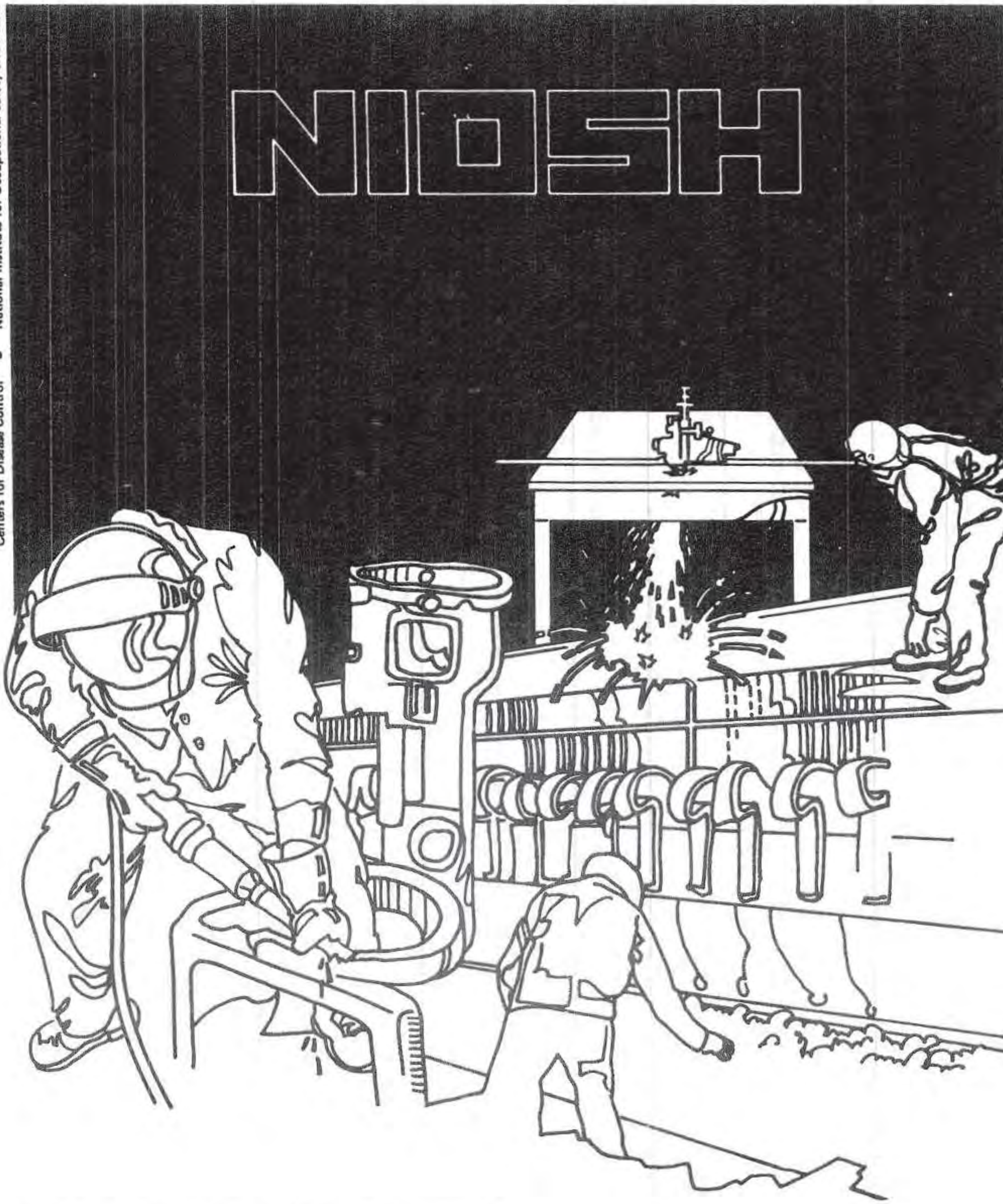

Health Hazard Evaluation Report

MHETA 85-083-1976
ZELLWOOD FARMS, INC.
ZELLWOOD, FLORIDA

PREFACE

The Hazard Evaluations and Technical Assistance Branch of NIOSH conducts field investigations of possible health hazards in the workplace. These investigations are conducted under the authority of Section 20(a)(6) of the Occupational Safety and Health Act of 1970, 29 U.S.C. 669(a)(6) which authorizes the Secretary of Health and Human Services, following a written request from any employer or authorized representative of employees, to determine whether any substance normally found in the place of employment has potentially toxic effects in such concentrations as used or found.

The Hazard Evaluations and Technical Assistance Branch also provides, upon request, medical, nursing, and industrial hygiene technical and consultative assistance (TA) to Federal, state, and local agencies; labor; industry and other groups or individuals to control occupational health hazards and to prevent related trauma and disease.

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Zellwood Farms, Inc.
Zellwood, Florida

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I. SUMMARY

In August 1985, Zellwood Farms, Inc. requested the National Institute for Occupational Safety and Health (NIOSH) to investigate a work-associated outbreak of respiratory problems among employees at the Zellwood Mushroom Farm (ZMF) in Zellwood, Florida. NIOSH investigators conducted a walk-through evaluation at ZMF on September 16-18, 1985. In February 1986, a NIOSH medical officer made a second visit to ZMF and area medical clinics/hospitals to obtain medical records of farm workers with respiratory problems. On September 14-20, 1986, NIOSH investigators conducted a cross-sectional medical and industrial hygiene survey at ZMF.

We conducted air sampling to evaluate particle size distributions and concentrations of respirable and total dusts, spores, viable microorganisms, endotoxins, and pesticides (diazinon, chlorpyrifos, pyrethrum, and formaldehyde). We also analyzed water samples for these pesticides and bulk materials for endotoxins and viable microorganisms. Medical studies of ZMF workers included an administered questionnaire, spirometry tests, chest radiographs, and serological analysis of blood samples.

Seven cases of Mushroom Workers Lung (MWL) were diagnosed among ZMF workers; these workers developed MWL between April, 1982 to August, 1985, and all but one have terminated employment at the farm. The seven cases occurred among workers from different farm operations, indicating that workers throughout the farm were exposed to disease-causing agents. Industrial hygiene data indicated that farm workers from every operation were exposed to organic dust constituents capable of causing MWL (a form of hypersensitivity pneumonitis). However, we were unable to identify any specific antigen as the cause of these MWL cases at ZMF. Compost handling operations on the wharf, spawn line, and casing line had the highest concentrations of organic dusts, including many of the fungal/bacterial constituents reported to cause MWL. Additionally ventilation practices used in the spawn area at the time of the MWL outbreak likely contributed to the dissemination of spawn dusts/composts to other farm areas. There are no exposure standards to assess the health risks from exposure to these organic dusts, bacteria, or fungi. Airborne concentrations of pesticides used at this farm were all below existing health standards/guidelines of the American Conference of Governmental Industrial Hygienists (ACGIH), the Occupational Safety and Health Administration (OSHA), and NIOSH.

None of the workers participating in the cross-sectional medical study at ZMF were diagnosed with an acute respiratory illness consistent with MWL; however, approximately 20% of the workers were experiencing some symptoms consistent with MWL. Approximately 10% of the workers had spirometry results suggestive of impaired pulmonary function, but interpretation was hampered by lack of adequate comparison groups. No abnormalities consistent with MWL were seen on the chest radiographs, and there was no evidence of lung fibrosis. The serological tests demonstrated that almost

all workers were exposed to antigens capable of causing MWL, but their tests did not serve as useful predictors of disease status. The absence of definite cases of MWL is not strong evidence that this working population is not at future risk of MWL given the limitations of a cross-sectional survey and the nature of MWL. MWL is a difficult disease to diagnosis, at any single point in time the number of active cases can be expected to be small, and we surveyed active workers.

Seven cases of MWL occurred among ZMF workers between 1982 to 1985; no additional MWL cases were identified in the current farm workforce at the time of the cross-sectional study. However, during this study which examined farm workers at one point in time, it is unlikely that active acute cases of MWL would be observed. Organic dust constituents capable of causing MWL were identified at ZMF; consequently, some workers continue to be at risk of developing MWL. Recommendations for reducing MWL health risks at ZMF are presented in section X of this report.

KEYWORDS: SIC 2033 (Mushroom Farming) Mushroom Workers Lung, Hypersensitivity Pneumonitis, Fungi, Bacteria, Endotoxins, Organic Dusts

II. INTRODUCTION

In August 1985, the Division of Respiratory Disease Studies, National Institute for Occupational Safety and Health (NIOSH) received a request from Zellwood Farms, Inc., a mushroom farm near Orlando, Florida to evaluate an outbreak of respiratory problems among farm workers. From April 1982, until August 1985, seven farm workers were diagnosed as having mushroom workers lung (MWL) a type of hypersensitivity pneumonitis. NIOSH investigators conducted a walk-through evaluation at Zellwood Mushroom Farm (ZMF) on September 16-18, 1985, to collect background information on the problems at this workplace and to become familiar with the farm processes. In February 1986, a NIOSH medical officer made a second visit to ZMF and area medical clinics/hospitals to obtain medical records for those workers who were diagnosed with hypersensitivity pneumonitis. On September 14-20, 1986, NIOSH investigators conducted an occupational health survey at ZMF; this survey included a cross-sectional medical and environmental evaluation of farm workers/operations.

III. BACKGROUND

Mushroom Farming - ZMF grows Agaricus bispora mushrooms by portable tray farming methods. The farm has been in operation about 16 years and employs approximately 250 workers from four ethnic/racial backgrounds: white, black, Hispanic, and Vietnamese. Many of the Hispanics and Vietnamese speak little or no English. Mushroom farming at ZMF involves preparation of a growth medium (compost); spawning (seeding) the compost with mushroom mycelia; growing the mushrooms in cool, dark, damp areas; picking and packing of the mushrooms. The different stages in the mushroom farming processes at ZMF include: Phase I, Phase II, spawning, casing, set back, growing/picking, washing, and packing.

Phase I involves mixing the compost ingredients and putting this compost mixture in large, portable, wooden trays to grow the mushrooms. Several compost mixtures are used at ZMF; the compost in use during our evaluation consisted primarily of straw with horse manure, chicken manure, soybean screenings, gypsum, urea, and cotton seed meal. This operation is done outside in a yard area called the wharf. Water is added and the compost mixture is turned frequently to promote the growth of aerobic microorganisms. These organisms are needed to remove the outer cuticle layer from the straw so it can decompose and be used as a nutrient by the mushrooms. Front-end loaders are used to mix and transport the compost materials. After the ingredients have been mixed to form the compost, these materials are then taken to a mechanical filling line and deposited in the portable trays. This phase of the mushroom farming process takes about 35-45 days.

After Phase I, the trays of compost are taken inside by forklifts to the pasteurization room for Phase II treatment. In Phase II, the compost materials are heated to about 160°F with steam to promote the growth of the thermophilic actinomycete bacteria and to kill other organisms. The thermophilic actinomycetes are needed to convert ammonia present in the compost mixture to fixed nitrogen -- a nutrient source for the mushrooms. Ammonia conversion occurs during the temperature step down process when the tray temperatures are reduced from 160°F to 90°F (spawning) temperature. The Phase II process takes approximately six days.

Spawning is performed indoors on a mechanical line after pasteurization. The trays of compost are dumped, mushroom spawn (mycelia) is added, and the spawn/compost are mixed and put back in the trays. In addition to mushroom spawn, a spawn mate (soybean) ingredient is added as a nutrient. After spawning, the trays are placed in a spawn run room to promote growth of the mushroom mycelia. The spawned compost spends about 13 days in the spawn run room, where temperatures are controlled at approximately 78°F to promote mycelial growth.

Casing is done next. The spawned compost trays are taken back to the spawn line, where a layer of casing material (peat moss, lime, and spawned compost) is added to the top of the trays for nutrient purposes. These casing ingredients are assembled and mixed in a separate casing room.

Next, during set back, the trays of compost are taken to environmentally controlled rooms to produce the initial mushroom growth (from the mycelia) called pinning. In the set back rooms, temperatures are controlled at 68°F and airborne carbon dioxide concentrations are increased (approximately 10,000 - 15,000 ppm) to promote pinning.

Growing/picking is done after the mushrooms have pinned. The trays are taken to the growing and picking rooms where four crops (flushes) are picked over a 30 day period. There are 40 growing/picking rooms and each room holds 1/4 of a crop. Mushrooms are picked and sized into three categories.

Washing/packing operations are done next. Only a small portion of the mushrooms (about 10%) are cleaned in the washing line, while the others are taken directly to the coolers prior to packing operations. In the packing room they are packaged by size for transportation to market.

The mushroom farm uses a number of pesticide substances during the mushroom growing cycle. Most of the pesticide substances are applied at night by a night sanitation crew when the production shift workers are off duty. Those pesticides reported in use at ZMF included Benlate (benomyl), chlorine, diazinon, chlorpyrifos (Dursban), formaldehyde, and pyrethrum.

Workers in the wharf department prepare the compost, build and repair compost trays, and operate the tray filling, casing, and spawning lines. Workers in the growing and watering department water and check the temperature and moisture content of the compost throughout the entire mushroom growing process. They also monitor carbon dioxide concentrations during set back. Laboratory workers who evaluate the quality of compost ingredients are also in the growing department. Pickers cut the mushrooms from the compost, size, and transport them to washing or packing areas. Most of the Vietnamese work as pickers. Workers in the maintenance department may work in any area of the farm repairing and maintaining the facility, equipment, or vehicles. Workers in the night sanitation and monitoring department apply pesticides, clean the facility, and check and maintain the production process during the evening and night hours.

Mushroom Workers Lung (MWL) - Occasionally mushroom farm workers develop symptoms and respiratory conditions very similar to a disease seen among farmers exposed to moldy hay (farmers' lung). The first modern description of farmer's lung disease was in 1932 when J.M. Campbell described an acute respiratory disease in farm workers exposed to moldy hay.(1) Workers exposed to a variety of organic antigens from other sources such as wood dust, moldy sugar cane, birds, and cheese have been reported to develop the same condition as workers with MWL or Farmer's Lung; this respiratory disease is called hypersensitivity pneumonitis.(2,3,4,5) In general, the clinical features are similar regardless of the organic dust inhaled even though a different organic dust may have caused the disease. Cases commonly present with a nonproductive cough, dyspnea/shortness of breath, fever/chills, myalgia (muscle aches), pain/tightness in the chest, and malaise. With repeated exposure they may develop loss of appetite and weight loss, and the cough may become productive. Other less common symptoms include: headache, nausea/vomiting, and sore throat. The initial symptoms begin 4-8 hours after exposure and persist for several hours thereafter, but recovery is usually spontaneous with abstinence from further exposure. Recurrent exposures may cause the symptoms to be more severe and persistent indicating that the individual has become immunologically sensitized. Although the etiologic mechanism by which organic dusts induce these symptoms is unknown, an immunologic response (precipitating antibody, circulating antigen-antibody complex, or cell mediated immunity) is most likely involved.(7)

In a population of several dozen exposed workers, MWL rarely affects more than one or two individuals at any one time. Although the reason for this low attack rate is unclear, it indicates that individual susceptibility may be as important as environmental factors such as exposure to high concentrations of airborne antigens.(7)

Chest radiographs may appear normal, but in acutely ill patients there are frequently diffuse granular or miliary shadows with peripheral infiltrate in the lower and mid zones of both lungs. This suggests interstitial and alveolar involvement.(7)

Laboratory blood studies during acute attacks may show slight leucocytosis, but white blood cell counts are often within normal limits. Eosinophilia is rare, and hemoglobin and erythrocyte sedimentation rates are also usually within normal ranges. In essence, blood analysis of MWL patients often will not indicate a systemic inflammatory process.(7)

During acute attacks spirometry tests typically demonstrate a restrictive pattern with a decrease in vital capacity, diffusing capacity, and lung compliance. The reduced diffusing capacity clearly demonstrates that a major site of the disease process is the alveoli and pulmonary interstitium. Airway obstruction, indicated by reduced one-second forced vital capacity and its ratio to the total forced vital capacity, may also occur, especially in patients who may have endured several subacute attacks.(7)

Rarely do immunological analyses of serum from individuals with mushroom workers lung reveal reaction to any specific antigen. In fact in only one study have any subjects demonstrated increased antigenic reactivity to a particular environmental agent.(8) Sakula studied four cases of MWL among growers in Sussex, England. Cases tested positive for serum precipitin reactivity to the fungi Aspergillus fumigatus, Micromonospora vulgaris, and Micropolyspora faeni (Thermopolyspora polyspora). One case had positive tests to M. vulgaris, and another to M. faeni; the other two cases had negative tests. Mushroom workers are potentially exposed to a tremendous number of fungi, bacteria, and organic antigens which may cause hypersensitivity pneumonitis-type reactions. Therefore, it is not unlikely that serum from cases tested against a few select antigens would be negative. Serum analyses often do show reaction to extracts from compost and mushroom spawn, but these reactions are usually no greater in cases than in non-cases.

Radiographs, spirometry, and blood tests may be inconclusive, leaving the history of the symptomatic patient as the best indicator of whether they have MWL. If the classic symptoms quickly resolve on absence from exposure and then return upon reexposure, it is highly likely that the subject has become sensitized.

IV. LITERATURE REVIEW - MUSHROOM WORKERS LUNG:

So far only case-studies have been published in English language journals concerning MWL. These studies document 33 acute cases of MWL from England, Canada, and the United States. Table 1 lists the demographic characteristics of these cases. Age and tenure information were available on only 17 of the 33 cases. MWL may attack at any age, and although it generally strikes susceptible workers during their first few months of employment it may also occur in workers who have been employed in the mushroom industry for many years. MWL can effect workers in any occupation in the mushroom farm, but is more common among compost handlers and spawners. Table 2 lists the reported frequency of various symptoms among MWL cases. Every case was given a posterior-anterior radiograph which generally showed a diffuse bilateral infiltrate and fine miliary shadows or micronodules. However, two x-rays appeared normal. Spirometry testing was only occasionally reported, but it commonly demonstrated a restrictive pattern and reduced diffusing capacity.

Early on investigators suspected that MWL was an immunological hypersensitivity reaction, but so far the immunological evidence has proven to be inconclusive. Early studies tested the patients serum for antibody precipitins against only a few antigens, however later studies have tested serum against extracts from materials such as compost, and against numerous specific organisms. No extract from farm materials or specific organisms have been shown to conclusively cause any of the cases. In addition, asymptomatic mushroom workers and controls may have increased antibody levels to mushroom environment antigens while harboring no disease.(9)

Bringhurst was the first to describe MWL in 1959, when he reported 16 cases among migrant Puerto Rican workers in Chester county, Pennsylvania over a 2-year period.(10) Because the cases occurred only among the Puerto Rican workers he suspected that Hispanics may have had a predisposition to the disease. However, it is more likely that they were at greater risk of disease because they were more heavily exposed to mushroom spawn and aerosolized microorganisms/spores during the spawning process. Although no immunological or spirometry testing was done, this was the first documented evidence that mushroom workers were at risk to a disease which had symptomology and radiographic changes similar to those of Farmer's Lung.

Sakula, who reported disease among four workers in Sussex, England, was the first to document levels of precipitating antibodies in the serum.(8) One patient had antibodies to Micropolyspora faeni (Thermopolyspora polyspora)[1] and another to Micromonospora vulgaris; the sera from the other two patients were negative, but sera were only tested for levels of M. faeni, M. vulgaris, and Aspergillus fumigatus. Sakula concluded that the thermophilic actinomycetes, reported as the cause of Farmer's Lung, were also the cause of MWL.

Jackson and Welch documented two cases of MWL in Sheffield, England.(11) Although neither patient reacted to a variety of hay antigens, specific thermophilic actinomycetes, or extracts from compost before spawning occurred, both reacted to extracts from compost after spawning. One patient who underwent inhalation provocation tests, reacted to a dilute extract of mushroom compost after spawning.

Craig reported two cases of MWL in Quebec, Canada.(12) The serum of one patient was not precipitinogenic to Micropolyspora faeni, Thermoactinomyces vulgaris (Thermopolyspora vulgaris), or Aspergillus fumigatus; the serum of the other was not precipitinogenic to M. faeni or A. fumigatus. They concluded however, that mushroom compost contains a very large numbers of materials which, when inhaled, can cause antigenic reactions in the pulmonary tissue of susceptible individuals.

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[1] The nomenclature for certain thermophilic actinomycete bacteria has changed from the time of this publication; Thermopolyspora polyspora is more commonly termed Micropolyspora faeni.

Chan-Yeung reported a case of MWL in a highly susceptible young woman after spawning compost for just one day.(13) Previous exposures were confined to three or four brief visits to neighbors' mushroom houses. Her serum contained precipitins to an extract of pre-spawn compost, but not to post-spawn compost, spawn, or A. fumigatus.

Six cases with clinical and radiological characteristics of MWL were studied by Stewart in Suffolk, England.(14) All six patients attributed the onset of their symptoms to work with spawning compost. Up to that time, he conducted the most comprehensive immunologic study. Two cases showed precipitins to mushroom spores and a third to untreated mushroom compost and compost 14 days after spawning. Only the concentrated serum of the other three patients reacted to two or more of the compost extracts; but all had some reaction to the 14-day post pasteurized compost sample.

The last published case study was reported by Johnson -- a case in a migrant farm worker in Washington state.(15)

Mushroom Worker's Lung may strike a worker at any time during their occupational tenure. The tenure of these reported cases ranged from 1 day to 18 years. The median length of time the cases worked before they had to leave and sought medical attention was six weeks. In only 5 of the 33 cases did the disease occur after a tenure of greater than one year. This indicates that individual susceptibility is a major risk factor and this risk factor is important during the first year of exposure.

One-fourth of the cases were directly associated with the spawning operation, and all but two cases were directly related to handling compost. Of these other two cases, one was a picker-packer exposed primarily to harvested mushrooms and the other was a grower who supervised many areas of the production process. This suggests that those workers who handle compost are at greater risk of disease.

From the previous literature, it can be inferred that it is difficult to determine the nature of the antigen or antigens causing MWL.(16) The sporadic occurrence of the disease implies that the antigen is not always present in the working environment or, if present, is not in sufficient quantities to cause MWL.(15) Not all persons exposed to the antigens appear to be affected, so it would seem some individual constitutional factor predisposes a worker to the disease. The compost on which mushrooms are grown consists of hay and manure, which is allowed to decompose at high temperature and humidity. These conditions encourage the growth of many microorganisms including the thermophilic bacteria believed to be responsible for Farmer's Lung.(17) Thereby, workers are exposed to such a variety of antigens, it is likely that many antigens may be responsible for causing MWL. Immunological testing has been inconclusive. Since this testing has not been all encompassing, it is probable that individual susceptibilities to particular antigens have been missed.

Acute cases of hypersensitivity pneumonitis still sporadically occur among mushroom workers, and the cause of this disease and preventive measures remain elusive. In addition, we do not know whether other forms of disease exist in the population, such as chronic or subacute cases of MWL.

V. CONFIRMED CASES OF MUSHROOM WORKERS LUNG AT ZMF

The first worker at Zellwood Farms known to develop MWL initially experienced symptoms in April 1982. No other confirmed cases occurred until October 1984, but during the following year five additional workers developed MWL (Table 3).

Workers with long, as well as short tenures, and in jobs with varying degrees of exposure developed the disease. In fact, an office worker, who would be expected to have the lowest level of exposure, developed the disease. Age, sex, or smoking status did not have any association with disease development. Although half of the working population was Hispanic or Vietnamese, only white and black workers were noted to be cases.

Symptoms were progressive, with two or three symptoms occurring mildly in the late afternoon or evening of a workday. As the worker continued employment the symptoms increased in number, severity, and frequency, culminating in a severe attack. Severe episodes were characterized by shortness of breath, fever, chills, dry cough, and in some cases fatigue, malaise, muscle aches, and difficulty breathing. Four of the cases reported that their symptoms were first associated with spawning operations or were worse on days when spawning was done. Pulmonary function was restricted and diffusing capacity across the alveolar membrane was decreased. Chest radiographs revealed interstitial infiltrate and diffuse, fine reticulonodular markings.

Cases 1 through 5 were initially believed to have other illnesses. Initial diagnoses included: pneumonia, bronchitis, respiratory viral infection, and coronary insufficiency. Once these workers returned to the farm after recovering from a severe attack, the symptoms quickly recurred with equal or greater severity. The cases were referred to local pulmonary physicians who diagnosed them as MWL. Six of the seven workers were forced to stop working at the farm. Only the last case, who was diagnosed early when his symptoms were still mild, was able to continue work at the farm. This worker was transferred to a maintenance shop on farm property, but remote from the main building.

In all cases, once workers were removed from further exposure their symptoms resolved and did not return. Spirometry and chest radiographs also returned to normal. However, one worker from the wharf/spawning area continued to have moderately restricted pulmonary function several months after leaving the farm.

Four of the seven MWL cases and ten healthy asymptomatic ZMF workers had sera collected for serological tests. Three of the four cases also had sera available, which had been collected during their acute attacks. Serum precipitin reactions to extracts of antigenic material were measured by counter immunoelectrophoresis (Table 4).[18] No obvious differences were evident between MWL cases and controls. Serum antibody reactions to various microorganisms were also tested using enzyme immunosorbent assay (ELISA) (Table 5).[19] One case demonstrated reactivity to numerous organisms, but once again there were no apparent differences in reactivity between cases and controls.

VI. METHODS

After investigating the seven known MWL cases, we decided to conduct a cross-sectional industrial hygiene and medical study at ZMF. The following are the methods and results of that study.

A. Industrial Hygiene:

Industrial hygiene evaluations were done at ZMF to characterize the workplace of the mushroom farm worker in terms of exposure to organic dusts and pesticides that may be a cause of MWL or related respiratory disease. Samples were collected from major farming operations during a walk-through survey (September 16-18, 1985) and during an industrial hygiene survey (September 14-20, 1986). The walk-through survey was done to review the different mushroom farm processes and related environmental conditions/exposures. Environmental analytes collected during the preliminary walk-through evaluations were used to help direct subsequent industrial hygiene evaluations; these analytes included: airborne total dusts; endotoxins (bulk compost and airborne dust samples); airborne viable organisms; and viable organisms in bulk compost/spawn materials. Air samples were collected during the industrial hygiene survey for respirable and total dusts, particle size distributions, viable organisms, spores, and pesticides (diazinon, chlorpyrifos [Dursban], pyrethrum, and formaldehyde). Tap water samples from ZMF were also analyzed for diazinon, chlorpyrifos, and pyrethrum. Local exhaust ventilation flow measurements were taken at the spawn line.

Respirable and total dusts were collected using polyvinyl chloride (PVC) filter media with 5 micrometer (µm) pore size. The respirable dust samples were collected using a portable sampling pump calibrated to 1.7 liters per minute (lpm); a 10 mm nylon cyclone was used to separate the respirable dust fraction from total airborne dusts. This nylon cyclone has a 50 percent collection efficiency for dusts with an aerodynamic diameter of approximately 3.5 µm when operated at 1.7 lpm.[20] The total dust samples were collected with a portable sampling pump field calibrated to 2.0 lpm. Respirable and total dust samples were time-weighted over a minimum 6-hour sampling period; both personal and area samples were taken. Each dust sample was analyzed gravimetrically using an electrobalance with an instrumental precision of approximately 0.01 milligrams (mg). The limit of detection (LOD) for airborne respirable and total dusts was approximately 0.01 milligrams per cubic meter (mg/m^3) for an 8-hour air sample.[21] The total dust samples collected during the walk-through survey were also analyzed for endotoxins by the quantitative chromogenic modification of the limulus amebocyte lysate test (LAL).[22] This method has an analytical detection limit of about 0.1 endotoxin units per cubic meter of air (EU/m^3) for an 8-hour air sample.

Samples were also collected to measure the size distributions of airborne dusts. Particle size distribution samples were taken using the Sierra Model 296 personal cascade impactor. This is a six stage, multi-jet sampler which collects airborne particles on different stages according to their aerodynamic size. The dust is collected on Mylar collection substrates coated with impaction grease. Both personal and area samples were taken; samples were generally taken over a full shift based on filter loading. A sampling flow rate of 2.0 lpm was used; this flow rate provided the following aerodynamic cut points by stage: Stage 1 - 20 microns (µm); Stage 2 - 15 µm; Stage 3 - 10 µm; Stage 4 - 6 µm; Stage 5 - 3.5 µm; Stage 6 - 2 µm; and backup filter - <2 µm. The amount of dust collected on each stage was measured gravimetrically using an electrobalance. The particle mass concentration in each size range can be determined and size distribution established in comparison with the total mass of the sample.[20] Dust from some of these samples was removed and examined by light microscopy.

Total airborne dust samples were collected for spore count analysis on 37 mm diameter nucleopore filters. These samples were collected using a portable sampling pump calibrated at 2.0 lpm. The samples were time-weighted over a minimum 6-hour sampling period. Spore count analysis was done using light microscopy by the Allergy Research Laboratory at the University of Michigan.

Airborne samples for viable bacteria and fungi were collected using two different methods: the Andersen Biological N6 Sampler, and the raised jet, All Glass Impinger (AGI) 30.[23-25] The Andersen N6 sampler was used on a trial basis only during the walk-through evaluation. This sampler was found to be inappropriate for use in this agricultural setting due to problems of overloading; consequently, the AGI 30 sampler was selected for use during the industrial hygiene survey. The AGI 30 sampler was used with 20 milliliters of sterile, distilled water as the sampling media. Area samples were collected over a 15 to 30 minute sampling period at a flow rate of 12.5 lpm. Sampling/analysis was done for four types of organisms: 1) mesophilic fungi, 2) thermophilic fungi, 3) mesophilic bacteria, and 4) thermophilic bacteria. After sampling, the impinger solutions were refrigerated and then sent by express mail to West Virginia University (WVU) Department of Microbiology and Immunology for analysis. The impinger solutions were plated on a nutrient agar media. Rose bengal agar with streptomycin (RBS) was the media used to grow fungi; while, tripticase soy agar with cycloheximide (TSA) was the media used to grow bacteria. Following dilution plating, the agar plates were incubated at several temperatures according to the type of organism to be grown:

Mesophilic Fungi	RBS Media	24-28°c (room temperature)
Thermophilic Fungi	RBS Media	45°c
Mesophilic Bacteria	TSA Media	36°c
Thermophilic Bacteria	TSA Media	55°c

After incubation, the colonies growing on each plate were counted. The plates were then analyzed qualitatively to identify the genus of bacteria and fungi present in the samples. This work was done at the West Virginia University Department of Microbiology and Immunology.

Bulk compost/spawn materials were analyzed for endotoxin content by the LAL test. These bulk samples were also analyzed for concentrations of mesophilic, gram-negative bacteria, total mesophilic bacteria, thermophilic actinomycetes, mesophilic fungi and thermophilic fungi. Fungal cultures were grown in liquid broth (yeast-malt) in shake culture and plated on RBS media. Mesophilic fungi were incubated at 25°C while thermophilic fungi were incubated at 45°C. Gram-negative bacteria were grown on MacConkey agar and incubated at 35°C. Total mesophilic bacteria were grown on TSA agar and incubated at 35°C. Thermophilic actinomycetes were grown on one-half strength TSA agar and incubated at 55°C. After incubation, the number of colonies of bacteria or fungi growing in each sample was counted. The fungal plates were analyzed qualitatively to identify the genera of the fungi grown in the samples.

Diazinon and chylorpyrifos concentrations in air were sampled using Orbo 42 tubes proceeded by 37 mm diameter glass fiber filters. The samples were collected using portable sampling pumps calibrated to 2 lpm. Both personal and area samples were taken over a full work shift. Personal samples were taken during pesticide application only. The samples were analyzed by gas chromatography (GC) with an electron capture detector (ECD) according to NIOSH Method 5012.[21] The LOD for this sampling/analytical method would be approximately 0.005 micrograms per cubic meter of air($\mu g/m^3$) for an 8-hour sample.

Pyrethrum concentrations in air were sampled using a 37 mm diameter glass fiber filter. The samples were collected using portable sampling pumps calibrated to 2 lpm. Both personal and area samples were taken; personal samples were taken during pyrethrum application only. The samples were analyzed by high performance liquid chromatography by NIOSH Method 5008. This method has a LOD of about 2.0 $\mu g/m^3$ for an 8-hour sample.[21]

Samples of potable farm water collected from a plant water tap were analyzed for diazinon/chlorpyrifos and pyrethrum. These water samples were collected in glass containers and analyzed for chlorpyrifos/diazinon content by GC with an ECD and for pyrethrum by NIOSH Method 5008 using high performance liquid chromatography. The LOD for these analyses include: 1 μg/liter of water (μg/l) for pyrethrum, 0.034 μg/l for diazinon, and 0.006 μg/l for chlorpyrifos.[21]

Formaldehyde concentrations in air were sampled using a midget impinger with a sodium bisulfite collection media. The samples were collected using portable sampling pumps operated at a flow rate of 1.0 lpm. Full shift, area samples were taken. The samples were analyzed by spectrophotometry. This method has a LOD of about 0.001 ppm for an 8-hour sample.[21]

Volumetric air flow measurements were taken from the local exhaust ventilation system serving the spawn line. These measurements were taken from a dust traverse using the Alnor 6000 velometer.

B. Medical:

Every current employee at Zellwood Farms was asked to participate in the cross-sectional health study. After receiving an explanation of the study, volunteers consenting to participate were administered a questionnaire, given a spirometry test and postero-anterior chest radiograph, and had blood drawn for serological analysis.

Questionaire - The questionaire obtained information on workers' age, race, gender, smoking history, and prevalence and nature of various symptoms. (Appendix A)

Spirometry Tests - Spirometry was performed using a dry rolling-seal spirometer interfaced to an oscilloscope and an analog tape recorder. At least five maximal expiratory maneuvers were recorded for each person. All values were corrected to body temperature, pressure, saturated with water vapor (BTPS). The largest forced vital capacity (FVC), forced expiratory volume in one second (FEV_1), and peak flow (PF) curves were selected for analyses regardless of the curves on which they occurred. The spirometry measurements of subjects were eliminated if their two largest FVCs or FEV_1s varied by more than 10%.[26] A worker's FVC, FEV_1, PF, and ratio of FEV_1/FVC were compared to values predicted for individuals of the same age, sex, and height, and the percent of the predicted value was calculated using Knudson's equations.[27] These predicted values were estimated from a study of white subjects only. Since no appropriate predicted values were available for black, Hispanic, and Asian workers, their spirometry parameters were also compared to the predicted values from Knudson's equations. Therefore, the percent of the predicted value for the spirometry parameter should not be compared across races.

Chest Radiographs - Each chest radiograph was read independently by three certified pneumoconiosis ("B") readers, who without knowledge of subjects' ages, occupations, or smoking histories, classified the films according to the 1980 ILO International Classification of Radiographs of the

Pneumoconioses.[28] The median profusion of the three readings was used in the analysis. A chest radiograph was defined as positive if at least two of the three readers categorized the film as having the same abnormality.

Serological Analysis of Blood - Sera collected from ZMF workers were analyzed by double diffusion for precipitating antibodies to extracts of 13 different materials used in mushroom growing, 16 species of thermophilic actinomyces and molds isolated from agar samples collected at the farm, and *Agaricus bisporus* (*A. bisporus*) mushrooms and spores.[19] Sera were also analyzed by enzyme linked immunosorbent assay (ELISA) for precipitating antibodies to *A. bisporus* spores and by radioallergosorbent test (RAST) for immunoglobulin-E (IgE) antibody reaction to *A. bisporus* spores.[19,29,30]

VII. EVALUATION CRITERIA

Evaluation criteria are used as guidelines to assess the potential health effects of occupational exposures to substances and conditions found in the work environment. These criteria consist of exposure levels for substances and conditions to which most workers can be exposed day after day for a working lifetime without adverse health effects. Because of variation in individual susceptibility, a small percentage of workers may experience health problems or discomfort at exposure levels below these existing criteria. Consequently, it is important to understand that these evaluation criteria are guidelines, not absolute limits between safe and dangerous levels of exposure.

A. Industrial Hygiene

Several sources of environmental evaluation criteria exist and are commonly used by NIOSH investigators to assess occupational exposures. These include:

1. The U.S. Department of Labor, Occupational Safety and Health Administration (OSHA) permissible exposure limits (PEL's);[31]

2. The American Conference of Governmental Industrial Hygienists (ACGIH) Threshold Limit (Exposure) Values (TLV's);[32]

3. NIOSH recommended exposure limits (REL's).[33]

These criteria have been derived from industrial experience, from human and animal studies, and when possible, from a combination of the three. Consequently, due to differences in scientific interpretation of these data, there is some variability in exposure recommendations for certain substances. Additionally, OSHA considers economic feasibility in establishing occupational exposure standards; NIOSH and ACGIH do not consider economic feasibility in development of their criteria.

The exposure criteria described below are reported as full shift time-weighted average (TWA) exposure recommendations. These exposure criteria and standards are commonly reported as parts contaminant per million parts air (ppm), or milligrams of contaminant per cubic meter of air (mg/m^3). The "skin" notation for certain ACGIH TLV's implies that the substance is readily absorbed through the skin as a major route of exposure. Occupational criteria for the air contaminants measured during this study are as follows:[31-33]

SUBSTANCES	NIOSH (REL)	ACGIH (TLV)	OSHA (PEL)
Airborne bacteria/fungi from mushroom farming	No REL	No TLV	No PEL
Diazinon	No REL	0.1 mg/m^3 (skin)	No PEL
Chlorpyrifos (Dursban)	No REL	0.2 mg/m^3 (skin)	0.2 mg/m^3
Pyrethrum	No REL	5 mg/m^3	5 mg/m^3
Formaldehyde*	Lowest Feasible Level	1 ppm	1 ppm

*Considered to be a potential human carcinogen according to NIOSH, ACGIH, and OSHA.

The Environmental Protection agency (EPA) regulates concentrations of some pesticides in public drinking water according to the National Primary Drinking Water Regulations; at present, diazinon, chlorpyrifos, and pyrethrum are not included in this standard.[34]

Some of the substances measured during this evaluation have no recommended exposure level or standard. This would include some of the organic dust components including fungi, bacteria, or their spores. Exposure to certain organic dusts, and chemicals (i.e. pyrethrum) have been reported to cause hypersensitivity pneumonitis;[7,35-40] however, individual susceptibility is an important factor predisposing some to greater disease risk. This variability in host response complicates the interpretation of any environmental exposure/ disease relationships. Consequently, many of the industrial hygiene analytes measured during this evaluation are assessed relative to other farm operations or ambient conditions.

B. Medical:

The following criteria were used to define abnormalities and categorize workers as potential cases of MWL:

A. Workers complaining of two or more of the eight symptoms (cough, fever/chills, shortness of breath, chest tightness, muscle aches, fatigue, loss of appetite, and unexplained weight loss) commonly associated with MWL are considered potential cases, if the symptoms occur in the late afternoon or evening of a workday and resolve while away from work.

B. Workers with spirometry tests demonstrating a restricted pattern (i.e. FEV_1/FVC >70% and FVC less than 80% of predicted) are considered potential cases of MWL. Spirometry parameters FVC, FEV_1, and PF less than 80% of predicted and FEV_1/FVC less than 70% are considered below normal.(26,27)

C. Workers with chest radiographs showing diffuse interstitial infiltrates or evidence of fibrosis in the lung fields are considered potential cases of MWL.(28,36)

VIII. RESULTS

A. Industrial Hygiene

The total dust concentrations from all mushroom farm operations ranged from 0.01 mg/m^3 to a high of 3.8 mg/m^3 (Table 6). These samples had a geometric mean (GM) of 0.32 mg/m^3 and a geometric standard deviation (GSD) of 3.5. The respirable dust concentrations (Table 6) ranged from 0.04 mg/m^3 to a high of 2.38 mg/m^3. Respirable dust concentrations had a GM of 0.14 mg/m^3 and a GSD of 2.58. This range in dust concentration is explained in part by differences in dust concentrations among different mushroom farm areas/processes.

Tables 7 and 8 present GM respirable and total dust concentrations by area. The eight samples collected from the spawn operations had the highest GM respirable dust concentration, 0.46 mg/m^3 with a GSD of 2.38. The casing and wharf operations had the next highest GM respirable dust concentrations. These differences in respirable dust concentrations by area are statistically significant ($P<0.01$). The casing operation had the highest total dust concentration with a GM of 0.87 mg/m^3, followed by the wharf (GM = 0.74 mg/m^3) and spawn (GM = 0.55 mg/m^3) operations. The differences in total dust concentration by area are statistically significant using analysis of variance (AOV) ($P<0.01$). Respirable and total dust exposures by job category (Tables 9 and 10) indicate that line crew workers had the highest exposures; these workers run the wharf, spawn, and casing operations on alternating days.

Airborne dust size distributions from ZMF also varied by farm operation/area. The five particle size distribution (PSD) samples from the wharf area had a combined mass median aerodynamic diameter (MMAD) of 13 micrometers (µm), with a GSD of 2.8. The MMAD of the two samples collected from the casing area was similar to those collected from the wharf. The five PSD samples collected from the spawn area had a bimodal size distribution (two predominant dust sizes) with MMAD's of 3 µm and 14 µm. A distinguishing feature of the dust from the 3 µm spawn area mode (as continued to the 14 µm size mode) was an increased number of round spores in the 1-2 µm size range. Microscopic examination of these spores suggests that they are likely from thermophilic actinomycete bacteria.(41) (Note: This is consistent with other industrial hygiene sampling results, reported below indicating high concentrations of thermophilic actinomycete bacteria in the spawning area). The larger 14 µm dust size mode from this area is likely mechanically generated organic dusts similar to the wharf/casing areas. Airborne dusts from both the hallway and packing areas had a MMAD of 8.5 µm, with GSD's of 2.2 (hallway) and 4.0 (packing). PSD samples from the office and picking areas were unusable due to inadequate dust loading.

Endotoxins

The endotoxin concentrations from bulk materials and from airborne dusts are presented in Tables 11 and 12. The bulk compost samples collected from the wharf area had endotoxin concentrations ranging from 157 endotoxin units per milligram of compost (EU/mg) to 816 EU/mg, depending on the stage of compost preparation. The compost sample collected from the spawning operation, following pasteurization and the addition of mushroom spawn, had the highest endotoxin concentration, 1023 EU/mg. The spawn line materials added to the compost after pasteurization, mushroom spawn and spawn mate, had the lowest endotoxin concentrations: 31 EU/mg and 1 EU/mg, respectively. The bulk sample of chicken manure from the wharf, a compost ingredient, had an endotoxin concentration of 220 EU/mg. The airborne endotoxin concentration measured during spawning operations, 28 endotoxin units per cubic meter of air (EU/m^3), was higher than the airborne endotoxin concentrations from the wharf and casing operations.

Viable Fungi and Bacteria in Bulk Materials

Concentrations of viable fungi and bacteria in bulk materials/compost are presented in Table 13. Gram negative bacterial concentrations were the highest in mushroom spawn samples, 8.5×10^7 colony forming units per gram of material (CFU/g). Pre-fill compost samples from the wharf had a gram negative bacterial concentration of 2.2×10^6 CFU/g. Total mesophilic bacterial concentrations from the different compost samples ranged from 5.2×10^6 CFU/g (pre-flush sample) to 3.3×10^8 CFU/g (pre-dip sample). The chicken manure and mushroom spawn samples also had mesophilic bacterial concentrations of approximately 1×10^8 CFU/g. The thermophilic actinomycetes concentrations were highest in compost samples from the wharf with concentrations ranging from 6.5×10^7 to 1.6×10^8 CFU/g (Note: Spawned compost from the spawn line was not analyzed.) Mesophilic fungal concentrations were the highest in the bulk sample of mushroom spawn, 2.4×10^7 CFU/g; concentrations in the various compost samples ranged from less than 3.0×10^3 CFU/g to 1.8×10^4 CFU/g. Thermophilic fungal concentrations were all below 3.0×10^3 CFU/g except for the pre-spawn compost sample which had a concentration of 7.2×10^4 CFU/g.

Viable Fungi and Bacteria in Air

Concentrations of viable fungi and bacteria in air are presented in Table 14. Mesophilic fungal concentrations (28°C) ranged from non-detectable to a high of 550,000 colonies per cubic meter of air ($colonies/m^3$); these 31 samples had a GM concentration of 2,230 $colonies/m^3$ with a GSD of 39.

Thermophilic fungal concentrations (45°C) had a lower GM of 115 colonies/m^3 with a GSD of 54. Bacterial concentrations in air were generally higher than fungal concentrations and equally variable. Mesophilic bacterial concentrations (36°C) had a GM of 11,100 colonies/m^3 with a GSD of 54. Thermophilic bacterial concentrations (55°C) had a GM of 5,310 colonies/m^3 with a GSD of 33. The predominant mesophilic and thermophilic bacteria and fungi identified in these samples are presented in Table 15. These viable sampling results had a high variability due to the nature of the sampling/analytical methods; however, part of this high variability can also be explained by differences in bacterial and fungal concentrations among different farm operations (Tables 16-19).

Table 16 presents mesophilic fungal concentrations by farm operation. The highest mesophilic fungal concentration, 550,000 colonies/m^3, was measured during tray filling operations on the wharf. The operations with the highest GM mesophilic fungal concentrations would include the hallway, casing, picking, and wharf operations. The GM mesophilic fungal concentrations from these areas ranged from about 10,300 colonies/m^3 to 19,700 colonies/m^3. The highest thermophilic fungal concentrations were measured on the wharf during tray filling operations; the GM thermophilic fungal concentration from the five samples from this area was 13,400 colonies/m^3 with a GSD of 12 (Table 17). The next highest concentration of thermophilic fungi was measured during casing operation with a GM of 2,370 colonies/m^3 with a GSD of 4.8. The difference in thermophilic fungal concentrations by area was statistically significant by AOV ($P \leq 0.01$)

The spawn operation had the highest bacterial concentrations (Tables 18 and 19). The GM mesophilic bacterial concentration from the spawn operation was 283,000 colonies/m^3 with a GSD of 54. The wharf operations had a GM mesophilic bacterial concentration of 152,000 with a GSD of 14. Thermophilic bacterial concentrations were also the highest during spawning operations, GM = 212,000 with a GSD of 15. Again, the wharf had the next highest concentration of thermophilic bacteria with a GM of 17,600 and a GSD of 4. The difference in mesophilic and thermophilic bacterial concentrations by area was statistically significant by AOV ($P \leq 0.01$).

Airborne Spore Concentrations

Table 20 presents airborne spore concentrations by area. The variability of the spore count samples was generally lower than the airborne viable fungi and bacterial concentrations. The wharf operations had the highest spore counts with a GM of 151,000 spores/m^3 and a GSD of 2.1. The spores collected from this area were largely Penicillium and Aspergillus fungal species. The picking operations had the second highest spore counts with a GM of 20,200 and a GSD of 3.4. Agaricus type basidiospores from the mushrooms grown at ZMF were observed in some of the samples from this area. Penicillium and Aspergillus spores were the most common fungal spores identified in these samples.

Diazinon and Chlorpyrifos Concentrations

Diazinon and chlorpyrifos pesticide concentrations in air are presented in Table 21. Diazinon concentrations were higher than chlorpyrifos concentrations. Diazinon concentrations ranged from a low of 0.08 micrograms per cubic meter of air ($\mu g/m^3$) to a high of 44 $\mu g/m^3$. The highest diazinon concentrations were measured during casing operations on 9/17/86 following diazinon application in this area during the night shift on 9/16/86. Chlorpyrifos concentrations ranged from below detectable levels (LOD = approximately 0.005 $\mu g/m^3$ for an 8-hour sample) to a high of 0.3 $\mu g/m^3$. Chlorpyrifos concentrations were also highest during casing operations.

The tap water samples had no detectable diazinon or chlorpyrifos concentrations. The LOD for diazinon in water is 0.034 micrograms per liter (µg/l) and for chlorpyrifos, 0.006 µg/l.

Formaldehyde Concentrations

Airborne formaldehyde concentrations ranged from below detectable levels (approximately 0.001 ppm for an 8-hour sample) to a high of 0.015 ppm (Table 22). The highest formaldehyde concentration was measured in the spawn operation.

Pyrethrum Concentrations

Pyrethrum concentrations in air were detected only during the third shift when pesticide application was done; first shift pyrethrum concentrations were below detectable concentrations, approximately 2 $\mu g/m^3$ for an 8-hour sample. Concentrations from the three samples collected during the third shift ranged from 10 $\mu g/m^3$ to a high of 20 $\mu g/m^3$.

The pyrethrum concentrations in a tap water sample collected at ZMF were detectable (LOD = 1.0 µg/l) but did not exceed the limit of quantification (LOQ = 2.0 µg/l) for this sampling/analytical method.

Exhaust Ventilation Measurements

Exhaust ventilation system measurements were taken from the spawn line, the only farm operation with local exhaust ventilation. A three-sided exhaust hood was used at the spawn line above the tray dump step. The hood, measuring 7 ft. by 8 ft. by 8 ft., was designed to collect dust generated through the mechanical dumping of the compost trays prior to the addition of mushroom spawn and spawn mate. A three sided hood was used to enclose the upper end of the compost tray during dumping operations. This exhaust system had a volumetric flow rate of 1,400 cubic feet per minute (CFM).

The exhaust system in this spawn operation was installed in May 1985, following the occurrence of respiratory problems among some farm workers. Prior to this, farm officials report that the spawn operations appeared more dusty. Other ventilation practices in use at the farm prior to the spring of 1985 included the use of a roof exhaust fan and the use of large floor fans to cool the spawn line workers. The floor fans were reported to direct some spawn line dust emissions through the large garage door entrance to this area and into other areas of the plant. The spawn room is kept under a slight positive pressure to guard against infiltration of dusts/spores. These spawn room conditions/ventilation practices likely resulted in the emission of spawn-generated dusts to other plant areas. When spawn line doors were open, we observed general air flow from the spawn area down the main farm hallway. During the industrial hygiene survey, floor fans were not used along the spawn line, and the hallway entrance was kept closed as much as possible.

B. Medical:

From a total of 282 current mushroom workers, 259 (91.8%) elected to participate in this cross-sectional health study (Table 23). Only one subject chose not to receive a spirometry examination, six chose not to receive a chest x-ray, and 32 chose not to have blood drawn for serological analysis. Participation was relatively high in every work area.

The demographic characteristics of the population are presented in Table 24. The mushroom workers are a relatively young population with half the population younger than age 31. There are slightly more males than females. Four races are represented in the population with Hispanics and Asians representing greater proportions in the workforce than in the general population. Most of the Asians are Vietnamese immigrants; the Hispanics are from various Latin American countries. There are approximately the same number of smokers as nonsmokers. Turnover in the workforce is fairly rapid with a median tenure of 3.7 years.

On average, Hispanic males tend to be somewhat younger than the rest of the population. Although Asian workers encompass a broader age spectrum, the average ages of the other sex - race groups are similar. A majority of the white and black males have a history of smoking (86% and 93%, respectively), whereas a smaller percentage of the Hispanic and Asian males have a history of smoking. Only two Asian females (6%) had a history of smoking, and the females in general were less likely to be smokers than the males. The males had a mean tenure of 3.4 years, while the females had a somewhat higher mean tenure of 4.2 years. Women and Asian males tended to have the highest tenures and Hispanic males the lowest.

Workers were divided into seven different work groups (Table 25). Night monitors and night sanitation workers were combined into one group because their exposures were judged to be similar. The picking and packing areas, consisting of 68% of the study population, are the largest work groups. Women work almost exclusively in the picking, packing, and office areas. White males are generally in supervisor and maintenance positions. The wharf and growing work groups are staffed mainly by young Hispanic males. Asians work almost exclusively as pickers. Almost all maintenance and night workers are males with a history of smoking, whereas there is about an equal frequency of nonsmokers in the other work areas.

Symptoms - Workers were asked whether they had had any of the symptoms listed in Table 26 while employed at Zellwood Farms. Eight of these symptoms are commonly associated with Mushroom Workers Lung (MWL). Stuffy, runny nose, watery eyes, and wheezing breathing are symptoms of rhinitis and asthma. Numbness in the face or arms is not associated with any respiratory disease. About 7% of the workforce reported having nausea/vomiting, wheezing breathing, or numbness in the face and arms. This may represent the number of workers with nonspecific complaints associated with their job, and the degree of false or over-reporting of symptoms in this population.

None of the 259 workers were experiencing acute respiratory reactions consistent with MWL during the study. However, it was suspected that workers susceptible to acute reactions, with slowly progressing reactions, or chronic respiratory conditions caused by exposures at ZMF might express some symptoms commonly associated with MWL.

Table 27 presents the frequency of multiple symptoms associated with MWL. There were 156 (60%) workers who reported no symptoms of MWL. It is unlikely that a worker would experience only weight loss as a symptom of MWL without having any additional symptoms. Therefore, if workers complained only of weight loss or weight loss plus one other symptom not usually associated with MWL, they were not considered to have symptoms suggestive of MWL. Thus, 103 (40%) of the workforce complained of at least one symptom which has been associated with MWL, and 54 (21%) complained of two or more symptoms (i.e. potential cases).

The characteristics of potential cases were compared to noncases (Table 28). Younger workers complained of symptoms slightly more than older workers. Women and men complained with relatively equal frequency. Hispanics and blacks complained somewhat more than whites and Asians. Workers with a history of smoking complained of symptoms with similar frequency as nonsmokers and there was no difference in frequency of potential cases by tenure category. Workers from the wharf, growing/watering, and maintenance groups complained of symptoms more frequently than workers from other areas. Office workers had the fewest complaints with only one worker complaining of a single symptom. This frequency distribution of symtoms by area parallels the relative concentrations of dust and microorganisms. The wharf and growing areas had the highest exposures to dust and microbial agents, whereas the office areas had the lowest. Although workers in picking and packing were exposed to lower dust levels, there is the additional concern that the frequency of their complaints were lower because these areas were staffed largely by Hispanics and Asians. Due to language barriers or fear, these individuals were perhaps less likely to respond positively to questions regarding health complaints. This is not supported, however, by the finding that the wharf and growing areas, two areas with the greatest prevalence of complaints, were staffed largely by Hispanics.

Spirometry Tests - Of the 258 spirometry tests, 247 were judged acceptable. Tests of approximately 5% of the white and Hispanic workers exhibited restricted patterns, while 8% of the blacks and 21% of the asians had restricted patterns. However, the results of the spirometry tests cannot be compared across racial categories because they have only been compared to predicted values for whites, and not adjusted for racial differences in pulmonary function.

For each race the number of workers with below normal spirometry tests or restricted pulmonary function were compared by work area (Table 29). In every work area except the office, there were workers with below normal spirometry test results. However, disregarding jobs with few workers of a particular race, there were no obvious differences in the prevalence of abnormal pulmonary function by work area.

For each race, a comparison of spirometry parameters and number of symptoms consistent with MWL is presented in Table 30. Among whites and blacks workers considered potential cases ($\geq$2 symptoms) had a greater prevalence of below normal pulmonary function, but this trend was reversed among Hispanics and Asians.

Analysis of covariance was used to estimate the adjusted mean FVC, FEV_1, PF, and FEV_1/FVC for workers in each work area, number of symptoms consistent with MWL, and to statistically compare differences between the means. The means were adjusted for age, sex, race, height, and smoking status. The p-value expresses the probability of obtaining differences in mean values this great or greater by chance alone. None of the differences achieved statistical significance ($p<0.05$), therefore this analysis yields no clear evidence of differences in spirometry parameters by work area or prevalence of symptoms.

Chest Radiographs - A total of 253 workers received chest radiographs; 227 (90%) of these films were read as normal by at least two of the three readers (Table 32). However, this includes two workers whose films were interpreted to have small irregular opacities with profusion of 0/1, which is considered within usual limits. No chest radiographs from workers at Zellwood Farms were interpreted to have abnormalities consistent with acute or chronic hypersensitivity pneumonitis. Pleural thickening was noted on four radiographs, nodules or lesions of unknown etiology were noted on three, and granuloma or tuberculosis were noted on seven. Abnormalities such as cardiomegaly, emphysema, and scoliosis were noted on the films of 12 other workers.

Serology - Sera from 227 ZMF workers were analyzed for precipitin reactions to extracts from 14 mushroom production materials, two thermophilic actinomyces, 13 fungi (including three strains of *Aspergillus*, four strains of *Penicillium*, and yeast), and the pesticide pyrethrum. The percentage of workers in each work area that had positive reactions is listed in Table 33.

The ratio of the total number of positive reactions to antigers and the number of workers per work area and the number of positive reactions to microorganisms (thermophilic actinomyces and fungi) are also presented in Table 33.

Various forms of compost material elicited the most prevalent response with workers from every work area having positive reactions. Approximately 30-40% of the participants reacted to compost materials and workers from each work area were equally likely to have positive reactions. This indicates that workers in every area of the plant were potentially exposed to this rich group of antigens in compost. Workers in the wharf had the highest ratio of positive reactions to the total number of antigens, but not to the microorganisms.

There was no clear association between increasing number of MWL symptoms and antigenic responses. The percentages of workers with zero, one, and two or more MWL symptoms and positive responses to the various antigens are listed in Table 34. The ratios of the total number of positive reactions to all antigens and the number of workers in each MWL symptom group, and the number of positive reactions to microorganisms (thermophilic actinomyces and fungi) are also presented in Table 34.

Positive precipitin reactions were not associated with decreased spirometry parameters or evidence of restriction. However, analysis of spirometry data is hampered because as the data is stratified by race, and there are too few individuals in each category to make meaningful observations.

More pickers and packers had positive reactions to <u>Agaricus bisporus</u> spores, as measured by double diffusion and ELISA, than workers in other work groups. (Table 35) The prevalence of reaction to <u>A. bisporus spores</u>, as measured by RAST, was no greater among pickers and packers.

Positive reactions to spores were also more frequent among women, Asians, nonsmokers, and workers with higher tenure, but since women and Asians were most commonly pickers or packers, this association could be explained by work area exposure. There was no association between positive reactions to spores and either the number of MWL symptoms or the value of any spirometry parameter.

Positive serological reactions indicate evidence of exposure and immunologic response to the corresponding antigens. However, these reactions should not be used as predictors of past, present, or future MWL.

IX. DISCUSSION AND CONCLUSIONS

Seven workers developed hypersensitivity pneumonitis (MWL) while employed at ZMF. Symptoms and respiratory changes consistent with MWL resolved while away from work, but recurred when the workers returned to ZMF. The cases came from all work areas except the picking and night crew, indicating that virtually every work group was exposed to disease-causing agents. Industrial hygiene data from the evaluation of ZMF indicates that farm workers in all farm areas are exposed to organic dust constituents capable of causing hypersensitivity pneumonitis, and these exposures are variable by farm operation. Although, we were unable to identify a specific antigen/antigens as the cause of MWL at ZMF.

Sampling data from this evaluation does indicate that some farm operations/occupations may pose a greater MWL risk for susceptible workers. Consistent with past clinical investigations of MWL, line crew workers involved in compost handling operations: wharf, spawn line, and casing workers had the highest organic dust exposures. Airborne dusts from the spawning operation had a bimodal size distribution with a large respirable size mode comprised largely of small, round spores 1-3 µm in size. Dusts of respirable faction, sufficiently small in aerodynamic diameter to penetrate to the aveolor region of the lung, may pose the greatest exposure risk for MWL among susceptible individuals.[36]

The airborne dusts from these mushroom farming operations are comprised of a number of biological and chemical agents. Fungi, bacteria, and their spores are usually a significant component of airborne organic dusts from agricultural settings and are associated with the occurrence of HP.[37,38] The compost materials from ZMF served as a suitable substrate for the growth of many fungi and bacteria. Mechanical agitation of these compost materials is a primary source of airborne organic dusts, including bacteria and fungi. Airborne concentrations of viable bacteria and fungi at ZMF were quite variable suggesting both exposure differences by area and substantial exposure fluctuations within areas. Viable fungal concentrations in air were generally lower than bacterial concentrations. Airborne concentrations of mesophilic fungi (28°C) were not significantly different by area; thermophilic fungal concentrations were significantly different by area using AOV ($P<0.01$). Airborne fungal concentrations were comparatively high in the main farm hallway adjacent to spawning/casing operations indicating a potential for periodic high exposures for any workers using the hallway. Airborne fungal spore counts were the highest in the wharf area (GM = 151,000 spores/m^3). Agaricus type basidiospores from the mushrooms grown at the farm were detected only in samples from the picking rooms at a concentration of approximately 2400 spores/m^3. Most mushrooms are picked immature prior to complete development of the mushroom and spore liberation.

Some of the fungi identified from airborne samples (Aspergillus, Penicillium, and Doratomyces) have been identified as common fungi in other mushroom farm evaluations.[39,40] Many of the fungi identified in these samples are reported as causes of hypersensitivity pneumonitis in other occupational settings;[7,36].

Bacterial concentrations in air were the highest among compost handling operations on the wharf and spawn line. Concentrations of thermophilic actinomycete bacteria, primarily members of the genus Streptomyces, were highest during spawning (GM = 212,000 colonies/m^3). The highest thermophilic actinomycete concentration, 1×10^7 spores/m^3, was measured during spawning. Bulk compost samples from the wharf tray fill operation and spawn line had high thermophilic actinomycete concentrations, approximately 1×10^8 spores/gram, consistent with findings from other mushroom farm evaluations.(40-43) The pasteurization of the compost prior to spawning promotes growth of thermophilic actinomycetes. These bacteria lack a natural spore discharge mechanism; however, compost handling operations provide a mechanism for spore release as compost materials are agitated.(40) The high thermophilic actinomycete concentrations measured during spawning operations are similar to levels measured in other agricultural (farm) settings and associated with farmers lung - a form of hypersensitivity pneumonitis caused by genera of thermophilic bacteria other than Streptomyces sp.(7,36,41)

The endotoxin concentrations in bulk compost and in airborne dust samples from our preliminary walk-through evaluations were not high by comparison to estimated threshold levels derived from research in other occupational (cotton) settings; although, we collected only a limited number of samples.(44-46) Airborne endotoxin concentrations measured during the wharf, casing and spawn operations ranged from 12 endotoxin units per cubic meter of air (EU/m^3) to a high of 28 EU/m^3.

Exposure to pyrethrum, one of the pesticides used at the farm, has also been reported to cause hypersensitivity pneumonitis.(35) However, pyrethrum concentrations measured during one evaluation were low, well below existing health standards/guidelines. Airborne concentrations of other pesticides used at this farm (diazinon, chlorpyrifos, and formaldehyde) were also below existing health standards/guidelines.(31-32)

It is unknown why most of the MWL cases occurred at ZMF between October 1984 and August 1985, but exposures to disease causing antigens may have been higher during this time period. Although company officials reported no process/materials changes during this time period, there were some changes in the ventilation practices used for the spawn area. These ventilation practices used prior to May 1985 likely resulted in increased organic dust concentration during spawning and increased dissemination of spawn line emissions to other farm areas.

Although half of the workers were Hispanic or Asian, only white and black workers were noted to be MWL cases. It is possible that because most Asians and many Hispanics are pickers, they may be exposed to lower concentrations of antigens than the rest of the work force. It is also possible, however, that many of the Asians and Hispanics may leave ZMF when they develop symptoms and not report their health complaints to the company or the health care community. Once they leave the farm, their symptoms resolve; thereby they self-select themselves out of the population and remain unknown as cases.

In the cross-sectional study at ZMF approximately 10-20% of the workers reported symptoms consistent with MWL, and the most heavily exposed workers experienced the greatest prevalence of symptoms. About 10% of the population had below normal spirometry tests, but interpretation of the spirometry tests is hampered because predicted normal values were not available for blacks, Hispanics, and Asians, (61.8% of the population) and no adequate comparison group was studied. No worker was observed to suffer acute respiratory problems at ZMF and the abnormal spirometry tests were not associated with any particular work area or the number of MWL symptoms. Cross-sectional spirometry tests probably do not serve as useful indicators of workers encountering exposure to antigens or having symptoms of MWL. This is supported by the fact that the seven original MWL cases often had normal spirometry in the early stages of MWL, but developed a restrictive pattern only during a severe acute attack. Therefore periodic spirometry tests may not serve as a useful screening tool for workers at potential risk to MWL.

No radiographic abnormalities consistent with MWL were seen and there was no evidence of fibrosis, which might be expected if workers were experiencing long term chronic respiratory disease.

The serological analyses provided useful markers of exposure to antigens, but did not serve as useful indicators of disease status. These tests demonstrated that virtually every employee is exposed to disease-causing antigens. Development of MWL requires both individual susceptibility and exposure to disease-causeing antigens in high enough concentrations over a long enough time period to develop immunologic hypersensitivity. ZMF workers are clearly exposed to numerous anigens capable of causing MWL. There are no tests available at present to determine who is susceptible to what antigen and in what concentration.

X. RECOMMENDATIONS

1. Organic dusts from compost handling operations may pose a greater exposure risk for MWL and other respiratory illness. Therefore, steps should be taken to reduce organic dust exposures in these operations. Some dust control measures were initiated at ZMF following the occurrence of MWL and these control measures should be maintained:
   - A local exhaust ventilation system was added to the spawn line.
   - All entrances to the spawn room were kept closed during spawning operations to prevent the spread of spawn-generated organic dusts to other farm areas.
   - Use of the large floor fans on the spawn line was discontinued.

2. Additional engineering dust control methods could be used on the spawn, tray fill, and casing lines to further reduce organic dust concentrations/exposures:
   - Water spray systems could be installed to wet compost materials at all points of mechanical agitation on the tray fill and casing lines.
   - All points of mechanical agitation of compost materials on the tray fill, spawn, and casing lines could be enclosed if possible, to reduce dissemination of dusts into the workers environment/breathing zone.
   - The exhaust ventilation system could be extended to cover all points of mechanical agitation of compost on the spawn line. Exhaust ventilation would be an effective way to reduce organic dust concentrations during casing and tray fill line operations.

3. A respiratory protection program should be developed for maintenance workers, and other employees in jobs (eg. heavy equipment operators on the wharf) requiring periodic work in farm areas with high organic dust concentrations. A copy of the NIOSH Guide To Industrial Respiratory Protection is included to aid in the development of a respiratory protection program.

4. All ZMF employees should be educated on the symptoms/warning signs of MWL and the potential severity of this disease in chronic form.

5. ZMF should establish a medical surveillance and referral program for workers who experience health problems related to work at ZMF. This medical referral program should use a common physician (or medical institution) familiar with MWL and other occupational health problems of agricultural origin. ZMF workers who experience any of the symptoms of MWL should be sent for medical evaluation through this referral program.

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XIII. DISTRIBUTION AND AVAILABILITY OF REPORT

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1. Zellwood Farms, Inc.
2. OSHA, Region IV
3. NIOSH Regional Offices

TABLE 1

DEMOGRAPHIC DATA
FROM CASE STUDIES OF 33 MUSHROOM FARM WORKERS
FROM ENGLAND, CANADA AND THE UNITED STATES

ZELLWOOD FARMS
ZELLWOOD, FLORIDA
MHETA 85-083

*Age N = 17
Mean = 37.8 ± 14.3 years
Median = 38 years
Range = 17-64 years

Race	N	Percent
White	16	49
Hispanic	17	52
	33	
Sex		
Male	31	94
Female	2	6
	33	
Job		
Compost handlers	18	55
Spawners	13	39
Picker/Packer	1	3
General	1	3
	33	

*Tenure N = 17
Mean = 27.1 ± 55.8 months
2.3 ± 4.7 years
Median = 3 months
Range = 1 day - 18 years

* Age and tenure information was available on only 17 cases.

TABLE 2

SYMPTOMS REPORTED
FROM CASE STUDIES OF 33 MUSHROOM FARM WORKERS
FROM ENGLAND, CANADA AND THE UNITED STATES

ZELLWOOD FARMS
ZELLWOOD, FLORIDA
MHETA 85-083

	Cases with Symptoms	
Symptom	Number	Percentage
Cough (Usually dry)	30	91
Dyspnea/SOB/Breathlessness	27	82
Chest Pain/Chest Tightness	20	61
Sputum	17	51
Weight Loss	16	48
Fever/Chills/Rigors	15	45
Malaise/Fatigue	14	42
Headache	11	33
Nausea/Vomiting	9	27
Myalgia/Joint Pain	8	24
Anorexia (with or without weight loss)	8	24
Night Sweats	7	21
Sore Throat	4	12
Dizziness	3	9
Diarrhea 2	6.1	
Abdominal Pain	1	3
Runny Nose/Watery Eyes	1	3

TABLE 3

CONFIRMED CASES OF MUSHROOM WORKERS LUNG

ZELLWOOD FARMS
ZELLWOOD, FLORIDA
MHETA 85-083

Case No.	Sex	Age	Race	Job	Tenure	Onset of Symptoms
1	M	24	W	grower	3 yrs	04/82
2	F	36	W	packer	3 mth	10/84
3	M	52	W	maintenance	11 yrs	12/84
4	F	54	W	packer	10 yrs	01/85
5	F	26	W	office worker	4 mth	01/85
6	M	41	B	wharf/ spawning	12 yrs	04/85
7	M	31	W	maintenance	1 mth	08/85

TABLE 4

SERUM PRECIPITIN REACTIONS TO VARIOUS EXTRACTS OF
ANIGENIC MATERIAL ENCOUNTERED AT ZELLWOOD FARMS
MEASURED BY COUNTER IMMUNOELECTROPHORESIS

ZELLWOOD FARMS
ZELLWOOD, FLORIDA
MHETA 85-083

Case	Preflush	Chicken Manure	Spawn Mate	Spawn	Pre Spawn	Pre Fill	Pre Dip
3	+	+	+	+	+	+	+
5	+	-	-	-	+	+	+
6	+	-	-	-	+	+	+
7	+	+	-	-	-	+	+
Total Positive	4	2	1	1	3	4	4
Case (Acute Serum)							
5	+	-	-	-	+	+	+
6	+	-	-	-	-	+	+
7	+	+	-	+	-	+	+
Total Positive	3	1	0	1	1	3	3
Control							
1	+	+	-	-	-	+	+
2	+	+	-	+	+	+	+
3	+	+	-	-	-	+	+
4	+	-	-	-	-	+	+
5	+	+	-	+	+	+	+
6	+	-	-	-	-	+	+
7	+	+	-	-	-	+	+
8	+	+	-	-	-	+	+
9	+	+	-	-	-	+	+
10	+	+	-	-	-	+	+
Total Positive	10	8	0	2	2	10	10

TABLE 5

SERUM ANTIBODY REACTIONS TO VARIOUS MICROORGONISMS
MEASURED BY ENZYME IMMUNOSORBENT ASSAY (ELISA)

ZELLWOOD FARMS
ZELLWOOD, FLORIDA
MHETA 85-083

Case	* 1	2	3	4	5	6	7	8	9	10	11	
3	--	--	1:320	1:80	--	--	1:320	1:160	1:320	1:80	1:80	1:32
5	--	--	--	--	--	--	--	--	--	--	--	--
6	1:160	--	--	--	--	--	--	--	1:80	--	--	--
7	--	--	--	--	--	--	--	--	--	--	--	--
Case (Acute Serum)												
5	1:320	--	--	--	--	--	--	--	1:640	--	1:160	1:80
6	1:80	--	--	--	--	--	--	--	1:80	--	--	--
7	--	--	--	--	--	--	--	--	--	--	--	--
ontrol												
1	--	--	--	--	--	--	--	--	--	--	--	--
2	--	--	--	--	--	--	--	--	1:80	--	--	--
3	--	--	--	--	--	--	--	--	--	--	--	--
4	--	--	--	--	--	--	--	--	1:1280	1:1280	1:160	--
5	--	--	--	--	--	--	--	--	1:160	1:80	--	--
6	--	--	--	--	--	--	--	--	1:80	--	--	1:80
7	--	--	--	--	--	--	--	--	--	--	--	--
8	--	--	--	--	--	--	1:160	--	1:160	1:80	--	1:80
9	--	--	--	--	--	--	1:80	--	1:80	--	--	--
10	--	--	--	--	--	--	--	--	--	--	--	

Positive reactions are expressed as the highest dilution ratio for which a positive respons is still obtained.

*Meanings of heading on Table

1. Micropolyspora faeni
2. Thermoactinomyces vulgaris I
3. Thermoactinomyces vulgaris II
4. Thermoactinomyces sacchari
5. Saccharomonospora viridis
6. Thermoactinomyces candidus I
7. Thermoactinomyces candidus II
8. Thermoactinomyces candidus III
9. Aspergillus fumigatus I
10. Aspergillus fumigatus II
11. Aspergillus fumigatus III
12. Aspergillus niger

TABLE 6

RESPIRABLE AND TOTAL DUST CONCENTRATIONS (MG/M^3) IN AIR

ZELLWOOD FARMS
ZELLWOOD, FLORIDA
MHETA 85-083

	SAMPLES	GM	GSD	RANGE LOW	RANGE HIGH
Respirable Dust	32	0.14	2.58	0.04	2.38
Total Dust	31	0.32	3.53	0.01	3.84

Includes Both Personal Exposure Measurements and Area Samples as Time-Weighted Averages.
MG/M^3 - Milligrams Per Cubic Meter of Air.
GM - Geometric Mean.
GSD - Geometric Standard Deviation.
-The Limit of Detection for Airborne Dusts is Approximately 0.01 MG/M^3 for an 8-Hour Sample.

TABLE 7

AIRBORNE RESPIRABLE DUST CONCENTRATIONS (MG/M^3) BY AREA

ZELLWOOD FARMS
ZELLWOOD, FLORIDA
MHETA 85-083

AREA	SAMPLES	GM	GSD	RANGE LOW	RANGE HIGH
Wharf	8	0.13	2.01	0.05	0.48
Spawn	8	0.46	2.38	0.13	2.38
Casing	4	0.14	1.69	0.09	0.23
Hallway	3	0.09	1.61	0.06	0.15
Picking	2	0.06	1.77	0.04	0.09
Packing	4	0.09	1.05	0.08	0.09
Office	2	0.05	1.26	0.04	0.06
Ambient	1	0.05	--	--	--

Includes Both Personal Exposure Measurements and Area Samples As Time-Weighted Averages.
MG/M^3 - Milligrams Per Cubic Meter of Air.
GM - Geometric Mean.
GSD - Geometric Standard Deviation.
-The Limit of Detection for Airborne Dusts is Approximately 0.01 MG/M^3 for an 8-Hour Sample.

TABLE 8

AIRBORNE TOTAL DUST CONCENTRATIONS (MG/M^3) BY AREA

ZELLWOOD FARMS
ZELLWOOD, FLORIDA
MHETA 85-083

AREA	SAMPLES	GM	GSD	RANGE LOW	RANGE HIGH
Wharf	6	0.74	1.54	0.38	1.40
Spawn	6	0.55	2.0	0.17	1.18
Casing	4	0.87	4.38	0.11	3.84
Hallway	3	0.12	1.81	0.07	0.24
Picking	4	0.14	2.20	0.05	0.31
Packing	4	0.22	2.55	0.07	0.66
Office	2	0.08	1.86	0.05	0.12
Ambient	1	0.01	--	--	--

Includes Both Personal Exposure Measurements and Area Samples as Time-Weighted Averages.
MG/M^3 - Milligrams Per Cubic Meter of Air.
GM - Geometric Mean.
GSD - Geometric Standard Deviation.
-The Limit of Detection for Airborne Dusts is Approximately 0.01 MG/M^3 for an 8-Hour Sample.

TABLE 9

RESPIRABLE DUST EXPOSURES (MG/M^3) BY JOB

ZELLWOOD FARMS
ZELLWOOD, FLORIDA
MHETA 85-083

JOB	SAMPLES	GM	GSD	RANGE LOW	RANGE HIGH
Line Crew	8	0.29	3.30	0.06	2.38
Lift/Haulage Operator	2	0.17	4.45	0.06	0.48
Front-End Loader Oper.	2	0.08	2.22	0.05	0.14
Packer	2	0.09	1.08	0.08	0.09

Full Shift, Personal Breathing Zone Samples.
MG/M^3 - Milligrams Per Cubic Meter of Air.
GM - Geometric Mean.
GSD - Geometric Standard Deviation.
- The Limit of Detection for Airborne Dust is Approximately 0.01 MG/M^3 for an 8-Hour Sample.

TABLE 10

TOTAL DUST EXPOSURES (MG/M^3) BY JOB

ZELLWOOD FARMS
ZELLWOOD, FLORIDA
MHETA 85-083

JOB	SAMPLES	GM	GSD	RANGE LOW	RANGE HIGH
Line Crew	5	1.07	2.17	0.57	3.84
Lift/Haulage Operator	2	0.49	2.78	0.24	1.01
Maintenance	2	0.59	1.88	0.38	0.92
Picker	2	0.09	2.59	0.05	0.18
Packer	2	0.21	1.53	0.16	0.29

Full Shift, Personal Breathing Zone Samples.
MG/M^3 - Milligrams Per Cubic Meter of Air.
GM - Geometric Mean.
GSD - Geometric Standard Deviation.
- The Limit of Detection for Airborne Dust is Approximately 0.01 MG/M^3 for an 8-Hour Sample.

TABLE 11

ENDOTOXIN CONCENTRATION IN BULK SAMPLES (EU/MG)

ZELLWOOD FARMS
ZELLWOOD, FLORIDA
MHETA 85-083

MATERIAL	LOCATION	CONCENTRATIONS
Compost		
- Pre-dip	Wharf	758
- Pre-fill	Wharf	816
- Pre-spawn (tray full line)	Wharf	157
- Pre-spawn (tray full line)	Wharf	347
- Spawned	Spawn line	1023
- Pre-flush	Growing room	611
Chicken manure	Wharf	220
Mushroom spawn	Spawn line	31
Mushroom spawn	Spawn line	1

EU/MG - Endotoxin Units Per Milligram of Compost.

TABLE 12

AIRBORNE ENDOTOXIN CONCENTRATIONS (EU/M^3) BY AREA

ZELLWOOD FARMS
ZELLWOOD, FLORIDA
MHETA 85-083

AREA	DATE	CONCENTRATION
Wharf	9/17/87	14.3
Wharf	9/17/87	13.3
Spawn	9/16/87	28
Casing	9/18/87	12.3

EU/M^3 - Endotoxin Units Per Cubic Meter From Partial Period Area Samples.

TABLE 13

VIABLE MICROORGANISM CONCENTRATIONS (CFU/g) IN BULK MATERIAL SAMPLES

ZELLWOOD FARMS
ZELLWOOD, FLORIDA
MHETA 85-083

Material	Gram Negative Bacteria (35°C)	Total Bacteria (35°C)	Thermophilic Actinomycetes (55°C)	Fungi (25°C)	Thermophilic Fungi (45°C)
Compost					
- Pre-dip (wharf)	3.4×10^6	3.3×10^8	6.5×10^7	$<3.0 \times 10^3$	$<3.0 \times 10^3$
- Pre-fill (wharf)	2.2×10^6	1.7×10^8	1.3×10^8	8.3×10^3	$<3.0 \times 10^3$
- Pre-spawn (wharf)	$<3.0 \times 10^6$	2.7×10^8	1.6×10^8	1.8×10^4	7.2×10^4
- Pre-flush (growing room)	5.9×10^4	5.2×10^6	$<3.0 \times 10^3$	4.6×10^3	$<3.0 \times 10^3$
Chicken Manure	$<3.0 \times 10^3$	1.9×10^8	$<3.0 \times 10^3$	$<3.0 \times 10^3$	$<3.0 \times 10^3$
Mushroom Spawn	8.5×10^7	1.6×10^8	7.6×10^5	2.4×10^7	$<3.0 \times 10^3$
Mushroom Spawn Mate	$<3.0 \times 10^3$	6.3×10^3	$<3.0 \times 10^3$	$<3.0 \times 10^3$	$<3.0 \times 10^3$

CFU/g - Colony Forming Units Per Gram of Bulk Material.

TABLE 14

AIRBORNE CONCENTRATIONS OF VIABLE MICROORGANISMS (COLONIES/M^3)

ZELLWOOD FARMS
ZELLWOOD, FLORIDA
MHETA 85-083

	SAMPLES	GM	GSD	RANGE LOW	RANGE HIGH
Fungi (28°C)	31	2,230	39	ND	550,000
Bacteria (36°C)	31	11,100	62	ND	126,000,000
Fungi (45°C)	31	115	54	ND	844,000
Bacteria (55°C)	31	5,310	33	ND	10,800,000

From Partial Period Area Samples.
°C - Incubation Temperatures in Degree Celsius.
GM - Geometric Mean.
GSD - Geometric Standard Deviation.
ND - No Colonies Detected.

TABLE 15

PREDOMINANT FUNGI AND BACTERIA IDENTIFIED IN AIR SAMPLES

ZELLWOOD FARMS
ZELLWOOD, FLORIDA
MHETA 85-083

FUNGI	BACTERIA
28° C	36°C
Neurospora SP.	Sarcina SP.
Trichoderma SP.	Micrococcus SP.
Penicillium SP.	Flavobacter SP.
Cladosporium SP.	Acinetobacter SP.
Aspergillus SP.	Xanthomonas SP.
Doratomyces SP.	
45° C	55° C
Mucor SP. Aspergillus SP.	Streptomyces SP.

TABLE 16

AIRBORNE MESOPHILIC FUNGAL CONCENTRATIONS (COLONIES/M^3) BY AREA
28°C INCUBATION

ZELLWOOD FARMS
ZELLWOOD, FLORIDA
MHETA 85-083

AREA	SAMPLES	GM	GSD	RANGE LOW	RANGE HIGH
Wharf	5	10,300	36	267	550,000
Spawn	8	245	167	ND	497,000
Casing	4	13,800	3.8	3,560	72,200
Hallway	4	19,700	1.7	12,000	42,800
Picking	2	10,800	3.9	4,080	28,700
Packing	3	6,180	2.2	2,500	10,000
Office	2	351	1.1	328	374
Ambient	1	ND	--	--	--

From Partial Period Area Samples.
GM - Geometric Mean.
GSD - Geometric Standard Deviation.
ND - No Colonies Detected.

TABLE 17

AIRBORNE THEROMPHILIC FUNGAL CONCENTRATIONS (COLONIES/M^3) BY AREA
45°C INCUBATION

ZELLWOOD FARMS
ZELLWOOD, FLORIDA
MHETA 85-083

				RANGE	
AREA	SAMPLES	GM	GSD	LOW	HIGH
Wharf	5	13,400	12	1,230	844,000
Spawn	8	27.1	17	ND	965
Casing	4	2,370	4.8	373	8,560
Hallway	4	140	42.9	ND	9,410
Picking	2	25.3	96.3	ND	639
Packing	3	14	90.6	ND	2,450
Office	2	ND	--	--	--
Ambient	1	ND	--	--	--

From Partial Period Area Samples.
GM - Geometric Mean.
GSD - Geometric Standard Deviation.
ND - No Colonies Detected.

TABLE 18

AIRBORNE MESOPHILIC BACTERIAL CONCENTRATIONS (COLONIES/M^3) BY AREA
36°C INCUBATION

ZELLWOOD FARMS
ZELLWOOD, FLORIDA
MHETA 85-083

				RANGE	
AREA	SAMPLES	GM	GSD	LOW	HIGH
Wharf	5	152,000	14	9,780	3,990,000
Spawn	8	283,000	54	3,600	126,000,000
Casing	4	9,020	91.1	400	5,940,000
Hallway	4	1,290	3.4	463	7,410
Picking	2	19,300	6.2	5,320	70,300
Packing	3	292	5.4	50	1,430
Office	2	1,200	1.43	929	1,540
Ambient	1	89	--	--	--

From Partial Period Area Samples.
GM - Geometric Mean.
GSD - Geometric Standard Deviation.
ND - No Colonies Detected.

TABLE 19

AIRBORNE THERMOPHILIC BACTERIAL CONCENTRATIONS (COLONIES/M^3) BY AREA
55°C INCUBATION

ZELLWOOD FARMS
ZELLWOOD, FLORIDA
MHETA 85-083

				RANGE	
AREA	SAMPLES	GM	GSD	LOW	HIGH
Wharf	5	17,600	4	2,810	74,100
Spawn	8	212,000	15	4,470	10,800,000
Casing	4	1,200	1.9	782	3,060
Hallway	4	4,640	1.61	2,310	6,800
Picking	2	1,120	6.39	301	4,150
Packing	3	119	63	ND	1,390
Office	2	1,070	1.35	867	1,320
Ambient	1	116	--	--	--

From Partial Period Area Samples.
GM - Geometric Mean.
GSD - Geometric Standard Deviation.
ND - No Colonies Detected.

TABLE 20

AIRBORNE SPORE CONCENTRATIONS (SPORES/M^3) BY AREA

ZELLWOOD FARMS
ZELLWOOD, FLORIDA
MHETA 85-083

AREA	SAMPLES	GM	GSD	RANGE LOW	RANGE HIGH	Comments/ Observations
Wharf	2	151,000	2.1	87,300	249,000	Mostly penicillium & aspergillus spores
Spawn	4	3,560	4.3	993	12,800	Penicillium & aspergillus spores observed in some samples
Casing	3	10,200	20	533	217,000	Penicillium, aspergillus & cladosporium spores
Hallway	2	1,960	5.9	561	6,880	--
Picking	3	20,200	3.4	6,270	70,700	Agaricus type basidiospores observed in some samples
Packing	1	15,900	--	--	--	
Office	2	1,160	1.1	1,100	1,220	Mostly penicillium & aspergillus spores

Full Shift Area Samples.
GM - Geometric Mean.
GSD - Geometric Standard Deviation.

TABLE 21

AIRBORNE DIAZINON AND CHLORPYRIFOS[1] CONCENTRATIONS ($\mu g/m^3$)

ZELLWOOD FARMS
ZELLWOOD, FLORIDA
MHETA 85-083

AREA	DATES	SHIFT	DIAZINON CONCENTRATION	CHLORPYRIFOS CONCENTRATION
Spawn	9/15/86	1	0.4	ND
Hallway	9/15/86	1	0.4	0.01
Wharf	9/16/86	1	0.08	ND
Office	9/16/86	1	2.6	0.02
Casing	9/17/86	1	44	0.3
Hallway	9/17/86	1	4.5	0.02
Pesticide Appl* (Personal Sample)	9/17/86	2	1.9	0.2
Casing	9/17/86	2	6.7	0.2
Spawn	9/18/86	1	0.4	.01
Picking	9/18/86	1	0.9	ND
Pesticide Appl* (Personal Sample)	9/18/86	2	0.2	.03
Main Hall	9/18/86	2	0.1	ND
Wharf	9/19/86	1	0.6	.01

[1] Chlorpyrifos is a genaric name for the product Dursban.
$\mu g/m^3$ - Micrograms Per Cubic Meter of Air.
- From Full Shift Area and Personal Samples.
- The Limit of Detection for Airborne Concentrations of Diazinon and is approximately 0.005 $\mu g/m^3$ for an 8-hour sample.

ND - Samples Below the Limit of Detection.
* Appl - Applicator

TABLE 22

AIRBORNE FORMALDEHYDE CONCENTRATIONS (PPM)

ZELLWOOD FARMS
ZELLWOOD, FLORIDA
MHETA 85-083

AREA	DATES	SHIFT	CONCENTRATION
Spawn	9/15/86	1	0.015
Hallway	9/15/86	1	0.006
Wharf	9/16/86	1	0.003
Office	9/16/86	1	0.005
Casing	9/17/86	1	0.004
Hallway	9/17/86	2	0.006
Wharf	9/19/86	1	ND

From Full Shift Area Samples.
PPM - Parts Per Million Parts Air by Volume.
ND - Samples Below the Analytical Detection Limit, Approximately 0.001 ppm for an 8-Hour Sample.

TABLE 23

WORKER PARTICIPATION BY WORK AREA
CROSS-SECTIONAL HEALTH STUDY

ZELLWOOD FARMS
ZELLWOOD, FLORIDA
MHETA 85-083

				Medical Tests		
Department	N	n	%	X-ray	PFT	Serology
Wharf	15	14	93	14	14	13
Water/growing	18	18	100	17	18	16
Picking	137	121	88	118	121	115
Packing	56	55	98	55	55	40
Maintenance	30	28	93	28	28	24
Night Monitors	3	2	67	1	2	2
Night Sanitation	13	13	100	13	13	12
Office	10	8	80	7	7	5
Overall	282	259	92	253	258	227

N - Number of employees.
n - Number of employees choosing to participate in the cross-sectional health survey.

TABLE 24

CHARACTERISTICS OF THE STUDY POPULATION
CROSS-SECTIONAL HEALTH STUDY

ZELLWOOD FARMS
ZELLWOOD, FLORIDA
MHETA 85-083

259 Subjects

Age	Number	Frequency
≤ 26	69	27%
27-38 years	120	46%
≥ 38	70	27%

Mean 33.1 ± 9.5 years
Median 31
Range 17-61

Race		
White	99	38%
Black	26	10%
Hispanic	64	25%
Asian	70	27%
Sex		
Male	150	58%
Female	109	42%
Smoking Status		
Smokers	113	44%
Ex-smokers	33	12%
Nonsmokers	113	44%
Tenure		
≤ 1	68	26%
1-5 years	116	45%
≥ 5	75	29%

Mean 3.7 ± 3.6 years
Median 2.5 years
Range 0 - 16.8 years

TABLE 25

CHARACTERISTICS OF STUDY POPULATION
BY WORK AREA
CROSS-SECTIONAL HEALTH STUDY

ZELLWOOD FARMS
ZELLWOOD, FLORIDA
MHETA 85-083

		Gender**		Race**				Smoking Status**			Mean
	Mean Age*	Male	Female	White	Black	Hispanic	Asian	Non Smk	Smoker	Exsmoker	Tenure*
Wharf	30.7±4.8	14(100)	0	2(14)	3(21)	9(64)	0	7(50)	4(29)	3(21)	4.7±3.3
Growing/water	29.6±9.0	18(100)	0	5(28)	0	13(72)	0	8(44)	5(28)	5(28)	2.7±2.0
Picking	33.5±10.0	60(50)	61(50)	19(16)	7 (6)	30(25)	65(54)	65(54)	46(38)	10(8)	4.2±3.7
Packing	33.0±8.9	13(24)	42(76)	34(62)	10(18)	7(13)	4(7)	26(47)	26(47)	3(6)	3.0±3.4
Maintenance	34.1±9.5	27(96)	1(4)	24(86)	1 (4)	3(11)	0	1(4)	22(79)	5(18)	3.4±3.9
Night Workers	34.2±12.1	15(100)	0	7(47)	5(33)	2(123)	1(7)	2(13)	9(60)	4(27)	3.2±2.8
Office	35.9±8.0	3(38)	5(63)	8(100)	0	0	0	4(50)	1(13)	3(38)	5.2±5.1

* ± standard deviation
** Percent in parentheses

TABLE 26

NUMBER OF EMPLOYEES REPORTING VARIOUS SYMPTOMS
CROSS-SECTIONAL HEALTH STUDY

ZELLWOOD FARMS
ZELLWOOD, FLORIDA
MHETA 85-083

	Workers Reporting Symptoms	
	Number	Percent(%)
Stuffy, runny nose, watery eyes	68	26
Cough*	43	17
Fatigue*	41	16
Myalgias*	33	13
Chest tightness*	28	11
Chills, fever*	26	10
Short of breath*	26	10
Nausea/vomiting	18	7
Numbness in face/arms	18	7
Weight loss*	18	7
Wheezing breathing	17	7
Loss of appetite*	15	6

*Symptoms commonly associated with mushroom workers lung.

TABLE 27

NUMBER OF EMPLOYEES REPORTING SYMPTOMS ASSOCIATED WITH MUSHROOM WORKERS LUNG

ZELLWOOD FARMS
ZELLWOOD, FLORIDA
MHETA 85-083

No. of Symptoms	Number	Percent(%)
0	156	60
1	49	19
2	17	7
3	16	6
4	14	5
5	5	2
6	1	0.4
7	1	0.4
8	0	0.0
	259	

TABLE 28

NUMBER OF WORKERS WITH SYMPTOMS ASSOCIATED
WITH MUSHROOM WORKERS LUNG (MWL) BY CATEGORIES OF AGE, SEX, RACE,
SMOKING, TENURE, AND WORK AREA
CROSS-SECTIONAL HEALTH STUDY

ZELLWOOD FARMS
ZELLWOOD, FLORIDA
MHETA 85-083

No. of Symptoms	Age in Years < 26	27-38	>38
0	39 (57)	70 (58)	47 (67)
1	14 (20)	27 (23)	11 (16)
>2	16 (23)	23 (19)	12 (17)
	69	120	70

Sex

Symptoms	Male	Female
0	92 (61)	64 (59)
1	33 (22)	19 (17)
>2	25 (17)	26 (24)
	150	109

Race

Symptoms	White	Black	Hispanic	Asian
0	60 (61)	11 (42)	31 (48)	54 (77)
1	18 (18)	10 (39)	16 (25)	8 (11)
>2	21 (21)	5 (19)	17 (27)	8 (11)
	99	26	64	70

TABLE 28 (continued)

NUMBER OF WORKERS WITH SYMPTOMS ASSOCIATED
WITH MUSHROOM WORKERS LUNG (MWL) BY CATEGORIES OF AGE, SEX, RACE,
SMOKING, TENURE, AND WORK AREA
CROSS-SECTIONAL HEALTH STUDY

ZELLWOOD FARMS
ZELLWOOD, FLORIDA
MHETA 85-083

Smoking Status

Symptoms	Nonsmoker	Smoker	Exsmoker
0	71 (62)	67 (59)	18 (54)
1	20 (18)	22 (19)	10 (30)
≥2	22 (19)	24 (21)	5 (15)
	113	112	33

Tenure in Years

Symptoms	< 1	1-5	> 5
0	42 (62)	71 (61)	43 (57)
1	11 (16)	24 (21)	17 (23)
≥2	15 (22)	21 (18)	15 (20)
	68	116	75

Work Area

Symptoms	Wharf	Grow	Pick	Pack	Maint	Night	Office
0	4 (29)	9 (50)	79 (65)	34 (62)	13 (46)	10 (67)	7 (87)
1	5 (36)	4 (22)	20 (16)	11 (20)	10 (36)	1 (7)	1 (12)
2	5 (36)	5 (28)	22 (18)	10 (18)	5 (18)	4 (27)	0
	14	18	121	55	28	15	8

TABLE 29

SPIROMETRY PARAMETERS BY WORK AREA
BY RACE
CROSS-SECTIONAL HEALTH STUDY

ZELLWOOD FARMS
ZELLWOOD, FLORIDA
MHETA 85-083

White

% Predicted FVC	Wharf	Grow	Pick	Pack	Maint	Night	Office	Total
<80	--	--	1	2	1	1	--	5
≥80	2/2	5/5	18/19	30/32	23/24	6/7	7/7	91/96
% Predicted FEV1								
<80	--	--	--	2	3	1	--	6
≥80	2/1	5/5	19/19	30/32	21/24	6/7	7/7	90/96
%Predicted PF								
<80	--	--	1	6	4	2	--	13
≥80	2/2	5/5	18/19	26/32	20/24	5/7	7/7	83/96
% FEV1/FVC								
<70	--	--	1	--	4	2	--	7
≥70	2/2	5/5	18/19	32/32	20/24	5/7	7/7	89/96
Restrictive Pattern								
Yes	0	0	1	2	1	0	0	4
No	2/2	5/5	18/19	30/32	23/24	7/7	7/7	92/96

TABLE 29 (continued)

SPIROMETRY PARAMETERS BY WORK AREA
BY RACE
CROSS-SECTIONAL HEALTH STUDY

ZELLWOOD FARMS
ZELLWOOD, FLORIDA
MHETA 85-083

Black

% Predicted FVC	Wharf	Pick	Pack	Maint	Night	Total
<80	--	1	1	--	--	2
≥80	3/3	6/7	9/10	1/1	4/4	23/25
% Predicted FEV1						
<80	1	1	2	--	1	5
≥80	2/3	6/7	8/10	1/1	3/4	20/25
% Predicted PF						
<80	--	--	1	--	--	1
≥80	3/3	7/7	9/10	4/1	3/4	24/25
% FEV1/FVC						
<70	--	--	--	--	1	1
≥70	3/3	7/7	10/10	1/1	3/4	24/25
Restrictive Pattern						
Yes	0	1	1	0	0	2
No	3/3	6/7	9/10	1/1	3/3	23/25

TABLE 29 (continued)

SPIROMETRY PARAMETERS BY WORK AREA
BY RACE
CROSS-SECTIONAL HEALTH STUDY

ZELLWOOD FARMS
ZELLWOOD, FLORIDA
MHETA 85-083

Hispanic

% Predicted FVC	Wharf	Grow	Pick	Pack	Maint	Night	Total
<80	--	1	1	1	--	--	3
≥80	9	12	29	6	3	2	61
	9	13	30	7	3	2	64
% Predicted FEV1							
<80	--	1	1	1	--	--	3
≥80	9	12	29	6	3	2	61
	9	13	30	7	3	2	64
% Predicted PF							
<80	--	1	3	--	--	--	4
≥80	9	12	27	7	3	2	60
	9	13	30	7	3	2	64
% FEV1/FVC							
<70	--	--	2	--	--	--	4
≥70	9	13	28	7	3	2	62
	9	13	30	7	3	2	64
Restrictive Pattern							
Yes	0	1	1	1	0	0	3
No	9	12	29	6	3	2	61
	9	13	30	7	3	2	64

TABLE 29 (continued)

SPIROMETRY PARAMETERS BY WORK AREA
BY RACE
CROSS-SECTIONAL HEALTH STUDY

ZELLWOOD FARMS
ZELLWOOD, FLORIDA
MHETA 85-083

Asian

% Predicted FVC	Pick	Pack	Night	Total
<80	11	3	--	14
≥80	46	1	1	48
	57	4	1	62
% Predicted FEV1				
<80	9	1	--	10
≥80	48	3	1	52
	57	4	1	62
% Predicted PF				
<80	14	1	1	16
≥80	43	3	--	46
	57	4	1	62
% Percent				
<70	1	--	1	2
≥70	56	4	--	60
	57	4	1	62
Restrictive Pattern				
Yes	10	3	0	13
No	46	1	1	49
	56	4	1	62

TABLE 30

SPIROMETRY PARAMETERS AND NUMBER OF SYMPTOMS
CONSISTENT WITH MUSHROOM WORKER'S LUNG (MWL)
BY RACE
CROSS-SECTIONAL HEALTH STUDY

ZELLWOOD FARMS
ZELLWOOD, FLORIDA
MHETA 85-083

White

NUMBER OF SYMPTOMS

% Predicted FVC	0	1	>2	Total
<80	2	1	2	5
>80	55	17	19	91
	57	18	21	96
% Predicted FEV1				
<80	3	1	2	6
>80	54	17	19	90
	57	18	21	96
% Predicted PF				
<80	7	3	3	13
>80	50	15	18	83
	57	18	21	96
% FEV1/FVC				
<70	4	2	1	7
≥70	53	16	20	89
	57	18	21	96
Restrictive Pattern				
Yes	1	1	2	4
No	56	17	19	92
	57	18	21	96

TABLE 30 (continued)

SPIROMETRY PARAMETERS AND NUMBER OF SYMPTOMS
CONSISTENT WITH MUSHROOM WORKER'S LUNG (MWL)
BY RACE
CROSS-SECTIONAL HEALTH STUDY

ZELLWOOD FARMS
ZELLWOOD, FLORIDA
MHETA 85-083

Black

NUMBER OF SYMPTOMS

% Predicted FVC	0	1	>2	Total
<80	1	0	1	2
≥80	10	10	3	23
	11	10	4	25
% Predicted FEV1				
<80	1	0	3	4
≥80	10	10	1	21
	11	10	4	25
% Predicted PF				
<80	1	0	0	1
≥80	10	10	4	24
	11	10	4	25
% FEV1/FVC				
<70	1	0	0	1
≥70	10	10	4	24
	11	10	4	25
Restrictive Pattern				
Yes	1	0	1	2
No	10	10	3	23
	11	10	4	25

TABLE 30 (continued)

SPIROMETRY PARAMETERS AND NUMBER OF SYMPTOMS
CONSISTENT WITH MUSHROOM WORKER'S LUNG (MWL)
BY RACE
CROSS-SECTIONAL HEALTH STUDY

ZELLWOOD FARMS
ZELLWOOD, FLORIDA
MHETA 85-083

Hispanic

	NUMBER OF SYMPTOMS			
% Predicted FVC	0	1	≥2	Total
<80	1	2	0	3
≥80	30	14	17	61
	31	16	17	64
% Predicted FEV1				
<80	1	2	0	3
≥80	30	14	17	61
	31	16	17	64
% Predicted PF				
<80	3	1	0	4
≥80	28	15	17	60
	31	16	17	64
% FEV1/FVC				
<70	1	0	1	2
≥70	30	16	16	62
	31	16	17	64
Restrictive Pattern				
Yes	1	2	0	3
No	30	14	17	61
	31	16	17	64

TABLE 30 (continued)

SPIROMETRY PARAMETERS AND NUMBER OF SYMPTOMS
CONSISTENT WITH MUSHROOM WORKER'S LUNG (MWL)
BY RACE
CROSS-SECTIONAL HEALTH STUDY

ZELLWOOD FARMS
ZELLWOOD, FLORIDA
MHETA 85-083

Asian

NUMBER OF SYMPTOMS

% Predicted FVC	0	1	>2	Total
<80	11	2	1	14
>80	38	5	5	48
	49	7	6	62
% Predicted FEV1				
<80	9	0	1	10
>80	40	7	5	52
	49	7	6	62
% Predicted PF				
<80	14	1	1	16
>80	35	6	5	36
	49	7	6	62
% FEV1/FVC				
<70	2	0	0	2
>70	47	7	6	60
	49	7	6	62
Restrictive Pattern				
Yes	10	2	1	13
No	39	5	5	49
	49	7	6	62

TABLE 31

ADJUSTED MEAN
SPIROMETRY PARAMETERS BY AREA
ADJUSTED FOR AGE, HEIGHT, SEX, RACE, AND SMOKING STATUS
CROSS-SECTIONAL HEALTH STUDY

ZELLWOOD FARMS
ZELLWOOD, FLORIDA
MHETA 85-083

	Wharf	Grow	Pick	Pack	Maint	Night	Office	P Value
FVC (1)	4.04	4.08	3.95	3.84	3.89	4.33	4.26	0.08
FEV_1(1)	3.13	3.33	3.23	3.17	3.10	3.32	3.52	0.22
PF (1/s)	7.41	7.87	7.60	7.51	7.46	7.07	8.89	0.18
FEV_1/FVC (%)	78.2	81.6	81.9	82.9	80.3	77.2	83.1	0.08
Number of Workers	14	18	121	55	28	15	7	

ADJUSTED MEAN
SPIROMETRY PARAMETERS BY NUMBER OF SYMPTOMS
COMMONLY ASSOCIATED WITH MUSHROOM WORKERS LUNG

	0	1	≥2	P-Value
FVC (1)	3.99	3.87	4.06	0.20
FEV_1 (1)	3.26	3.14	3.21	0.23
PF (1/s)	7.67	7.45	7.47	0.54
FEV_1/FVC (%)	81.9	82.0	79.5	0.06
Number of Workers	148	51	48	

TABLE 32

INTERPRETATION OF CHEST RADIOGRAPHS
CROSS-SECTIONAL HEALTH STUDY

ZELLWOOD FARMS
ZELLWOOD, FLORIDA
MHETA 85-083

Total Number of Radiographs	=	253
Interpreted as Normal	=	227 (90%)
Interpreted as Abnormal	=	26 (10%)
pleural abnormality	=	4
nodules	=	3
granulomata/tuberculosis	=	7
other abnormalities	=	12

TABLE 33

PERCENTAGE OF WORKERS WITH POSITIVE PRECIPITIN REACTIONS TO VARIOUS ANTIGENS
BY WORK AREA
CROSS-SECTIONAL HEALTH STUDY

ZELLWOOD FARMS
ZELLWOOD, FLORIDA
MHETA 85-083

	Wharf	Grow	Pick	Pack	Maint	Night	Office	Total
Number of Workers	13	16	115	40	24	14	5	227
Antigen								
Production Materials:					Percent			
Chicken Manure	23	6	9	5	--	14	20	8
Soybean Meal	8	6	2	3	8	7	--	4
Cotton Seed Meal	8	--	--	--	--	7	--	1
Cotton Seed Hulls	8	6	6	3	8	--	--	5
Prespawn Compost	39	6	24	20	21	14	--	21
Stockpiled Compost	31	31	47	40	50	43	60	44
Spawn	15	6	12	18	--	--	--	11
Spawnmate	8	--	--	3	--	--	--	1
RBS Supplement	8	--	1	5	4	7	--	3
Post Spawn Compost	46	31	37	33	25	21	40	34
Compost + Mycelia	46	31	40	35	21	21	20	35
Peatmoss + Mycelia	46	6	23	8	13	7	--	18
Spent Compost	15	6	28	13	33	21	60	24
Mushroom (A. Bisporus)	8	6	17	23	13	--	--	15
Spores (A. Bisporus)	--	6	14	20	4	7	--	12
Thermophilic Actinomyces:								
Micropolyspora Faeni	--	6	7	13	17	7	20.0	9
Thermoactinomyces Vulgaris	--	6	--	3	4	--	--	1

TABLE 33 (continued)

PERCENTAGE OF WORKERS WITH POSITIVE PRECIPITIN REACTIONS TO VARIOUS ANTIGENS
BY WORK AREA
CROSS-SECTIONAL HEALTH STUDY

ZELLWOOD FARMS
ZELLWOOD, FLORIDA
MHETA 85-083

	Wharf	Grow	Pick	Pack	Maint	Night	Office	Total
Fungi:				Percent				
Aspergillus 1	--	6	1	--	4	--	--	1
Aspergillus 2	--	--	3	--	4	--	--	2
Aspergillus 3	--	--	3	3	4	--	--	2
Penicillin 1	--	--	--	--	--	--	--	--
Penicillin 2	--	--	2	3	--	--	--	1
Penicillin 3	--	--	2	--	--	--	--	1
Penicillin 4	--	--	1	--	--	--	--	1
Mucor	--	--	2	--	--	--	--	1
Tricoderura	--	--	--	--	--	--	--	--
Neurospora	--	6	1	--	4	--	--	1
Cladosporium	--	--	--	--	--	--	--	--
Doratomyces	8	6	1	--	--	--	--	1
Yeast	--	6	--	--	4	--	--	1
Pyrethrum	8	--	18	15	21	36	--	17
Total # Positive Reactions	42	30	343	104	63	30	11	623
Ratio:								
Total # Positive Reactions / Number of Workers	3.2	1.9	3.0	2.6	2.6	2.1	2.2	2.7
Total # Positive Reactions to Microorganisms / Number of Workers	0.1	0.4	0.2	0.2	0.4	0.1	0.2	0.2

TABLE 34

PERCENTAGE OF WORKERS WITH POSITIVE PRECIPITIN REACTIONS TO VARIOUS ANTIGENS BY NUMBER OF MWL SYMPTOMS
CROSS-SECTIONAL HEALTH STUDY

ZELLWOOD FARMS
ZELLWOOD, FLORIDA
MHETA 85-083

	Number MWL Symptoms			
	0	1	≥2	
Number of Workers	135	47	45	227
Antigen		Percent (%)		
Chicken Manure	8	15	2	
Soybean Meal	2	4	7	
Cottonseed Meal	--	2	2	
Cottonseed Hulls	5	6	4	
Prespawn	22	17	24	
Stock Compost	53	32	31	
Spawn Extract	8	17	11	
Spawnmate	1	2	--	
RBS Supplement	2	4	4	
Post Spawn	33	40	31	
Compost + Mycelia	36	43	24	
Peatmoss + Mycelia	20	19	9	
Spent Compost	24	34	13	
Mushroom Extract	13	17	18	
Spores	15	9	7	
Thermophilic Actinomyces:				
Micropolyspora faeni	9	6	11	
Thermoactinomyces vulgaris	--	2	4	

TABLE 34 (continued)

PERCENTAGE OF WORKERS WITH POSITIVE PRECIPITIN REACTIONS TO
VARIOUS ANTIGENS BY NUMBER OF MWL SYMPTOMS
CROSS-SECTIONAL HEALTH STUDY

ZELLWOOD FARMS
ZELLWOOD, FLORIDA
MHETA 85-083

	Number MWL Symptoms			
	0	1	>2	
N = Number of Workers	135	47	45	227
Antigen		Percent (%)		
Fungi:				
Aspergillus 1	2	--	2	
Aspergillus 2	1	2	4	
Aspergillus 3	2	--	4	
Penicillium 1	--	--	--	
Penicillium 2	2	2	--	
Penicillium 3	--	1	2	
Penicillium 4	1	--	--	
Mucor	2	--	--	
Tricoderma	--	--	--	
Neurospora	2	--	--	
Cladospora	--	--	--	
Doratomyces	1	--	4	
Yeast	2	--	--	
Pyrethrum	16	23	11	

TABLE 35

PERCENTAGE OF WORKERS WITH POSITIVE REACTIONS TO AGARICUS BISPORUS SPORES
AS MEASURED BY DOUBLE DIFFUSION, ELISA, AND RAST
BY WORK AREA
CROSS-SECTIONAL HEALTH STUDY

ZELLWOOD FARMS
ZELLWOOD, FLORIDA
MHETA 85-083

	Wharf	Grow	Pick	Pack	Maint	Night	Office	Total
Number of Workers	12	16	115	41	23	14	5	226
Test					Percent			
Double Diffusion	--	6	14	20	4	7	--	12
ELISA	33	25	54	46	13	14	20	42
RAST	25	--	15	2	9	14	20	12

H85-083 ____________

CONSENT TO PARTICIPATE IN A HEALTH HAZARD STUDY

The National Institute for Occupational Safety and Health (NIOSH) is conducting this study in an attempt to identify the cause of illness at Zellwood Farms, Inc. This study will include a questionnaire, chest x-ray, pulmonary function exam (spirometry), and a blood test. Each participant will receive full information in writing about his/her test results, and the results will be sent to a doctor of the participant's choice, if requested.

You should not experience any risks or discomforts as a result of your participation in this study other than the needle stick necessary for drawing blood. Injury from this project is unlikely, but if you have any reaction to the test procedures, you should contact Wayne Sanderson at (304) 291-4223.

Your participation is voluntary and you may withdraw your consent and end your participation at any time. The information you provide is covered by the Privacy Act, and we will not reveal your information in identifiable form to anyone without your permission.

I have read this consent form and I agree to participate in this study.

PARTICIPANT: ____
Signature of Participant

DATE: ________________

- -

PLEASE SEND THE RESULTS OF MY TESTS TO:

DOCTOR: ____
Name of Doctor

ADDRESS: ____

____

H85-083________

ZELLWOOD FARMS
ZELLWOOD, FLORIDA
MHETA 85-083

QUESTIONNAIRE

I. PERSONAL HISTORY

SUBJECT IDENTIFICATION NO.: ____ ____ ____ (1 2 3)

DATE: ____________________

NAME (LAST-FIRST-MIDDLE INT.): ____________________

ADDRESS: ____________________

____

TELEPHONE: ( ) - ____ - ____

DATE OF BIRTH: (Month - Day - Year) ___ ___ - ___ ___ - ___ ___ (4 5 - 6 7 - 8 9)

1 = WHITE 4 = HISPANIC
2 = BLACK 5 = ASIAN
3 = AMERICAN NATIVE

RACE: ________ (10)

1 = MALE
2 = FEMALE

SEX: ________ (11)

CURRENT HEIGHT (CENTIMETERS): ____ ____ ____ (12 13 14)

CURRENT WEIGHT (KILOGRAMS): ____ ____ (15 16)

X-RAY ____________

PFT ____________

QUESTIONNAIRE ____________

BLOOD ____________

II. OCCUPATIONAL HISTORY

WHEN DID YOU BEGIN WORK AT ZELLWOOD FARMS? (MONTH/YEAR) ____ ____, 19 ____ ____
17 18 19 20

WHAT IS YOUR REGULAR SHIFT? ________
21

1 = DAY
2 = EVENING
3 = NIGHTS
4 = ROTATING

HOW MANY HOURS PER WEEK DO YOU USUALLY WORK AT YOUR PRESENT JOB? ________
22

1 = 0-20
2 = 20-40
3 = >40

PLEASE LIST ALL JOBS YOU HAVE HAD AT ZELLWOOD FARMS AND THE DATES YOU BEGAN AND ENDED EACH JOB. START WITH YOUR CURRENT POSITION AND GO BACKWARDS IN TIME.

A. CURRENT JOB TITLE: ____________________ ____ ____
23 24

DATE BEGAN AND ENDED FROM: ____ ____, 19 ____ ____
25 26 27 28

TO: PRESENT.

B. OTHER JOB TITLE: ____________________ ____ ____
29 30

DATE BEGAN AND ENDED FROM: ____ ____, 19 ____ ____
31 32 33 34

TO: ____ ____, 19 ____ ____
35 36 37 38

C. OTHER JOB TITLE: ____________________ ____ ____
39 40

DATE BEGAN AND ENDED FROM: ____ ____, 19 ____ ____
41 42 43 44

TO: ____ ____, 19 ____ ____
45 46 47 48

D. OTHER JOB TITLE: ____________________ ____ ____
49 50

DATE BEGAN AND ENDED FROM: ____ ____, 19 ____ ____
51 52 53 54

TO: ____ ____, 19 ____ ____
55 56 57 58

DO YOU WEAR A MASK OR RESPIRATOR IN YOUR WORK? ________
59

1 = YES
0 = NO

HB5 083 ____________

WHAT OTHER JOBS HAVE YOU HAD (BESIDES EMPLOYMENT AT ZELLWOOD FARMS)?
BEGIN WITH MOST RECENT AND WORK BACKWARDS.

A. INDUSTRY AND JOB TITLE ____________ ___ ___ ___
60 61 62

OF YEARS ___ ___
63 64

B. INDUSTRY AND JOB TITLE ____________ ___ ___ ___
65 66 67

OF YEARS ___ ___
68 69

C. INDUSTRY AND JOB TITLE ____________ ___ ___ ___
70 71 72

OF YEARS ___ ___
73 74

D. INDUSTRY AND JOB TITLE ____________ ___ ___ ___
75 76 77

OF YEARS ___ ___
78 79

HAVE YOU EVER HAD TO LEAVE A JOB BECAUSE OF RESPIRATORY PROBLEMS?
YES = 1 NO = 0 ___
80

III. PERSONAL EXPOSURE

A. SMOKING

HAVE YOU EVER SMOKED CIGARETTES? ______ 81

1 = YES
0 = NO
IF NO SKIP TO B.

IF YES, a) DO YOU SMOKE CIGARETTES NOW? ______ 82

1 = YES
0 = NO

b) WHAT IS THE TOTAL NUMBER OF YEARS YOU SMOKED? ____ 83 ____ 84

c) WHAT IS THE AVERAGE NUMBER OF CIGARETTES YOU SMOKED PER DAY? ____ 85 ____ 86

B. DO YOU KEEP OR COME IN CLOSE CONTACT WITH ANY ANIMALS? (e.g. dog, cat, mouse, goat) ______ 87

1 = YES
0 = NO

a. ______________________ ______________
(TYPE OF ANIMAL) NUMBER

b. ______________________ ______________
(TYPE OF ANIMAL) NUMBER

c. ______________________ ______________
(TYPE OF ANIMAL) NUMBER

IV. SYMPTOMS

PLEASE FOLLOW DIRECTIONS CAREFULLY AND PROVIDE YOUR BEST ESTIMATE WHENEVER NUMBERS ARE REQUESTED?

WHILE EMPLOYED AT ZELLWOOD FARMS, HAVE YOU HAD ANY OF THE FOLLOWING SYMPTOMS?

1. STUFFY, RUNNY NOSE AND/OR WATERY EYES:

   1 = YES 0 = NO
   (IF NO GO TO QUESTION 2) ____ 88

   A. WHEN DID YOU FIRST NOTICE THE OCCURRENCE OF THE SYMPTOMS? ____ ____, 19 ____ ____ (89 90 91 92)

   B. HOW OFTEN DO THESE SYMPTOMS OCCUR? ____ 93

   1 = EVERYDAY = ALL THE TIME
   2 = SOMETIME EVERY WEEK = FREQUENTLY
   3 = EVERY ONCE IN A WHILE = SOMETIMES = OCCASIONALLY
   4 = ONCE OR TWICE PER YEAR = RARELY

   C. WHAT TIME OF DAY DO THE SYMPTOMS GENERALLY BEGIN? ____ 94

   1 = MORNING 2 = AFTERNOON 3 = EVENING
   4 = NIGHT 5 = UNRELATED TO TIME OF DAY

   D. DID YOU SEE A DOCTOR BECAUSE OF THESE SYMPTOMS?
   1 = YES 0 = NO ____ 95

   IF "YES" WHAT WAS (WERE) HIS DIAGNOSIS?

   ____

2. CHILLS AND/OR FEVER (ONLY REPORT EPISODES WITHOUT RUNNY NOSE OR SORE THROAT!!)

   1 = YES 0 = NO
   (IF NO GO TO QUESTION 3) ____ 96

   A. WHEN DID YOU FIRST NOTICE THE OCCURRENCE OF THESE SYMPTOMS? ____ ____, 19 ____ ____ (97 98 99 100)

   B. HOW OFTEN DO THESE SYMPTOMS OCCUR? ____ 101

   1 = EVERYDAY = ALL THE TIME
   2 = SOMETIME EVERY WEEK = FREQUENTLY
   3 = EVERY ONCE IN A WHILE = SOMETIMES = OCCASIONALLY
   4 = ONCE OR TWICE PER YEAR = RARELY

C. WHAT TIME OF DAY DO THE SYMPTOMS GENERALLY BEGIN? ____ 102

1 = MORNING 2 = AFTERNOON 3 = EVENING
4 = NIGHT 5 = UNRELATED TO TIME OF DAY

D. DID YOU SEE A DOCTOR BECAUSE OF THESE SYMPTOMS? ____ 103
1 = YES 0 = NO

IF "YES" WHAT WAS (WERE) HIS DIAGNOSIS?

____

3. NAUSEA/VOMITING:

1 = YES 0 = NO
(IF NO GO TO QUESTION 4) ____ 104

A. WHEN DID YOU FIRST NOTICE THE OCCURRENCE OF THE SYMPTOMS? ____ 105 ____ 106, 19 ____ 107 ____ 108

B. HOW OFTEN DO THESE SYMPTOMS OCCUR? ____ 109

1 = EVERYDAY = ALL THE TIME
2 = SOMETIME EVERY WEEK = FREQUENTLY
3 = EVERY ONCE IN A WHILE = SOMETIMES = OCCASIONALLY
4 = ONCE OR TWICE PER YEAR = RARELY

C. WHAT TIME OF DAY DO THE SYMPTOMS GENERALLY BEGIN? ____ 110

1 = MORNING 2 = AFTERNOON 3 = EVENING
4 = NIGHT 5 = UNRELATED TO TIME OF DAY

D. DID YOU SEE A DOCTOR BECAUSE OF THESE SYMPTOMS? ____ 111
1 = YES 0 = NO

IF "YES" WHAT WAS (WERE) HIS DIAGNOSIS?

____

4. COUGH:

1 = YES 0 = NO
(IF NO GO TO QUESTION 5) ____ 112

DO YOU COUGH UP MUCOUS WHEN YOU COUGH? ____ 113
1 = YES 0 = NO

A. WHEN DID YOU FIRST NOTICE THE OCCURRENCE OF THE SYMPTOMS? ____ 114 ____ 115, 19 ____ 116 ____ 117

H85 083 ________

B. HOW OFTEN DO THESE SYMPTOMS OCCUR? ____ 118

1 = EVERYDAY = ALL THE TIME
2 = SOMETIME EVERY WEEK = FREQUENTLY
3 = EVERY ONCE IN A WHILE = SOMETIMES = OCCASIONALLY
4 = ONCE OR TWICE PER YEAR = RARELY

C. WHAT TIME OF DAY DO THE SYMPTOMS GENERALLY BEGIN? ____ 119

1 = MORNING 2 = AFTERNOON 3 = EVENING
4 = NIGHT 5 = UNRELATED TO TIME OF DAY

D. DID YOU SEE A DOCTOR BECAUSE OF THESE SYMPTOMS? ____ 120
1 = YES 0 = NO

IF "YES" WHAT WAS (WERE) HIS DIAGNOSIS?

____

5. FATIGUE:

1 = YES 0 = NO
(IF NO GO TO QUESTION 6) ____ 121

A. WHEN DID YOU FIRST NOTICE THE
OCCURRENCE OF THE SYMPTOMS? ____ ____, 19 ____ ____
122 123 124 125

B. HOW OFTEN DO THESE SYMPTOMS OCCUR? ____ 126

1 = EVERYDAY = ALL THE TIME
2 = SOMETIME EVERY WEEK = FREQUENTLY
3 = EVERY ONCE IN A WHILE = SOMETIMES = OCCASIONALLY
4 = ONCE OR TWICE PER YEAR = RARELY

C. WHAT TIME OF DAY DO THE SYMPTOMS GENERALLY BEGIN? ____ 127

1 = MORNING 2 = AFTERNOON 3 = EVENING
4 = NIGHT 5 = UNRELATED TO TIME OF DAY

D. DID YOU SEE A DOCTOR BECAUSE OF THESE SYMPTOMS? ____ 128
1 = YES 0 = NO

IF "YES" WHAT WAS (WERE) HIS DIAGNOSIS?

____

6. <u>WHEEZING BREATHING:</u> ____ 129

1 = YES 0 = NO
(IF NO GO TO QUESTION 7)

A. WHEN DID YOU FIRST NOTICE THE
OCCURRENCE OF THESE SYMPTOMS? ____ ____, 19 ____ ____
130 131 132 133

B. HOW OFTEN DO THESE SYMPTOMS OCCUR? ____ 134

1 = EVERYDAY = ALL THE TIME
2 = SOMETIME EVERY WEEK = FREQUENTLY
3 = EVERY ONCE IN A WHILE = SOMETIMES = OCCASIONALLY
4 = ONCE OR TWICE PER YEAR = RARELY

C. WHAT TIME OF DAY DO THE SYMPTOMS GENERALLY BEGIN? ____ 135

1 = MORNING 2 = AFTERNOON 3 = EVENING
4 = NIGHT 5 = UNRELATED TO TIME OF DAY

D. DID YOU SEE A DOCTOR BECAUSE OF THESE SYMPTOMS?
1 = YES 0 = NO ____ 136

IF "YES" WHAT WAS (WERE) HIS DIAGNOSIS?

____

7. <u>SHORTNESS OF BREATH:</u> ____ 137

1 = YES 0 = NO
(IF NO GO TO QUESTION 8)

A. WHEN DID YOU FIRST NOTICE THE
OCCURRENCE OF THESE SYMPTOMS? ____ ____, 19 ____ ____
138 139 140 141

B. HOW OFTEN DO THESE SYMPTOMS OCCUR? ____ 142

1 = EVERYDAY = ALL THE TIME
2 = SOMETIME EVERY WEEK = FREQUENTLY
3 = EVERY ONCE IN A WHILE = SOMETIMES = OCCASIONALLY
4 = ONCE OR TWICE PER YEAR = RARELY

C. WHAT TIME OF DAY DO THE SYMPTOMS GENERALLY BEGIN? ____ 143

1 = MORNING 2 = AFTERNOON 3 = EVENING
4 = NIGHT 5 = UNRELATED TO TIME OF DAY

D. DID YOU SEE A DOCTOR BECAUSE OF THESE SYMPTOMS?
1 = YES 0 = NO ____ 144

IF "YES" WHAT WAS (WERE) HIS DIAGNOSIS?

____

8. CHEST TIGHTNESS: ____ 145

1 = YES 0 = NO
(IF NO GO TO QUESTION 9)

A. WHEN DID YOU FIRST NOTICE THE OCCURRENCE OF THESE SYMPTOMS? ____ ____, 19 ____ ____ (146 147 148 149)

B. HOW OFTEN DO THESE SYMPTOMS OCCUR? ____ 150

1 = EVERYDAY = ALL THE TIME
2 = SOMETIME EVERY WEEK = FREQUENTLY
3 = EVERY ONCE IN A WHILE = SOMETIMES = OCCASIONALLY
4 = ONCE OR TWICE PER YEAR = RARELY

C. WHAT TIME OF DAY DO THE SYMPTOMS GENERALLY BEGIN? ____ 151

1 = MORNING 2 = AFTERNOON 3 = EVENING
4 = NIGHT 5 = UNRELATED TO TIME OF DAY

D. DID YOU SEE A DOCTOR BECAUSE OF THESE SYMPTOMS? ____ 152
1 = YES 0 = NO

IF "YES" WHAT WAS (WERE) HIS DIAGNOSIS? ____________

9. LOSS OF APPETITE: ____ 153

1 = YES 0 = NO
(IF NO GO TO QUESTION 10)

A. WHEN DID YOU FIRST NOTICE THE OCCURRENCE OF THESE SYMPTOMS? ____ ____, 19 ____ ____ (154 155 156 157)

B. HOW OFTEN DO THESE SYMPTOMS OCCUR? ____ 158

1 = EVERYDAY = ALL THE TIME
2 = SOMETIME EVERY WEEK = FREQUENTLY
3 = EVERY ONCE IN A WHILE = SOMETIMES = OCCASIONALLY
4 = ONCE OR TWICE PER YEAR = RARELY

C. WHAT TIME OF DAY DO THE SYMPTOMS GENERALLY BEGIN? ____ 159

1 = MORNING 2 = AFTERNOON 3 = EVENING
4 = NIGHT 5 = UNRELATED TO TIME OF DAY

D. DID YOU SEE A DOCTOR BECAUSE OF THESE SYMPTOMS? ____ 160
1 = YES 0 = NO

IF "YES" WHAT WAS (WERE) HIS DIAGNOSIS? ____________________

10. NUMBNESS IN THE FACE AND ARMS: ____ 161

1 = YES 0 = NO
(IF NO GO TO QUESTION 11)

A. WHEN DID YOU FIRST NOTICE THE OCCURRENCE OF THESE SYMPTOMS? ____ ____, 19 ____ ____ (162 163 164 165)

B. HOW OFTEN DO THESE SYMPTOMS OCCUR? ____ 166

1 = EVERYDAY = ALL THE TIME
2 = SOMETIME EVERY WEEK = FREQUENTLY
3 = EVERY ONCE IN A WHILE = SOMETIMES = OCCASIONALLY
4 = ONCE OR TWICE PER YEAR = RARELY

C. WHAT TIME OF DAY DO THE SYMPTOMS GENERALLY BEGIN? ____ 167

1 = MORNING 2 = AFTERNOON 3 = EVENING
4 = NIGHT 5 = UNRELATED TO TIME OF DAY

D. DID YOU SEE A DOCTOR BECAUSE OF THESE SYMPTOMS? ____ 168
1 = YES 0 = NO

IF "YES" WHAT WAS (WERE) HIS DIAGNOSIS? ____________________

11. MYALGIAS (SENSE OF ACHING ALL OVER): ____ 169

1 = YES 0 = NO
(IF NO GO TO QUESTION 12)

A. WHEN DID YOU FIRST NOTICE THE OCCURRENCE OF THESE SYMPTOMS? ____ ____, 19 ____ ____ (170 171 172 173)

B. HOW OFTEN DO THESE SYMPTOMS OCCUR? ____ 174

1 = EVERYDAY = ALL THE TIME
2 = SOMETIME EVERY WEEK = FREQUENTLY
3 = EVERY ONCE IN A WHILE = SOMETIMES = OCCASIONALLY
4 = ONCE OR TWICE PER YEAR = RARELY

C. WHAT TIME OF DAY DO THE SYMPTOMS GENERALLY BEGIN? ____ 175

1 = MORNING 2 = AFTERNOON 3 = EVENING
4 = NIGHT 5 = UNRELATED TO TIME OF DAY

H85-083________

D. DID YOU SEE A DOCTOR BECAUSE OF THESE SYMPTOMS? ____ 176
1 = YES 0 = NO

IF "YES" WHAT WAS (WERE) HIS DIAGNOSIS?

____

12. UNEXPLAINED WEIGHT LOSS: ____ 177

1 = YES 0 = NO
(IF NO GO TO QUESTION 13)

A. WHEN DID YOU FIRST NOTICE THE OCCURRENCE OF THE SYMPTOMS? ____ 178 ____ 179, 19 ____ 180 ____ 181

B. HOW MUCH WEIGHT DID YOU LOSE? ____ 182 ____ 183

C. DID YOU SEE A DOCTOR BECAUSE OF THIS WEIGHT LOSS? ____ 184

1 = YES 0 = NO

WHAT WAS HIS DIAGNOSIS?

____

VI MEDICAL HISTORY

1. HAVE YOU EVER BEEN HOSPITALIZED FOR ANY CHEST ILLNESS, CHEST INJURY, OR CHEST SURGERY? ____ 1 = YES 0 = NO
185

IF YES:

a. FOR EACH HOSPITALIZATION, GIVE THE REASON AND THE DATE HOSPITALIZED:

REASON	DATE
(1) ____________	____________
(2) ____________	____________
(3) ____________	____________

2. WERE YOU EVER TOLD BY A PHYSICIAN THAT YOU HAVE ANY OF THE FOLLOWING CONDITIONS? IF YOU HAVE ANY OF THESE, PLEASE LIST THE YEAR IN WHICH IT WAS FIRST DIAGNOSED?

CONDITIONS?		TOLD BY PHYSICIAN?	YEAR FIRST DIAGNOSED
a. TUBERCULOSIS	____ 186	1 = YES 0 = NO	19____
b. PNEUMONIA	____ 187	1 = YES 0 = NO	19____
c. BRONCHITIS	____ 188	1 = YES 0 = NO	19____
d. EMPHYSEMA	____ 189	1 = YES 0 = NO	19____
e. ASTHMA	____ 190	1 = YES 0 = NO	19____
f. OTHER CHEST/LUNG DISEASE (SPECIFY________)	191	1 = YES 0 = NO	19____
g. ECZEMA	____ 192	1 = YES 0 = NO	19____
h. SINUSITIS	____ 193	1 = YES 0 = NO	19____
i. HAY FEVER	____ 194	1 = YES 0 = NO	19____
j. OTHER ALLERGIES	____ 195	1 = YES 0 = NO	19____
k. HEART DISEASE (SPECIFY________)	____ 196	1 = YES 0 = NO	19____

END OF QUESTIONNAIRE

THANK YOU FOR YOUR TIME!