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INDUSTRIAL ACCIDENTS AND HYGIENE SERIES

THE PROBLEM OF DUST PHTHISIS IN THE GRANITE-STONE INDUSTRY

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PREFACE.

In continuation of previous investigations into the dust hazard of certain trades,[1] the present investigation was originally undertaken in behalf of a committee appointed by the National Tuberculosis Association, and while the writer was chairman two preliminary reports were published during 1918 and 1919. It was found impracticable, however, on the part of the writer to continue his work as chairman of the committee and the investigation was therefore brought to a conclusion entirely on his own responsibility, the strictly medical and radiological work of the inquiry having been assumed by Dr. Edward R. Baldwin, whose report, dated June 11, 1921, is published in Appendix G. This report did not come to my attention until after my own investigations had been completed and on account of its brevity much of the material required for a conclusive opinion is for the time being not available.[2]

It is to be hoped that sometime in the future the National Tuberculosis Association will publish in full detail the results of this investigation, which represents 427 physical and X-ray examinations of stone workers in the Barre district. Of particular interest is the statement that "expensive silicosis might exist with little or no impairment of health and no manifest physical signs," a conclusion suggestive of the great practical value of periodical X-ray examinations as a means of disclosing the earliest possible indications of lung damage.

My own investigations would have been quite impossible but for the whole-hearted cooperation of the Granite Cutters' International Association of America and the correlated experience data obtained

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[1] Bulletins Nos. 79, 82, and 231 of the U. S. Bureau of Labor Statistics, Washington, D. C., 1908–1918.

[2] Since this report was completed the Barre branch of the Granite Cutters' International Association has made an agreement with the Presbrey-Leland Co. of Barre, Vt., to go into effect Apr. 1, 1922, and continue in force until Apr. 1, 1925.

Article VI of this agreement provides as follows:

SECTION 1. All dust-creating machines must be adequately equipped with dust-removing devices when proven practical, the practicability of such devices to be passed upon in accordance with provisions laid down in Article XX of this agreement [providing for an adjustment committee].

SEC. 2. Within one month from the signing of this agreement a body of six members, to be known as the "health committee," shall be created. Of the committee three members shall be appointed by the employer and three by the local branch G. C. I. A. It shall be the duty of this committee to investigate, to assist in the development, the perfecting, and the introduction of dust-removing devices; to consider insurance against sickness and improve in every possible way general working conditions.

SEC. 3. Funds for the development and experimental work of this committee shall be provided in the following manner: One-half of 1 per cent to be deducted weekly from the wage of each member of the local branch G. C. I. A. The employer to set aside each week an amount equal to the total sum derived from the above source. This fund shall be placed in the hands of a treasurer elected by a majority of the health committee. Should the funds thus provided be either inadequate or more than sufficient for the desired purpose, any necessary modification may be made by mutual agreement.

SEC. 4. The health committee shall make a written progress and financial report on or about Apr. 1 and Oct. 1 of each year to the employer and the local branch G. C. I. A.

SEC. 5. Should the members of the health committee be unable to agree, any subject in controversy shall be submitted to the adjustment committee in accordance with Article XX of this agreement.

This provision is in entire accordance with the results of the present investigation suggesting similar action on the part of other firms or employers desirous of avoiding labor conflicts as the results of preventable conditions affecting the health hazard in particular industries or occupations. The agreement is likewise applicable to other dusty trades subject to an excessive sickness or mortality rate.

through the courtesy and liberality of the Journeymen Stone Cutters' Association and the Glass Bottle Blowers' Association. The field investigations were made by an experienced sanitary engineer, thoroughly familiar with occupational disease problems, and I am also obliged to Mr. Sylvester Schattschneider for the results of his corresponding investigations in the limestone districts of Indiana. Every possible opportunity for investigation was extended to me by the manufacturers of the Barre and Bedford districts, who readily granted permission for a complete inspection of their plants, at the same time giving much valuable advice in the furtherance of the inquiry. I am especially indebted to the United States Bureau of Mines, and particularly to Mr. E. A. Holbrook, assistant director, and to Mr. A. C. Fieldner, supervising chemist at the Pittsburgh Experimental Station, for their invaluable cooperation in technical matters largely outside of the plan and scope of my own investigations. Preliminary results of the work of the Bureau of Mines are included under Appendix E. It is not claimed for the present investigation that it has been exhaustive or final upon many important matters, which will require further consideration. But it may be questioned whether any corresponding industry has ever before been subjected to an equally extended inquiry, not only into the medical but also into the correlated social and economic facts affecting the welfare of the employees concerned. The results are certainly extremely suggestive of the direction in which it will be necessary to initiate radical reforms if a material reduction in mortality and a consequential improvement in health and longevity are to be brought about through the combined action of the employer, the employee, and the State.

FREDERICK L. HOFFMAN.

EAST ORANGE, N. J., *April 17, 1922.*

CONTENTS.

CHARTS.

BULLETIN OF THE
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THE PROBLEM OF DUST PHTHISIS IN THE GRANITE-STONE INDUSTRY.

INTRODUCTION AND SUMMARY.

In continuation of investigations into the mortality from tuberculosis in dusty trades, extending over a long period of years, the present inquiry into the mortality of granite-stone workers in the State of Vermont was decided upon after careful consideration as both an insurance and a medical problem of the first importance. In the rating practice of insurance companies stone cutting is generally classed as a single industry, although it has long since been recognized that material variations are met with in the different branches as regards the nature of the dust inhaled. The preliminary consideration of the present investigation is set forth in Mortality from Respiratory Diseases in Dusty Trades (Inorganic Dusts), published by the United States Bureau of Labor Statistics in June, 1918, as Bulletin No. 231 and the first and second preliminary reports of the committee on mortality from tuberculosis in dusty trades, of the National Tuberculosis Association, published in 1919. For the present purpose the results here presented are largely limited to the statistical aspects of the problem, though equally urgent is a comprehensive descriptive account of shop conditions and processes of manufacture bearing directly upon health hazards.

SUMMARY OF CONCLUSIONS.

The results, in a general way, may be summarized as follows:

(1) The granite-stone industry is carried on by wage earners who, broadly speaking, live under sanitary conditions above the average, so that possibly unfavorable environmental factors are of decidedly secondary importance.

(2) The housing conditions under which granite workers live are also above the average, so that in this respect the environmental factors are favorable to a low mortality rather than otherwise.

(3) Anthropometric records clearly establish the fact of a superior physique, indicative of a higher degree of disease resistance, as determined by a relative weight above the average. From this point of view, therefore, granite workers should experience a relatively low mortality from pulmonary tuberculosis instead of a mortality decidedly above the average normal to industrial occupations.

(4) Granite workers, considered by specific occupations, show wide variations in tuberculosis frequency, the excess in the death rate being most marked among the men employed in granite-stone cutting, it being especially severe among the men employed in the use of pneumatic tools. Certain occupations, such as polishing, tool sharpening, bed setting, etc., do not show a marked excess, if any, in the mortality from pulmonary tuberculosis, clearly indicating that the risk is practically proportionate to dust exposure.

(5) Compared with the normal death rate of adult males of the State of Vermont, or of New England, the mortality from pulmonary tuberculosis among granite-stone workers has increased enormously during the last two years, as contrasted with a diminishing mortality in the population at large. Against a decrease in the pulmonary tuberculosis death rate of adult males of the State of Massachusetts from 288.5 per 100,000 exposed to risk during 1895–1899 to 203.2 during 1915–1918 there had been an increase in the corresponding death rate of granite cutters of the New England States from 432.0 per 100,000 during 1895–1899 to 1056.7 during 1915–1918.[1] The only other occupation for which information is available for the corresponding period of time is that of glass-bottle blowers, among whom the mortality from pulmonary tuberculosis diminished from 418.6 per 100,000 to 265.9. These statistics for the New England States are confirmed by similar data for every other stonecutting center of the United States, proving with absolute certainty that in every section of the country the tuberculosis mortality of this group of industrial workers is increasing, in contrast to a locally diminishing death rate from this most fatal of all diseases.

The same conclusion applies to nontuberculous respiratory diseases, for it is shown that the mortality from bronchitis, pneumonia, and asthma is also on the increase among granite cutters, in contrast to a diminishing rate of frequency among adult males of the general population.

While normally the rate of tuberculosis frequency diminishes with increasing adult age, the contrary is shown to be the fact as to granite cutters, among whom the death rate from pulmonary tuberculosis at ages 60 and over reaches truly appalling proportions, so much so that the statistical evidence would seem incredible if it were not supported by the additional and equally suggestive data for nontuberculous respiratory diseases.

(6) The investigation brings out clearly the supremely important fact that the incidence of the disease is practically proportionate to the length of the trade life. In other words, the effect of dust inhalation is one of growing seriousness, according to the rate of dust accumulation in the lungs. It is shown that normally a maximum effect is produced by the twenty-first year of trade life, and that therefore stone centers with a comparatively new or largely shifting population will fail to disclose the seriousness of the situation, which is readily observed in the stone centers with a fixed and long-settled population.

These conclusions are in conformity to the observations made in South Africa and Australia, clearly indicating that the cause of the excessive liability to pulmonary tuberculosis is the inhalation of

[1] Exclusive of last three months of 1918.

granite dust in a comminuted form of practically ultramicroscopical particles.

(7) Unfortunately, no autopsy material is as yet available in this country to determine the dust content of the silicotic lung. In no direction can modern experimental medicine render more useful assistance than in this. The commendable work of the South African Institute for Medical Research may be referred to as an example which should be followed in this country.

(8) The nature of the dust inhaled also requires much more extended scientific consideration. For the present purpose, however, it is sufficient to state that the average silicotic content of granite is 72.96 per cent; of sandstone, 85.42 per cent; and of limestone, 1.22 per cent.

The evidence is absolutely conclusive that the dust hazard depends primarily upon the silicotic content of the dust inhaled. The evidence is also conclusive that workers exposed to marble or limestone dust suffer a decidedly lesser liability to pulmonary tuberculosis than those exposed to granite or sandstone dust, with a high silicotic content.

It is regrettable that for the time being no trustworthy data as to the death rate of marble workers from pulmonary tuberculosis should be available, but it may be said from such investigations as have been made that as to mortality from this cause, the marble industry of the State of Vermont is in marked contrast to the granite industry carried on under much the same conditions except for the nature of the dust. But original material has been collected for the limestone industry, as represented in southern Indiana, on the basis of which it is possible to state that for the period 1915–1918, in contrast to a death rate from pulmonary tuberculosis of 1,044.3 per 100,000 exposed to risk for granite cutters and 1,029.9 for sandstone cutters, the mortality of limestone cutters was only 425.5 and of glass-bottle blowers, also exposed more or less to a dust hazard, 265.9 per 100,000. Recalling that the normal pulmonary tuberculosis mortality of adult males in Massachusetts is only 203.2 per 100,000, it is shown that the present death rate from pulmonary tuberculosis among granite cutters is five times the normal experience in the population at large, and probably six times what it should be on the basis of strictly noninjurious occupations carried on largely under hygienic conditions and in the open air.

The dust problem, in its mechanical as well as pathogenic aspects, and in its particular application to the granite-stone industry, has never received the requisite technical consideration, the urgency of which is clearly indicated by the preceding conclusions. It is encouraging, however, to be able to say that as a result of the present investigation the United States Bureau of Mines has initiated a study of the dust problem, the findings of which will be forthcoming in due course of time and will no doubt throw much valuable light upon aspects now more or less obscure.

Nor has the subject received the requisite consideration from the medical point of view, for there are abundant reasons for believing that the disease certified as pulmonary tuberculosis among granite workers is often not a true form of tuberculosis, but, strictly speaking, a silicosis or pneumonoconiosis, or, in other words, dust phthisis of nontubercular origin, though possibly in its terminal stage complicated by a superinduced tuberculosis. If this conclusion is correct,

the medical profession has been derelict in not recognizing important differences in the symptomatology of the disease, which, as judged by the available evidence, must present material variations from the normal course of the disease as manifest in those who suffer from pulmonary tuberculosis not complicated by dust phthisis.

To much the same effect is the further conclusion that methods of prevention applicable to a true form of tuberculosis will be largely inapplicable to a disease chiefly nontubercular in its origin and frequently nontubercular in its termination. In other words, the so-called campaign against tuberculosis rests upon the theory of the disease being infectious, and therefore transmissible from one person to another. If, however, the disease as it occurs with such excessive frequency among granite-stone cutters is largely nontubercular or nonbacillary in its origin and progress, it is self-evident that it can not be infectious, and does not, therefore, constitute a serious menace to the adult population.

If the disease is nontuberculous, it must also be self-evident that a different form of treatment may be required in many cases and that the treatment usually followed in pulmonary tuberculosis may prove of no value. The South African investigations, briefly referred to, clearly indicate that differences in treatment are called for on a better understanding of the true nature of the ailment when affecting men employed in the granite-stone industry. If these conclusions should be sustained by subsequent investigations, it is clear that no progress toward a material reduction in the death rate is likely to be made until the present apathy on the part of the medical profession gives way to a clearer realization of the problems and difficulties that are involved in the present case.

(9) One important aid in diagnosis often overlooked is the practical usefulness of radiological examinations of the chest. It is hoped that the emphasis given to the urgency of such investigations may yield satisfactory results in the future. For the present purpose it may be sufficient to say that radiological examinations have been of the utmost value in determining the progress of dust infiltration throughout the lungs and in clearly indicating the extent of stone consolidation to the point of fatality.

If the so-called pulmonary tuberculosis among granite-stone cutters is not a true tuberculosis and therefore not infectious, some evidence should be forthcoming from the family records of deceased stone workers to substantiate this point of view. As a matter of fact, the results of the present investigation emphatically support this conclusion and prove that relatives dying from tuberculosis, either prior or subsequent to the deaths of granite cutters dying from tuberculosis, have been relatively few among the wives and daughters, while relatively very common among fathers, sons, and brothers, much less exposed to personal contact, but in all probability also employed in the granite-stone industry.

(10) The present investigation includes the question of previous occupation and many related aspects which do not admit of a brief generalization. It may be said, however, that there is nothing to indicate otherwise than that the men, industrially considered, are of a superior social and economic status, which should be more than a normal safeguard against an excessive liability to dust phthisis. The wages in the granite industry are relatively high, and the hours of

work are below rather than above the normal, but at the same time, it should be pointed out, in the northern section of the country during the winter months, indoor employment being the rule, the dust hazard is enormously increased in severity. While much has been done with regard to dust reduction, there are reasons for believing that the most dangerous form of dust is not successfully removed, if at all, by the devices generally in use. Shop conditions vary widely, but give evidence of superficial industrial inspection on the part of the State and a lack of appreciation of the menace of the dust as a health-injurious element of the industry. A further fact which bears directly upon the question is the comparative rarity of vacations of sufficient length, which, habitually followed, would unquestionably increase disease resistance. The question, in fact, may well be raised whether it would not be compatible with the best interests of all concerned to prohibit indoor stone cutting by pneumatic tools entirely unless an effective dust removing device can be introduced which will do away with the dust hazard now common to practically all the shops in which indoor work during the winter is a necessity. In the southern States, where most of the work is done out of doors, the death rate from pulmonary tuberculosis among granite cutters during the period 1912–1918 was only 441.1 per 100,000 of population, against 962.3 for the New England States. This difference may safely be attributed in a large measure to the fact that indoor employments are much less common in the South than in the North.

(11) In the aggregate, the evidence clearly supports the conclusion that the granite-stone industry, perhaps more than any other dusty trade, demands the utmost, and thoroughly qualified, consideration on the part of the State, the medical profession, and the labor organizations directly concerned. At the present time the death rate among granite workers is practically the highest known for any occupation of record, and the increase in the death rate from year to year is lamentable evidence of inefficiency on the part of health-promoting agencies to bring about reduction and control. The problem concerns not only the wage earners, who directly pay a frightful toll in needless deaths and prolonged chronic disease, but the burden also falls, and possibly with crushing weight, upon the industry, which is deprived of skilled workers, indispensable to the trade, and of apprentices, no longer attracted to an occupation recognized even among those not familiar with the statistical facts as one of the most deadly on record.

The present inquiry should prove of particular value as an indication of new methods by which the facts of industrial health can be determined with practical certainty and at minimum expense. The investigation emphasizes the futility of broad generalizations, in which essential matters of detail are disregarded. There is a vast amount of superficial observation and advice on the dust problem in industry which serves no practical purpose whatever. There are unquestionably important conclusions, even some which have been given utterance by high authority, which are no longer in exact conformity to the facts. The general prevailing theory on the subject has been well stated by Prof. Edgar L. Collis in a recent work on The Industrial Clinic (p. 80), as follows: "Long-continued inhalation of dust favors diseases of the lungs, especially bronchitis and emphysema, interstitial pneumonia, and fibroid phthisis, the disease varying with the nature of the dust. The character of the

particles composing dust is of special importance. The most injurious kinds are insoluble and inorganic dusts, which become impacted in the walls of the bronchioles or air cells of the lungs, are not easily expectorated, and set up irritation and chronic inflammation of the tissues around. The soluble and organic particles are much less injurious. For example, the relative innocuity of coal dust in causing lung disease is marked in comparison with the lung mischief prevalent amongst cutlers, file makers, needle, pin, and tool makers." Yet even these simple facts are far from being recognized as regards their true etiological significance in the tuberculosis policy of State industry.

NONRECOGNITION OF THE NATURE OF PROBLEM.

In a program report of a committee on tuberculosis policy, presented to the Conference of State and Provincial Boards of Health at Atlantic City, N. J., on June 6, 1919, there is not a single reference to the dust problem in 16 specific recommendations bearing chiefly upon treatment and public control after a reportable stage of the disease has been reached. In this program, as in so many other notable efforts the sanatorium treatment of the disease is overemphasized as a public question, when prior consideration should be given to preventive measures giving promise of practical results. The policy of the State should be not to begin with the first recognition of developed disease in the patient, but to recognize pretuberculous possibilities or predisposing conditions, the effective control of which alone can justify the hope of far-reaching results. Reference may here be made to an interesting recognition of the foregoing point of view in a discussion on "How tuberculosis schemes fail, and why," by Dr. Stephen J. Maher, of New Haven, Conn., in the Medical Record of December 11, 1920. This author summarizes his views as follows:

(*a*) The overemphasis given to the value of the activities of the nonmedical antituberculosis workers.
(*b*) The disinclination of most physicians to join heartily in a medical campaign dominated by nonmedical functionaries.
(*c*) The disinclination or inability of these nonmedical officials to indorse or utilize medical research.
(*d*) The obtuseness of even the medical officers of the tuberculosis campaigns to the importance of the following facts:
(1) Aside from its specific toxic power, the most important character of the tubercle bacillus is its waxy, resistant capsule.
(2) Serological tests prove that there is a family relationship between the tubercle bacilli and all bacilli that possess these waxy capsules.
(3) Many ordinary nonacid-fast bacteria, when subjected to an unfavorable environment, develop waxy capsules, and thus become demonstrably family relations of the tubercle bacillus.

Much more than all this is involved in the failure of the so-called campaign against tuberculosis to develop a thoroughly effective plan giving the assurance of measurable results within a reasonable period of time. Until the industrial aspects of the disease, and particularly the dust question, are more clearly realized, there is little hope of a reduction of tuberculosis frequency among industrial workers, whose economic value to the nation entitles them to first consideration. One recent writer, whose work is widely used as a text-book, has given utterance to the belief that "the higher incidence of tuberculosis among those exposed to inorganic dust is due to the fact that

dust acts as a convenient carrier of tubercle baccilli. In other words, it is not the preliminary injury which the dust is responsible for that predisposes the individual to tuberculosis, but the readiness with which tubercle bacilli may be carried into the respiratory tract by a dust-laden atmosphere." As said in an editorial in the Lancet of November 15, 1919 (p. 888): "This theory does not account * * * for the tuberculous death rate of granite dressers, who are greatly exposed to dust, working, as many of them do, in closed sheds and using pneumatic tools, being lower than that of sandstone masons, who, working with hammer and chisels in open lean-to-sheds, are less exposed to dust; but sandstone is nearly pure silica, while granite only contains 30 per cent. [In the United States this is 73 per cent.] Tuberculosis implanted on silicosis has clinical manifestations and an underlying pathology which clearly distinguishes it from tuberculosis (possibly dust-borne in origin) not associated with silicotic fibrosis." Both the author and the critic fall lamentably short of the requisite thoroughness in discussions of this kind. If the present investigation proves anything of value, it clearly indicates that the so-called pulmonary tuberculosis in the granite-cutting industry is not a true form of tuberculosis in the large majority of cases, but in its origin and development a true silicosis, which may or may not be complicated by superinduced bacillary infection. To allege that such a disease is contracted by infected dust particles is to display complete ignorance of the true mechanical and pathological questions involved. It is equally erroneous to assume that granite dust contains only 30 per cent of silica, for there is not a granite dust in this country of which samples have been available for the present purpose which does not contain from 70 per cent to 90 per cent of this most injurious element. Unfortunately, dust samples of the Aberdeen quarries which had been expected had not been received in time for consideration in this report.[2]

In continuation of the foregoing extract from the Lancet it is said: "We are surprised to find a clinician of Dr. Landis's standing not accentuating more clearly these two clinical types of pulmonary tuberculosis, especially when referring to the occurrence of phthisis among textile operatives, tobacco-factory workers, and garment makers." In the case referred to pulmonary tuberculosis from the type of dust involved is primarily a nontuberculous interstitial pneumonia, or a true silicosis, without bacillary infection, essentially different both as to diagnosis and prognosis from pulmonary tuberculosis in the accepted form. According to the Lancet it is regrettable that the statement should have been made that "the sharper and more angular the dust particles the greater will be the amount of mechanical injury, and hence the greater the inflammatory reaction." "Assuredly," it is said, "minute particles, mostly below 1 micron in diameter, moving slowly in the moist interior of an alveolus, can have no power to cause mechanical injury; were the matter in doubt the comparative absence of fibrosis in those exposed to the inhalation of fine emery and glass dusts, hard, angular, and spicular as they are, would lay it at rest. Silica dust is dangerous, not on account of its hardness and shape, but of its chemical composition." Much of this,

[2] Since this was written a preliminary report on Aberdeen granite dust samples, furnished by Dr. Matthew Hay, has been made by the United States Bureau of Mines (see pp. 147-149).

it may be respectfully submitted, borders on blind conjecture. The cause of industrial disease prevention is not advanced by guesswork theorizing, even though the authors are otherwise recognized authorities in their profession.

RESULTS OF INVESTIGATION OF MINERS' PHTHISIS BUREAU OF SOUTH AFRICA.

It may not be out of place to quote in this connection from an article in the British Medical Journal of January 1, 1921, reviewing the annual report of the Miners' Phthisis Medical Bureau of South Africa for 1919, based upon 32,000 statutory clinical examinations and investigations, the following statement:

> The prevalence of pulmonary tuberculosis, whether "pure" or complicated by silicosis, as revealed at the periodical examinations of 15,000 miners of European descent, was at the rate of 1,141 per 100,000, as compared with 1,267 and 909 for the two preceding years, respectively. The prevalence rate of silicosis, whether in its pure form or complicated by tuberculosis, was 5,532 per 100,000, as compared with 5,602 and 5,595 for the two previous years. As ascertained at the periodical examinations, the attack rate of tuberculosis not complicated by silicosis was 255 per 100,000, as compared with 259 for the preceding year.

RECOMMENDATIONS OF BRITISH MEDICAL RESEARCH COMMITTEE.

These observations suggest the urgent need of a much more qualified study of the subject than has thus far been made. The interest at stake is the health and well-being of an important section of our industrial population, which has a right to insist that phrases and platitudes give way to facts and trustworthy conclusions. A brief reference may therefore be made to what is probably the most promising line of research being carried on at the present time. The Medical Research Committee of the Privy Council of Great Britain during the last two years has published two volumes on The Science of Ventilation and Open-Air Treatment, which are indicative of strictly scientific methods and which may safely be relied upon as ultimately rendering assistance in the furtherance of the objective indicated. The second volume includes a discussion of the dust problem, in which, among other matters, mention is made of the work of Winslow and Browne and the important statistical conclusions of Brownlee. There is also included a table, compiled by Collis, with reference to Aberdeen granite cutters, showing "the far greater incidence of deaths from respiratory diseases in shut-up granite-cutters' shops than in open-air sections of the works." While the conclusions advanced are for the time tentative, the methods of the medical research committee are suggestive of the direction to be followed to advantage in similar investigations in this country. The foregoing suggests also a brief reference to a publication on Ventilation of Factories and Workshops, issued by the Home Office, London, 1920, containing a brief outline of standards of ventilation, localized air circulation and ventilation tests, useful in the practical consideration of the problem as met with in the granite industry in this country.

INVESTIGATIONS OF YALE MEDICAL SCHOOL.

In conclusion, attention may properly be directed to investigations in this country which will bear favorable comparison to what is being done abroad. Foremost among those who are to-day actively

prosecuting technical studies of the dust problem are Prof. C. E. A. Winslow and Mr. Leonard Greenburg, of the Yale School of Medicine. Particularly suggestive is a recent contribution on "Industrial tuberculosis and control of the factory dust problem," in the Journal of Industrial Hygiene for February, 1921. These two authors jointly with Mr. E. H. Reeves, scientific assistant, of the United States Public Health Service, have issued a report on The Efficiency of Certain Devices Used for the Protection of Sand Blasters against the Dust Hazard, published in the Public Health Reports of March 5, 1920. Prof. Winslow, also with the assistance of Mr. Leonard Greenburg and Mr. David Greenburg, scientific assistant to the United States Public Health Service, published a paper on The Dust Hazard in the Abrasive Industry, with particular reference to the incidence of tuberculosis among workers exposed to mineral and metallic dusts.

INVESTIGATIONS OF UNITED STATES PUBLIC HEALTH SERVICE.

The subject is also covered in a report by Dr. Paul M. Holmes, passed assistant surgeon, United States Public Health Service, in Public Health Reports for January 2, 1920, on the Health Hazards in the Industries of Niagara Falls. In an earlier report on Standards for Measuring the Efficiency of Exhaust Systems in Polishing Shops, Prof. Winslow, jointly with Messrs. Greenburg and H. C. Angermyer, scientific assistant, United States Public Health Service, gave consideration to the standards of air dustiness and involved technical aspects of dust control, amplified by standards for ventilation applicable to polishing shops. The most recent contribution is a report on Tuberculosis Among Polishers and Grinders in an Ax Factory, by Dr. W. Herbert Drury, contributed to Public Health Reports of February 4, 1921. In this investigation local mortality data were utilized, the tuberculosis death rate of polishers and grinders having been determined for the period 1900–1919 as having been 19 per 1,000, compared with 1.6 for other persons in the mill and 2 for the general population of the mill district. It was also ascertained that the mortality from pulmonary infections other than tuberculosis was 4.3 per 1,000 of population for polishers and grinders, as against 1.7 for other mill employees. The investigation, while too limited in plan and scope to warrant entirely safe conclusions, nevertheless in the main supports the corresponding investigation for granite cutters, emphasizing the importance of localizing the dust hazard and the resulting mortality.

UNREALIZED PROMISES OF PREVENTION.

The foregoing investigations are the most encouraging indication of the gradual accumulation of trustworthy data useful as a basis for community action along effective preventive lines. The wholehearted cooperation of the labor organizations interested in the present investigation also foreshadows a broader interest on their part in preventive measures that will prove productive of results. The day has gone by when there was justification for phrases and platitudes such as perhaps were unavoidable at the outset of the campaign against tuberculosis. Those who rendered assistance in the organization of the movement and who have given furtherance to its plans

and purposes have reason to feel satisfied with the results and disappointed at the failure to do better. It is just 12 years since Mr. John A. Kingsbury, in the American Review of Reviews for April, 1910, published an article on "No tuberculosis in New York State in 1920." The article is illustrated by a picture of a brass band employed to rally audiences for the New York State tuberculosis campaign. In a concluding sentence Mr. Kingsbury remarks, with reference to the method referred to: "These, it is admitted, are revival methods, but they stand the pragmatic test—they work. They not only get the people out, but they get the people stirred to action. To every one who attends these meetings the fact is brought home poignantly that 16,000 lives are sacrificed annually in New York State to a preventable disease, and that something must be done about it now." The question may properly be raised as to what actually has been done to reduce materially and effectively the mortality of 16,000 deaths referred to when the estimated mortality from tuberculosis in New York State during 1920 was placed by the authorities at 13,000!

IMPORTANCE OF OCCUPATIONAL DISEASE RECOGNITION.

The present discussion is intended to reemphasize the industrial aspects of disease along lines of prevention which can not possibly fail. If the dust hazard is the causative factor in the enormous respiratory disease mortality of granite and other stone workers and if preventive means are possible by which the dust menace can be brought under control, it is for the State, for the labor organizations, and for the industries concerned to see to it that what can be done about it is done without needless delay.

SCOPE OF INQUIRY.

In its final analysis and as a practical question the problem of pulmonary tuberculosis and of nontuberculous respiratory diseases in modern industry is primarily one of dust control, or the prevention of atmospheric pollution as a condition precedent to wholesome methods of work essential to health and life. In no industry is this question of greater importance than in the manufacture of stone products, in which, since the introduction of pneumatic tools for cutting and carving purposes, the dust problem has attained to the proportion of a deadly menace to the workers, who are as yet but vaguely aware of the risk incurred by injudicious dust exposure during processes frequently admitting of no effective methods of mechanical control.

The mortality figures of stone workers have for many years indicated a general death rate above the normal for indoor occupations, particularly from lung diseases generally diagnosed as pulmonary tuberculosis. More often, however, the prevailing diseases are of the nontuberculous or of the fibrotic type best illustrated by the so-called "miner's phthisis," which in a large proportion of cases is nontuberculous and as such named variously pneumoconiosis, silicosis, etc. As yet the investigations into the true nature of the problem of dust phthisis are far from sufficiently extensive to be really conclusive as a basis for drastic and practically possible methods of prevention.

Even more lamentable, however, is the prevailing apathy to the known facts of a situation which must be looked upon as of the very first importance to the worker, whose toil is an indispensable contribution to the welfare of mankind.

METHOD OF INQUIRY.

For the purpose of determining with at least an approach to scientific accuracy the mortality facts of the stone industry the present investigation was undertaken, and it has had the hearty cooperation of official authorities, labor organizations, manufacturers, etc. The investigation is a continuation of the investigation the results of which are reported in Bulletin No. 231 of the United States Bureau of Labor Statistics, on Mortality from Respiratory Diseases in Dusty Trades, in which the stone industry is given preliminary consideration, including observations on marble, slate, and limestone workers. Since that investigation includes general observations on dust phthisis, it would not seem necessary to enlarge upon the underlying considerations illustrated in a more concrete form in the present case. After a careful reexamination of the data derived from general experience in dusty trades the granite industry was selected as probably the best illustration of the health-injurious consequences of long-continued inhalation of inorganic, silicious dust. It also seemed advisable to limit the investigation chiefly to the Barre stone-cutting industry of the State of Vermont, partly on account of the hearty cooperation of the State board of health, which provided facilities for an examination of death certificates extending over a long period of years.

The investigation also had the exceptional advantage of the assistance of the local labor unions, subsequently extended to include the entire experience of the Granite Cutters' International Association of America. In addition, the manufacturers of the district provided the necessary facilities for shop inspections, interviews with workmen, and the examination of dust-removing devices in operation at the present time. Assistance was also rendered by the Commissioner of Industries of the State of Vermont, the State Commission on Dusty Trades, and the Vermont Tuberculosis Association, Inc. Through these agencies and by means of accepted methods of inquiry a large amount of entirely new statistical and other material was collected and amplified by the industrial mortality experience of the Prudential Insurance Co. of America. This material has been brought together for the present purpose and is now presented as suggestive of a method of inquiry giving promise of really practical and far-reaching results.

The general vital statistics utilized for the present purpose have all been derived from the official reports of the several States, particularly: Annual Reports upon the Births, Marriages, Divorces, and Deaths in the State of Maine; Biennial Reports Relating to the Registration and Return of Births, Marriages, Divorces, and Deaths in New Hampshire; Annual Reports of the State Board of Health of the State of Vermont; Annual Reports on the Vital Statistics of Massachusetts; Annual Reports Relating to the Registry and Return of Births, Marriages, and Deaths, and of Divorce in the State of Rhode Island; Registration Reports of the Bureau of Vital

Statistics of the State of Connecticut; Mortality Statistics of the United States Bureau of the Census. Population statistics have all been derived from the Census Reports of the United States Bureau of the Census or the Decennial Census Reports of Massachusetts. Population estimates for intercensal years have been arrived at by the arithmetical method. The population estimates were completed before the results of the census of 1920 were available.

OCCUPATIONAL DISEASES OF THE STONE INDUSTRY.

By way of introduction, the general problem may be stated in the following extract from Kober and Hanson's Diseases of Occupation and Vocational Hygiene (p. 625). Regarding stonecutters and marble workers it is said:

> These occupations have from time immemorial been regarded as inimical to health, and even Ramazzini, in the first book on Occupational Diseases, calls attention to the fact that the inhalation of the dust incident to hewing, cutting, and polishing of marble or of stone produces a troublesome cough, and that a goodly number of the operatives become asthmatic and consumptive. We know now that the inhalation of mineral dust develops sooner or later pneumoconiosis, which may eventuate in pulmonary tuberculosis. It is generally held that the liability to diseases of the respiratory passages is less in the case of paving-stone cutters and slate splitters and in the sawing, grinding, polishing, and lathe work, which can be conducted by the wet process, than in the case of monument or custom work, and particularly in the surfacing, carving, and cutting with pneumatic tools. The greatest amount of dust is evolved by the surfacing machines which are operated with compressed air. Of the various tools employed, the bushing hammer creates the finest dust. Unfortunately work with pneumatic tools can not be done by the wet process, as the pasty material created by a mixture of water and dust clogs up the tools. The work is usually done in large open sheds or in the yards, but even under such conditions the men are exposed to clouds of dust. The sawing of granite and marble into slabs, turning in lathes, and the final polishing can be conducted by the wet process; soapstone sawing and cutting for joints is frequently done dry and is attended with exposure to considerable dust.

IMPORTANCE OF OCCUPATIONAL SEGREGATION.

The foregoing observations concern stonecutters and marble workers as a group, but it will be shown by the present investigation that it is of the first importance that each type of stone-dust exposure should be separately considered, as the inclusion of dissimilar stone workers in a group in mortality investigations is certain to lead to erroneous conclusions regarding individual occupational hazards. For example, in the article referred to there occurs the statement that "in analyzing the statistics of the towns in the State of Vermont, where most of the granite and marble industry is carried on, the writer found that Barre, Montpelier, Rutland, Proctor, Dorset, Hardwick, Bethel, and Ryegate, with a combined population of 34,889, had a tuberculosis death rate of 2.2 per 1,000 of population, against a rate of 1.3 for the entire State."

Hence for other than the most general purposes the inclusion of marble workers with those engaged in the cutting and polishing of granite is clearly unscientific. Unfortunately no comprehensive investigations have as yet been made into the mortality of marble workers, but from preliminary inquiries it would appear to be an entirely safe conclusion that the exposure to marble dust is much less harmful than the continuous inhalation of granite dust. All investigations regarding the health-injurious nature of stone-dust exposure require then to be considered with reference to the nature

of the dust inhaled, for wide variations in mortality rates are met with when the chemical and mechanical properties of the dust are taken into account. Even so careful an observer as the late J. T. Arlidge in his treatise on the Hygiene, Diseases, and Mortality of Occupations (p. 303) made the error of reasoning from an entirely inadequate basis of observed experience regarding workers in granite, stating that:

> From special inquiries I have made it would appear that the numerous hands employed around Aberdeen in the cutting, dressing, and polishing of granite are seldom victims of pulmonary lesions attributable to their occupation. This may be esteemed an unexpected fact, considering the density of granite and its lithological elements.
>
> Prof. Hamilton, of Aberdeen University (in a private letter), seeks an explanation from the igneous character of the rock, which opposes itself to the throwing off of dust, because its particles, unlike those of stratified rocks, do not exist in granite ready formed, but require to be made by the chisel of the workman. "The dust in granite working would in all likelihood be coarser than in chiseling stratified rock, and would be caught in the superior respiratory passages without gaining entrance to the air vesicles, where alone it seems to make its way into the pulmonary lymphatics."
>
> But whatever be its explanation, the fact remains, confirmed by several medical men of large experience in Aberdeen, that, though they suffer somewhat from chronic bronchitis, the severe lesions indicative of fibrosis and industrial "phthisis" are almost unknown among the masons and polishers in the Aberdeen quarries.

It will be shown that workers in the Aberdeen district suffer most seriously from pulmonary tuberculosis and from nontuberculous respiratory diseases, and while as yet no exact analysis has been made of the petrological character of the stone dusts from Aberdeen as compared with those from Edinburgh or the dust samples collected in the stone centers of this country there are convincing reasons for believing that the mortality rate will be found to vary largely in proportion to essential differences in the mechanical and chemical properties of the dust inhaled (see p. 22 et seq.).

PATHOLOGY OF DUST INHALATION.

In this connection the following observations by Arlidge (pp. 245, 246 of his treatise) on the pathology and symptomatology of dust inhalation are of much practical value:

> Bronchitis, asthma, fibroid and tubercular consumption occupy a foremost place in the category of causes of British mortality; and without doubt these maladies are largely attributable to the inhalation of dust, operating per se or in conjunction with constitutional proclivities and insanitary surroundings. Pathologists tell us of the presence of bacilli in tubercular disease, and favor the belief that these minute bodies are the cause of it. This notion may represent a whole truth or only a partial one; in my opinion, the latter, for I doubt if these bacilli actually develop phthisis, unless there be some antecedent change in the vitality of the affected tissue; a change wrought by depressing causes connected with the mode of life, or with constitutional debility and inherited taint, or with the occupation followed, of which contributory factors two or more may cooperate. And assuredly the breathing of dust may be reckoned as one such of no slight energy. In other words, I look upon a phthisical lung as one prepared for the germination and multiplication of bacilli and not a primary product of those microscopic organisms, nor of the products of their organic existence. And I find an analogy in the vegetable kingdom, where failing plant vigor is the precursor of the appearance of devastating fungi, and not the fungi the starting point of plant death. The spores of fungi light upon a tissue in which vital forces are failing and allow the development of abnormal fluids, and in the altered organic matter those spores find a suitable nidus for growth. Having established themselves, the fungi now become active agents in breaking down the vegetable tissues. Plants full of vigor will resist the attacks of fungi falling upon them from neighboring plants of the same species.

So it is, I believe, with bacilli; they require a weakened tissue to give them foothold; but having got it, their vast powers of propagation and the transforming action of their vitality on surrounding material render their action highly destructive. That the injection of bacilli into the blood will start tuberculosis is a fact that does not contravene the foregoing view. They have thereby obtained a nonnatural access by the agency of the blood, which brings them into immediate relation with tissues in process of degeneration or of decay, that is, with tissues in a state of weakness and unable to resist their attacks as epiphytic organisms; on the one hand abstracting from them the necessary elements for complete formation, and, on the other, poisoning the plasma by metamorphosed products, the result of their own vital endowments.

It must be accepted as a fact that dust induces a malady bearing a strong similitude to tubercular phthisis and yet that the malady is not tubercular in its actual nature.

In cases of potters' consumption from inhaled dust, occurring under my own observation, bacilli have been sought in vain, excepting where hemoptysis, hectic, and other indications that tubercular mischief has been at work, as accessory or collateral. For experience proves that the dust-produced lung disease may coexist with tubercular phthisis, and, further, that where labor is prosecuted in a dusty atmosphere tubercular mischief in those constitutionally predisposed to it is more likely to arise.

The present investigation would seem fully to support this important conclusion, leading to the conviction that in many cases the diseases reported as pulmonary tuberculosis should be more accurately defined as nontuberculous respiratory diseases generally comprehended under the term "fibrosis," for in many cases it will not be found possible to establish the tuberculous nature of the disease by positive bacteriological findings.

New conceptions as regards the true nature of the tuberculous infection in the human organism are of such complexity that they can not possibly be dealt with on this occasion. The view seems to be gaining ground that the soil is more important than the seed and that the chief protection of the individual lies in a maximum of disease resistance. According to a recent statement illustrating this new conception Dr. Edgar L. Collis is quoted as follows:

Professor Collis dealt with stone masons' phthisis or tuberculosis of the lungs, as to which it has generally been considered that the stone dust which the mason inhales acted as sharp-edged particles lacerating and irritating the lining of the air passages. Professor Collis has shown, however, that the silica (quartz) of the stone dust acts rather as a chemical than as a physical agent, rendering the membrane a better growth-supporting medium for tuberculosis bacilli.

PREVIOUS INVESTIGATIONS IN THE STONE INDUSTRY.

ANCIENT ORIGIN OF THE STONE INDUSTRY.

The stone industry is one of the very oldest as well as most widely diffused occupations. Prof. Edgar L. Collis in his Milroy lecture on Industrial Pneumoconiosis (p. 3) draws attention to the extraordinary incidence of lung disease among the flint knappers of Brandon, the lineal representatives of prehistoric employments for the making of stone implements, pointing out the interesting fact that—

The flint knappers of Brandon, the lineal occupational representatives of this the oldest of industries, who still use tools similar in shape to the deer-horn picks of their prehistoric ancestors, suffer a terrible mortality from phthisis induced by flint dust generated in their work; and early last century Bourgoin pointed out the ravages produced among the population of Meusnes in France by the introduction of the gun-flint industry. "By a fate," says Chateauneuf, "which seems connected with all that concerns the art of war this industry slays those who follow it; it kills them before

their time; for them there is no old age. When asked the cause of so premature a mortality, doctors and officials give the same reply—pulmonary phthisis induced by prolonged inhalation of dust generated from working flints." Probability suggests, therefore, that the starting point of human progress was associated with at least one form of industrial pneumoconiosis and that, if tuberculosis affected prehistoric man, the mortality experienced must have been as severe as that found in existence to-day.

Prof. Collis has enlarged upon this problem in his evidence before the Royal Commission on Metalliferous Mines and Quarries,[3] suggesing a brief reference to a recent communication of the writer in the Scientific American, December 23, 1920, on the question of "Why the cliff dwellers vanished," in which the causative factor for the complete disappearance of this interesting fragment of population is attributed to the serious and continuous dust exposure in the making of stone implements, in the literally carving of rock shelters out of the solid stone, in the making of flint arrowheads and stone tools, and, finally, in the carrying on of the pottery industry. The amount of dust exposure must have been enormous and even more fatal than under modern conditions of stonework with pneumatic tools.

Collis gives a proportionate mortality of 77.8 per cent for phthisis in the case of the Brandon flint knappers, as against 11.2 per cent for all males 15 years of age and over in England and Wales, 1900-1902. The calculated death rates per 1,000 (though based on small numbers) are given as 41.0 and 1.6, respectively. Yet the wives of these workmen were singularly exempt from a liability to phthisis, no deaths at all having occurred among them, though for the Brandon rural population the observed proportionate mortality was 6.5 per cent as compared with 77.8 per cent for the flint knappers. It is most regrettable that this interesting experience should not have been reported upon in more detail and continued down to date.

ABERDEEN MORTALITY INVESTIGATIONS.

The same conclusion applies to the interesting and important data for the city of Aberdeen, Scotland, reported upon by Dr. Matthew Hay, in his annual report as medical officer of health for 1909.[4] Since this report is practically inaccessible and rarely referred to in the literature of tuberculosis or industrial hygiene, the more important observations are given in full, as follows:

> Considerable interest attaches in Aberdeen to the incidence of phthisis among stonecutters and masons, owing to their considerable number and to the danger to which they are exposed from the inhalation of granite dust. All masons are not, however, so exposed, as a proportion of them, varying with the character of the building, are employed solely in building and are known within the trade as "wallers," while the remainder are engaged in hewing and dressing stones. Wallers are not so distinguished in the death registers. Nor is any distinction made in the registers between masons, whether hewers or wallers, employed in connection with buildings and stonecutters employed in the numerous monumental yards. As a rule, a hewer working in the latter is known as a stonecutter, but he is not infrequently designated a mason.
>
> In calculating the death rate among hewers it has been found necessary to form masons and stonecutters into one group and to include wallers. As wallers are not exposed to the inhalation of dust and presumably do not suffer more from phthisis than the average workman in other trades, their inclusion in the group tends to lower the death rate from phthisis; but after careful inquiry I am of the opinion that their

[3] Minutes of Evidence Taken Before the Royal Commission on Metalliferous Mines and Quarries, Vol. II, p. 262, London, 1914.

[4] For more recent statistics, see pp. 149–152.

proportion in the whole group during the past 10 years has not exceeded one-seventh, owing to the large number of stonecutters in the monumental yards.

Stone polishers and stone sawyers form a separate group, as the processes in which they are engaged are wet processes and not accompanied with dust.

For all the occupations dealt with I have omitted persons under 21 years of age—that is, roughly, all apprentices—as they vary considerably in their proportion and in their age at entrance in different trades. I have also excluded masters, who are usually not exposed to the same occupational risks as their workmen.

I have given, for comparison, the death rate from all other causes of death, and have separately distinguished lung diseases other than phthisis, as also diseases of the circulatory and nervous system. The last two are taken together, owing to considerable changes recently in their classification.

The statistical analysis includes the deaths during a 10-year period (1900–1909) derived from trade-union experience. For purposes of comparison the data are also given for a number of other important occupations.

The number of deaths from phthisis during the period under consideration was only 99 for stonecutters and masons and 11 for polishers and sawyers, but the results are most suggestive of conditions as much neglected by the authorities in Scotland as they are in this country. For stonecutters the proportionate mortality from phthisis was 31.0 and for all lung diseases 45.0. For stone polishers and sawyers the proportion for phthisis was only 14.0 and for all lung diseases 38.0. For ordinary laborers the investigation disclosed a proportionate mortality of 9.0 and 31.0, respectively. The average annual number of stonecutters and masons exposed to risk was 1,750 and of polishers and sawyers 420, giving a phthisis death rate of 5.7 per 1,000 for the former and 2.5 for the latter. These rates are for employees only. For the wives and widows of stonecutters and masons the phthisis death rate was 1.8 and for those of polishers and sawyers 1.6 per 1,000, which compares with rates of 1.7 for the wives and widows of painters, 1.9 for those of bakers, and 2.1 for those of laborers. The following interesting observations on these tables will best emphasize the main conclusions drawn from the investigation.

Table B [2] shows that stonecutters and masons stand above all the others with a death rate (5.7 per 1,000) from phthisis that is three times as high as the average (1.9) for males above 21 years. If allowance is made for the inclusion of wallers, among whom the mortality from phthisis can scarcely be higher than the average, the death rate among persons actually engaged in the cutting and hewing of granite is probably about 6.2 per 1,000.

As a rule, occupations with a high mortality from phthisis have also an increased mortality from other lung diseases. This is not the case with stonecutters and masons in Aberdeen, or with printers or lithographers, or with clerks. In all three occupations the mortality from other lung diseases is under the average. Tailors and comb makers, however, follow the usual rule, having a somewhat high mortality from other lung diseases. The result is that if the rates for phthisis and other lung diseases are combined tailors and comb makers, with 8.8 and 8.6 per 1,000, respectively, take precedence of stonecutters and printers, with 8.2 and 5.6, respectively.

The proportion of old men engaged in stonecutting is lower than the average, and this is more distinctly the case with printers, and especially with clerks. On the other hand, the proportion of old men among tailors is high, and it is probably fairly high among comb makers.

The necessary age corrections, without overemphasizing details, are made in Table C [3], differentiating ages under and over 55 years. This table confirms the previous conclusions as regards the excessive incidence of phthisis among stonecutters not only at the younger ages but even more so at ages 55 and over.

TABLE 1.—NUMBER OF DEATHS OF PERSONS OVER 21 YEARS OF AGE (EXCLUDING EMPLOYERS) IN ABERDEEN, 1900 TO 1909, AND PROPORTION DYING FROM LUNG DISEASES, BY OCCUPATION.

Occupation.	Estimated average annual number of employed persons over 21 years of age.	Total number of deaths from—						Per cent deaths from phthisis and all lung diseases are of deaths from all causes.	
		Lung diseases.			Circulatory and nervous diseases.	Other diseases.	All causes.	Phthisis.	All lung diseases.
		Phthisis.	Excluding phthisis.	Including phthisis.					
Males.									
Stonecutters and masons	1,750	99	43	142	80	94	316	31	45
Stone polishers and sawyers	420	11	21	32	21	23	76	14	38
Joiners, sawyers, shipwrights, and cabinetmakers	1,420	26	48	74	99	122	295	9	25
Painters	420	9	17	26	39	22	87	10	30
Tailors	620	20	35	55	56	53	164	12	33
Bakers	360	5	16	21	23	30	74	7	29
Engineers, blacksmiths, riveters, and firemen	2,600	47	60	107	134	126	367	13	29
Printers and lithographers	380	17	4	21	17	14	52	33	41
Comb makers	345	15	15	30	25	23	78	19	38
Carters	1,450	16	45	61	44	72	177	9	34
Laborers	3,600	81	203	284	299	352	935	9	31
Clerks	1,220	46	18	64	48	66	178	26	36
Females.									
Dressmakers and milliners	1,750	34	26	60	47	57	164	21	37
Domestic servants	3,500	74	116	190	238	310	738	10	26

TABLE 2.—AVERAGE ANNUAL DEATH RATE OF PERSONS OVER 21 YEARS OF AGE (EXCLUDING EMPLOYERS) IN ABERDEEN, 1900 TO 1909, BY OCCUPATION.

Occupation.	Estimated average annual number of employed persons above 21 years of age.	Annual number of deaths per 1,000 persons from—							
		Lung diseases.			Circulatory and nervous diseases.	Other diseases.	All causes.	Tuberculosis.	
		Phthisis.	Excluding phthisis.	Including phthisis.				Wives and widows.	Unmarried children.
Males.									
Stonecutters and masons	1,750	5.7	2.5	6.2	4.6	5.4	18.1	1.8	4.7
Stone polishers and sawyers	420	2.5	4.8	7.3	4.8	5.2	17.3	1.6	5.5
Joiners, sawyers, shipwrights, etc.	1,420	1.8	3.4	5.2	7.0	8.6	20.8	1.8	3.7
Painters	420	2.1	4.0	6.1	9.3	5.2	20.7	1.7	4.5
Tailors	620	3.2	5.6	8.8	9.0	8.5	26.5	1.6	2.7
Bakers	360	1.4	4.4	5.8	6.4	8.3	20.6	1.9	4.4
Engineers, blacksmiths, etc.	2,600	1.8	2.3	4.1	5.2	4.8	14.1	1.6	3.9
Printers and lithographers	380	4.5	1.1	5.6	4.5	3.7	13.7	1.1	1.6
Comb makers	345	4.3	4.3	8.6	7.2	6.7	22.5	2.0	3.2
Carters	1,450	1.1	3.1	4.2	3.0	5.0	12.2	1.8	4.7
Laborers	3,600	2.3	5.6	7.9	8.3	9.8	26.0	2.1	4.4
Clerks	1,220	3.8	1.5	5.3	3.9	5.4	14.6	1.1	0.7
Females.									
Dressmakers and milliners	1,750	1.9	1.5	3.4	2.7	3.3	9.4	.....	.....
Domestic servants	3,500	2.1	3.5	5.4	6.8	6.8	21.1	.....	.....
All males 21 years and over, irrespective of employment	.....	1.9	3.3	5.2	5.6	8.0	18.8	.....	.....
All females, 21 years and over, irrespective of employment	.....	1.7	2.7	4.4	5.1	8.3	17.8	.....	.....

TABLE 3.—NUMBER OF DEATHS, GROUPED ACCORDING AS AGE WAS UNDER OR OVER 55 YEARS, AMONG PERSONS OVER 21 YEARS OF AGE (EXCLUDING EMPLOYERS) IN SPECIFIED OCCUPATIONS IN ABERDEEN, 1900 TO 1909, AND DEATH RATE FROM LUNG DISEASES OF THOSE UNDER 55 YEARS OF AGE.

Occupation.	Per cent of persons over 55 years of age estimated from census of 1901.	Total number of deaths from—				Number of deaths of persons under 55 years per 1,000 persons under 55 years.		
		Phthisis.		Other lung diseases.				
		Under 55 years.	Over 55 years.	Under 55 years.	Over 55 years.	Phthisis.	Other lung diseases.	All lung diseases.
Males.								
Stonecutters and masons	9	77	22	14	29	4.9	0.9	5.8
Stone polishers and sawyers	10	9	2	9	12	2.4	2.4	4.8
Joiners, sawyers, shipwrights, etc	16	24	2	12	36	2.0	1.0	3.0
Painters	7	9	0	7	10	2.3	1.8	4.1
Tailors	16	17	3	7	28	3.2	1.3	4.5
Bakers	7	4	1	10	6	1.2	3.0	4.2
Engineers, blacksmiths, etc	12	44	3	26	34	1.9	1.1	3.0
Printers and lithographers	5	17	0	2	2	4.7	.6	5.3
Comb makers	15	13	2	2	13	4.5	.7	5 2
Carters	8	15	1	26	19	1.1	1.9	3.0
Laborers	22	67	14	71	132	2.4	2.5	4.9
Clerks	6	46	0	10	8	4.0	.9	4.9
Females.								
Dressmakers and milliners	11	33	1	7	19	2.1	.5	2.6
Domestic servants	10	66	8	26	90	2.2	.9	3.1
All males 21 to 55 years, irrespective of employment						2.1	1.5	3.6
All females 21 to 55 years, irrespective of employment						1.9	.8	2.7

AGE INCIDENCE IN DUST PHTHISIS.

It is further said that—

Attention may be directed to the exceptionally large number of deaths from phthisis among stonecutters after the age of 55. In nearly every other occupation, except that of laborers, phthisis is relatively rare as a cause of death after this age; and it is possible that, so far as concerns Aberdeen, the considerable number of deaths from phthisis among older laborers is in part due to the presence among them of former stonecutters. Among 1,750 stonecutters and masons there were during the past 10 years 22 deaths from phthisis of persons above 55 years of age. Among 3,600 laborers there were 14 deaths. In the 9,235 other male persons dealt with in the tables there were only 14 deaths. Many cases of phthisis in stonecutters must either have begun late or lasted long. Such may be cases of persons with little constitutional predisposition to tuberculosis in whom the tubercle germ only succeeds in overcoming the greater vital resistance after a protracted struggle.

Attention is also directed to the fallacy of the average age at death as an index figure of mortality, since a low average age by no means consistently coincides with a high death rate, as is frequently assumed to be the case. The source of the fallacy is in a large measure to be found in the varying age constitution of the occupational groups and also, no doubt, to a widely varying length of trade life. No average age at death would therefore reveal the truly enormous differences in the increased liability of stoneworkers to pulmonary phthisis. For illustration, in the Aberdeen experience the average age at death from phthisis was 43 years for stonecutters and the same for stone polishers, against 41 years for laborers and 30 years for clerks, while the phthisis death rates per 1,000 were 5.7 for stonecutters, 2.5 for polishers, 2.3 for laborers, and 3.8 for clerks. In commenting on these divergent figures it is said that—

Two of the occupations (stonecutting and comb making) with the highest death rate from phthisis are the two occupations with the highest average age at death from that disease. Both are dust occupations. There is some ground for believing, not only from these figures but from the results of similar investigations elsewhere, that dust-produced phthisis is, in many cases, slow in leading to a fatal result. On the other hand clerks with a high death rate from phthisis have a low average age at death from that disease. This, no doubt, is in large part due to age constitution, but it suggests the question whether phthisis caused by vitiated air, as in small ill-ventilated offices, and occurring among persons working with the chest in a cramped position, does not tend to a speedier issue. The figures for tailors are rather opposed to this view. The four occupations with the lowest death rates from phthisis—namely, carters, bakers, engineers, and joiners—have average ages at death from that disease of 38, 39, 38, and 36, respectively. These ages, as compared with those for other occupations, are neither high nor low.

EFFECT OF PNEUMATIC TOOLS.

Aside from the foregoing general statistical observations, the report by Dr. Hay considers the question, of special practical importance, as to the effect of pneumatic tools as a factor in the mortality from phthisis. These observations are of such exceptional value that they are given almost in their entirety as contained in the original report:

In regard to the mortality from phthisis among stonecutters and masons, the question has been raised as to whether the introduction of pneumatically driven tools, which produce more fine dust than the old hand chisels, has increased the amount of phthisis and lung disease. I am informed that previous to 1900 very few pneumatic tools were in use in Aberdeen. Between 1900 and 1905, and especially after 1902, their use rapidly extended, so that by 1905 they had come into full use in practically all stonecutting yards.

The following table gives the number of deaths among stonecutters and masons combined for each of the 15 years ending with 1909. The first five years (1895–1899) represent a period practically unaffected by pneumatic tools, the second five years (1900–1904) a period in which pneumatic tools were coming into use, and the third five years (1905–1909) a period in which the tools were in full use. Only deaths at ages of 21 years and upwards are included.

TABLE 4.—NUMBER OF DEATHS AMONG STONECUTTERS AND MASONS COMBINED FROM PHTHISIS AND OTHER LUNG DISEASES, 1895 TO 1909.

Cause of death.	1895	1896	1897	1898	1899	Total.
	First period (1895–1899).					
Phthisis	6	9	12	7	13	47
Other lung diseases	5	1	5	9	8	28
Total	11	10	17	16	21	75
	Second period (1900–1904).					
	1900	1901	1902	1903	1904	Total.
Phthisis	10	6	13	12	9	50
Other lung diseases	6	10	5	2	8	31
Total	16	16	18	14	17	81
	Third period (1905–1909).					
	1905	1906	1907	1908	1909	Total.
Phthisis	11	10	9	11	8	49
Other lung diseases	2	3	3	1	3	12
Total	13	13	12	12	11	61

The numbers for 1900–1904 are slightly above those for 1895–1899 in respect both of phthisis and of other lung diseases. The total number for 1905–1909 is, however, considerably down; but the fall is practically confined to deaths from lung diseases other than phthisis.

The first two periods are fairly comparable, except that allowance should be made for an increase of perhaps 10 per cent in the number of persons employed as between the first and second periods and for the fact that during these two periods the mortality from phthisis in the community as a whole was falling. As probably the effect of the latter influence did rather more than equalize the effect of the former, a comparison of the first two periods would appear to show that the introduction of pneumatic tools had produced some increase, although not a large increase, in the death rate from phthisis and other lung diseases.

As regards the third period (1905–1909), while the number of stonecutters and masons employed in monumental yards has not fallen off, but rather increased, there has been a great decline in the number of building masons in employment, due to unusual depression in the building trade. Some of these out of employment as mason hewers have, I believe, found employment as stonecutters in monumental yards, and thus checked in some measure the advancement of apprentices to the status of journeyman. Some have emigrated to America. Some have drifted into laboring, but not improbably in the event of death within two or three years of leaving their trade their deaths have been registered by their relatives as the deaths of masons. It is difficult to know to what extent to make allowance for these disturbing factors. Probably any reasonable allowance would not raise the total number of deaths from phthisis and other lung diseases combined above or even up to the number for each of the two preceding quinquennial periods, but it would raise the number of deaths from phthisis above the numbers for these periods.

The difficulties emphasized are common to all inquiries of this kind, but probably somewhat more seriously in the case of the Aberdeen district than of Barre, Vt., where, however, a large number of former Aberdeen cutters have been actively at work for many years.

The workmen employed at stonecutting in monumental yards are usually known as stonecutters, although sometimes called masons, while those employed in building yards are usually called masons, although sometimes designated as stonecutters. If we take the deaths of persons during the past 15 years who when they died were registered as stonecutters, we find that in the three 5-year periods, beginning with the first, the number of deaths was 29, 28, and 36, respectively. This gives an increase of eight deaths in the third period as compared with the second period, or an increase of nearly one-third. If, however, the deaths from other lung diseases are added, the figures for the three periods become 39, 43, and 42. Allowing for an increase of workmen over the 15 years, these figures would not appear to indicate any appreciable increase in mortality; but they must be viewed in the light of the fact that since 1895–1899 the mortality from phthisis and other lung diseases in the city generally has fallen very considerably. The conclusion must therefore be that the introduction of pneumatic tools has prevented stonecutters sharing in the general decline in the death rate from lung diseases. It is of interest to add that the average age at death of stonecutters dying of phthisis and other lung diseases has risen considerably, being for the three 5-year periods, 36, 44, and 46 years, respectively.

Other difficulties met with in an exact determination of the facts are illustrated by the following extract:

About the time of the introduction of pneumatic tools for granite cutting, but not altogether as a consequence of it, the sheds, which had usually been entirely open along the front, as in the case of an ordinary builder's shed, began to be closed. The closure, while increasing the liability to the inhalation of dust, must at the same time have afforded some protection against cold and possible chills. This may possibly account in part for the diminution during the past five years in the number of deaths from lung diseases other than phthisis. But the numbers dealt with are small, and allowance must be made for mere chance variations.

During all three periods the mortality from lung diseases other than phthisis has been exceptionally low as compared with the rate in other occupations. The unusual combination, in the case of workers in stone, of a high mortality from phthisis, with a low mortality from lung diseases other than phthisis, may serve to bear out the statement made by the late Prof. Hamilton, professor in pathology in Aberdeen for about 25

years, and previously for several years pathologist to the Edinburgh Royal Infirmary, that a definate development of so-called lithosis, or a fibroid affection of the lungs due to stone dust, is rare among granite workers in Aberdeen, although common among freestone workers in Edinburgh.

RACIAL AND SOCIAL INFLUENCES.

The same problem confronts an investigation into the facts of the present situation at Barre, and a much more extended inquiry than has been possible would be required to determine with accuracy the precise influence of the numerous occupational, social, and even racial influences which more or less determine the death rate from any particular disease during a given period of years. Of no small importance in this connection are changes in the viewpoint of the medical profession, which leans now toward one theory and now toward another in matters of pathology, symptomatology, and clinical diagnosis, as well as in the interpretation of autopsy findings. Dr. Hay, in some detailed comments on a statement by the late Prof. Hamilton, remarks:

I have searched the post-mortem records of the Aberdeen infirmary for the past 15 years for information on this point, and have found few marked indications of lithosis in stonecutters, whatever was the cause of death; but the autopsies of stonecutters and masons are not numerous and do not amount to more than one in a year, whereas the total deaths from all causes among such persons average about 30 yearly. In only three autopsies out of 13 was a condition of lithosis stated to have been found, and in only one case was it fairly well marked. In two of the cases tuberculosis was mentioned as present. In one case the deceased was known to have been employed for some time in the South in working with freestone.

PROBLEM OF FAMILY INFECTION.

To the foregoing is here added the following concluding passage from a report which will always rank as one of the classics in the early literature of diseases of occupations, reserving for future consideration the incidental observations on the relation of occupational phthisis to the mortality from tuberculosis among wives and children, a question of only academic importance in the present discussion. The remarks by Dr. Hay follow:

As I have a strong conviction as to the important part played by constitutional susceptibility in the production of phthisis, I am of the opinion that the entrance to all trades with a high mortality from phthisis should be guarded, as far as possible, against the admission of youths with a definite family history of tuberculosis, or with defective chest development, or with lung weakness. Each intending entrant should be examined by a medical man and careful inquiry made into the health history of his family.

In addition, every reasonable and practicable method for diminishing the dangers attached to the trade should be enforced. In the case of stonecutters it would appear to be possible, as in certain other trades accompanied by injurious dust, to devise arrangements by which the dust might in large measure be drawn away from the faces of the workmen.

IMPORTANCE OF STONE DUST ANALYSIS.

The present investigation, though limited largely to the Barre district, confirms much of what has been said in connection with the Aberdeen inquiry. Until an analysis has been made of the dust of the Aberdeen stone the most important link in the chain of comparative evidence will be wanting. The comparison gains in interest and value when the fact is taken into account that of the total of 1,137

granite cutters in the Barre district in August, 1919, 557 were of Italian parentage, 181 of Scotch descent, and 87 of Spanish. It would make a most useful contribution to knowledge if the more recent experience of Aberdeen and Edinburgh could be brought together, and, if possible, in a form corresponding to the present investigation. It would also be most useful if at the same time the possibly varying methods of clinical diagnosis and objective autopsy findings were made note of, for, as pointed out by Prof. Collis in a learned discussion[5]—

These distinctions, implied or definitely stated, between the types of respiratory trouble which follow inhalation of different dusts are the more notable, because even to-day pneumoconioses are pigeonholed in clinical teaching as a single entity, ascribed to exposure to any and every form of injurious dust, of which pulmonary fibrosis sums up the pathological findings and phthisis the morbid result.

Prof. Collis quotes from the earlier report of the Royal Commission on Metalliferous Mines and Quarries the remarks of Peacock,[6] that—

The form of the disease in which there is local consolidation in some portion of the lungs bears a close general resemblance to true consumption, and especially where, as often happens, the voice is husky and the patient expectorates blood. There are, however, features by which it is sufficiently distinguished from that disease. It usually occurs in persons who do not present any hereditary disposition to phthisis, their parents and other relatives often having attained advanced ages and being quite healthy. It commences at a later period of life than phthisis; indeed, in persons who have reached ages at which consumption is by no means of frequent occurrence. It is also much slower and less active in its progress, so that in persons who have been ill for several years the signs often do not indicate extensive or advanced disease. The quickness of pulse, the rapid and extreme emaciation, and the night perspirations so characteristic of true phthisis are also generally absent or only slightly marked, and there is rarely diarrhea; indeed, the bowels are often obstinately confined.

These and other investigations confirm one another, leaving no reasonable doubt that it is primarily the exposure to health-injurious dust that determines the excessive incidence of occupational phthisis. Yet neither the Government nor the medical profession during the long intervening period of years has given the matter the requisite amount of qualified consideration. Collis rather mildly observes in his conclusions: "Why work so well started was then allowed to lie dormant for so long, while other aspects of public health were being strenuously developed by medical officers of health, with inspectors of nuisances appointed for every town and district, reinforced now by a battalion of tuberculosis officers, is astonishing."

MORTALITY AMONG GRANITE-STONE WORKERS.

ANALYSIS OF VERMONT GRANITES.

The present investigation was decided upon after most careful consideration as covering probably the most typical of the so-called dusty trades, and, while largely statistical, the outlook is most hopeful that the supplementary investigations by the Bureau of Mines will add a large amount of new, technical information urgently needed in preventive efforts of far-reaching importance to the trade. The investigation at the outset took into account the general facts of tuberculosis occurrence in the State of Vermont, and particularly in the counties of Washington and Caledonia, in which the major portion of

[5] Milroy Lectures, 1915. "Industrial pneumonoconioses", by Edgar L. Collis, M. B., p. 4.
[6] Idem., p. 6.

the mills and quarries are located. The technical data regarding the geographic distribution of the granites of Vermont, the geologic features of the various quarries, and the descriptive accounts of the more important beds have been reported upon in sufficient detail for the present purpose in Bulletin No. 404 of the United States Geological Survey (Washington, 1909). This publication includes a classification of Vermont granites, reference to the texture of the stone and its petrographic name, and analysis in some detail of a few types indicative of a high silica content, as shown, for illustration, in the samples of "dark Barre granite" (p. 51) and the "Bethel granite" (p. 111), as given below:

TABLE 5.—CHEMICAL ANALYSIS OF GRANITE SAMPLES.

Constituent.	Dark Barre granite.	Bethel granite.
	Per cent.	*Per cent.*
Silica	69.89	77.52
Alumina	15.08	16.78
Soda	4.73	1.21
Potash	4.29	.62
Lime	2.07	2.56
Iron oxide	1.46	.84
Other elements	2.48	.47
	100.00	100.00

This comparison would seem sufficient for the present purpose to emphasize the material differences in the composition of the Vermont granites, but since the mineral proportions vary even more decidedly, the following analyses of representative stones are included:

TABLE 6.—ESTIMATED PERCENTAGES OF MINERAL ELEMENTS OF TYPICAL VERMONT GRANITES.

Type of stone.	Quartz.	Feldspar.	Mica.
	Per cent.	*Per cent.*	*Per cent.*
Dark-blue Hardwick	21.8	62.1	16.2
Newark granite	30.3	64.8	4.6
Randolph granite	21.2	76.5	2.3
Dark Barre granite	26.6	65.5	7.9
Fletcher quarry	31.2	63.1	5.7
Rochester granite	29.6	62.1	8.3

How far these varying constituent mineral elements of the Vermont granites bear upon the health-injurious nature of the stone dust inhaled during cutting and carving processes has not yet been determined, but it is to be assumed that these and related facts will be taken account of in the dust investigations by the Bureau of Mines. The mortality has been ascertained for each plant or working shed separately, so that a correlation of the technical data will be feasible, the number employed in each plant being also a matter of record, together with a full report on plant conditions, both sanitary and mechanical, including the presence or absence of dust removing or controlling devices.[7]

[7] It has not been feasible to include the reports on shop conditions within the present discussion as it is concerned with the mortality rather than the sanitary aspects of the stone industry.

SANITARY TOPOGRAPHY OF BARRE DISTRICT, VT.

The following is a brief descriptive account of the Barre district:[8]

The city of Barre lies about 5 miles southeast of Montpelier, and the Barre quarries are 3 miles farther southeast, near the southeast corner of the township of Barre, and a few of them are in Williamstown, in Orange County, which adjoins Barre on the south. The city of Barre lies on Stephens Brook, a tributary of the Winooski, which empties into Lake Champlain. About half a mile south-southeast of Barre City this brook receives a tributary from the southeast known as Jail River. Some 2½ miles southeast of the city this river flows through a canyon-like gorge between flat-topped masses of sand, clay, and bowlders over 200 feet thick. A little north of Jail River at this point a roundish granite mass, known as Cobble Hill, rises to a height of 1,100 feet, by aneroid, above the city, and 2 miles about southwest of this hill and a little south of the river another granite mass, known as Millstone Hill, rises to a height of 1,200 feet, by aneroid, above the city. Fifty-six quarries are grouped about these two granite masses, and of these 52 are about Millstone Hill.

To this are here added extracts relating to the geology of the district, useful for comparison with the granite areas of other sections:

Finlay's map shows that he regards the two granite hills as parts of one granite area with a north-northeast trend over 4 miles long by 1½ wide, surrounded by slate and schist. Its representation on the State geologic map of 1861 is not far different. The writer's [T. Nelson Dale] time was too short to enable him to trace the boundaries of the granite and schist, nor was a map suitable for such purpose available. Finlay represents a schist tongue crossing Millstone Hill diagonally from northwest to southeast, and Cobble Hill as all granite, but the writer found schist on the north side of the top of the Cobble, without, however, determining its northern limit. The schist capping also crops out at Jones Brothers' and Barclay's quarries, and near the Marr & Cordon quarry of the Consolidated Company, and in Websterville.

These are the chief geologic features of the Barre district. Four formations are represented: (1) The schist, a metamorphosed marine argillaceous and calcareous sediment of unknown thickness, underlying the city and surrounding the granite area; (2) the granite, of igneous origin, intruded in the schist and forming two domes, 2 miles apart, with an intervening depression, which in consequence of the erosion of the schist now project through it; (3) certain dark basic dikes of later date cutting the granite and the schist also; (4) finally, masses of sand, clay, and bowlders, over 200 feet thick, in the hollow between the domes of glacial origin overlying the schist and part of the granite.

As many as seven different sets of surface forms have existed here: (1) The original surface of the sediments of clay and sand before their emergence from the sea; (2) the surface of those sediments after their metamorphism into schist and before the granitic intrusion; (3) the surface of the schist mass as modified by the granitic intrusion; (4) the surface of the schist and granite masses which resulted from the long period of preglacial erosion; (5) the original surface of the superimposed glacial deposits; (6) the surface of the glacial deposits as modified by glacial lake levels; (7) the surfaces produced in both unmodified and modified glacial deposits by postglacial streams. It is assumed in this outline that any modifications of the eroded rock surface by the glacier were unimportant, and the surface of the ice sheet itself has not been considered.

Much valuable information in detail is available through other sources, particularly the reports of the State geologist of Vermont, while Bulletin No. 404 of the United States Geological Survey includes a brief bibliography on the economic geology of granite useful for more extended research. (See particularly Day's report on Granite Quarrying in Europe; Mineral Resources, 1893; and the report of the eleventh census on Methods of Quarrying, Cutting, and Polishing Granite, Washington, 1892.)

DEATH CERTIFICATES ANALYZED.

The mortality analysis made from original data through the cooperation of the Vermont State Board of Health covers a period of 26 years, limited to the counties of Washington and Caledonia. The

[8] The Granites of Vermont, by T. Nelson Dale, Washington, D. C., 1909, p. 47 et seq.

total number of death certificates examined was 18,406, of which 2,092 were deaths from pulmonary tuberculosis and 166 deaths from other forms of tuberculosis, or 11.4 and 0.9 per cent, respectively, of the mortality from all causes.

MORTALITY EXPERIENCE OF THE GRANITE CUTTERS' INTERNATIONAL ASSOCIATION.

The mortality analysis of the Granite Cutters' International Association of America is for the entire United States and Canada, but in somewhat greater detail for the State of Vermont. For the whole United States and Canada this experience concerns an exposure in 1917 of 8,274 granite cutters, the highest number of members having been reported for the year 1906 (10,185) and the lowest for the year 1895 (2,850). The total mortality under observation during the period 1889–1917 was 3,357, which has been correlated to the adult male population of New England for the same period, showing a surprising divergence in the results.

TABLE 7.—MORTALITY FROM ALL CAUSES AMONG THE GRANITE CUTTERS OF THE UNITED STATES AND CANADA COMPARED WITH THAT OF THE ADULT MALE POPULATION OF NEW ENGLAND,[1] 1889 TO 1917.

[Data for granite cutters taken from experience of the Granite Cutters' International Association of America.]

Year.	Granite cutters.			Males of New England[1] 20 years of age and over.		
	Number exposed.	Deaths.	Death rate per 1,000.	Population.	Deaths.	Death rate per 1,000.
1889	3,834	45	11.7	[2] 989,392	[2] 17,530	[2] 17.7
1890	4,949	62	12.5	[2] 1,016,405	[2] 18,961	[2] 18.6
1891	6,407	55	8.6	[2] 1,038,240	[2] 19,532	[2] 18.8
1892	4,375	70	16.0	1,270,871	25,759	20.3
1893	3,887	73	18.8	1,294,364	25,197	19.5
1894	3,399	79	23.2	1,317,857	23,910	18.1
1895	2,850	57	20.0	1,341,352	24,228	18.1
1896	4,116	48	11.7	1,367,030	24,533	17.9
1897	4,779	53	11.1	1,392,708	24,318	17.5
1898	4,457	76	17.1	1,418,386	24,892	17.5
1899	4,471	62	13.9	1,444,065	25,589	17.7
1900	5,362	62	11.6	1,469,744	26,352	17.9
1901	6,864	71	10.3	1,488,842	26,969	18.1
1902	7,760	87	11.2	1,507,940	25,869	17.2
1903	8,768	88	10.0	1,527,038	27,186	17.8
1904	8,568	118	13.8	1,546,137	27,649	17.9
1905	9,148	143	15.6	1,565,236	28,497	18.2
1906	10,185	144	14.1	1,596,379	27,855	17.4
1907	9,056	138	15.2	1,627,522	30,696	18.9
1908	8,810	149	16.9	1,658,665	28,390	17.1
1909	9,869	111	11.2	1,689,808	28,783	17.0
1910	9,607	179	18.6	1,720,952	30,833	17.9
1911	9,225	178	19.3	1,748,102	31,367	17.9
1912	8,742	165	18.9	1,775,252	30,515	17.2
1913	7,797	206	26.4	1,802,402	31,465	17.5
1914	9,721	217	22.3	1,829,552	31,725	17.3
1915	9,052	202	22.3	1,856,702	31,687	17.1
1916	9,739	206	21.2	1,883,852	34,184	18.1
1917	8,274	213	25.7	[2] 1,656,157	[2] 29,731	[2] 18.0

[1] Connecticut excepted.
[2] New Hampshire, Vermont, Massachusetts, and Rhode Island.

A summary of this table for five-year periods clearly illustrates present-day tendencies and, as regards the stone-cutting industry, tendencies in the wrong direction.

TABLE 8.—MORTALITY FROM ALL CAUSES AMONG THE GRANITE CUTTERS OF THE UNITED STATES AND CANADA, COMPARED WITH THAT OF THE ADULT MALE POPULATION OF NEW ENGLAND, 1889 TO 1917, BY 5-YEAR PERIODS.

[Data for granite cutters taken from experience of the Granite Cutters International Association of America.]

Period.	Granite cutters.				Males of New England 20 years of age and over.			
	Number exposed.	Deaths.	Death rate per 1,000.	Relative number (1889–1894 =100).	Aggregate population.	Deaths.	Death rate per 1,000.	Relative number (1889–1894 =100).
1889–1894	26,851	384	14.3	100.0	6,927,129	130,889	18.9	100.0
1895–1899	20,673	296	14.3	100.0	6,963,541	123,560	17.7	93.7
1900–1904	37,322	426	11.4	79.7	7,539,701	134,025	17.8	94.2
1905–1909	47,068	685	14.6	102.1	8,137,610	144,221	17.7	93.7
1910–1914	45,092	945	21.0	146.8	8,876,260	155,905	17.6	93.1
1915–1917	27,065	621	22.9	160.1	5,396,711	95,602	17.7	93.7

The death rate from all causes of granite cutters has increased from 11.7 per 1,000 in 1889 to 25.7 in 1917, while during the corresponding period the adult male death rate of the New England States has declined from 20.3 in 1892 to 18.0 in 1917. Since so many factors enter into the total mortality experience of the Granite Cutters' Association, it has seemed best to limit the more detailed comparison of tuberculosis frequency to well-defined areas, beginning, however, with the State of Vermont.

TABLE 9.—MORTALITY FROM PULMONARY TUBERCULOSIS AMONG THE GRANITE CUTTERS OF VERMONT, COMPARED WITH THAT OF THE GENERAL ADULT POPULATION OF THE STATE, 1896 TO 1918.

[Data for granite cutters taken from experience of the Granite Cutters' International Association of America.]

Year.	Granite cutters.			General population (20 years of age and over).		
	Number exposed.	Deaths.	Death rate per 100,000.	Population.	Deaths.	Death rate per 100,000.
1896	1,164	3	257.7	214,008	444	207.5
1897	1,262	5	396.2	215,081	348	161.8
1898	1,491	6	402.4	216,153	380	175.8
1899	1,667	8	479.9	217,226	464	213.6
1900	1,843	5	271.3	218,298	399	182.8
1901	1,860	5	268.8	219,120	391	178.4
1902	2,198	9	409.5	219,942	358	162.8
1903	2,342	8	341.6	220,763	329	149.0
1904	2,504	11	439.3	221,585	344	155.2
1905	2,595	20	770.7	222,407	369	165.9
1906	2,938	19	646.7	223,229	334	149.7
1907	3,046	25	820.7	224,051	323	144.2
1908	2,881	22	763.6	224,872	338	150.3
1909	3,134	19	606.2	225,694	305	135.1
1910	3,296	27	819.2	226,516	281	124.0
1911	3,352	25	745.8	227,338	300	132.0
1912	3,266	19	581.8	228,160	238	104.3
1913	3,660	28	765.0	228,981	289	126.2
1914	3,529	38	1,076.8	229,803	262	114.0
1915	3,613	32	885.7	230,625	231	100.2
1916	3,233	43	1,330.0	231,447	297	128.3
1917	2,921	32	1,095.5	232,269	224	96.4
1918[1]	2,727	26	953.4	.....	.....	.....

[1] Exclusive of last three months of 1918.

A summary of the data in the foregoing table follows:

TABLE 10.—MORTALITY FROM PULMONARY TUBERCULOSIS AMONG GRANITE CUTTERS, COMPARED WITH THAT OF THE GENERAL ADULT POPULATION OF VERMONT, 1896 TO 1918, BY 5-YEAR PERIODS.

[Data for granite cutters taken from experience of the Granite Cutters' International Association.]

Period.	Granite cutters.				General adult population (20 years of age and over).			
	Number exposed.	Deaths.	Death rate per 100,000.	Relative number (1896–1899 =100).	Aggregate population.	Deaths.	Death rate per 100,000.	Relative number (1896–1899 =100).
1896–1899	5,584	22	394.0	100.0	862,468	1,636	189.7	100.0
1900–1904	10,747	38	353.6	89.7	1,099,708	1,821	165.6	87.3
1905–1909	14,594	105	719.5	182.6	1,120,253	1,669	149.0	78.5
1910–1914	17,103	137	801.0	203.3	1,140,798	1,370	120.1	63.3
1915–1918 [1]	12,494	133	1,064.5	270.2	694,341	752	[2] 108.3	57.1

[1] Exclusive of last three months of 1918. [2] 1915–1917.

During the period under observation the mortality from pulmonary tuberculosis among granite cutters increased from a rate of 257.7 per 100,000 in 1896 to 953.4 in 1918 (a maximum figure of 1330.0 having been reached in 1916), while the corresponding mortality of the general adult population declined from a rate of 207.5 in 1896 to 96.4 in 1917, excluding in the case of granite cutters the last three months of 1918 on account of the influenza epidemic.

COMPARATIVE NEW ENGLAND MORTALITY DATA.

The results of this comparison are quite similar to one for the granite cutters of the State of Massachusetts, as shown by Table 11. The pulmonary tuberculosis death rate of the adult male population of the State diminished from 295.0 per 100,000 in 1896 to 209.2 in 1917, whereas the corresponding mortality of the granite cutters of this State increased from 410.2 in 1897 to 1056.3 in 1918. A maximum death rate of 1250.0 was reached in 1916.

TABLE 11.—MORTALITY FROM PULMONARY TUBERCULOSIS AMONG THE GRANITE CUTTERS OF MASSACHUSETTS COMPARED WITH THAT OF THE GENERAL ADULT POPULATION OF THE STATE, 1896 TO 1918.

[Data for granite cutters taken from experience of the Granite Cutters' International Association of America.]

Year or period.	Granite cutters.			Male population (20 years of age and over).			General population (20 years of age and over).		
	Number exposed.	Deaths.	Death rate per 100,000.	Population.	Deaths.	Death rate per 100,000.	Population.	Deaths.	Death rate per 100,000.
1896	991	.....	.....	791,091	2,334	295.0	1,649,279	4,648	281.8
1897	975	4	410.2	810,369	2,282	281.6	1,686,922	4,571	271.0
1898	966	6	621.1	829,647	2,373	286.0	1,724,565	4,482	259.9
1899	1,001	9	899.1	848,925	2,382	280.6	1,762,208	4,461	253.1
1900	1,194	4	335.0	868,201	2,298	264.7	1,799,851	4,426	245.9
1901	1,307	9	688.6	880,578	2,308	262.1	1,827,738	4,347	237.6
1902	1,525	12	786.9	892,955	2,141	239.8	1,855,625	4,040	217.7
1903	1,630	8	490.6	905,332	2,022	223.3	1,883,512	3,857	204.8
1904	1,732	7	404.2	917,709	2,211	240.9	1,911,399	4,187	219.0
1905	1,941	8	412.2	930,088	2,195	236.0	1,939,287	4,081	210.4
1906	2,279	11	482.7	954,510	2,156	225.9	1,983,662	3,948	199.0
1907	2,067	10	483.8	978,932	2,336	238.6	2,028,037	4,152	204.7
1908	1,952	15	768.4	1,003,354	2,207	220.0	2,072,412	3,883	187.4
1909	2,028	9	443.8	1,027,776	2,127	207.0	2,116,787	3,852	182.0
1910	1,894	14	739.2	1,052,198	2,252	214.0	2,161,163	3,978	184.1
1911	2,041	14	685.9	1,072,627	2,233	208.2	2,199,045	3,887	176.8
1912	1,890	20	1,058.2	1,093,056	2,128	194.7	2,236,927	3,713	166.0
1913	1,826	22	1,204.8	1,113,485	2,220	199.3	2,274,809	3,670	161.3
1914	1,782	20	1,122.3	1,133,914	2,275	200.6	2,312,691	3,716	160.7
1915	1,792	13	725.4	1,154,343	2,201	190.7	2,350,571	3,693	157.1
1916	1,840	23	1,250.0	1,174,772	2,460	209.4	2,388,453	3,998	167.4
1917	1,804	16	886.9	1,195,201	2,500	209.2	2,426,335	4,086	168.4
1918 [1]	1,988	21	1,056.3	.....	.....	.....	.....	.....	.....
1896–1899	3,933	19	483.1	3,280,032	9,371	285.7	6,822,974	18,162	266.2
1900–1904	7,388	40	541.4	4,464,775	10,980	245.9	9,278,125	20,857	224.8
1905–1909	10,267	53	516.2	4,894,660	11,021	225.2	10,140,185	19,916	196.4
1910–1914	9,433	90	954.0	5,465,280	11,108	203.2	11,184,635	18,964	169.6
1915–1918 [1]	7,424	73	983.3	[2] 3,524,316	[2] 7,161	[2] 203.2	[2] 7,165,359	[2] 11,777	[2] 164.4

[1] Exclusive of last three months of 1918. [2] 1915–1917.

Table 12 shows the corresponding data for Maine and New Hampshire and for the New England States combined.

TABLE 12.—MORTALITY FROM PULMONARY TUBERCULOSIS AMONG THE GRANITE CUTTERS OF MAINE AND NEW HAMPSHIRE AND OF THE NEW ENGLAND STATES COMPARED WITH THAT OF THE GENERAL ADULT POPULATION OF THE SAME STATES, 1896 TO 1918.

[Data for granite cutters taken from experience of the Granite Cutters' International Association of America.]

MAINE AND NEW HAMPSHIRE.

Year or period.	Granite cutters.			General population (20 years of age and over).		
	Number exposed.	Deaths.	Death rate per 100,000.	Population.	Deaths.	Death rate per 100,000.
1896	1,033	5	484.0	692,379	1,526	220.4
1897	1,054	3	284.6	697,517	1,533	219.8
1898	979	4	408.6	702,656	1,373	195.4
1899	894	5	559.2	707,794	1,371	193.7
1900	1,224	7	571.9	712,934	1,404	196.9
1901	1,627	4	245.8	717,051	1,414	197.2
1902	1,887	8	423.9	721,169	1,305	181.5
1903	1,556	9	578.4	725,287	1,220	168.2
1904	1,896	11	580.2	729,404	1,369	187.7
1905	1,864	13	697.4	733,521	1,236	168.5
1906	1,951	11	563.8	737,639	1,210	164.0
1907	1,718	7	407.4	741,757	1,210	163.1
1908	1,809	13	718.6	745,874	1,171	157.0
1909	1,930	5	259.1	749,991	1,110	148.0
1910	1,968	15	762.2	754,110	1,201	159.3
1911	1,798	9	500.5	758,228	1,111	146.5
1912	1,609	9	559.9	762,345	1,015	133.1
1913	1,375	19	1,381.6	766,462	1,023	133.5
1914	1,557	11	706.5	770,580	999	129.6
1915	1,382	9	651.2	774,698	1,039	134.1
1916	1,317	13	987.0	778,815	1,005	129.0
1917	1,257	18	1,432.0	782,932	967	123.5
1918 [1]	1,187	17	1,432.2	.....	.....	.....
1896–1899	3,960	17	429.3	2,800,346	5,803	207.2
1900–1904	8,190	39	476.2	3,605,845	6,712	186.1
1905–1909	9,272	49	528.5	3,708,782	5,937	160.1
1910–1914	8,307	63	758.4	3,811,725	5,349	140.3
1915–1918 [1]	5,143	57	1,108.3	[2] 2,336,445	[2] 3,011	[2] 128.9

NEW ENGLAND STATES.

1896	3,747	10	266.9	3,337,474	8,373	250.9
1897	3,918	15	382.8	3,397,264	8,221	242.0
1898	4,046	17	420.2	3,457,056	8,139	235.4
1899	4,029	26	645.3	3,516,846	8,234	234.1
1900	4,758	20	420.3	3,576,638	8,248	230.6
1901	5,300	20	377.4	3,628,786	8,121	223.8
1902	6,166	30	486.5	3,680,935	7,547	205.0
1903	6,251	31	495.9	3,733,083	7,294	195.4
1904	6,842	32	467.7	3,785,232	7,751	204.8
1905	7,202	43	597.1	3,837,381	7,653	199.4
1906	8,049	49	608.8	3,907,419	7,353	188.2
1907	7,569	46	607.7	3,977,457	7,715	194.0
1908	7,316	56	765.4	4,047,494	7,329	181.1
1909	7,798	38	487.3	4,117,530	7,193	174.7
1910	7,888	59	748.0	4,187,571	7,427	177.4
1911	7,937	54	680.4	4,250,416	7,234	170.2
1912	7,609	49	644.0	4,313,259	6,792	157.5
1913	7,767	74	952.7	4,376,102	6,865	156.9
1914	7,567	75	991.1	4,438,947	6,948	156.5
1915	7,453	61	818.5	4,501,789	6,925	153.8
1916	7,051	84	1,191.3	4,564,633	7,367	161.4
1917	6,662	72	1,080.8	4,627,477	7,472	161.5
1918 [1]	6,605	73	1,105.2	.....	.....	.....
1896–1899	15,740	68	432.0	13,708,640	32,967	240.5
1900–1904	29,317	133	453.7	18,404,674	38,961	211.7
1905–1909	37,934	232	611.6	19,887,281	37,243	187.3
1910–1914	38,768	311	802.2	21,566,295	35,266	163.5
1915–1918 [1]	27,771	290	1,044.3	[2] 13,693,899	[2] 21,764	[2] 158.9

[1] Exclusive of last three months of 1918.

[2] 1915–1917.

This table is self-explanatory and requires no extended consideration, nor has it seemed necessary to correlate similar tables for other stone centers of the United States, but the facts as summarized in Table 13, which gives the death rates of granite cutters for a 23-year period, as based upon the experience of the Granite Cutters' International Association of America, show that, without exception, there was a persistent increase in the rates during the entire period. The districts which exhibit the highest prevailing rates at the present time are Vinal Haven, Hurricane Island, and Mount Waldo, Me.; Hallowell, North Jay, and Portland, Me.; Barre, Vt., and Montpelier, Vt. Lower rates are shown for the granite-cutting districts of the Southern, the Pacific Coast, and the Southwestern States, where, no doubt, much, if not all, of the work of cutting and carving is done outside or in open sheds.

TABLE 13.—MORTALITY FROM PULMONARY TUBERCULOSIS AMONG GRANITE CUTTERS OF THE PRINCIPAL GRANITE-CUTTING CENTERS, 1896 TO 1918, BY PERIODS OF YEARS.

[Experience of the Granite Cutters' International Association of America.]

Place and period.	Nunaber exposed.	Deaths.	Death rate per 100,000.	Place and period.	Number exposed.	Deaths.	Death rate per 100,000.
Vinal Haven, Hurricane Island, and Mount Waldo, Me.:				Boston, Worcester, and Cape Ann, Mass.:			
1896–1903	2,126	15	705.6	1896–1903	1,585	7	441.6
1904–1911	2,842	25	879.7	1904–1911	3,582	16	446.7
1912–1918[1]	884	15	1,696.8	1912–1918[1]	2,601	22	845.8
Hallowell, North Jay, and Portland, Me.:				Providence and Westerly, R. I., and Stony Creek, Conn.:			
1896–1903	2,448	12	490.2	1896–1903	2,838	17	599.0
1904–1911	2,356	26	1,103.6	1904–1911	3,484	23	660.2
1912–1918[1]	1,624	25	1,539.4	1912–1918[1]	3,630	33	909.1
Concord and Milford, N. H.:				Albany and New York, N. Y.:			
1896–1903	1,941	8	412.2	1896–1903	3,731	23	616.4
1904–1911	2,806	12	427.7	1904–1911	3,921	31	790.6
1912–1918[1]	3,044	26	854.1	1912–1918[1]	4,349	41	942.7
Barre, Vt.:				Buffalo, Cleveland, Detroit, and Chicago:			
1896–1903	8,708	36	413.4	1896–1903	714	1	140.1
1904–1911	12,579	118	938.1	1904–1911	1,373	12	873.9
1912–1918[1]	12,141	145	1,194.3	1912–1918[1]	1,796	16	890.9
Montpelier, Vt.:				Philadelphia, Pa.:			
1896–1903	1,723	6	348.2	1896–1903	1,620	7	432.1
1904–1911	3,262	21	643.8	1904–1911	2,061	15	727.8
1912–1918[1]	2,918	30	1,028.1	1912–1918[1]	1,547	12	775.7
Quincy and West Quincy, Mass.:							
1896–1903	4,821	25	518.6				
1904–1911	6,811	37	543.2				
1912–1918[1]	6,101	50	819.5				

[1] Exclusive of influenza-epidemic period.

VALUE OF PROPORTIONATE MORTALITY FIGURES.

The proportionate mortality figures for tuberculosis have not undergone a corresponding change. No satisfactory explanation can be made of this phenomenon without an extended statistical analysis, which for the present purpose would seem not to be called for. For all ages the percentage the deaths from pulmonary tuberculosis are of the mortality from all causes is 44.6 for the period 1906–1918. The proportionate mortality figures are extraordinarily high at ages 25 to 64, for which years nearly one-half of the entire

mortality is due to pulmonary tuberculosis alone. The facts, in detail, are given in Table 14, for the entire United States and Canada, for the State of Vermont alone, and for other sections of the country.

TABLE 14.—PROPORTIONATE MORTALITY FROM PULMONARY TUBERCULOSIS AMONG GRANITE CUTTERS, 1906 TO 1918, BY AGE GROUP AND PERIOD OF YEARS.

[Experience of Granite Cutters' International Association of America.]

UNITED STATES AND CANADA.

Age at death.	1906–1912.			1913–1918.[1]			1906–1918.[1]		
	Deaths from all causes.	Deaths from pulmonary tuberculosis.		Deaths from all causes.	Deaths from pulmonary tuberculosis.		Deaths from all causes.	Deaths from pulmonary tuberculosis.	
		Number.	Per cent of deaths from all causes.		Number.	Per cent of deaths from all causes.		Number.	Per cent of deaths from all causes.
20 to 24 years	35	7	20.0	11	2	18.2	46	9	19.6
25 to 29 years	57	30	52.6	34	13	38.3	91	43	47.3
30 to 34 years	72	34	47.2	63	31	49.2	135	65	48.2
35 to 39 years	122	56	45.9	107	52	48.6	229	108	47.2
40 to 44 years	152	75	49.4	152	94	61.8	304	169	55.6
45 to 49 years	136	75	55.2	183	103	56.3	319	178	55.8
50 to 54 years	149	78	52.4	194	92	47.4	343	170	49.6
55 to 59 years	116	42	36.2	131	64	48.9	247	106	42.9
60 to 64 years	96	33	34.4	127	55	43.3	223	88	39.5
65 to 69 years	64	15	23.4	95	25	26.3	159	40	25.2
70 to 74 years	27	4	14.8	45	10	22.2	72	14	19.4
75 to 79 years	14	.....	.....	17	1	5.9	31	1	3.2
80 years and over	10	.....	.....	12	.....	.....	22	.....	.....
Total	1,050	449	42.8	1,171	542	46.3	2,221	991	44.6

VERMONT.

20 to 24 years	12	4	33.3	2	.....	.....	14	4	28.6
25 to 29 years	23	15	65.2	16	11	68.8	39	26	66.7
30 to 34 years	21	8	38.1	20	12	60.0	41	20	48.8
35 to 39 years	45	25	55.6	43	23	53.5	88	48	54.5
40 to 44 years	51	27	52.9	63	40	63.5	114	67	58.8
45 to 49 years	41	24	58.5	71	51	71.8	112	75	67.0
50 to 54 years	41	30	73.2	50	29	58.0	91	59	64.8
55 to 59 years	24	11	45.8	39	23	59.0	63	34	54.0
60 to 64 years	13	8	61.5	17	6	35.3	30	14	46.7
65 to 69 years	5	1	20.0	10	3	30.0	15	4	26.7
70 to 74 years	2	.....	.....	3	.....	.....	5	.....	.....
75 to 79 years	1	.....	.....	.....	.....	.....	1	.....	.....
80 years and over	.....	.....	.....	.....	.....	.....	.....	.....	.....
Total	279	153	54.8	334	198	59.3	613	351	57.3

MASSACHUSETTS, CONNECTICUT, AND RHODE ISLAND.

20 to 24 years	3	1	33.3	1	.....	.....	4	1	25.0
25 to 29 years	14	7	50.0	6	2	33.3	20	9	45.0
30 to 34 years	11	6	54.5	18	8	44.4	29	14	48.3
35 to 39 years	38	13	34.2	19	10	52.6	57	23	40.4
40 to 44 years	28	15	53.6	23	17	73.9	51	32	62.7
45 to 49 years	38	21	55.3	42	23	54.8	80	44	55.0
50 to 54 years	37	13	35.1	53	24	45.3	90	37	41.1
55 to 59 years	43	18	41.9	41	21	51.2	84	39	46.4
60 to 64 years	30	11	36.7	42	18	42.8	72	29	40.3
65 to 69 years	33	7	21.2	40	10	25.0	73	17	23.3
70 to 74 years	14	4	28.5	22	5	22.7	36	9	25.0
75 to 79 years	3	.....	.....	6	.....	.....	9	.....	.....
80 years and over	5	.....	.....	5	.....	.....	10	.....	.....
Total	297	116	39.1	318	138	43.4	615	254	41.3

[1] Exclusive of last quarter of 1918.

TABLE 14.—PROPORTIONATE MORTALITY FROM PULMONARY TUBERCULOSIS AMONG GRANITE CUTTERS, 1906 TO 1918, BY AGE AND GROUP PERIOD OF YEARS—Con.

MAINE AND NEW HAMPSHIRE.

Age at death.	1906–1912			1913–1918			1906–1918		
	Deaths from all causes.	Deaths from pulmonary tuberculosis.		Deaths from all causes.	Deaths from pulmonary tuberculosis.		Deaths from all causes.	Deaths from pulmonary tuberculosis.	
		Number.	Per cent of deaths from all causes.		Number.	Per cent of deaths from all causes.		Number.	Per cent of deaths from all causes.
20 to 24 years	3	.....	.....	1	1	100.0	4	1	25.0
25 to 29 years	7	4	57.1	1	.....	.....	8	4	50.0
30 to 34 years	8	6	75.0	5	4	80.0	13	10	76.9
35 to 39 years	10	4	40.0	8	5	62.5	18	9	50.0
40 to 44 years	19	10	52.6	14	8	57.1	33	18	54.5
45 to 49 years	21	13	61.9	17	9	52.9	38	22	57.9
50 to 54 years	24	10	41.7	33	18	54.5	57	28	49.1
55 to 59 years	20	5	25.0	20	10	50.0	40	15	37.5
60 to 64 years	19	8	42.1	18	10	55.6	37	18	48.6
65 to 69 years	12	4	33.3	12	6	50.0	24	10	41.7
70 to 74 years	6	1	16.6	8	3	37.5	14	4	28.6
75 to 79 years	2	.....	.....	2	.....	.....	4	.....	.....
80 years and over	2	.....	.....	.....	.....	.....	2	.....	.....
Total	153	65	42.5	139	74	53.2	292	139	47.6

On the whole there is a remarkable consistency, confirming the mortality figures based on the exposure to risk and exhibiting the highest proportionate death rates for the State of Vermont, where, for the period 1906–1918, 57.3 per cent of the deaths from all causes were due to pulmonary tuberculosis alone. The highest proportionate mortality figures occurred at ages 45 to 49, being 67.0 per cent of the deaths from all causes. For Massachusetts, Connecticut, and Rhode Island the corresponding proportion—for ages 40 to 44 years—was 62.7, which would seem not to require additional evidence to sustain the conclusion, previously advanced, that the present mortality problems of the stone industry are such as to call most urgently for qualified public consideration.

OCCUPATIONAL MORTALITY IN THE GRANITE INDUSTRY.

In the foregoing observations the mortality experience of the Granite Cutters' International Association of America has been considered without reference to particular employments. In Table 15, however, an analysis is presented of the principal occupations, and, while the facts for other employments than cutting are relatively limited, they are entirely conclusive. Taking the period of 1905–1918 as a convenient basis of comparison, it is shown by Table 15 that the death rate of granite cutters in the districts of Barre, Vt., and Quincy, Mass., combined was 949.6 per 100,000, in contrast to a rate of 339.4 for tool sharpeners, 254.4 for lumpers, boxers, and derrick men, and 187.6 for polishers. These results strikingly confirm the conclusions, based upon general observations, that the excess in the death rate bears primarily, if not exclusively, upon the granite cutters and carvers, or those who make use of pneumatic tools.

TABLE 15.—MORTALITY FROM PULMONARY TUBERCULOSIS AMONG THE GRANITE CUTTERS OF BARRE, VT., AND QUINCY, MASS., COMPARED WITH THAT OF TOOL SHARPENERS, LUMPERS, BOXERS, DERRICK MEN, AND GRANITE POLISHERS, 1896 to 1918.

Year or period.	Granite cutters.[1]			Tool sharpeners.[2]			Lumpers, boxers,[3] and derrick men.			Granite polishers.[1]		
	Number exposed.	Deaths.	Death rate per 100,000.	Number exposed.	Deaths.	Death rate per 100,000.	Number exposed.	Deaths.	Death rate per 100,000.	Number exposed.	Deaths.	Death rate per 100,000.
1896	1,339	3	224.0	108	.....	.....	.....	.....	.....	.....	.....	.....
1897	1,325	6	452.8	122	.....	.....	.....	.....	.....	.....	.....	.....
1898	1,570	7	445.8	148	.....	.....	.....	.....	.....	.....	.....	.....
1899	1,679	6	357.4	147	1	.....	.....	.....	.....	.....	.....	.....
1900	1,887	7	371.0	98	.....	.....	.....	.....	.....	.....	.....	.....
1901	1,836	10	544.7	190	1	.....	.....	.....	.....	.....	.....	.....
1902	1,931	12	621.4	189	.....	.....	.....	.....	.....	.....	.....	.....
1903	1,962	10	509.7	192	.....	.....	.....	.....	.....	.....	.....	.....
1904	1,932	11	569.4	224	1	.....	.....	.....	.....	.....	.....	.....
1905	2,252	19	843.6	244	2	.....	229	.....	.....	106	.....	.....
1906	2,309	17	736.2	263	.....	.....	246	1	.....	126	.....	.....
1907	2,568	18	702.3	301	2	.....	263	.....	.....	197	.....	.....
1908	2,487	24	965.0	292	1	.....	281	1	.....	219	.....	.....
1909	2,574	16	621.6	284	1	.....	296	2	.....	195	.....	.....
1910	2,555	27	1,056.8	278	1	.....	291	2	.....	194	1	.....
1911	2,718	23	846.2	239	.....	.....	211	.....	.....	232	1	.....
1912	2,562	20	780.6	231	2	.....	289	.....	.....	250	.....	.....
1913	2,605	25	959.7	235	.....	.....	314	1	.....	257	1	.....
1914	2,666	31	1,162.8	210	.....	.....	344	1	.....	273	2	.....
1915	2,885	30	1,039.9	183	1	.....	312	.....	.....	272	.....	.....
1916	2,677	35	1,307.4	169	.....	.....	280	1	.....	298	1	.....
1917	2,482	28	1,128.1	162	.....	.....	281	1	.....	295	.....	.....
1918[4]	2,365	26	1,099.4	150	1	.....	294	.....	.....	284	.....	.....
1896–1899	5,913	22	372.1	525	1	.....	.....	.....	.....	.....	.....	.....
1900–1904	9,548	50	523.7	893	2	.....	.....	.....	.....	.....	.....	.....
1905–1909	12,185	94	771.4	1,384	6	.....	1,315	4	.....	843	.....	.....
1910–1914	13,106	126	961.4	1,193	3	.....	1,449	4	.....	1,206	5	.....
1915–1918[4]	10,409	119	1,143.2	664	2	.....	1,167	2	.....	1,149	1	.....
1905–1918[4]	35,700	339	949.6	3,241	11	339.4	3,931	10	254.4	3,198	6	187.6

[1] Barre, Vt., and Quincy, Mass.
[2] Quincy, Mass., Westerly, R. I., Barre and Hardwick, Vt.
[3] Barre, Vt.
[4] Exclusive of last three months of 1918.

Similar results have been observed elsewhere. In Table 16 the mortality from pulmonary tuberculosis among the granite workers of the Barre and Quincy districts is compared with the corresponding mortality in the Derbyshire district of England, reported upon by Dr. Sidney Barwise in a notable report on the Prevalence of Phthisis Among Quarry Workers and Miners to the Derbyshire County Council, February 6, 1913.

TABLE 16.—MORTALITY FROM PULMONARY TUBERCULOSIS AMONG THE GRANITE WORKERS OF BARRE, VT., AND QUINCY, MASS., COMPARED WITH THAT AMONG SPECIFIED STONE WORKERS, COAL MINERS, AND AGRICULTURISTS IN DERBYSHIRE COUNTY, ENGLAND.

Occupation.	Death rate per 100,000.
BARRE, VT., AND QUINCY, MASS.—1905–1918.[1]	
Standard pulmonary tuberculosis death rate[2]	**173.5**
Granite cutters	949.6
Tool sharpeners	339.4
Lumpers, boxers, and derrick men	254.4
Granite polishers	187.6
DERBYSHIRE COUNTY, ENGLAND—1901–1910.	
Standard phthisis death rate[3]	**77.0**
Gritstone workers	1,370.0
The two Matlocks and the two Darleys, stone workers (some in limestone)	700.0
Bakewell registration district, gritstone and limestone works	500.0
Persons employed in and about limestone quarries and works	171.0
Limestone workers	152.0
Persons employed in and about coal mines	68.0
Persons employed in agriculture	66.0

[1] Exclusive of influenza-epidemic period.
[2] General population of Vermont and Massachusetts (20 years of age and over).
[3] The phthisis rate for England and Wales is below the American rate because of the high mortality from acute and chronic bronchitis, which is eight to ten times more common than in this country.

MORTALITY FROM ALL CAUSES.

To facilitate a broader study of the subject, but without enlarging unduly upon matters of detail, Table 17 is included to illustrate the mortality from various causes, limited to the granite cutters of New England, as compared with the male population of Massachusetts, 20 to 69 years of age, inclusive.

TABLE 17.—MORTALITY FROM SPECIFIED CAUSES (ABRIDGED INTERNATIONAL LIST) AMONG THE GRANITE CUTTERS OF NEW ENGLAND COMPARED WITH THAT OF THE MALE POPULATION OF MASSACHUSETTS, 20 TO 69 YEARS OF AGE, 1913 TO 1917.

Abridged international list number.[1]	Cause of death.	Granite cutters of New England.		Males of Massachusetts, 20 to 69 years of age.	
		Number of deaths.	Death rate per 100,000.	Number of deaths.	Death rate per 100,000.
1	Typhoid fever	2	5.5	541	9.8
2	Typhus fever	.....	.....	.....	.....
3	Malaria	.....	.....	10	.2
4	Smallpox	.....	.....	9	.2
5	Measles	1	2.7	16	.3
6	Scarlet fever	1	2.7	35	.6
7	Whooping cough	.....	.....	1	.....
8	Diphtheria and croup	.....	.....	53	1.0
9	Influenza	3	8.2	240	4.3
10	Asiatic cholera	.....	.....	.....	.....
11	Cholera nostras	.....	.....	1	.....
12	Other epidemic diseases	.....	.....	409	7.4
13	Tuberculosis of the lungs	366	1,002.7	11,533	208.4
14	Tuberculous meningitis	3	8.2	165	3.0
15	Other forms of tuberculosis	3	8.2	529	9.6
16	Cancer and other malignant tumors	23	63.0	4,875	88.1
17	Simple meningitis	2	5.5	155	2.8
18	Cerebral hemorrhage and softening	15	41.1	4,229	76.4
19	Organic diseases of the heart	64	175.3	9,226	166.7
20	Acute bronchitis	9	24.6	87	1.6
21	Chronic bronchitis	7	19.2	265	4.8
22	Pneumonia	59	161.6	5,963	107.8
23	Other diseases of the respiratory system (tuberculosis excepted)	23	63.0	1,740	31.4
24	Diseases of the stomach (cancer excepted)	.....	.....	717	13.0
26	Appendicitis and typhlitis	6	16.4	688	12.4
27	Hernia, intestinal obstruction	.....	.....	488	8.8
28	Cirrhosis of the liver	.....	.....	871	15.7
29	Acute nephritis and Bright's disease	20	54.8	6,031	109.0
34	Senility	.....	.....	36	.6
35	Violent deaths (suicide excepted)	7	19.2	6,777	122.5
36	Suicide	20	54.8	1,628	29.4
37	Other defined diseases	72	197.3	13,470	243.4
38	Diseases ill defined or unknown	4	11.0	272	4.9
	All causes	710	[2] 19.4	71,060	12.8

[1] Manual of the International List of Causes of Death, United States Bureau of the Census, Washington, D. C., 1916.
[2] Death rate per 1,000.

Table 18 illustrates the mortality changes in the accumulated experience of the Granite Cutters' International Association of America, but limited to the New England States, and the principal causes of death, emphasizing an increasing death rate not only from pulmonary tuberculosis but also from pneumonia, bronchitis, asthma, heart disease, and cancer. It also shows the comparative death rate for the Massachusetts adult population, indicating throughout for tubercular and respiratory diseases a diminishing mortality, in contrast to an increasing death rate among the granite cutters of the New England States. This table, clearly sustains the conclusion

that the factors which make for a lower respiratory mortality among the general population are offset by the decidedly health-injurious conditions affecting the lives of persons employed in the granite-cutting industry.

TABLE 18.—MORTALITY FROM SPECIFIED CAUSES AMONG THE GRANITE CUTTERS OF NEW ENGLAND COMPARED WITH THAT OF THE MALE POPULATION OF MASSACHUSETTS, 20 TO 69 YEARS OF AGE, 1896 TO 1918, BY PERIOD.

Period.	Granite cutters of New England.		Male population of Massachusetts, 20 to 69 years of age.	
	Number of deaths.	Death rate per 100,000.	Number of deaths.	Death rate per 100,000.
	Tuberculosis of the lungs. (28)[1]			
1896–1899	68	432.0	.....	.....
1900–1904	133	453.7	10,592	247.4
1905–1909	232	611.6	10,653	225.0
1910–1914	311	802.2	10,805	204.5
1915–1918[2]	290	1,044.3	[2] 6,997	[3] 207.0
	Pneumonia. (92)[1]			
1896–1899	12	76.2	.....	.....
1900–1904	29	98.9	5,568	130.1
1905–1909	32	84.4	5,570	117.6
1910–1914	49	126.4	5,870	111.1
1915–1918[2]	56	201.6	3,805	[3] 112.6
	Bronchitis. (89, 90)[1]			
1896–1899	3	19.1	.....	.....
1900–1904	3	10.2	718	16.8
1905–1909	7	18.5	570	12.0
1910–1914	13	33.5	467	8.8
1915–1918[2]	12	43.2	187	[3] 5.5
	Asthma. (96)[1]			
1896–1899	1	6.4	.....	.....
1900–1904	5	17.1	332	7.8
1905–1909	3	7.9	233	4.9
1910–1914	10	25.8	113	2.1
1915–1918[2]	7	25.2	64	[3] 1.9
	Organic diseases of the heart. (79)[1]			
1896–1899	6	38.1	.....	.....
1900–1904	23	78.5	5,979	139.7
1905–1909	56	147.6	6,609	139.6
1910–1914	59	152.2	7,128	134.9
1915–1918[2]	55	198.0	5,894	[3] 174.4
	Cancer and other malignant tumors. (39–45)[1]			
1896–1899	3	19.1	.....	.....
1900–1904	4	13.6	2,629	61.4
1905–1909	11	29.0	3,348	70.7
1910–1914	24	61.9	4,141	78.4
1915–1918[2]	17	61.2	3,057	90.4

[1] The numbers in parentheses refer to the international list numbers. See Manual of the International List of Causes of Death, United States Bureau of the Census, Washington, D. C., 1916.
[2] Exclusive of influenza-epidemic period.
[3] 1915–1917.

MORTALITY BY SINGLE YEARS OF LIFE.

To make the foregoing analysis as complete as possible Table 19 has been included, which exhibits the mortality among the granite cutters by single years of life from pulmonary tuberculosis, from nontuberculous respiratory diseases, from all other causes, and from all causes combined. According to this table the maximum age attained in a total of 2,221 deaths was 87 years. The average age at death from pulmonary tuberculosis was 47.4 years, from nontuberculous respiratory diseases 51.9 years, from all other causes 50.9 years, and from all causes combined, 49.5 years. The corresponding average ages at death of the adult white male population of the United States registration area were 41 years for pulmonary tuberculosis, 57.5 years for tuberculous respiratory diseases, 58.9 years for all other causes, and 56.6 years for all causes combined. It is therefore shown that death from pulmonary tuberculosis among granite cutters occurs on the average about six years later than among the normal male population, while from all causes combined granite cutters die about seven years earlier.

TABLE 19.—MORTALITY FROM PULMONARY TUBERCULOSIS, NONTUBERCULOUS RESPIRATORY DISEASES, AND ALL CAUSES AMONG THE GRANITE CUTTERS OF THE UNITED STATES AND CANADA, 1906 TO 1918,[1] BY AGE AT DEATH.

[Experience of the Granite Cutters' International Association of America.]

Age at death.	Deaths from pulmonary tubercu-losis.	Deaths from non-tuberculous respiratory diseases.	Deaths from all other causes.	Deaths from all causes.
20 years	.....	.....	2	2
21 years	1	1	7	9
22 years	1	2	11	14
23 years	5	1	3	9
24 years	2	.....	10	12
25 years	4	1	8	13
26 years	9	3	9	21
27 years	10	1	10	21
28 years	11	1	6	18
29 years	9	4	5	18
30 years	13	2	8	23
31 years	12	.....	11	23
32 years	12	4	12	28
33 years	17	2	9	28
34 years	11	3	19	33
35 years	20	5	14	39
36 years	23	7	23	53
37 years	21	4	17	42
38 years	23	8	21	52
39 years	21	4	18	43
40 years	38	8	22	68
41 years	23	1	12	36
42 years	38	10	22	70
43 years	33	8	19	60
44 years	37	10	23	70
45 years	39	5	21	65
46 years	36	5	22	63
47 years	30	7	27	64
48 years	37	5	25	67
49 years	36	4	20	60
50 years	38	3	37	78
51 years	28	5	21	54
52 years	40	9	27	76
53 years	28	10	25	63
54 years	36	7	29	72
55 years	25	7	18	50
56 years	20	3	23	46
57 years	27	5	19	51
58 years	19	9	20	48
59 years	15	3	34	52
60 years	14	6	19	39
61 years	20	9	24	53
62 years	22	7	19	48
63 years	20	4	17	41
64 years	12	5	25	42
65 years	7	5	18	30
66 years	11	9	11	31
67 years	9	10	23	42

[1] Exclusive of last three months of 1918.

TABLE 19.—MORTALITY FROM PULMONARY TUBERCULOSIS, NONTUBERCULOUS RESPIRATORY DISEASES, AND ALL CAUSES AMONG THE GRANITE CUTTERS OF THE UNITED STATES AND CANADA, 1906 TO 1918, BY AGE AT DEATH—Concluded.

[Experience of the Granite Cutters' International Association of America.]

Age at death.	Deaths from pulmonary tuberculosis.	Deaths from nontuberculous respiratory diseases.	Deaths from all other causes.	Deaths from all causes.
68 years	6	5	18	29
69 years	7	5	15	27
70 years	4	4	13	21
71 years	4	2	4	10
72 years	3	3	11	17
73 years	1	2	13	16
74 years	2	.....	6	8
75 years	.....	3	3	6
76 years	1	2	5	8
77 years	.....	.....	4	4
78 years	.....	1	6	7
79 years	.....	.....	6	6
80 years	.....	1	4	5
81 years	.....	1	3	4
82 years	.....	1	3	4
83 years	.....	.....	1	1
84 years	.....	.....	.....	.....
85 years	.....	2	5	7
86 years	.....	.....	.....	.....
87 years	.....	.....	1	1
Total	991	264	966	2,221
Average age at death	47.4	51.9	50.9	49.5
Proportionate mortality	44.6	11.9	43.5	100.0
WHITE MALES, UNITED STATES REGISTRATION AREA (20 YEARS OF AGE AND OVER).				
Average age at death	41.0	57.5	58.9	56.6

TUBERCULOUS AND NONTUBERCULOUS LUNG DISEASES.

The general death rate at all ages of granite cutters in the State of Vermont during the period 1911–1917 was 20.11 per 1,000, but from pulmonary tuberculosis alone the rate was 11.84 and from nontuberculous respiratory diseases 2.76. The excess in the pulmonary tuberculosis mortality falls, however, with divergent degrees of severity upon different age periods, as clearly shown in Table 20.

TABLE 20.—MORTALITY FROM PULMONARY TUBERCULOSIS, NONTUBERCULOUS RESPIRATORY DISEASES, AND ALL CAUSES AMONG THE GRANITE CUTTERS OF BARRE, VT., BY AGE GROUPS, 1911 TO 1917.

[Experience of the Granite Cutters' International Association of America.]

Age at death.	Number exposed.	Pulmonary tuberculosis.		Nontuberculous respiratory diseases.		All causes.	
		Deaths.	Death rate per 1,000.	Deaths.	Death rate per 1,000.	Deaths.	Death rate per 1,000.
15 to 19 years	302	.....	.....	.....	.....	.....	.....
20 to 24 years	1,015	.....	.....	.....	.....	2	1.97
25 to 29 years	1,490	10	6.71	.....	.....	12	8.05
30 to 34 years	2,083	4	1.92	2	0.96	11	5.28
35 to 39 years	2,441	13	5.32	5	2.05	23	9.42
40 to 44 years	1,997	30	15.02	5	2.50	44	22.03
45 to 49 years	1,566	30	19.16	6	3.83	53	33.84
50 to 54 years	918	29	31.59	5	5.45	40	43.57
55 to 59 years	345	20	57.97	5	14.49	36	104.35
60 to 64 years	109	8	73.39	4	36.70	17	155.96
65 years and over	64	2	31.25	2	31.25	10	156.25
Total	12,330	146	11.84	34	2.76	248	20.11

The table emphasizes the comparatively late onset of tuberculosis among granite cutters. The death rate does not assume serious proportions until ages 40 years and over. The nontuberculous respiratory diseases are of comparatively small importance for ages under 55.

Comparing the mortality from nontuberculous respiratory diseases among the granite cutters of Barre, Vt., with that of the male population of Massachusetts for 1911 to 1917, it is shown in Table 21 that the death rate per 100,000 for the granite cutters was 275.8, while for the adult male population of Massachusetts it was only 179.5. The death rate from these diseases for granite cutters over 60 years of age is exceedingly high—3,468.2 per 100,000.

TABLE 21.—MORTALITY FROM NONTUBERCULOUS RESPIRATORY DISEASES AMONG THE GRANITE CUTTERS OF BARRE, VT., COMPARED WITH THAT OF THE MALE POPULATION OF MASSACHUSETTS, 1911–1917, BY AGE GROUPS.

[Data for granite cutters taken from experience of the Granite Cutters' International Association of America.]

Age at death.	Granite cutters of Barre, Vt.			Male population of Massachusetts.		
	Number exposed.	Deaths.	Death rate per 100,000.	Population.	Deaths.	Death rate per 100,000.
15 to 29 years	2,807	.....	.....	3,427,123	1,287	37.6
30 to 39 years	4,524	7	154.7	2,017,626	1,794	88.9
40 to 49 years	3,563	11	308.7	1,600,792	2,458	153.5
50 to 59 years	1,263	10	791.8	1,054,755	2,780	263.6
60 years and over	173	6	3,468.2	907,713	7,850	864.8
Total	12,330	34	275.8	9,008,009	16,169	179.5
Standardized rates[1]	.....	.....	275.8	.....	.....	124.6

[1] Standardization based on the age distribution of the granite cutters of Barre, Vt., 1911–1917.

COMPARATIVE OCCUPATIONAL MORTALITY.

When the mortality rates at all ages for granite cutters are compared with other occupations involving a considerable health hazard the contrast is quite striking. It will suffice for the present purpose to utilize the standard occupational mortality figures for England and Wales for the period 1900–1902, no later data having been published. The death rate for granite cutters at Barre, Vt., from pulmonary tuberculosis was 11.84 per 1,000 exposed, for English tin miners 7.80, for tool and cutlery makers 3.76, and for potters 2.72. Yet all of the three trades referred to for purposes of comparison are recognized as distinctly injurious to health, though none approach the excessive death rates for granite cutters in the Barre district. This excess is not maintained in a comparison of the mortality from nontuberculous respiratory diseases in the different occupations. In general, for all of the three occupations the rates for these diseases are higher than those for granite cutters. The nontuberculous death rate for the granite cutters of Barre, Vt., was 2.76 per 1,000 exposed. This compares with a rate of 8.22 for tin miners, 4.31 for potters, and 3.61 for tool and cutlery makers. All crude death rates are, however, in a measure misleading, and the true state of facts is only

shown with accuracy by an analysis of the mortality for divisional periods of life. The importance of this is particularly emphasized in considering the crude death rate for all causes, for while the death rate of granite cutters was 20.11 per 1,000 it was 25.25 for tin miners, 16.94 for tool and cutlery makers, and 14.50 for potters. The facts in detail are shown in Table 22:

TABLE 22.—MORTALITY FROM PULMONARY TUBERCULOSIS, NONTUBERCULOUS RESPIRATORY DISEASES, AND ALL CAUSES AMONG THE GRANITE CUTTERS OF BARRE, VT., 1911 TO 1917, COMPARED WITH THAT AMONG TIN MINERS, POTTERS, AND TOOL, INSTRUMENT, AND CUTLERY MAKERS IN ENGLAND AND WALES, 1900 TO 1902, BY AGE GROUPS.

Age at death.	Death rate per 1,000.			
		England and Wales.		
	Granite cutters of Barre, Vt. (1911–1917).	Tin miners (1900–1902).	Potters (1900–1902).	Tool, instrument, and cutlery makers (1900–1902).
	Pulmonary tuberculosis.			
15 to 19 years	.....	0.25	0.62	0.17
20 to 24 years	.....	1.73	1.34	1.57
25 to 34 years	3.91	7.04	2.00	2.94
35 to 44 years	9.69	11.84	3.79	5.90
45 to 54 years	23.75	16.81	7.14	7.13
55 to 64 years	61.67	17.11	4.37	5.26
65 years and over	31.25	18.21	.97	1.97
Total	11.84	7.80	2.72	3.76
	Nontuberculous respiratory diseases.			
15 to 19 years	.....	0.25	0.46	0.23
20 to 24 years	.....	.69	.58	.56
25 to 34 years	0.56	3.52	.64	1.14
35 to 44 years	2.25	10.69	3.29	2.01
45 to 54 years	4.43	12.14	10.78	5.40
55 to 64 years	19.82	26.04	23.10	10.42
65 years and over	31.25	71.04	35.04	25.46
Total	2.76	8.22	4.31	3.61
	All causes.			
15 to 19 years	.....	1.49	2.62	2.09
20 to 24 years	1.97	5.53	3.68	3.32
25 to 34 years	6.44	13.41	5.26	6.32
35 to 44 years	15.10	27.15	14.52	13.65
45 to 54 years	37.44	38.75	31.64	25.97
55 to 64 years	116.74	72.17	54.15	42.05
65 years and over	156.25	222.22	118.25	100.65
Total	20.11	25.25	14.50	16.94

According to this table pulmonary tuberculosis does not assume serious proportions until about the age 35, but beginning with age 45 and to the end of life the rates for granite cutters are decidedly in excess of those for other dusty trades, and, of course, very much more so than those for occupations not involving health-injurious dust exposure.

The foregoing observations would seem to justify the conclusion that the granite-cutters' trade is not only inherently injurious to

health, but decidedly more so, as regards its specific liability to pulmonary tuberculosis, than the corresponding employments in tin mining, potteries, and tool and cutlery making.

There is nothing in the climate of New England or of the State of Vermont which is suggestive of a predisposition to an excessive death rate from pulmonary tuberculosis or from nontuberculous respiratory diseases. An analysis of the mortality by months and seasons shows that the death rate of granite cutters conforms in its fluctuations to the standard for the male population of the State of Massachusetts. The season showing the highest death rates is January to March, while the lowest death rates are experienced in July to September. The mortality by months and seasons is shown in Table 23.

TABLE 23.—MORTALITY FROM PULMONARY TUBERCULOSIS AMONG THE GRANITE CUTTERS OF NEW ENGLAND COMPARED WITH THAT OF THE MALE POPULATION OF MASSACHUSETTS, 1908–1918, BY MONTHS AND QUARTERS.

Month or quarter.	Granite cutters of New England.		Males of Massachusetts (all ages).	
	Deaths.[1]	Annual death rate per 100,000.	Deaths.[2]	Annual death rate per 100,000.
January	67	1,081.5	2,236	154.9
February	55	887.8	2,295	159.0
March	62	1,000.8	2,535	175.6
April	60	968.5	2,408	166.8
May	60	968.5	2,345	162.4
June	56	904.0	1,994	138.1
July	51	823.2	1,970	136.5
August	42	678.0	1,921	133.1
September	42	678.0	1,730	119.8
October	47	758.7	1,817	125.9
November	53	855.5	1,792	124.1
December	46	742.5	2,071	143.5
Total	641	862.3	25,114	145.0
January to March	184	990.1	7,066	163.2
April to June	176	947.0	6,747	155.8
July to September	135	726.4	5,621	129.8
October to December	146	785.6	5,680	131.1
Total	641	862.3	25,114	145.0

[1] September, 1908, to August, 1918. [2] January, 1908, to December, 1917.

EFFECT OF THE STONE INDUSTRY ON INFLUENZA MORTALITY.

In all of the general mortality calculations the last three months of 1918, on account of the epidemic of influenza, have been omitted. To make the present investigation as complete as possible, however, Table 24, is included, which not only presents the influenza death rate but also the case attack rate, as ascertained by personal inquiry of every granite cutter in the Barre district. The table is for the period from September, 1918, to April, 1919, inclusive, and shows an annual attack rate from influenza and pneumonia combined of 672.6 per 1,000 exposed to risk at all ages (15 years and over). The attack rate was highest in the age period 25 to 29 years, in which almost every granite cutter was affected by the disease (979.8 per 1,000). The annual death rate for all ages for the period under observation (allowance being made for variations in the length of exposure) was 102.4 per 1,000. It may be questioned whether any other trade suffered an equal mortality of over 10 per cent. The maximum mor-

tality prevailed at ages 30 to 34, when the rate attained to the almost incredible figure of 197.2 per 1,000 per annum, or nearly 20 per cent. In other words, out of 251 granite cutters, ages 30 to 34, exposed to risk for a period of eight months, 33, or 13.1 per cent, died during this interval. At all ages, out of 1,405 cutters exposed to risk 630, or 44.8 per cent, were attacked with the disease during the eight months under observation. The number of deaths from influenza was 33 and from pneumonia 63, and the combined mortality 96, or 6.8 per cent of the cutters exposed to risk. Of the 630 cases of influenza and pneumonia 96 died, equivalent to a case-fatality rate of 15.2 per cent. The highest fatality rate occurred at ages 30 to 34 years, at which 26 per cent died.

TABLE 24.—MORTALITY FROM INFLUENZA, PNEUMONIA,[1] AND PULMONARY TUBERCULOSIS AMONG THE GRANITE CUTTERS OF BARRE, VT., DURING THE EPIDEMIC PERIOD OF 1918-19,[2] BY AGE.

[Experience of the Granite Cutters' International Association of America.]

Age.	Number exposed Sept. 1, 1918.	Cases of influenza and pneumonia.	Annual attack rate (cases per 1,000 exposed).	Number of deaths from—				Annual death rate from influenza and pneumonia per 1,000 exposed.	Case fatality rate (deaths per 100 cases of influenza and pneumonia).
				Pulmonary tuberculosis.	Influenza.	Pneumonia.	Influenza and pneumonia.		
15 to 19 years	36	18	750.0	.....	.....	.....	.....	.....	.....
20 to 24 years	110	56	763.6	.....	3	4	7	95.4	12.5
25 to 29 years	173	113	979.8	.....	5	14	19	164.7	16.8
30 to 34 years	251	127	759.0	1	10	23	33	197.2	26.0
35 to 39 years	268	125	699.6	.....	4	11	15	84.0	12.0
40 to 44 years	226	102	676.9	3	7	6	13	86.2	12.7
45 to 49 years	174	52	448.2	4	3	2	5	43.0	9.6
50 to 54 years	105	25	357.2	3	1	2	3	42.9	12.0
55 to 59 years	42	8	285.8	4	.....	1	1	35.7	12.5
60 years and over	20	4	300.0	.....	.....	.....	.....	.....	.....
Total	1,405	630	672.6	15	33	63	96	102.4	15.2

[1] All forms.
[2] Including the months from September, 1918, to April, 1919, both inclusive.

The mortality from pulmonary tuberculosis during the period under observation was normal. As may be seen from Table 25, there were only 15 deaths during this period, compared with 14 deaths during the corresponding months of 1916-17 and 19 deaths during the same eight months of 1915-16.

TABLE 25.—DEATHS FROM SPECIFIED CAUSES AMONG THE GRANITE CUTTERS OF BARRE, VT., 15 YEARS OF AGE AND OVER, DURING NORMAL PERIODS.

Period.	Number of deaths from—		
	Pulmonary tuberculosis.	Influenza.	Pneumonia.
September, 1912, to April, 1913	12	.....	1
September, 1913, to April, 1914	12	.....	.....
September, 1914, to April, 1915	13	.....	3
September, 1915, to April, 1916	19	.....	2
September, 1916, to April, 1917	14	.....	1

Table No. 26, showing the corresponding figures for telephone employees, while presenting a somewhat different age distribution, is yet sufficiently comparable for the present purpose to emphasize the truly extraordinary incidence of influenza among granite cutters in the year 1918. At all ages the attack rate for granite cutters was 410 per 1,000 exposed, which compares with 155 for telephone employees. The death rate was 54.8 for granite cutters as against only 4.9 for the telephone industry, and the case fatality rate 13.4 per cent for granite cutters as against only 3.2 per cent for telephone employees.

TABLE 26.—MORTALITY FROM INFLUENZA, BRONCHITIS, AND PNEUMONIA[1] AMONG THE GRANITE CUTTERS OF BARRE, VT., COMPARED WITH THAT AMONG THE MALE EMPLOYEES OF THE EASTERN GROUP OF TELEPHONE COMPANIES, BELL SYSTEM, 1918.

[Data for telephone employees, from "Influenza in the eastern group of telephone companies, Bell system," 1918, by Billings and Wynne, in Journal of Industrial Hygiene, vol. 1, No. 10.]

Age.	Annual attack rate (cases per 1,000 exposed).		Annual death rate per 1,000 exposed.		Case fatality rate (deaths per 100 cases).	
	Granite cutters of Barre, Vt.	Telephone employees.	Granite cutters of Barre, Vt.	Telephone employees.	Granite cutters of Barre, Vt.	Telephone employees.
16 to 19 years	436	198	.....	10.1	.....	5.1
20 to 24 years	467	156	50.0	6.0	10.7	3.9
25 to 34 years	518	182	95.0	6.6	18.3	3.6
35 to 44 years	421	133	46.4	3.3	11.0	2.5
45 to 54 years	252	115	26.2	2.6	10.4	2.3
55 to 64 years	194	119	16.1	2.1	8.3	1.8
65 years and over	.....	176	.....	.....	.....	.....
Total	410	155	54.8	4.9	13.4	3.2

[1] Lobar and broncho pneumonia.

An additional comparison is made in Table 27 with bituminous coal miners and the industrial white male experience of the Metropolitan Life Insurance Company for ages 15 to 65, inclusive. The annual death rate from influenza and pneumonia combined was 213.6 for granite cutters, 50.1 for bituminous coal miners, and 22.3 for white males insured on the industrial plan.

TABLE 27.—MORTALITY FROM INFLUENZA AND PNEUMONIA AMONG THE GRANITE CUTTERS OF BARRE, VT., COMPARED WITH THAT AMONG BITUMINOUS COAL MINERS AND ALL OCCUPIED WHITE MALES, GROUP INSURANCE EXPERIENCE, METROPOLITAN LIFE INSURANCE COMPANY, OCTOBER TO DECEMBER, 1918.

[Experience of the Granite Cutters' International Association of America; Statistical Bulletin, Metropolitan Life Insurance Company, vol. 1, No. 1.]

Age.	Annual death rate per 1,000.		
	Granite cutters.[1]	Bituminous coal miners.[2]	All industrial white males.
15 to 25 years	164.4	29.5	17.5
25 to 45 years	270.0	62.1	32.6
45 to 65 years	82.0	44.4	11.7
Total	213.6	50.1	22.3

[1] 75 deaths. [2] 64 deaths.

The foregoing observations clearly indicate an extraordinary lack of disease resistance on the part of an element of the population which by occupational selection would suggest a comparative immunity. It is regrettable that as far as known the subject should not have attracted the attention of qualified observers. It is quite probable, however, that the dust exposure in the industry, with the serious damage done by the dust to the lungs of employees, was in a large measure one of the causative factors explaining the relatively excessive influenza mortality rate and case fatality.

EFFECT OF TRADE LIFE ON MORTALITY.

The epidemic of influenza illustrates an aspect of dust phthisis which seems not to have heretofore received the requisite consideration. In the Barre district the large majority of granite cutters have been at work for many years, and therefore, at the time of the epidemic, they were in a physically damaged condition and peculiarly liable to attack from an essentially respiratory affection, or at least to the resulting complications. It is probably true of dust phthisis, as also of influenza, that long-continued dust exposure results in lung damage, with a resulting liability to most serious consequences at a period of life when, broadly speaking, the normal incidence of pulmonary tuberculosis is of diminishing importance. This fact is brought out by an analysis of the occurrence of tuberculosis among the granite cutters in the Barre, Vt., district according to the duration of trade life. This duration was ascertained by means of an individual examination of the records of the Barre branch of the Granite Cutters' International Association of America, amplified by personal inquiry, illustrated by the blank utilized in the present investigation (see p. 138). The occupational history of the workmen included a statement of the time employed in each occupation and the length of employment in the occupation now followed. As far as the writer knows, a similar extended investigation has never been made for mortality purposes in a single dusty trade. The trade-life inquiry of the New Jersey Bureau of Labor Statistics more than 20 years ago was merely with reference to the length of employment for general purposes and not correlated to mortality. The present investigation embraces the workmen still living, but also covers in detail the years of trade life followed by 399 granite cutters who died from pulmonary tuberculosis during the period 1886 to 1919.

The investigation is limited for the present purpose to pulmonary tuberculosis. It shows, as may be seen from Table 28, that there were no deaths from the disease during the first two years of trade life as granite cutters, and comparatively few deaths during the first eight years of trade experience. But beginning with the ninth year the cases increase until a maximum is reached at the twenty-first year of exposure, which would seem to conform to other observations indicating that it requires about two decades of continuous dust inhalation to produce conditions most favorable to death from pulmonary tuberculosis.[9] If this conjecture is correct, then the comparatively high average age at death from pulmonary tuberculosis previously given as 47.4, or about six years later than in the normal

[9] More accurately, dust phthisis or fibroid lung disease, generally certified as pulmonary tuberculosis.

white male population, would be explained in a satisfactory manner. But there arises the further question as to whether the disease diagnosed as pulmonary tuberculosis is not in very truth a non-tuberculous fibroid form of lung disease. Qualified observations suggest a thorough and impartial medical inquiry conforming to the methods followed by the Miners' Phthisis Prevention Committee of South Africa, but for present purposes it may be asserted without fear of successful contradiction that the health-injurious consequences of dust exposure in granite cutting and quartz mining under normal conditions do not attain the most serious proportions until the workman has been employed at his trade for about 21 years. A new labor element recently introduced into the trade is therefore not likely to show the effect of dust exposure common to the granite-cutting industry when carried on under normal conditions, since the length of injurious trade exposure is insufficient for the purpose.

TABLE 28.—MORTALITY FROM PULMONARY TUBERCULOSIS AMONG THE GRANITE CUTTERS OF BARRE, VT., BY YEARS OF EXPOSURE TO GRANITE DUST AND AGE AT DEATH, 1886 TO 1919.

[Where a dash (—) is used, age at death is not known.]

Exposure to granite dust.	Number of deaths.	Individual deaths, by age of granite cutter at death.
1 year		
2 years		
3 years	2	— —
4 years	4	40 36 — —
5 years	7	68 53 — — — — —
6 years	5	41 28 — — —
7 years	3	— — —
8 years	2	— —
9 years	10	51 47 40 39 31 28 — — — —
10 years	10	51 51 46 45 42 39 33 — — —
11 years	16	61 55 51 42 42 34 28 — — — — — — — — —
12 years	7	47 46 41 37 32 23 —
13 years	11	54 48 48 40 40 37 37 36 — — —
14 years	13	64 55 45 44 39 39 39 38 36 34 32 — —
15 years	16	51 51 49 49 47 46 45 42 40 39 38 38 30 25 — —
16 years	21	59 56 54 53 51 50 48 47 44 43 43 38 37 37 37 36 36 — — — — —
17 years	19	68 62 57 46 46 45 45 43 42 42 35 30 27 24 — — — — —
18 years	17	64 63 60 57 57 56 53 51 51 49 46 45 43 43 42 40 25
19 years	23	65 62 62 61 55 54 53 53 53 51 49 48 47 44 43 41 41 40 40 39 38 37 33 29
20 years	23	72 68 65 62 61 57 56 55 54 49 48 46 45 45 44 42 41 41 40 36 34 30 30
21 years	27	67 62 61 60 58 56 56 52 50 50 49 49 48 47 46 43 42 42 41 40 40 40 37 36 33 30 —
22 years	23	65 64 63 58 56 55 55 54 54 52 50 49 49 49 48 47 46 45 44 42 42 40 —
23 years	25	61 59 58 57 56 53 52 51 50 48 48 47 46 45 44 44 44 44 43 43 41 38 34 33 —
24 years	23	65 63 61 56 55 55 54 53 53 53 52 52 52 52 50 50 50 46 46 43 42 40 35
25 years	16	72 68 56 56 54 52 51 50 49 47 47 47 47 45 44 42
26 years	21	62 62 62 61 61 58 56 53 53 52 52 51 48 48 48 47 46 37 36 — —
27 years	17	64 63 58 58 57 55 55 53 52 51 50 50 48 46 42 41 40
28 years	11	62 60 59 58 57 56 52 51 50 48 45
29 years	12	74 57 57 56 55 54 54 54 50 43 41 —
30 years	7	67 67 54 52 50 42 —
31 years	4	57 57 50 42
32 years	3	60 54 52
33 years	1	64
34 years		
Total	399	

The foregoing observations are further confirmed by a comparison of the experience of the Bendigo quartz miners of Victoria, Australia.[10] Reduced to the same basis, it is shown in Table 29 that during five quinquennial periods the pulmonary tuberculosis death rate of Bendigo miners increased from 485.0 to 1,024.0 per 100,000 exposed to risk. The corresponding increase in the pulmonary tuberculosis death rate of New England granite cutters was from 432.0 to 1,044.3 per 100,000 exposed, showing a strikingly similar change. It would be difficult to find a more conclusive comparison showing clearly that the conditions affecting granite cutters of New England are even more detrimental to life than those affecting the Bendigo miners, who have for many years attracted world-wide attention as a body most liable to health-injurious conditions of work.

TABLE 29.—MORTALITY FROM PULMONARY TUBERCULOSIS AMONG THE GRANITE CUTTERS OF THE NEW ENGLAND STATES, 1896 to 1918, COMPARED WITH THAT OF BENDIGO QUARTZ MINERS, VICTORIA, 1875 TO 1909.

[Rates for granite cutters based on experience of Granite Cutters' International Association of America.]

Chronological comparison.			Comparison based on trade life.		
Period.	Death rate per 100,000.		Trade life by periods.	Death rate per 100,000.	
	Granite cutters of New England.	Bendigo miners.		Granite cutters of New England.	Bendigo miners.
1875–1879	.....	485.0	1	[a] 432.0	485.0
1880–1884	.....	569.0	2	453.7	569.0
1885–1889	.....	800.0	3	611.6	800.0
1890–1894	.....	846.0	4	802.2	846.0
1895–1899	[a] 432.0	1,024.0	5	[b] 1,044.3	1,024.0
1900–1904	453.7	1,008.0	6	.....	1,008.0
1905–1909	611.6	[c] 1,296.0	7	.....	[c] 1,296.0
1910–1914	802.2	.....			
1915–1918	[b] 1,044.3	.....			

[a] 1896–1899.
[b] Exclusive of influenza-epidemic period.
[c] 1905–1906 (six months).

The foregoing information is amplified by Table No. 30, showing the mortality from all causes according to the duration of trade life, and there is further included a correlation table (No. 31), showing the ages and years of dust exposure of living granite cutters in the Barre, Vt., district, numbering 1,137, as ascertained by personal inquiry. According to this table there were no granite cutters at work at an age higher than 74 years, the majority being around the age period 35 to 39 years, the major portion of whom had been at work as granite cutters from 10 to 24 years. In other words, without a material introduction of new labor the workmen at present employed will within a few years reach the period of trade life most fatal as regards pulmonary tuberculosis, although even at the present time the death rate from this disease is more than 50 per cent of the mortality from all causes (pulmonary tuberculosis 11.84 and all causes 20.11 per 1,000).

[10] See Report on the Ventilation of the Bendigo Mines, by Walter Summons, M. D., Victoria Department of Mines, Melbourne, 1906; and Report of an Investigation at Bendigo into the Prevalence, Nature, Causes, and Prevention of Miner's Phthisis, by Walter Summons, M. D., Melbourne, 1907.

TABLE 30.—MORTALITY FROM ALL CAUSES AMONG THE GRANITE CUTTERS OF THE UNITED STATES AND CANADA, 1889 TO 1917, COMPARED WITH THAT OF BENDIGO QUARTZ MINERS, VICTORIA, 1875 TO 1909.

[Rates for granite cutters based on experience of the Granite Cutters' International Association of America.]

Chronological comparison.			Comparison based on trade life.		
Period.	Death rate per 1,000.		Trade life by periods.	Death rate per 1,000.	
	Granite cutters of the United States and Canada.	Bendigo miners.		Granite cutters of the United States and Canada.	Bendigo miners.
1875–1879	.....	18.0	1	[1] 14.3	18.0
1880–1884	.....	19.0	2	14.3	19.0
1885–1889	.....	28.2	3	11.4	28.2
1890–1894	[1] 14.3	28.4	4	14.6	28.4
1895–1899	14.3	31.8	5	21.0	31.8
1900–1904	11.4	25.6	6	22.9	25.6
1905–1909	14.6	[2] 27.0	7	.....	[2] 27.0
1910–1914	21.0	.....			
1915–1917	22.9	.....			

[1] 1889–1894. [2] 1905–1906 (six months).

TABLE 31.—DISTRIBUTION OF LIVING GRANITE CUTTERS OF BARRE, VT., BY AGE AND YEARS OF EXPOSURE TO GRANITE DUST, AUGUST, 1919.

Age.	Number of granite cutters exposed each classified number of years to granite dust.												
	1 to 4.	5 to 9.	10 to 14.	15 to 19.	20 to 24.	25 to 29.	30 to 34.	35 to 39.	40 to 44.	45 to 49.	50 to 54.	55 to 59.	Total.
15 to 19 years	28	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	28
20 to 24 years	48	46	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	95
25 to 29 years	6	72	50	10	.....	.....	.....	.....	.....	.....	.....	.....	138
30 to 34 years	6	20	71	82	12	2	.....	.....	.....	.....	.....	.....	193
35 to 39 years	1	15	47	61	81	16	2	.....	.....	.....	.....	.....	223
40 to 44 years	3	9	16	32	58	50	15	1	.....	.....	.....	.....	184
45 to 49 years	.....	5	6	14	20	41	40	15	1	1	.....	.....	143
50 to 54 years	.....	1	3	5	5	19	29	18	5	.....	.....	.....	85
55 to 59 years	.....	1	.....	1	3	4	4	9	8	2	.....	.....	32
60 to 64 years	.....	.....	.....	.....	.....	.....	2	1	3	3	1	.....	10
65 to 69 years	.....	.....	.....	.....	.....	.....	.....	.....	.....	1	1	1	3
70 to 74 years	.....	.....	.....	.....	.....	.....	.....	.....	.....	1	2	.....	3
Total	92	169	194	205	179	132	92	44	17	8	4	1	1,137

OCCUPATIONAL DISTRIBUTION IN THE GRANITE INDUSTRY.

The following analysis, by occupation, makes clear the complex nature of the industry and the importance of segregating employees working under widely varying health-injurious conditions of employment:

Analysis by occupations of the granite-cutting industry of Barre, Vt., August, 1919.

Occupation.	No.	Occupation.	No.
Granite cutters:		Polishers:	
Hand tools	1	Hand	15
Pneumatic tools	964	Mill	117
Surfacing machines, in sheds	100	Lathe	5
Surfacing machines, outside	56	Bed setters	48
Lathes	12	Sawyers	14
Drills	1	Engineers	14
Sand-blast	3	Firemen	1
Tool sharpeners	39	Electricians	1
Lumpers:		Machinists	7
General	59	Tool grinders	73
Grouters	16	Tool carriers	6
Hook followers	44	Draftsmen	40
Boxers	35	Foremen	38
Derrick men:		Manufacturers	111
Boom	17		
Traveling crane	32	Total	1,869

The relatively small number of some occupations unfortunately prevents a conclusive statistical analysis, but as far as possible the principal occupational distinctions are maintained in the present discussion, and particularly is this true for manufacturers and foremen, who, though representing a group supposed to be relatively free from health-injurious conditions, nevertheless vary to a measurable degree in the health hazard of the employment.

PHYSIQUE OF GRANITE WORKERS.

Aside from the occupation as such, the disease incidence is affected by physical selection and by external conditions, which require to be taken into account. The opinion generally prevails that stone workers are a physically selected class who because of superior health should be less liable to pulmonary tuberculosis than other workers, if conditions favorable to disease development did not arise out of the industrial problems dealt with. It was therefore thought best to determine in each and every case the height and weight, as well as the relative weight, of the men employed as granite cutters in the Barre district. This important information was secured by personal interview and with the hearty cooperation of the wage earners themselves. The results of this important investigation are for the present given only in general outline, but sufficiently for the purpose of emphasizing the clearly superior physical characteristics of granite cutters employed in the Barre district in August, 1919. It is important to keep this point in mind, for conditions were undoubtedly better when the occupation was first taken up, there having, no doubt, been some impairment during the intervening years of trade life.

Table 32 shows the proportionate age distribution of the granite cutters of Barre, Vt., as compared with male employees in specified dusty trades, by occupations, while Table 33 gives the number and per cent of the granite cutters in each occupational group.

TABLE 32.—PROPORTIONATE AGE DISTRIBUTION OF LIVING MALES IN THE GRANITE-CUTTING INDUSTRY OF BARRE, VT., COMPARED WITH THAT OF MALE EMPLOYEES IN SPECIFIED DUSTY TRADES, BY OCCUPATION GROUP.

GRANITE-CUTTING INDUSTRY.[1]

Occupation group.	Per cent in each specified age group.				
	10 to 13	14 to 15	16 to 20	21 to 44	45 and over.
Engineers, firemen, electricians, and machinists	.....	.....	4.35	47.82	47.83
Tool sharpeners	.....	.....	.....	53.85	46.15
Polishers, bed setters, and sawyers	.....	.....	10.05	49.25	40.70
Manufacturers and foremen	.....	.....	.67	62.42	36.91
Lumpers, boxers, and derrick men	.....	0.49	12.32	59.60	27.59
Cutters	.....	.09	3.52	72.12	24.27
Tool grinders and tool carriers	6.33	16.45	53.17	10.13	13.92
Draftsmen	.....	.....	20.00	70.00	10.00
Total	.27	.80	7.33	64.21	27.39

[1] August, 1919.

TABLE 32.—PROPORTIONATE AGE DISTRIBUTION OF LIVING MALES IN THE GRANITE-CUTTING INDUSTRY OF BARRE, VT., COMPARED WITH THAT OF MALE EMPLOYEES IN SPECIFIED DUSTY TRADES, BY OCCUPATION GROUP—Concluded.

OCCUPATIONS WITH EXPOSURE TO MINERAL DUST. [1]

Occupation group.	Per cent in each specified age group.				
	10 to 13	14 to 15	16 to 20	21 to 44	45 and over.
Whitewashers	0.06	0.24	3.91	41.86	53.93
Plasterers	.04	.29	6.83	60.49	32.35
Marble and stone yards	.04	.53	7.84	63.88	27.73
Color mixers (not paint)	.....	1.75	13.29	59.67	25.29
Paper hangers, apprentices and helpers	.05	1.00	9.24	65.09	24.62
Paint factories	.08	1.92	15.44	63.69	18.87
Molders	.....	.03	7.19	73.99	18.79
Lacquerers, japanners, enamelers	.....	1.88	14.20	66.21	17.71
Lithographers	.....	.14	16.96	65.28	17.62
Potteries	.21	2.31	16.91	63.31	17.26
Crass blowers	.....	.11	6.18	76.81	16.90
Brick, tile and terra-cotta factories	.61	2.28	15.80	64.48	16.83
Lime, cement, and gypsum factories	.17	.88	11.88	71.09	15.98
Asbestos workers	.17	1.25	10.11	74.44	14.03
Mirror makers	.14	1.16	14.56	70.17	13.97
Glass factories (excluding blowers)	.64	6.70	23.52	55.68	13.46
Core makers	.02	2.49	24.57	64.56	8.36
Mica workers	.....	3.70	37.04	51.85	7.41
Total	.22	1.64	12.43	66.00	19.71

[1] Compiled from Report of Bureau of the Census on Occupation Statistics, 1910.

TABLE 33.—AGE DISTRIBUTION OF LIVING EMPLOYEES AND MANUFACTURERS IN THE GRANITE-CUTTING INDUSTRY OF BARRE, VT., AUGUST, 1919, BY OCCUPATION GROUPS.

NUMBER.

Age.	Cutters.	Tool sharpeners.	Lumpers, boxers and derrick men.	Polishers, bed setters, and sawyers.	Engineers, firemen, electricians, and machinists.	Tool grinders and tool carriers.	Draftsmen.	Manufacturers and foremen.	Total.
15 to 19 years	28	.....	20	16	1	57	8	1	131
20 to 24 years	95	.....	23	22	.....	8	9	2	159
25 to 29 years	138	3	31	23	1	3	10	9	218
30 to 34 years	192	7	34	17	4	.....	5	20	279
35 to 39 years	224	7	26	22	4	.....	4	26	313
40 to 44 years	184	4	13	18	2	.....	.....	36	257
45 to 49 years	143	11	14	21	4	.....	1	26	220
50 to 54 years	86	5	18	28	6	3	2	21	169
55 to 59 years	31	1	15	19	1	1	.....	4	72
60 to 64 years	10	1	4	11	.....	5	.....	2	33
65 years and over	6	.....	5	2	.....	2	1	2	18
Total	1,137	39	203	199	23	79	40	149	1,869

PER CENT.

15 to 19 years	2.46	.....	9.85	8.04	4.35	72.14	20.00	0.67	7.01
20 to 24 years	8.36	.....	11.33	11.05	.....	10.13	22.50	1.34	8.51
25 to 29 years	12.14	7.69	15.27	11.57	4.35	3.80	25.00	6.04	11.66
30 to 34 years	16.88	17.95	16.75	8.54	17.39	.....	12.50	13.42	14.93
35 to 39 years	19.70	17.96	12.81	11.05	17.39	.....	10.00	17.46	16.76
40 to 44 years	16.18	10.26	6.40	9.05	8.70	.....	.....	24.17	13.76
45 to 49 years	12.58	28.20	6.90	10.55	17.39	.....	2.50	17.45	11.78
50 to 54 years	7.56	12.82	8.87	14.06	26.08	3.80	5.00	14.09	9.04
55 to 59 years	2.73	2.56	7.39	9.55	4.35	1.27	.....	2.68	3.83
60 to 64 years	.88	2.56	1.97	5.53	.....	6.33	.....	1.34	1.76
65 years and over	.53	.....	2.46	1.01	.....	2.53	2.50	1.34	.96
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

Table 34 presents the age, height, weight, and relative weight, by which is meant pounds per unit of height. These figures for granite cutters, coal miners, and all occupied males in the ordinary mortality experience of the Prudential Insurance Company are compared with the medico-actuarial standards. According to this table the average height of granite cutters was below the accepted normal for the different groups used for purposes of comparison, including the medico-actuarial standard, which is representative chiefly of the more prosperous professional or mercantile elements. Leaving out of consideration the different age groups, it appears that the average height of granite cutters was 66.6 inches, of coal miners 67.8 inches, of all occupied males 68.1 inches, and of the medico-actuarial standard 68.5 inches. In contrast to this difference in height is the marked superiority in weight. The average weight of granite cutters was 160.8 pounds, of coal miners 155.1 pounds, of all occupied males 157.0 pounds, and of the medico-actuarial standard 156.2 pounds. These differences, reduced to a basis of relative weight, show that granite-cutters' weight on the average was 2.41 pounds per inch of height, coal miners' 2.29 pounds, and all occupied males' 2.30 pounds, while according to the medico-actuarial standard the expected average would be 2.28 pounds. These differences are so striking and so uniform as to require most careful consideration. They clearly emphasize the physical superiority of granite cutters in comparison with other labor elements of our general population. The comparison is even more impressive when it is considered that the averages for insurance applicants are based on measurements at the time of application, while the averages for granite cutters were obtained after many years of trade life and inclusive of all elements, whether or not eligible for life insurance.

TABLE 34.—AVERAGE HEIGHT AND WEIGHT OF THE GRANITE CUTTERS OF BARRE, VT., COMPARED WITH THOSE OF COAL MINERS, ALL OCCUPIED MALES, AND THE MEDICO-ACTUARIAL STANDARD.

[Data for coal miners (1896–1915) and all occupied males (1896–1914) from Prudential ordinary experience.]

Age.	Average height (inches).				Average weight (pounds).				Relative weight (pounds per inch).			
	Granite cutters.	Coal miners.	All occupied males.	Medico-actuarial standard.	Granite cutters.	Coal miners.	All occupied males.	Medico-actuarial standard.	Granite cutters.	Coal miners.	All occupied males.	Medico-actuarial standard.
15 to 24 years	66.4	67.8	68.1	68.3	147.8	146.7	145.0	147.0	2.23	2.16	2.12	2.15
25 to 34 years	66.8	68.4	68.3	68.5	157.6	157.6	155.0	154.6	2.36	2.30	2.26	2.26
35 to 44 years	66.4	67.5	68.1	68.5	163.8	155.1	160.0	160.9	2.47	2.30	2.35	2.35
45 to 54 years	66.4	67.8	67.9	68.5	165.6	157.1	163.0	164.8	2.49	2.32	2.40	2.41
55 to 64 years	67.6	67.0	67.8	68.4	166.7	151.4	163.0	165.3	2.47	2.26	2.40	2.42
65 years and over	67.2	67.0	67.9	66.5	164.7	165.0	162.0	166.0	2.45	2.46	2.38	2.50
Total	66.6	67.8	68.1	68.5	160.8	155.1	157.0	156.2	2.41	2.29	2.30	2.28

The writer is not aware of more conclusive evidence concerning the physical status of granite cutters in its relation to an excessive incidence of pulmonary tuberculosis. Normally, tubercular disease and deficiency in weight go together, whereas this disease is generally less common among those who are overweight. Regardless of this

point of view, granite cutters are shown to have experienced the greatest liability to pulmonary tuberculosis of all those engaged in the representative dusty trades.

PHYSIQUE IN RELATION TO RACE.

A factor of importance in this connection is the nativity of the workmen, for a large proportion of the granite cutters in the Barre district are from the south of Europe, especially Italy and Spain. Since these southern Europeans are of lower stature than the natives of Scotland and the United States, the subject has been made one of special inquiry, and the facts are set forth in the required detail in Table 35.

TABLE 35.—COMPARATIVE ANTHROPOMETRY OF GRANITE CUTTERS OF BARRE, VT., AUGUST, 1919, BY BIRTHPLACE OF WORKMAN'S MOTHER.

Age.	Average height (inches).				Average weight (pounds).				Relative weight (pounds per inch).			
	Italy.	Scotland.	Spain.	Medico-actuarial standard.	Italy.	Scotland.	Spain.	Medico-actuarial standard.	Italy.	Scotland.	Spain.	Medico-actuarial standard.
15 to 24 years	66.6	66.2	65.8	68.3	148.0	140.7	150.8	147.0	2.22	2.12	2.29	2.15
25 to 34 years	66.5	67.3	66.5	68.5	158.0	152.9	153.7	154.6	2.38	2.27	2.31	2.26
35 to 44 years	65.8	67.2	65.2	68.5	165.5	157.7	161.9	160.9	2.51	2.35	2.48	2.35
45 to 54 years	63.9	67.5	66.5	68.5	168.6	165.7	175.0	164.8	2.64	2.45	2.63	2.41
55 to 64 years	66.7	67.9	64.0	68.4	165.1	164.9	170.0	165.3	2.48	2.43	2.66	2.42
65 years and over	65.0	68.0	.....	66.5	141.0	180.0	.....	166.0	2.17	2.65	.....	2.50
Total	65.7	67.3	66.0	68.5	162.4	158.5	155.1	156.2	2.47	2.36	2.35	2.28

Workmen of Italian, Scotch, and Spanish descent constitute 74.6 per cent of the granite cutters of the Barre district. The average height was 65.7 inches for natives of Italy, 67.3 inches for natives of Scotland, and 66 inches for natives of Spain, as compared with the medico-actuarial standard of 68.5 inches. The average weight was 162.4 pounds for natives of Italy, 158.5 pounds for natives of Scotland, 155.1 pounds for natives of Spain, and 156.2 pounds according to the medico-actuarial standard. Reducing these figures to a common basis, the relative weight of natives of Italy was 2.47 pounds per inch of height, of natives of Scotland 2.36 pounds, of natives of Spain 2.35 pounds, as compared with the medico-actuarial standard of only 2.28 pounds. Thus the general physical superiority of granite cutters at present at work in the Barre district indicates clearly a superior degree of physical resistance to a disease normally associated with deficiency in weight.

This aspect of the problem is of such importance that it has seemed advisable to add Table 36, showing in detail the distribution of weights above and below the standard, with a due regard to ages attained. This table shows that for persons of Italian descent 80.7 per cent are overweight, of Scotch descent 54.6 per cent, and of Spanish descent 74.5 per cent. For the remaining granite cutters of the Barre district, largely native Americans, the percentage of overweight was 64.0.

TABLE 36.—DISTRIBUTION OF GRANITE CUTTERS OF BARRE, VT., OF FOREIGN DESCENT, ACCORDING TO OVERWEIGHT AND UNDERWEIGHT, AUGUST, 1919, BY AGE GROUP.

NUMBER OF CUTTERS OF ITALIAN DESCENT.

Pounds.	Age.							Per cent of total.
	15 to 24 years.	25 to 34 years.	35 to 44 years.	45 to 54 years.	55 to 64 years.	65 years and over.	Total.	
Above standard weight:								
50 and over	.....	4	14	4	1	.....	23	4.0
45 to 49	2	4	3	5	.....	.....	14	2.5
40 to 44	.....	3	6	8	.....	.....	17	3.0
35 to 39	.....	2	10	3	.....	.....	15	2.6
30 to 34	.....	7	15	7	.....	.....	29	5.1
25 to 29	.....	8	27	11	.....	.....	46	8.0
20 to 24	6	15	24	11	1	.....	57	10.0
15 to 19	2	22	29	10	.....	.....	63	11.0
10 to 14	10	29	25	10	2	.....	76	13.2
5 to 9	5	26	26	10	.....	.....	67	11.7
1 to 4	9	20	19	6	.....	.....	54	9.4
Total	34	140	198	85	4	.....	461	.....
Standard weight	.....	6	5	3	.....	.....	14	2.5
Below standard weight:								
1 to 4	5	15	9	3	.....	.....	32	5.6
5 to 9	2	13	12	7	3	1	38	6.6
10 to 14	1	3	4	4	.....	.....	12	2.1
15 to 19	1	2	3	3	.....	.....	9	1.5
20 to 24	.....	.....	2	1	1	.....	4	.7
25 to 29	.....	.....	1	.....	.....	.....	1	.1
30 to 34	.....	.....	.....	.....	.....	.....	.....	.....
35 to 39	.....	.....	.....	.....	.....	.....	.....	.....
40 to 44	.....	.....	.....	.....	.....	.....	.....	.....
45 to 49	.....	.....	.....	.....	.....	.....	.....	.....
50 and over	.....	.....	.....	.....	.....	.....	.....	.....
Total	9	33	31	18	4	1	96	.....
	Per ct.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	
Overweight	79.1	78.2	84.7	80.2	50.0	.....	80.7	.....
Standard	.....	3.4	2.1	2.8	.....	.....	2.5	.....
Underweight	20.9	18.4	13.2	17.0	50.0	100.0	16.8	.....
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

NUMBER OF CUTTERS OF SCOTCH DESCENT.

Above standard weight:								
50 and over	.....	.....	1	1	.....	.....	2	1.1
45 to 49	.....	.....	1	.....	.....	.....	1	.5
40 to 44	.....	2	1	.....	.....	.....	3	1.6
35 to 39	.....	1	1	.....	.....	.....	2	1.1
30 to 34	.....	.....	3	1	.....	.....	4	2.1
25 to 29	.....	1	2	4	.....	.....	7	3.7
20 to 24	.....	.....	2	3	.....	1	6	3.2
15 to 19	.....	3	2	5	3	.....	13	7.0
10 to 14	.....	5	8	4	.....	1	18	9.6
5 to 9	5	4	4	5	1	.....	19	10.2
1 to 4	2	3	10	7	5	.....	27	14.5
Total	7	19	35	30	9	2	102	.....
Standard weight	.....	3	1	1	1	.....	6	3.2
Below standard weight:								
1 to 4	3	1	6	8	2	.....	20	10.7
5 to 9	1	9	10	2	1	.....	23	12.3
10 to 14	.....	6	10	4	.....	.....	20	10.7
15 to 19	.....	2	5	2	.....	.....	9	4.8
20 to 24	.....	.....	2	1	1	.....	4	2.1
25 to 29	.....	.....	1	1	.....	.....	2	1.1
30 to 34	.....	1	.....	.....	.....	.....	1	.5
35 to 39	.....	.....	.....	.....	.....	.....	.....	.....
40 to 44	.....	.....	.....	.....	.....	.....	.....	.....
45 to 49	.....	.....	.....	.....	.....	.....	.....	.....
50 and over	.....	.....	.....	.....	.....	.....	.....	.....
Total	4	19	34	18	4	.....	79	.....
	Per ct.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	
Overweight	63.6	46.4	50.0	61.3	64.3	100.0	54.6	.....
Standard	.....	7.3	1.4	2.0	7.1	.....	3.2	.....
Underweight	36.4	46.3	48.6	36.7	28.6	.....	42.2	.....
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

TABLE 36.—DISTRIBUTION OF GRANITE CUTTERS OF BARRE, VT., OF FOREIGN DESCENT, ACCORDING TO OVERWEIGHT AND UNDERWEIGHT, AUGUST, 1919, BY AGE GROUP—Concluded.

NUMBER OF CUTTERS OF SPANISH DESCENT.

Pounds.	Age.							Per cent of total.
	15 to 24 years.	25 to 34 years.	34 to 44 years.	45 to 54 years.	55 to 64 years.	65 years and over.	Total.	
Above standard weight:								
50 and over	1	.....	.....	.....	.....	.....	1	1.1
45 to 49	.....	.....	.....	.....	.....	.....	.....	.....
40 to 44	.....	.....	1	.....	.....	.....	1	1.1
35 to 39	.....	1	1	.....	.....	.....	2	2.2
30 to 34	.....	.....	1	.....	.....	.....	1	1.1
25 to 29	4	7	3	1	1	.....	16	17.8
20 to 24	4	4	.....	.....	.....	.....	8	8.9
15 to 19	4	2	4	.....	.....	.....	10	11.1
10 to 14	2	1	2	1	.....	.....	6	6.7
5 to 9	6	6	3	.....	.....	.....	15	16.7
1 to 4	1	5	1	.....	.....	.....	7	7.8
Total	22	26	16	2	1	.....	67	.....
Standard weight	1	2	.....	.....	.....	.....	3	3.3
Below standard weight:								
1 to 4	5	7	1	.....	.....	.....	13	14.4
5 to 9	.....	4	1	.....	.....	.....	5	5.6
10 to 14	.....	1	.....	.....	.....	.....	1	1.1
15 to 19	.....	1	.....	.....	.....	.....	1	1.1
20 to 24	.....	.....	.....	.....	.....	.....	.....	.....
25 to 29	.....	.....	.....	.....	.....	.....	.....	.....
30 to 34	.....	.....	.....	.....	.....	.....	.....	.....
35 to 39	.....	.....	.....	.....	.....	.....	.....	.....
40 to 44	.....	.....	.....	.....	.....	.....	.....	.....
45 to 49	.....	.....	.....	.....	.....	.....	.....	.....
50 and over	.....	.....	.....	.....	.....	.....	.....	.....
Total	5	13	2	.....	.....	.....	20	.....
	Per ct.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	
Overweight	78.5	63.4	88.9	100.0	100.0	.....	74.5	.....
Standard	3.6	4.9	.....	.....	.....	.....	3.3	.....
Underweight	17.9	31.7	11.1	.....	.....	.....	22.2	.....
Total	100.0	100.0	100.0	100.0	100.0	.....	100.0	100.0

NUMBER OF CUTTERS OF OTHER DESCENT.

Above standard weight:								
50 and over	1	1	1	.....	.....	.....	3	1.0
45 to 49	.....	1	3	1	2	.....	7	2.4
40 to 44	.....	2	1	1	.....	.....	4	1.4
35 to 39	.....	3	.....	3	1	.....	7	2.4
30 to 34	1	2	6	3	.....	.....	12	4.2
25 to 29	.....	3	3	5	2	.....	13	4.5
20 to 24	7	3	7	.....	1	.....	18	6.2
15 to 19	4	8	5	3	.....	.....	20	6.9
10 to 14	5	10	9	5	5	1	35	12.1
5 to 9	7	12	7	5	1	.....	32	11.1
1 to 4	3	9	6	13	2	1	34	11.8
Total	28	54	48	39	14	2	185	.....
Standard weight	3	1	4	.....	.....	.....	8	2.8
Below standard weight:								
1 to 4	5	5	18	5	1	.....	34	11.8
5 to 9	3	5	2	7	1	.....	18	6.2
10 to 14	1	2	5	14	1	.....	23	8.0
15 to 19	.....	2	5	5	1	.....	13	4.5
20 to 24	1	.....	1	4	.....	.....	6	2.1
25 to 29	.....	.....	.....	.....	.....	.....	.....	.....
30 to 34	.....	.....	1	.....	1	.....	2	.7
35 to 39	.....	.....	.....	.....	.....	.....	.....	.....
40 to 44	.....	.....	.....	.....	.....	.....	.....	.....
45 to 49	.....	.....	.....	.....	.....	.....	.....	.....
50 and over	.....	.....	.....	.....	.....	.....	.....	.....
Total	10	14	32	35	5	.....	96	.....
	Per ct.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	
Overweight	68.3	78.3	57.1	52.7	73.7	100.0	64.0	.....
Standard	7.3	1.4	4.8	.....	.....	.....	2.8	.....
Underweight	24.4	20.3	38.1	47.3	26.3	.....	33.2	.....
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

SANITARY CONDITIONS.

The foregoing observations emphasize the important conclusion that granite cutters represent physically a superior class of risk. Practically the same conclusion applies to the general environment as determined by a housing survey, with particular reference to both outside and inside sanitary conditions. This survey was made in conformity to the usual methods of inquiry as shown by the general blank used (see p. 138). The report on outside sanitary conditions in this part of the investigation was made by a trained sanitary engineer, and each house was personally visited, the results of the investigation being made a matter of record at the time of the inspection. These outside sanitary conditions represent general observations corresponding to the method followed in the tenement-house survey of the Bureau of Labor Statistics of Massachusetts.[a] The inside sanitary conditions are with reference to light and air and general cleanliness, while the room accommodation is with reference to the total number of rooms and persons in the household. The results of this investigation do not seem to require extended consideration.

The tabular analysis shown in Table 37 differentiates houses of (1) manufacturers and foremen, (2) draftsmen, (3) engineers, firemen, electricians, and machinists, (4) tool grinders and tool carriers, (5) polishers, bed setters, and sawyers, (6) lumpers, boxers, and derrick men, (7) tool sharpeners, and (8) granite cutters.

TABLE 37.—PROPORTIONATE DISTRIBUTION OF MANUFACTURERS AND EMPLOYEES IN THE GRANITE-CUTTING INDUSTRY OF BARRE, VT., ACCORDING TO HOME HYGIENIC CONDITIONS AND TUBERCULOSIS HISTORY IN FAMILY, AUGUST, 1919, BY PERSONS PER ROOM.

MANUFACTURERS AND FOREMEN.

Persons per room.	Number.	Inside sanitary conditions.						Outside sanitary conditions.			Tuberculosis history in family.
		Cleanliness.			Light and air.			Good.	Fair.	Bad.	
		Good.	Fair.	Bad.	Good.	Fair.	Bad.				
		Per ct.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*
0.1 to 0.5	39	74.4	25.6	0.0	76.9	23.1	0.0	76.9	23.1	0.0	23.1
0.5 to 1.0	92	53.3	46.7	.0	54.3	45.7	.0	55.4	44.6	.0	27.2
1.0 to 1.5	15	33.3	66.7	.0	40.0	60.0	.0	33.3	66.7	.0	20.0
1.5 to 2.0	3	66.7	33.3	.0	66.7	33.3	.0	.0	100.0	.0	.0
2.0 and over											
Total	149	57.0	43.0	.0	59.1	40.9	.0	57.7	42.3	.0	24.8

DRAFTSMEN.

0.1 to 0.5	6	83.3	16.7	0.0	100.0	0.0	0.0	100.0	0.0	0.0	53.3
0.5 to 1.0	30	53.3	43.3	3.4	53.3	46.7	.0	56.7	43.3	.0	30.0
1.0 to 1.5	4	25.0	75.0	.0	50.0	50.0	.0	75.0	25.0	.0	25.0
1.5 to 2.0											
2.0 and over											
Total	40	55.0	42.5	2.5	60.0	40.0	.0	65.0	35.0	.0	30.0

[a] Twenty-third annual report of the Massachusetts Bureau of Labor Statistics, Boston, 1893.

TABLE 37.—PROPORTIONATE DISTRIBUTION OF MANUFACTURERS AND EMPLOYEES IN THE GRANITE-CUTTING INDUSTRY OF BARRE, VT., ACCORDING TO HOME HYGIENIC CONDITIONS AND TUBERCULOSIS HISTORY IN FAMILY, AUGUST, 1919, BY PERSONS PER ROOM—Concluded.

ENGINEERS, FIREMEN, ELECTRICIANS, AND MACHINISTS.

Persons per room.	Number.	Inside sanitary conditions.						Outside sanitary conditions.			Tuberculosis history in family.
		Cleanliness.			Light and air.			Good.	Fair.	Bad.	
		Good.	Fair.	Bad.	Good.	Fair.	Bad.				
		Per ct.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*
0.1 to 0.5	3	33.3	66.7	0.0	33.3	66.7	0.0	66.7	33.3	0.0	66.7
0.5 to 1.0	12	25.0	58.3	16.7	33.3	58.4	8.3	25.0	66.7	8.3	8.3
1.0 to 1.5	7	28.6	57.1	14.3	28.6	71.4	.0	28.6	71.4	.0	57.1
1.5 to 2.0	1	.0	100.0	.0	.0	100.0	.0	.0	100.0	.0	.0
2.0 and over											
Total	23	26.1	60.9	13.0	30.4	65.2	4.4	30.4	65.2	4.4	30.4

TOOL GRINDERS AND TOOL CARRIERS.

0.1 to 0.5	9	44.4	44.4	11.2	55.6	44.4	0.0	66.7	33.3	0.0	22.2
0.5 to 1.0	40	22.5	70.0	7.5	22.5	75.0	2.5	25.0	72.5	2.5	5.0
1.0 to 1.5	23	4.3	86.9	8.8	4.3	95.7	.0	4.3	95.7	.0	4.3
1.5 to 2.0	4	25.0	50.0	25.0	.0	100.0	.0	25.0	75.0	.0	.0
2.0 and over	3	.0	66.7	33.3	.0	100.0	.0	.0	100.0	.0	33.3
Total	79	19.0	70.9	10.1	19.0	79.7	1.3	22.8	75.9	1.3	7.6

POLISHERS, BED SETTERS, AND SAWYERS.

0.1 to 0.5	27	22.2	70.4	7.4	18.5	77.8	3.7	30.0	65.0	5.0	29.6
0.5 to 1.0	97	20.6	74.2	5.2	19.6	78.4	2.0	24.4	73.2	2.4	17.5
1.0 to 1.5	66	6.1	75.8	18.1	6.1	89.4	4.5	8.5	86.4	5.1	34.8
1.5 to 2.0	6	.0	83.3	16.7	.0	83.3	16.7	.0	80.0	20.0	33.3
2.0 and over	3	.0	100.0	.0	.0	100.0	.0	.0	100.0	.0	33.3
Total	199	15.1	74.9	10.0	14.1	82.4	3.5	18.3	77.5	4.2	25.6

LUMPERS, BOXERS, AND DERRICK MEN.

0.1 to 0.5	27	11.1	77.8	11.1	11.0	85.2	3.8	12.5	83.3	4.2	7.4
0.5 to 1.0	98	13.3	76.5	10.2	11.2	87.8	1.0	14.6	84.3	1.1	18.4
1.0 to 1.5	64	3.1	79.7	17.2	3.0	97.0	.0	3.2	96.8	.0	23.4
1.5 to 2.0	12	8.3	58.3	33.4	8.3	83.4	8.3	16.6	83.4	.0	25.0
2.0 and over	2	.0	100.0	.0	50.0	50.0	.0	.0	100.0	.0	.0
Total	203	9.4	76.4	14.2	8.9	89.7	1.4	10.6	88.3	1.1	18.7

TOOL SHARPENERS.

0.1 to 0.5	8	0.0	100.0	0.0	0.0	100.0	0.0	0.0	100.0	0.0	25.0
0.5 to 1.0	20	30.0	50.0	20.0	35.0	65.0	.0	30.0	70.0	.0	40.0
1.0 to 1.5	11	27.3	54.5	18.2	27.3	72.7	.0	27.3	72.7	.0	36.4
1.5 to 2.0											
2.0 and over											
Total	39	23.1	61.5	15.4	25.6	74.4	.0	23.1	76.9	.0	35.9

GRANITE CUTTERS.

0.1 to 0.5	72	20.8	59.7	19.5	20.8	72.2	7.0	20.8	72.2	7.0	[1] 53.3
0.5 to 1.0	566	13.2	72.8	14.0	13.1	84.6	2.3	13.1	84.3	2.6	[1] 31.2
1.0 to 1.5	445	6.3	66.1	27.6	6.5	88.3	5.2	6.5	87.9	5.6	[1] 30.1
1.5 to 2.0	39	2.6	61.5	35.9	7.7	82.1	10.2	5.1	84.6	10.3	[1] 31.3
2.0 and over	15	.0	73.3	26.7	.0	100.0	.0	6.7	93.3	.0	[1] 16.7
Total	1,137	10.5	69.0	20.5	10.6	85.4	4.0	10.6	85.0	4.4	[1] 31.9

[1] Exclusive of those of Italian and Spanish descent.

Briefly summarized, the analysis shows that the inside sanitary conditions as to cleanliness were unsatisfactory or bad, as follows:

Houses of—	Per cent.
Manufacturers and foremen	0.0
Draftsmen	2.5
Engineers, firemen, electricians, and machinists	13.0
Tool grinders and tool carriers	10.1
Polishers, bed setters, and sawyers	10.0
Lumpers, boxers, and derrick men	14.2
Tool sharpeners	15.4
Granite cutters	20.5

The corresponding figures as to inside sanitary conditions with reference to light and air were bad as follows:

Houses of—	Per cent.
Manufacturers and foremen	0.0
Draftsmen	.0
Engineers, firemen, electricians, and machinists	4.4
Tool grinders and tool carriers	1.3
Polishers, bed setters, and sawyers	3.5
Lumpers, boxers, and derrick men	1.4
Tool sharpeners	.0
Granite cutters	4.0

With reference to tuberculosis, the inside conditions as to light and air are obviously of most importance, and the results of the investigation indicate that on the whole these conditions, with the exception of a small fraction of the houses, were sufficiently satisfactory to justify the assumption that the inside environment was above the normal for average wage earners in other sections or industrial districts.

The outside sanitary conditions were unsatisfactory or bad, as follows:

Houses of—	Per cent.
Manufacturers and foremen	0.0
Draftsmen	.0
Engineers, firemen, electricians, and machinists	4.4
Tool grinders and tool carriers	1.3
Polishers, bed setters, and sawyers	4.2
Lumpers, boxers, and derrick men	1.1
Tool sharpeners	.0
Granite cutters	4.4

These statistics fully support the previous conclusion and justify the statement as regards both inside and outside sanitary conditions that the environment of persons employed in the Barre district is unquestionably above the normal average of wage earners generally. In connection with this survey an effort was made to ascertain the tuberculosis history of the family, and, on the whole, no difficulty was met with in securing an accurate and complete statement of the facts. The record as it appears on the original blank (see p. 138) shows the relation of the person affected with tuberculosis to the head of the family, the sex, age, disease condition, or whether formerly a patient. For present purposes it will be sufficient to indicate the percentage of homes with tuberculosis in the family, but it must be kept in mind that the record shows that granite cutters are suffering from an extremely high death rate from the disease. The proportion of homes with tuberculosis history in the family was as follows:

Homes of—	Number.	Per cent, with a history of tuberculosis.
Manufacturers and foremen	149	24.8
Draftsmen	40	30.0
Engineers, firemen, electricians, and machinists	23	30.4
Tool grinders and tool carriers	79	7.6
Polishers, bed setters, and sawyers	199	25.6
Lumpers, boxers, and derrick men	203	18.7
Tool sharpeners	39	35.9
Granite cutters	1,137	31.9

In the case of some of the occupations referred to the numbers, of course, are too small for an entirely safe conclusion, but the facts as to the inside and outside sanitary conditions are summarized in Table 38, arranged according to the percentage of tuberculosis history in the family for the different occupational groups. This table does not seem to suggest that there is a very definite ascertainable relation of a tuberculosis history to the inside or outside sanitary conditions of the premises.

TABLE 38.—PROPORTIONATE DISTRIBUTION OF MANUFACTURERS AND EMPLOYEES IN THE GRANITE-CUTTING INDUSTRY OF BARRE, VT., ACCORDING TO HOME HYGIENIC CONDITIONS AND TUBERCULOSIS HISTORY IN FAMILY, AUGUST, 1919, BY OCCUPATION GROUPS.

Occupation group.	Number.	Inside sanitary conditions.						Outside sanitary conditions.			Tuberculosis history in family.
		Cleanliness.			Light and air.						
		Good.	Fair.	Bad.	Good.	Fair.	Bad.	Good.	Fair.	Bad.	
		Per ct.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*
Tool sharpeners	39	23.1	61.5	15.4	25.6	74.4	0.0	23.1	76.9	0.0	35.9
Cutters	1,137	10.5	69.0	20.5	10.6	85.4	4.0	10.6	85.0	4.4	31.9
Engineers, firemen, electricians, and machinists	23	26.1	60.9	13.0	30.4	65.2	4.4	30.4	65.2	4.4	30.4
Draftsmen	40	55.0	42.5	2.5	60.0	40.0	.0	65.0	35.0	.0	30.0
Polishers, bed setters, and sawyers	199	15.1	74.9	10.0	14.1	82.4	3.5	18.3	77.5	4.2	25.6
Manufacturers and foremen	149	57.0	43.0	.0	59.1	40.9	.0	57.7	42.3	.0	24.8
Lumpers, boxers, and derrick men	203	9.4	76.4	14.2	8.9	89.7	1.4	10.6	88.3	1.1	18.7
Tool grinders and tool carriers	79	19.0	70.9	10.1	19.0	79.7	1.3	22.8	75.9	1.3	7.6

ABSENCE OF OVERCROWDING.

Table 39 shows the actual and proportionate distribution of workmen according to occupational groups and room density, with comparative data as to overcrowding, on the basis of the English standard of more than two persons in a room, correlated with the mortality rate from pulmonary tuberculosis for the four principal occupational groups sufficiently numerous to yield a satisfactory basis for arriving at safe conclusions. This table also indicates no such pronounced differences in room congestion as would seem to have a direct bearing upon wide variations in the tuberculosis death rate, being indicative rather, of an environment on the whole favorable to a low tuberculosis death rate, although as a matter of fact an excessive death rate prevails in the case of at least two of the principal occupations in the granite industry.

TABLE 39.—ROOM ACCOMMODATION IN HOMES OF MANUFACTURERS AND EMPLOYEES IN GRANITE-CUTTING INDUSTRY OF BARRE, VT., AUGUST, 1919, BY OCCUPATION GROUPS.

Persons per room.	Manufacturers and foremen.		Draftsmen.		Engineers, firemen, electricians, and machinists.		Tool grinders and tool carriers.		Polishers, bed setters, and sawyers.		Lumpers, boxers, and derrick men.		Tool sharpeners.		Granite cutters.		Total.	
	No.	Per cent.	No.	Per cent.	No.	Per cent.	No.	Per cent.	No.	Per cent.	No.	Per cent.	No.	Per cent.	No.	Per cent.	No.	Per cent.
0.10 to 0.25	1	0.7	----	----	1	4.3	----	----	----	----	3	1.5	----	----	5	0.4	10	0.5
0.25 to 0.50	38	25.5	6	15.0	2	8.7	9	11.4	27	13.6	24	11.8	8	20.5	67	5.9	181	9.7
0.50 to 0.75	66	44.3	18	45.0	10	43.6	19	24.1	58	29.2	64	31.6	11	28.2	303	26.6	549	29.4
0.75 to 1.00	26	17.4	12	30.0	2	8.7	21	26.6	39	19.6	34	16.7	9	23.1	263	23.1	406	21.7
1.00 to 1.25	14	9.4	3	7.5	7	30.4	21	26.6	54	27.1	51	25.1	10	25.6	372	32.7	532	28.4
1.25 to 1.50	1	.7	1	2.5	----	----	2	2.5	12	6.0	13	6.4	1	2.6	73	6.4	103	5.5
1.50 to 1.75	3	2.0	----	----	----	----	3	3.8	5	2.5	11	5.4	----	----	28	2.5	50	2.7
1.75 to 2.00	----	----	----	----	1	4.3	1	1.2	1	.5	1	.5	----	----	11	1.0	15	.8
2.00 to 2.25	----	----	----	----	----	----	3	3.8	3	1.5	1	.5	----	----	12	1.1	19	1.0
2.25 to 2.50	----	----	----	----	----	----	----	----	----	----	----	----	----	----	1	.1	1	.1
2.50 to 2.75	----	----	----	----	----	----	----	----	----	----	----	----	----	----	1	.1	1	.1
2.75 to 3.00	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
3.00 to 3.25	----	----	----	----	----	----	----	----	----	----	1	.5	----	----	1	.1	2	.1
Total	149	100.0	40	100.0	23	100.0	79	100.0	199	100.0	203	100.0	39	100.0	1,137	100.0	1869	100.0

Item.	Manufacturers and foremen.	Draftsmen.	Engineers, firemen, electricians, and machinists.	Tool grinders and tool carriers.	Polishers, bed setters, and sawyers.	Lumpers, boxers, and derrick men.	Tool sharpeners.	Granite cutters.	Total.
Average number of persons per room	0.67	0.65	0.76	0.87	0.83	0.82	0.72	0.87	0.83
Overcrowding[1] (per cent)	.0	.0	.0	3.8	1.5	1.0	.0	1.3	1.2
Death rate from pulmonary tuberculosis per 100,000	----	----	----	----	187.6	254.4	339.4	949.6	----

[1] On the basis of English standard of more than 2 persons per room.

The amount of overcrowding on the basis of the English standard of more than two persons in a room was most pronounced in the case of tool grinders and carriers and of granite cutters, and was relatively high in the case of polishers, bed setters, and sawyers, although this group shows a tuberculosis death rate very much lower than the corresponding rates for tool sharpeners and granite cutters. In fact, the investigation seems to justify the conclusion that on the whole the housing conditions are not greatly at variance for different wage-earning groups, and when compared with other housing surveys for industrial sections the results are decidedly in favor of men employed in the granite industry.

Comparing, for illustration, the room accommodation of granite cutters in Barre, Vt., with the housing conditions of workmen in Brooklyn and in the Chicago Stock Yards district, with a due regard to racial elements, the results as shown in Table 40 are as follows: The average number of persons to a room was 0.87 for the granite cutters of Barre, against 1.49 for Brooklyn workingmen's families, 1.12 for the Slovaks and 1.30 for the Lithuanians of the Chicago Stock Yards district, and 1.29 for the Greeks and Italians in the

vicinity of Hull House. The overcrowding on the basis of the English standard of more than two persons in a room was 1.3 per cent for granite cutters, 24.2 per cent for Brooklyn workingmen's families, 14.6 per cent for the Slovaks, and 12.9 per cent for the Lithuanians of the Chicago Stock Yards district, and 16.6 per cent for Greeks and Italians in the vicinity of Hull House.

TABLE 40.—ROOM ACCOMMODATION IN HOMES OF THE GRANITE CUTTERS OF BARRE, VT., COMPARED WITH THAT OF SELECTED GROUPS OF WORKINGMEN IN BROOKLYN AND CHICAGO.

[Housing Standards in Brooklyn, by John C. Gebhart, 1918; Chicago housing conditions, VIII, IX, and X, by Wilson, Smith, Hughes, and Walker, in the American Journal of Sociology, Vols. XX and XXI.]

Persons per room.	Granite cutters.	Brooklyn workingmen's families.	Chicago housing districts.		
			20th ward (Slovaks).	4th ward (Lithuanians).	Vicinity of Hull House (Greeks and Italians).
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
0.10 to 0.25	0.4	0.1	0.6	0.2	0.3
0.25 to 0.50	5.9	.9	2.2	1.8	3.5
0.50 to 0.75	26.6	6.7	11.6	10.1	12.8
0.75 to 1.00	23.1	6.5	9.0	9.4	8.5
1.00 to 1.25	32.7	20.2	25.3	19.2	22.9
1.25 to 1.50	6.4	16.7	16.0	19.4	13.1
1.50 to 1.75	2.5	17.2	17.3	18.0	17.0
1.75 to 2.00	1.0	7.5	3.5	9.0	5.3
2.00 to 2.25	1.1	11.1	8.6	8.2	8.6
2.25 to 2.50	.1	5.2	2.2	2.4	3.7
2.50 to 2.75	.1	4.1	2.1	1.7	2.3
2.75 to 3.00	.....	.5	.....	.....	.2
3.00 to 3.25	.1	1.8	1.4	.4	1.0
3.25 to 3.50	.....	.2	.....	.1	.1
3.50 to 3.75	.....	.5	.....	.....	.2
3.75 to 4.00	.....	.....	.....	.....	.....
4.00 to 4.25	.....	.6	.1	.1	.3
4.25 to 4.50	.....	.....	.....	.....	.....
4.50 to 4.75	.....	.1	.....	.....	.1
4.75 to 5.00	.....	.....	.....	.....	.....
5.00 and over	.....	.1	.1	.....	.1
Total	100.0	100.0	100.0	100.0	100.0
Average number of persons per room	0.87	1.49	1.12	1.30	1.29
Overcrowding[1] (per cent)	1.3	24.2	14.6	12.9	16.6

[1] On the basis of English standard of more than 2 persons per room.

The foregoing observations are amplified by Table 41, illustrating the conditions of overcrowding in the principal cities of representative sections of England and Wales, according to the census of 1911. This table presents a really extraordinary contrast in that the range of room density, as measured by the percentage of total population having more than two persons in a room, was from 39.8 per cent in the Finsbury metropolitan borough of London to 12.8 per cent in the Darlington metropolitan borough of Durham, against only 1.3 per cent for the granite cutters of Barre, Vt.

TABLE 41.—OVERCROWDING IN HOMES OF GRANITE CUTTERS AT BARRE, VT., COMPARED WITH THOSE OF "PRIVATE FAMILIES" OCCUPYING TENEMENTS IN THE MORE CONGESTED METROPOLITAN BOROUGHS, COUNTY BOROUGHS, AND URBAN DISTRICTS OF MORE THAN 50,000 INHABITANTS OF ENGLAND AND WALES.

Boroughs or districts.	Number of persons living more than two in a room.	Per cent of total population.
ENGLAND AND WALES, 1911.		
Finsbury metropolitan borough (London)	33,917	39.8
Shoreditch metropolitan borough (London)	39,127	36.6
Stepney metropolitan borough (London)	92,305	35.0
Gateshead county borough (Durham)	38,716	33.7
Bethnal Green metropolitan borough (London)	41,152	33.2
South Shields county borough (Durham)	34,998	32.9
Sunderland county borough (Durham)	48,125	32.6
Newcastle-upon-Tyne, city of, county borough (Northumberland)	81,141	31.6
Tynemouth county borough (Northumberland)	17,167	30.7
Southwark metropolitan borough (London)	46,800	25.8
Holborn metropolitan borough (London)	9,716	25.6
St. Pancras metropolitan borough (London)	51,214	25.5
Bermondsey metropolitan borough (London)	28,591	23.4
St. Marylebone metropolitan borough (London)	21,178	20.7
Poplar metropolitan borough (London)	32,240	20.6
Islington metropolitan borough (London)	62,789	20.0
Plymouth county borough (Devonshire)	18,565	17.5
Kensington metropolitan borough (London)	26,681	17.1
St. Helens county borough (Lancashire)	16,018	17.0
West Hartlepool county borough (Durham)	10,537	16.7
Dewsbury metropolitan borough (Yorkshire, West Riding)	8,646	16.6
Devonport county borough (Devonshire)	11,058	16.2
Paddington metropolitan borough (London)	20,885	16.2
West Ham county borough (Essex)	43,714	15.3
Dudley county borough (Worcestershire)	7,591	15.0
Chelsea metropolitan borough (London)	8,832	14.9
Fulham metropolitan borough (London)	21,784	14.6
Hammersmith metropolitan borough (London)	16,212	14.2
Willesden urban district (Middlesex)	21,175	13.9
Lambeth metropolitan borough (London)	38,816	13.6
Camberwell metropolitan borough (London)	34,174	13.5
Middlesbrough county borough (Yorkshire, North Riding)	13,513	13.4
Battersea metropolitan borough (London)	21,814	13.3
Wigan county borough (Lancashire)	11,297	12.9
Westminster, city of, metropolitan borough (London)	16,596	12.9
Darlington metropolitan borough (Durham)	6,912	12.8
GRANITE-CUTTING INDUSTRY, BARRE, VT.		
Granite cutters	15	1.3

The available data would seem to leave no other conclusion than that, aside from a more favorable physical condition, the granite cutters of the Barre district live under home conditions decidedly superior to those of wage-earners' families in the more congested centers of population. It would therefore seem to follow as a self-evident conclusion that the conditions predisposing to ill health and shortness of life, particularly to the excessive incidence of tuberculous or nontuberculous respiratory diseases, must be traceable to the industry in which the men are employed.

ABSENCE OF FAMILY INFECTION.

The relative frequency occurrence of tuberculosis in the families of granite cutters naturally raises the important question of the danger of infection. So much is included in what is still a serious matter of controversy that it would not serve a practical purpose to enlarge upon this subject at this time. The information collected during the present inquiry is, however, of such exceptional value that all the essential facts are presented in tabular form in Tables 42 to 45.

The practical value of this information will be better realized when attention is directed to the theoretical assumption according to which the extraordinary amount of pulmonary tuberculosis among granite cutters should have proved a fertile source of disease dissemination among other members of their families. As a matter of fact, no such dissemination has taken place, and particularly not in the case of granite-cutters' wives, for the relative frequency of pulmonary tuberculosis among them is considerably less than that which would be theoretically assumed to occur.

MORTALITY AMONG FAMILIES OF GRANITE CUTTERS.

FAMILY MORTALITY RECORDS OF GRANITE CUTTERS.

It has seemed advisable to consider very briefly in this connection the occurrence of pulmonary tuberculosis among the families of granite cutters, to determine, as far as this may be possible, the extent to which the disease as met with in the granite industry is unquestionably of an infectious character, or, conversely, the practical certainty that the prevailing lung diseases are of a nontubercular fibroid type erroneously diagnosed as tuberculous or of bacillary origin. Theoretically, the disease should be met with in practically the same proportions among the different members of granite-cutters' families as among the granite cutters themselves, on the assumption that through infection the disease is spread from one diseased adult to another. The evidence available, however, would seem to prove a relative infrequency of pulmonary tuberculosis, especially among granite-cutters' wives, who of all the members of the family are most exposed to the risk of direct contact infection. It is not implied, of course, that in many cases the diseases met with are not strictly tuberculous or a type of superinduced tuberculosis upon a preexisting pneumoconiosis. It is recognized that adult contact infection is of itself less common than is generally assumed to be the case, but the present investigation clearly emphasizes that the excessive frequency of lung diseases among granite cutters is not shared among other members of the families most exposed to the risk of contact infection. The data upon which these conclusions are based represent a special analysis of 18,406 deaths in the counties of Caledonia and Washington. The names on these certificates were carefully checked one against another and amplified, as far as practicable, by personal inquiry and the local cemetery records. It is realized that while such an investigation has inherent limitations and that it, of course, can not be extended to the entire family history of the persons concerned, it is the only method available by which a fair approximation of the truth can be arrived at. The data collected are presented in Tables 42 to 48, showing the causes of death among different members of granite-cutters' families both prior and subsequent to the granite cutter's death from tuberculosis. In the tables the deaths of sisters are excluded because of the fact that the names are too often lost sight of through marriage. Table 42 clearly indicates that deaths from tuberculosis are comparatively rare among granite-cutters' wives, but relatively excessively common among granite-cutters' brothers, who. it may be assumed, also represent employments in the granite-cutting

industry. The number of families for which it was possible to work up a family mortality record and in which the head of the family died from pulmonary tuberculosis during the period 1893–1919 was 162. The total number of persons represented by these 162 families was 232. Of this number, 20 wives died previous to the death of the granite cutter from pulmonary tuberculosis, while 24 died subsequently. Of the 20 prior deaths only 3 were from pulmonary tuberculosis, while among the 24 subsequent deaths, 5 were from pulmonary tuberculosis. Without attempting a refinement in analysis, it would seem entirely safe to conclude that, considering the relatively large exposure, the occurrence of death from tuberculosis among granite-cutters' wives is unquestionably below what would be expected on the probable degree of infectiousness in adult life. Similar conclusions apply to daughters and mothers. The larger number of deaths among sons, fathers, and brothers is in all probability directly attributable to their employment in the stone industry.

TABLE 42.—FAMILY MORTALITY[1] OF GRANITE CUTTERS OF WASHINGTON AND CALEDONIA COUNTIES, VT., WHO DIED FROM PULMONARY TUBERCULOSIS, 1893 TO 1919, CLASSIFIED ACCORDING TO RELATIONSHIP, CAUSE OF DEATH, AND WHETHER DEATH WAS PRIOR OR SUBSEQUENT TO THAT OF DECEASED CUTTER.

[Based on records of families of 162 deceased cutters. Abbreviations: B.=brother; F.=father; S.=son; M.=mother; D.=daughter; W.=wife.]

Abridged international list number.[2]	Cause of death.	Prior deaths.						Subsequent deaths.					
		B.	F.	S.	M.	D.	W.	W.	D.	M.	S.	F.	B.
1	Typhoid fever	1	....	1	....	1	....	....	....	....	....	....	1
9	Influenza	1	....	....	....	....	....	1	2	....	....	....	....
12	Other epidemic diseases	....	....	....	....	....	....	....	....	....	....	....	....
13	Tuberculosis of the lungs	27	6	9	3	1	3	5	2	....	5	5	23
14	Tuberculous meningitis	....	....	....	....	....	....	....	....	....	....	....	....
15	Other forms of tuberculosis	....	....	....	....	....	....	....	....	....	....	....	....
16	Cancer and other malignant tumors	1	....	....	3	....	1	4	....	1	....	....	3
17	Simple meningitis	1	....	....	....	....	....	1	....	....	....	....	....
18	Cerebral hemorrhage and softening	....	1	....	....	....	....	2	....	1	1	1	2
19	Organic diseases of the heart	4	1	....	....	....	1	2	1	1	....	2	1
20	Acute bronchitis	....	....	....	....	....	1	....	....	1	....	....	....
21	Chronic bronchitis	....	....	....	2	....	....	1	....	....	....	....	....
22	Pneumonia	5	2	....	2	1	3	1	1	....	1	1	7
23	Other diseases of the respiratory system (tuberculosis excepted)	2	3	1	....	....	1	....	....	....	....	....	3
24	Diseases of the stomach (cancer excepted)	....	....	....	....	....	....	....	....	....	....	1	....
26	Appendicitis and typhlitis	....	....	....	....	....	....	....	....	....	....	....	1
27	Hernia, intestinal obstruction	....	....	....	....	....	....	1	....	....	....	....	....
28	Cirrhosis of the liver	....	....	....	....	....	....	1	....	....	....	....	....
29	Acute nephritis and Bright's disease	1	....	1	1	....	3	2	....	1	....	1	2
30	Noncancerous tumors and other diseases of the female genital organs	....	....	....	....	....	....	....	....	....	....	....	....
31	Puerperal septicemia (puerperal fever, peritonitis)	....	....	....	....	2	....	1	....	....	....	....	....
32	Other puerperal accidents of pregnancy and labor	....	....	....	....	1	1	....	1	....	....	....	....
33	Congenital debility and malformations	1	....	....	....	....	....	....	....	....	....	....	....
34	Senility	....	3	....	....	....	....	....	....	1	....	....	....
35	Violent deaths (suicide excepted)	1	....	1	....	....	....	....	....	....	1	....	....
36	Suicide	....	....	....	....	....	....	....	....	....	....	....	1
37	Other diseases	3	2	1	3	....	6	2	....	1	1	1	5
38	Unknown or ill-defined diseases	2	1	....	....	....	....	....	....	....	....	....	1
	All causes	50	19	14	14	6	20	24	7	7	9	12	50

[1] Adults 15 years of age and over.
[2] Manual of the International List of Causes of Death, United States Bureau of the Census, Washington, D. C., 1916.

Family records were also obtained for 133 deceased stonecutters who died from causes other than pulmonary tuberculosis during the period 1893–1919 (Table 43). Among this group the total number of deaths of other members of the family recorded was 151. There were 20 prior deaths of wives and 18 subsequent deaths of wives from all causes, and 3 deaths from pulmonary tuberculosis among the former and 1 death among the latter. It would serve no purpose to apply refined methods of statistical analysis to so small a statistical basis of information, but, again, it is a safe inference that pulmonary tuberculosis is comparatively of about the same degree of occurrence among the wives of granite cutters dying from tuberculosis as among those who died from other causes. Practically the same conclusions apply to other members of the family.

TABLE 43.—FAMILY MORTALITY[1] OF GRANITE CUTTERS OF WASHINGTON AND CALEDONIA COUNTIES, VT., WHO DIED FROM CAUSES OTHER THAN PULMONARY TUBERCULOSIS, 1893 TO 1919, CLASSIFIED ACCORDING TO RELATIONSHIP, CAUSE OF DEATH, AND WHETHER DEATH WAS PRIOR OR SUBSEQUENT TO THAT OF DECEASED CUTTER.

[Based on records of families of 133 deceased cutters. Abbreviations: B.=brother; F.=father; S.=son; M.=mother; D.=daughter; W.=wife.]

Abridged international list number.[2]	Cause of death.	Prior deaths.						Subsequent deaths.					
		B.	F.	S.	M.	D.	W.	W.	D.	M.	S.	F.	B.
1	Typhoid fever	1											
9	Influenza	3			1		1	3			3		2
12	Other epidemic diseases												
13	Tuberculosis of the lungs	14	2	2			3	1			1	2	13
14	Tuberculous meningitis			1									
15	Other forms of tuberculosis												
16	Cancer and other malignant tumors	1			1			2		2		2	2
17	Simple meningitis										1		
18	Cerebral hemorrhage and softening	2	1		2		1	1		1	1	2	
19	Organic diseases of the heart	4	1		2			2		1		2	2
20	Acute bronchitis												
21	Chronic bronchitis							1					
22	Pneumonia	2		1	2	1	3	2			2	1	3
23	Other diseases of the respiratory system (tuberculosis excepted)												
24	Diseases of the stomach (cancer excepted)												
26	Appendicitis and typhlitis	1											
27	Hernia, intestinal obstruction					1		1					1
28	Cirrhosis of the liver						1						
29	Acute nephritis and Bright's disease				1		5			2			
30	Noncancerous tumors and other diseases of the female genital organs						1						
31	Puerperal septicemia (puerperal fever, peritonitis)												
32	Other puerperal accidents of pregnancy and labor												
33	Congenital debility and malformations												
34	Senility		1					1					
35	Violent deaths (suicide excepted)	3		1			1	1					
36	Suicide	1		1									1
37	Other diseases	1	2		2	1	4	3		1		1	1
38	Unknown or ill-defined diseases	1									1		1
	All causes	34	7	6	11	3	20	18		7	9	10	26

[1] Adults 15 years of age and over.
[2] Manual of the International List of Causes of Death, United States Bureau of the Census, Washington, D. C., 1916.

FAMILY MORTALITY RECORDS OF FARMERS.

It was found possible to ascertain in a similar manner the family mortality record of 77 farmers, including 108 deaths of other members of the family (Table 44). All these farmers died from tuberculosis, there having been 8 prior deaths of wives from all causes, and 15 subsequent deaths, with 1 death each from pulmonary tuberculosis. The data are insufficient for the purpose of a strictly scientific conclusion, but it is safe conjecture that pulmonary tuberculosis is relatively not more common among the families of granite cutters, who are excessively subject to the disease, than among farmers, who are subject only to a normal rate of incidence.

TABLE 44.—FAMILY MORTALITY[1] OF FARMERS OF WASHINGTON AND CALEDONIA COUNTIES, VT., WHO DIED FROM PULMONARY TUBERCULOSIS, 1893 TO 1919, CLASSIFIED ACCORDING TO RELATIONSHIP, CAUSE OF DEATH, AND WHETHER DEATH WAS PRIOR OR SUBSEQUENT TO THAT OF DECEASED FARMER.

[Based on records of families of 77 deceased farmers. Abbreviations: B.=brother; F.=father; S.=son; M.=mother; D.=daughter; W.=wife.]

Abridged international list number.[2]	Cause of death.	Prior deaths.						Subsequent deaths.					
		B.	F.	S.	M.	D.	W.	W.	D.	M.	S.	F.	B.
1	Typhoid fever	....	....	1	....	....	....	....	....	....	....	....	....
9	Influenza	....	....	....	....	....	1	....	....	....	....	....	1
12	Other epidemic diseases	....	....	....	....	....	....	....	....	....	....	....	....
13	Tuberculosis of the lungs	3	3	3	5	3	1	1	2	1	4	3	3
14	Tuberculous meningitis	....	....	....	....	....	....	....	....	....	1	....	....
15	Other forms of tuberculosis	....	....	....	....	....	....	....	....	....	....	....	....
16	Cancer and other malignant tumors	....	....	....	....	....	....	1	....	1	....	....	1
17	Simple meningitis	....	....	....	....	....	1	....	....	....	....	....	....
18	Cerebral hemorrhage and softening	....	....	....	2	....	1	1	....	2	....	....	....
19	Organic disease of the heart	....	....	....	1	....	2	1	....	2	....	2	3
20	Acute bronchitis	....	....	....	....	....	....	....	....	....	....	....	....
21	Chronic bronchitis	....	....	....	....	....	....	....	....	....	....	....	....
22	Pneumonia	....	1	....	....	....	1	2	....	1	1	1	
23	Other diseases of the respiratory system (tuberculosis excepted)	....	....	....	....	....	....	1	....	....	....	....	1
24	Diseases of the stomach (cancer excepted)	....	....	....	....	....	....	....	....	....	....	....	....
26	Appendicitis and typhlitis	....	....	....	....	....	....	....	....	....	....	....	....
27	Hernia, intestinal obstruction	....	....	....	1	....	....	....	....	....	....	....	....
28	Cirrhosis of the liver	....	....	....	....	....	....	....	....	....	....	....	1
29	Acute nephritis and Bright's disease	....	3	....	....	....	....	1	....	....	....	2	1
30	Noncancerous tumors and other diseases of the female genital organs	....	....	....	....	....	....	....	....	....	....	....	....
31	Puerperal septicemia (puerperal fever, peritonitis)	....	....	....	....	....	....	....	....	....	....	....	....
32	Other puerperal accidents of pregnancy and labor	....	....	....	....	....	....	....	....	....	....	....	....
33	Congenital debility and malformations	....	....	....	....	....	....	....	....	....	....	....	....
34	Senility	....	1	....	....	....	....	4	....	1	....	1	1
35	Violent deaths (suicide excepted)	....	....	....	....	1	....	....	....	1	....	....	1
36	Suicide	1	....	....	....	....	....	....	....	....	....	1	1
37	Other diseases	....	2	....	1	....	1	3	....	1	1	3	3
38	Unknown or ill-defined diseases	....	....	....	1	....	....	....	....	....	....	....	1
	All causes	4	10	4	11	4	8	15	2	10	7	13	20

[1] Adults 15 years of age and over.
[2] Manual of the International List of Causes of Death, United States Bureau of the Census, Washington, D. C., 1916.

Finally, there is included the mortality record of 904 deceased farmers who died from causes other than pulmonary tuberculosis. The number of deaths of other members of the family among this group was 1,204. It is shown in Table 45 that there were 212 prior deaths of wives, with 11 deaths from pulmonary tuberculosis, and 285 subsequent deaths of wives, with 4 deaths from pulmonary tuberculosis. It is significant that the number of deaths from this disease among brothers and fathers, both prior and subsequent, should have been

so much less proportionately than observed among deaths of male relatives of granite cutters dying both from pulmonary tuberculosis and from other causes. This disparity can only be explained on the ground of occupational exposure. It may, of course, be objected that the data for granite cutters are insufficient, especially when contrasted with the much larger exposure of nontuberculous farmers' families, and the question may be raised that 5 subsequent deaths of wives of tuberculous granite cutters from pulmonary tuberculosis, among 24 deaths from all causes is a much higher proportion than the 4 deaths from this disease among the 285 subsequent deaths of wives of nontuberculous farmers. It is not, of course, argued that deaths from infection do not occur in adult life among wives whose husbands have died of the disease, but if the risk of adult infection were at all a serious phenomenon it is a practical certainty that the proportion of infected wives dying from pulmonary tuberculosis would have been much greater than has actually been the case. It is not intended that any of the foregoing observations and conclusions should be carried too far, but the material seemed too valuable to be omitted from the present discussion. The method certainly suggests practically infinite possibilities for the future, being indicative of reasonably trustworthy results provided the analysis is made with the requisite impartiality.

TABLE 45.—FAMILY MORTALITY [1] OF FARMERS OF WASHINGTON AND CALEDONIA COUNTIES, VT., WHO DIED FROM CAUSES OTHER THAN PULMONARY TUBERCULOSIS, 1893 TO 1919, CLASSIFIED ACCORDING TO RELATIONSHIP, CAUSE OF DEATH, AND WHETHER DEATH WAS PRIOR OR SUBSEQUENT TO THAT OF DECEASED FARMER.

[Based on records of families of 904 deceased farmers. Abbreviations: B.=brother; F.=father; S.=son; M.=mother; D.=daughter; W.=wife.]

Abridged international list number.[2]	Cause of death.	Prior deaths.						Subsequent deaths.					
		B.	F.	S.	M.	D.	W.	W.	D.	M.	S.	F.	B.
1	Typhoid fever	....	....	2	....	3	....	3	1	....	1	....	....
9	Influenza	2	....	1	2	....	5	12	1	1	....	....	2
12	Other epidemic diseases	....	....	....	....	1	2	2	1	....	1	1	....
13	Tuberculosis of the lungs	3	....	1	1	11	11	4	4	....	3	1	....
14	Tuberculous meningitis	....	....	....	....	1	1	....	2	....	1	....	....
15	Other forms of tuberculosis	....	....	....	....	....	2	....	....	....	....	....	2
16	Cancer and other malignant tumors	20	4	2	6	....	21	24	1	5	3	2	17
17	Simple meningitis	....	....	....	....	1	....	....	....	....	....	....	....
18	Cerebral hemorrhage and softening	23	8	7	3	....	27	39	3	3	4	7	22
19	Organic diseases of the heart	33	7	2	5	4	35	29	1	7	5	3	33
20	Acute bronchitis	5	....	....	1	....	1	11	....	2	1	1	4
21	Chronic bronchitis	....	....	....	2	....	5	4	....	1	....	....	....
22	Pneumonia	26	4	9	10	....	26	33	1	5	4	3	12
23	Other diseases of the respiratory system (tuberculosis excepted)	5	1	1	1	1	8	14	....	....	5	1	5
24	Diseases of the stomach (cancer excepted)	2	....	1	1	....	4	5	....	....	1	....	2
26	Appendicitis and typhlitis	....	....	....	1	....	3	1	....	....	....	....	....
27	Hernia, intestinal obstruction	1	1	1	....	....	5	5	....	1	2	1	1
28	Cirrhosis of the liver	....	....	....	....	2	....	....	....	....	....	....	....
29	Acute nephritis and Bright's disease	13	2	4	1	3	10	12	1	1	5	4	16
30	Noncancerous tumors and other diseases of the female genital organs	....	....	....	....	1	1	1	....	....	....	....	....
31	Puerperal septicemia (puerperal fever, peritonitis)	....	....	....	....	....	....	....	....	....	....	....	....
32	Other puerperal accidents of pregnancy and labor	....	....	....	....	....	....	....	....	....	....	....	....
33	Congenital debility and malformations	1	....	....	....	....	....	1	....	....	....	....	....
34	Senility	12	10	1	5	1	12	32	....	7	....	3	19
35	Violent deaths (suicide excepted)	5	3	3	....	....	2	2	3	....	2	1	6
36	Suicide	3	1	1	....	1	....	1	....	....	5	1	1
37	Other diseases	26	12	5	6	3	26	47	2	6	12	7	44
38	Unknown or ill-defined diseases	5	....	....	3	1	5	3	....	....	1	1	7
	All causes	185	53	41	48	34	212	285	21	39	56	37	193

[1] Adults 15 years of age and over.
[2] Manual of the International List of Causes of Death, United States Bureau of the Census. Washington, D. C., 1916.

EVIDENCE CONCLUSIVE AS TO AN EXCESSIVE MORTALITY FROM DUST PHTHISIS.

The general conclusions derived from these data would therefore seem to support the theory that granite cutters in the State of Vermont are subject to an excessive frequency of death from pulmonary tuberculosis, not because of an exceptional risk of contact infection, or because of inferior physique, or because of unfavorable housing conditions or other sanitary deficiencies, but primarily because of the occupational exposure, which in its final analysis is reduced to the dust hazard resulting from the excessive use of pneumatic tools.

EVIDENCE INCONCLUSIVE AS TO CONTACT INFECTION.

To make the foregoing observations as useful as possible, three additional tables are included, illustrating the family mortality of granite manufacturers and cutters from principal causes, classified according to the frequency of deaths from given causes during the period 1893–1919. Table 46 shows the distribution of deaths by causes, based on the records of 227 families of granite cutters and manufacturers. These 227 families are represented by 543 deaths, in 404 of which a given cause of death occurred once in a family, in 112 twice, and in 27 three or more times. Tuberculosis is the only disease which shows a well-defined tendency to recurrence in the same family. Considering the universal distribution of this disease, its relative occurrence among granite-cutters' families can not be looked upon as abnormal, for against 93 families with only one death from tuberculosis there were 42 with two deaths and only 7 with three or more deaths.[a]

[a] In this connection the following statement by Dr. Harry Le Barnes of the Vollum Lake Sanatorium, R. I., on the incidence of tuberculosis of husbands and wives is of interest:

"The histories of 229 consecutive widowed patients admitted to the Rhode Island State Sanatorium, 1905–1921, showed that 93, or 40 per cent, lost their consorts by death from tuberculosis, the tuberculosis mortality being over three times that of the married people of the community."

This statement would justify the conclusion that the type of lung disease called pulmonary tuberculosis in the Barre district as it concerns granite workers is in all probability a nontuberculous form of dust phthisis, frequently complicated in its terminal stage by a superinduced but less infectious type of true tuberculosis.

TABLE 46.—FAMILY MORTALITY[1] OF GRANITE MANUFACTURERS AND CUTTERS OF WASHINGTON AND CALEDONIA COUNTIES, VT., FROM PRINCIPAL CAUSES, 1893 TO 1919, CLASSIFIED ACCORDING TO FREQUENCY OF DEATHS FROM GIVEN CAUSE.

[Based on the records of 227 families.]

Cause of death.	Number of families with no deaths from given cause.	Families with one death from given cause.			Families with two deaths from given cause.			Families with three or more deaths from given cause.		
		No.	Deaths.	Deaths of granite manufacturers and cutters.	No.	Deaths.	Deaths of granite manufacturers and cutters.	No.	Deaths.	Deaths of granite manufacturers and cutters.
Tuberculosis of the lungs	85	93	93	81	42	84	59	7	24	15
Pneumonia	171	52	52	30	3	6	2	1	3	1
Organic diseases of the heart	194	31	31	9	2	4	2	....	.....	.....
Bright's disease	198	25	25	11	4	8	2	....	.....	.....
Cerebral hemorrhage and apoplexy	207	20	20	4	....	.....	.....	....	.....	.....
Influenza	207	18	18	8	2	4	4	....	.....	.....
Cancer of the stomach and liver	218	7	7	3	2	4	3	....	.....	.....
Typhoid fever	220	7	7	3	....	.....	.....	....	.....	.....
Senility	220	7	7	.....	....	.....	.....	....	.....	.....
Purulent infection and septicemia	221	6	6	2	....	.....	.....	....	.....	.....
Angina pectoris	221	6	6	.....	....	.....	.....	....	.....	.....
Chronic bronchitis	221	6	6	3	....	.....	.....	....	.....	.....
Cancer of the peritoneum, intestines, and rectum	222	5	5	2	....	.....	.....	....	.....	.....
Cancer of the female genital organs	222	5	5	.....	....	.....	.....	....	.....	.....
Cancer of other organs	222	5	5	2	....	.....	.....	....	.....	.....
Traumatism by other crushing (vehicles, etc.)	222	5	5	3	....	.....	.....	....	.....	.....
Alcoholism (acute or chronic)	223	4	4	2	....	.....	.....	....	.....	.....
Diseases of the arteries, atheroma, etc	223	4	4	2	....	.....	.....	....	.....	.....
Broncho-pneumonia	223	4	4	1	....	.....	.....	....	.....	.....
Pulmonary congestion and pulmonary apoplexy	223	4	4	3	....	.....	.....	....	.....	.....
Hernia and intestinal obstruction	223	4	4	.....	....	.....	.....	....	.....	.....
Cirrhosis of the liver	223	4	4	.....	....	.....	.....	....	.....	.....
Suicide by firearms	223	4	4	4	....	.....	.....	....	.....	.....
Diabetes	224	3	3	.....	....	.....	.....	....	.....	.....
Acute endocarditis	224	3	3	1	....	.....	.....	....	.....	.....
Acute bronchitis	224	3	3	.....	....	.....	.....	....	.....	.....
Appendicitis and typhlitis	224	3	3	2	....	.....	.....	....	.....	.....
Other diseases of the liver	224	3	3	1	....	.....	.....	....	.....	.....
Acute nephritis	224	3	3	1	....	.....	.....	....	.....	.....
Accidental drowning	224	3	3	2	....	.....	.....	....	.....	.....
Homicide by firearms	224	3	3	1	....	.....	.....	....	.....	.....
All other causes	.....	....	54	16	....	2	1	....	.....	.....
Total	.....	....	404	197	....	112	73	....	27	16

[1] Adults 15 years of age and over.

In Table 47 it is shown that among 2,040 families representing occupations other than granite cutters in Caledonia and Washington Counties, Vt., there occurred 4,608 deaths, of which 4,034 were in families in which 1 death from each given cause occurred, 534 in families having 2 deaths from each given cause, and 40 in families having 3 or more deaths from each given cause. Of the 534 deaths occurring in families having 2 deaths from a given cause 116 were from pulmonary tuberculosis, and in 40 families having 3 or more deaths from a given cause there were 18 from pulmonary tuberculosis. Here again an inference might seem justified that pulmonary tuberculosis is somewhat more common among granite-cutters' families

as the result of direct contact infection; but, taking all the facts into consideration, the writer is inclined to think that the data do not justify such a conclusion.

TABLE 47.—MORTALITY[1] FROM PRINCIPAL CAUSES IN FAMILIES OF WASHINGTON AND CALEDONIA COUNTIES, VT., 1893 TO 1919, OTHER THAN THOSE OF GRANITE MANUFACTURERS AND CUTTERS, CLASSIFIED ACCORDING TO FREQUENCY OF DEATHS FROM GIVEN CAUSE.

[Based on records of 2,040 families.]

Cause of death.	Number of families with no deaths from given cause.	Families with one death from given cause.		Families with two deaths from given cause.		Families with three or more deaths from given cause.	
		No.	Deaths.	No.	Deaths.	No.	Deaths
Tuberculosis of the lungs	1,699	277	277	58	116	6	18
Pneumonia	1,575	407	407	56	112	2	7
Organic diseases of the heart	1,517	471	471	50	100	2	6
Bright's disease	1,756	266	266	18	36	.....	.....
Cerebral hemorrhage and apoplexy	1,630	375	375	33	66	2	6
Influenza	1,941	95	95	4	8	.....	.....
Cancer of the stomach and liver	1,929	104	104	7	14	.....	.....
Typhoid fever	1,996	41	41	3	6	.....	.....
Senility	1,808	221	221	11	22	.....	.....
Purulent infection and septicemia	2,022	17	17	.....	.....	1	3
Angina pectoris	1,973	65	65	2	4	.....	.....
Chronic bronchitis	1,987	52	52	1	2	.....	.....
Cancer of the peritoneum, intestines, and rectum	2,014	26	26	.....	.....	.....	.....
Cancer of the female genital organs	2,006	34	34	.....	.....	.....	.....
Cancer of other organs	1,961	77	77	2	4	.....	.....
Traumatism by other crushing (vehicles, etc.)	2,009	28	28	3	6	.....	.....
Alcoholism (acute or chronic)	2,028	12	12	.....	.....	.....	.....
Diseases of the arteries, atheroma, etc	1,911	126	126	3	6	.....	.....
Broncho-pneumonia	1,968	71	71	1	2	.....	.....
Pulmonary congestion and pulmonary apoplexy	1,987	52	52	1	2	.....	.....
Hernia and intestinal obstruction	2,005	35	35	.....	.....	.....	.....
Cirrhosis of the liver	2,022	17	17	1	2	.....	.....
Suicide by firearms	2,021	19	19	.....	.....	.....	.....
Diabetes	2,000	38	38	2	4	.....	.....
Acute endocarditis	2,028	12	12	.....	.....	.....	.....
Acute bronchitis	2,004	35	35	1	2	.....	.....
Appendicitis and typhlitis	2,019	21	21	.....	.....	.....	.....
Other diseases of the liver	2,017	23	23	.....	.....	.....	.....
Acute nephritis	2,019	21	21	.....	.....	.....	.....
Accidental drowning	2,028	11	11	1	2	.....	.....
Homicide by firearms	2,039	1	1	.....	.....	.....	.....
All other causes	.....	.....	984	.....	18	.....	.....
Total	.....	.....	4,034	.....	534	.....	40

[1] Adults 15 years of age and over.

Table 46 includes the additional information of the deaths of granite cutters and manufacturers, extracted from the family mortality so as to make possible a more strict comparison with deaths of members of the family without reference to the heads of such families. The importance of this is more clearly indicated in Table 48, which gives the proportionate distribution of deaths. Possibly more extended consideration should have been given to this point, for of course the influence of the heavy mortality of granite cutters themselves on the aggregate family mortality is very serious.

TABLE 48.—FAMILY MORTALITY[1] OF GRANITE MANUFACTURERS AND CUTTERS FROM PRINCIPAL CAUSES COMPARED WITH THAT OF ALL OTHER FAMILIES OF WASHINGTON AND CALEDONIA COUNTIES, VT., 1893 TO 1919.

[Based on records of 227 families of granite manufacturers and cutters and 2,040 families of others.]

Cause of death.	No deaths from given cause.			One death from given cause.			Two or more deaths from given cause.		
	Families of granite manufacturers and cutters.		All other families.	Families of granite manufacturers and cutters.		All other families.	Families of granite manufacturers and cutters.		All other families.
	Including manufacturers and cutters.	Excluding manufacturers and cutters.		Including manufacturers and cutters.	Excluding manufacturers and cutters.		Including manufacturers and cutters.	Excluding manufacturers and cutters.	
	Per ct.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*
Tuberculosis of the lungs	37.4	80.6	83.3	41.0	18.1	13.6	21.6	1.3	3.1
Pneumonia	75.3	89.0	77.2	22.9	10.1	20.0	1.8	.9	2.8
Organic diseases of the heart	85.5	90.3	74.3	13.6	9.7	23.1	.9	.....	2.6
Bright's disease	87.2	92.1	86.1	11.0	7.0	13.0	1.8	.9	.9
Cerebral hemorrhage and apoplexy	91.2	93.0	79.9	8.8	7.0	18.4	.....	.....	1.7
Influenza	91.2	96.5	95.1	7.9	3 5	4.7	.9	.....	.2
Cancer of the stomach and liver	96.0	97.8	94.6	3.1	2.2	5.1	.9	.....	3
Typhoid fever	96.9	98.2	97.9	3.1	1.8	2.0	.....	.....	.1
Senility	96.9	96.9	88.7	3.1	3.1	10.8	.....	.....	.5
Purulent infection and septicemia	97.4	98.2	99.1	2.6	1.8	.8	.....	.....	.1
Angina pectoris	97.4	97.4	96.7	2.6	2.6	3.2	.....	.....	.1
Chronic bronchitis	98.7	98.7	97.4	2.6	1.3	2.5	.....	.....	.1
Cancer of the peritoneum, intestines, and rectum	97.8	98.7	98.7	2.2	1.3	1.3	.....	.....	.....
Cancer of the female genital organs	97.8	97.8	98.3	2.2	2.2	1.7	.....	.....	.....
Cancer of other organs	97.8	98.7	96.1	2.2	1.3	3.8	.....	.....	.1
Traumatism by other crushing (vehicles, etc.)	97.8	99.1	98.5	2.2	.9	1.4	.....	.....	.1
Alcoholism (acute or chronic)	98.2	99.1	99.4	1.8	.9	.6	.....	.....	.....
Diseases of the arteries, atheroma, etc	98.2	99.1	93.7	1.8	.9	6.2	.....	.....	.1
Broncho-pneumonia	98.2	98.7	96.5	1.8	1.3	3.4	.....	.....	.1
Pulmonary congestion and pulmonary apoplexy	98.2	99.6	97.4	1.8	.4	2.5	.....	.....	.1
Hernia and intestinal obstruction	98.2	98.2	98.3	1.8	1.8	1.7	.....	.....	.....
Cirrhosis of the liver	98.2	98.2	99.1	1.8	1.8	.8	.....	.....	.1
Suicide by firearms	98.2	100.0	99.1	1.8	.....	.9	.....	.....	.....
Diabetes	98.7	98.7	98.0	1.3	1.3	1.9	.....	.....	.1
Acute endocarditis	98.7	99.1	99.4	1.3	.9	.6	.....	.....	.....
Acute bronchitis	98.7	98.7	98.2	1.3	1.3	1.7	.....	.....	.1
Appendicitis and typhilitis	98.7	99.6	99.0	1.3	.4	1.0	.....	.....	.....
Other diseases of the liver	98.7	99.1	98.9	1.3	.9	1.1	.....	.....	.....
Acute nephritis	98.7	99.1	99.0	1.3	.9	1.0	.....	.....	.....
Accidental drowning	98.7	99.6	99.4	1.3	.4	.5	.....	.....	.1
Homicide by firearms	98.7	99.1	99.9	1.3	.9	.1	.....	.....	.....

[1] Adults 15 years of age and over.

Excluding manufacturers and cutters, it is shown that among granite-cutters' families no tuberculosis occurred in 80.6 per cent of all the families considered, against 83.3 per cent for nongranite-cutters' families, as dealt with in greater detail in Table 47. The disease occurred once among 18.1 per cent of granite-cutters' families as against 13.6 per cent for all other families, and it occurred twice or more in the proportion of 1.3 per cent for granite-cutters' families to 3.1 per cent for all other families. This really sustains the conclusion, previously advanced, that the frequency of pulmonary tuberculosis among immediate relatives of granite cutters, but particu-

larly wives, daughters, and mothers, is much less than as a mere matter of probability would be assumed to be the case.

Inquiry was made as to the mortality from pulmonary tuberculosis among the families of living granite workers and it was found that of a total of 1,869 granite workers interviewed, 312 gave positive tuberculosis histories in their families. The distribution of the members of the families who had died from the disease was as follows:

TABLE 49.—MORTALITY FROM PULMONARY TUBERCULOSIS IN THE FAMILIES OF LIVING GRANITE WORKERS OF BARRE, VT., AUGUST, 1919, CLASSIFIED ACCORDING TO AGE AT DEATH, AND RELATIONSHIP TO THE GRANITE WORKERS, OF THE DECEASED MALES.

Age at death.	Deceased males.								
	Brothers.	Uncles.	Fathers.	Brothers-in-law.	Cousins.	Fathers-in-law.	Grandfathers.	Sons.	Total.
10 to 19 years	8				1			5	14
20 to 29 years	25	2	1	4				8	40
30 to 39 years	17	6	2	3					28
40 to 49 years	30	17	21	5	2	3		2	80
50 to 59 years	22	14	31	2		3	1		73
60 to 69 years	3	7	20	1	1	1	1		34
70 to 79 years		1	1			1	2		5
80 to 89 years						2			2
Total	105	47	76	15	4	10	4	15	276
Average age	37.9	48.0	53.3	39.2	42.5	59.6	66.5	24.6	44.5

Age at death.	Deceased females.								
	Aunts.	Sisters.	Sisters-in-law.	Mothers.	Cousins.	Mothers-in-law.	Wives.	Grandmothers.	Daughters.	Total.
10 to 19 years		4	1		2				1	8
20 to 29 years		26	4	2	1		5		1	39
30 to 39 years	4	5	1	10			2	1		23
40 to 49 years	5	6	1	3		3		2		20
50 to 59 years	4	1		4			2	1		12
60 to 69 years	2	1				2		3		8
70 to 79 years				1				2		3
80 to 89 years								1		1
Total	15	43	7	20	3	5	9	10	2	114
Average age	45.1	28.3	26.6	39.8	17.0	49.8	34.7	59.6	22.0	36.2

The occupations which had been followed by the deceased males were as follows:

TABLE 50.—DISTRIBUTION OF DECEASED MALES BY OCCUPATION.

Occupations.	Brothers.	Uncles.	Fathers.	Brothers-in-law.	Cousins.	Fathers-in-law.	Grandfathers.	Sons.	Total.
Granite cutters	54	23	56	8	2	5	1	5	154
Farmers	4	4	3	1			2		14
All other occupations	47	20	17	6	2	5	1	10	108
Total	105	47	76	15	4	10	4	15	276

TRADE LIFE AND OCCUPATIONAL CHANGES.

OCCUPATION THE PRIMARY CAUSATIVE FACTOR OF EXCESSIVE TUBERCULOSIS MORTALITY.

Evidently the principal underlying conditions responsible for the excessive amount of mortality from lung disease in granite cutting are occupational. It is therefore necessary to inquire with exceptional thoroughness into matters concerning trade life and occupational changes, as to which the available information for other trades is extremely limited. In the present investigation it has been found possible to ascertain facts of the first importance, emphasizing circumstances which unquestionably bear upon the larger question of disease predisposition and relative frequency. With these data of comparable value there are included some corresponding statistics for limestone workers in southern Indiana as representing a branch of the stone industry subject unquestionably to quite a different occupational hazard. The first question which requires consideration is the extent to which previous employments may possibly modify the risk inherent in the granite-cutting industry. Information as to such previous employments has been obtained by personal inquiry for many occupations, but for practical reasons the tabular analysis is limited to 50 of the most important. The details of the investigation are given in Table 51, according to which the previous occupation of granite cutters was chiefly marble cutting or farming. This is followed by tool grinding and drilling in granite quarries. None of the other occupations are of sufficient numerical importance to bear directly upon the question at issue. The average length of previous employment in marble cutting was nine years and in farming eight years. This is reduced to only two years in tool grinding and 3.4 years in drilling.

TABLE 51.—DISTRIBUTION OF WORKERS IN GRANITE-CUTTING INDUSTRY IN BARRE, VT., AUGUST, 1919, ACCORDING TO THE 50 MOST IMPORTANT PREVIOUS OCCUPATIONS.

Previous occupations.	Granite cutters.		Workers other than granite cutters.	
	Per cent.	Average period of employment (years).	Per cent.	Average period of employment (years).
Marble cutters	31.6	9.0	7.5	9.5
Farmers	20.0	8.0	35.1	10.5
Tool grinders, granite industry	6.9	2.0	12.2	2.0
Granite cutters			15.3	15.4
Drillers, granite quarries	2.8	3.4	4.8	6.8
Messengers	2.0	2.2	1.5	1.5
Clerks	1.8	2.4	4.7	2.4
Grocers and butchers	1.7	3.4	1.8	3.6
Masons and bricklayers	1.7	7.7	2.5	9.4
Lumpers, granite industry	1.7	1.8	6.1	6.2
Tool carriers, granite industry	1.4	2.0	1.5	3.0
Mechanics and machinists	1.3	3.2	3.6	4.2
Carpenters	1.2	5.0	1.2	6.1
Blacksmiths, general	1.2	4.1	2.5	8.7
Teamsters	1.1	3.3	5.5	5.3
Bakers	.8	3.3	1.1	5.9
Woodchoppers	.7	5.7	2.3	5.2
Derrick men, granite industry	.7	1.9	2.2	4.0
Granite polishers	.6	4.7	3.1	6.4
Sailors	.6	5.1	1.2	8.4
Painters	.5	2.8	.5	8.4

TABLE 51.—DISTRIBUTION OF WORKERS IN GRANITE-CUTTING INDUSTRY IN BARRE, VT., AUGUST, 1919, ACCORDING TO THE 50 MOST IMPORTANT PREVIOUS OCCUPATIONS—Concluded.

Previous occupations.	Granite cutters.		Worders other than granite cutters.	
	Per cent.	Average period of employment (years).	Per cent.	Average period of employment (years).
Spinners, woolen mills	0.4	3.6	0.4	3.8
Soldiers	.4	3.6	1.4	2.4
Weavers, woolen mills	.4	3.3	.7	3.4
Grouters, granite quarries	.4	.5	1.4	2.0
Rivet heaters	.4	1.4	.4	2.0
Ropemakers	.4	2.0		
Section men, railway	.4	1.8	3.6	4.6
Shoemakers	.4	4.8		
Weavers, cotton mills	.4	5.1		
Brakemen, railway	.3	1.8	1.2	2.6
Paving-stone cutters	.3	6.3	.4	3.7
Liquor dealers and bartenders	.3	1.9		
Tailors	.3	6.3	.4	7.3
Carders, woolen mills	.2	3.0		
Comb makers	.2	1.5		
Draftsmen, granite industry	.2	4.0	.8	7.3
Locomotive firemen	.2	1.3	.7	3.4
Freight agents	.2	2.5	.7	5.9
Mail carriers	.2	2.0	.5	8.2
Miners, copper	.2	.6	.7	4.2
Miners, iron	.2	4.0	.4	8.8
Miners, coal			.4	4.0
Plumbers	.2	2.8	.8	7.2
Spinners, cotton mills	.2	2.2		
Sandstone cutters	.1	6.0	.5	4.0
Hoisting engineers, granite quarries	.1	10.0	.7	3.4
Boiler makers	.1	1.5	.5	5.5
Finishers, cotton mills	.1	2.3		
Tool sharpeners, granite industry	.1	2.0	.5	1.0
Coachmen	.1	1.6	.4	1.7
Druggists	.1	3.1		
All other occupations [1]	7.2	2.9	15.4	5.0
All previous occupations [1]	[2] 73.3	6.0	[2] 82.9	7.1

[1] Exclusive of granite cutting.
[2] These percentages are less than the sums of the percentages in the columns immediately above, for the reason that multiple employments are involved.

Workers other than granite cutters in the granite industry lead in farming as the previous occupation, followed, however, by granite cutting and tool grinding in the granite industry, while marble cutting is the fourth most important previous occupation. Among granite cutters 31.6 per cent of the men had previously been employed in marble cutting, with an average duration of employment of nine years. The proportion for other workers in the granite industry was only 7.5 per cent, with an average duration of employment of 9.5 years.

In the case of granite cutters the previous employment at farming is represented by 20 per cent of the workers, with an average duration of eight years. Farming is represented by 35.1 per cent for other workers in the granite industry with an average duration of 10.5 years.

ABSENCE OF PREVIOUS OCCUPATIONAL PREDISPOSITION.

In view of the facts that marble cutting, as a matter of practical certainty, involves a much lesser degree of predisposition to lung disease than granite cutting and that farming, broadly speaking, is one of the healthiest of outdoor employments, it is clear that the previous occupational conditions were not such as to predispose exceptionally to pulmonary tuberculosis. In the case of granite cutters 73.3 per cent had followed some previous occupation and for an average period of six years. In the case of other employees in the granite-cutting industry 82.9 per cent had followed some previous employment, of an average duration of 7.1 years. Thus the foregoing analysis (given in more detail in Table 52 for the different branches of the granite-cutting industry), illustrating wide variations in previous occupational conditions, would certainly seem deserving of extended consideration in arriving at definite conclusions concerning other dangerous trades.

TABLE 52.—OCCUPATIONAL HISTORY OF WORKERS IN GRANITE-CUTTING INDUSTRY IN BARRE, VT., AUGUST, 1919.

Present occupation.	Previous occupation.						Present occupation.	
	Per cent of workers previously employed as—			Average period of employment (years).			Average period of employment (years).	Average present age.
	Stone cutters.[1]	Farmers.	All other occupations.[2]	Stone cutters.[1]	Farmers.	All other occupations.[2]		
Tool sharpeners	5.1	15.4	64.2	13.7	8.0	5.3	21.0	41.8
Granite cutters	[3] 32.0	20.0	43.0	[3] 8.9	8.0	3.1	17.7	37.4
Polishers	9.5	48.2	87.8	4.5	10.4	4.5	17.3	41.4
Manufacturers	80.2	28.8	60.4	19.4	8.5	5.2	15.7	43.4
Engineers [4]	13.0	47.8	73.9	6.3	9.5	5.2	14.5	41.7
Lumpers	16.8	49.6	90.8	10.4	11.3	5.5	10.7	38.1
Boxers	20.0	37.2	94.0	8.3	11.5	4.9	7.9	36.2
Draftsmen	7.5	2.5	47.5	11.5	7.0	2.7	7.4	28.5
Foremen	80.0	12.5	92.5	17.4	7.7	3.0	7.1	37.2
Sawyers	.....	64.3	92.9	.....	15.6	4.9	6.8	36.0
Derrick men	12.2	22.5	93.9	6.2	10.1	3.4	6.6	30.4
Bed setters	8.3	62.5	95.8	7.3	11.8	4.6	6.4	34.4
Tool grinders	13.7	17.8	32.9	21.6	9.2	4.9	2.4	23.3
Tool carriers	.....	16.7	66.7	.....	.5	.7	.9	22.8
Average	29.5	25.9	56.0	11.2	9.3	3.9	15.2	37.2

[1] Granite, limestone, marble, sandstone, slate, and talc.
[2] Exclusive of present occupation.
[3] Exclusive of granite cutting.
[4] Inclusive of engineers, firemen, electricians, and machinists.

For all granite workers the average duration of employment in the occupation now followed was 15.2 years, while the attained average age was 37.2 years, but for the granite cutters alone the average period of employment in the present occupation was 17. 7 years, while the average attained age was 37.4 years. These figures, combined with those given in Table 51, give a full account of preoccupational conditions, the wide variations of which clearly illustrate the doubtful nature of conclusions based on general statistics, disregarding previous employments. To facilitate the study of this important aspect of trade life in its relation to mortality, Table 53 is included, which gives in detail the years of employment in the specific occupation followed for all the essential branches of the granite-cutting industry and the number of men employed in a stated number of previous occupations.

TABLE 53.—DISTRIBUTION OF MANUFACTURERS AND EMPLOYEES IN THE GRANITE-CUTTING INDUSTRY OF BARRE, VT., AUGUST, 1919, BY YEARS OF EMPLOYMENT IN PRESENT OCCUPATION AND NUMBER OF PREVIOUS OCCUPATIONS.

GRANITE CUTTERS.

Present employment.	Number of previous occupations.							Total.
	None.	One.	Two.	Three.	Four.	Five.	Six.	
PERIOD.	**Number.**							
0 to 4 years	5	47	20	18	2	.....	.....	92
5 to 9 years	34	119	13	3	.....	.....	.....	169
10 to 14 years	26	148	14	5	1	.....	.....	194
15 to 19 years	63	113	25	3	1	.....	.....	205
20 to 24 years	59	86	23	9	2	.....	.....	179
25 to 29 years	39	58	29	5	.....	1	.....	132
30 to 34 years	35	43	9	2	1	1	1	92
35 to 39 years	28	12	4	.....	.....	.....	.....	44
40 to 44 years	9	7	1	.....	.....	.....	.....	17
45 to 49 years	4	3	1	.....	.....	.....	.....	8
50 to 54 years	1	2	1	.....	.....	.....	.....	4
55 to 59 years	1	.....	.....	.....	.....	.....	.....	1
Total	304	638	140	45	7	2	1	1,137
Per cent of grand total	26.7	56.1	12.3	4.0	0.6	0.2	0.1	100.0
Average period of present employment (years).	21.6	16.4	16.7	13.4	.....	.....	.....	17.7
PERIOD.	**Per cent.**							
0 to 4 years	1.6	7.4	14.3	40.0	28.5	.....	.....	8.1
5 to 9 years	11.2	18.7	9.3	6.7	.....	.....	.....	14.9
10 to 14 years	8.7	23.2	10.0	11.1	14.3	.....	.....	17.0
15 to 19 years	20.7	17.6	17.9	6.7	14.3	.....	.....	18.0
20 to 24 years	19.4	13.5	16.4	20.0	28.6	.....	.....	15.7
25 to 29 years	12.8	9.1	20.7	11.1	.....	50.0	.....	11.6
30 to 34 years	11.5	6.7	6.4	4.4	14.3	50.0	100.0	8.1
35 to 39 years	9.2	1.9	2.9	.....	.....	.....	.....	3.9
40 to 44 years	3.0	1.1	.7	.....	.....	.....	.....	1.5
45 to 49 years	1.3	.5	.7	.....	.....	.....	.....	.7
50 to 54 years	.3	.3	.7	.....	.....	.....	.....	.4
55 to 59 years	.3	.....	.....	.....	.....	.....	.....	.1
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

GRANITE POLISHERS.

PERIOD.	**Number.**							
0 to 4 years	1	12	11	6	1	.....	1	32
5 to 9 years	2	5	2	3	1	.....	.....	13
10 to 14 years	2	6	3	3	1	.....	.....	15
15 to 19 years	1	7	5	.....	.....	.....	.....	13
20 to 24 years	3	6	4	3	.....	.....	.....	16
25 to 29 years	4	8	4	3	1	1	.....	21
30 to 34 years	2	13	4	1	1	.....	.....	21
35 to 39 years	1	2	2	.....	.....	.....	.....	5
40 to 44 years	1	1	1	.....	.....	.....	.....	3
45 to 49 years	.....	.....	.....	.....	.....	.....	.....	.....
50 to 54 years	.....	.....	.....	.....	.....	.....	.....	.....
55 to 59 years	.....	.....	.....	.....	.....	.....	.....	.....
Total	17	60	36	19	5	1	1	139
Per cent of grand total	12.2	43.2	25.9	13.7	3.6	0.7	0.7	100.0
Average period of present employment (years).	21.6	18.4	15.9	13.2	.....	.....	.....	17.3
PERIOD.	**Per cent.**							
0 to 4 years	5.9	20.0	30.6	31.5	20.0	.....	100.0	23.0
5 to 9 years	11.8	8.3	5.6	15.8	20.0	.....	.....	9.4
10 to 14 years	11.8	10.0	8.3	15.8	20.0	.....	.....	10.8
15 to 19 years	5.9	11.7	13.8	.....	.....	.....	.....	9.4
20 to 24 years	17.6	10.0	11.1	15.8	.....	.....	.....	11.5
25 to 29 years	23.4	13.3	11.1	15.8	20.0	100.0	.....	15.1
30 to 34 years	11.8	21.7	11.1	5.3	20.0	.....	.....	15.1
35 to 39 years	5.9	3.3	5.6	.....	.....	.....	.....	3.6
40 to 44 years	5.9	1.7	2.8	.....	.....	.....	.....	2.2
45 to 49 years	.....	.....	.....	.....	.....	.....	.....	.....
50 to 54 years	.....	.....	.....	.....	.....	.....	.....	.....
55 to 59 years	.....	.....	.....	.....	.....	.....	.....	.....
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

TABLE 53.—DISTRIBUTION OF MANUFACTURERS AND EMPLOYEES IN THE GRANITE-CUTTING INDUSTRY OF BARRE, VT., AUGUST, 1919, BY YEARS OF EMPLOYMENT IN PRESENT OCCUPATION AND NUMBER OF PREVIOUS OCCUPATIONS—Continued.

MANUFACTURERS AND FOREMEN.

Present employment.	Number of previous occupations.							Total.
	None.	One.	Two.	Three.	Four.	Five.	Six.	
PERIOD.	**Number.**							
0 to 4 years	.....	9	13	2	4	.....	1	29
5 to 9 years	2	7	16	4	4	.....	.....	33
10 to 14 years	1	10	12	3	2	1	.....	29
15 to 19 years	.....	9	7	1	1	.....	.....	18
20 to 24 years	.....	10	5	1	.....	.....	.....	16
25 to 29 years	1	8	5	2	.....	.....	.....	16
30 to 34 years	.....	6	1	.....	.....	.....	.....	7
35 to 39 years	.....	.....	.....	.....	.....	.....	.....	.....
40 to 44 years	.....	1	.....	.....	.....	.....	.....	1
45 to 49 years	.....	1	.....	.....	.....	.....	.....	1
50 to 54 years	.....	.....	.....	.....	.....	.....	.....	.....
55 to 59 years	.....	.....	.....	.....	.....	.....	.....	.....
Total	4	61	59	13	11	1	1	150
Per cent of grand total	2.7	40.7	39.3	8.7	7.3	0.7	0.7	100.0
Average period of present engagement (years)	13.8	17.1	11.4	11.5	6.3	.....	.....	13.4
PERIOD.	**Per cent.**							
0 to 4 years	.....	14.8	22.0	15.4	36.4	.....	100.0	19.3
5 to 9 years	50.0	11.5	27.1	30.7	36.4	.....	.....	21.9
10 to 14 years	25.0	16.4	20.3	23.1	18.1	100.0	.....	19.3
15 to 19 years	.....	14.8	11.9	7.7	9.1	.....	.....	12.0
20 to 24 years	.....	16.4	8.5	7.7	.....	.....	.....	10.7
25 to 29 years	25.0	13.1	8.5	15.4	.....	.....	.....	10.7
30 to 34 years	.....	9.8	1.7	.....	.....	.....	.....	4.7
35 to 39 years	.....	.....	.....	.....	.....	.....	.....	.....
40 to 44 years	.....	1.6	.....	.....	.....	.....	.....	.7
45 to 49 years	.....	1.6	.....	.....	.....	.....	.....	.7
50 to 54 years	.....	.....	.....	.....	.....	.....	.....	.....
55 to 59 years	.....	.....	.....	.....	.....	.....	.....	.....
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

TOOL SHARPENERS.

PERIOD.	**Number.**							
0 to 4 years	.....	1	1	2	.....	.....	.....	4
5 to 9 years	1	1	.....	.....	.....	.....	.....	2
10 to 14 years	1	3	.....	.....	.....	.....	.....	4
15 to 19 years	3	2	.....	1	.....	.....	.....	6
20 to 24 years	3	3	1	.....	.....	.....	.....	7
25 to 29 years	2	2	1	.....	.....	.....	.....	5
30 to 34 years	3	2	1	1	1	.....	.....	8
35 to 39 years	.....	1	.....	.....	.....	.....	.....	1
40 to 44 years	1	1	.....	.....	.....	.....	.....	2
45 to 49 years	.....	.....	.....	.....	.....	.....	.....	.....
50 to 54 years	.....	.....	.....	.....	.....	.....	.....	.....
55 to 59 years	.....	.....	.....	.....	.....	.....	.....	.....
Total	14	16	4	4	1	.....	.....	39
Per cent of grand total	35.8	41.0	10.3	10.3	2.6	.....	.....	100.0
Average period of present employment (years)	22.9	21.2	19.8	12.4	.....	.....	.....	21.0
PERIOD.	**Per cent.**							
0 to 4 years	.....	6.3	25.0	50.0	.....	.....	.....	10.3
5 to 9 years	7.1	6.3	.....	.....	.....	.....	.....	5.1
10 to 14 years	7.1	18.7	.....	.....	.....	.....	.....	10.3
15 to 19 years	21.5	12.5	.....	25.0	.....	.....	.....	15.4
20 to 24 years	21.5	18.6	25.0	.....	.....	.....	.....	17.9
25 to 29 years	14.3	12.5	25.0	.....	.....	.....	.....	12.8
30 to 34 years	21.4	12.5	25.0	25.0	100.0	.....	.....	20.5
35 to 39 years	.....	6.3	.....	.....	.....	.....	.....	2.6
40 to 44 years	7.1	6.3	.....	.....	.....	.....	.....	5.1
45 to 49 years	.....	.....	.....	.....	.....	.....	.....	.....
50 to 54 years	.....	.....	.....	.....	.....	.....	.....	.....
55 to 59 years	.....	.....	.....	.....	.....	.....	.....	.....
Total	100.0	100.0	100.0	100.0	100.0	.....	.....	100.0

TABLE 53.—DISTRIBUTION OF MANUFACTURERS AND EMPLOYEES IN THE GRANITE-CUTTING INDUSTRY OF BARRE, VT., AUGUST, 1919, BY YEARS OF EMPLOYMENT IN PRESENT OCCUPATION AND NUMBER OF PREVIOUS OCCUPATIONS—Continued.

DRAFTSMEN.

Present employment.	Number of previous occupations.							Total.
	None.	One.	Two.	Three.	Four.	Five.	Six.	
PERIOD.	**Number.**							
0 to 4 years	8	3	2	5	.....	.....	.....	18
5 to 9 years	7	.....	3	2	.....	.....	.....	12
10 to 14 years	3	1	.....	.....	.....	.....	.....	4
15 to 19 years	2	.....	2	.....	.....	.....	.....	4
20 to 24 years	.....	.....	.....	.....	.....	.....	.....	.....
25 to 29 years	1	.....	.....	.....	.....	.....	.....	1
30 to 34 years	.....	1	.....	.....	.....	.....	.....	1
35 to 39 years	.....	.....	.....	.....	.....	.....	.....	.....
40 to 44 years	.....	.....	.....	.....	.....	.....	.....	.....
45 to 49 years	.....	.....	.....	.....	.....	.....	.....	.....
50 to 54 years	.....	.....	.....	.....	.....	.....	.....	.....
55 to 59 years	.....	.....	.....	.....	.....	.....	.....	.....
Total	21	5	7	7	.....	.....	.....	40
Per cent of grand total	52.5	12.5	17.5	17.5	.....	.....	.....	100.0
Average period of present employment (years)	7.9	10.1	2.4	2.4	.....	.....	.....	7.4
PERIOD.	**Per cent.**							
0 to 4 years	38.1	60.0	28.6	71.4	.....	.....	.....	45.0
5 to 9 years	33.3	.....	42.8	28.6	.....	.....	.....	30.0
10 to 14 years	14.3	20.0	.....	.....	.....	.....	.....	10.0
15 to 19 years	9.5	.....	28.6	.....	.....	.....	.....	10.0
20 to 24 years	.....	.....	.....	.....	.....	.....	.....	.....
25 to 29 years	4.8	.....	.....	.....	.....	.....	.....	2.5
30 to 34 years	.....	20.0	.....	.....	.....	.....	.....	2.5
35 to 39 years	.....	.....	.....	.....	.....	.....	.....	.....
40 to 44 years	.....	.....	.....	.....	.....	.....	.....	.....
45 to 49 years	.....	.....	.....	.....	.....	.....	.....	.....
50 to 54 years	.....	.....	.....	.....	.....	.....	.....	.....
55 to 59 years	.....	.....	.....	.....	.....	.....	.....	.....
Total	100.0	100.0	100.0	100.0	.....	.....	.....	100.0

ENGINEERS, FIREMEN, ELECTRICIANS, AND MACHINISTS.

PERIOD.	**Number.**							
0 to 4 years	.....	3	.....	.....	1	1	.....	5
5 to 9 years	.....	.....	2	1	.....	1	.....	4
10 to 14 years	1	.....	1	3	.....	.....	.....	5
15 to 19 years	1	1	.....	.....	.....	.....	.....	2
20 to 24 years	2	.....	1	.....	1	.....	1	5
25 to 29 years	.....	.....	.....	.....	.....	.....	.....	.....
30 to 34 years	1	.....	.....	.....	.....	.....	.....	1
35 to 39 years	1	.....	.....	.....	.....	.....	.....	1
40 to 44 years	.....	.....	.....	.....	.....	.....	.....	.....
45 to 49 years	.....	.....	.....	.....	.....	.....	.....	.....
50 to 54 years	.....	.....	.....	.....	.....	.....	.....	.....
55 to 59 years	.....	.....	.....	.....	.....	.....	.....	.....
Total	6	4	4	4	2	2	1	23
Per cent of grand total	26.1	17.4	17.4	17.4	8.7	8.7	4.3	100.0
Average period of present employment (years)	27.7	6.5	10.2	10.5	.....	.....	.....	14.5
PERIOD.	**Per cent.**							
0 to 4 years	.....	75.0	.....	.....	50.0	50.0	.....	21.7
5 to 9 years	.....	.....	50.0	25.0	.....	50.0	.....	17.4
10 to 14 years	16.7	.....	25.0	75.0	.....	.....	.....	21.7
15 to 19 years	16.7	25.0	.....	.....	.....	.....	.....	8.7
20 to 24 years	33.2	.....	25.0	.....	50.0	.....	100.0	21.7
25 to 29 years	.....	.....	.....	.....	.....	.....	.....	.....
30 to 34 years	16.7	.....	.....	.....	.....	.....	.....	4.4
35 to 39 years	16.7	.....	.....	.....	.....	.....	.....	4.4
40 to 44 years	.....	.....	.....	.....	.....	.....	.....	.....
45 to 49 years	.....	.....	.....	.....	.....	.....	.....	.....
50 to 54 years	.....	.....	.....	.....	.....	.....	.....	.....
55 to 59 years	.....	.....	.....	.....	.....	.....	.....	.....
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

TABLE 53.—DISTRIBUTION OF MANUFACTURERS AND EMPLOYEES IN THE GRANITE-CUTTING INDUSTRY OF BARRE, VT., AUGUST, 1919, BY YEARS OF EMPLOYMENT IN PRESENT OCCUPATION AND NUMBER OF PREVIOUS OCCUPATIONS—Continued.

BED SETTERS.

Present employment.	Number of previous occupations.							Total.
	None.	One.	Two.	Three.	Four.	Five.	Six.	
PERIOD.	**Number.**							
0 to 4 years	.....	9	8	7	2	2	.....	28
5 to 9 years	.....	1	6	.....	.....	.....	.....	7
10 to 14 years	1	2	2	1	1	.....	.....	7
15 to 19 years	1	1	1	.....	.....	.....	.....	3
20 to 24 years	.....	.....	1	.....	.....	.....	.....	1
25 to 29 years	.....	1	1	.....	.....	.....	.....	2
30 to 34 years	.....	.....	.....	.....	.....	.....	.....	.....
35 to 39 years	.....	.....	.....	.....	.....	.....	.....	.....
40 to 44 years	.....	.....	.....	.....	.....	.....	.....	.....
45 to 49 years	.....	.....	.....	.....	.....	.....	.....	.....
50 to 54 years	.....	.....	.....	.....	.....	.....	.....	.....
55 to 59 years	.....	.....	.....	.....	.....	.....	.....	.....
Total	2	14	19	8	3	2	.....	48
Per cent of grand total	4.2	29.2	39.6	16.7	6.3	4.0	.....	100.0
Average period of present employment (years)	12.5	4.8	9.0	3.3	.....	.....	.....	6.4
PERIOD.	**Per cent.**							
0 to 4 years	.....	64.3	42.0	87.5	66.7	100.0	.....	58.3
5 to 9 years	.....	7.1	31.6	.....	.....	.....	.....	14.6
10 to 14 years	50.0	14.4	10.5	12.5	33.3	.....	.....	14.6
15 to 19 years	50.0	7.1	5.3	.....	.....	.....	.....	6.2
20 to 24 years	.....	.....	5.3	.....	.....	.....	.....	2.1
25 to 29 years	.....	7.1	5.3	.....	.....	.....	.....	4.2
30 to 34 years	.....	.....	.....	.....	.....	.....	.....	.....
35 to 39 years	.....	.....	.....	.....	.....	.....	.....	.....
40 to 44 years	.....	.....	.....	.....	.....	.....	.....	.....
45 to 49 years	.....	.....	.....	.....	.....	.....	.....	.....
50 to 54 years	.....	.....	.....	.....	.....	.....	.....	.....
55 to 59 years	.....	.....	.....	.....	.....	.....	.....	.....
Total	100.0	100.0	100.0	100.0	100.0	100.0	.....	100.0

TOOL GRINDERS AND TOOL CARRIERS.

PERIOD.	**Number.**							
0 to 4 years	46	15	7	1	.....	1	.....	70
5 to 9 years	2	2	.....	1	.....	1	.....	6
10 to 14 years	.....	.....	2	.....	.....	.....	.....	2
15 to 19 years	.....	.....	.....	.....	1	.....	.....	1
20 to 24 years	.....	.....	.....	.....	.....	.....	.....	.....
25 to 29 years	.....	.....	.....	.....	.....	.....	.....	.....
30 to 34 years	.....	.....	.....	.....	.....	.....	.....	.....
35 to 39 years	.....	.....	.....	.....	.....	.....	.....	.....
40 to 44 years	.....	.....	.....	.....	.....	.....	.....	.....
45 to 49 years	.....	.....	.....	.....	.....	.....	.....	.....
50 to 54 years	.....	.....	.....	.....	.....	.....	.....	.....
55 to 59 years	.....	.....	.....	.....	.....	.....	.....	.....
Total	48	17	9	2	1	2	.....	79
Per cent of grand total	60.8	21.5	11.4	2.5	1.3	2.5	.....	100.0
Average period of present employment (years)	1.9	1.6	.....	.....	.....	.....	.....	2.3
PERIOD.	**Per cent.**							
0 to 4 years	95.8	88.2	77.8	50.0	.....	50.0	.....	88.6
5 to 9 years	4.2	11.8	.....	50.0	.....	50.0	.....	7.6
10 to 14 years	.....	.....	22.2	.....	.....	.....	.....	2.5
15 to 19 years	.....	.....	.....	.....	100.0	.....	.....	1.3
20 to 24 years	.....	.....	.....	.....	.....	.....	.....	.....
25 to 29 years	.....	.....	.....	.....	.....	.....	.....	.....
30 to 34 years	.....	.....	.....	.....	.....	.....	.....	.....
35 to 39 years	.....	.....	.....	.....	.....	.....	.....	.....
40 to 44 years	.....	.....	.....	.....	.....	.....	.....	.....
45 to 49 years	.....	.....	.....	.....	.....	.....	.....	.....
50 to 54 years	.....	.....	.....	.....	.....	.....	.....	.....
55 to 59 years	.....	.....	.....	.....	.....	.....	.....	.....
Total	100.0	100.0	100.0	100.0	100.0	100.0	.....	100.0

TABLE 53.—DISTRIBUTION OF MANUFACTURERS AND EMPLOYEES IN THE GRANITE-CUTTING INDUSTRY OF BARRE, VT., AUGUST, 1919, BY YEARS OF EMPLOYMENT IN PRESENT OCCUPATION AND NUMBER OF PREVIOUS OCCUPATIONS—Concluded.

LUMPERS, BOXERS, AND DERRICK MEN.

Present employment.	Number of previous occupations.							Total.
	None.	One.	Two.	Three.	Four.	Five.	Six.	
PERIOD.	Number.							
0 to 4 years	3	24	29	15	9	3	1	84
5 to 9 years	2	22	13	2	.....	.....	.....	39
10 to 14 years	2	5	19	6	2	.....	.....	34
15 to 19 years	1	5	3	3	2	2	.....	16
20 to 24 years	.....	6	6	2	2	.....	.....	16
25 to 29 years	1	2	6	1	.....	.....	.....	10
30 to 34 years	.....	.....	1	.....	.....	.....	.....	1
35 to 39 years	.....	.....	1	.....	.....	.....	.....	1
40 to 44 years	1	.....	.....	.....	.....	.....	.....	1
45 to 49 years	1	.....	.....	.....	.....	.....	.....	1
50 to 54 years	.....	.....	.....	.....	.....	.....	.....	.....
55 to 59 years	.....	.....	.....	.....	.....	.....	.....	.....
Total	11	64	78	29	15	5	1	203
Per cent of grand total	5.4	31.5	38.4	14.3	7.4	2.5	0.5	100.0
Average period of present employment (years)	16.4	8.1	9.8	8.1	8.3	.....	.....	9.1
PERIOD.	Per cent.							
0 to 4 years	27.2	37.5	37.2	51.7	60.0	60.0	100.0	41.4
5 to 9 years	18.2	34.4	16.7	6.9	.....	.....	.....	19.2
10 to 14 years	18.2	7.8	24.3	20.7	13.4	.....	.....	16.7
15 to 19 years	9.1	7.8	3.8	10.3	13.3	40.0	.....	7.9
20 to 24 years	.....	9.4	7.7	6.9	13.3	.....	.....	7.9
25 to 29 years	9.1	3.1	7.7	3.5	.....	.....	.....	4.9
30 to 34 years	.....	.....	1.3	.....	.....	.....	.....	.5
35 to 39 years	.....	.....	1.3	.....	.....	.....	.....	.5
40 to 44 years	9.1	.....	.....	.....	.....	.....	.....	.5
45 to 49 years	9.1	.....	.....	.....	.....	.....	.....	.5
50 to 54 years	.....	.....	.....	.....	.....	.....	.....	.....
55 to 59 years	.....	.....	.....	.....	.....	.....	.....	.....
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

This table, for the first time, as far as is known, in occupational-disease investigation, presents in a convenient form the essential facts, which unquestionably have a direct bearing upon the observed mortality rate from a certain specified cause of death. Limiting the consideration for the time being to granite cutters only, it is shown that of 1,137 men thus employed, 304, or 26.7 per cent, had followed no previous occupation; 638, or 56.1 per cent, had followed one previous employment; 140, or 12.3 per cent, had followed two employments; 45, or 4 per cent, had followed three or more employments. For all occupations the average length of employment in granite cutting had been 17.7 years, but of those who had followed no previous employment it was 21.6 years; of those who had had one previous occupation, 16.4 years; of those who had two previous occupations, 16.7 years; and of those who had three or more previous occupations, 13.4 years.

That these figures are trustworthy is clearly indicated by the corresponding figures for granite polishers, which give an average previous trade life of 17.3 years, but for those who had followed no other occupation 21.6 years. Important variations are disclosed by other

occupations, which, however, do not seem to require extended discussion.

The facts are conveniently summarized in Table 54, which contains the requisite data as well as the proportionate distribution for 1,872 persons employed in the granite industry at Barre, Vt. For all such employees the average attained age was 37.2 years, or for granite cutters 37.4 years, for granite polishers and sawyers 40.4 years, and for manufacturers and foremen 41.8 years. Certain occupations are subject to selection, so that the age factor is of much importance, but in the case of granite cutters, polishers, and sawyers it may safely be assumed that once selected as a vocation the employment is generally followed throughout adult life. In all occupations employment changes at ages over 45 are few and far between. Occupational elimination in advanced adult life is therefore more probably the result of an excessive death rate than because of a choice of other employments for reasons of better earning power or better conditions of work.

TABLE 54.—DISTRIBUTION OF MANUFACTURERS AND EMPLOYEES IN THE GRANITE-CUTTING INDUSTRY OF BARRE, VT., AUGUST, 1919, BY OCCUPATION AND YEARS OF EMPLOYMENT IN PRESENT OCCUPATION.

Employment in present occupation.	Tool sharpeners.	Granite cutters.	Granite polishers and sawyers.	Engineers, firemen, electricians, and machinists.	Manufacturers and foremen.	Lumpers, boxers, and derrickmen.	Draftsmen.	Bed setters.	Tool grinders and tool carriers.	Total.
PERIOD.	Number.									
0 to 4 years	4	92	40	5	29	84	18	28	70	370
5 to 9 years	2	169	15	4	33	39	12	7	6	287
10 to 14 years	4	194	17	5	29	34	4	7	2	296
15 to 19 years	6	205	14	2	18	16	4	3	1	269
20 to 24 years	7	179	17	5	16	16	.....	1	.....	241
25 to 29 years	5	132	21	.....	16	10	1	2	.....	187
30 to 34 years	8	92	21	1	7	1	1	.....	.....	131
35 to 39 years	1	44	5	1	.....	1	.....	.....	.....	52
40 to 44 years	2	17	3	.....	1	1	.....	.....	.....	24
45 to 49 years	.....	8	.....	.....	1	1	.....	.....	.....	10
50 to 54 years	.....	4	.....	.....	.....	.....	.....	.....	.....	4
55 to 59 years	.....	1	.....	.....	.....	.....	.....	.....	.....	1
Total	39	1,137	153	23	150	203	40	48	79	1,872
Average period of present employment (years)	21.0	17.7	16.1	14.5	13.4	9.1	7.4	6.4	2.3	15.2
Average age	41.8	37.4	40.4	41.7	41.8	35.9	28.5	34.4	23.3	37.2
PERIOD.	Per cent.									
0 to 4 years	10.3	8.1	23.0	21.7	19.3	41.4	45.0	58.3	88.6	19.7
5 to 9 years	5.1	14.9	9.4	17.4	21.9	19.2	30.0	14.6	7.6	15.3
10 to 14 years	10.3	17.0	10.8	21.7	19.3	16.7	10.0	14.6	2.5	15.8
15 to 19 years	15.4	18.0	9.4	8.7	12.0	7.9	10.0	6.2	1.3	14.4
20 to 24 years	17.9	15.7	11.5	21.7	10.7	7.9	.....	2.1	.....	12.9
25 to 29 years	12.8	11.6	15.1	.....	10.7	4.9	2.5	4.2	.....	10.0
30 to 34 years	20.5	8.1	15.1	4.4	4.7	.5	2.5	.....	.....	7.0
35 to 39 years	2.6	3.9	3.6	4.4	.....	.5	.....	.....	.....	2.8
40 to 44 years	5.1	1.5	2.2	.....	.7	.5	.....	.....	.....	1.3
45 to 49 years	.....	.7	.....	.....	.7	.5	.....	.....	.....	.5
50 to 54 years	.....	.4	.....	.....	.....	.....	.....	.....	.....	.2
55 to 59 years	.....	.1	.....	.....	.....	.....	.....	.....	.....	.1
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

COMPARATIVE MORTALITY OF LIMESTONE WORKERS.

To emphasize this point to greater practical advantage, attention is directed to Table 55, which gives a comparison of the ages of living granite and limestone workers as determined by means of a special personal inquiry, and at the same time the distribution of deaths, as based on trade-union data, especially for granite cutters, limestone and sandstone cutters, and glass-bottle blowers. In the case of living granite cutters the proportion 50 years of age and over was 11.69 per cent as against 19.18 per cent for sandstone and limestone cutters, the latter subject unquestionably as a group to a much lesser occupational-disease liability than the former. Conversely, the deaths at early years of life form 7.64 per cent in the experience of granite cutters as against 4.05 per cent in the experience of sandstone and limestone cutters. The glass-bottle blowers are hardly comparable with the other two groups in that among them proportionately a much larger number of young persons are employed, which accounts for the fact that of the deaths of these workers 15.74 per cent occurred in ages under 30.

TABLE 55.—PROPORTIONATE AGE DISTRIBUTION OF GRANITE CUTTERS AT BARRE, VT., AND OF DEATHS FROM ALL CAUSES AMONG THE GRANITE CUTTERS OF THE UNITED STATES AND CANADA, COMPARED WITH THAT OF SANDSTONE AND LIMESTONE CUTTERS AND GLASS-BOTTLE BLOWERS.

Age group.	Granite cutters.		Sandstone and limestone cutters.		Glass-bottle blowers—deaths in United States and Canada, 1892–1919.
	Employed at Barre, Vt., August, 1919.	Deaths in United States and Canada, 1906–1919.	Limestone cutters [1] employed at Bedford, Ind., September, 1920.	Deaths in United States and Canada, 1888–1920.	
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
10 to 14 years	.....	.....	0.26	.....	.....
15 to 19 years	2.46	.....	4.35	.....	0.04
20 to 24 years	8.36	2.28	9.97	1.02	3.85
25 to 29 years	12.14	5.36	13.81	3.03	11.85
30 to 34 years	16.89	8.45	14.58	7.22	15.50
35 to 39 years	19.70	11.38	15.09	10.88	14.17
40 to 44 years	16.18	13.03	13.81	15.02	11.27
45 to 49 years	12.58	13.37	8.95	14.06	10.07
50 to 54 years	7.56	14.61	8.95	12.81	7.75
55 to 59 years	2.73	10.54	6.39	13 38	6.66
60 to 64 years	.88	9.30	2.81	9.03	5.54
65 to 69 years	.26	6.56	.77	6.86	5.76
70 to 74 years	.26	3.16	.26	3.37	3.61
75 to 79 years	.....	1.21	.....	1.32	2.54
80 to 84 years	.....	.45	.....	1.31	.96
85 to 89 years	.....	.26	.....	.51	.43
90 to 94 years	.....	.04	.....	.18	.....
Total	100.00	100.00	100.00	100.00	100.00
Under 30 years	22.96	7.64	28.39	4.05	15.74
30 to 49 years	65.35	46.23	52.43	47.18	51.01
50 years and over	11.69	46.13	19.18	48.77	33.25
Total	100.00	100.00	100.00	100.00	100.00

[1] Includes planer men.

After all the most significant fact is the length of trade exposure to dust-producing conditions and as shown by Table 56 granite workers throughout the entire comparative experience show a larger proportionate distribution with the longer periods of dust exposure. This table should be considered in conjunction with

Table 28, which emphasizes the fact that most of the deaths from pulmonary tuberculosis occurred among granite workers who had been from 19 to 24 years exposed to the continuous and considerable inhalation of granite dust. It is brought out by Table 56 that some of the granite workers had suffered over 50 years of dust exposure and yet were still alive and able to follow their occupation. Limestone workers apparently represent a more recent trade development, for comparing this group with granite workers it is shown that in all the longer periods of dust exposure the proportion is considerably higher among the latter than among the former, as, for illustration, at 20 to 24 years of exposure the percentage for granite cutters is 15.74, as against only 7.16 for limestone workers, and at 25 to 29 years the comparative proportion was 11.61 per cent for granite cutters, as against 4.09 per cent for limestone workers.

TABLE 56.—PROPORTIONATE DISTRIBUTION OF LIVING GRANITE CUTTERS AT BARRE, VT., BY AGE AND YEARS OF EXPOSURE TO GRANITE DUST, COMPARED WITH THAT OF LIMESTONE CUTTERS AND PLANER MEN IN LAWRENCE COUNTY, IND., 1919–1920.

[Heavy black squares show where the proportionate distribution of granite cutters equals or exceeds that of limestone cutters. Figures in first line opposite age group are for granite cutters; in second line, for limestone cutters and planer men.]

Age group.	Years of exposure to granite or limestone dust.												Total
	0 to 4	5 to 9	10 to 14	15 to 19	20 to 24	25 to 29	30 to 34	35 to 39	40 to 44	45 to 49	50 to 54	55 to 59	
	P. ct.	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	
10 to 14 years	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
	0.25	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	0.25
15 to 19 years	2.46	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	2.46
	4.35	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	4.35
20 to 24 years	4.22	4.05	0.09	.....	.....	.....	.....	.....	.....	.....	.....	.....	8.36
	6.39	3.32	.26	.....	.....	.....	.....	.....	.....	.....	.....	.....	9.97
25 to 29 years	0.53	6.33	4.40	0.88	.....	.....	.....	.....	.....	.....	.....	.....	12.14
	2.57	5.62	5.36	.26	.....	.....	.....	.....	.....	.....	.....	.....	13.81
30 to 34 years	0.53	1.76	6.24	7.21	1.06	0.18	.....	.....	.....	.....	.....	.....	16.98
	2.05	4.09	5.89	2.30	.26	.....	.....	.....	.....	.....	.....	.....	14.59
35 to 39 years	0.09	1.31	4.13	5.37	7.12	1.41	0.18	.....	.....	.....	.....	.....	19.61
	2.05	2.81	4.85	3.07	2.05	.26	.....	.....	.....	.....	.....	.....	15.09
40 to 44 years	0.26	0.79	1.41	2.81	5.10	4.40	1.32	0.09	.....	.....	.....	.....	16.18
	1.02	1.29	5.13	3.31	1.53	1.01	.26	.....	.....	.....	.....	.....	13.55
45 to 49 years	.....	0.44	0.53	1.23	1.76	3.60	3.52	1.32	0.09	.....	.....	.....	12.49
	0.51	.77	2.81	2.05	1.28	1.02	.51	.26	.....	.....	.....	.....	9.21
50 to 54 years	.....	0.09	0.26	0.44	0.44	1.67	2.55	1.58	0.44	0.09	.....	.....	7.56
	1.02	.51	1.53	2.05	1.28	.77	1.28	.25	.26	.....	.....	.....	8.95
55 to 59 years	.....	0.09	.....	0.09	0.26	0.35	0.34	0.79	0.71	0.18	.....	.....	2.81
	0.51	.77	0.26	1.53	.51	.77	1.02	.51	.51	.....	.....	.....	6.39
60 to 64 years	.....	.....	.....	.....	.....	.....	0.18	0.09	0.26	0.26	0.09	.....	0.88
	0.25	0.25	0.77	0.51	.....	.....	.....	.26	.51	.26	.....	.....	2.81
65 to 69 years	.....	.....	.....	.....	.....	.....	.....	.....	.....	0.09	0.09	0.09	0.27
	.....	0.26	.....	0.26	0.25	.....	.....	.....	.....	.....	.....	.....	.77
70 to 74 years	.....	.....	.....	.....	.....	.....	.....	.....	.....	0.08	0.18	.....	0.26
	.....	.....	.....	.....	.....	0.26	.....	.....	.....	.....	.....	.....	.26
Total	8.09	14.86	17.06	18.03	15.74	11.61	8.09	3.87	1.50	0.70	0.36	0.09	100.00
	20.97	19.69	26.86	15.34	7.16	4.09	3.07	1.28	1.28	.26	.....	.....	100.00

It is not an easy matter to disentangle evidence more or less conflicting and contradictory. It might easily be assumed that because granite workers show on an average a longer trade exposure than limestone workers they are less liable to an excessive death rate from lung disease at older ages, but, as clearly brought out by the mortality analysis, the very opposite is the case. It will remain for those who are qualified to do so to pass upon the question whether the processes of lung fibrosis are not in their initial stages the cause of a deferred mortality, while at the same time the certainty of ultimate death from this disease is a foregone conclusion. If it were possible to work out tables of mortality by duration of trade life in particular occupations, much might be learned as to the direct consequences of continuous dust inhalation. The nearest approach to this is Table 57, in which granite and limestone cutters are compared with gold miners in the Transvaal as to the years of employment at the occupation now followed. The latter occupation is unquestionably, or was before preventive measures were adopted, the most life-destructive employment known. Nowhere has the question of miner's phthisis, which is essentially a process of lung fibrosis, attracted more attention than in South Africa. But the table shows that continued employment for a considerable length of time is very rare especially as compared with granite cutting, which, as said before, is one of the oldest of trades and includes a large proportion of men who have been employed at stonework in some capacity or other for more than a generation. The suggestion may be placed on record that a thorough examination of the survivors of long-continued trade exposure would make a most useful practical contribution to the dust pathology of the granite industry. It is certainly as important to know why men survive or do not succumb to health-injurious conditions as why they fall victims to factors injurious to life and health more or less accurately understood.

TABLE 57.—PROPORTIONATE DISTRIBUTION OF THE GRANITE CUTTERS OF BARRE, VT., BY YEARS OF EMPLOYMENT IN PRESENT OCCUPATION, COMPARED WITH THAT OF THE LIMESTONE CUTTERS OF BEDFORD, IND., AND THE TRANSVAAL GOLD MINERS OF THE UNION OF SOUTH AFRICA.

Employment in present occupation.	Granite cutters of Barre, Vt., Aug., 1919.	Limestone cutters [1] of Bedford, Ind., Sept., 1920.	Transvaal gold miners, 1918–19.[2]
	Per cent.	*Per cent.*	*Per cent.*
1 to 4 years	8.09	20.97	50.18
5 to 9 years	14.86	19.69	40.04
10 to 14 years	17.06	26.86	8.49
15 to 19 years	18.03	15.34	1.17
20 to 24 years	15.74	7.16	.10
25 to 29 years	11.61	4.09	.02
30 to 34 years	8.09	3.07	.....
35 to 39 years	3.87	1.28	.....
40 to 44 years	1.50	1.28	.....
45 to 49 years	.70	.26	.....
50 to 54 years	.36	.....	.....
55 to 59 years	.09	.....	.....
Total	100.00	100.00	100.00

[1] Inclusive of limestone cutters, planer men, and milling-machine operators.
[2] Annual Reports of the Miners' Phthisis Board and Miners' Phthisis Medical Bureau, July 31, 1919.

The details of this analysis for the three groups of employments by single years of trade life are given in Table 58. According to this table recent employments among granite cutters in the State of Vermont represented only 3.77 per cent for men having been employed one year compared with 10.48 per cent for limestone workers and 10.12 per cent for the Transvaal gold miners. It is suggestive that among the granite cutters the oldest employee now living should have been 56 years at work.

TABLE 58.—PROPORTIONATE DISTRIBUTION OF GRANITE CUTTERS OF BARRE, VT., BY YEARS OF EMPLOYMENT IN PRESENT OCCUPATION, COMPARED WITH THAT OF THE LIMESTONE CUTTERS OF BEDFORD, IND., AND THE TRANSVAAL GOLD MINERS OF THE UNION OF SOUTH AFRICA.

Employment in present occupation.	Granite cutters of Barre, Vt., August, 1919.	Limestone cutters[1] of Bedford, Ind., September, 1920.	Transvaal gold miners,[2] 1918–19.
	Per cent.	*Per cent.*	*Per cent.*
1 year	3.77	10.48	10.12
2 years	1.68	3.08	11.73
3 years	1.32	1.53	15.14
4 years	1.32	5.88	13.19
5 years	3.42	2.55	10.94
6 years	2.84	3.84	9.17
7 years	3.25	3.84	8.46
8 years	2.63	4.86	6.94
9 years	2.72	4.60	4.53
10 years	4.82	8.17	3.01
11 years	1.32	3.58	2.26
12 years	6.12	5.65	1.49
13 years	2.98	2.30	1.10
14 years	4.82	7.16	.63
15 years	4.30	5.63	.48
16 years	2.81	4.60	.31
17 years	3.86	1.79	.23
18 years	3.73	3.06	.10
19 years	3.33	.26	.05
20 years	5.96	3.07	.05
21 years	1.93	.77	.02
22 years	2.72	1.28	.01
23 years	2.85	1.27	.01
24 years	2.28	.77	.01
25 years	2.89	1.02	.01
26 years	1.58	.51	.....
27 years	3.07	1.79	.01
28 years	2.14	.26	.....
29 years	1.93	.51	.....
30 years	4.12	1.79	.....
31 years	.70	.....	.....
32 years	1.58	.26	.....
33 years	.64	.51	.....
34 years	1.05	.51	.....
35 years	1.40	.26	.....
36 years	.72	.50	.....
37 years	.44	.26	.....
38 years	.96	.26	.....
39 years	.35	.....	.....
40 years	.18	1.02	.....
41 years	.....	.26	.....
42 years	.36	.....	.....
43 years	.70	.....	.....
44 years	.26	.....	.....
45 years	.44	.....	.....
46 years	.09	.....	.....
47 years	.09	.....	.....
48 years	.....	.26	.....
49 years	.08	.....	.....
50 years	.18	.....	.....
51 years	.....	.....	.....
52 years	.....	.....	.....
53 years	.09	.....	.....
54 years	.09	.....	.....
55 years	.....	.....	.....
56 years	.09	.....	.....
Total	100.00	100.00	100.00

[1] Inclusive of limestone cutters, planer men, and milling-machine operators.
[2] Annual Reports of the Miners' Phthisis Board and Miners' Phthisis Medical Bureau, July 31, 1919.

SUPPLEMENTARY CONSIDERATIONS.

AVERAGE AGE AT DEATH.

The foregoing discussion has been made to include certain supplementary considerations which will be found of both interest and value in the interpretation of the major portion of the information considered. Table 59 gives the details of the mortality from all causes and the aggregate years of life lived during the period 1906–1918, with the average age at death.

TABLE 59.—AVERAGE AGE AT DEATH OF THE GRANITE CUTTERS OF THE UNITED STATES AND CANADA, 1906 TO 1918, BY YEARS.

[Data from experience of the Granite Cutters' International Association of America.]

Year or period.	Deaths from all causes.	Years of life.	Average age at death.	Year or period.	Deaths from all causes.	Years of life.	Average age at death.
1906	144	6,326	43.9	1915	202	10,418	51.6
1907	138	6,626	48.0	1916	206	10,516	51.0
1908	149	6,805	45.7	1917	213	10,655	50.0
1909	111	5,279	47.6	1918 [1]	167	8,369	50.1
1910	179	8,574	47.9	1918 [2]	397	16,809	42.3
1911	178	8,953	50.3				
1912	165	8,234	49.9	1906–1909	542	25,036	46.2
1913	206	10,357	50.3	1910–1914	945	47,099	49.8
1914	217	10,981	50.6	1915–1918 [1]	788	39,958	50.7

[1] Exclusive of last three months of 1918. [2] Entire year of 1918.

There is probably no more misleading figure in mortality statistics than the average age at death unless used with extreme caution as an indication of a possible improvement in longevity.[a] The average age at death is of course profoundly influenced by the average age of the living, which varies in practically every trade, industry, and locality. In the experience of the Granite Cutters' International Association of America, embracing men employed throughout the United States and Canada, the average age at death has slowly increased from 46.2 years during 1906–1909 to 50.7 years during 1915–1918. The indicated increase of 4.5 years reflects, broadly speaking, the health progress of the country at large, obscuring the detrimental tendencies elsewhere shown to have resulted from a larger exposure to health-injurious dust. Taking the period under observation by single years, it appears that during 1906–1918, excluding the last three months of that year, the average age at death was increased 6.2 years. According to Table 60, in comparison with sandstone and limestone cutters and glass-bottle blowers, this increase is in fair conformity to the general health progress of the country.

[a] See observation on the "average age" question on p. 18.

TABLE 60.—AVERAGE AGE AT DEATH OF GRANITE CUTTERS, COMPARED WITH THAT OF SANDSTONE AND LIMESTONE CUTTERS AND GLASS-BOTTLE BLOWERS, OF UNITED STATES AND CANADA, 1889 TO 1920, BY YEARS.

Year or period.	Granite cutters.	Sandstone and limestone cutters.	Glass-bottle blowers.	Year or period.	Granite cutters.	Sandstone and limestone cutters.	Glass-bottle blowers.
1889	.....	53.0	.....	1909	47.6	50.0	44.7
1890	.....	46.4	.....	1910	47.9	49.9	45.7
1891	.....	44.1	.....	1911	50.3	52.6	46.7
1892	.....	41.4	37.0	1912	49.9	51.4	48.1
1893	.....	42.1	40.4	1913	50.3	51.8	44.4
1894	.....	43.8	39.4	1914	50.6	52.5	47.5
1895	.....	40.1	37.4	1915	51.6	53.6	48.5
1896	.....	42.7	43.0	1916	51.0	52.2	50.6
1897	.....	43.5	39.8	1917	50.0	55.8	49.7
1898	.....	43.1	41.9	1918 [1]	50.1	55.9	46.9
1899	.....	48.2	40.8	1918 [2]	42.3	53.1	42.5
1900	.....	47.8	40.1	1919	49.1	53.1	50.5
1901	.....	45.2	42.2	1920 [3]	.....	56.0	.....
1902	.....	49.2	40.3				
1903	.....	46.4	42.7	1889–1894	.....	43.0	[4] 39.0
1904	.....	50.1	39.6	1895–1899	.....	44.2	40.9
1905	.....	51.3	41.5	1900–1904	.....	47.8	40.9
1906	43.9	49.6	43.9	1905–1909	[5] 46.2	50.0	43.2
1907	48.0	51.6	42.5	1910–1914	49.8	51.5	46.5
1908	45.7	47.7	43.6	1915–1918 [1]	50.7	54.3	48.9

[1] Exclusive of last three months of 1918.
[2] Entire year of 1918.
[3] First nine months of 1920.
[4] 1892–1894.
[5] 1906–1909.

Comparing the period 1915–1918 with 1905-1909, against an increase of 4.5 years in the average age at death of granite cutters the increase for sand and limestone cutters has been 4.3 years, but for glass-bottle blowers the increase was 5.7 years. In the latter case there are reasons for believing that health improvements in the trade itself account, in part at least, for the longer average duration of life or the higher average age at death.

Since the present investigation is chiefly concerned with pulmonary tuberculosis, Table 61 has been included, showing the proportionate mortality from tuberculosis in the experience of the Granite Cutters' International Association of America for the period 1906 to 1918 and of the industrial experience of the Prudential Insurance Co. of America for the period 1914 to 1917, including under the term "stoneworkers," however, marbleworkers and others engaged in stoneworking processes. This table emphasizes the fallacy of using insurance experience data for comparative purposes without a due consideration of all the facts involved, particularly the element of selection, which though not very stringent in the case of industrial insurance is nevertheless reflected in the more favorable proportionate mortality particularly at the older age. Comparing all ages, the percentage that deaths from pulmonary tuberculosis were of the mortality from all causes was 57.3 per cent for the granite-cutters union as against 33.8 per cent for marble and stone workers in the Prudential experience. There is, however, no question but that marble workers particularly are subject to a more favorable experience than granite cutters. The same conclusion applies to limestone workers and possibly to other

important branches of the stone industry. Particularly suggestive is the high proportionate mortality figure from tuberculosis among granite cutters at ages 45 and over.

TABLE 61.—PROPORTIONATE MORTALITY FROM PULMONARY TUBERCULOSIS AMONG THE GRANITE CUTTERS OF VERMONT, 1906 TO 1918,[1] COMPARED WITH THAT OF MARBLE AND STONE WORKERS, 1914 TO 1917, BY AGE GROUP.

[Data from experience of the Granite Cutters' International Association of America, and industrial experience of Prudential Insurance Co.]

Age at death.	Granite cutters (1906 to 1918).[1]			Insured marble and stone workers (1914 to 1917).[2]		
	Deaths from all causes.	Deaths from pulmonary tuberculosis.		Deaths from all causes.	Deaths from pulmonary tuberculosis.	
		Number.	Per cent of deaths from all causes.		Number.	Per cent of deaths from all causes.
15 to 24 years	14	4	28.6	17	5	29.4
25 to 34 years	80	46	57.5	37	19	51.4
35 to 44 years	202	115	56.9	85	41	48.2
45 to 54 years	203	134	66.0	124	54	43.5
55 to 64 years	93	48	51.6	159	50	31.4
65 years and over	21	4	19.0	98	7	7.1
Total	613	351	57.3	520	176	33.8

[1] Exclusive of last three months of 1918.
[2] Inclusive of block makers, cleaners, cutters, drillers, foremen, grinders, inspectors, laborers, and monument makers.

It has not been feasible to calculate extended mortality tables by single years of life, but as a contribution toward possible further investigation in this direction Table 62 is included, giving by single years all deaths in the experience of the Granite Cutters' International Association for the period 1906 to 1919, and including 2,723 deaths.[a] This table illustrates the need of a large and extended exposure to permit of the calculation of normal frequency curves without the use of mathematics. The table on the whole, however, fairly indicates the normal age distribution among granite cutters and the concentration of deaths at a relatively later period of adult life than normally met with, but falling far short at the older ages, particularly at ages 80 and over. This can only be explained by the excess mortality from pulmonary tuberculosis, or more acurately dust phthisis, at ages 40 and over.

[a] See, however, in this connection the discussion on pp. 35 and 36 and Table 19.

TABLE 62.—MORTALITY FROM ALL CAUSES AMONG THE GRANITE CUTTERS OF THE UNITED STATES AND CANADA, 1906 TO 1919, BY AGE.

[Data from experience of the Granite Cutters' International Association of America.]

Age at death.	Deaths.		Age at death.	Deaths.	
	Number.	Per cent.		Number.	Per cent.
20 years	4	0.15	58 years	53	1.95
21 years	9	.33	59 years	57	2.09
22 years	14	.51	60 years	50	1.84
23 years	16	.59	61 years	55	2.02
24 years	19	.70	62 years	59	2.17
25 years	22	.81	63 years	49	1.80
26 years	31	1.14	64 years	40	1.47
27 years	30	1.10	65 years	36	1.32
28 years	32	1.17	66 years	37	1.36
29 years	31	1.14	67 years	45	1.65
30 years	45	1.65	68 years	32	1.17
31 years	41	1.51	69 years	29	1.06
32 years	53	1.95	70 years	25	.92
33 years	45	1.65	71 years	15	.55
34 years	46	1.69	72 years	19	.70
35 years	61	2.24	73 years	19	.70
36 years	64	2.35	74 years	8	.29
37 years	61	2.24	75 years	6	.22
38 years	66	2.42	76 years	9	.33
39 years	58	2.13	77 years	6	.22
40 years	82	3.01	78 years	7	.26
41 years	59	2.17	79 years	5	.18
42 years	84	3.08	80 years	4	.15
43 years	64	2.35	81 years	4	.15
44 years	66	2.42	82 years	3	.11
45 years	70	2.57	83 years	1	.04
46 years	74	2.72	84 years	.....	.....
47 years	70	2.57	85 years	6	.22
48 years	77	2.83	86 years	.....	.....
49 years	73	2.68	87 years	1	.04
50 years	91	3.33	88 years	.....	.....
51 years	74	2.72	89 years	.....	.....
52 years	89	3.27	90 years	.....	.....
53 years	74	2.72	91 years	.....	.....
54 years	70	2.57	92 years	.....	.....
55 years	60	2.20	93 years	1	.04
56 years	62	2.28			
57 years	55	2.02	Total	2,723	100.00

MORTALITY OF GRANITE MANUFACTURERS.

In the foregoing discussion granite workers, represented chiefly by granite cutters, have been considered separately from granite manufacturers. The latter represent, however, a group of granite workers of exceptional interest in that, with few exceptions, granite manufacturers are men who formerly worked at trades as journeymen, chiefly as granite cutters, and although relieved from much of the most injurious dust exposure the nature of their work requires close supervision and frequent presence in the granite-cutting sheds. It has, therefore, been considered advisable to include a table showing the proportionate mortality from pulmonary tuberculosis among granite manufacturers as well as among granite cutters in the State of Vermont, in the State of Massachusetts, and in Rhode Island and Connecticut combined, and also in the States of Maine and New Hampshire, considered as a group. According to Table 63 a large portion of the deaths from pulmonary tuberculosis in every group are concentrated in the age period 40 to 49, or from 63.2 per cent of the mortality from all causes for granite manufacturers and 62.8 per cent for granite cutters of Vermont to 58 per cent and 56.3 per cent for the other two geographical groups. This result is rather unexpected, as it has generally been assumed that granite manufacturers, because

of a lesser exposure, were more free from the occupational hazards of the employment. The data suggest that in the light of the previous discussion manufacturers suffer the consequences of early exposure, terminating fatally on the average in a trade life of about 21 years. Considering all ages, the results are somewhat favorable for granite manufacturers, but the differences are not sufficiently striking to set aside the conclusion that for practical purposes granite manufacturers suffer proportionately about as much from tuberculosis as granite cutters. For all ages combined, the percentage that deaths from pulmonary tuberculosis were of the mortality from all causes is 49.1 in the case of granite manufacturers and 57.3 in the case of granite cutters for the State of Vermont and 41.3 and 47.6, respectively, for the other two geographical divisions considered. The foregoing discussion leaves no other conclusion than that the nature and the degree of dust exposure primarily determine the worker's liability to dust phthisis, generally diagnosed as pulmonary tuberculosis.

TABLE 63.—PROPORTIONATE MORTALITY FROM PULMONARY TUBERCULOSIS AMONG THE GRANITE MANUFACTURERS OF WASHINGTON AND CALEDONIA COUNTIES, VT., COMPARED WITH THAT OF GRANITE CUTTERS IN THE NEW ENGLAND STATES, BY AGE GROUP.

Age at death.	Granite manufacturers.[1]			Granite cutters.[2]								
				Vermont.			Massachusetts, Connecticut, and Rhode Island.			Maine and New Hampshire.		
	Deaths from all causes.	Deaths from pulmonary tuberculosis.		Deaths from all causes.	Deaths from pulmonary tuberculosis.		Deaths from all causes.	Deaths from pulmonary tuberculosis.		Deaths from all causes.	Deaths from pulmonary tuberculosis.	
		No.	Per cent of deaths from all causes.		No.	Per cent of deaths from all causes.		No.	Per cent of deaths from all causes.		No.	Per cent of deaths from all causes.
20 to 29 years	.....	.....	.....	53	30	56.6	24	10	41.7	12	5	41.7
30 to 39 years	8	3	37.5	129	68	52.7	86	37	43.0	31	19	61.3
40 to 49 years	19	12	63.2	226	142	62.8	131	76	58.0	71	40	56.3
50 to 59 years	14	8	57.1	154	93	60.4	174	76	43.7	97	43	44.3
60 to 69 years	12	4	33.3	45	18	40.0	145	46	31.7	61	28	45.9
70 to 79 years	2	.....	.....	6	.....	.....	45	9	20.0	18	4	22.2
80 years and over	.....	.....	.....	.....	.....	.....	10	.....	.....	2	.....	.....
Total	55	27	49.1	613	351	57.3	615	254	41.3	292	139	47.6

[1] 1898–1918, exclusive of the last quarter of 1918. [2] 1906–1918, exclusive of the last quarter of 1918.

DIFFERENCES IN STONE COMPOSITION.

A thorough scientific investigation would have to take into account the true nature of the dust inhaled in particular shops and under particular working conditions, since the composition of the stone often varies widely. Especially is this so in the case of limestone and sandstone cutting, where the range may be from constituents of comparative harmlessness to those of most deadly seriousness. It may be laid down as a general principle that the injuriousness of the dust is proportionate to the silica content, and to emphasize the wide range in conditions, particularly as regards limestone and

marble workers, Table 64 is included as a preliminary contribution toward a more extended study of the dust problem in granite cutting, particularly that now in progress by the United States Bureau of Mines.

This table shows that the proportion of silica in the dark Barre granite is 69.89 per cent, in Lake Superior sandstone 87.02 per cent, in Indiana limestone 1.00 per cent, while there is practically no silica in the white marble of Rutland, Vt. Conversely, there is practically no calcium carbonate in the Vermont granite or the Lake Superior sandstone, although it forms 97.27 per cent of Indiana limestone and 90.7 per cent of the white marble of Rutland, Vt. Unless such differences in stone composition are taken into account the conclusions affecting mortality and disease liability may be widely at variance with the facts.

TABLE 64.—TYPICAL CHEMICAL ANALYSIS OF GRANITE, LIMESTONE, SANDSTONE, AND MARBLE.

Constituent.	Dark Barre granite.[1]	Indiana oolitic limestone.[2]	Lake Superior sandstone.[3]	White marble[4] of Rutland, Vt.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
Silica (SiO_2)	69.89	1.00	87.02	.....
Alumina (Al_2O_3)	15.08	.33	7.17	0.39
Soda (Na_2O)	4.73	.....	.22	.....
Potash (K_2O)	4.29	.....	1.43	.....
Lime (CaO)	2.07	.....	.11	.....
Calcium carbonate ($CaCO_3$)	.....	97.27	.....	90.70
Iron oxide (FeO)	1.46	.....	.....	.14
Iron sesquioxide (Fe_2O_3)	1.04	.59	3.91	.....
Other elements	1.44	.81	.14	8.77
Total	100.00	100.00	100.00	100.00

[1] Dale, T. Nelson: The Granites of Vermont, United States Geological Survey Bul. 404, p. 51.
[2] Blatchley, Raymond S.: The Indiana Oolitic Limestone Industry in 1907, Thirty-second Annual Report of the Department of Geology and Natural Resources, Indiana, 1907, p. 376.
[3] Buckley, E. R.: The Building and Ornamental Stones of Wisconsin, Wisconsin Geological and Natural History Survey Bul. No. 4, Economic Series No. 2, 1898, p. 175.
[4] Clarke, F. W.: Analyses of Rocks and Minerals, United States Geological Survey Bul. 591, p. 225.

REGULARITY OF EMPLOYMENT.

Finally, there are the factors of labor and shop conditions. It does not fall within the province of the present discussion to enlarge upon these aspects, which would require explanations in detail of processes of manufacture, dust removing, apparatus, etc., each of which represents a subject demanding special consideration. In the course of the investigation, however, some very interesting material was collected as regards vacation time and periods of involuntary idleness, absence on account of sickness, etc., which it seems well worth while making a matter of permanent record. According to Table 65, of 1,869 granite workers (including all occupations) 1,449, or 77.53 per cent, had no vacation during the year, while the remainder had vacation periods averaging 34 days. Of the 1,869 the number who experienced no periods of involuntary idleness was 1,834, or 98.13 per cent. The average length of the periods of idleness of the remainder was 75.7 days.

Of exceptional interest are the data regarding absence on account of sickness, which, however, include the influenza period of 1918 and must therefore be accepted with due reserve. Out of 1,869 em-

ployees 899, or 48.1 per cent, were absent more or less on account of sickness, the average duration of such sickness being 26.5 days. The distribution of sickness by length of time is of special interest, it being shown that the major portion was of less than four weeks' duration. There can be no question, however, that sickness, generally speaking and particularly of course from nontubercular respiratory affections, is more common among granite workers than among men employed in other trades. It may be pointed out in this connection that the death rate per 1,000 from all causes, which was 26.2 for granite cutters during 1918, excluding influenza, is increased to 46.7 when influenza is included. For sandstone and limestone cutters the death rate per 1,000 from influenza was only increased from 19.8 to 25.8, and for glass-bottle blowers from 17.0 to 25.9. These results strikingly confirm the earlier observations in these discussions regarding the decidedly fatal aspect of influenza among the granite cutters of the Barre district.

TABLE 65.—DISTRIBUTION OF GRANITE WORKERS OF BARRE, VT., ACCORDING TO VACATION TIME, INVOLUNTARY IDLENESS, AND ABSENCE FROM WORK ON ACCOUNT OF SICKNESS, AUGUST, 1918, TO AUGUST, 1919.

Period of unemployment.	Vacation.		Involuntary idleness.		Absence on account of sickness.[1]	
	Number of workers.	Per cent of total.	Number of workers.	Per cent of total.	Number of workers.	Per cent of total.
None	1,449	77.53	1,834	98.13	970	51.90
1 to 6 days	18	.96	1	.05	159	8.51
1 week	93	4.98	1	.05	126	6.74
2 weeks	113	6.05	6	.32	225	12.04
3 weeks	32	1.71	1	.05	95	5.08
4 weeks	63	3.37	7	.38	100	5.35
5 weeks	6	.32	1	.05	31	1.66
6 weeks	11	.59	.....	.....	28	1.50
7 weeks	2	.11	.....	.....	6	.32
2 months	26	1.39	5	.27	64	3.42
3 months	38	2.03	2	.11	40	2.14
4 months	7	.37	4	.21	8	.43
5 months	5	.27	2	.11	7	.37
6 months and over	6	.32	5	.27	10	.54
Total	1,869	100.00	1,869	100.00	1,869	100.00
Average period (days)	34.0		75.7		26.5	

[1] Inclusive of influenza of 1918.

Table 66 presents the comparative results for granite workers and limestone workers, based, for limestone workers, upon an original investigation during the two years 1919 and 1920. In the first place it is significant that while 77.53 per cent of the granite cutters had no vacation, the proportion of limestone workers having no vacation was 94.95 per cent. The comparison illustrates clearly the superior economic condition of the granite cutters. For the granite cutters who took a vacation the average length of such vacation was 34 days as against only 29.6 days for limestone workers. Thus not only was a larger proportion of granite cutters free from the burden of work during a part of the year, but the period of freedom was longer than in the case of limestone workers, although the latter group experiences a decidedly lower mortality from pulmonary tuberculosis.

In the case of involuntary idleness a larger proportion of limestone workers were absent from work, but the duration of such absence was less. The period of involuntary idleness in the case of granite cutters was 75.7 days, as against 56.9 days for limestone workers. Absence on account of sickness did not affect 51.9 per cent of the granite workers as against 72.02 per cent for limestone workers. Of those who were absent on account of sickness the duration was practically the same, being, respectively, 26.5 days for granite cutters and 25.6 days for limestone workers. These data, while not finally conclusive, are suggestive of the better economic condition of granite cutters as compared with limestone workers, but are decidedly less favorable regarding the loss of time on account of sickness, attributable without question to inherent conditions of the employment rather than to other predisposing causes.

TABLE 66.—PROPORTIONATE DISTRIBUTION OF GRANITE WORKERS OF BARRE, VT., ACCORDING TO VACATION TIME, INVOLUNTARY IDLENESS, AND ABSENCE FROM WORK ON ACCOUNT OF SICKNESS, AUGUST, 1918, TO AUGUST, 1919, COMPARED WITH THAT OF LIMESTONE WORKERS OF LAWRENCE COUNTY, IND., 1919 TO 1920.

Period.	Vacation.		Involuntary idleness.		Absence on account of sickness.	
	Granite workers.	Limestone workers.	Granite workers.	Limestone workers.[1]	Granite workers.[2]	Limestone workers.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
None	77.53	94.95	98.13	61.29	51.90	72.02
1 to 6 days	.96	.56	.05	.37	8.51	6.34
1 week	4.98	.93	.05	1.31	6.74	4.48
2 weeks	6.05	1.86	.32	3.45	12.04	6.44
3 weeks	1.71	.....	.05	3.17	5.08	2.98
4 weeks	3.37	.56	.38	7.37	5.35	2.80
5 weeks	.32	.....	.05	.....	1.66	.....
6 weeks	.59	.....	.....	.....	1.50	.....
7 weeks	.11	.....	.....	.....	.32	.....
2 months	1.39	.47	.27	13.25	3.42	3.08
3 months	2.03	.47	.11	6.81	2.14	.84
4 months	.37	.10	.21	1.68	.43	.37
5 months	.27	.....	.11	.37	.37	.28
6 months and over	.32	.10	.27	.93	.54	.37
Total	100.00	100.00	100.00	100.00	100.00	100.00
Average period.....days..	34.0	29.6	75.7	56.9	26.5	25.6

[1] Inclusive of time lost through strikes.
[2] Inclusive of influenza of 1918.

COMPARATIVE OCCUPATIONAL MORTALITY DATA.

MORTALITY OF LIMESTONE AND SANDSTONE CUTTERS AND GLASS-BOTTLE BLOWERS.

The comparative mortality of granite workers and of men employed in similar dusty trades has not heretofore been made the subject of an extended and thoroughly qualified investigation. Even the present inquiry does not justify entirely safe conclusions, but it has seemed worth while to bring together the available data likely to prove useful in connection with further investigations. The most trustworthy data available for the purpose are the statistics of the limestone cutters' union arrived at by the same method as has been followed in the case of granite cutters, the data being differentiated

as regards limestone and sandstone cutters on account of the wide differences in occupational hazards. In addition there are available the statistics of glass-bottle blowers, and all of the four groups of data are compared with the mortality of the adult male population of Massachusetts.[a]

Table 67 shows the mortality from all causes among granite cutters of the United States and Canada, compared with sandstone cutters, limestone cutters, glass-bottle blowers, and the adult male population of New England. The data are strictly comparable since 1905 and indicate a marked increase in the death rate for granite cutters, a stationary condition for sandstone cutters, a diminishing death rate for limestone cutters, a slightly increased rate for glass-bottle blowers, and a stationary condition for the adult male population of New England. These rates have not been standardized on account of the varying age constitution of the different occupational groups considered, but for practical purposes they would seem to be conclusive.

[a] The present investigation clearly emphasizes the fallacy of combining stone workers' mortality data by grouping occupations with a widely varying dust hazard. In the medico-actuarial mortality investigation by the Association of Life Insurance Medical Directors and the Actuarial Society of America in 1912, for illustration, journeymen stonecutters are considered as a group, yielding a ratio of actual to expected mortality of 214 per cent. The resulting conclusion may safely be said to apply practically exclusively to granite and sandstone cutters, while it fails to disclose the much more favorable position of limestone workers. The medico-actuarial investigation, furthermore, fails on the ground of insufficient data in that the total number of deaths considered was only 76. Objection may also be raised to the term "journeymen," which is practically never used in actual experience, the men employed being designated by the occupational terms used in the present investigation. It may be pointed out at the same time that in dusty trades the health-injurious consequences rarely affect younger ages, and that therefore the inclusion of apprentices in a combined experience is most likely to impair the resulting conclusions. The results of the medico-actuarial investigation in detail are as follows:

Medico-actuarial experience.

Age group.	Exposed to risk.	Actual deaths.	Expected deaths.	Ratio of actual deaths to expected deaths.
				Per cent.
15 to 29 years	2,579	17	11.96	142
30 to 39 years	2,289	32	13.44	238
40 to 49 years	681	22	6.75	326
50 to 59 years	138	5	3.20	156
60 years and over	3	.....	.10	.....
All ages	5,690	76	35.44	214

According to this experience, out of 5,690 stone workers exposed to risk 4,868, or 85.6 per cent, were under 40 years of age. Since about 20 years is required to show the full effect of stone-dust exposure, the element most liable to the after effects of such exposure was practically not represented in the medico-actuarial experience. (See age distribution of stone workers by single years of life, pp. 35, 36.)

TABLE 67.—MORTALITY FROM ALL CAUSES AMONG GRANITE CUTTERS OF THE UNITED STATES AND CANADA COMPARED WITH THAT OF SANDSTONE AND LIMESTONE CUTTERS AND GLASS-BOTTLE BLOWERS OF THE UNITED STATES AND CANADA AND THE ADULT MALE POPULATION OF NEW ENGLAND, 1889 TO 1920.

Year or period.	Granite cutters.			Sandstone cutters.			Limestone cutters.			Glass-bottle blowers.			Male population of New England [1] (20 years of age and over).		
	Number exposed.	Deaths.	Death rate per 1,000.	Number exposed.	Deaths.	Death rate per 1,000.	Number exposed.	Deaths.	Death rate per 1,000.	Number exposed.	Deaths.	Death rate per 1,000.	Population.	Deaths.	Death rate per 1,000.
1889	3,834	45	11.7										989,392	17,530	[2] 17.7
1890	4,949	62	12.5										1,016,405	18,961	[2] 18.6
1891	6,407	55	8.6										1,038,240	19,532	[2] 18.8
1892	4,375	70	16.0							2,580	23	8.9	1,270,871	25,759	20.3
1893	3,887	73	18.8							2,536	22	8.7	1,294,364	25,197	19.5
1894	3,399	79	23.2							2,676	29	10.8	1,317,857	23,910	18.1
1895	2,850	57	20.0							2,560	20	7.8	1,341,352	24,228	18.1
1896	4,116	48	11.7							2,455	34	13.8	1,367,030	24,533	17.9
1897	4,779	53	11.1							2,333	26	11.1	1,392,708	24,318	17.5
1898	4,457	76	17.1							2,386	28	11.7	1,418,386	24,892	17.5
1899	4,471	62	13.9							3,643	35	9.6	1,444,065	25,589	17.7
1900	5,362	62	11.6							4,302	42	10.0	1,469,744	26,352	17.9
1901	6,864	71	10.3							5,309	60	11.3	1,488,842	26,969	18.1
1902	7,760	87	11.2							6,207	66	10.6	1,507,940	25,869	17.2
1903	8,768	88	10.0							6,799	72	10.6	1,527,038	27,186	17.8
1904	8,568	118	13.8							7,177	99	13.8	1,546,137	27,649	17.9
1905	9,148	143	15.6	2,699	43	15.9	4,221	98	23.2	7,311	95	13.0	1,565,236	28,497	18.2
1906	10,185	144	14.1	2,714	82	30.2	4,245	79	18.6	8,093	96	11.9	1,596,379	27,855	17.4
1907	9,056	138	15.2	2,676	81	30.3	4,315	110	25.5	8,631	112	13.0	1,627,522	30,696	18.9
1908	8,810	149	16.9	2,589	70	27.0	4,434	77	17.4	8,384	116	13.8	1,658,665	28,390	17.1
1909	9,869	111	11.2	2,172	49	22.6	4,803	88	18.3	9,035	92	10.2	1,689,808	28,783	17.0
1910	9,607	179	18.6	2,660	79	29.7	4,618	84	18.2	8,854	125	14.1	1,720,952	30,833	17.9
1911	9,225	178	19.3	2,468	53	21.5	3,944	99	25.1	8,682	118	13.6	1,748,102	31,367	17.9
1912	8,742	165	18.9	2,415	65	26.9	3,766	62	16.5	9,166	113	12.3	1,775,252	30,515	17.2
1913	7,797	206	26.4	2,155	53	24.6	3,581	59	16.5	8,719	114	13.1	1,802,402	31,465	17.5
1914	9,721	217	22.3	1,895	40	21.1	3,395	55	16.2	8,544	116	13.6	1,829,552	31,725	17.3
1915	9,052	202	22.3	1,654	39	23.6	3,069	54	17.6	7,776	122	15.7	1,856,702	31,687	17.1
1916	9,739	206	21.2	1,369	45	32.9	3,681	59	16.0	7,790	114	14.6	1,883,852	34,184	18.1
1917	8,274	213	25.7	1,249	24	19.2	3,524	62	17.6	8,466	94	11.1	1,656,157	29,731	[2] 18.0
1918 [3]	6,374	167	26.2	874	25	28.6	2,416	40	16.6	6,425	109	17.0			
1918 [4]	8,373	391	46.7	1,165	49	42.1	3,221	64	19.9	8,567	222	25.9			
1919				782	20	25.6	2,108	43	20.4	8,072	89	11.0			
1920 [5]				576	10	17.4	2,506	38	15.2						
1889–1894	26,851	384	14.3							7,792	74	9.5	6,927,129	130,889	18.9
1895–1899	20,673	296	14.3							13,377	143	10.7	6,963,541	123,560	17.7
1900–1904	37,322	426	11.4							29,694	339	11.4	7,539,701	134,025	17.8
1905–1909	47,068	685	14.6	12,850	325	25.3	22,018	452	20.5	41,454	511	12.3	8,137,610	144,221	17.7
1910–1914	45,092	945	21.0	11,593	290	25.0	19,304	359	18.6	43,964	586	13.3	8,876,260	155,905	17.6
1915–1918 [3]	33,439	788	23.6	5,146	133	25.8	12,690	215	16.9	30,457	439	14.4	5,396,711	95,602	[6] 17.7

[1] Connecticut excepted.
[2] New Hampshire, Vermont, Massachusetts, and Rhode Island.
[3] Exclusive of last 3 months of 1918.
[4] Entire year of 1918.
[5] First 9 months of 1920.
[6] 1915–1917.

In this table the mortality from all causes fails to reflect the extraordinary mortality from pulmonary tuberculosis or dust phthisis, which suggests the absolute necessity of a detailed analysis to visualize unfavorable tendencies, for during the period 1910–1914, which may be looked upon as normal, the death rate of granite cutters was 21 per 1,000 as against 25 for sandstone cutters, 18.6 for limestone cutters, 13.3 for glass-bottle blowers, and 17.6 for the male population of Massachusetts. The indicated differences fall far short of reflecting the true disparity in the mortality rates from both causes or their influence upon the true life expectancy of granite cutters, which is unquestionably much more serious than would be apparent from a superficial and noncritical analysis.

Table 68 illustrates the striking and really extraordinary differences in tuberculosis disease frequency among granite, sandstone, and limestone workers. It is shown that the tuberculosis mortality of the granite cutters of Vermont per 100,000 has increased from 719.5 in 1905–1909 to 1,064.5 in 1915–1918, and that of the granite cutters of New England from 611.6 to 1,056.7. During the same period the mortality of sandstone cutters has increased from 910.5 to 1,029.9, while for limestone cutters the death rate has diminished from 626.8 to 425.5. There was also a material decline during the same period in the mortality of glass-bottle blowers, or from 381.1 to 265.9 per 100,000, while among the male population of Massachusetts 20 years of age and over the death rate from pulmonary tuberculosis diminished from 225.2 to 203.2. For practical purposes the evidence is therefore entirely conclusive that the serious effects of dust inhalation are practically limited to granite and sandstone cutters and are increasing in severity. The primary cause of this difference is unquestionably the silica content of the dust inhaled, for, according to the analysis of such dust samples as have been available for the purpose, the proportion of silica in granite dust, as shown in Table 69, is 72.96 per cent, and in sandstone dust 85.42 per cent, while in limestone dust the proportion is only 1.22 per cent. Since this question will receive further consideration, it need not here be enlarged upon.[a]

[a] For a more extended discussion of this question see p. 108 et seq. It may be said in this connection that it is to be hoped the Bureau of Mines will give full publicity to the data collected by the ascertainment of actual shop conditions in the Barre district. A preliminary account of the method followed of determining by comparative tests the air dustiness of granite shops by means of the dust counter, the konimeter, or the sugar tube, has been published in The Research Laboratory, the technical periodical of the Bureau of Mines, under date of July, 1921. It is explained in this discussion that averages of all tests at Barre "show that the konimeter method indicates about 13 times as many dust particles as the dust counter, and the sugar tube about 7 times as many as the konimeter." These important differences in the results secured by different methods clearly indicate the extreme urgency of such investigations being made by those best qualified to make them. The following statement may be quoted in this connection: "Very large variations in degree of dustiness at any one plant are apparent. In all but two situations the numbers of particles indicated by the sugar were much greater than those by the konimeter, and the numbers indicated by the konimeter were greater than those by the dust counter. The lower result with the dust counter is due partly to inability to observe some of the smaller particles at a magnification of 50 diameters. On the other hand, the sugar-tube particles, counted at 110 diameter, were much more than those with the konimeter, counted at 200 diameter."

TABLE 68.—MORTALITY FROM PULMONARY TUBERCULOSIS AMONG GRANITE CUTTERS OF THE NEW ENGLAND STATES COMPARED WITH THAT OF SANDSTONE AND LIMESTONE CUTTERS AND GLASS-BOTTLE BLOWERS OF THE UNITED STATES AND CANADA AND THE ADULT MALE POPULATION OF MASSACHUSETTS, 1892 to 1920.

Year or period.	Granite cutters.						Sandstone cutters.			Limestone cutters.			Glass-bottle blowers.			Male population of Massachusetts (20 years of age and over).		
	Vermont.			New England.														
	Number exposed.	Deaths.	Death rate per 100,000.	Number exposed.	Deaths.	Death rate per 100,000.	Number exposed.	Deaths.	Death rate per 100,000.	Number exposed.	Deaths.	Death rate per 100,000.	Number exposed.	Deaths.	Death rate per 100,000.	Population.	Deaths.	Death rate per 100,000.
1892	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	2,580	6	232.6	720,535	2,320	332.0
1893	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	2,536	5	236.6	737,628	2,271	307.9
1894	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	2,676	10	373.7	754,721	2,247	297.7
1895	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	2,560	8	312.5	771,813	2,318	300.3
1896	1,164	3	257.7	3,747	10	266.9	.....	.....	.....	.....	.....	.....	2,455	12	488.8	791,091	2,334	295.0
1897	1,262	5	396.2	3,918	15	382.8	.....	.....	.....	.....	.....	.....	2,333	14	600.1	810,369	2,282	281.6
1898	1,491	6	402.4	4,046	17	420.2	.....	.....	.....	.....	.....	.....	2,386	7	293.4	829,647	2,373	286.0
1899	1,667	8	479.9	4,029	26	645.3	.....	.....	.....	.....	.....	.....	3,643	15	411.7	848,925	2,382	280.6
1900	1,843	5	271.3	4,758	20	420.3	.....	.....	.....	.....	.....	.....	4,202	17	404.6	868,201	2,298	264.7
1901	1,860	5	268.8	5,300	20	377.4	.....	.....	.....	.....	.....	.....	5,309	19	357.9	880,578	2,308	262.1
1902	2,198	9	409.5	6,166	30	486.5	.....	.....	.....	.....	.....	.....	6,207	21	338.3	892,955	2,141	239.8
1903	2,342	8	341.6	6,251	31	495.9	.....	.....	.....	.....	.....	.....	6,799	13	191.2	905,332	2,022	223.3
1904	2,504	11	439.3	6,842	32	467.7	.....	.....	.....	.....	.....	.....	7,177	31	431.9	917,709	2,211	240.9
1905	2,595	20	770.7	7,202	43	597.1	2,699	25	926.3	4,221	40	947.6	7,311	32	437.7	930,088	2,195	236.0
1906	2,938	19	646.7	8,049	49	608.8	2,714	35	1,289.6	4,245	20	471.1	8,093	29	358.3	954,510	2,156	225.9
1907	3,046	25	820.7	7,569	46	607.7	2,676	24	896.9	4,315	30	695.2	8,631	36	417.1	978,932	2,336	238.6
1908	2,881	22	763.6	7,316	56	765.4	2,589	21	811.1	4,434	22	496.2	8,384	33	393.6	1,003,354	2,207	220.0
1909	3,134	19	606.2	7,798	38	487.3	2,172	12	552.5	4,803	26	541.3	9,035	28	309.9	1,027,776	2,127	207.0
1910	3,296	27	819.2	7,888	59	748.0	2,660	25	939.8	4,618	15	324.8	8,854	35	395.3	1,052,198	2,252	214.0
1911	3,352	25	745.8	7,937	54	680.4	2,468	19	769.8	3,944	20	507.1	8,682	30	345.5	1,072,627	2,233	208.2
1912	3,266	19	581.8	7,609	49	644.0	2,415	17	703.9	3,766	13	345.2	9,165	16	174.6	1,093,056	2,128	194.7
1913	3,660	28	765.0	7,767	74	952.7	2,155	22	1,020.9	3,581	12	335.1	8,719	33	378.5	1,113,485	2,220	199.3
1914	3,529	38	1,076.8	7,567	75	991.1	1,895	16	844.3	3,395	10	294.6	8,544	28	327.7	1,133,914	2,275	200.6
1915	3,613	32	885.7	7,453	61	818.5	1,654	13	786.0	3,069	14	456.2	7,776	25	321.5	1,154,343	2,201	190.7
1916	3,233	43	1,330.0	7,051	84	1,191.3	1,369	18	1,314.8	3,681	13	353.2	7,790	15	192.6	1,174,772	2,460	209.4
1917	2,921	32	1,095.5	6,662	72	1,080.8	1,249	12	960.8	3,524	17	482.4	8,466	21	248.0	1,195,201	2,500	209.2
1918[1]	2,727	26	953.4	4,954	59	1,191.0	874	10	1,144.2	2,416	10	413.9	6,425	20	311.3	.....	.....	.....
1918[2]	.....	.....	.....	6,605	73	1,105.2	1,165	14	1,201.7	3,221	16	496.7	8,567	24	280.1	1,215,630	2,728	224.4
1919	.....	.....	.....	.....	.....	.....	782	8	1,023.0	2,108	5	237.2	8,072	12	148.7	.....	.....	.....
1920[3]	.....	.....	.....	.....	.....	.....	576	5	868.1	2,506	10	399.0	.....	.....	.....	.....	.....	.....
1892–1894	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	7,792	22	282.3	2,212,884	6,838	309.0
1895–1899	5,584	22	394.0	15,740	68	432.0	.....	.....	.....	.....	.....	.....	13,377	56	418.6	4,051,845	11,689	288.5
1900–1904	10,747	38	353.6	29,317	133	453.7	.....	.....	.....	.....	.....	.....	29,694	101	340.1	4,464,775	10,980	245.9
1905–1909	14,594	105	719.5	37,934	232	611.6	12,850	117	910.5	22,018	138	626.8	41,454	158	381.1	4,894,660	11,021	225.2
1910–1914	17,103	137	801.0	38,768	311	802.2	11,593	99	854.0	19,304	70	362.6	43,964	142	323.0	5,465,280	11,108	203.2
1915–1918[1]	12,494	133	1,064.5	26,120	276	1,056.7	5,146	53	1,029.9	12,690	54	425.5	30,457	81	265.9	[3] 3,524,316	[4] 7,161	[4] 203.2

[1] Exclusive of last three months of 1918. [2] Entire year of 1918. [3] First nine months of 1920. [4] 1915–1917.

TABLE 69.—CHEMICAL ANALYSES OF GRANITE, SANDSTONE, AND LIMESTONE.

Constituent.	Granite.	Sandstone.	Limestone.
	Per cent.	*Per cent.*	*Per cent.*
Silica (SiO_2)	72.96	85.42	1.22
Alumina (Al_2O_3)	15.04	5.92	.46
Soda (Na_2O)	4.05	.70	.....
Potash (K_2O)	3.76	.59	.....
Lime (CaO)	1.48	1.41	.....
Iron oxide (FeO)	.78	.23	.....
Iron sesquioxide (Fe_2O_3)	1.19	2.44	.12
Magnesium oxide (MgO)	.26	.23	.....
Calcium carbonate ($CaCO_3$)	.....	.....	96.37
Magnesium carbonate ($MgCO_3$)	.....	.....	1.37
Other elements	.57	2.87	.33
Total	100.09	99.81	99.87

A more detailed analysis of the mortality data by principal causes of death, as shown in Table 70, emphasizes other marked variations in the mortality experience which are in all probability also directly attributable to differences in the mechanical and chemical properties of the dust inhaled. It is shown that the death rate for granite cutters from pneumonia during 1915–1918 was 201.6 per 100,000, for sandstone cutters 310.9, and for limestone cutters 118.2. The differences are less marked for bronchitis and asthma, although in the case of both of these diseases the death rates for granite cutters are excessive.

TABLE 70.—MORTALITY FROM SPECIFIED CAUSES AMONG GRANITE CUTTERS OF THE NEW ENGLAND STATES COMPARED WITH THAT OF SANDSTONE AND LIMESTONE CUTTERS AND GLASS-BOTTLE BLOWERS OF THE UNITED STATES AND CANADA AND THE ADULT MALE POPULATION OF MASSACHUSETTS, BY PERIODS OF YEARS.

Period.	Granite cutters.		Sandstone cutters.		Limestone cutters.		Glass-bottle blowers.		Males of Massachusetts.(20 to 69 years of age).	
	Number of deaths.	Death rate per 100,000.	Number of deaths.	Death rate per 100,000.	Number of deaths.	Death rate per 100,000.	Number of deaths.	Death rate per 100,000.	Number of deaths.	Death rate per 100,000.
	Tuberculosis of the lungs.									
1900–1904	133	453.7	.....	.....	.....	.....	101	340.1	10,592	247.4
1905–1909	232	611.6	117	910.5	138	626.8	158	381.1	10,653	225.0
1910–1914	311	802.2	99	854.0	70	362.6	142	323.0	10,805	204.5
1915–1918[1]	290	1,044.3	53	1,029.9	54	425.5	81	265.9	6,997	[2] 207.0
	Pneumonia.									
1900–1904	29	98.9	.....	.....	.....	.....	27	90.9	5,568	130.1
1905–1909	32	84.4	18	140.1	27	122.6	37	89.2	5,570	117.6
1910–1914	49	126.4	23	198.4	23	119.1	51	116.0	5,870	111.1
1915–1918[1]	56	201.6	16	310.9	15	118.2	50	164.2	3,805	[2] 112.6
	Bronchitis.									
1900–1904	3	10.2	.....	.....	.....	.....	1	3.4	718	16.8
1905–1909	7	18.5	3	23.3	4	18.2	3	7.2	570	12.0
1910–1914	13	33.5	2	17.2	6	31.1	6	13.6	467	8.8
1915–1918[1]	12	43.2	2	38.9	4	31.5	.....	.....	187	[2] 5.5

[1] Exclusive of the last three months of 1918.

[2] 1915–1917.

TABLE 70.—MORTALITY FROM SPECIFIED CAUSES AMONG GRANITE CUTTERS OF THE NEW ENGLAND STATES COMPARED WITH THAT OF SANDSTONE AND LIMESTONE CUTTERS AND GLASS-BOTTLE BLOWERS OF THE UNITED STATES AND CANADA AND THE ADULT MALE POPULATION OF MASSACHUSETTS, BY PERIODS OF YEARS—Concluded.

Period.	Granite cutters.		Sandstone cutters.		Limestone cutters.		Glass-bottle blowers.		Males of Massachusetts (20 to 69 years of age).	
	Number of deaths.	Death rate per 100,000.	Number of deaths.	Death rate per 100,000.	Number of deaths.	Death rate per 100,000.	Number of deaths.	Death rate per 100,000.	Number of deaths.	Death rate per 100,000.
	Asthma.									
1900–1904	5	17.1	.....	.....	.....	.....	4	13.5	332	7.8
1905–1909	3	7.9	4	31.1	4	18.2	8	19.3	233	4.9
1910–1914	10	25.8	3	25.9	3	15.5	4	9.1	113	2.1
1915–1918[1]	7	25.2	2	38.9	2	15.8	.....	.....	64	[2] 1.9
	Organic diseases of the heart.									
1900–1904	23	78.5	.....	.....	.....	.....	33	111.1	5,979	139.7
1905–1909	56	147.6	17	132.3	24	109.0	54	130.3	6,609	139.6
1910–1914	59	152.2	16	138.0	26	134.7	57	129.6	7,128	134.9
1915–1918[1]	55	198.0	6	116.6	18	141.8	51	167.4	5,894	[2] 174.4
	Cancer and other malignant tumors.									
1900–1904	4	13.6	.....	.....	.....	.....	8	26.9	2,629	61.4
1905–1909	11	29.0	2	15.6	8	36.3	9	21.7	3,348	70.7
1910–1914	24	61.9	5	43.1	10	51.8	29	66.0	4,141	78.4
1915–1918[1]	17	61.2	4	77.7	8	63.0	23	75.5	3,057	[2] 90.4

[1] Exclusive of the last three months of 1918. [2] 1915–1917.

When compared with the male population of Massachusetts it is shown in this table that the mortality of granite cutters during 1915–1918 was 201.6 for pneumonia as against 112.6 for Massachusetts; for bronchitis the rate was 43.2 for granite cutters and only 5.5 for Massachusetts; for asthma it was 25.2 for granite cutters and 1.9 for Massachusetts. Thus all of the nontubercular respiratory diseases, as well as tuberculosis, rightly or wrongly diagnosed, show a mortality figure materially in excess of the rates expected on the basis of the State data perhaps most useful for comparative purposes. The mortality from organic heart diseases was 198.0 for granite cutters, as against 174.4 for Massachusetts, while the figure for cancer was, respectively, 61.2 and 90.4.

To make the foregoing comparison as useful as possible Table 71 shows the mortality from 36 specified causes for the four occupational groups considered and the adult male population of Massachusetts for the period 1913 to 1917. The most significant fact in this table is the excessive mortality from pulmonary tuberculosis among granite cutters, shown to have been 1,002.7 per 100,000 against 973.3 for sandstone cutters, 382.6 for limestone cutters, 295.4 for glass blowers, and 208.4 for adult males of the State of Massachusetts.

TABLE 71.—MORTALITY FROM SPECIFIED CAUSES AMONG GRANITE CUTTERS OF THE NEW ENGLAND STATES COMPARED WITH THAT OF SANDSTONE AND LIMESTONE CUTTERS AND GLASS-BOTTLE BLOWERS OF THE UNITED STATES AND CANADA AND THE ADULT MALE POPULATION OF MASSACHUSETTS, 1913 TO 1917.

Abridged international list number.[1]	Cause of death,	Granite cutters.		Sandstone cutters.		Limestone cutters.		Glass-bottle blowers.		Males of Massachusetts (20 to 69 years of age).	
		Number of deaths.	Death rate per 100,000.	Number of deaths	Death rate per 100,000.	Number of deaths.	Death rate per 100,000.	Number of deaths.	Death rate per 100,000.	Number of deaths.	Death rate per 100,000.
1	Typhoid fever	2	5.5	2	24.0	2	11.6	6	14.5	541	9.8
2	Typhus fever										
3	Malaria									10	.2
4	Smallpox			1	12.0	1	5.8			9	.2
5	Measles	1	2.7	1	12.0	2	11.6			16	.3
6	Scarlet fever	1	2.7	1	12.0	1	5.8			35	.6
7	Whooping cough									1	
8	Diphtheria and croup									53	1.0
9	Influenza	3	8.2	1	12.0	1	5.8			240	4.3
10	Asiatic cholera										
11	Cholera nostras									1	
12	Other epidemic diseases			2	24.0	3	17.4	1	2.4	409	7.4
13	Tuberculosis of the lungs	366	1,002.7	81	973.3	66	382.6	122	295.4	11,533	208.4
14	Tuberculous meningitis	3	8.2	2	24.0	3	17.4	2	4.8	165	3.0
15	Other forms of tuberculosis	3	8.2	3	36.0	2	11.6			529	9.6
16	Cancer and other malignant tumors	23	63.0	4	48.1	10	58.0	31	75.1	4,875	88.1
17	Simple meningitis	2	5.5	2	24.0	3	17.4	4	9.7	155	2.8
18	Cerebral hemorrhage and softening	15	41.1	10	120.2	17	98.6	28	67.8	4,229	76.4
19	Organic diseases of the heart	64	175.3	12	144.2	24	139.1	51	123.5	9,226	166.7
20	Acute bronchitis	9	24.6	4	48.1	3	17.4	1	2.4	87	1.6
21	Chronic bronchitis	7	19.2			2	11.6	1	2.4	265	4.8
22	Pneumonia	59	161.6	20	240.3	18	104.3	58	140.4	5,963	107.8
23	Other diseases of the respiratory system (tuberculosis excepted)	23	63.0	13	156.2	8	46.4	13	31.5	1,740	31.4
24	Diseases of the stomach (cancer excepted)			1	12.0	4	23.2	9	21.8	717	13.0
26	Appendicitis and typhlitis	6	16.4	4	48.1	7	40.6	4	9.7	688	12.4
27	Hernia and intestinal obstruction					3	17.4	3	7.3	488	8.8
28	Cirrhosis of the liver			1	12.0	8	46.4	13	31.5	871	15.7
29	Acute nephritis and Bright's disease	20	54.8	13	156.2	27	156.5	52	125.9	6,031	109.0
34	Senility			1	12.0	2	11.6	6	14.5	36	.6
35	Violent deaths (suicide excepted)	7	19.2	9	108.1	30	173.9	42	101.7	6,777	122.5
36	Suicide	20	54.8	2	24.0	6	34.8	14	33.9	1,628	29.5
37	Other defined diseases	72	197.3	8	96.1	31	179.7	80	193.7	13,470	243.4
38	Diseases ill-defined or unknown	4	11.0	3	36.0	5	29.0	19	46.0	272	4.9
	All causes	710	[2] 19.4	201	[2] 24.2	289	[2] 16.8	560	[2] 13.6	71,060	[2] 12.8

[1] Manual of the International List of Causes of Death, United States Bureau of the Census, Washington, D. C., 1916.
[2] Death rate per 1,000.

SWISS OCCUPATIONAL EXPERIENCE.

The most useful intensive data for comparative purposes are for Switzerland and Holland. The data for Switzerland unfortunately are only for the period 1879 to 1900, but the statistics are of such exceptional interest, being available by divisional periods of life, that it seems advisable to include the data in the present investigation. These are very briefly referred to, as an illustration of the possibilities of further inquiries in this direction rather than as regards their comparable value, since the statistics have reference to industries rather than to occupations. Table 72 exhibits the comparative mortality from all causes among stonecutters, lime and brick burners, gypsum, cement and asphalt workers, farmers, and all occupied males in the Swiss Republic, first, for the period 1879 to 1890 and, second, for the period 1889 to 1900. To be strictly comparable these statistics have been standardized to eliminate minor divergencies due to an abnormal age distribution, but without reference to such standardization it is shown that the death rate has been consistently high for stonecutters, being 29.4 per 1,000 of population during 1889–1900, as against 29.2 during 1879–1890. The standardized death rates reduce these rates considerably, or, respectively, to 22.7 and 22.5. There has therefore not been the increase in the mortality shown to have taken place among American granite workers, but this is probably attributable to the lesser use of pneumatic tools at this comparatively early period of the stone-working industry.

The standardized death rate for lime and brick burners is a very much lower rate, being 10 per 1,000 for the period 1889–1900 and for farmers it was also 10, while for gypsum, cement, and asphalt workers the rate during the same period was only 9.4. The necessity for standardization is clearly illustrated in the case of farmers, for which the crude death rate was 21 per 1,000. For occupied males generally the standardized rate decreased from 13.7 during 1879–1890 to 12.4 during 1889–1900.

TABLE 72.—MORTALITY FROM ALL CAUSES AMONG THE GRANITE CUTTERS OF BARRE, VT., COMPARED WITH THAT OF THE MALE POPULATION OF MASSACHUSETTS AND STONECUTTERS, LIME AND BRICK BURNERS, GYPSUM, CEMENT, AND ASPHALT WORKERS, FARMERS, AND ALL OCCUPIED MALES OF SWITZERLAND, BY AGE GROUPS.

[Experience of the Granite Cutters International Association of America; Ehe, Geburt und Tod in der schweizerischen Bevölkerung, 1879–1890, Part III, Bern, 1903, p. 99; 1889–1900, Part V, Bern, 1916, p. 275.]

Age at death.	Granite cutters of Barre, Vt. 1911–1917			Male population of Massachusetts. 1911–1917			Stonecutters—Switzerland.[1] 1879–1890		
	Number exposed.	Deaths.	Death rate per 1,000.	Population.	Deaths.	Death rate per 1,000.	Number exposed.	Deaths.	Death rate per 1,000.
15 to 19 years	302	.....	.....	1,070,611	3,638	3.4	5,028	28	5.6
20 to 29 years	2,505	14	5.6	2,356,512	11,871	5.0	14,154	112	7.9
30 to 39 years	4,524	34	7.5	2,017,626	15,312	7.6	16,644	269	16.2
40 to 49 years	3,563	97	27.2	1,600,792	19,428	12.1	12,990	383	29.5
50 to 59 years	1,263	76	60.2	1,054,755	23,608	22.4	8,322	369	44.3
60 years and over	173	27	156.1	907,713	64,816	71.4	5,460	670	122.7
Total	12,330	248	20.1	9,008,009	138,673	15.4	62,598	1,831	29.2
Standardized rates[2]	.....	.....	20.1	.....	.....	10.7	.....	.....	22.5

[1] Inclusive of marble cutters.
[2] Standardization based on age distribution of the granite cutters of Barre, Vt., 1911–1917.

TABLE 72.—MORTALITY FROM ALL CAUSES AMONG THE GRANITE CUTTERS OF BARRE, VT., COMPARED WITH THAT OF THE MALE POPULATION OF MASSACHUSETTS AND STONECUTTERS, LIME AND BRICK BURNERS, GYPSUM, CEMENT, AND ASPHALT WORKERS, FARMERS, AND ALL OCCUPIED MALES OF SWITZERLAND, BY AGE GROUPS—Concluded.

Age at death.	Stonecutters[1]—Switzerland. 1889–1900			Lime and brick burners—Switzerland.					
				1879–1890			1889–1900		
	Number exposed.	Deaths.	Death rate per 1,000.	Number exposed.	Deaths.	Death rate per 1,000.	Number exposed.	Deaths.	Death rate per 1,000.
15 to 19 years	5,130	26	5.1	6,270	18	2.9	6,756	22	3.3
20 to 29 years	15,564	108	6.9	11,106	51	4.6	13,704	61	4.4
30 to 39 years	12,828	195	15.2	9,480	85	9.0	11,172	75	6.7
40 to 49 years	12,084	372	30.8	8,676	102	11.8	8,994	85	9.4
50 to 59 years	7,944	383	48.2	5,430	151	27.8	5,760	132	22.9
60 years and over	5,022	639	127.2	3,636	379	104.2	3,642	393	107.9
Total	58,572	1,723	29.4	44,598	786	17.6	50,028	768	10.4
Standardized rates[2]			22.7			12.0			15.0
	Gypsum, cement, and asphalt workers—Switzerland. 1889–1900			Farmers—Switzerland.					
				1879–1890			1889–1900		
15 to 19 years	3,864	14	3.6	647,658	2,214	3.4	614,220	2,079	3.4
20 to 29 years	12,336	57	4.6	955,080	5,238	5.5	958,944	4,807	5.0
30 to 39 years	10,398	73	7.0	775,296	5,895	7.6	757,458	5,322	7.0
40 to 49 years	6,606	71	10.7	789,696	9,514	12.0	723,306	7,898	10.9
50 to 59 years	3,186	62	19.5	735,438	15,848	21.5	694,416	14,500	20.9
60 years and over	1,200	66	55.0	746,382	59,857	80.2	785,994	60,460	76.9
Total	37,590	343	9.1	4,649,550	98,566	21.2	4,534,338	95,066	21.0
Standardized rates[2]			9.4			10.8			10.0

Age at death.	All occupied males—Switzerland.					
	1879–1890			1889–1900		
15 to 19 years	1,613,832	7,477	4.6	1,763,142	7,621	4.3
20 to 29 years	2,618,370	19,721	7.5	3,056,298	19,478	6.4
30 to 39 years	2,186,556	22,533	10.3	2,408,964	21,403	8.9
40 to 49 years	1,917,840	29,720	15.5	1,963,116	27,633	14.1
50 to 59 years	1,505,502	39,232	26.1	1,552,530	39,812	25.6
60 years and over	1,484,556	117,866	79.4	1,612,398	122,462	75.9
Total	11,326,656	236,549	20.9	12,356,448	238,409	19.3
Standardized rates[2]			13.7			12.4

[1] Inclusive of marble cutters.
[2] Standardization based on age distribution of the granite cutters of Barre, Vt., 1911–1917.

A similar comparison of the mortality from pulmonary tuberculosis is made in Table 75, which also can only be referred to very briefly, since it would obviously be to small purpose to base a conclusion upon data which have reference to a period when trade conditions were probably much at variance with those prevailing at the present time. It is shown, however, that the standardized death rate from pulmonary tuberculosis among stonecutters increased in the two periods 1879–1890 and 1889–1900 from 896.2 to 911.7 per 100,000. These rates compare with a standardized death rate for the granite cutters of Barre, Vt., for 1911–1917, of 1,184.1 per 100,000. The corresponding rate for the adult male population of Massachusetts was only 207.7.

For lime and brick burners the standardized rate diminished from 280.3 for 1879–1890 to 225.9 for 1889–1900, while for gypsum, cement, and asphalt workers for the period 1889–1900 the rate was 210.2. For the farming population of Switzerland the rates diminished from 182.9 for 1879–1890 to 175.3 for 1889–1900, while for all occupied males the rate decreased from 344.8 to 312.3.

These statistics therefore in a general way confirm the conclusions based upon the granite-cutters' experience of North America. It is to be hoped that sometime in the near future later statistics will be made available through the Swiss statistical bureau.

TABLE 73.—MORTALITY FROM PULMONARY TUBERCULOSIS AMONG GRANITE CUTTERS OF BARRE, VT., COMPARED WITH THAT OF THE MALE POPULATION OF MASSACHUSETTS AND STONE CUTTERS, LIME AND BRICK BURNERS, GYPSUM, CEMENT, AND ASPHALT WORKERS, FARMERS, AND ALL OCCUPIED MALES OF SWITZERLAND, BY AGE GROUPS.

[Experience of the Granite Cutters' International Association of America; Ehe Geburt und Tod in der schweizerischen Bevölkerung, 1879–1890, Part III, Bern, 1903, p. 103; 1889–1900, Part V, Bern, 1916, p. 283.]

Age at death.	Granite cutters of Barre, Vt. 1911–1917			Male population of Massachusetts. 1911–1917			Stonecutters [1]—Switzerland. 1879–1890		
	Number exposed.	Deaths.	Death rate per 100,000.	Population.	Deaths.	Death rate per 100,000.	Number exposed.	Deaths.	Death rate per 100,000.
15 to 19 years	302			1,070,611	890	83.1	5,028	6	119.3
20 to 29 years	2,505	10	399.2	2,356,512	4,109	174.4	14,154	40	282.6
30 to 39 years	4,524	17	375.8	2,017,626	4,349	215.6	16,644	133	799.1
40 to 49 years	3,563	60	1,684.0	1,600,792	3,655	228.3	12,990	182	1,401.1
50 to 59 years	1,263	49	3,879.6	1,054,755	2,345	222.3	8,322	98	1,177.6
60 years and over	173	10	5,780.3	907,713	1,559	171.8	5,460	66	1,208.8
Total	12,330	146	1,184.1	9,008,009	16,907	187.7	62,598	525	838.7
Standardized rates [2]			1,184.1			207.7			896.2

Age at death.	Stonecutters [1]—Switzerland. 1889–1900			Lime and brick burners—Switzerland.					
				1879–1890			1889–1900		
	Number exposed.	Deaths.	Death rate per 100,000.	Number exposed.	Deaths.	Death rate per 100,000.	Number exposed.	Deaths.	Death rate per 100,000.
15 to 19 years	5,130	3	58.5	6,270	3	47.8	6,756	4	59.2
20 to 29 years	15,564	53	340.5	11,106	20	180.1	13,704	23	167.8
30 to 39 years	12,828	89	693.8	9,480	37	390.3	11,172	27	241.7
40 to 49 years	12,084	175	1,448.2	8,676	21	242.0	8,994	18	200.1
50 to 59 years	7,944	119	1,498.0	5,430	14	257.8	5,760	23	399.3
60 years and over	5,022	49	975.7	3,636	7	192.5	3,642	12	329.4
Total	58,572	488	833.2	44,598	102	228.7	50,028	107	213.9
Standardized rates [2]			911.7			280.3			225.9

Age at death.	Gypsum, cement and asphalt workers—Switzerland. 1889–1900			Farmers—Switzerland.					
				1879–1890			1889–1900		
	Number exposed.	Deaths.	Death rate per 100,000.	Number exposed.	Deaths.	Death rate per 100,000.	Number exposed.	Deaths.	Death rate per 100,000.
15 to 19 years	3,864	3	77.6	647,658	437	67.5	614,220	436	71.0
20 to 29 years	12,336	19	154.0	955,080	1,408	147.4	958,944	1,353	141.1
30 to 39 years	10,398	18	173.1	775,296	1,441	185.9	757,458	1,354	178.8
40 to 49 years	6,606	16	242.2	789,696	1,554	196.8	723,306	1,347	186.2
50 to 59 years	3,186	12	376.6	735,438	1,668	226.8	694,416	1,537	221.3
60 years and over	1,200	4	333.3	746,382	1,611	215.8	785,994	1,569	199.6
Total	37,590	72	191.5	4,649,550	8,119	174.6	4,534,338	7,596	167.5
Standardized rates [2]			210.2			182.9			175.3

Age at death.	All occupied males—Switzerland.					
	1879–1890			1889–1900		
	Number exposed.	Deaths.	Death rate per 100,000.	Number exposed.	Deaths.	Death rate per 100,000.
15 to 19 years	1,613,832	2,101	130.2	1,763,142	2,161	122.6
20 to 29 years	2,618,370	7,962	304.1	3,056,298	7,880	257.8
30 to 39 years	2,186,556	8,008	365.2	2,408,964	7,604	315.6
40 to 49 years	1,917,840	7,000	365.0	1,963,116	6,824	347.6
50 to 59 years	1,505,502	5,305	352.4	1,552,530	5,597	360.5
60 years and over	1,484,556	4,126	277.9	1,612,398	4,375	271.3
Total	11,326,656	34,502	304.6	12,356,448	34,441	278.7
Standardized rates [2]			344.8			312.3

[1] Inclusive of marble cutters.
[2] Standardization based on the age distribution of the granite cutters of Barre, Vt., 1911–1917.

DUTCH OCCUPATIONAL EXPERIENCE.

The data for the Netherlands are available for the period 1908 to 1911 and therefore of more recent date. They are limited to glass cutters, glass blowers, stonecutters, plasterers, masons, carpenters, painters, and paper hangers. According to Table 74 the standardized mortality rate per 1,000 from all causes was 19.7 for the granite cutters of Barre, Vt., and 28.5 for glass cutters, 7.6 for glass blowers, 16.6 for stonecutters, 6.4 for plasterers, 5.9 for masons, 6.7 for carpenters, 7.5 for painters, and 7.8 for paper hangers in the Netherlands. The exceptionally high mortality of glass cutters is in part explained by the very limited experience, probably insufficient to yield thoroughly trustworthy results, but with this exception and that of stonecutters, the mortality of granite cutters is more than twice the mortality from all causes among any other occupation more or less exposed to dust or other occupational hazards.

TABLE 74.—MORTALITY FROM ALL CAUSES AMONG GRANITE CUTTERS OF BARRE, VT., COMPARED WITH THAT OF SPECIFIED OCCUPATIONS IN THE MANUFACTURING AND MECHANICAL INDUSTRIES OF THE NETHERLANDS.

[Experience of the Granite Cutters' International Association of America; Die Sterblichkeit nach dem Beruf in den Niederlanden, 1908–1911, by Sanitätsrat Dr. Prinzing, Ulm. Archiv für Soziale Hygiene und Demographie, Leipzig, 1919, vol. 13, Nos. 1 and 2, pp. 43–97.]

Age at death.	Granite cutters of Barre, Vt. 1911–1917			Glass industry—Netherlands. 1908–1911					
				Glass cutters.			Glass blowers.		
	Number exposed.	Deaths.	Death rate per 1,000.	Number exposed.	Deaths.	Death rate per 1,000.	Number exposed.	Deaths.	Death rate per 1,000.
18 to 24 years	1,137	2	1.8	540	2	3.7	2,040	9	4.4
25 to 34 years	3,573	23	6.4	572	4	7.0	1,652	11	6.7
35 to 44 years	4,438	67	15.1	236	3	12.7	1,072	5	4.7
45 to 54 years	2,484	93	37.4	88	9	102.3	480	5	10.4
55 to 64 years	454	53	116.7	36	.....	.....	184	6	32.6
Total	12,086	238	19.7	1,472	18	12.2	5,428	36	6.6
Standardized rates [1]	.....	.....	19.7	.....	.....	28.5	.....	.....	7.6

Age at death.	Stonecutters [2]—Netherlands. 1908–1911			Building trades—Netherlands. 1908–1911					
				Plasterers.			Masons.		
18 to 24 years	2,424	7	2.9	4,216	10	2.4	17,156	58	3.4
25 to 34 years	2,596	16	6.2	4,824	22	4.6	21,088	78	3.7
35 to 44 years	1,412	27	19.1	3,772	14	3.7	15,660	72	4.6
45 to 54 years	1,368	37	27.0	3,380	38	11.2	15,152	143	9.4
55 to 64 years	760	40	52.6	2,060	60	29.1	10,632	260	24.4
Total	8,560	127	14.8	18,252	144	7.9	79,688	611	7.7
Standardized rates [1]	.....	.....	16.6	.....	.....	6.4	.....	.....	5.9

	Building trades—Netherlands. 1908–1911								
	Carpenters.			Painters and decorators.			Paper hangers.		
18 to 24 years	58,816	216	3.7	27,728	115	4.1	5,616	20	3.6
25 to 34 years	45,800	209	4.6	26,612	135	5.1	5,500	25	4.5
35 to 44 years	33,092	187	5.6	19,452	107	5.5	4,584	31	6.8
45 to 54 years	33,644	330	9.8	14,616	186	12.7	2,996	33	11.0
55 to 64 years	21,844	536	24.5	8,504	226	26.6	1,584	59	37.2
Total	193,196	1,478	7.6	96,912	769	7.9	20,280	168	8.3
Standardized rates [1]	.....	.....	6.7	.....	.....	7.5	.....	.....	7.8

[1] Standardization based on the age distribution of the granite cutters of Barre, Vt., 1911–1917.
[2] Inclusive of marble cutters.

The corresponding mortality from pulmonary tuberculosis is shown in Table 75. This table yields practically the same results as shown by other comparative data, the standardized death rates from tubercular disease having been 1,191.5 per 100,000 for the granite cutters of Vermont, 169. 8 for plasterers, 154.4 for masons, 222.1 for carpenters, 222.9 for painters, and 315.6 for paper hangers.

TABLE 75.—MORTALITY FROM PULMONARY TUBERCULOSIS AMONG THE GRANITE CUTTERS OF BARRE, VT., COMPARED WITH THAT OF SPECIFIED OCCUPATIONS IN THE MANUFACTURING AND MECHANICAL INDUSTRIES OF THE NETHERLANDS.

[Experience of the Granite Cutters' International Association of America; Die Sterblichkeit nach dem Beruf in den Niederlanden, 1908-1911, by Sanitätsrat Dr. Prinzing, Ulm. Archiv für Soziale Hygiene und Demographie, Leipzig, 1919, vol. 13, Nos. 1 and 2, pp. 43-97.

Age at death.	Granite cutters of Barre, Vt. 1911-1917			Glass industry—Netherlands. 1908-1911					
				Glass cutters.			Glass blowers.		
	Number exposed.	Deaths.	Death rate per 100,000.	Number exposed.	Deaths.	Death rate per 100,000.	Number exposed.	Deaths.	Death rate per 100,000.
18 to 24 years	1,137	.....	.....	540	2	370.4	2,040	2	98.0
25 to 34 years	3,573	14	391.8	572	3	524.5	1,652	5	302.7
35 to 44 years	4,438	43	968.9	236	2	847.5	1,072	2	186.6
45 to 54 years	2,484	59	2,375.2	88	5	5,681.8	480	3	625.0
55 to 64 years	454	28	6,167.4	36	.....	.....	184	1	543.5
Total	12,086	144	1,191.5	1,472	12	815.2	5,428	13	239.5
Standardized rates [1]	.....	.....	1,191.5	.....	.....	1,698.4	.....	.....	331.6

Age at death.	Stonecutters [2]—Netherlands. 1908-1911			Building trades—Netherlands. 1908-1911					
				Plasterers.			Masons.		
	Number exposed.	Deaths.	Death rate per 100,000.	Number exposed.	Deaths.	Death rate per 100,000.	Number exposed.	Deaths.	Death rate per 100,000.
18 to 24 years	2,424	2	82.5	4,216	5	118.6	17,156	22	128.2
25 to 34 years	2,596	9	346.7	4,824	12	248.8	21,088	28	132.8
35 to 44 years	1,412	15	1,062.3	3,772	1	26.5	15,660	24	153.2
45 to 54 years	1,368	18	1,315.8	3,380	11	325.4	15,152	26	171.6
55 to 64 years	760	13	1,710.5	2,060	7	339.8	10,632	31	291.6
Total	8,560	57	665.9	18,252	36	197.2	79,688	131	164.4
Standardized rates [1]	.....	.....	841.1	.....	.....	169.8	.....	.....	154.4

Age at death.	Building trades—Netherlands. 1908-1911								
	Carpenters.			Painters and decorators.			Paper hangers.		
	Number exposed.	Deaths.	Death rate per 100,000.	Number exposed.	Deaths.	Death rate per 100,000.	Number exposed.	Deaths.	Death rate per 100,000.
18 to 24 years	58,816	107	181.9	27,728	59	212.8	5,616	10	178.1
25 to 34 years	45,800	101	220.5	26,612	65	244.2	5,500	16	290.9
35 to 44 years	33,092	76	229.7	19,452	37	190.2	4,584	16	349.0
45 to 54 years	33,644	72	214.0	14,616	36	246.3	2,996	8	267.0
55 to 64 years	21,844	67	306.7	8,504	24	282.2	1,584	15	947.0
Total	193,196	423	218.9	96,912	221	228.0	20,280	65	320.5
Standardized rates [1]	.....	.....	222.1	.....	.....	222.9	.....	.....	315.6

[1] Standardization based on the age distribution of the granite cutters of Barre, Vt., 1911-1917.
[2] Inclusive of marble cutters.

The statistics for the Netherlands are fortunately also available for nontuberculous respiratory diseases. The facts are shown in Table 76, but they need not be further enlarged upon than to say that the standardized mortality of granite cutters of Vermont from this group of causes was 264.8 per 100,000, as against 175.2 for stonecutters of the Netherlands, 71.2 for plasterers, and 79.1 for masons.

TABLE 76.—MORTALITY FROM NONTUBERCULOUS RESPIRATORY DISEASES AMONG THE GRANITE CUTTERS OF BARRE, VT., COMPARED WITH THAT OF SPECIFIED BUILDING TRADES OF THE NETHERLANDS, BY AGE GROUPS.

[Experience of the Granite Cutters' International Association of America; Die Sterblichkeit nach dem Beruf in den Niederlanden, 1908-1911, by Sanitätsrat Dr. Prinzing, Ulm. Archiv für Soziale Hygiene und Demographie, Leipzig, 1919, vol. 13, Nos. 1 and 2, pp. 43-97.]

Age at death.	Granite cutters of Barre, Vt. 1911-1917		
	Number exposed.	Deaths.	Death rate per 100,000.
18 to 24 years	1,137	.....	.....
25 to 34 years	3,573	2	56.0
35 to 44 years	4,438	10	225.3
45 to 54 years	2,484	11	442.8
55 to 64 years	454	9	1,982.4
Total	12,086	32	264.8
Standardized rates[1]			264.8

Age at death.	Stonecutters[2]—Netherlands. 1908-1911			Plasterers—Netherlands. 1908-1911			Masons—Netherlands. 1908-1911		
	Number exposed.	Deaths.	Death rate per 100,000.	Number exposed.	Deaths.	Death rate per 100,000.	Number exposed.	Deaths.	Death rate per 100,000.
18 to 24 years	2,424	1	41.3	4,216	1	23.7	17,156	2	11.7
25 to 34 years	2,596	.....	.....	4,824	2	41.5	21,088	6	28.4
35 to 44 years	1,412	3	212.5	3,772	1	26.5	15,660	9	57.5
45 to 54 years	1,368	4	292.4	3,380	6	177.5	15,152	23	151.8
55 to 64 years	760	7	921.0	2,060	5	242.7	10,632	47	442.1
Total	8,560	15	175.2	18,252	15	82.2	79,688	87	109.2
Standardized rates[1]	.....	.....	175.2	.....	.....	71.2	.....	.....	79.1

Age at death.	Carpenters—Netherlands. 1908-1911			Painters and decorators—Netherlands. 1908-1911			Paper hangers—Netherlands. 1908-1911		
18 to 24 years	58,816	10	17.0	27,728	3	10.8	5,616	.....	.....
25 to 34 years	45,800	18	39.3	26,612	8	30.1	5,500	.....	.....
35 to 44 years	33,092	24	72.5	19,452	9	46.3	4,584	2	43.6
45 to 54 years	33,644	42	124.8	14,616	19	130.0	2,996	4	133.5
55 to 64 years	21,844	97	444.1	8,504	41	482.1	1,584	2	126.3
Total	193,196	191	98.9	96,912	80	82.5	20,280	8	39.4
Standardized rates[1]	.....	.....	81.8	.....	.....	72.2	.....	.....	49.3

[1] Standardization based on the age distribution of the granite cutters of Barre, Vt., 1911-1917.
[2] Inclusive of marble cutters.

Summarizing the rates for all the occupations for which the information is available for the period 1908 to 1911, it is shown by Table 77 that for occupations with exposure to inorganic dust the mortality from pulmonary tuberculosis was 635.0 per 100,000, for occupations with exposure to organic dust 231.0, and for occupations carried on in the open air only 163.0. The differences are less marked in the case of nontuberculous respiratory diseases, having been, respectively, 206.0 for inorganic dust, 151.0 for organic dust, and 136.0 for open-air occupations. These statistics are derived from an extremely valuable discussion of the occupational mortality of the Netherlands by Sanitary Councillor Dr. Prinzing, a leading German authority on the subject.

TABLE 77.—OCCUPATIONAL MORTALITY IN THE NETHERLANDS FROM PULMONARY TUBERCULOSIS, NONTUBERCULOUS RESPIRATORY DISEASES, AND ALL CAUSES, 1908 TO 1911, CLASSIFIED ACCORDING TO EXPOSURE TO DUST.

[Die Sterblichkeit nach dem Beruf in den Niederlanden, 1908-1911, by Sanitätsrat by Dr. Prinzing, Ulm. Archiv für Sozial Hygiene und Demographie, vol. 13, Nos. 1 and 2, p. 96.]

Occupational group.	Standardized death rates, per 100,000 exposed, for all ages from—		
	Pulmonary tuberculosis.	Nontuberculous respiratory diseases.	All causes.
Occupations with exposure to:			
Inorganic dusts	635.0	206.0	[1] 15.5
Organic dusts	231.0	151.0	[1] 8.9
Open-air occupations	163.0	136.0	[1] 8.1

[1] Rate per 1,000 exposed.

ENGLISH OCCUPATIONAL MORTALITY STATISTICS.

The following table is included as a matter of convenient reference, particularly suggestive of the statistical methods of presentation most likely to prove useful for practical purposes. The first part of the table shows the mortality from all causes, the second the mortality from pulmonary tuberculosis, and the third the mortality from nontuberculous respiratory diseases.

There are no later official statistics for England and Wales than 1900–1902. The data for this period are compared with the preceding inquiry for 1890–1892. The rates have been recalculated and standardized on the basis of the Barre granite-cutters' experience for 1911–1917.

TABLE 78.—MORTALITY FROM ALL CAUSES, PULMONARY TUBERCULOSIS, AND NONTUBERCULOUS RESPIRATORY DISEASES, AMONG THE GRANITE CUTTERS OF BARRE, VT., COMPARED WITH THAT OF SPECIFIED OCCUPATIONS IN THE MANUFACTURING AND MECHANICAL INDUSTRIES OF ENGLAND AND WALES, BY AGE GROUPS.

[Experience of the Granite Cutters' International Association of America; Supplements to the Fifty-fifth and Sixty-fifth Annual Reports of the Registrar General of Births, Deaths, and Marriages in England and Wales, Part II, London, 1897 and 1908.]

ALL CAUSES.

Age at death.	Granite cutters of Barre, Vt. 1911–1917			Stone and slate quarriers—England and Wales.					
				1890–1892			1900–1902		
	Number exposed.	Deaths.	Death rate per 1,000.	Number exposed.	Deaths.	Death rate per 1,000.	Number exposed.	Deaths.	Death rate per 1,000.
15 to 19 years	302	.....	.....	16,329	55	3.4	24,282	64	2.6
20 to 24 years	1,015	2	2.0	18,414	104	5.6	30,906	139	4.5
25 to 34 years	3,573	23	6.4	37,287	277	7.4	52,494	258	4.9
35 to 44 years	4,438	67	15.1	33,120	480	14.5	43,467	382	8.8
45 to 54 years	2,484	93	37.4	24,045	608	25.3	33,705	611	18.1
55 to 64 years	454	53	116.7	13,185	681	51.6	19,206	661	34.4
65 years and over	64	10	156.2	5,475	793	144.8	7,683	724	94.2
Total	12,330	248	20.1	147,855	2,998	20.3	211,743	2,839	13.4
Standardized rates[1]	.....	.....	20.1	.....	.....	15.7	.....	.....	10.4

	Tin miners—England and Wales.						Lead miners—England and Wales. 1890–1892		
	1890–1892			1900–1902					
15 to 19 years	7,092	21	3.0	4,032	6	1.5	1,989	6	3.0
20 to 24 years	4,836	34	7.0	2,895	16	5.5	2,325	15	6.5
25 to 34 years	5,829	47	8.1	4,548	61	13.4	3,705	35	9.4
35 to 44 years	3,492	50	14.3	3,462	94	27.2	3,336	45	13.5
45 to 54 years	3,042	101	33.2	2,142	83	38.7	2,718	65	23.9
55 to 64 years	2,088	138	66.1	1,344	97	72.2	2,028	135	66.6
65 years and over	786	143	181.9	549	122	222.2	726	178	245.2
Total	27,165	534	19.7	18,972	479	25.2	16,827	479	28.5
Standardized rates[1]	.....	.....	18.3	.....	.....	25.8	.....	.....	16.8

[1] Standardization based on the age distribution of the granite cutters of Barre, Vt., 1911–1917.

TABLE 78.—MORTALITY FROM ALL CAUSES, PULMONARY TUBERCULOSIS, AND NON-TUBERCULOUS RESPIRATORY DISEASES, AMONG THE GRANITE CUTTERS OF BARRE, VT., COMPARED WITH THAT OF SPECIFIED OCCUPATIONS IN THE MANUFACTURING AND MECHANICAL INDUSTRIES OF ENGLAND AND WALES, BY AGE GROUPS—Continued.

ALL CAUSES—Concluded.

Age at death.	Lead miners—England and Wales. 1900–1902			Ironstone miners—England and Wales.					
				1890–1892			1900–1902		
15 to 19 years	1,302	8	6.1	6,732	23	3.4	4,869	15	3.1
20 to 24 years	1,662	8	4.8	7,674	35	4.6	6,984	21	3.0
25 to 34 years	3,243	24	7.4	13,791	82	5.9	13,104	70	5.3
35 to 44 years	2,478	32	12.9	12,216	100	8.2	10,422	69	6.6
45 to 54 years	2,295	40	17.4	8,385	143	17.1	8,583	105	12.2
55 to 64 years	1,383	70	50.6	3,696	123	33.3	4,827	135	28.0
65 years and over	621	134	215.8	975	144	147.7	1,506	148	98.3
Total	12,984	316	24.3	53,469	650	12.2	50,295	563	11.2
Standardized rates[1]			13.9			10.5			8.2

Age at death.	Coal miners—England and Wales.						Cutlers and scissors makers—England and Wales. 1890–1892		
	1890–1892			1900–1902					
15 to 19 years	283,536	1,082	3.8	307,785	985	3.2	8,067	19	2.4
20 to 24 years	249,525	1,402	5.6	301,512	1,347	4.5	7,368	40	5.4
25 to 34 years	380,355	2,391	6.3	510,879	2,522	4.9	11,619	99	8.5
35 to 44 years	265,098	2,552	9.6	345,939	2,645	7.6	9,963	208	20.9
45 to 54 years	162,981	3,165	19.4	224,634	3,295	14.7	7,866	280	35.6
55 to 64 years	80,403	3,521	43.8	107,454	3,866	36.0	4,086	246	60.2
65 years and over	25,677	3,760	146.4	30,003	4,195	139.8	2,208	302	136.8
Total	1,447,575	17,873	12.3	1,828,206	18,855	10.3	51,177	1,194	23.3
Standardized rates[1]			12.1			9.7			20.6

Age at death.	Cutlers and scissors makers—England and Wales. 1900–1902			File makers—England and Wales.					
				1890–1892			1900–1902		
15 to 19 years	5,466	7	1.3	3,597	6	1.7	2,676	7	2.6
20 to 24 years	4,941	19	3.8	2,757	19	6.9	2,253	11	4.9
25 to 34 years	10,818	82	7.6	5,049	56	11.1	4,116	40	9.7
35 to 44 years	8,952	152	17.0	4,632	121	26.1	3,765	67	17.8
45 to 54 years	7,233	231	31.9	3,345	134	40.1	3,150	108	34.3
55 to 64 years	4,764	220	46.2	1,596	113	70.8	1,845	92	49.9
65 years and over	1,944	219	112.7	699	103	147.4	693	69	99.6
Total	44,118	930	21.1	21,675	552	25.5	18,498	394	21.3
Standardized rates[1]			17.4			24.7			18.9

Age at death.	All occupied males—England and Wales.					
	1890–1892			1900–1902		
15 to 19 years	4,185,732	10,694	2.6	4,526,391	11,048	2.4
20 to 24 years	3,668,295	18,581	5.1	4,336,335	19,132	4.4
25 to 34 years	6,147,030	44,821	7.3	7,337,565	44,101	6.0
35 to 44 years	4,714,230	58,613	12.4	5,668,233	57,911	10.2
45 to 54 years	3,426,093	70,779	20.7	4,624,074	71,365	17.7
55 to 64 years	2,072,076	75,971	36.7	2,424,456	75,180	31.0
65 years and over	1,178,679	120,598	102.3	1,202,520	106,296	88.4
Total	25,392,135	400,057	15.8	29,519,574	385,033	13.0
Standardized rates[1]			13.1			11.0

[1] Standardization based on the age distribution of the granite cutters of Barre, Vt., 1911–1917.

TABLE 78.—MORTALITY FROM ALL CAUSES, PULMONARY TUBERCULOSIS, AND NON-TUBERCULOUS RESPIRATORY DISEASES, AMONG THE GRANITE CUTTERS OF BARRE, VT., COMPARED WITH THAT OF SPECIFIED OCCUPATIONS IN THE MANUFACTURING AND MECHANICAL INDUSTRIES OF ENGLAND AND WALES, BY AGE GROUPS—Continued.

PULMONARY TUBERCULOSIS.

Age at death.	Granite cutters of Barre, Vt. 1911–1917			Stone and slate quarriers—England and Wales.					
				1890–1892			1900–1902		
	Number exposed.	Deaths.	Death rate per 100,000.	Number exposed.	Deaths.	Death rate per 100,000.	Number exposed.	Deaths.	Death rate per 100,000.
15 to 19 years	302			16,329	11	67.4	24,282	13	53.5
20 to 24 years	1,015			18,414	24	130.3	30,906	53	171.5
25 to 34 years	3,573	14	391.8	37,287	93	249.4	52,494	79	150.5
35 to 44 years	4,438	43	968.9	33,120	158	477.1	43,467	92	211.6
45 to 54 years	2,484	59	2,375.2	24,045	151	628.0	33,705	145	430.2
55 to 64 years	454	28	6,167.4	13,185	79	599.2	19,206	80	416.5
65 years and over	64	2	3,125.0	5,475	20	365.3	7,683	25	325.4
Total	12,330	146	1,184.1	147,855	536	362.5	211,743	487	230.0
Standardized rates [1]			1,184.1			407.2			239.0

Age at death.	Tin miners—England and Wales.						Lead miners—England and Wales. 1890–1892.		
	1890–1892			1900–1902					
	Number exposed.	Deaths.	Death rate per 100,000.	Number exposed.	Deaths.	Death rate per 100,000.	Number exposed.	Deaths.	Death rate per 100,000.
15 to 19 years	7,092	7	98.7	4,032	1	24.8	1,989	3	150.8
20 to 24 years	4,836	16	330.8	2,895	5	172.7	2,325	7	301.1
25 to 34 years	5,829	20	342.5	4,548	32	703.6	3,705	16	431.8
35 to 44 years	3,492	21	601.4	3,462	41	1,184.3	3,336	21	629.5
45 to 54 years	3,042	41	1,347.8	2,142	36	1,680.7	2,718	20	735.8
55 to 64 years	2,088	38	1,819.9	1,344	23	1,711.3	2,028	19	936.9
65 years and over	786	17	2,162.8	549	10	1,821.5	726	4	551.0
Total	27,165	160	589.0	18,972	148	780.1	16,827	90	534.9
Standardized rates [1]			695.7			1,059.5			564.6

Age at death.	Lead miners—England and Wales. 1900–1902			Ironstone miners—England and Wales.					
				1890–1892			1900–1902		
	Number exposed.	Deaths.	Death rate per 100,000.	Number exposed.	Deaths.	Death rate per 100,000.	Number exposed.	Deaths.	Death rate per 100,000.
15 to 19 years	1,302	2	153.6	6,732	10	148.5	4,869	4	82.2
20 to 24 years	1,662	2	120.3	7,674	6	78.2	6,984	4	57.3
25 to 34 years	3,243	15	462.5	13,791	18	130.5	13,104	16	122.1
35 to 44 years	2,478	6	242.1	12,216	21	171.9	10,422	15	143.9
45 to 54 years	2,295	12	522.9	8,385	14	167.0	8,583	17	198.1
55 to 64 years	1,383	10	723.1	3,696	4	108.2	4,827	18	372.9
65 years and over	621	4	644.1	975	2	205.1	1,506	3	199.2
Total	12,984	51	392.8	53,469	75	140.3	50,295	77	153.1
Standardized rates [1]			354.3			147.7			149.1

Age at death.	Coal miners—England and Wales.						Cutlers and scissors makers—England and Wales. 1890–1892		
	1890–1892			1900–1902					
	Number exposed.	Deaths.	Death rate per 100,000.	Number exposed.	Deaths.	Death rate per 100,000.	Number exposed.	Deaths.	Death rate per 100,000.
15 to 19 years	283,536	165	58.2	307,785	126	40.9	8,067	9	111.6
20 to 24 years	249,525	346	138.7	301,512	304	100.8	7,368	20	271.4
25 to 34 years	380,355	460	120.9	510,879	467	91.4	11,619	38	327.1
35 to 44 years	265,098	376	141.8	345,939	364	105.2	9,963	80	803.0
45 to 54 years	162,981	338	207.4	224,634	331	147.4	7,866	61	775.5
55 to 64 years	80,403	179	222.6	107,454	198	184.3	4,086	33	807.6
65 years and over	25,677	52	202.5	30,003	49	163.3	2,208	6	271.7
Total	1,447,575	1,916	132.4	1,828,206	1,839	100.6	51,177	247	482.6
Standardized rates [1]			150.0			111.0			596.0

[1] Standardization based on the age distribution of the granite cutters of Barre, Vt., 1911–1917.

TABLE 78.—MORTALITY FROM ALL CAUSES, PULMONARY TUBERCULOSIS, AND NONTUBERCULOUS RESPIRATORY DISEASES, AMONG THE GRANITE CUTTERS OF BARRE, VT., COMPARED WITH THAT OF SPECIFIED OCCUPATIONS IN THE MANUFACTURING AND MECHANICAL INDUSTRIES OF ENGLAND AND WALES, BY AGE GROUPS—Continued.

PULMONARY TUBERCULOSIS—Concluded.

Age at death.	Cutlers and scissors makers—England and Wales. 1900–1902			File makers—England and Wales. 1890–1892			1900–1902		
15 to 19 years	5,466	.....	.....	3,597	1	27.8	2,676	1	37.4
20 to 24 years	4,941	10	202.4	2,757	6	217.6	2,253	4	177.5
25 to 34 years	10,818	41	379.0	5,049	22	435.7	4,116	16	388.7
35 to 44 years	8,952	80	893.6	4,632	38	820.4	3,765	22	584.3
45 to 54 years	7,233	80	1,106.0	3,345	27	807.2	3,150	24	761.9
55 to 64 years	4,764	35	734.7	1,596	11	689.2	1,845	8	433.6
65 years and over	1,944	3	154.3	699	3	429.2	693	.....	.....
Total	44,118	249	564.4	21,675	108	498.3	18,498	75	405.4
Standardized rates [1]	.....	.....	695.8	.....	.....	622.8	.....	.....	508.2

Age at death.	All occupied males—England and Wales. 1890–1892			1900–1902		
15 to 19 years	4,185,732	2,916	69.7	4,526,391	2,465	54.5
20 to 24 years	3,668,295	7,137	194.6	4,336,335	6,730	155.2
25 to 34 years	6,147,030	16,137	262.5	7,337,565	14,913	203.2
35 to 44 years	4,714,230	16,154	342.7	5,668,233	15,550	274.3
45 to 54 years	3,426,093	11,595	338.4	4,024,074	12,235	304.0
55 to 64 years	2,072,076	5,498	265.3	2,424,456	5,241	216.2
65 years and over	1,178,679	1,766	149.8	1,202,520	1,329	110.5
Total	25,392,135	61,203	241.0	29,519,574	58,463	198.0
Standardized rates [1]	.....	.....	295.9	.....	.....	241.5

NONTUBERCULOUS RESPIRATORY DISEASES, BY AGE GROUPS.

Age at death.	Granite cutters of Barre, Vt. 1911–1917			Stone and slate quarriers—England and Wales. 1890–1892			1900–1902		
15 to 19 years	302	.....	.....	16,329	7	42.9	24,282	3	12.4
20 to 24 years	1,015	.....	.....	18,414	10	54.3	30,906	22	71.2
25 to 34 years	3,573	2	56.0	37,287	51	136.8	52,494	39	74.3
35 to 44 years	4,438	10	225.3	33,120	93	280.8	43,467	88	202.4
45 to 54 years	2,484	11	442.8	24,045	155	644.6	33,705	143	424.3
55 to 64 years	454	9	1,982.4	13,185	227	1,721.6	19,206	160	833.1
65 years and over	64	2	3,125.0	5,475	233	4,255.7	7,683	158	2,056.5
Total	12,330	34	275.8	147,855	776	524.8	211,743	613	289.5
Standardized rates [1]	.....	.....	275.8	.....	.....	362.5	.....	.....	227.6

Age at death.	Tin miners—England and Wales. 1890–1892			1900–1902			Lead miners—England and Wales. 1890–1892		
15 to 19 years	7,092	2	28.2	4,032	1	24.8	1,989	1	50.3
20 to 24 years	4,836	2	41.4	2,895	2	69.1	2,325	1	43.1
25 to 34 years	5,829	3	51.5	4,548	16	351.8	3,705	3	81.0
35 to 44 years	3,492	11	315.0	3,462	37	1,068.7	3,336	8	239.8
45 to 54 years	3,042	29	953.3	2,142	26	1,213.8	2,718	16	588.7
55 to 64 years	2,088	47	2,250.9	1,344	35	2,604.2	2,028	46	2,268.2
65 years and over	786	45	5,725.2	549	39	7,103.8	726	52	7,162.5
Total	27,165	139	511.7	18,972	156	822.3	16,827	127	754.7
Standardized rates [1]	.....	.....	434.4	.....	.....	864.4	.....	.....	356.6

[1] Standardization based on the age distribution of the granite cutters of Barre, Vt., 1911–1917.

TABLE 78.—MORTALITY FROM ALL CAUSES, PULMONARY TUBERCULOSIS, AND NONTUBERCULOUS RESPIRATORY DISEASES, AMONG THE GRANITE CUTTERS OF BARRE, VT., COMPARED WITH THAT OF SPECIFIED OCCUPATIONS IN THE MANUFACTURING AND MECHANICAL INDUSTRIES OF ENGLAND AND WALES, BY AGE GROUPS—Concluded.

NONTUBERCULOUS RESPIRATORY DISEASES, BY AGE GROUPS—Concluded.

Age at death.	Lead miners—England and Wales. 1900–1902			Ironstone miners—England and Wales. 1890–1892			Ironstone miners—England and Wales. 1900–1902		
15 to 19 years	1,302	1	76.8	6,732	1	14.8	4,869	1	20.5
20 to 24 years	1,662			7,674	5	65.2	6,984	1	14.3
25 to 34 years	3,243	2	61.7	13,791	11	79.8	13,104	9	68.7
35 to 44 years	2,478	7	282.5	12,216	18	147.3	10,422	10	96.0
45 to 54 years	2,295	8	348.6	8,385	40	477.0	8,583	31	361.2
55 to 64 years	1,383	21	1,518.4	3,696	44	1,190.5	4,827	24	497.2
65 years and over	621	33	5,314.0	975	50	5,128.2	1,506	23	1,527.2
Total	12,984	72	554.5	53,469	169	316.1	50,295	99	196.8
Standardized rates[1]			269.6			245.0			155.1

Age at death.	Coal miners—England and Wales. 1890–1892			Coal miners—England and Wales. 1900–1902			Cutlers and scissors makers—England and Wales. 1890–1892		
15 to 19 years	283,536	89	31.4	307,785	80	26.0	8,067	3	37.2
20 to 24 years	249,525	159	63.7	301,512	119	39.5	7,368	10	135.7
25 to 34 years	380,355	348	91.5	510,879	335	65.6	11,619	17	146.3
35 to 44 years	265,098	559	210.9	345,939	451	130.4	9,963	48	481.8
45 to 54 years	162,981	929	570.0	224,634	739	329.0	7,866	102	1,296.7
55 to 64 years	80,403	1,325	1,647.9	107,454	1,092	1,016.2	4,086	115	2,814.5
65 years and over	25,677	1,283	4,996.7	30,003	1,171	3,902.9	2,208	100	4,529.0
Total	1,447,575	4,692	324.1	1,828,206	3,987	218.1	51,177	395	771.8
Standardized rates[1]			310.0			193.8			617.5

Age at death.	Cutlers and scissors makers—England and Wales. 1900–1902			File makers—England and Wales. 1890–1892			File makers—England and Wales. 1900–1902		
15 to 19 years	5,466	1	18.3	3,597	1	27.8	2,676	2	74.7
20 to 24 years	4,941	1	20.2	2,757	5	181.4	2,253	3	133.2
25 to 34 years	10,818	19	175.6	5,049	9	178.3	4,116	9	218.7
35 to 44 years	8,952	20	223.4	4,632	22	475.0	3,765	10	265.6
45 to 54 years	7,233	46	636.0	3,345	36	1,076.2	3,150	16	507.9
55 to 64 years	4,764	55	1,154.5	1,596	31	1,942.4	1,845	25	1,355.0
65 years and over	1,944	54	2,777.8	699	31	4,434.9	693	18	2,597.0
Total	44,118	196	444.3	21,675	135	622.8	18,498	83	448.7
Standardized rates[1]			315.1			549.0			335.2

Age at death.	All occupied males—England and Wales. 1890–1892			All occupied males—England and Wales. 1900–1902		
15 to 19 years	4,185,732	1,069	25.5	4,526,391	1,097	24.2
20 to 24 years	3,668,295	2,245	61.2	4,336,335	2,078	47.9
25 to 34 years	6,147,030	6,975	113.5	7,337,565	5,696	77.3
35 to 44 years	4,714,230	11,784	250.0	5,668,233	9,432	166.4
45 to 54 years	3,426,093	17,630	514.6	4,024,074	13,364	332.1
55 to 64 years	2,072,076	21,393	1,032.4	2,424,456	15,850	653.8
65 years and over	1,178,679	30,543	2,591.3	1,202,520	21,365	1,776.7
Total	25,392,135	91,639	360.9	29,519,574	68,855	233.2
Standardized rates[1]			283.7			187.0

[1] Standardization based on the age distribution of the granite cutters of Barre, Vt., 1911–1917.

STONE-DUST CORRELATION DATA.[a]

It does not fall within the present discussion to consider in detail the technical aspects of the dust problem. It is anticipated that the forthcoming results of the investigation by the United States Bureau of Mines will present for the first time a full statement of the facts required for practical purposes. It has, however, been thought necessary to consider briefly the nature of the dust problems as illustrated by the analysis of different types of stones quarried or manipulated for commercial purposes. Table 79 contains an analysis of the principal stones for important stone centers of the United States, differentiating granite, sandstone, slate, limestone, and marble. In each case the source of the analysis is indicated in the footnotes. The averages in the last column of the table were arrived at by the simple process of addition and division, possibly suggesting the importance of more minute methods of collective sampling, although it would seem that for the present purpose this method will meet every reasonable requirement. The averages show that for the principal stone centers of the United States the proportion of silica in granite is 72.96 per cent, in sandstone 85.42 per cent, in slate 61.54 per cent, in limestone 1.22 per cent, and in marble 0.97 per cent. The deviation from the average is clearly indicated by the details for stone samples of the different States, but suggests, however, no change in the conclusion that an excessive death rate in the stone industry is primarily conditioned by the silica content of the stone manipulated. Hence it would seem of the first importance that in any future investigations into the problem of stone-workers' mortality the character of the stone manipulated should be taken into account, and this, of course, suggests the further conclusion that it is of equal importance that the precise occupations followed be considered rather than the trade or industry as a whole.

[a] For additional observations on stone-dust correlation data see remarks on pp. 22 and 23 and Appendix D on the mineralogy of the dust problem, as well as Appendix E, giving the analysis of granite-stone dust made by the Bureau of Mines from dust samples collected at Barre, Vt., and Aberdeen, Scotland. For an exceedingly important discussion of limestone and tuberculosis see an article by that title in Rock Products of Jan. 14, 1922, by Nathan C. Rockwood. This discussion is one of the most promising indications of an approach of the question from the strictly practical point of view, in that the article includes numerous letters from representatives of the stone industry throughout the country, some of whom are strongly of the opinion that limestone dust actually inhibits tuberculous processes, while others are of the opinion that "limestone dust has a beneficial effect on pulmonary tuberculosis."

TABLE 79.—TYPICAL ANALYSES OF GRANITE, SANDSTONE, SLATE, LIMESTONE, AND MARBLE.

GRANITE.

Constituent.	Vermont.[1]		Massachusetts.[2]		Maine.[3]		New Hampshire.[2]		Rhode Island.[2]		North Carolina.[4]		Georgia.[5]		Wisconsin.[6]	Average.
	Barre.	Bethel.	Quincy.	Milford.	Blue Hill.	North Jay.	Concord.	Redstone.	Westerly (gray).	Westerly (red).	Mount Airy.	Salisbury.	Elberton.	Stone Mountain.	Wausau.	
	Per ct.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*
Silica (SiO_2)	69.89	77.52	73.93	72.02	73.02	71.54	74.47	71.44	71.64	73.05	70.70	75.14	71.00	72.56	76.54	72.96
Alumina (Al_2O_3)	15.08	16.78	12.29	14.43	16.22	14.24	14.15	14.72	15.66	14.53	16.50	16.10	16.33	14.81	13.82	15.04
Soda (Na_2O)	4.73	1.21	4.66	5.85	3.60	3.39	1.97	7.66	1.58	1.72	4.56	5.82	4.80	4.94	4.32	4.05
Potash (K_2O)	4.29	.62	4.63	5.41	3.42	4.73	4.14	.89	5.60	5.39	2.45	2.57	4.65	5.30	2.31	3.76
Lime (CaO)	2.07	2.56	.31	1.18	.94	.98	1.70	.....	2.70	2.06	2.96	.93	1.83	1.19	.85	1.48
Iron oxide (FeO)	1.46	.84	1.55	.89	2.59	1.18	1.21	.46	} 2.34	2.96	{	.....	.....	.....	.....	.78
Iron sesquioxide (Fe_2O_3)	1.04	.....	2.91	1.25	.....	.74	1.16	2.39			{ 2.34	.....	1.12	.94	1.62	1.19
Magnesium oxide (MgO)	.66	.32	.04	(7)	7 7	.34	.63	.96	.....	.....	.29	.04	.35	.20	.01	.26
Other elements	.54	.33	.59	.68	.21	1.45	.78	1.39	.48	.29	.09	.....	.87	.70	.20	.57
Total	99.76	100.18	100.91	101.71	100.00	98.59	100.21	99.91	100.00	100.00	99.89	100.60	100.95	100.64	99.67	100.09

[1] The Granites of Vermont, by T. Nelson Dale, U. S. Geological Survey, Bul. 404, pp. 51–111.
[2] The Chief Commercial Granites of Massachusetts, New Hampshire, and Rhode Island, by T. Nelson Dale, U. S. Geological Survey, Bul. 354, pp. 81–193.
[3] Twentieth Annual Report, U. S. Geological Survey, 1898–99, Part VI, pp. 392, 393.
[4] North Carolina Geological Survey, Bul. 2, 1916, pp. 106–155.
[5] Granites of the Southeastern Atlantic States, by Thomas Leonard Watson, U. S. Geological Survey, Bul. 426, pp. 225–235.
[6] Building and Ornamental Stones, by Ernest Robertson Buckley, Ph. D., Wisconsin Geological and Natural History Survey, Bul. No. 4, Economic Series, No. 2, 1898, p. 136.
[7] Trace.

TABLE 79.—TYPICAL ANALYSES OF GRANITE, SANDSTONE, SLATE, LIMESTONE, AND MARBLE—Continued.

SANDSTONE.

Constituent.	Pennsylvania.[8]		Ohio.[9]		Wisconsin.[10]		Minnesota.[8]	Connecticut.[8]	Massachusetts.[8]	New Jersey.[8]	Maryland.[8]	Arizona.[8]	Utah.[8]	California.[8]	Oregon.[8]	Average.
	Hummelstown.	Newton.	Berea.	McDermott.	Bass Island.	Port Wing.	Sandstone.	Cromwell.	East Long Meadow.	Avondale.	Frostburg.	Flagstaff.	Jennings Spur.	Colusa.	Chitwood.	
	Per ct.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*
Silica (SiO_2)	90.34	82.31	93.13	85.60	87.02	89.33	98.69	70.84	81.38	82.05	99.25	79.10	83.64	85.99	72.45	85.42
Alumina (Al_2O_3)	4.35	11.46	3.86	7.25	7.17	6.05	1.06	13.15	9.44	5.27	.61	1.30	.46	4.82	12.60	5.92
Soda (Na_2O)	.19	3.76	.....	.....	.22	.59	.17	5.43	.....	.20	.....	.....	.....	.....	.....	.70
Potash (K_2O)	1.30	.17	.....	.....	1.43	2.12	.....	3.30	.....	.60	.....	.....	.....	.....	.....	.59
Lime (CaO)	.95	.27	.19	(7)	.11	(7)	.42	3.09	.76	3.35	.11	7.76	.....	.....	4.10	1.41
Iron oxide (FeO)	.74	.....	.54	.....	.....	.....	(7)	.....	.....	.....	.25	.....	1.96	.....	.....	.23
Iron sesquioxide (Fe_2O_3)	1.09	1.07	.11	2.60	3.91	1.41	.....	2.48	3.54	2.71	.....	2.45	.....	4.49	10.80	2.44
Magnesium oxide (MgO)	.17	.19	.25	(7)	.06	(7)	.01	(7)	.28	.76	.....	.23	.70	.76	(7)	.23
Other elements	.61	.87	1.43	2.45	.....	.....	.....	1.71	4.60	5.11	.....	9.03	13.34	3.94	.....	2.87
Total	99.74	100.13	99.51	97.90	99.92	99.50	100.35	100.00	100.00	100.00	100.22	99.96	100.10	100.00	99.95	99.81

[8] Twentieth Annual Report, U. S. Geological Survey, 1898–99, Part VI, pp. 356–445.
[9] Building Stones of Ohio, by J. A. Bownocker, Geological Survey of Ohio, fourth series, Bul. 18, 1915, pp. 74–133.
[10] Building and Ornamental Stones of Wisconsin, by Ernest Robertson Buckley, Ph. D., Wisconsin Geological and Natural History Survey, Bul. No. 4, Economic Series No. 2, 1898, pp. 175–197.

SLATE.

Constituent.	Maine.[11]	Vermont.[11]			New York.[11]			Pennsylvania.		Virginia.[11]	Tennessee.[12]	Arkansas.[12]	California.[12]	Quebec.[13]		Average.
	Monson.	West Pawlet.	South Poultney.	Brownell.	Hampton.	Granville.	Hamburg.	Delta.[11]	Lehigh County[12]	Arvonia.	Maryville.	Montgomery County.	Slatington.	New Rockland.	Danville.	
	Per ct.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*
Silica (SiO_2)	54.24	67.76	62.37	59.84	67.61	67.55	67.70	55.88	56.38	60.65	58.45	66.16	47.30	63.39	67.85	61.54
Alumina (Al_2O_3)	24.71	14.12	15.43	15.02	13.20	12.59	13.49	21.85	15.27	16.87	21.88	8.62	15.53	15.97	9.10	15.58
Soda (Na_2O)	1.43	1.39	1.14	1.12	.67	.61	4.91	.46	1.30	2.18	2.34	.64	} 3.17	{ 3.33	1.80	1.67
Potash (K_2O)	.72	3.52	4.20	4.48	4.45	4.13	.....	3.64	3.51	3.80	1.60	4.96		{ 3.60	.44	3.08
Lime (CaO)	5.23	.63	.77	2.20	.11	.26	.81	.16	4.23	1.91	1.85	1.77	7.83	.67	.98	1.96
Iron oxide (FeO)	.....	4.71	5.34	4.73	1.20	1.24	2.75	9.03	3.23	.....	.....	3.44	} 8.00	{	11.14	3.34
Iron sesquioxide (Fe_2O_3)	8.39	.81	1.34	1.23	5.36	5.61	.....	.....	1.67	7.79	6.04	9.04		{ 4.68	.....	3.71
Magnesium oxide (MgO)	2.59	2.38	3.14	3.41	3.20	3.27	1.29	1.50	2.84	2.39	.46	.78	7.86	2.99	3.23	2.76
Other elements	2.69	4.75	6.07	8.25	4.20	4.76	9.05	7.10	11.96	4.32	7.31	2.47	10.04	3.65	5.34	6.13
Total	100.00	100.07	99.80	100.28	100.00	100.02	100.00	99.62	100.39	99.91	99.94	97.88	99.73	98.28	99.88	99.77

[11] Twentieth Annual Report, U. S. Geological Survey, 1898-99, Part VI (continued), pp. 394-458.
[12] Slate Deposits and Slate Industry of the United States, by T. Nelson Dale, U. S. Geological Survey, Bul. No. 275, 1906, pp. 36-88.
[13] Report on the Building and Ornamental Stones of Canada, by Wm. A. Parks, B. A., Ph. D., Department of Mines, Canada, vol. 3, 1914, pp. 238-242.

TABLE 79.—TYPICAL ANALYSES OF GRANITE, SANDSTONE, SLATE, LIMESTONE, AND MARBLE—Concluded.

LIMESTONE.[14]

Constituent.	Indiana.		Illinois.		Kentucky.		Alabama.		Missouri.		Michigan.		Ohio.		Pennsylvania.	Average.
	Bedford.	Bloomington.	Alton.	Millstadt.	Memphis Junction.	Inor.	Village Springs.	Lagarde.	Carthage.	Rush Tower.	Dundee.	Calcite.	Marble Cliff.	Piqua.	Bellefonte.	
	Per ct.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*
Silica (SiO_2)	0.63	0.86	2.01	1.12	1.42	3.56	2.00	0.62	1.43	1.20	0.81	0.34	1.40	0.18	0.79	1.22
Alumina (Al_2O_3)	.....	.16	1.41	.....	.39	1.70	2.00	.36	.44	.....	.41	.....	.58	.13	.19	.46
Iron sesquioxide (Fe_2O_3)	.39		.41	.44			.....	.....	.....	.....	.....	.....	.....	.23	.....	.12
Calcium carbonate ($CaCO_3$)	98.20	98.11	95.79	98.43	95.31	92.00	93.00	98.36	97.51	97.67	95.00	97.85	91.03	98.75	98.50	96.37
Magnesium carbonate ($MgCO_3$)	.39	.92	.38	.....	1.12	.....	3.00	.65	.24	.81	3.86	1.26	6.86	.73	.37	1.37
Other elements	.....	.....	.....	.01	1.76	1.82	.....	.....	.36	.32	.....	.....	.55	.01	.15	.33
Total	99.61	100.05	100.00	100.00	100.00	99.08	100.00	99.99	99.98	100.00	100.08	99.45	100.42	100.03	100.00	99.87

MARBLE.

Constituent.	Vermont.[15]	Massachusetts.[15]	New York.[16]			Pennsylvania.[15]	Georgia.[15]		Colorado.[15]	California.[15]	Alaska.[17]		British Columbia.[18]		Average.
	Proctor.	North Adams.	Gouverneur.		Harrisville.	Annville.	Marblehill.	Tate.	Beulah.	Colton.	Marble Cove.	Tokeen.	Nitinat.	Marble Bay.	
	Per ct.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*
Insoluble matter	0.63	.....	3.55	1.26	1.01	.....	0.61	.....	.....	.....	3.61	0.01	2.64	1.26	0.97
Silica (SiO_2)	.....	0.69	.....	.....	.....	1.64	1.07	.....	0.62	0.06	.....	.....	.....	.....	.27
Alumina (Al_2O_3)	.01	.06	.13	.65	.23	.....	.14	.22	.25	.....	.....	.....	.....	.40	2.16	.14
Iron sesquioxide (Fe_2O_3)			.08	.29	.63	.04	.23		.....	.04	.....	.....	.....			.13
Calcium carbonate ($CaCO_3$)	98.37	93.86	87.06	87.47	88.94	76.17	95.10	98.96	97.32	98.00	92.90	95.44	99.51	96.89	85.00	92.73
Magnesium carbonate ($MgCO_3$)	.77	5.34	6.40	7.50	6.85	21.79	3.96	.....	1.60	.....	4.50	1.45	.94	.42	11.32	4.86
Other elements	.11	.05	1.73	1.48	1.78	.....	.....	.08	.26	.05	2.60	.....	.....	.....	.....	.54
Total	99.89	100.00	98.95	98.65	99.44	99.64	100.50	99.87	100.05	98.15	100.00	100.00	100.46	100.35	99.74	99.64

[14] Mineral Resources of the United States, Part II, Nonmetals, 1911, pp. 653-697.
[15] Twentieth Annual Report, U. S. Geological Survey, 1898-99, Part VI (continued), pp. 359-447.
[16] The Quarry Materials of New York—Granite, Gneiss, Trap, and Marble, by D. H. Newland, Sixty-ninth Annual Report, New York State Museum, 1915, vol. 2, pp. 186-193.
[17] Marble Resources of Southeastern Alaska, by Ernest F. Burchard and Theodore Chapin, U. S. Geological Survey, Bul. 682, pp. 53-69.
[18] Report on the Building and Ornamental Stones of Canada, by Wm. A. Parks, B. A., Ph. D., Department of Mines, Canada, Vol. V, 1917, pp. 149-161.

GRAPHIC PRESENTATION OF RESULTS OF INVESTIGATION.

The foregoing results are presented in graphic form in six charts as follows: 1. Comparative proportionate distribution of granite cutters of Barre, Vt., limestone cutters of Bedford, Ind., and Transvaal gold miners, by years of employment (Chart 1); 2. Mortality from specified causes among granite cutters of New England, compared with that of the adult males of Massachusetts (Chart 2); 3. Mortality of granite cutters of Barre, Vt., and adult males of Massachusetts, by divisional periods of life (Chart 3); 4. Mortality from tuberculosis of the lungs among granite cutters, by geographical districts and periods of years (Chart 4); 5. Correlation between the chemical composition of stone and the mortality from tuberculosis of the lungs among granite cutters, sandstone cutters, and limestone cutters (Chart 5); 6. Family mortality from tuberculosis of the lungs of granite cutters compared with that of farmers of Washington and Caledonia Counties, Vt., 1893–1919 (Chart 6).

CHART 1.

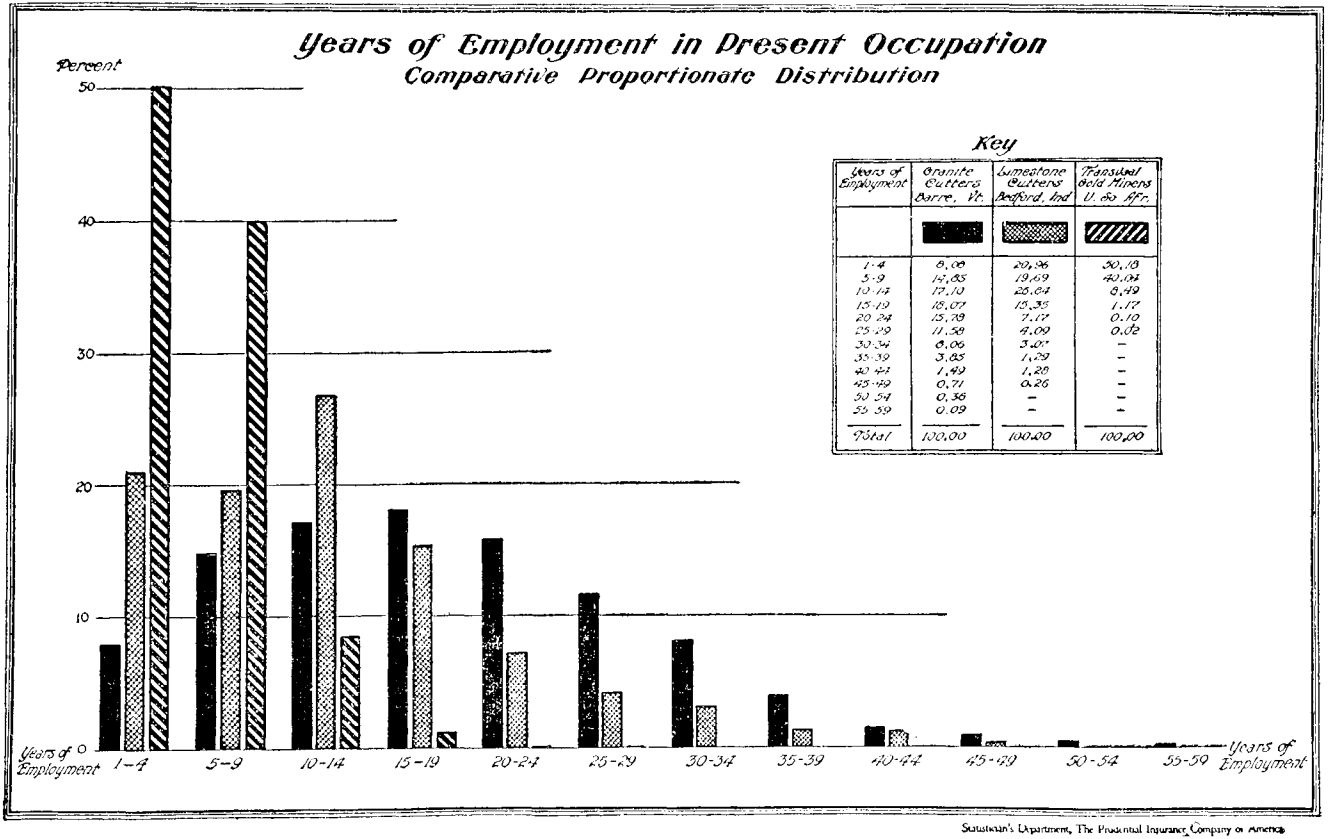

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CHART 2.

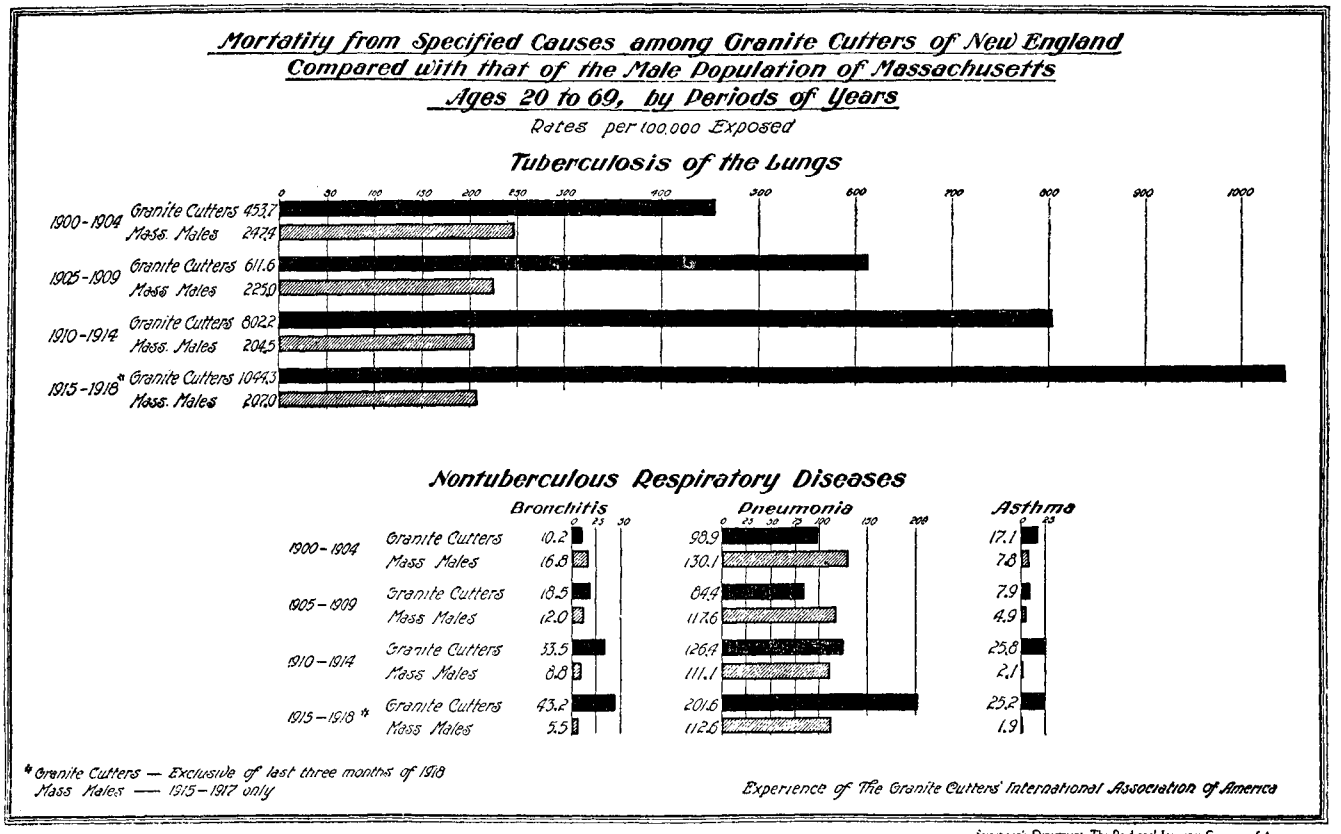


CHART 3.

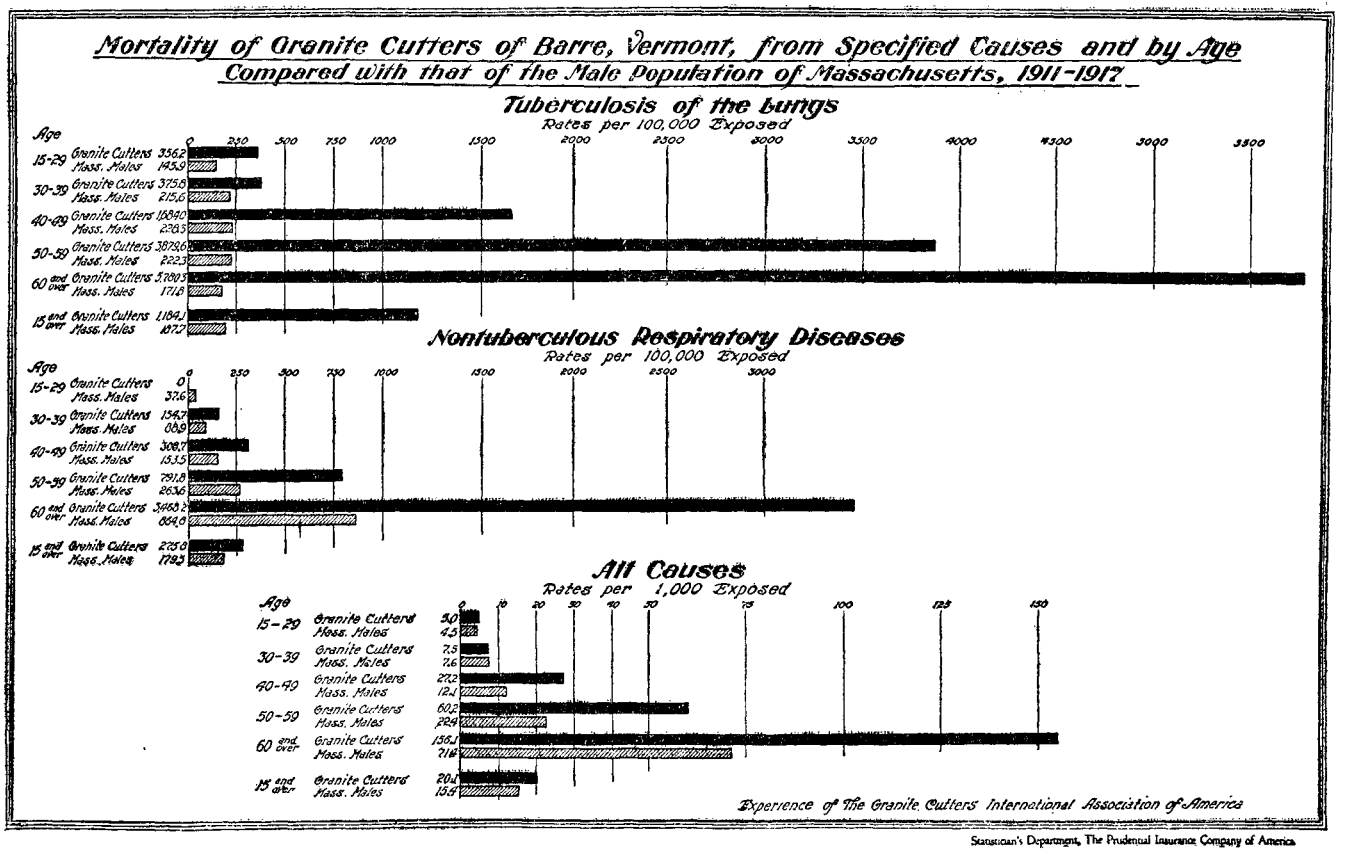


CHART 4.

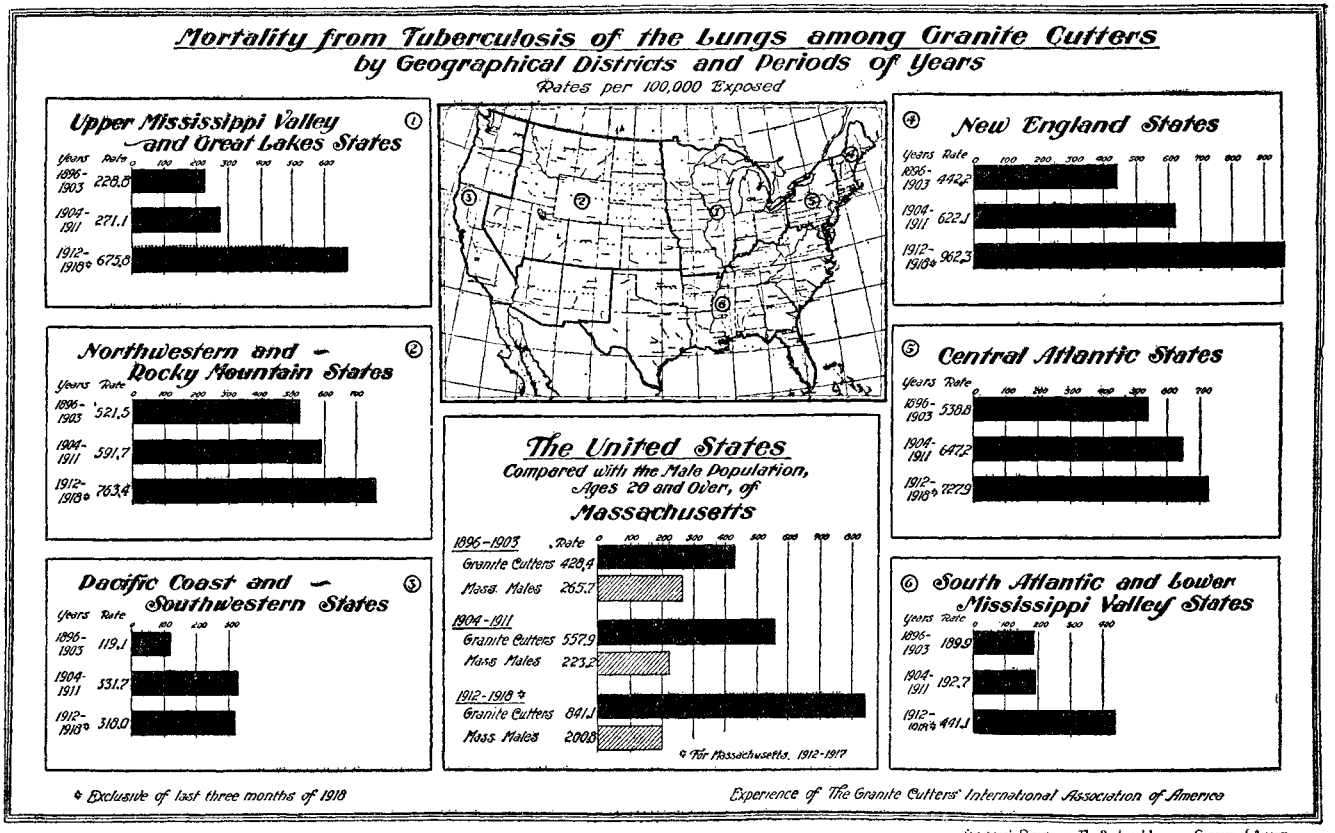


CHART 5.

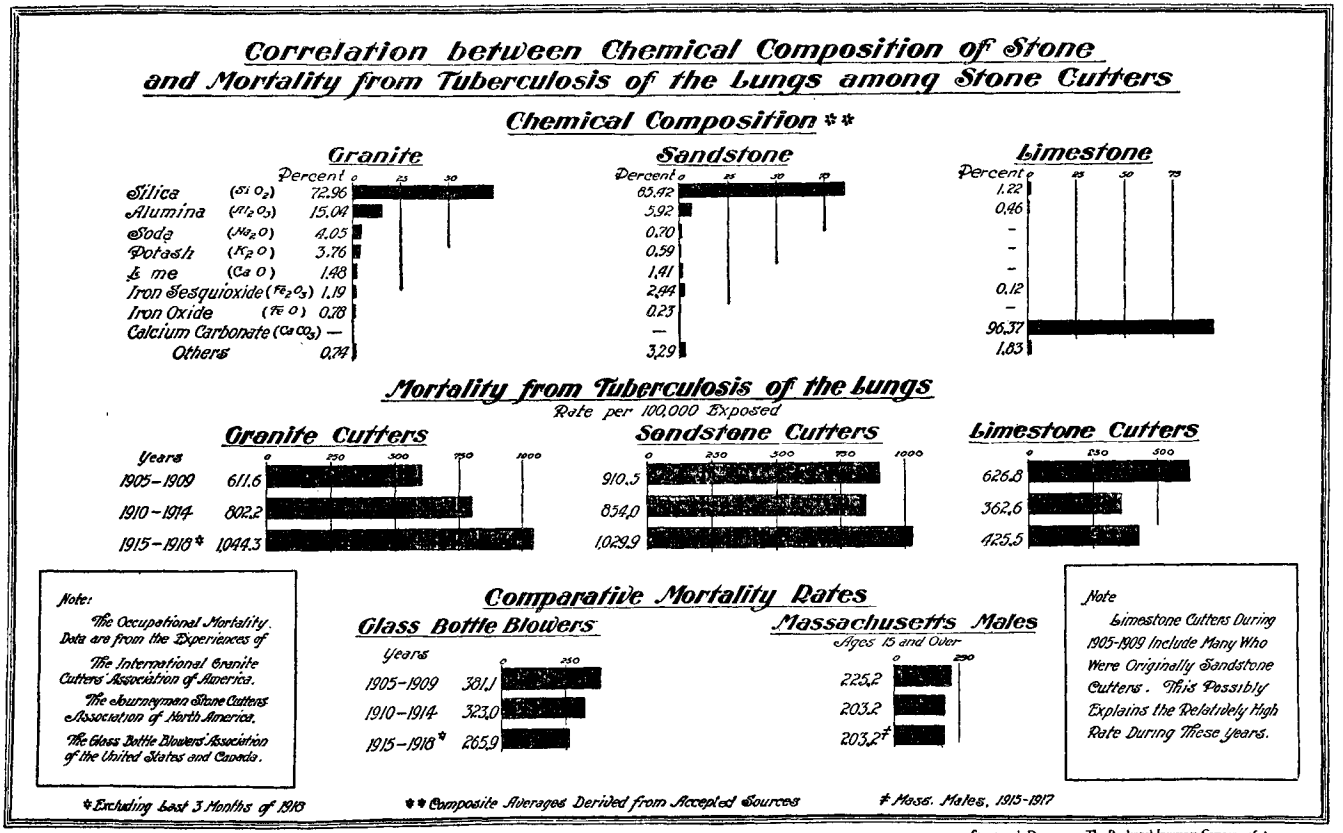
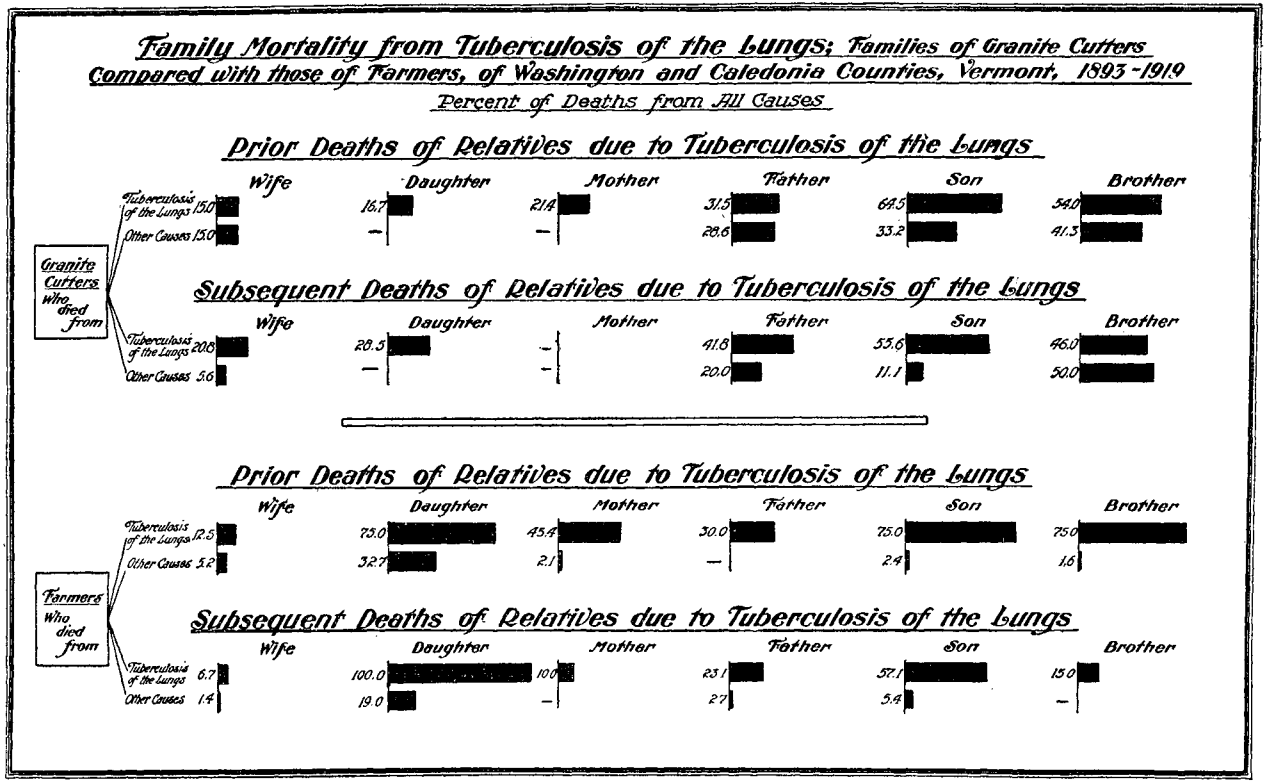


CHART 6.



Statistician's Department, The Prudential Insurance Company of America

OTHER INVESTIGATIONS.

GERMAN OCCUPATIONAL EXPERIENCE.

It has not seemed necessary to amplify the foregoing statistical observations by an extended discussion of other inquiries into the mortality of stoneworkers. The subject is dealt with in some detail in Mortality from Respiratory Diseases in Dusty Trades (Inorganic Dusts), published by the United States Bureau of Labor Statistics in June, 1918 (Bulletin No. 231). Reference, however, should be made to two important German investigations of 1913 and 1915, although they are useful as an indication of the method to be followed rather than as finally conclusive concerning the results. These writers have clearly realized the importance of considering the chemical and mechanical aspects of the dust problem, following in this respect the admirable discussion of dust and occupation in Grotjahn and Kaup's Handbook of Social Hygiene.[4] American textbooks on occupational diseases fail in not giving equally extended consideration to this important aspect of the occupational disease problem.

The first of the two special investigations referred to is a treatise on the stone industry in the Grand Duchy of Baden by Dr. Föhlisch, originally contributed to the annual report of the Grand Ducal Factory Inspection Service of Baden for the year 1912.[5] In this discussion the author, following a brief geological outline, takes into account the technical aspects of the stone industry, its statutory regulations and control, the economic and social condition of labor, hours, wages, labor laws, labor organizations, safety regulations, and sanitation. Attention is given to the experience of local sick funds, but limited, unfortunately, to the years 1910 and 1911. The sickness figures throughout are higher for stonecutters than for quarrymen or other stoneworkers. For sandstone workers the morbidity from pulmonary tuberculosis was 3.7 per cent for stonecutters, 2.2 per cent for quarrymen, and 0.3 per cent for other employments. These statistics are for the sick fund of Freudenberg and probably typical of the industry. The analysis, unfortunately, is too limited to be as useful as the intrinsic value of the data would suggest.

For granite workers the sick fund of Achern returns a morbidity figure of 6.6 per cent for all occupations, against 3.7 per cent for stonecutters in the sandstone industry. Dr. Föhlisch, however, states that the mortality data do not seem to indicate an excessive death rate from tuberculosis, but the conclusions are based on entirely too fragmentary a statistical basis to accept them as final. He explains, however, that the observed result in all probability is in part attributable to the comparatively recent introduction of the industry, in that several generations would be required to establish the true incidence of the disease as the result of occupational conditions. This, of course, is in strict conformity to the conclusion elsewhere advanced—that it requires on an average about 21 years of occupational exposure to show the most disastrous effects of considerable and continuous granite-dust inhalation.

The second discussion, of present importance, is by Dr. Franz Koelsch, who, in 1915, contributed a discussion on the lung diseases

[4] Handwörterbuch der Sozialen Hygiene, herausgegeben von Dr. med. A. Grotjahn und Prof. Dr. med. J. Kaup; Band II, Leipzig, 1912.

[5] Die Steinindustrie in Grossherzogtum Baden, von Regierungsrat Dr. Föhlisch, Beilage zum Jahresbericht des Grosh. Gewerbeaufsichtsamts für das Jahr 1912, Karlsruhe, 1913.

of stoneworkers to the Central Organ for Industrial Hygiene,[6] in continuation of an earlier and even more extended discussion contributed to Grotjahn and Kaup's Handbook of Social Hygiene (Vol. II, pp. 512–530). Dr. Koelsch is one of the foremost authorities of the present period on industrial diseases, with particular reference to original investigations into the conditions under which industry is carried on. In the discussion referred to the excessive mortality of stoneworkers from pulmonary tuberculosis is emphasized, although the statistical data are far from sufficient for entirely safe conclusions. There are extended observations on the pathology of dust inhalation and much new information, which seems not to have attracted the attention it should have, probably because the paper does not appear to have been translated in its entirety. It is pointed out, for illustration, that in the administration division of Marktheidenfeld, where special investigations were made, during the period 1899 to 1908, 17.3 per cent of the total mortality was from tuberculosis, while for particular stonecutting localities the rates per 1,000 exposed to risk were as high as 6.5, 6.2, 5.8, 4.4, 4.2, and 3.7, against a general average of only 3.1. These results conform to the observed experience in the State of Vermont and suggest that where the local death rate from pulmonary tuberculosis in industrial districts exceeds the observed average, it is a safe assumption that the causative factors for the excess are industrial rather than general. Dr. Koelsch draws attention to another fact, also observed in the granite centers of Vermont, that increasing difficulty is experienced in securing apprentices for the stonecutting industry, largely as the result of the known excess of tuberculosis in the stoneworking trade. The method adopted by Dr. Koelsch would have been more useful and conclusive if the statistical data had been more representative of the industry, both as regards the number of wage earners exposed to risk and the period of time over which the observations extended. (See Appendix H, p. 162).

RECENT BENDIGO (AUSTRALIA) INVESTIGATION.

There has recently been published an extremely interesting and practically useful report on an inquiry into the prevalence of tuberculosis at Bendigo by Dr. D. G. Robertson, of the Quarantine Service of the Commonwealth of Australia. This publication is certain to become a classic in occupational-disease investigation, partly on account of the method of inquiry developed and partly because of the extraordinary results disclosed. It is an admirable and brief presentation of a subject of enormous importance to the mining industry of Australia, the results of the investigation being summarized as follows:

1. The necessity for some scheme of compensation for miners with advanced damage to their lungs caused by their occupation.
2. Accommodation for early cases of tuberculosis.
3. Accommodation for advanced cases which are at present acting as centers of infection.
4. Early action to insure complete cleansing and disinfection of premises now occupied by advanced cases of tuberculosis.
5. Definite continuance of supervision of contacts who have reacted to the tuberculin test and shown indications of having been infected by tuberculosis.

[6] Über die Lungenerkrankungen der Steinhauer, von Regierungs und Medizinal-rat Dr. Franz Koelsch, in Zentralblatt für Gewerbehygiene, Vol. III, pp. 259–264, 273–279, Berlin, 1915.

The report includes appendixes and cards used in the Bendigo campaign, a report form, and a poster calling public attention to the tuberculosis facts, particularly to miner's phthisis or fibrosis. It is only possible on this occasion to make mention of the extraordinary increase in frequency of pulmonary diseases among the miners in the Bendigo district from a rate as low as 78.42 in 1908 to a rate as high as 163.79 in 1918. Deaths from pneumonia have likewise shown a tendency to increase. The statistical investigation is summarized as follows:

1. Tuberculosis, particularly pulmonary, has been markedly more prevalent in Bendigo than elsewhere in the State of Victoria.
2. The section of the population most greatly affected has been that of the adult males. There has been a progressive tendency for the clinical manifestations of tuberculosis to be exhibited amongst males as age advances, reaching a maximum about the sixtieth year.
3. There has been an increased incidence of tuberculosis among females, compared with the rest of Victoria. Females of all ages showed an increase of 25 per cent, and those over 18 one of 18 per cent, during the last 14 years over the rate of the female population of Victoria as a whole.
4. The rate of tubercular disease other than pulmonary showed only a slight increase compared with that of the State as a whole.
5. The presence of miners in the community and their occupation has undoubtedly been an important factor in the production of the high rate of disease in Bendigo.
6. There has been a steady diminution in the incidence of tuberculosis in Bendigo during the last 30 years, Bendigo sharing this fall in common with the State of Victoria as a whole.

The general conclusions of what will always rank as one of the most lucid contributions to the problem of dust phthisis are as follows:

1. It has been proved in the statistical portion of this report that the incidence of tuberculosis has for many years been very much greater in Bendigo than elsewhere in the State of Victoria.
2. One hundred and fifty-one cases of tuberculosis were living in the Bendigo district at the end of July, 1920.
3. No measures whatsoever are being taken by the local health authorities to prevent advanced cases of consumption from spreading the disease. No hospital accommodation for this type of case is available, and patients have therefore to remain in their own homes. No supervision is exercised, and the health authorities are even unaware whether the notified cases are living or dead, residing in the residence stated on the notification or not. In other words, notification is practically a waste of public money.
4. Medical practitioners are mostly reporting pulmonary tuberculosis when very advanced; 86 per cent of the deaths during the last five years from this cause have been notified within six months of death. Moreover, cases proved definitely tubercular by the findings of tubercle bacilli in the sputum and dying during the period of the investigation have been signed up on the death certificates as "fibrosis of the lungs." These facts emphasize the necessity for better facilities being given the medical profession for more thorough examination of their patients. A laboratory for the investigation of clinical material and the services of a competent radiographer at the Bendigo Hospital are absolutely essential.
5. Strong presumptive evidence of the infectious nature of tuberculosis has been obtained through this investigation. Practically one-half of the cases investigated gave definite history of exposure to infection. More striking is the fact that 65 per cent of the home contacts of advanced cases of pulmonary tuberculosis gave positive Von Pirquets, as opposed to 21 per cent where no history of exposure to infection was obtained. Seventy-eight children under the age of 15 gave definitely positive Von Pirquet reactions, and in only two of these was there no history of exposure to infection.
6. It is considered that the incidence of tuberculosis in the Bendigo district demands immediate measures being taken to combat its spread, and if possible to eradicate it. The measures considered most suitable are as follows:

(*a*) The erection and equipment of a sanatorium. Accommodation for at least 100 persons should be provided. This sanatorium should be divided into two sections,

one for advanced and the other for early cases. To this sanatorium all advanced cases should be encouraged to go. Where the home conditions of a patient are such that infection to others is most probable, then the compulsory clauses of the health act should be enforced.

(*b*) The old supreme court building should be maintained as a clinic. Here all consultations of tuberculosis patients may be made, a dispensary for the treatment of home patients established, and the laboratory used for the investigation of clinical material.

The staff required immediately would be one medical officer and one nurse. Pending the building of the sanatorium their time would be fully occupied in keeping the patients and those giving positive Von Pirquet reactions, mentioned in this report, under surveillance, whilst their medical treatment may also be undertaken. It would also be advisable to subsidize the Bendigo Hospital, so that the services of a competent radiographer might be obtained. Arrangements should be made for the local health authorities, or, failing them, the central authority, to advise the medical officer of all notifications as soon as received.

7. Better financial assistance should be rendered to families where the breadwinners are incapacitated through tuberculosis. In many cases it is difficult to prevail upon sufferers in the early stages to undergo sanatorium treatment, as it means their families are practically left to starve. The invalid pension should continue in all cases where the pensioner undergoes hospital treatment for tuberculosis.

8. A miners' compensation act should at once be introduced. It is pitiful to note the great distress prevailing at the present time throughout the Bendigo district by reason of a large number of the wage earners being totally incapacitated solely through their occupation without any monetary compensation beyond the State grant of five shillings per week. The compensation afforded should extend to the widow in all cases. As emphasized previously, a large percentage of miners die from tuberculosis, and their children show evidence of infection, and therefore require careful attention, which is impossible under the present financial circumstances of most of the families.

AMERICAN INDUSTRIAL DUST INVESTIGATIONS.

Winslow and Greenburg in an article on "Industrial tuberculosis and the control of the factory dust problem," in the Journal of Industrial Hygiene for January, 1921 (pp. 333–343), and February, 1921 (pp. 378–395), summarize most of the available information on tuberculosis and dust control, emphasizing in a general way the specific influence of particular dusts in relation to tuberculosis, without, however, clearly differentiating the important conclusion that the prevailing types of industrial lung disease are in all probability more of the nontuberculous than of the true tuberculous variety. Thus, for illustration, the conclusion that "it is clear that the dusts to which workers are exposed in metal mining, quarrying, and grinding strongly predispose to tuberculosis and that the dusts produced in coal mining and cement working do not," fails to draw attention to the fact that in the light of more recent investigations it is safe to assume that the prevailing disease types are nontuberculous, certainly so in their origins, rather than of the true bacillary tuberculous variety of lung disease. The authors of this important contribution, however, advance the solution of the problem materially by their technical discussion of the factory-dust problem, including a summary of the determination of the average dust content of the air in various types of industrial establishments, which should be useful for practical purposes in further investigations into the nature of the dust problem in the granite-cutting industry. The discussion includes observations on the control of the dust hazard by the wearing of respirators and helmets and on the importance of different analytical standards in the control of industrial dust hazards, concluding with the statement that "a standard based on the number of one-

fourth standard unit (1–10 microns) particles in the air should prove even more valuable than one based on weight," and that "so far as the number of small dust particles is concerned, there is no great difference between well-equipped grinding and polishing shops. In either case [the] studies [made] indicate that the dust content of the air can be kept generally under 300,000 one-fourth standard unit particles per cubic foot and should not average over 200,000 such particles." It is said, however, that these standards are only tentative and that they are subject to revision "with the development of a wider knowledge of the air conditions in representative workshops." The articles include a useful bibliography of recent contributions to the dust problem.

SUGGESTIVE MEDICAL OBSERVATIONS.

In connection with the foregoing, attention should be directed to a most important discussion on the relation of pulmonary tuberculosis to silicosis in Cobbett's Treatise on the Causes of Tuberculosis (Cambridge, 1917). This discussion from the medical point of view is of the first importance, as it includes extended observations on the nature of dangerous dusts, followed by remarks on the low degree of infectiousness shown by that form of phthisis which is common among persons whose work compels them to inhale the dust of hard siliceous stones. This investigation by Cobbett is fully confirmed by the new data for the granite industry of Vermont, which also supports, among others, the conclusion "that there appears to be no ground for thinking that home infection or family susceptibility has played any considerable part in the causation of the disease." Cobbett quotes Wheatley to the effect that "many of the cases returned as phthisis may have been nontuberculous lithosis." He takes exception to the conclusion advanced by Collis "that tubercule bacilli after growing in lungs which have been modified by silica dust become less virulent." In his opinion this seems very improbable, and he advances a simple explanation, believing that "there is a scarcity of bacilli expectoration." He also directs attention to the fact that "tubercule bacilli would seem to be remarkably scarce in the sputum of South African gold miners who suffer from phthisis." He quotes Arlidge to the effect that "in cases of potters' consumption from inhaled dust bacilli have been sought for in vain," and therefore concludes that "it is indeed by no means certain that the phthisis which is so frequently a disease among the classes of workmen which we are now considering is always a manifestation of tuberculosis. In its early stages, at least, it is probably not so." The work contains much additional evidence to this effect and clearly sustains the conclusion arrived at on the basis of the Barre data—that the prevailing type of industrial lung disease in granite-stone cutting is not, in its initial stage at least, a bacillary form of pulmonary tuberculosis.

THE PROBLEM OF LUNG FIBROSIS.

It is precisely this confusion of terms which seems to justify the broader viewpoint which underlies the present investigation—that what we are here concerned with is not a true form of pulmonary tuberculosis in the accepted sense, but rather a lung fibrosis, possibly

in the majority of cases complicated by a terminal tuberculosis infection. Notwithstanding an extensive literature on the subject, this aspect of industrial lung disease has not received the necessary amount of qualified consideration. In an interesting and practically useful contribution on "Pulmonary fibrosis, tuberculous and nontuberculous," contributed to the London Lancet under date of June 1, 1918 (p. 765), Dr. G. T. Herbert, tuberculosis officer for Hackney and Bethnel Green, takes occasion to say that "in all except the acute cases of pulmonary tuberculosis a greater or less degree of fibrosis of the lungs occurs. So striking are the physical signs of fibrotic tuberculosis in an adult of over 40 [years of age] who has extensive disease but few symptoms apart from cough and dyspnœa, and so uncommon are cases of fibrosis due to other causes in this period, unless accompanied by bronchiectasis, that the idea of pulmonary fibrosis has become inseparably linked with that of chronic pulmonary tuberculosis. The physical signs due to the fibrosis are subconsciously regarded as due to the essential tuberculous lesions, with the result that fibrosis found in children of school age is often diagnosed as tuberculous without hesitation and without consideration of the possibility of a cause other than tuberculosis." What is true of children is even more true of adults with continuous exposure to minute particles of inorganic dust. Certainly as early as 1894 Sir Andrew Clark and others, in a discussion of fibroid diseases of the lung, clearly differentiated three groups of pulmonary fibrosis as follows: 1. Pure fibroid or fibroid phthisis, by which is understood a condition in which there are no tubercles; 2. Tuberculo-fibroid disease, a condition which is primarily tubercular but subsequently runs a fibroid course; 3. Fibrotubercular, a condition in which primarily fibroid disease has become tubercular.

From a careful and extended consideration of the mortality experience of granite cutters the conclusion would therefore seem justified that the disease generally diagnosed as pulmonary tuberculosis is in truth fibroid phthisis, as thus defined by Sir Andrew Clark, and is considered free from tubercular infection, while in the majority of cases the disease is probably fibrotubercular or an original fibrosis complicated by subsequent and true tubercular infection. Dr. Herbert adds his own explanation—that "the first group [fibroid phthisis] is convincingly proved to be a common disease, clinically and pathologically, and would doubtless have been accepted and known as such if a satisfactory name had been found for it. After rejecting the terms 'fibroid degeneration,' 'silicosis,' 'chronic pneumonia,' 'interstitial pneumonia,' 'melanosis,' and 'gray induration,' [Sir Andrew Clark and his associates] chose 'fibroid phthisis,' to contrast it with 'pulmonary phthisis,' the name which they considered would stand forever unchanged for what is now known as 'pulmonary tuberculosis.' "

The writer is not aware that this viewpoint is generally accepted on the part of medical practitioners with experience among granite cutters, and there is nothing to indicate it on the part of the Vermont State Medical Society. Yet it must be self-evident that as regards both diagnosis and treatment a precise differentiation of disease types must be of the first importance, and the same conclusion applies to methods of successful prevention and control.

DIAGNOSTIC DIFFICULTIES.

As regards the diagnosis of early phthisis, it must be kept in mind that there are generally four accepted conditions: 1. Cough and expectoration; 2. Loss of weight; 3. Loss of appetite; 4. Rise in temperature.

The view is now generally accepted that no phthisis can exist without these symptoms in the ordinary way; but how far these symptoms are characteristic of fibroid phthisis in its initial stage is open to question. Dr. Herbert in the article referred to (p. 766) remarks: "Tuberculosis infection is almost ubiquitous, but resultant tuberculosis disease of the alveolar tissue comparatively rare. Commonly in children, and probably frequently in adults, tuberculosis disease has developed from an old tuberculous infection, and in doing so has passed through four successive stages, namely: 1. That of tuberculosis processes in the root glands, recognized by laboratory tests; 2. That of changes in the walls of the air passages, said to be (but not proved to be) tuberculosis by radiologists; 3. That of early tuberculosis invasion of the lung tissue, which may give rise to signs recognizable on examinations; 4. That of more or less advanced disease, with tubercular bacilli in the sputum."

He points out in this connection that the stages indicated "overlap to a certain extent and in any given case the changes may be active or inactive." But it must be self-evident a diagnostic principle applicable to pulmonary phthisis may be widely at variance in the earliest possible recognition of a case of fibroid phthisis. Quoting once more from Dr. Herbert, "the intermediate group of fibro-tubercular disease is responsible for much of the confusion that exists between the extreme types." But unfortunately he did not consider the much more important type, from the industrial viewpoint, of fibroid phthisis, which there are the strongest reasons for believing is much more often erroneously diagnosed as a tuberculo-fibroid disease. If the present discussion fails, therefore, in conforming to the foregoing principles, it is because the prevailing lung disease in the Barre granite-cutting districts is almost without exception diagnosed as pulmonary phthisis, making it necessary that for the present purpose the term "industrial lung disease" should be given the preference.

THE PROBLEM OF DUST INFECTION.

The infectious character of true pulmonary tuberculosis justifies measures of prevention and control essentially different from those made in efforts to reduce the excessive incidence of fibroid phthisis. The dictum of Sir Douglas Powell, "that if there were no dirty surroundings and bad habits of life the infection of tuberculosis would also cease to be operative" is still the accepted one. But in fibroid phthisis it is not primarily a question of infection, but one of lung injury as the result of continuous and considerable dust inhalation. The lung disease affecting granite cutters is not essentially conditioned on filthy surroundings nor on air organically contaminated, but on a dust-laden atmosphere resulting from industrial processes, which may or may not admit of effective control. Sir Malcolm Morris has on numerous occasions emphasized the view that "we must be on our guard against overstressing the factor of

infection." This conclusion certainly applies with particular force to the lung diseases met with among granite workers. Investigations conclusively show that of the three factors generally considered as predisposing to pulmonary tuberculosis—infection, heredity, and environment—it is only the latter, and in a very restricted sense, which applies to the mortality problem under review. Infection probably occurs in the vast majority of cases in early infancy. The later outbreak of the disease is attributable to diminished resistance, and in industrial life perhaps there is no more potent cause than lung injury, resulting from the inhalation of large quantities of minute particles of inorganic dust.

INVESTIGATION OF MINERS' PHTHISIS COMMISSION OF SOUTH AFRICA.

It was the clear recognition of this viewpoint on the part of the Miner's Phthisis Commission of the Union of South Africa that made possible the adoption of remedial measures which have been of direct and far-reaching advantage to the industrial population. The report of the commission, published in 1912, is one of the most notable contributions to the knowledge of a question which is of world-wide importance, wherever dust-producing occupations are carried on. It would not be feasible on this occasion to review extensively the findings of this commission, but the inclusion of the following observations may add to the practical value of the present investigation. Regarding a differentiation of miner's phthisis, it is said that "the disease known as miner's phthisis, or more correctly as silicosis, has been shown to be a chronic fibrosis of the lung due to the inhalation of fine angular dust suspended in the mine atmosphere."

MINERS' PHTHISIS, OR SILICOSIS.

This is amplified by the further and particularly significant conclusion that "medical evidence has not disclosed the existence of an appreciable amount of tuberculosis disease amongst miners." After reviewing the more important investigations made in South Africa, Cornwall, and Australia, the general conclusions are summarized in the statement (p. 7) that—

> First, it is apparent that the excessive incidence of lung disease amongst miners engaged in a certain class of metalliferous mining is not a feature peculiar to the mines in the Transvaal, and although the extent and character of that incidence may vary in detail in different mining communities the broad fact is well established of the prevalence of fibroid phthisis as a specific occupational disease amongst metalliferous miners working in hard rock.
>
> Second, it is of the highest importance to note that these investigations have everywhere led to the same conclusions as to the nature and causation of the disease which has come to be commonly known as miner's phthisis, and the evidence they contain, together with the very large local experience of miner's phthisis, has enabled us the more readily to formulate a working definition of the disease we are asked to investigate and to construct definite clinical standards for its identification and classification.

CONCLUSIONS OF PREVIOUS INVESTIGATIONS.

The miner's phthisis here referred to would seem to be for all practical purposes identical with the type of industrial lung disease commonly met with among granite cutters and generally erroneously diagnosed as pulmonary tuberculosis. Before proceeding to the pathology and symptoms of the disease as laid down by the Miners'

Phthisis Commission the main conclusions of previous investigations may be quoted as a matter of convenient reference. These are stated as follows:

(1) That the excessive mortality amongst certain classes of metalliferous miners has been due to lung diseases, and particularly to the disease known as miner's phthisis, and that in regard to diseases other than those of the respiratory organs the mortality of metalliferous miners as a class compares quite favorably with that of the general male population.

(2) That this mortality has greatly increased in each locality since the general introduction of rock drills into mining practice and falls most heavily upon rock-drill miners; general miners also suffer, but to a less extent.

(3) That clinical and pathological evidence, supported by evidence relating to the occupational conditions under which the disease arises, shows that the primary cause of miner's phthisis is the repeated inhalation over prolonged periods of the fine rock dust generated in mining operations, that this cause produces reactive changes in the lungs which are of the nature of a slow progressive fibroid change, and that upon this condition tuberculosis infection becomes commonly eventually superimposed.

(4) That the objects to be aimed at in all measures to be taken to obviate the incidence of the disease must be to prevent the generation and inhalation of rock dust, to prevent the contamination of the mine air by the fumes of explosives and by respiratory and other impurities, and to control the risk of the spread of tuberculous infection amongst miners.

PATHOLOGY OF LUNG FIBROSIS.

The process of rock drilling here referred to is practically identical with the use of pneumatic tools in stonecutting, carving, etc. It is practically certain, however, that the latter processes are even more injurious than the former. Broadly speaking, the duration of trade life necessary to show the full effect of continuous and considerable dust inhalation is probably the same, or, approximately, 20 years. Considering now and very briefly the pathology of miner's phthisis, as defined in the report of the South African commission, the facts may be briefly summarized as follows:

It [the disease] is primarily a chronic fibrosis of the lung, a chronic interstitial pneumonia, as it is technically described. The irritant properties of the fine dust particles inhaled produce chronic catarrhal processes in the air cells and respiratory passages. From these a certain proportion of the dust particles are taken up and pass into the substance of the lung, where they produce a chronic inflammation, which results in the production of fibroid changes around each focus of irritation. These changes become in time distributed in varying degree throughout the whole lung substance and in the fibrous framework of the lung and the pleura which invests it. These fibroid areas increase in extent and ultimately coalesce to form patches of consolidation, obliterating in the process the true lung tissue and gradually but inevitably encroaching on the amount of normal lung substance available for respiration. The process at once induces and is extended by the occurrence of recurrent "colds," slight attacks of pleurisy, and localized catarrhal inflammations, and is aided, no doubt, by exposure to sudden variation of temperature. The change is a diffuse one affecting both lungs, but not always equally. It takes a considerable time, commonly a period of several years, to impair the working capacity of those affected. It is not intrinsically an infective process, but is due to mechanical irritation, although its progress may be and often is accelerated by inflammatory attacks due to bacterial invasion. This is the primary condition found in all true cases of miner's phthisis—all are primarily cases of silicosis, which is the name given to the fibroid disease of the lung caused by the inhalation of stone dust.

These observations clearly indicate the nontubercular nature of fibroid phthisis, at least in its essential stage, when preventive measures are most likely to prove effective. It is emphasized in the subsequent conclusions that the condition of simple fibrosis may exist and progress for years, but that in the later stage of the disease "the lung so damaged is commonly invaded by the tubercle bacillus. In at least a great majority of cases tuberculous infection becomes

toward the end superimposed upon the preexisting silicosis and the symptoms and course of the disease become to a greater or less extent altered accordingly."

DIFFERENTIATION OF DISEASE SYMPTOMS

The symptoms of fibrosis of the lungs are stated by the commission to be "slight shortness of breath and recurrent bronchial colds. The general health is good, the working capacity is not interfered with. A man may remain in this stage for a long period." There is nothing said here of expectoration, of loss of weight or loss of appetite and rise in temperature, clearly indicating that a precise diagnosis would differentiate the initial conditions of fibroid phthisis very readily, but it is certain these symptoms increase: "Cough—often a morning cough and perhaps accompanied by sickness, commonly with a little expectoration—distinct shortness of breath on exertion, a more frequent liability to slight but obstinate bronchial attacks, and frequent flitting pleuritic pains are the symptoms which first attract serious notice. These are the symptoms when the condition is established. The general health may not be noticeably affected, there may be no loss of flesh, but there is now a definite impairment of working efficiency."

SILICOSIS AND TUBERCULOSIS.

The report of the South African commission in this connection points out that "physical examination of such a typical case of defined silicosis will show certain definite signs. Of these the most obvious is impaired expansion of the chest and a characteristic rigidity, especially of the upper portions on each side anteriorly." This condition has been described as follows:

"The chest is remarkably motionless, the man seems deaf to the request to draw his breath"; and this is amplified by the statement that—

> The entry of air into the lungs is impaired—the breath sounds are diminished in extent and volume and are commonly altered in character. Typically, one finds a wavy, interrupted, lagging inspiration, the quality of the sounds is often harsh, and all types of bronchovesicular breathing may be found. True "bronchial" breathing is not common at this stage. There may be patches of impaired resonance to percussion due to thickened pleura or small areas of consolidation; evidence of old and recent local pleurisy is common, especially in the lateral regions of the chest; bronchitic "rhonchi" may be heard here and there; "crepitation" is comparatively rare. But the complete clinical picture is now unmistakable. In the stage of early fibrosis one finds also, but to a lesser extent and degree, the cardinal signs of impaired expansion of the chest, impaired air entry, and alteration in the character of the breath sounds, with perhaps evidence of slight localized pleurisy.

It is not necessary to enlarge further upon the differential diagnosis of fibroid phthisis and fibroid and pulmonary phthisis, but the following quotation will conclude the clinical picture.

> As the disease progresses to the advanced stage the cardinal symptom of shortness of breath becomes more urgent and distressing, the cough more frequent, expectoration may be more copious, but is still often slight. The patient becomes unable to work—he loses flesh—his narrow, shrunken, rigid chest may scarcely expand at all on breathing. The shoulders are hunched, the chest appears to be practically fixed in the position of extreme expiration. The lips are bluish, the pulse rapid, the expression anxious, the right side of the heart dilates under the strain.

To this admirable clinical description of an uncomplicated case of fibroid phthisis is added the following observation on a superimposed tuberculosis: "Tuberculosis may supervene on this condition of

fibrosis at any stage, but it is not common to find it in association with early or even with moderately advanced cases. It is in the great majority of cases a terminal phenomenon attacking the sufferer from fibrosis when that condition is already advanced. When that occurs the downward progress of the patient is usually very rapid."

GENERAL CONCLUSIONS.

The present investigation emphasizes the urgent need of a much more comprehensive study of the predisposing factors responsible for tuberculosis occurrence. Much of the literature on the subject reflects hearsay or secondary evidence rather than original observations and extended personal experience. Many of the accepted theories on tuberculosis are general principles deduced from experience entirely too limited for a broad generalization. This view is clearly emphasized in such a work as The Shibboleths of Tuberculosis, by Dr. Marcus Patterson, medical superintendent of the Metropolitan Asylum Board and late medical superintendent of the Brompton Sanatorium. Dr. Patterson makes it clear that upon many of the most important questions regarding cautions and treatment qualified medical opinion is as yet far from being in entire agreement. He himself concludes that the increase in the tuberculosis death rate since 1914 is attributable not so much to war causes as to better diagnosis, a conclusion wholly unacceptable to those who have considered the question in its larger aspects, for if better diagnosis increased the death rate during 1915 to 1918 a lesser degree of accuracy in diagnosis must, in part at least, account for the material decrease in the disease during 1919–1921. The theory of questionable accuracy in diagnosis is always acceptable to those who have not made a thorough inquiry into all the facts, particularly the statistical intricacies of a highly complex medical problem.

CONTRADICTORY MEDICAL OPINIONS.

Medical men, unfortunately, often lack the requisite statistical training and the time or the facilities for considering exhaustively the underlying problem of collective disease experience. Trained as they often are in minute laboratory research, they fail most conspicuously in being able to give due consideration to occurrences represented as mass phenomena, intelligible only by means of a qualified statistical analysis. The charge of inaccuracy in diagnosis is often made in connection with medical controversies to set aside overwhelming statistical evidence based upon the only records available. These records in each and every case represent the last word of the attending physician as regards the true cause of death, and while obviously errors must occur and certainly do occur it is of the essence of the statistical method that in the absence of a strong bias such errors will tend to balance one another and will not impair materially the general conclusions arrived at.

Death certificates rarely fail to disclose the general truth of a given cause of death, however far they may fall short in matters of detail or in absolute precision in bedside diagnosis. They may fail correctly to state that the death was due to a tuberculous process positively identified by the presence of the bacillus, but they will rarely fail in disclosing the fact that the pathogenic process was one

of destructive lung injury often due to causes largely within human control. It may be pointed out in this connection that in the judgment of qualified authorities a positive tubercle-bacilli test of the sputum is not in itself evidence of active tuberculous disease, while, conversely, a negative tubercle-bacilli test is not necessarily evidence that the disease is not present. All that is definitely known, in the words of Dr. Patterson, is that "the presence of bacilli in the sputum will definitely prove infection but not activity." The proof of such infection will, however, be of the utmost value in a doubtful case of illness, where there are marked constitutional symptoms and few physical signs. In the absence of an entire agreement upon questions like the foregoing there must necessarily prevail a wide diversity of opinion in death certification, but in the writer's judgment not sufficient to impair the value of such records for statistical purposes. (See in this connection some very excellent observations on the etiology of tuberculosis, based upon an extended review of Prof. Calmette's recent work on "Bacillary infection and tuberculosis in men and animals" in the Boston Medical Journal, December 11, 1920; also an important letter on the "Etiology of tuberculosis," by Major Greenwood, in the Lancet, December 4, 1920–A.)

RESULTS OF SOUTH AFRICAN MEDICAL RESEARCH.

Accepting, as it is believed one must, the statistical evidence of a material increase in industrial lung disease among granite workers during the last 15 or 20 years, in contrast to a marked decline in the incidence of the disease among limestone and glass workers, there remains a debatable question as to whether the disease reported as pulmonary tuberculosis is not in the majority of cases a true form of pneumoconiosis, or industrial lung disease, without evidence of bacillary infection. The questions involved are not likely to be solved by animal experimentation, but will require the methods of the strictly scientific inquiry adopted by the South African Institute for Medical Research. With particular reference to miner's phthisis, it may be pointed out in this connection that under the miner's phthisis act of South Africa, 1916, "every European applicant for employment underground in the mines of Witwater's Rand is required to submit himself for medical examination at the bureau, the object being to exclude from work underground any person who is physically unfit for such work. In addition all miners employed underground must be similarly examined at intervals of not more than six months to ascertain whether or not they are suffering from either tuberculosis or silicosis or both." The examination conducted at the bureau is a very thorough one and embraces both clinical and X-ray investigations. Such research is obviously called for in the case of the granite workers of the Barre district, subject as they are to one of the very highest death rates from pulmonary tuberculosis on record for any industry or any section of the world. If the present investigation could have been conducted along the lines adopted by the South African Institute for Medical Research and the Miners' Phthisis Medical Bureau of South Africa, much additional evidence would have been available further to confirm the lamentable conclusions reached. As an illustration of the extraordinary thoroughness of the work of the Miners' Phthisis Medical Bureau of South Africa, it may be said that the office has a complete medical and

radiographic record of 35,816 miners and that since the inauguration of the bureau in August, 1916, up to the 31st of December, 1919, upwards of 11,500 examinations have been carried on. Largely as the result of the work of the Miners' Phthisis Medical Bureau the incidence of silicosis among South African miners has decreased. Even among native laborers, notwithstanding the continued prevalence of influenza, the death rate declined from 12.8 per 1,000 in 1910 to 2.6 per 1,000 in 1919. Is it too much to expect that workers in the stone industry of the United States should receive the same qualified medical consideration that is extended to native mine laborers on the Rand?

SOUTH AFRICAN SILICOSIS STATISTICS.

The disastrous experience of the last 15 years, involving the loss of countless useful lives, is suggestive of the conclusion that if silicosis, or pneumoconiosis, or whatever term may be acceptable, were recognized as an industrial disease, entitling the person injured to adequate pecuniary compensation, a material reduction in the death rate would be only a question of time. This conclusion would involve the larger question of adequate medical supervision and control of persons employed in connection with granite-stone cutting processes, more or less in conformity to the methods adopted and found favorable in South Africa. There may be included here a statement from the annual report of Dr. W. Watkins-Pitchford, chairman of the Miners' Phthisis Medical Bureau for the year 1919, who reports over 32,000 statutory clinical examinations and investigations: "The prevalence of pulmonary tuberculosis (pure or complicated by silicosis), as revealed at the periodical examinations of 15,000 miners of European descent, was at the rate of 1.14 per 1,000, as compared with 1.27 and 0.91 for the two preceding years, respectively. The prevalence of silicosis, either in a pure form or complicated by tuberculosis, was 5.53 per 1,000, as compared with 5.56 and 5.60 for the two preceding years. As ascertained at the periodical examinations, the attack rate of tuberculosis not complicated by silicosis was 0.255 per 1,000, as compared with 0.259 for the preceding year." In only one case was pulmonary tuberculosis detected at the periodical examination of a person who had passed the initial examination of the bureau. The reports contain much additional information of the utmost practical value, but it is possible to give only the concluding observation—that "tuberculosis affecting the silicotic miner is relatively noncommunicable to a healthy person," a conclusion apparently in full conformity to the facts found in investigations made into family history of granite cutters dying from industrial lung disease in Barre, Vt. (See the Lancet, January 1, 1921.)

BRITISH SILICOSIS ACT.

A similar act, or rather an amplification of the workmen's compensation act of 1906, was adopted by Great Britain in 1918. No results under this act are as yet available, but the measure clearly foreshadows a development of a new governmental policy in dealing rationally, effectively, and equitably with the occurrence of industrial disease directly traceable to continued and considerable dust exposure. The scheme putting into effect the silicosis act of 1918 requires that "every workman shall be examined at prescribed intervals, and

these examinations are to be made at the works unless the medical officer otherwise decides. Any workman who at the commencement of the scheme has been employed in the industry for more than 20 years is exempt from these examinations, but newcomers must be examined within three months of their commencing work, and if the medical officer finds any workman to be suffering from silicosis or silicosis accompanied by tuberculosis to such a degree as to make it dangerous for him to continue to work in the industry, he shall suspend the workman from further employment." Whether this regulation is sufficient for the purpose only experience can demonstrate. It is highly suggestive, however, that in 1919 there should have been issued the "refractories industries scheme," which concerns the industrial manipulation of material containing not less than 80 per cent of silica, chiefly applicable to fire-brick manufacture and the quarrying and dressing of hard stone, as well as to certain processes in potteries. All workmen employed in such processes are to be examined once a year and on certain additional occasions by a medical officer appointed by the secretary of state. It is of interest in this connection to quote from the Lancet of May 24, 1919, that it is to be noted "that the view that silicosis of itself can cause death is accepted" and "failing a positive sputum test the differentiation of fatal silicosis from silico-tuberculosis must be difficult save by a speedy post-mortem examination and animal inoculation." The Lancet, however, concludes that the various provisions for compensation seem fair and that there is evidence of a sympathetic consideration of the workmen's lot. The scheme of the workmen's compensation silicosis act of 1918 was published as Statutory Rules and Orders, 1919, No. 12, under date of January 6. These observations emphasize the direction along which lies the practical solution of the problem of an excessive incidence of pulmonary tuberculosis or industrial lung disease among granite workers. The conclusions, however, apply to a much wider range of occupations in which the exposure to silicosis dust is the direct causative factor of an excessive death rate at the period of life when continued duration is of the utmost economic importance to the person concerned, the industry, and the State.

RECENT SILICOSIS INVESTIGATIONS.

Considerable progress has been made with technical investigations, which, however, with regard to American experience, can not be considered final until the results of the investigation by the Bureau of Mines are available. One of the most recent contributions on pulmonary silicosis is an extended discussion by Dr. E. L. Middleton, medical officer to the Welsh National Memorial (Tuberculosis) Association, contributed to the Journal of Industrial Hygiene for March, 1921 (pp. 433–448). This admirable discussion includes a consideration of the following industries: (1) Manufacture of silica bricks and silica flour milling; (2) scythe-stone making; (3) lead mining; (4) quarrying, and (5) stone dressing. A number of actual cases in each of these industries are described, including 11 stone dressers, typical of the class of people considered in the present inquiry. Under the subtitle "Pathogenesis" the writer presents his observations on air pollution by dust, on the essential fineness of dangerous silica dust, and on the specific qualities of silica as a disease producer. These observations can not be conveniently reduced to the form of a broad

generalization, but with reference to the fineness of dangerous silica dusts it is pointed out that "the size of the silica particles is a consideration of the utmost importance in the causation and prevention of silicosis," for, he remarks, it follows that "the naked-eye appearance of the atmosphere of a workplace is no criterion of its safety, for the most dangerous particles are invisible under good conditions, and even much coarser contamination of air would be unrecognizable in the deficient light of mines, kilns, and sheds." He concludes in this connection that "the dust which causes the lung changes in silicosis is, then, the very fine silica particles of less than 12 microns and averaging little more than 1 micron in size." This statement is amplified by the additional observation that "recent researches and the observations of numerous investigators indicate that the purity of the silica dust must be recognized as a factor of prime importance in the causation of silicosis." He deplores the lack of mortality statistics of silicosis, in connection with which it may be said that deaths from fibroid or miner's phthisis are rarely returned as such, but are generally reported under the designation of pulmonary tuberculosis. That the specific reporting of such cases would not be difficult is emphasized by the official reports of the registrar general of Queensland, who for some years past has returned deaths from miner's phthisis among nontuberculous respiratory diseases. The Queensland returns indicate an increasing mortality from this affection, from a minimum of 19 deaths in 1911 to 46 deaths in 1918.[1] The classification in the international list of miner's phthisis under 97–A, in class 4, or diseases of the respiratory system, precisely emphasizes the practical importance of the conclusion that the alleged form of tuberculosis met with among granite-stone workers is, in the majority of cases, a nontuberculous type of fibroid lung disease.

In considering the pathology of pulmonary silicosis Dr. Middleton points out that "the weight of the lung is always increased when silicosis is present," and that "increase in weight may amount to twice the normal weight in advanced silicosis, when complications such as edema and pneumonia are included."

This statement is amplified by an observation derived from the study by the South African Institute for Medical Research, according to which "(1) the total weight of silica in the diseased lungs was much higher (from 2.8 to 9.6 grams) than in the normal lung (0.55 gram), and (2) the proportion of silica in the ash of the diseased lungs was much greater (from 29 to 48 per cent) than in the normal lung (14.7 per cent)."

In a brief discussion of the symptoms of pulmonary silicosis attention is directed to the length of time intervening between onset and serious disease manifestations. This period was found to have been an average of 14.26 years, and although a relatively small number of cases were under observation the duration of trade-life exposure was found to be longest in the case of stone masons (equivalent to stone cutters) or 22.3 years. This conforms almost exactly to the American experience, which places the duration at about 21 years. The observations on symptoms include important remarks on dyspnea, cough, influenza and colds, hemoptysis, and other symptoms, a detailed discussion of which does not seem to fall within the province of this inquiry.

[1] Vital Statistics of Queensland, 1919 (No. 60), Brisbane, 1921.

PHYSICAL SIGNS OF SILICOSIS.

As regards physical signs, it is, however, of importance to point out that "silicosis is a disease only according to the degree in which it departs from the accepted normal of adult life," for, it is said, "the danger and difficulty, of course, lie in the time which it takes for the inhaled dust to produce the pathological changes in the lung to which the physical signs and symptoms are due." The urgency of early diagnosis is emphasized in the statement that "routine examinations in dusty industries are, therefore, greatly to be desired. The physical signs, however slight, at each examination should be charted and variations in later findings carefully noted and their value assessed." The commonest early physical sign of pulmonary silicosis is found in the right mammary region, or above the fourth rib, where the breath sounds may be of a harsh character and rather puerile in quality. Radiography is referred to as a valuable addition to the ordinary means of diagnosing silicosis, giving useful help in detecting the presence of tuberculous foci and other complications. The importance of radiography as an auxiliary aid in determining the true extent of lung damage as the result of continuous dust inhalation is freely recognized by all who have given the subject qualified consideration.

DESCRIPTIVE CASES.

The investigation by Dr. Middleton includes an extremely valuable account of descriptive cases suggestive of a similar portrayal of the clinical material available for this country. In the aggregate, 57 cases were subjected to specialized consideration, with results as shown in Table 80.

TABLE 80.—CASES OF TUBERCULOSIS FOLLOWING EMPLOYMENT IN DUSTY OCCUPATIONS.

Occupation.	Number of cases.	Employment in industry, in years.			Average age at onset, in years.	Average time in industry before onset, in years.	Initial symptom.	
		Shortest.	Longest.	Average.			Dyspnea.	Cough.
Silica-stone workers	18	[1] 6	18	3.75	37.0	13.2	9	3
Scythestone workers	6	2.5	33	21.0	38.66	17.2	2	1
Quarrymen	6	.....	.....	.....	41.83	.....	2	.....
Lead miners	16	4.0	37	18.75	44.41	23.7	11	4
Stonemasons	11	15.0	32	22.3	40.25	22.4	.....	5
Total	57	.....	.....	14.259	40.41	18.95	24	13

Occupation.	Other symptoms.				Tubercle bacilli in sputum.	Family history of tuberculosis.[2]	Fatal cases.	Average age at death, in years.	Average term of invalidism, in years.	Average duration of symptoms, in years.
	Hemoptysis.	Night sweats.	Weakness.	Wasting.						
Silica-stone workers	7	5	14	13	5	5 (1)	8	39.5	1.83	3.8
Scythestone workers	3	2	5	4	2	3 (2)	4	48.75	1.75	3.5
Quarrymen	2	3	4	5	6	2 (2)	5	44.2	2.08	2.5
Lead miners	3	9	15	13	4	5 (4)	12	48.58	1.58	3.75
Stonemasons	1	8	9	10	4	4	6	46.16	[3] 11.33	6.25
Total	16	27	47	45	21	19	35	45.5	[3] 19.45	4.0

[1] Weeks.
[2] Numbers in parentheses are additional cases with doubtful family histories.
[3] Months.

This table, aside from its intrinsic value, is suggestive of the clinical classification most likely to prove useful for practical medical and preventive purposes. It is shown that for all occupations the average age at death was 45.5 years, the average duration of invalidity 19.45 months, and the average duration of symptoms 4.0 years.

On the supremely important question of prognosis it is said that—

With a fibrosis sufficiently extensive to affect more than a minimum amount of air tissue a progressive course of symptoms is to be looked for. The amount of involvement necessary before definite disease can be considered permanent appears to vary with the individual. * * * According to the exposure, on the one hand, and the efficiency of the natural defensive mechanism, on the other, the lungs become aged by the accumulation of dust and the resulting fibrosis. The term "silicosis" therefore is relative and implies that the sufferer has exceeded the limits of average balance between inhalation and elimination, with the result that a deleterious accumulation has accrued to his disadvantage.

Following some very interesting general observations (which, however, can not here be included), it is said:

From the onset of symptoms until death the period of time which can be called the illness varies widely. The reservation regarding the actual onset and the admitted onset must be kept in mind, as the latter only is available to the clinician. Longest in the stonemason series, the average duration of symptoms in 6 fatal cases among these workers was six and one-fourth years, in 12 lead miners three and three-fourth years, in 8 silica workers three and three-fourth years, in 4 scythestone makers three and one-half years, in 5 quarrymen two and one-half years.

PRIMARY IMPORTANCE OF SILICOSIS.

Considering the occurrence of silicosis with tuberculosis, it is said:

The most important variation in the course of the disease is the occurrence of tuberculosis. While there is evidence that tuberculosis may coexist with silicosis without producing any apparent alteration in the course of the disease, in the majority of instances the development of tuberculosis is along a different line and produces definite evidences of its presence. In the earliest cases of silicosis, and especially in young subjects, the disease when first seen may be indistinguishable from ordinary tuberculous phthisis. The superadded disease has produced symptoms before the antecedent silicosis has developed sufficiently to demand medical attention· hence it is missed.

DANGER OF ERRONEOUS CONCLUSIONS.

The foregoing observations are of extraordinary practical importance in view of the prevailing nonrecognition of the distinction pointed out in the large majority of cases now diagnosed as pulmonary tuberculosis. Attention is drawn to the influence of each of the two conditions on the other, which, when existing together, may give some information, "for, as has been mentioned before, the silicotic process is hastened in the presence of tuberculosis, and the changes due to it are unevenly distributed throughout the lung or lobe. Hence an excess of activity in the course of silicosis, with a development toward a tuberculous type, gives an indication which is obvious enough. More and more such a case approaches the ordinary tuberculous disease as it advances, with the wasting, lassitude, pyrexia, night sweats, and increase of cough and expectoration found in the common ulcerative chronic tuberculosis."

These observations explain the perfectly natural assumption that in a large majority of cases the type of disease dealt with in its final stages is a true form of tuberculosis, without an appreciation of the fact that in all probability the disease in its initial stages, when

preventive measures would be most effective, is a case of non-tuberculous respiratory disease. Dr. Middleton reemphasizes this conclusion as follows:

The occurrence of tuberculosis has the effect of carrying the disease to a fatal issue more rapidly than when this complication is absent. In 15 cases in which tubercle bacilli were found in the sputum the average duration from the onset of admitted symptoms was 3.17 years; in 20 cases in which tubercle bacilli were not found the average duration was 4.62 years. The difference as stated is less than it should be, as several cases of shortest duration in the latter group were certainly tuberculous, though no opportunity was obtained for sputum examination.

In concluding the foregoing observations on the symptoms and physical signs of pulmonary silicosis, Dr. Middleton takes occasion to say:

It might, of course, be argued that cases of pulmonary tuberculosis occurring in young persons exposed to silica dust are ordinary cases of that disease without reference to the industrial environment, and in some cases this may be so. It has been pointed out, however, by many observers that the inhalation of silica dust predisposes to the development of tuberculosis, and it must be admitted that this baneful influence may have been at work in precipitating the onset of pulmonary tuberculosis, although no characteristic symptoms of silicosis had been observed.

RESTATEMENT OF SILICOSIS CONCLUSIONS.

The results of this investigation by Dr. Middleton, which may be considered epoch making in its practical bearing upon the larger problem of prevention and control, are summarized in the following final conclusions:

1. Silicosis is caused by the inhalation of minute particles of dust of high silica content.
2. The finest particles are most directly injurious, as they reach the lymphatic channels of the lung, producing progressive fibrosis; the dust is most dangerous at the first moment of generation, before dampening or agglutination has occurred.
3. The disease produced can be diagnosed from physical signs—in some cases before the patient has become aware of definite symptoms.
4. Silicosis predisposes to tuberculosis of the lung, as a result of the changes produced in the lung. It may, however, exist and prove fatal without any definite evidence of a superadded tuberculous infection.
5. The only means of combating the disease is by prophylaxsis—in preventing the generation of dust at its source, in obviating its inhalation by the use of masks, and in excluding any affected persons when the condition becomes recognizable.
6. The prophylactic measures should be carried out in all industries where the inhalation of dust of high silica content is a contingent danger.

APPENDIXES.

APPENDIX A.—INQUIRY BLANK USED IN THIS INVESTIGATION.

STONE INDUSTRY.

PERSONAL RECORD.

Name.....
Present address.....
Age..... Sex..... Race.....
Married, single, widowed or divorced.....
Country or State of birth.....
Height..... Weight.....

OCCUPATIONAL HISTORY.

Industries employed in, prior to present employment.....
.....
Exact occupation followed in each industry.....
Time in each occupation.....
Exact occupation now followed.....
Length of employment in present occupation: Yrs..... Mos.....
Additional occupations now followed.....
Vacation time last year: Weeks..... Days.....
Involuntary idleness last year: Weeks..... Days.....
Absence from work on account of sickness last year: Weeks..... Days.....

PRESENT WORKING CONDITIONS.

Tools used: Hand..... Pneumatic.....
Type of pneumatic tool used.....
Cutting process: Dry..... Moist.....
Provisions for removal of dust.....
Provisions against inhalation of dust.....
Are respirators used?.....
Ventilation: Good..... Fair..... Bad.....
Method followed in cleaning up.....

HOME HYGIENE.

OUTSIDE SANITARY CONDITIONS.

Good..... Fair..... Bad.....

INSIDE SANITARY CONDITIONS.

Light and air: Good..... Fair..... Bad.....
Cleanliness: Good..... Fair..... Bad.....

ROOM ACCOMMODATION.

Total number of rooms..... Persons in household.....
Average number of persons per room.....

TUBERCULOSIS IN FAMILY.

Relation to head of family.	Sex.	Age.	At present diseased.		Suspected.	Formerly a patient.
			Active.	Arrested.		
.....	.....	.....	.....	.....	.....	.....
.....	.....	.....	.....	.....	.....	.....
.....	.....	.....	.....	.....	.....	.....

Remarks: .....
.....

APPENDIX B.—MEDICAL BLANK RECOMMENDED.

Physical and X-ray examinations Name of plant.....
Dr. ..... Location.....

STONE INDUSTRY.

PERSONAL DATA.

1 Name.....
2 Address.....
3 Age.....
4 Birthplace of workman.....
5 Birthplace of workman's mother.....

TRADE LIFE.

6 Firm, or place of work.....
7 Kind of stone worked.....
8 Exact occupation.....
9 Years followed.....
10 Former occupations.....

DUST EXPOSURE.

11 Types of pneumatic tools used.....
12 How many years?.....
13 What particular operation is most dust producing?.....
14 Is general dust exposure apparently harmful?.....

PHYSICAL DATA.

15 Height (standing).....
16 Weight (ordinary clothing).....
17 Chest—Full inspiration..... Full expiration.....
18 Any evidence of chest deformity?.....
19 Pulse..... Respiration..... Temperature.....
20 Muscular development—Very strong..... Normal..... Very poor.....
21 Loss of weight— Yes..... No.....
22 Loss of strength—Yes..... No.....
23 Is workman a habitual nose breather?.....

CLINICAL DATA.

24 Chest—Palpation.....
Percussion.....
Auscultation.....
25 Night sweats— Yes..... No.....
26 Cough Yes..... No.....
27 Pain in chest— Yes..... No.....
28 Shortness of breath—Yes..... No.....
29 Expectorations— Yes..... No.....
30 X-ray examination—Positive..... Doubtful..... Negative.....
31 Preliminary clinical diagnosis.....

DIAGNOSIS.

32 Indicated present capacity for work—Good..... Fair..... Bad.....
33 Diagnosis of silicosis—Positive..... Doubtful..... Negative.....
34 Diagnosis of tuberculosis—Positive..... Doubtful..... Negative.....
35 Remarks.....

APPENDIX C.—INCIDENCE OF PULMONARY TUBERCULOSIS IN TRADES WITH EXPOSURE TO MINERAL DUST.[1]

The following summary has been derived from a large variety of official sources and is intended to facilitate the technical study of the dust aspects of the problem of respiratory diseases in trades with exposure to inorganic dust. The analysis includes (*a*) the occupation; (*b*) the composition of the dust; (*c*) the death rate from pulmonary tuberculosis per 100,000 exposed to risk; (*d*) the locality or country; and (*e*) the source of information.

The arrangement of the occupations is as nearly as possible according to the nature of the dust exposure, beginning with knappers and ganister workers and miners, continuing with sandstone workers and granite cutters, stonecutters generally, including marble workers, and concluding with slate and limestone workers and miscellaneous (but chiefly mining) employments.

[1] Prepared by Sylvester Schattschneider.

TABLE 1.—MORTALITY FROM PULMONARY TUBERCULOSIS IN SPECIFIED OCCUPATIONS WITH EXPOSURE TO METALLIC AND MINERAL DUSTS.

Occupation.	Composition of dust.	Year.	Death rate per 100,000.	Locality or country.	Source of information.
Flint knappers	Free silica, 100 per cent		4,100.0	Brandon, England	Milroy Lectures (1915), Industrial pneumoconiosis, with special reference to dust phthisis, by Prof. Edgar L. Collis (Oxon).
Ganister miners	Free silica, about 95 per cent	1894–1898	2,229.0	Don Valley-Stocksbridge	Journal of the Sanitary Institute, Vol. XXI, 1899, Part I, p. 66.
Ganister brickmakers	Free silica, about 98 per cent		3,700.0		The influence of dust inhalation on the incidence of phthisis, by Prof. Edgar L. Collis, The Lancet, Jan. 22, 1921, p. 179.
Tin miners	Tinstone, granite, and quartz. Free silica, about 75 per cent.		1,760.0	Cornwall	Report on the health of Cornish miners, by J. S. Haldane, M. D., F. R. S., Joseph S. Martin, and R. Arthur Thomas, London, 1904.
Gold miners	Gold-bearing quartz. Free silica, about 90 per cent.		1,270.0	Bendigo, Australia	Report of an investigation at Bendigo into the prevalence, nature, causes, and prevention of miner's phthisis, by Walton Summons, M. D., B. S., Melbourne, 1907.
Gritstone workers	Free silica, about 96 per cent	1901–1910	1,370.0	Bakewell registration district, Derbyshire.	Report on the prevalence of phthisis among quarry workers and miners, by Sidney Barwise, M. D., B. Sc., D. P. H., Derby, 1913.
Gritstone workers (some in limestone).		1901–1910	700.0	Derbyshire	Do.
Sandstone cutters		1905–1909	910.5	United States and Canada	Mortality experience of the Journeymen Stone Cutters' Association of North America.
Do		1910–1914	854.0	do	Do.
Do		[1] 1915–1918	1,029.9	do	Do.
Do		1910–1911	2,164.0	Wertheim, Germany	Die Steinindustrie im Grossherzogtum Baden, by Regierungsrat Dr. Föhlisch, Karlsruhe, 1913.
Sandstone masons	Free silica, up to 95 per cent		1,670.0	Grinshill	Annual report of the chief inspector of factories and workshops for the year 1912, p. 216, London, 1913.
Do	do		1,340.0	Derbyshire	Do.
Do		1880–1911	1,671.0	Clive and Grinshill	Minutes of evidence taken before the Royal Commission on Metalliferous Mines and Quarries, Vol. III, p. 72, London, 1914.
Do	Mostly quartz (silica)		1,370.0	Great Britain	Second report of the Royal Commission on Metalliferous Mines and Quarries, 1914.
Do			1,310.0	New South Wales	Interim report of Board of Trade, Sydney, 1918.
Sandstone workers		1880–1911	1,120.0	Clive and Grinshill	Minutes of evidence taken before the Royal Commission on Metalliferous Mines and Quarries, Vol. III, p. 70, London, 1914.
Sandstone quarrymen			990.0	New South Wales	Interim report of Board of Trade, Sydney, 1918.
Do		1880–1911	794.0	Clive and Grinshill	Minutes of evidence taken before the Royal Commission on Metalliferous Mines and Quarries, Vol. III, p. 72, London, 1914.

[1] Exclusive of the last three months of 1918.

TABLE 1.—MORTALITY FROM PULMONARY TUBERCULOSIS IN SPECIFIED OCCUPATIONS WITH EXPOSURE TO METALLIC AND MINERAL DUSTS—Concluded.

Occupation.	Composition of dust.	Year.	Death rate per 100,000.	Locality or country.	Source of information.
Rock choppers and sewer miners.	Sandstone (silica) and shale		740.0	New South Wales	Interim report of Board of Trade, Sydney, 1918.
Granite cutters	Feldspar, mica, and about 30 per cent quartz (silica).	1895–1899	432.0	New England States	Mortality experience of the Granite Cutters' International Association of America.
Do	do	1900–1904	453.7	do	Do.
Do	do	1905–1909	611.6	do	Do.
Do	do	1910–1914	802.2	do	Do.
Do	do	[1]1915–1918	1,056.7	do	Do.
Do	Free silica, about 30 per cent		620.0		Annual report of the chief inspector of factories and workshops for the year 1912, p. 216, London, 1913.
Granite cutters and masons	Feldspar, mica, and about 30 per cent quartz (silica).	1900–1909	570.0	Aberdeen	Report by the medical officer of health of the city of Aberdeen for the year 1909. Matthew Hay, M. D., L. L. D.
Stonecutters (inclusive of marble workers).		1879–1890	838.7	Switzerland	Ehe, Geburt und Tod in der schweizerischen Bevölkerung, 1879–1890, Part III, p. 103, Bern, 1903; 1889–1900, Part V, p. 283, Bern, 1916.
Do		1889–1900	833.2	do	Do.
Do		1908–1911	665.9	Holland	Archiv für Soziale Hygiene und Demographie, vol. 13, Nos. 1 and 2, pp. 43–97, Leipzig, 1919.
Do		1890	435.8	Registration area of United States.	Eleventh Census of the United States, 1890, Vol. VI, Vital Statistics, Part I, p. 143.
Do		1900	540.5	do	Twelfth Census of the United States, 1900, Vol. III, Vital Statistics, Part I, p. cclxxxv.
Stone, slate quarriers		1890–1892	362.5	England and Wales	Supplement to the fifty-fifth annual report of the registrar general of England and Wales, Part II, p. 137, London, 1897.
Do		1900–1902	230.0	do	Supplement to the sixty-fifth annual report of the registrar general of England and Wales, Part II, p. 143, London, 1908.
Slate quarriers	Chiefly silicate of aluminum		180.0	Merionethshire, Wales	Report of the departmental committee on Merionethshire slate mines, 1895.
Slate quarriers and mill workers	do	1900–1906	202.0	Festiniog, Wales; Oakeley quarries.	Minutes of evidence taken before the Royal Commission on Metalliferous Mines and Quarries, Vol. III, p. 114, London, 1914.
Do	do	1905–1911	280.0	do	Do.
Do	do	1900–1911	250.0	do	Do.
Limestone cutters	Calcium carbonate, with an inconsiderable amount of silica.	1905–1909	626.8	United States and Canada	Mortality experience of the Journeymen Stone Cutters' Association of North America.
Do	do	1910–1914	362.6	do	Do.
Do	do	[1]1915–1918	425.5	do	Do.
Limestone masons	Free silica, none, or less than 1 per cent.		200.0	Derbyshire	Annual report of the chief inspector of factories and workshops for the year 1912, p. 216, London, 1913.

Limestone quarriers and workers.	.....	1901–1910	171.0	.....do.....	Report to the Derbyshire County Council on the prevalence of phthisis among quarry workers and miners, by Sidney Barwise, M. D., B. Sc., D. P. H., Derby, 1913.
Limestone workers.....	.....	1901–1910	152.0	.....do.....	Do.
Limestone quarriers.....	.....	1900–1912	150.0	Isle of Portland, England...	Annual report of the chief inspector of factories and workshops for the year 1913, p. 149, London, 1914.
Limestone masons.....	.....	1900–1912	140.0	.....do.....	Do.
Lime and brick burners.....	.....	1879–1890	228.7	Switzerland.....	Ehe, Geburt und Tod in der schweizerischen Bevölkerung, 1879–1890, Part III, p. 103, Bern, 1903.
Do.....	.....	1889–1900	213.9	.....do.....	Ehe, Geburt und Tod in der schweizerischen Bevölkerung, 1889–1900, Part V, p. 283, Bern, 1916.
Gypsum, cement, and asphalt workers.	.....	1889–1900	191.5	.....do.....	Do.
Lead miners.....	Lead ore, limestone, chert, and quartz (silica).	1890–1892	534.9	England and Wales.....	Supplement to the fifty-fifth annual report of the registrar general of England and Wales Part II, London, 1897.
Do.....	.....do.....	1900–1902	392.8	.....do.....	Supplement to the sixty-fifth annual report of the registrar general of England and Wales, Part II, London, 1908.
Ironstone miners.....	Chiefly iron ore and limestone.....	1890–1892	140.3	.....do.....	Do.
Do.....	.....do.....	1900–1902	153.1	.....do.....	Do.
Coal miners.....	Carbon.....	1890–1892	132.4	.....do.....	Do.
Do.....	.....do.....	1900–1902	100.6	.....do.....	Do.
Do.....	.....do.....	1901–1910	68.0	Clay Cross, Derbyshire.....	Report on the prevalence of phthisis among quarry workers and miners, by Sidney Barwise, M. D., B. Sc., D. P. H., Derby, 1913.
Employees of ax factory, polishers and grinders.	.....	1900–1919	1,900.0	Connecticut ax factory.....	Dr. W. Herbert Drury, Yale School of Medicine. Industrial tuberculosis and the control of the factory-dust problem, by C. E. A. Winslow, D. P. H., and Leonard Greenburg, C. E.
Employees of ax factory (all)...	.....	1900–1919	650.0	.....do.....	The Journal of Industrial Hygiene, Vol. II, No. 9, 1921, p. 340.
Grinders (metal).....	Steel and quartz. Free silica, 50 to 100 per cent.	1910	1,480.0	Sheffield.....	Annual report on health of the city of Sheffield for the year 1910, p. 15. H. Sourfield, M. D.
Cutlers (metal).....	Steel, emery, etc. Free silica, none.	1910	580.0	.....do.....	Do.

[1] Exclusive of the last three months of 1918.

APPENDIX D.—MINERALOGY OF THE DUST PROBLEM.

To facilitate the technical consideration of some of the questions discussed, the following observations on the primary mineral composition of the "dark Barre" granite may prove useful. Reference may be made to Bulletin 132, on Siliceous Dust in Relation to Pulmonary Disease, published by the Bureau of Mines in 1917. Other important works which have been consulted are a Treatise on Rocks and Rock Minerals, by Pirsson, New York, 1910; Chamberlin and Salisbury's Geology, Vol. I, New York, 1909 (Chap. VII) and An Introduction to Geology, by Wm. B. Scott, New York, 1909 (Chap. A and Chap. X).

The following tabular analysis shows the specific characteristics of the feldspar (65.5 per cent), quartz (26.6 per cent), and mica (7.9 per cent) in the granite quarried in the Barre district, Vt.:

TABLE 1.—SPECIFIC CHARACTERISTICS OF THE STONE QUARRIED AND MANIPULATED IN THE BARRE DISTRICT, VT.

Mineral element.	Hardness.	Tenacity.	Fusibility.	Solubility.
Feldspar:				
Orthoclase (a potassium-aluminum silicate).	6–6.5	Brittle....	A fine splinter fuses before the blowpipe with difficulty.	Not acted upon by ordinary acids to an appreciable degree.
Oligoclase (a sodium-calcium-aluminum silicate).	6–7	Brittle....	Fuses at 3.5 to a clear or glasslike enamel.	Not materially acted upon by acids.
Quartz (silica).....	7	Brittle to tough.	Infusible before the blowpipe.	Insoluble in all acids except hydroflouric.
Mica:				
Biotite (a potassium-aluminum-magnesium-iron silicate).	2.5–3	Tough.....	Whitens before the blowpipe and fuses on the edges when in thin scales.	Completely decomposed by boiling sulphuric acid.
Muscovite (a potassium-aluminum silicate).	2–2.5	Tough....	Whitens before the blowpipe and fuses on thin edges to yellowish glass.	Insoluble in acids.

The technical terms used are explained as follows:

Hardness.—By the "hardness" of a mineral is understood the resistance which it offers to abrasion. The degree of hardness is determined by observing the ease or difficulty with which one mineral is scratched by another or by a file or knife.

In minerals there are all grades of hardness, from that of a substance impressible by the finger nail to that of a diamond. To give precision to the use of this character, the following scale of hardness, introduced by Mohs, has been generally adopted: 1, Talc; 2, gypsum; 3, calcite; 4, fluorite; 5, apatite; 6, feldspar (orthoclase); 7, quartz; 8, topaz; 9, sapphire; 10, diamond.

The point of a pocketknife blade is ordinarily tempered to a hardness of a little over 5, and common window glass is of a hardness of about 5.5.

Fusibility.—All grades of fusibility exist among minerals, from those which fuse in large fragments in the flame of the candle (stibnite) to those which fuse only on the thinnest edges in the hottest blowpipe flame (bronzite), and still again there are a considerable number which are entirely infusible (e. g., corundum).

The following scale of fusibility, proposed by von Kobell, is commonly in use: 1, Stibnite; 2, natrolite; 3, almandine garnet; 4, actinolite; 5, orthoclase; 6, bronzite.

A few additional references are the following: The Granites of Vermont, by T. Nelson Dale, U. S. Geological Survey, Bul. 404, Washington, 1909; Common Minerals and Rocks, by R. D. George, Colorado Geological Survey, Bul. 12, 1917; A Textbook of Mineralogy, by Edward Salisbury Dana, 17th ed., 1893; A System of Mineralogy, by James Dwight Dana, 15th ed., 1877; The Nonmetallic Minerals, by George P. Merrill, 2d ed., 1910; Manual of Mineralogy and Petrography, by James D. Dana, 7th ed., 1889.

APPENDIX E.—ANALYSIS OF GRANITE-STONE DUST. (BARRE, VERMONT, AND ABERDEEN, SCOTLAND.)

The Chemical Division of the Pittsburgh Experiment Station of the Bureau of Mines has completed a preliminary report on the rock-dust investigation undertaken at Barre, Vt. The report is by Dr. Herbert Insley of the Bureau of Mines, amplified by a paper on comparative tests of air dustiness by S. H. Katz and L. J. Trostel of the technical staff of the Pittsburgh Experiment Station, which has been printed in the Journal of the American Society of Heating and Ventilating Engineers, July, 1921. The analysis of the rock dust obtained at Barre was found to disclose the presence of only biotite, feldspar, and quartz in quantities sufficiently large to justify consideration as possible direct or contributory causes of dust phthisis. Following are extracts from Dr. Insley's report, of which a manuscript copy has been kindly placed at the disposal of the author by Mr. A. C. Fieldner, supervising chemist of the Pittsburgh Station:

Thin sections of Barre granite for petrographic study were made from chips collected in the coarse material from the vacuum ventilation system at one of the plants. These chips are probably fairly representative of the "dark" Barre granite, the type of rock on which the three plants were working exclusively at the time of the investigations.

The essential constituents of the "dark" Barre granite are potash feldspar (orthoclase and microcline), quartz, biotite, and limesoda feldspar (oligoclase-albite to oligoclase). Accessory minerals, magnetite, titanite, allanite, etc., are not common.

The orthoclase is more or less altered and sericitized and in places alteration has gone on to such an extent that very little of the primary orthoclase remains. Microcline, on the other hand, is usually fresh and unaltered. Quartz grains show the effects of strain by the marked undulatory extinction and the pronounced cracks present. Secondary quartz is present as a cavity filling. Biotite was evidently one of the first minerals to crystallize from the molten magma, for it is found inclosed in both quartz and feldspar. The biotite is usually fresh, although sometimes slightly altered to chlorite.

In order to determine the relative amounts of the essential minerals present in the granite, two methods were tried. The Rosiwal method on a thin section of the granite was first tried, using a low magnification (about 30 diameters). An average of 10 fields was taken, but the difference between individual analyses was so great, the greatest difference being about 39 per cent, that the method was discarded as being too inaccurate.

For the second method, a large number of the chips of the same material from which thin sections were made were crushed to pass through a 200-mesh screen. The crushed and screened material was thoroughly mixed, a small portion was placed on a microscope slide and immersed in a liquid of known index of refraction. The microscope was used with a photomicrographic camera, a plain glass plate to which tracing paper was attached being substituted for the ground glass plate. The lens system and camera length used gave a magnification of about 300 diameters. The image of the grains on the thin paper were traced and then cut out. The pieces of paper representing grains having an index of refraction higher than the liquid in which they were immersed were weighed separately from those having an index lower than the liquid and the relative percentage of the two calculated. The index of refraction of the liquid was 1.555. Another slide was prepared in which the grains were immersed in a liquid of index 1.545, and the same procedure of tracing and weighing was repeated. By observing the Becke line at the borders of the grains when immersed in the liquid with an index of 1.555, biotite could be distinguished from quartz and feldspar. When immersed in the liquid with index of 1.545, biotite and quartz could be distinguished from feldspar. Five analyses were made with each liquid, and the average of each set calculated. The results gave the volume percentages of biotite, quartz, and feldspar (orthoclase, microcline, and plagioclase). There was no attempt made to determine the relative quantities of the different kinds of feldspar present, but in all the analyses of the chips, as well as of the dust samples, the percentage of plagioclase was very much less than the percentage of orthoclase and microcline. The volume percentages obtained were recalculated to weight percentages by multiplying by the specific gravities of the minerals. The specific gravity of biotite was taken as 3, that of quartz as 2.65, and that of feldspar as 2.57. In no case were two analyses found which differed by more than 10 per cent.

The report by Dr. Insley continues as follows:

Seven samples of rock dust obtained from various localities in the stone-cutting plants at Barre, Vt., were examined with the polarizing microscope and the relative amounts of each constituent (biotite, quartz, and feldspar) determined approximately. For this purpose, the following simple method was used: The sample of dust was screened through a 200-mesh screen, the product obtained was thoroughly mixed, and a small amount was placed on a microscope slide and immersed in a liquid having an index of refraction of 1.555. The dust particles higher and lower than 1.555 were distinguished by the Becke line phenomenon and counted separately and the percentages of each calculated. Five fields were counted in this way and the average taken. The same procedure was followed, using a liquid with index of refraction of 1.545. The volume percentages thus obtained were recalculated on the basis of the specific gravities of the different constituents to give weight percentages. This method was used on a portion of the sample analyzed by the tracing-paper method. The results obtained by both methods were the same, although the counting method in most cases is probably much less accurate than the tracing cloth paper method. The counting method has the advantage of being much quicker and it probably has sufficient accuracy for the purposes of this investigation.

In the microscopic examinations of the dusts the term "very fine" is used to describe particles having diameters of less than 10 microns (a micron being 0.001 millimeter or about $\frac{1}{25000}$ of an inch).

Seven rock-dust samples are described in detail and illustrated by micro-photographs of exceptional descriptive value. Briefly, the results may be restated as follows:

Sample No. 77971 shows 70 per cent of feldspar, 19 per cent of quartz, and 11 per cent of biotite, etc. This sample reveals rather a small amount of very fine dust, while fragments of 25 microns or larger were usually rounded. Smaller particles, however, were found to have sharp, knife-like edges or sometimes needle-like slivers. This sample is considered by the Bureau of Mines to represent one of the least harmful samples of dust secured during the investigation.

Sample No. 77972 discloses 67 per cent of feldspar, 22 per cent of quartz, and 11 per cent of biotite, etc. Very fine particles were not common in this sample, while other particles were usually rounded, although sharp, knife-like particles were present. Particles of feldspar and mica were usually rounded; while a large flake of dark-colored biotite and a smaller, well-defined cleavage fragment of feldspar were visible in the micro-photographic figure. This sample also represents, in the judgment of the Bureau of Mines, one of the least harmful samples of dust secured through the investigation.

In sample No. 77973 the proportion of feldspar was 65 per cent, of quartz 21 per cent, and of biotite, etc., 14 per cent. In this sample a large amount of very fine dust was present and decidedly more so than in the two preceding samples. There were also a number of sharp, needle-like particles. This sample, according to the Bureau of Mines, represents one of the most harmful types of dust, corresponding to sample 77976, to be described later.

Sample No. 77974 contains 67 per cent of feldspar, 18 per cent of quartz, and 15 per cent of biotite, etc. The proportion of very fine dust in this sample was rather high, but, apparently, not so high as in sample 77973 and 77976. Fine needle-like particles were abundant in this sample.

Sample No. 77975, representing air-floated dust derived from a beam near the roof, contains 63 per cent of feldspar, 22 per cent of quartz, and 15 per cent of biotite, etc. The percentage of very fine dust was fairly high, while needle-like particles and particles with sharp angles were found very abundant, expecially in very fine material.

Sample No. 77976 contained 59 per cent of feldspar, 28 per cent of quartz, and 13 per cent of biotite, etc. This sample also contained a very high percentage of very fine dust, corresponding to sample 77973, while sharp needle-like particles were found fairly abundant.

Sample No. 77977 contained 68 per cent of feldspar, 20 per cent of quartz, and 12 per cent of biotite. It was also found to contain a fairly high percentage of very fine dust, while sharp needle-like particles were very abundant.

The conclusions concerning this preliminary investigation are summarized by Dr. Insley as follows:

Of the dust samples described in the preceding pages, those numbered 77973 and 77976 contain very large amounts of very fine dust. Sample No. 77973 was taken from a rafter. Dust that lodged there must have been fine enough to remain in suspension in the air for long periods of time and to be easily carried and lifted by air currents. The fineness of sample No. 77976 was probably due to the type of machine that created the dust.

It was thought before completing the mineral analyses that the fineness of the dust and the place from which the dust sample was taken, such as beams near the roof, might make considerable difference in the composition of the dust. However, the analyses as given show only small variations and these variations may be in part due to errors in analyses and sampling. Whatever difference in composition is due to air separation of the dust constituents is so slight that it has no effect on the harmfulness of the dusts.

Silicosis, or miner's phthisis, is caused by the abrasion of lung tissue by fine particles of hard, insoluble dust. The properties of rock dusts that make them injurious to lung tissue are not exactly known, but it is generally agreed that the harmfulness depends to a great extent upon the following properties: Hardness of the minerals of which the dust is composed, solubility of the minerals in the fluids of the lungs, shape and size of dust particles. Particles less than 10 microns in diameter and more than 1 micron in diameter are thought to be more harmful than other sizes. Sharp particles with jagged edges or thin sliverlike particles are probably more injurious than particles with blunt edges.

Of the minerals occurring in Barre granite, only biotite, feldspar, and quartz are present in large enough quantities to be considered as possible causes of miner's phthisis. Biotite is probably the least harmful of the three predominant mineral constituents, since its hardness on Moh's scale is only 2.5–3, and the particles of biotite observed in the dust samples usually had rounded edges. Feldspar is probably much more harmful than biotite, since its hardness is from 6 to 6.5, and small, sliverlike cleavage fragments are often present in the fine dusts. Quartz has a hardness of 7, and grains of this mineral seem to have a greater tendency to break up into particles with long, sharp edges than grains of biotite or feldspar. Quartz is probably the most injurious of any of the constituents of the Barre granite, but, because of the greater quantity of feldspar present, the latter mineral may play a greater part as a cause of miner's phthisis than quartz.

Particles of steel from the drills and cutting tools used in the stone-cutting plants have sometimes been considered the chief cause of miner's phthisis at Barre. Steel particles were not definitely identified in any of the dust samples from Barre. If present they must occur in such small quantities as to be negligible as a cause for miner's phthisis.

According to Dr. Insley, if the relative amount of very fine dust in a dust sample is an indication of the harmfulness of that dust, then the samples No. 77973 and No. 77976 should be the most harmful, while those numbered 77971 and 77972 should be the least harmful.

The results of this investigation should prove of far-reaching value to those concerned with problems of dust phthisis in the mineral and related industries. They are, as far as known, the first strictly scientific contribution to the study of the problem of dust phthisis in American industry. The results are amplified by a preliminary manuscript report on "Rock-Dust Samples from the Stone-Cutting Plants of Aberdeen, Scotland," kindly provided by Dr. Matthew Hay, the medical officer of health, in the furtherance of the present investigation. The report by Dr. Insley upon these samples is as follows:

The following report is based on the microscopic and petrographic examination of 10 samples of rock dust from the stone-cutting plants of Aberdeen, Scotland, submitted to the Bureau of Mines by Dr. Frederick L. Hoffman, of the Prudential Insurance Co., and obtained originally from Dr. Matthew Hay, the medical officer of health of the Public Health Department at Aberdeen.

For several samples the report is rather indecisive, due to the following causes: No hand samples of the rocks from which the dusts originated were submitted, and as the dusts were often quite fine certain minerals could not be definitely determined. Most of the minerals were determined solely on their approximate indices of refraction. No data as to the nature of the rocks from which the dusts originated accompanied the samples.

The mineralogical composition given for each sample is only approximate and may be in error by as much as 5 to 10 per cent. The following method was used to determine the mineralogical composition. A portion of the sample was screened through a 200-mesh screen, with screen openings of 0.074 millimeters, and the material thus obtained was examined under the petrographic microscope after being immersed in a liquid of known index of refraction. By the Becke line effect, mineral particles of higher refraction than the liquid could be distinguished from those of lower refraction than the liquid. The grains of each mineral present were counted and the percentage composition was based on this count. Where more than two minerals were present in quantities greater than 5 per cent, another analysis was made, using a liquid of different index of refraction. Thus, if quartz, orthoclase, and biotite were present, a liquid with a refractive index of 1.555 was used to distinguish the biotite from the quartz and orthoclase, and a liquid with index of 1.535 to distinguish the orthoclase from the quartz and biotite. Error may be present due to the fact that one mineral may crush finer than another. In every analysis three fields were counted and the average taken.

Considered in the order of their numerical arrangement, these samples show the following results:

Sample No. 1, marked "Emerald Pearl-Norway," shows 67 per cent of feldspar, 15 per cent of biotite, 13 per cent of quartz, and 5 per cent of opaque minerals. Opaque minerals were not determined. The particles were found generally large with very few under 10 microns, while few sharp particles were noted.

Sample No. 2, marked "Bonnacord Black-Sweden," shows 62 per cent of feldspar, 33 per cent of olivine (?), and 5 per cent of biotite. The particles were large, few were smaller than 10 microns, and there were only a few particles with sharp edges.

Sample No. 3, marked "Sclattie-Aberdeenshire," contained 53 per cent of feldspar, 27 per cent of quartz, 15 per cent of biotite, and 5 per cent of opaque minerals. This sample contained a large percentage of very fine material, or of less than 10 microns in diameter while also containing a large number of fine slivers and particles with sharp edges.

Sample No. 4, marked "Rubislaw-Aberdeenshire," contained 65 per cent of feldspar, 23 per cent of quartz, and 12 per cent of biotite. The fineness and shape of the particles in this sample were about the same as in sample No. 3.

Sample No. 5, marked "Peterhead-Aberdeen," contained 80 per cent of feldspar, 10 per cent of quartz, 5 per cent of hornblende (?) and 5 per cent of opaque minerals. A large number of very fine particles were present in this sample and sharp knife-like particles were numerous.

Sample No. 6, marked "Balmoral Red-Sweden," contained 77 per cent of feldspar, 12 per cent of biotite, and 11 per cent of quartz. Sharp knife-like particles and thin slivers were fairly abundant.

Sample No. 7, marked "Glencoe-Finland," contained 51 per cent of feldspar, 35 per cent of quartz, and 14 per cent of biotite. This sample contained a large number of very fine particles, many of which had sharp edges.

Sample No. 8, marked "Green-Sweden," contained 75 per cent of feldspar and 25 per cent of augite (?) and biotite. In this sample a very large number of fine particles were present.

Sample No. 9, marked "Kemnay-Aberdeenshire," contained 69 per cent of feldspar, 20 per cent of quartz, 6 per cent of biotite, and 5 per cent of opaque. Very fine particles and particles with sharp edges were not abundant.

Sample No. 10, marked "Rubislaw-Aberdeen," contained 63 per cent of feldspar, 29 per cent of quartz, and 8 per cent of biotite. A rather large quantity of very fine dust was present, with an abundance of sharp sliverlike particles.

As intimated in the report, the Aberdeen samples were probably not sufficient for strictly comparable conclusions with the data derived from the Barre granite-cutting shops, but they afford for the first time a thoroughly trustworthy basis of comparison between the underlying factors responsible for phthisis in the granite-cutting industry of Aberdeen and the corresponding labor conditions in the granite-cutting industry of the Barre district. Both series of samples justify the suggestion that further research in this direction through the Bureau of Mines would, unquestionably, yield results of far-reaching importance to medical science and industrial betterment.

APPENDIX F.—STONE WORKERS' MORTALITY, ABERDEEN, SCOTLAND.

Since this paper was prepared the following material bearing upon the health conditions in the stone industry of Aberdeen has been received from Dr. Matthew Hay, medical officer of health, with the information brought down to the end of the year 1920. The letter transmitting the tabular data states in part as follows:

I am afraid that, although the information now sent is as reliable as we can make it from the material available, it may not be very satisfactory for the purposes of comparison between the last 10 years and the preceding 10 years, due chiefly to the war having covered part of the later period. The war carried into its service men from all kinds of occupations, including stonecutters and masons. The number of stonecutters and masons in employment during the years of the war was only about a half to two-thirds what it was during the five years before the war. Thus the number of stonecutters and masons at work in 1910 was about 1,590 and remained much the same until 1914. In 1915 it fell to about 1,070 and went on decreasing until 1918, when the number was about 510. Since 1918 it has been gradually increasing, but is still considerably short of the numbers before the war.

It will be seen from the table now sent you that there was an absolute increase of deaths from phthisis during the years 1914 to 1917, inclusive. In four of the years dealt with in Table 1 we know of one or two of the men who died from phthisis having been in the army, and whose death may, therefore, have been due to the severities of army service; but it is difficult to get full information regarding this point, as we have dealt only with those who died in Aberdeen or in Scotland, and whose deaths were transferred to us by the registrar general. Deaths abroad or in England were not included, and were not reported to us, and accordingly we have no means of knowing of them.

You will observe that the death rate from phthisis in the five years preceding the war, including the year 1914, toward the end of which the war began, was 5.4, as against 5.7 for the preceding 10 years. In the five years following 1914 the death rate averaged 13.7.

I need not say that it would be altogether wrong to attribute this higher death rate recently to any change in the conditions of occupation among stonecutters in the city. These conditions have remained practically unaltered from what they were during the years immediately preceding the war.

I send you also a table giving the total number of deaths from tuberculosis and certain other diseases for the different occupations dealt with in my report of 1910, the figures now given being for the whole period 1910–1919. The corresponding figures for the period 1900–1909 are also given, having been extracted from the special report of 1910.

It will be noted that the percentage of deaths from pulmonary tuberculosis in deaths from all causes has, during the later decennium, declined slightly, as compared with the earlier decennium, but the decline is not so great as in certain other trades in which the tuberculosis death rate was found in the early decennium to be high—notably printers and clerks.

It may also interest you to have the inclosed table (Table 3) giving the average age at death of stonecutters and masons for each of the years from 1910 to 1919, in order to show whether the age rose during the war, owing to the absence of the younger men on military and naval service. The effect was not very pronounced, as you will see, in respect of phthisis. It is more obvious in regard to deaths from circulatory and nervous diseases.

I inclose, further, a table (Table 5) giving you the death rate from pulmonary tuberculosis among males and among females in the whole city during 11 years 1910–

1920. It is interesting to observe how the death rate rose much more among women than among men. I think this must have been due mainly to anxieties of the war in those who remained at home. I am inclined to think that, although there was restriction in the supply of certain articles of food, it was rather in respect of the less essential articles, and we had no evidence in the city of anything approaching to starvation. Food, of course, became dearer as the war went on, but wages also rose correspondingly. The allowances to the wives and children of the men who went to the war were, in the later part of the war at least, fairly substantial.

You asked for samples of granite dust in your letter. I am sending you under separate cover samples of dust from 10 different kinds of granite as used in Aberdeen for the making of monuments. Five of the samples are of foreign granites, which are used to a considerable extent in Aberdeen for monuments. The others are from Aberdeenshire. They were all obtained from the monumental granite yards and represent the dust as collected in the sheds while the men were carrying on their work.

The results of this investigation are a notable contribution to the scientific study of the problem of dust phthisis in the stone industry. The tables emphasize the statistical methods most likely to yield reasonably trustworthy results, and further improvements in statistical technique would unquestionably be advisable. Until factory inspection departments secure the necessary powers to install health registers for all employees in dangerous trades, amplified by powers to make preliminary physical examinations of applicants for work and periodical physical examinations subsequent to commencement of work, such data as the preceding must needs serve as a tentative basis for conclusions which affect the present and future welfare of a considerable portion of men employed in gainful occupations wherever industries are carried on.

TABLE 1.—NUMBER OF DEATHS AND DEATH RATES OF STONECUTTERS AND MASONS IN ABERDEEN, SCOTLAND, FROM PULMONARY TUBERCULOSIS AND OTHER CAUSES, 1910–1919.

Year.	Number of deaths.				Deaths per 1,000 persons employed.			
	Pulmonary tuberculosis.	Lung diseases, excluding pulmonary tuberculosis.	Circulatory and nervous diseases.	All causes.	Pulmonary tuberculosis.	Lung diseases, excluding pulmonary tuberculosis.	Circulatory and nervous diseases.	All causes.
1910	9	4	8	29	5.7	2.5	5.0	18.3
1911	7	3	13	36	4.8	2.1	9.0	24.8
1912	5	3	8	29	3.5	2.1	5.6	20.2
1913	9	4	13	34	6.3	2.8	9.1	23.8
1914	10	6	10	33	6.4	3.8	6.4	21.1
1915	12	4	18	42	11.2	3.7	16.8	39.3
1916	[1] 11	3	7	30	13.5	3.7	8.6	36.7
1917	[1] 14	3	11	38	22.7	4.8	17.8	61.6
1918	[2] 8	6	12	36	15.8	11.8	23.7	71.0
1919	[1] 9	4	6	23	9.6	4.3	6.4	24.4
Total	94	40	106	330	8.2	3.5	9.3	28.9
1910–1914	.....	.....	.....	.....	5.4	.....	.....	.....
1915–1919	.....	.....	.....	.....	13.7	.....	.....	.....
1920	4	3	7	25	4.0	2.9	6.9	24.6

[1] Including 1 known to be in Army, similar inquiry not made regarding deaths from other causes.
[2] Including 2 known to be in Army, similar inquiry not made regarding deaths from other causes.

TABLE 2.—NUMBER OF DEATHS OF WORKERS IN ABERDEEN, SCOTLAND, AND PROPORTION DYING FROM PULMONARY TUBERCULOSIS, 1900–1909 AND 1910–1919, BY OCCUPATIONS.

Occupation.	1900–1909			1910–1919					
	Number of deaths.		Per cent of deaths from pulmonary tuberculosis.	Total number of deaths.					Per cent of deaths from pulmonary tuberculosis.
	All causes.	Pulmonary tuberculosis.		Pulmonary tuberculosis.	Lung diseases, excluding pulmonary tuberculosis.	Circulatory and nervous diseases.	Other diseases.	All causes.	
Males.									
Stonecutters and masons	316	99	31	94	40	106	90	330	28
Stone polishers and sawyers	76	11	14	9	15	21	30	75	12
Joiners, shipwrights, etc	295	26	9	19	29	108	131	287	7
Painters	87	9	10	4	6	27	38	75	5
Tailors	164	20	12	14	11	42	50	117	12
Bakers	74	5	7	5	13	37	28	83	6
Engineers, blacksmiths, etc	367	47	13	36	80	222	261	599	6
Printers and lithographers	52	17	33	8	3	16	22	49	16
Comb makers	78	15	19	10	15	33	37	95	11
Carters	177	16	9	16	32	71	96	215	7
Laborers	935	81	9	118	179	415	486	1,198	10
Clerks	178	46	26	41	13	74	74	202	20
Females.									
Dressmakers and milliners	164	34	21	28	18	47	69	162	17
Domestic servants	738	74	10	63	93	283	391	830	8

TABLE 3.—AVERAGE AGE AT DEATH OF STONECUTTERS AND MASONS OF ABERDEEN, SCOTLAND, BY YEARS, 1910 TO 1919.

Year.	Phthisis.	Lung diseases, excluding phthisis.	Circulatory and nervous diseases.	Other causes.	All causes.
1910	43	59	52	55	51
1911	52	59	57	59	57
1912	44	59	62	61	58
1913	45	60	61	56	56
1914	48	59	66	52	56
1915	47	58	66	56	58
1916	47	54	63	54	53
1917	52	59	66	56	58
1918	46	65	60	62	58
1919	50	71	67	42	57
Average (years)	48	61	62	57	56

TABLE 4.—AVERAGE AGE AT DEATH OF WORKERS IN ABERDEEN, SCOTLAND, DYING FROM PULMONARY TUBERCULOSIS AND ALL CAUSES, 1900–1909 AND 1910–1919, BY OCCUPATIONS.

Occupation.	Average age at death of workers dying in—						
	1900–1909		1910–1919				
	All causes.	Pulmonary tuberculosis.	Pulmonary tuberculosis.	Lung diseases, excluding pulmonary tuberculosis.	Circulatory and nervous diseases.	Other diseases.	All causes.
Males.							
Stonecutters and masons	51	43	48	61	62	57	56
Stone polishers and sawyers	54	43	48	53	64	63	61
Joiners, shipwrights, etc	60	36	39	68	66	64	64
Painters	51	30	36	63	60	54	56
Tailors	59	41	41	53	62	65	60
Bakers	56	39	37	62	62	60	60
Engineers, blacksmiths, etc	55	38	45	57	61	56	57
Printers and lithographers	48	33	34	53	55	54	51
Comb makers	57	47	47	57	61	58	58
Carters	54	38	48	54	61	53	55
Laborers	59	41	42	59	62	60	58
Clerks	47	30	32	51	57	60	53
Females.							
Dressmakers and milliners	52	29	34	75	60	55	55
Domestic servants	62	34	39	66	65	63	62

TABLE 5.—DEATH RATES FROM PULMONARY TUBERCULOSIS IN ABERDEEN, SCOTLAND, BY YEARS, 1910 TO 1920.

Year.	Deaths per 100,000 of population.			Year.	Deaths per 100,000 of population.		
	Males.	Females.	Both sexes.		Males.	Females.	Both sexes.
1910	112	110	111	1916	108	117	113
1911	137	98	116	1917	129	100	113
1912	104	87	95	1918	103	110	107
1913	126	87	105	1919	91	79	84
1914	124	87	104	1920	75	112	95
1915	133	132	133				

APPENDIX G.—REPORT OF MEDICAL INVESTIGATION OF GRANITE CUTTERS OF BARRE, VERMONT.

COMMITTEE ON THE MORTALITY FROM TUBERCULOSIS IN DUSTY TRADES.

REPORT OF THE CHAIRMAN OF THE MEDICAL INVESTIGATION OF THE GRANITE CUTTERS OF BARRE, VERMONT.

To the Executive Committee of the National Tuberculosis Association.

GENTLEMEN: The following summary report presents the conclusions reached from the medical examination made during the past 13 months of approximately 475 men employed in the granite industry at the city of Barre, Vt.

It forms a continuation of and a supplement to the statistical investigation reported to the executive committee by Dr. Frederick L. Hoffman, chairman of the special committee on dusty trades, in April, 1920.

As indicated in the report of Dr. Hoffman, the difficulties of carrying out an adequate physical and X-ray examination of the men at the city of Barre were considerable. But for the enthusiastic and generous help from one of the local physicians in Barre, Dr. D. C. Jarvis, who was able to carry out the X-ray examinations with his own equipment and technicians, the expense would have been very great. In order to make it possible he was obliged to add some apparatus at his own expense, besides giving fully of his time and means to perfecting the technique of chest examinations for stereoscopic view. It is fair to state that without his aid the investigation would not have been possible or the quality of the X-ray negatives of such excellence.

The physical examinations were made for the most part by Dr. John H. Woodruff and Dr. Roscoe E. Avery, local physicians, who also gave their services gratuitiously and who were most intelligent and efficient in their work. A series of clinics was arranged to accommodate the men after working hours and on Sundays. The services of Dr. Edward J. Rogers, medical director of the Vermont State Sanatorium, and of Dr. Henry A. Ladd, State tuberculosis consultant, were also secured for several of the clinics; also of Dr. P. Challis Bartlett, chief medical examiner of the Framingham Demonstration, who held two sessions, and of Dr. Morgan, of the Metropolitan Sanatorium at Mount McGregor, N. Y. To all of these gentlemen, as well as to the office staff of Dr. Jarvis, I desire to make due acknowledgment of our cordial appreciation. During all of the clinics at which the visiting consultants were present, two of which were held by your chairman, the more obscure cases, in which the diagnosis of tuberculosis was difficult, were examined.

The ready and helpful cooperation of the secretary of the Vermont State Board of Health, Dr. Charles F. Dalton, and the Vermont Tuberculosis Association was also obtained.

The Barre Granite Cutters' Association gladly cooperated and contributed an assessment toward the expenses, as stated in a previous report by Dr. Hoffman.

The Granite Manufacturers' Association was favorably disposed toward the investigation when its object was fully understood, and undoubtedly would have contributed collectively toward the expense but for a prolonged strike which was inaugurated simultaneously with the start of the physical examination clinics. This untoward incident seriously hampered the survey, though at first many men were willing to undergo examination because they were idle. Later, as the strike continued, more than 500 left the city, many of whom have not returned since the resumption of the work in the fall of 1920.

The number originally recorded in the inquiry conducted by Mr. Sylvester Schattschneider was 1,085. Of this number 235 were also subjected to a physical and X-ray examination. The remainder, comprising nearly half of those examined, had not been reached in the preliminary survey. The number who were usually regarded as migratory ranged from 8 to 10 per cent. Twelve have died during the investiga-

tion. Thus a statement of the physical findings can be made concerning only one-fourth of the original number surveyed.

Nevertheless, it is a satisfaction to report upon a sufficiently large number to reveal the serious effects on men who had undergone long exposure to granite dust. It must be borne in mind that it was natural to expect the men who were suffering from ill health to seek examination. The figures, therefore, can not be taken literally to apply to the total number of men employed, when percentages are considered; they apply only to the men who were examined. It was indeed found difficult to induce as many as were desired of the men in apparent health to undergo the examinations. Nevertheless ultimately, through the persistent efforts of the Granite Cutters' Association, many such were examined.

The primary object in each case was the discovery of tuberculosis, whether or not complicated by silicosis.[1] The history of all illnesses was taken, family or household exposure to tuberculosis, and period of employment as a stone cutter. Much other data was collected, which can not be considered in a brief report. In a large number the examination included the nose and throat as well as the chest. Stereoscopic films were made in most cases and by a uniform technique, made possible by the use of modern methods. The faulty negatives were due in the main to inability of the men to understand the directions and to nervousness.

In the reading of films I have had the helpful assistance and criticisms of the Trudeau Sanatorium staff, especially of Mr. Homer L. Sampson, the resident roentgeneologist, who studied the entire collection. The X-ray findings were recorded without referring to the history notes, and hence are unbiased by knowledge of the physical examination or sputum findings.

After all the data had been entered on the history blanks (see p. 158) they were submitted to Miss Jessamine S. Whitney, statistician of the National Tuberculosis Association, who has been most helpful in arranging the accompanying tables and in suggesting the best use of the material.

A total of 427 men have been examined by both X-ray and physical methods. Records of the physical examinations were omitted on the history charts in 31 cases. There were in addition 48 examinations by the X-ray not included in the tables, as the histories were imperfect or wanting. In 69 cases (16 per cent) the X-ray films were imperfect or blurred.

It was soon discovered that remarkably extensive silicosis might exist with little or no impairment of health and no manifest physical signs. On the other hand, after a tabulation of those cases found to be tuberculous by a sputum examination, there were physical signs recorded in 19 out of 26 (see Table 1). Likewise, in the men who showed a definitely tuberculous shadow by X-ray examination, 14 out of 31 revealed chest signs. Among those exhibiting in the X-ray films silicosis alone, without suspicion of a complicating tuberculosis, only 14 per cent had any physical signs. There were 56 in whom tuberculosis was suspected by X-ray examination, in 27 of whom physical signs were recorded.

In the suspected class there were a number of X-ray films in which tuberculosis and silicosis were indistinguishable. The latter obtained chiefly in advanced silicosis with much density in the chest films. The material has been studied and tabulated according to the usual three stages of tuberculosis as adopted by the National Tuberculosis Association, or the Turban standard, but only on the basis of the radiographic appearances. Likewise, three stages of silicosis were recorded in conformity with the standards used in the studies of the South African Miners' Phthisis Prevention Committee[2] and those of Lanza and Childs in their study of the zinc miners of Missouri.[3]

[1] This term is used because silica has been found to be the principal ingredient of granite, as of other forms of quartz stone.

[2] General Report of the Miners' Phthisis Prevention Committee, Pretoria, 1916.

[3] Miners' Consumption, etc., by A. J. Lanza and S. B. Childs, U. S. Public Health Bulletin No. 85, January, 1917.

The South African committee was able to correlate the radiographic appearances with the pathological findings in silicosis with and without complicating tuberculosis in 26 fatal cases. The opportunity for post-mortem examinations in Barre were not frequent, and but one was secured during the investigation and this one a tuberculous silicotic case from an outside institution not included in the tables. The general impression obtained of the relatively small number examined in our study completely supports the inestimable importance of a technically good radiogram, especially a stereogram, in detecting silicosis in its early and late stages. It is also capable of differentiating by skilled interpretation between simple silicosis and a complicating tuberculosis. To quote the last report [4] of the Miners' Phthisis Board:

"It is the unanimous opinion of the bureau that a technically satisfactory radiogram is of paramount importance in assisting in the formation of a just decision as to the presence or absence of silicosis. It is also of the greatest utility in the diagnosis of all but the very earliest cases of tuberculosis. Our experience has, however, confirmed the suspicion that unless the X-ray negative reaches a well-defined standard of technical excellence its interpretation may be erroneous."

I have quoted this paragraph because of its practical importance in the valuation of our observations.

In the present report the details concerning the effect of granite dust inhalation and the method of determining silicosis and its complications must be omitted. The description given by Childs from the examination of 100 radiograms of the zinc miners, and the South African reports above mentioned, are very complete and can be referred to if desired. A later report dealing with the medical data will be submitted when the histories have been completed. A proposition to make successive radiograms of the men already reported upon is being considered by the Barre representatives as a logical outcome of the investigation.

Analysis of results as tabulated.—It is only necessary to glance at the tables to discover, not only an extensive amount of silicosis, but also a very considerable number complicated with tuberculosis. Besides, there are an equal number of suspected tuberculosis cases, making altogether one-fourth of the men examined. It must be remembered that, except for the open tuberculosis cases with the presence of bacilli in the sputum, who were in most instances incapacitated, the majority were at strenuous work and no prediction is at present justified as to the ultimate results to them of the dormant tuberculosis infection. It is significant that physical signs were found in one-half of those suspected of tuberculosis, and they comprised most of those classed in the third stage of silicosis. On the other hand, the physical signs were seldom so clear as to be alone conclusive in the diagnosis of tuberculosis. Sputum examinations were sought for in all cases, but it was a difficult matter to obtain specimens. When present it was most often mucoid except in a few late stage cases of tuberculosis.

Table 1 shows the result of the interpretation of the radiograms.

Table 2 gives the average time of exposure to dust.

Table 3 summarizes the symptoms. It exhibits the inadequacy of histories taken of men who consider themselves well. But few admitted any symptoms except when suffering from advanced silicosis with or without tuberculosis.

Table 4 relates the time of exposure to dust and the stages of silicosis. Note should be made of the fact that prolonged exposure is not necessarily followed by silicosis or tuberculosis.

Table 5 sets forth the relation of race to stages of silicosis. It was noted early in the radiograms that Italians commonly escaped the severe forms of silicosis, the percentage of third-stage cases being one-half that of other races. No explanation is at present obvious, though it was noted that the Italians have come more recently to the

[4] Annual Report of the Miners' Phthisis Board, etc., Capetown, 1920, p. 35.

Barre district than the Scotch, for example, and many had been engaged in marble cutting elsewhere.

Conclusions.—While the histories and examinations were incomplete and to some extent imperfect, the stereoradiograms of 475 granite cutters of the city of Barre, Vt., were of unquestionable value.

The disclosure of high percentages both of silicosis and tuberculosis in the men examined concerns these men alone. Nevertheless it must be admitted that similar results must be expected for a certain proportion of men engaged for 10 or more years in this trade.

The preliminary statistical inquiry covering the mortality from tuberculosis in the granite industry of Barre, Vt., revealed an increasing rate, according to the report submitted by the chairman, Dr. F. L. Hoffman.

The medical and X-ray examination has furnished confirmation of the correctness of the diagnoses, for the most part, of tuberculosis complicating advanced silicosis when such has been made on death certificates in the absence of a positive sputum.[5]

Whether the high incidence of tuberculosis has any close relation to family infection in this group was not clearly brought out from the histories. Healed and calcified tubercles were noted in 10.8 per cent of the X-ray films, exclusive of those adjudged tuberculous because of more extensive lesions or actual clinical disease.

The fact that tuberculosis apparently supervenes on an extensive silicosis, usually after 10 to 15 years' exposure, suggests the marked predisposing influence of granite dust (as of all quartz dust), whether from recent or old infection.

Finally, it is gratifying to report that this investigation has stimulated experimentation with dust-removing devices especially adapted to the pneumatic cutting process. Through the efforts of Dr. D. C. Jarvis, with the assistance of one of the manufacturers in Barre, a large measure of success has already been attained in the perfection of a practical aspirator. Coincident with the general adoption of dust removers it is to be hoped and recommended that wherever granite cutting is carried on facilities should be provided for careful physical examinations and periodical radiograms of the chest by a skilled and uniform technique.

(Signed) EDWARD R. BALDWIN, M. D.

SARANAC LAKE, N. Y., *June 11, 1921.*

TABLE 1.—RESULTS OF X-RAY AND PHYSICAL EXAMINATIONS OF 427 MEN EMPLOYED IN THE GRANITE INDUSTRY IN BARRE, VT.

Classification of cases.	Total.	Confirmed by physical signs.	Confirmed by symptoms.	Tuberculosis (Turban standard).			Silicosis.				
				Stage I.	Stage II.	Stage III.	Stage I.	Stage II.	Stage III.	Suspected.	None.
All cases	427	97	113	34	28	7	198	75	44	82	28
Clinical tuberculosis (tubercle bacilli in sputum)	26	[a] 19	26	3	16	7	3	6	13	4	.....
Tuberculosis, definite, by X-ray interpretation	31	[b] 14	14	11	3	.....	11	11	7	1	1
Tuberculosis, suspected, by X-ray interpretation	56	[c] 27	23	18	9	.....	25	11	18	2	.....
Tuberculosis, infection (healed calcified tubercles)	35	[d] 2	7	2	.....	.....	21	8	1	5	.....
Silicosis, uncomplicated	157	[e] 21	41	.....	.....	.....	119	33	5	.....	.....
Silicosis, suspected, uncomplicated	26	[b] 2	2	.....	.....	.....	.....	.....	.....	26	.....
Unsatisfactory films	69	[b] 11	.....	.....	.....	.....	19	6	.....	44	.....
Normal chests	27	[b] 1	.....	.....	.....	.....	.....	.....	.....	.....	27

[a] No record, 1. [b] No record, 2. [c] No record, 8. [d] No record, 1. [e] No record, 13.

[5] From the Vermont State Board of Health it was ascertained that in 75.4 per cent of the deaths of such cutters reported from Barre as tuberculous at death the sputum was positive on the State Laboratory records.

TABLE 2.—AVERAGE TIME OF EXPOSURE TO GRANITE DUST OF 427 MEN EMPLOYED IN THE GRANITE INDUSTRY IN BARRE, VT., WHO WERE GIVEN X-RAY AND PHYSICAL EXAMINATIONS.

Classification of cases.	Total cases.	Average time of exposure to dust (in years).					
		Confirmed by symptoms.	Silicosis.				
			Stage I.	Stage II.	Stage III.	Suspected.	None.
All cases	427	23.7	19.2	25.5	29.7	18.3	16.1
Clinical tuberculosis (tubercle bacilli in sputum)	26	25.3	10.0	21.6	29.5	38.0	.....
Tuberculosis, definite, by X-ray interpretation	31	28.0	27.8	30.4	28.4	(1)	[2] 14.0
Tuberculosis, suspected, by X-ray interpretation	56	24.2	20.9	28.7	29.7	23.0	.....
Silicosis, uncomplicated (but including those showing healed calcified tubercles)	218	21.6	18.5	22.9	30.0	15.6	.....
Unsatisfactory films	69	.....	18.1	33.3	.....	19.5	.....
Normal chests	27	.....	.....	.....	.....	.....	16.2

[1] Unknown (1 case). [2] 1 case.

TABLE 3.—NUMBER OF BARRE, VT., GRANITE CUTTERS EXAMINED WHO HAD SPECIFIED SYMPTOMS, BY STAGE OF SILICOSIS.

Symptom.	Silicosis.					Total.	Per cent.
	Suspected.	Stage I.	Stage II.	Stage III.	None.		
All cases	82	198	75	44	28	427	100.0
Cough	3	18	11	14	.....	46	10.8
Expectoration	5	33	18	15	1	72	16.8
Shortness of breath	6	19	15	19	2	61	14.3
Loss of strength	1	4	10	11	2	28	6.5
Hemoptysis	.....	.....	2	2	1	5	1.2
Loss of appetite	1	5	1	5	.....	12	2.8

TABLE 4.—TIME OF EXPOSURE TO GRANITE DUST OF 427 BARRE, VT., GRANITE CUTTERS AS RELATED TO STAGE OF SILICOSIS.

Time of exposure to granite dust.	Silicosis.										Total.	
	Suspected.		Stage I.		Stage II.		Stage III.		None.		No.	Per cent.
	No.	Per cent.	No.	Per cent.	No.	Per cent.	No.	Per cent.	No.	Per cent.		
All cases	82	19.2	198	46.4	75	17.6	44	10.3	28	6.5	427	100.0
Under 1 year	3	60.0	2	40.0	.....	.....	.....	.....	.....	.....	5	1.2
1 year and under 2 years	.....	.....	1	100.0	.....	.....	.....	.....	.....	.....	1	.2
2 to 4 years	3	33.3	3	33.3	3	33.3	.....	.....	.....	.....	9	2.2
5 to 9 years	13	31.0	19	45.2	3	7.1	.....	.....	7	16.7	42	9.8
10 to 14 years	14	22.6	36	58.1	6	9.7	1	1.6	5	8.1	62	14.5
15 to 19 years	9	13.0	43	62.3	9	13.0	3	4.3	5	7.2	69	16.2
20 to 24 years	14	19.7	32	45.1	14	19.8	6	8.5	5	7.0	71	16.6
25 to 29 years	8	13.3	27	45.0	14	23.3	8	13.3	3	5.0	60	14.1
30 to 40 years	9	12.2	25	33.8	18	24.3	20	27.0	2	2.7	74	17.3
Over 40 years	4	25.0	1	12.5	6	37.5	4	25.0	.....	.....	16	3.7
Unknown	5	27.8	8	44.4	2	11.1	2	11.1	1	5.5	18	4.2

TABLE 5.—RELATION OF RACE TO SPECIFIED STAGES OF SILICOSIS AS SHOWN BY X-RAY AND PHYSICAL EXAMINATION OF 427 BARRE, VT., GRANITE CUTTERS, CLASSIFIED BY AGE.

Nationality and stage of silicosis.	Age (years).												Total.	
	Under 20.	20 to 24.	25 to 29.	30 to 34.	35 to 39.	40 to 44.	45 to 49.	50 to 54.	55 to 59.	60 to 64.	65 to 69.	70 and over.	Unknown.	No.	Per cent.
All cases	4	17	44	77	71	75	60	42	20	3	2	1	11	427	100.0
Italian	1	11	17	36	41	35	22	14	5	....	1	.....	2	186	43.6
Suspected	....	5	8	6	8	3	4	5	1	....	1	.....	2	43	23.1
Stage I	....	4	7	22	21	19	7	6	....	....	....	.....	.....	86	46.2
Stage II	1	1	1	5	6	6	8	2	2	....	....	.....	.....	32	17.2
Stage III	....	....	....	1	....	5	3	1	2	....	....	.....	.....	12	6.5
None	....	1	1	2	6	3	....	....	....	....	....	.....	.....	13	7.0
Scotch	1	....	4	17	15	19	13	10	7	1	1	.....	2	90	21.1
Suspected	1	....	1	2	4	1	2	2	....	....	....	.....	.....	13	14.4
Stage I	....	....	2	12	10	12	3	4	....	....	....	.....	1	44	48.9
Stage II	....	....	....	2	1	3	6	1	3	1	1	.....	.....	18	20.0
Stage III	....	....	....	....	....	2	2	3	4	....	....	.....	.....	11	12.2
None	....	....	1	1	....	1	....	....	....	....	....	.....	1	4	4.4
American	1	3	2	5	1	3	7	3	....	1	....	.....	.....	26	6.1
Suspected	....	2	....	....	1	....	1	....	....	....	....	.....	.....	4	15.4
Stage I	1	1	2	4	....	1	2	....	....	....	....	.....	.....	11	42.2
Stage II	....	....	....	....	....	1	1	1	....	....	....	.....	.....	3	11.5
Stage III	....	....	....	....	....	1	3	2	....	1	....	.....	.....	7	26.9
None	....	....	....	1	....	....	....	....	....	....	....	.....	.....	1	3.8
Other nationalities	....	3	19	17	13	14	13	10	4	1	....	.....	1	95	22.2
Suspected	....	2	1	4	3	2	4	....	....	....	....	.....	.....	16	16.8
Stage I	....	1	10	9	9	8	3	4	2	1	....	.....	1	48	50.5
Stage II	....	....	2	3	....	3	4	2	....	....	....	.....	.....	14	14.7
Stage III	....	....	....	....	....	1	2	4	2	....	....	.....	.....	9	9.5
None	....	....	6	1	1	....	....	....	....	....	....	.....	.....	8	8.4
Unknown	1	....	2	2	1	3	5	5	4	....	....	1	6	30	7.0
Suspected	1	....	....	1	1	1	2	....	....	....	....	.....	.....	6	20.0
Stage I	....	....	1	....	....	2	1	1	1	....	....	.....	3	9	30.0
Stage II	....	....	....	1	....	....	2	2	1	....	....	1	1	8	26.7
Stage III	....	....	....	....	....	....	....	2	2	....	....	.....	1	5	16.6
None	....	....	1	....	....	....	....	....	....	....	....	.....	1	2	6.7

HISTORY BLANK USED IN INVESTIGATION.

INDIVIDUAL HISTORY.

Plant.....
Serial No.....
Index No.....

Last name..... Date....., 19...
First name..... Street..... No.....
Sex..... Age.....
Nationality..... Time in United States..... In Barre..... M. S. W.
School attended now (if child):
Place of business..... Kind of work.....
Factory work at home..... Total income.....
Habits: Alcohol..... Tobacco..... Patent med..... Tea.....
Coffee..... Narcotics.....
Sickness in past few years requiring M. D.....
Injuries..... Operations.....
T. B.: Now..... Suspected..... In past..... When.....
M. D..... Place of treatment: Home..... Institution.....
Results.....
Nature of present illness, if any.....
Name of present M. D.....

History of—

Exposure to T. B.: Infancy..... School..... Work..... Home.....

Scarlet fever	"Slow fever"	"Cough"
Pneumonia	Typhoid	Tumors (breast)
Grippe	"Fever"	Measles
Malaria	"Sore throat"	Pleurisy
"Decline"	"Colds"	Adenoids
Whooping cough	Chest injuries	"Run down"
Fainting spells	"Rheumatism"	Asthma
Bronchitis	Blood spitting	Diphtheria
Large glands	Tonsilitis	Mumps
		Any other diseases

Is menstruation regular:
Any special interests:
Remarks:

Name of investigator.....

HEALTH EXAMINATION.

Usual weight..... Height.....
Temperature..... Pulse..... Respiration..... Blood pressures..S.. D....
Cough..... Sh. of breath..... Hemoptysis.....
Expectoration..... Loss of strength..... Loss of appetite.....
Pain in chest: Front upper half one side.....
Front upper half both sides.....
Back lower half one side.....
Back lower half two sides.....
Front and back one side.....
Front and back both sides.....
Night sweats..... Occasional..... Frequent.....
Supra sternal pitting..... Blood count.....
Supra clavicular pitting..... Urinalysis.....
Direction of clavicles outward..... X-ray examination.....
Scapula R. Flat prominent abducted..... Sputum.....
L. Flat prominent abducted..... Wasserman.....
Ant. post measurement caliper midway scapula .....
Same lateral 7th rib in axilla.....
Girth of chest at nipples in inches at full expiration.....
Full inspiration.....
Girth of chest from int. border of scapula to nipple R. side.....
L. side.....
Hours of employment..... Bad posture..... Fatigue.....
Ventilation..... Vacation.....
Sleep alone..... How much average.....
Food: Breakfast.....
Dinner.....
Supper.....
How many sleep in same room.....
Do you sleep with windows open.....

Examiner.....

GENERAL EXAMINATION.

General appearance: Healthy..... Emaciated..... Pale.....
Physical development: Robust..... Good..... Fair..... Poor.....
Mouth breather.....Vaccinated within five years.....Corneal scars R.... L...
Corneal scar R..... L.....
Vision: R..... L..... With glasses, R..... L..... Wears reading glasses.....
Eyes: Congestion..... Conjunctivitis..... Other abnormalities.....
Ears: Otorrhea—Acute..... Chronic..... Breasts.....
Nose and throat: Catarrh—Acute..... Tonsils—Septic..... Enlarged.....
Septum..... Turbinates.....
Adenoid..... Moustache.....
Hair in nose..... Larynx.....

Teeth:

	Unclean.	Decayed.	Missing.	Artificial.
Upper.....	.....	.....	.....	.....
Lower.....	.....	.....	.....	.....

Tongue:

Badly coated.....

Lungs:

Inspection—shape: Normal..... Flat..... Barrel..... Retractions.....
Unequal expansion..... Old empyema scar.....
Percussion (locate findings): Dullness..... Flatness.....
Other changes in resonance.
Auscultation (locate findings): Change in: Breath sounds.....
Voice or whisper..... Rales: Persistent..... After cough.....
Sputum required..... Result.

Heart:
Rate..... Regular..... Irregular..... Murmur..... Heard loudest at..... Transmitted to back..... Arterial walls.....
Apex beat: Displaced downward..... Right..... Left.....
Pressure: Systolic..... Diastolic.....

Enlarged glands:
Occip..... Cerv..... Ax..... Epitroch..... Goiter.....

Skin:
Impetigo..... Favus..... Pediculosis..... Ringworm.....

Active nonpul. T. B.:
Spine..... Hip..... Knee..... Elsewhere.....

Malformations:
Round shoulders..... Kyphosis..... Scoliosis..... Lordosis.....
Anchylosis..... Lameness..... Other.....

Abdomen:
Flat..... Distended..... Tenderness..... Spasm..... Hernia.....
Tumor..... Other findings.....

Venereal:
Knee jerks..... Rhomberg..... Other.....

Diagnosis:

Remarks:

Examiner.....

FAMILY RECORD.

Landlord..... | Health insurance.....
Length of residence in Barre..... | Previous address.....
Church..... | Color.....

Name.	Age.	Birth-place.	Occupation (school).		In-come.	T. B.			Other illness now.	Cause of death.
			Place.	Kind.		Now.	Sus-pect.	In past.		
Family, adults:										
Children:										
Relatives:										
Help:										
Lodgers or boarders:										

Nurse.....

APPENDIX H.—GERMAN SICK-FUND EXPERIENCE.

Attention should be directed to an exceedingly important investigation into the industrial hygiene of particular trades reported to the medical section of the Ministry of the Interior of the Prussian Government by Dr. Karl Opitz, Berlin, 1919. This report is an exceptionally convenient summary of German sick-fund experience, amplified by data derived from the German Recruiting Service. Unfortunately, only the rates or percentages are given, so that it is difficult to say whether the conclusions are strictly trustworthy on the basis of a sufficiency of numbers. Military rejections on account of military unfitness on physical grounds represent 31.5 per cent of all rejections, as against 37.5 per cent for stonecutters (*Steinmetzen*). More pronounced, however, are the differences in the general sickness rate among members of the Leipzig Communal Sick Fund, which was reported as 39.6 per cent for all occupations, but as having been 69.6 per cent for quarrymen, 58.1 per cent for stonemasons, and 52.7 per cent for stonecutters.

In the experience of the Frankfort Sick Fund the rate was 62.9 per cent for all occupations and 58.8 per cent for stonecutters, but when only such sickness is considered as caused incapacity for work the rate for all occupations was 24.1 per cent, and for stonecutters 32.8 per cent. The Leipzig experience differentiates ages 15 to 19 and 20 to 24, with the following results: At ages 15 to 19 the sickness rate for all occupations was 37.3 per cent, but for stonecutters the rate was 54.2 per cent and for stonemasons 50.2 per cent. At ages 20 to 24 the rate for all occupations was 35.5 per cent as against 46.5 per cent for stonecutters and 44.6 per cent for stonemasons.

Diseases of the respiratory organs caused a rejection rate in the military recruiting service of 2 per cent of all rejections for all occupations, and of 16.7 per cent for stonecutters. In the experience of the Leipzig Sick Fund the sickness rate from diseases of the respiratory organs was 56.3 per 1,000 for all occupations as against 101.5 per 1,000 for stonecutters. In the experience of the Frankfort Sick Fund the sickness rate for bronchitis was 75.8 per 1,000 for all occupations and 110.3 per 1,000 for stonecutters. On limiting the term to those who were incapacitated for work as a result of bronchitis, the rate for all occupations was 29.8 per 1,000 as against 81.1 per 1,000 for stonecutters. Inflammation of the lungs in the experience of the Frankfort Sick Fund caused a general sickness rate of 4.2 per 1,000 as against only 3.2 per 1,000 for stonecutters. In the experience of the Leipzig Sick Fund at ages 15 to 19 respiratory diseases caused a sickness rate of 42.8 for all occupations as against 76 for stonesetters and 57.4 for stonecutters. At ages 20 to 24 the rate for all occupations was 50.7, for stonemasons 51.6, and for stonecutters 78.1.

These observations have reference to nontuberculous lung diseases. They clearly indicate a decidedly higher liability to such diseases on the part of men employed in the stone industry than on the part of workers in general.

Still more pronounced are the differences as regards a specific liability to pulmonary tuberculosis. In the experience of the Frankfort Sick Fund the average rate for all occupations was 3.3 per 1,000 members, but for stonecutters the tuberculosis sickness rate was 9.7. In the experience of the Leipzig Sick Fund the tuberculosis sickness rate for all occupations was 7.7 per 1,000, while for stonecutters it was 24.7, the highest figure for any occupation on record. For stonemasons the rate was only 5.3. The Leipzig figures for age periods confirm the observations elsewhere made that pulmonary tuberculosis is comparatively rare at ages under 30. At ages 15 to 19 the pulmonary sickness rate was 3.8 per 1,000 for all occupations, but only 2.6 per 1,000 for stonecutters, while at ages 20 to 24 the average rate was 7.3 as against only 1.6 for stonecutters.

APPENDIX I.—LIST OF REFERENCES.

"A study of pulmonary silicosis," by E. L. Middleton, M. D., in Journal of Industrial Hygiene, March, 1921.

Australia:

Inquiry into the Prevalence of Tuberculosis at Bendigo, by D. G. Robertson, M. D., Quarantine Service, Commonwealth of Australia, Melbourne, 1920.

Report of an Investigation at Bendigo into the Prevalence, Nature, Causes, and Prevention of Miners' Phthisis, by Walter Summons, Melbourne, Australia, 1907.

Report of the Royal Commission on Miner's Lung Disease, Perth, Western Australia, 1912.

Report of the Royal Commissioner on Pulmonary Diseases Among Miners, Perth, Western Australia, 1910.

Report on an Inquiry into the Prevalence of Tuberculosis at Bendigo, Service Publication No. 19 of the Quarantine Service of the Commonwealth of Australia.

Report on the Ventilation of the Bendigo Mines, by Walter Summons, Department of Mines, Victoria, Australia, 1906.

Reports on Miner's Phthisis and Pneumoconiosis, prepared for the New South Wales Board of Trade, Sydney, 1919.

Cocks, Gerhard H. Experimental Studies of the Effect of Various Atmospheric Conditions upon the Upper Respiratory Tract, American Laryngological Society, 1915.

Comparative Tests of Air Dustiness with the Dust Counter, Konimeter, and Sugar Tube, by S. H. Katz and L. J. Trostel, Pittsburgh, Pa., July, 1921.

"Compensation for phthisis in grinding industry," in The Lancet, London, November 27, 1920.

"Conjugal tuberculosis," note in British Medical Journal, October 15, 1921, p. 54.

Cottrell, F. G. Problems in Smoke, Fume, and Dust Abatement, Smithsonian Report for 1913, Washington, D. C., 1914.

Die Steinindustrie in Grossherzogtum Baden, von Regierungsrat Dr. Fohlisch Beilage zum Jahresbericht des Grosh-Gewerbeaufsamts für das Jahr 1912, Karlsruhe, 1913.

"Direct inhalation of calcium in treatment of pulmonary tuberculosis," note in Bulletin of the Academy of Medicine, Paris, December 20, 1921.

Diseases of Occupation and Vocational Hygiene, by Kober and Hanson, Philadelphia, Pa., 1916.

"Dust and phthisis," in Journal of American Medical Association, May 15, 1920.

"Dust in expired air," by Dr. J. S. Owens, in The Lancet, London, March 5, 1921.

"Dust in expired air," by the London correspondent, in Journal of American Medical Association, April 11, 1921.

"Dust inhalation and tuberculosis," in The Lancet, London, November 15, 1919, p. 888.

"Dust ventilation studies in metal mines," by D. Harrington, in Scientific American Monthly, February, 1921.

"Gannister disease," by C. L. Birmingham, in Journal of the Sanitary Institute, Vol. XXI, London, 1900.

Great Britain:

Annual Report of the Chief Inspector of Factories and Workshops for the year 1912, London, 1913 (Cd. 6852), with table on the "Mortality from pulmonary tuberculosis in certain dusty industries in relation to free silica present in the dust."

Annual Reports of the Chief Inspector of Factories and Workshops for the years 1913–1919, London, 1914–1920 (Cd. 7491).

Great Britain—Concluded.
Minutes of Evidence Taken Before the Royal Commission on Metalliferous Mines and Quarries, Vol. I (Cd. 7477), Vol. III (Cd. 7478), London, 1914.
Report by the Medical Officer of Health of Aberdeen, Scotland, Dr. Matthew Hay, for the year 1909, with an appendix on tuberculosis in Aberdeen.
Report on the Prevalence of Phthisis among Quarry Workers and Miners, Derbyshire County Council, by Dr. Sidney Barwise, Derby, England, 1913.
Report to the Secretary of State for the Home Department on the Health of Cornish Miners, London, 1904 (Cd. 2091).
Second Report of the Royal Commission on Metalliferous Mines and Quarries, London, 1914 (Cd. 7476).
Supplement of the 55th Annual Report of the Registrar General for England and Wales, Part II, 1897.
Supplement of the 65th Report of the Registrar General for England and Wales, Part II, 1908.
Hill, E. Vernon. "Quantitative determination of air dust," in Heating and Ventilating Magazine, June, 1917.
Hoffman, F. L. "Dust as a factor in occupation mortality," address before the Medical Society of the County of New York, in Medical Examiner and General Practitioner, New York, 1907.
—— "Dust hazard to health in the stone industry," in Proceedings of Seventh Annual Safety Council, National Safety Council, September, 1918.
—— First Preliminary Report on the Mortality from Tuberculosis in Dusty Trades, National Tuberculosis Association, 1918.
—— Influence of Trades on Disease, report to the Ninth Conference of Sanitary Officers of the State of New York, 1909.
—— "Legal protection from injurious dust," in American Legislation Review, American Association for Labor Legislation, June, 1911.
—— Menace of Dusts, Gases and Fumes, Bulletin of Pennsylvania Department of Labor, 1918.
—— Mortality from Consumption in Certain Occupations Exposed to Municipal and General Organic Dust, Bulletin No. 82, United States Bureau of Labor Statistics, May, 1909.
—— Mortality from Consumption in Dusty Trades, Bulletin No. 79, United States Bureau of Labor Statistics, November, 1908.
—— Mortality from Respiratory Diseases in Dusty Trades (Inorganic Dusts) Bulletin No. 231, United States Bureau of Labor Statistics, June, 1918.
—— "Mortality from tuberculosis in dusty trades," in Occupational Diseases, by Kober & Hanson, November, 1915.
—— "Prevention of disease by the elimination of dust," in Proceedings of the First National Conference of Mayors, June, 1910.
—— Second Preliminary Report on the Mortality from Tuberculosis in Dusty Trades, National Tuberculosis Association, 1919.
—— "The dust problem in industry," in Monthly Bulletin, American Museum of Safety, March, 1914.
"Incidence of tuberculosis in husband and wife," by Arnold Minnig, M. D., in the Medical Officer, London, January 8, 1921.
Industrial Pneumoconiosis, with Special Reference to Dust Phthisis, by Dr. Edgar L. Collis, Milroy Lectures, 1915, London, 1919.
"Industrial tuberculosis and the control of the factory dust problem," by Drs. Winslow and Greenburg, in Journal of Industrial Hygiene, January and February 1921.

Landis, H. R. M. "Pathological and clinical manifestations following the inhalation of dust, in Fifteenth Annual Report of Henry Phipps Institute, 1921; Journal of Industrial Hygiene, 1919.

"Mental and physical effects of fresh air," by McCall and Huestis, in The Scientific Monthly, 1921.

Miller and Smyth. "The dust hazard in certain industries," in Journal of American Medical Association, March 2, 1918.

"Miners' consumption and pulmonary tuberculosis," in New York Medical Record, June 1, 1918.

"Miners' phthisis," in The Lancet, London, January 14, 1922.

New York:

A Simple and Inexpensive Respirator for Dust Protection, Bulletin No. 90 of New York Department of Labor, Albany, 1918.

Hoods for Removing Dust Fumes and Gases, Special Bulletin No. 82 of New York Department of Labor, May, 1917. Albany, 1917.

Industrial Code Relating to the Removal of Dust, Gases, and Fumes, New York Department of Labor, 1915.

Occupational Statistics of the Netherlands, contributed to Archiv für Soziale Hygiene und Demographie, Leipzig, 1919, by Dr. Prinzing.

Oliver, Sir Thomas. "Dust and fume: Foes of industrial life," in Transactions of Fifteenth International Conference Hygiene and Demography, 1912.

Pancoast-Miller and Landis. "On a röntgenological study of the effects of dust inhalation upon the lungs," in Transactions of the Association of American Physicians, 1917.

"Pulmonary silicosis," note in American Review of Tuberculosis, May, 1921.

Prudden, T. Mitchell. Dust and Its Dangers, New York, 1907.

"Recent experiments in the control of air dustiness," by Dr. O. M. Spencer, in Journal of the Outdoor Life, May, 1921.

Report of the State Geologist on the Mineral Industry and Geology of Certain Areas of Vermont, Bellows Falls, 1910.

Report on Silica, in Annual Report of the Medical Research Council, 1920–21, London, 1922.

Reports of the Rhodesia Chamber of Mines, 1902–1910, Bulawayo, 1903–1921.

"Respiratory efficiency in relation to health and disease," Milroy Lectures, in The Lancet, London, September 17 to October 8, 1921.

"Silicosis among stone masons," note in The Lancet, London, October 1, 1921.

"Silicosis and tuberculosis among miners," in British Medical Journal, January 1, 1921.

"Silicosis on the Rand," in The Lancet, London, January 1, 1921.

"Spontaneous pneumoconiosis in the guinea pig," by Henry S. Willis, in The American Review of Tuberculosis, May, 1921.

"Studies on the relation of dust to the spread of tuberculosis," by Sweany and MacLane, in Illinois Medical Journal, December, 1919.

The ash of silicotic lungs, by Dr. John McCrae, South African Institute for Medical Research, Johannesburg, 1913.

"The diagnosis of pulmonary tuberculosis from the standpoint of the industrial physician," by Dr. Frank A. Craig, in New York Medical Record, April 1, 1922.

"The dust peril," by the Medical Correspondent of the London Times, Times Trade Supplement, November 15, 1919.

"The epidemiology of tuberculosis," in British Medical Journal, April 16, 1921.

The Hygiene Diseases and Mortality of Occupation, by Dr. J. T. Arlidge, London, 1892 (with supplementary chapter on the "Inhalation of dust, its pathology and symptomatology").

"The influence of dust inhalation upon the incidence of phthisis," by Dr. Edgar L. Collis, in The Lancet, London, January 22, 1921; Public Health, London, March, 1921.

The Nature of the Doubly Refracting Particles Seen in Microscopic Sections of Silicotic Lungs, and an Improved Method for Disclosing Siliceous Particles in Such Sections, by Drs. W. Watkins Pitchford and James Moir, Johannesburg, South Africa, 1916.

"The relation of health to atmospheric environment," by Leonard Hill, M. D., and M. Greenwood, in International Journal of Public Health, May–June, 1921, Geneva, Switzerland.

"The silicosis scheme," in The Lancet, London, May 24, 1919.

"Tuberculosis of husband and wife," by Harry Lee Barnes, in American Review of Tuberculosis, October, 1921.

"Über die Lungenerkrankungen der Steinhauer, von Regierungs und Medizinal-rat Dr. Franz Koelsch, in Zentralblatt für Gewerbehygiene, Vol. III, pp. 259–264, 273–279, Berlin, 1915.

Union of South Africa:

Preliminary Report of the Miners' Phthisis Prevention Committee, 1912, Cape Town, 1913.

Report of the Commission on Miners' Phthisis and Pulmonary Tuberculosis, Cape Town, 1912.

First Annual Report of the Miners' Phthisis Board, 1913, Cape Town, 1914.

Report of the Tuberculosis Commission, Cape Town, 1914.

Second Annual Report of the Miners' Phthisis Board, 1914, Cape Town, 1915.

Third Annual Report of the Miners' Phthisis Board, 1915, Cape Town, 1916.

Third Final Report of the Select Committee on the Working of the Miners' Phthisis Acts, Cape Town, 1916.

General Report of the Miners' Phthisis Prevention Committee, Pretoria, 1916.

Miners' Phthisis Board and Miners' Phthisis Medical Bureau Interim Reports, 1916, Cape Town, 1917.

Fourth Annual Report of the Miners' Phthisis Board, 1916, Cape Town, 1917.

Annual Report of the Miners' Phthisis Board, 1917, Cape Town, 1918.

Annual Report of the Miners' Phthisis Board, 1918, Cape Town, 1919.

Report of the Commission of Inquiry into the Working of the Miners' Phthisis Acts, Cape Town, 1919.

Final Report of the Miners' Phthisis Prevention Committee, Pretoria, 1919.

Act to Consolidate and Amend Acts Relating to Miners' Phthisis, Cape Town, 1919.

Annual Report of the Miners' Phthisis Board, 1919, Cape Town, 1920.

Annual Report of the Miners' Phthisis Board, 1920, Cape Town, 1921.

Annual Report for the Secretary of Mines and Industries, Miners' Phthisis Section, Pretoria, 1921.

Reports of the Transvaal Chamber of Mines, 1911–1920, Johannesburg, 1912–1921.

United States:

Eleventh Census of the United States, Vital Statistics, "Marble and stone cutters," p. 143, Washington, 1896.

Investigation of Dust in the Air of Granite-Working Plants, by S. H. Katz, Serial No. 2213, Reports of Investigations, United States Bureau of Mines, February, 1921.

Miners' Consumption in the Mines of Butte, Mont., Technical Paper No. 260, United States Bureau of Mines, Washington, 1921.

Mortality from Consumption in Certain Occupations Exposed to Municipal and General Organic Dust, Bulletin No. 82, United States Bureau of Labor Statistics, May, 1909.

United States—Concluded.

Mortality from Consumption in Dusty Trades, Bulletin No. 79, United States Bureau of Labor Statistics, November, 1908.

Mortality from Respiratory Diseases in Dusty Trades (Inorganic Dusts), Bulletin No. 231, United States Bureau of Labor Statistics, June, 1918.

Pulmonary Disease Among Miners in the Joplin District of Missouri, preliminary report of the United States Bureau of Mines, Washington, 1915.

Silicosis Dust in Relation to Pulmonary Disease Among Miners in the Joplin District of Missouri, United States Department of Mines, Washington, 1917.

The Development of the Ax-Making Industry in the United States, by Prof. C. E. A. Winslow and Dr. Leonard Greenburg, United States Public Health Reports, October 8, 1920.

The Efficiency of Certain Devices Used for the Protection of Sand Blasters Against the Dust Hazard, United States Public Health Service, Washington, 1920.

The Granites of Vermont, by T. Nelson Dale, United States Geological Survey, Washington, 1909.

Twelfth Census of the United States, Vital Statistics, "Marble and stone cutters," p. cclxxxv, Washington, 1902.

Ventilation in Metal Mines, by Daniel Harrington, Technical Paper No. 251, United States Bureau of Mines, Washington, 1921.

"What we do not know regarding tuberculosis," by Dr. Nathan Raw, M. P., president of the Tuberculosis Society, in The Lancet, London, June 18, 1921.

Workmen's Compensation (Silicosis) Act, 1918, Circular A. S. 203, National Health Insurance, London.

Workmen's Compensation (Silicosis) Act, 1918, Post Magazine and Insurance Monitor, February 8, 1919.

INDEX.

D.

E.

F.

G.

H.

N.

O.

P.

Q.

R.

S.

T.

U.

V.

W.

Y.

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