The potter and lead poisoning / by W. Dowling Prendergast.

THE POTTER

AND

LEAD POISONING.

BY

W. DOWLING PRENDERGAST,

M.D., M.Ch., M.A.O., Royal Univ. of Irel.;
D.P.H., Vict. Univ.;
Fellow of the Royal Institute of Public Health.

AUTHOR OF
"THE MODERN POTTER FROM A SANITARY POINT OF VIEW."

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TO

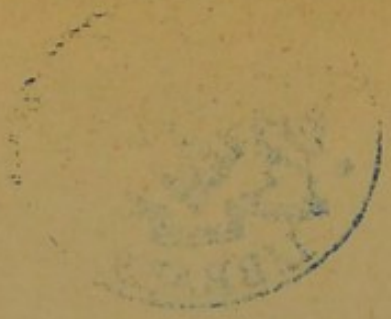
ARTHUR B. WHITELEGGE, B.Sc., M.D. (Lond.),

HER MAJESTY'S CHIEF INSPECTOR OF FACTORIES.

THIS WORK IS

DEDICATED BY THE AUTHOR.

"SPES MELIORA."



THE POTTER AND LEAD POISONING.

SYLLABUS.

7-9-98

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INTRODUCTION.

MY sole object in writing this book on THE POTTER AND LEAD POISONING is to point out how the disastrous effect, produced by the action of lead on the people engaged in the ceramic industry, may be minimised if not altogether prevented. Having worked professionally for fifteen years in the Potteries, my opportunities for studying this question have been very great, both from a medical and a practical point of view. The annual story told by the Registrar-General in his mortality statistics for the Potter, is a sad one; unfortunately, I am sorry to add, it is only half the truth, for the women workers do not appear in these lists.

Regarding lead poisoning, a few years ago a conference took place in the Potteries between master potters, workmen, and officials of the Factory Department of the Home Office, and in view of the then serious aspect of this branch of the trade, special rules were formulated. Since then there has been no diminution in the number of cases; on the contrary, they have increased, and an alarming series of cases, ending in complete blindness, have recently been only too frequent. They were unheard of in former times.

If, as the result of this work, some amelioration of the conditions under which these people labour will result, my reward will be an ample one.

Hordley House, Hanley,
May 1st, 1898.

Potter and Lead Poisoning.

CHAPTER I.

THE manufacture of pottery is at the present time established in a great number of places in England and Scotland. Its most important seat is North Staffordshire, where, during the last two hundred years, it has been steadily improved and developed.

The Potteries extend about ten miles in length, and about four in width. In this comparatively restricted area there are no less than six different towns, each retaining its special municipal organization, viz.:—Hanley, Stoke-on-Trent, Burslem, Longton, Fenton and Tunstall. Burslem is the most ancient pottery town. Hanley is the largest. These places, which, at the beginning of the last century, could only be described as small villages, are now bound together by a long and continuous line of factories and dwellings, presenting the appearance of a large and important city. The population may be roughly estimated at 250,000 inhabitants—a large population, which steadily increases. Hanley, for instance, has doubled its population in five-and-twenty years. The people are highly intelligent, with a decided liking for fine arts, which has been diligently fostered by the establishment of several schools of art, the facilities afforded by railways, and the stimulus given by local exhibitions.

Many people are at a loss to understand why it is that Staffordshire, where none of the clay suitable for the body of china or earthenware are found, should have been preferentially selected to the South of England, where white plastic clays and china clay are abundant. The following are some of the main reasons. The manufacture of a single ton of finished goods requires the consumption of many tons of coal or fireclay, consequently, when the carriage of the materials has to be paid, it is a matter of great moment, *ceteris paribus*, that it should be on the lightest, that is, the clay.

Furthermore, Staffordshire is one of the richest counties in England on account of its minerals. Coal is very cheap, and the marl required for the making of saggars and firebricks is found almost in every locality. In these respects very few districts are in possession of the same advantages for the manufacture of pottery. The abundance of these materials, in addition to the ironstone, explains also the important position taken by the iron and steel manufacturers in the same district. From an hygienic point of view, the association is rather fortunate. The potter's work tends to deteriorate him physically, and his mortality statistics are, in consequence, very high. The work of the collier and ironworker does not injure him materially, and when free from unforeseen accidents, the collier occupies a very low place in these statistics. The pottery industry in North Staffordshire gives employment to 46,000 people.

GLAZES.

Lead, from time immemorial, has been the principal material used for glazing purposes. Galena, or lead ore, in itself possesses all the requisite properties of a glaze. It is

possible by its fusibility, and without any addition, for it to be converted into a material sufficiently vitreous to stop the porosity of baked clays. This property gave it exceptional facilities for the making of vessels suitable either for liquids or for ordinary culinary purposes.

With the exception of hard porcelain and salt glazed ware, all other classes of pottery depended more or less on lead in its various compounds for the preparation of their glazes. When was lead first used in pottery? It is nigh impossible to answer this question. From the enamelled bricks brought to Europe from Nineveh, and the fine decorations of the palace of Darius at Suza, it is evident that it was used before the fifth century B.C. by the Assyrians. From the evidence afforded us, it was used not in a crude condition, but in a scientific or at least a highly ingenious way. In combining lead with tin the Eastern potters obtained that hard, white enamel which has since been the foundation of the excellent pottery produced by the Arabs, the Moors, the Spanish, the French, Italians and Dutch, under the varying nomenclature of Majolica, Nevers, Rouen and Delft ware, to name some of the best known types. As any archæological citations would be foreign to the idea we have in view, we will only state that when lead is combined with tin, in this opaque enamel, it ceases to be acted upon by acids, and consequently becomes innocuous. In the transparent glaze obtained by the use of the lead ore (the sulphide of lead or galena) the opposite effect is produced, for in this glaze we have the lead presented to us in one of its most dangerous forms. The ignorant potter could use it solely by grinding, or pounding it in a mortar. In some instances it was slightly calcined to drive off some of the sulphur. Not being liable to craze it suited all kinds of bodies, and was easily converted into a green, yellow or

brown glaze by the addition of a small quantity of copper, iron, or manganese oxides. In this form it was used by the ancient potters, as we can ascertain by examining specimens of old Persian decorations, in which we find opaque and transparent glazes used side by side.

In ancient literature we do not find in the writings on ceramic manufacture any references made as to the dangerous use of this material; it was only towards the latter end of last century that chemists, writing on this subject, objected to the use of vessels glazed after this fashion, pointing out the dangers when this glaze was heated in contact with acids, a poisonous effect being produced. No attention was paid to this objection, chiefly on account of the toxic properties of lead in the manufacture of pottery being not recognised as a distinct disease and not classified accordingly. Up to the end of last century the manufacture was in the hands of a very few individuals and, compared with the enormous output of the present day, their production was indeed insignificant. As the quantity of ware increases, so *pari passu* the number of cases of lead poisoning are more numerous. We must, therefore, be not surprised if little or no attention was paid to the few cases then cropping up.

From the 17th century to the middle of the 18th century the bulk of the Staffordshire pottery produced in this district consisted mainly of the coarse slip ware (Toft ware), glazed with the galena, and the salt glazed ware, in which no lead was used. Any attempt to make white ware depended a good deal on the use of the marl got from the coal measures being mixed more or less with the ball clay from the south of England. In 1720, Astbury made the great discovery of adding calcined flint for the purposes of rendering the body whiter. About the same period this material was added to the glaze in conjunction with lead,

and a great improvement ensued. This was shown by the manufacture by Wedgwood of the Queen's ware, the prototype of the present earthenware, the enormous production of which in the present century has been so remarkable. From Wedgwood's time the advance has been very rapid in the technical processes. Recently, in comparison with our continental rivals, it has in a degree slackened. Much cheaper labor on the continent and, above all, a more scientific training has brought this about. However, let us hope that in Staffordshire in the future we shall still hold the supremacy, and that we shall continue to be as we are at present, the largest producers of pottery in the world.

Before Wedgwood's time, we must say, the manufacture of glazes was in a very crude condition, for already soft porcelain had been produced in France—at St. Cloud—half-a-century before this time, and very shortly afterwards at Bow, in England. In the composition of the glazes for these refined wares the ingredients were more numerous and better selected, but lead always had the first place. The reason for this is not far to seek. Lead is found everywhere; it is cheap and possesses one precious advantage to the potter, that even with bad or careless firing in the ovens, it keeps the glossiness on the surface of the glazes much better than any other material. Moreover, if we may apply the term used in the Potteries, it resists "sulphuration." For sulphur in any shape or form is the potters' enemy. Some very competent manufacturers are so partial to the raw lead in glaze that they say it is necessary to prevent the spitting of the glaze when it has been re-fired in the kilns for decorative purposes. This may be so, but we maintain that all the lead when fritted is just as good an agent for the purpose they have in view.

I do not consider it necessary in this work to analyse

the various mixtures which go to form the bodies of the many varieties of ware manufactured in England. Into two large classes they are divided, viz.:—that of china and earthenware, the latter comprising a great assortment of decorative and fancy goods. Fortunately the materials are not very numerous, but they are of excellent quality, and their supply practically inexhaustible. They are obtained principally from the counties of Dorsetshire, Devon and Cornwall. The materials for making glazes number in all about six or seven; they, like the other substances, are also good of their kind, and inexpensive. The following are the materials used in the making of glazes—

I. Cornish Stone.—This is a granite in which the felspar is in a state of decomposition, but which retains a due proportion of potash, or soda, causing it to vitrefy at the temperature reached in the biscuit ovens. Its chemical composition can be described as a double silicate of alumina, soda or potash, with a varying amount of quartz. It is a most useful material, and is generally used in much larger quantities than pure silica. By its alumina it brings the glazes more in harmony with the body of the ware, and gives more fixity to the various elements, which, by their admixture, form a definite compound.

II. Flint—calcined and ground—is preferred to any other substance such as quartz or sand. Silica is the foundation of all vitreous mixtures. It acts as an acid in the process of vitrefaction.

III. Cornish Clay or China Clay (Kaolin, to give it its Chinese name) is also obtained from the decomposed granitic formations in Cornwall; but in this clay the decomposition has been so complete in its felspathic constituents, that all the alkaline materials have been

washed away. The pure silicate of alumina remains, which is a very refractory substance to deal with in pottery. It is used sometimes in the glazes, mainly to harden the mixture and to stop the crazing.

IV. The Carbonates of Lime or Barytes are used as fluxes, principally when we have to submit the glazes to a high temperature. Mixed with other various compounds they increase their fusibility. Chiefly on account of its cheapness is the carbonate of lime (chalk) used.

V. White Lead ($PbCo_3$). The carbonate of lead, cerusite and red lead ($2Pbo+Pbo_2$) are both powerful fluxes. When brought into contact with silica, an extremely small quantity of which is sufficient to convert it into a dense yellowish glass. White lead is used in preference to red lead in pottery. The latter, however, has many good qualities to make doubtful the reason for this choice. It is the excessive use of these compounds, especially the carbonate of lead, that makes the glazing process so hurtful.

VI. Borax.—This is the other great flux. When fused with silica it gives a much whiter fritt* than lead, and on this account is to be preferred in certain cases. It is not desirable, however, to suppress the lead altogether, because glazes made exclusively with borax are liable to be decomposed by over-grinding. It is considered that a small quantity of lead added to a

* Fritt is the technical term used when all the materials for the glaze have been mixed together and fired at a very high temperature in a special kiln. The resulting mass is perfectly vitreous. It is this fritt which is sent to the mill to be ground, and at the mill the additional raw lead is added.

boracic glaze makes it more permanent, and undoubtedly better when in the decorative departments it has to undergo several firings in the enamelling kilns. Not long since borax was a very expensive article, reaching in price more than £100 per ton; to-day it can be bought at £13 per ton, for the same quality. The price of this useful material, therefore, has taken away the great objection to its extensive use in former times; in fact, it is cheaper than lead. Its fritt, being lighter in comparison, will cover a larger quantity of ware.

VII. Dry or Crystallised Soda is sometimes used to increase the fusibility of the glaze. It is cheap, and its action is very powerful. It is not much used, however, as its silicates are decomposed at a lower temperature than the others. Fired at a low heat, it may produce a crazing of the glaze. Potash would produce the same result as soda, but its high price prevents its general use.

The Composition and Fusibility of the Glazes.

The composition and fusibility of the glazes used in the manufacture of pottery varies considerably, each manufacturer having his own special receipt. Considering the number of elements, their varying combinations are innumerable. But as the main object we have in view is the quantity of lead indispensable in such combinations, we will treat the lead exclusively, leaving all the other points untouched.

As we shall see presently, the amount of lead varies

considerably, and for each kind of ware the average has been taken of several mixtures.

	Amount of lead used
I. Cheap wares, such as Rockingham, Majolica, Palissy, and all colored glazes fixed at a low temperature ...	...from 40 to 65 p.c.
II. For cheap earthenware, called cream color	...from 30 to 35 p.c.
III. For best earthenware the mixtures varies considerably	...from 14 to 25 p.c.
IV. For china, which requires in the flat ware a surface of greater glossiness and brilliancy, more lead is used...	...from 18 to 33 p.c.

All these amounts are contained in the glazes when they are sent to the dippers.

Looking at the figures for earthenware, it is a fact that a good glaze can be made with 14 per cent. of lead; furthermore, it seems quite possible by increasing the amount of borax as a substitute for lead, to reduce it to 10 per cent.

That silica and lead preparations will combine, in any proportions, as some think who are engaged in the manufacture of pottery, is an opinion that is not tenable. It may be the case if the name of combination is applied to all vitreous bodies, but the experience of those who are engaged as chemists and experts in the glaze manufacture is, that when in the vitreous form, if the lead is in excess, it is not combined. For instance, we have heard of a manufacturer who, for the purpose of rendering the lead innocuous, was fritting eight parts of white lead with two of flint. This is exactly the reverse of what he should have

done, for very likely in ten parts of such a fritt, the largest quantity of lead remained in a very low state of oxidation. When Faraday undertook his experiments for making a very dense glass for optical purposes, he began with a mixture with two parts of silica with one of the protoxide of lead, to ensure that all the lead would enter into combination. There is no doubt that the respective quantities of these materials must be such that there should not be more base than can be saturated by the silicic acid. Apportioned in this way, it will be easy to understand that the fritting of the lead will deprive it of its toxic properties. This is the point that we wish, principally, to insist upon.

I have been assured by a gentleman who managed a manufactory of earthenware on the Continent, that the custom there was to fritt together all the ingredients of the glaze, and that in his works lead poisoning was unknown.

For a period, at the beginning of the earthenware manufacture, insoluble materials only were used, but as soon as soluble salts were introduced, it became necessary to have them all fritted together in order to prevent the absorption of the soluble compounds by a porous biscuit, and moreover to get a homogeneous compound.

This question of fritting all the lead is a most important one, for if the mill men and the other artisans have only to deal with the *fritted lead*, their chances of being attacked will be reduced to a minimum.

Some manufacturers, however, are of opinion that a portion of raw lead in the glaze is necessary to secure a perfect glossiness of the surface. Some others maintain that it is a guarantee against crazing. Raw lead in potting covers a multitude of sins. Two of the largest manufacturers of earthenware have already adopted the complete

fritting of all the lead, not only with advantage to themselves and their workpeople, but in addition, the glossiness of their work is well maintained. The fritted silicate of lead, and the raw bicarbonate of lead fuse at different temperatures, hence it is easy to assume that when we have these materials fired together, this glaze must be more liable to assume a starved, punctated surface, especially if there is careless firing.

As to crazing, we think this serious defect depends more on the quality of the biscuit body than on the degree of fusibility of the glaze. I have the authority of an expert in stating that the colours printed under the glaze will stand better when all the lead has been fritted than they will under one containing raw lead.

We will deal in another chapter of this book on the comparative influence exerted by these two systems of making glazes on the physical welfare of the workpeople. Here we will agree with those who think that a more liberal use of borax is one of the main antidotes to lead poisoning. It is cheap, and whiter than lead, easily fusible and in its management offering no great difficulties. In well-calculated combinations with the other ingredients, its compounds are just as stable as those of lead. Further on we will discuss Dr. Laurie's Appendix on "The Condition of Labour in the Potteries."* His remark that the introduction of an excess of borax into a glaze containing lead has a tendency to free the lead and make it more soluble, is not without foundation.

It is a question of quantities. In No. I. Fritt we get the excess and we get lead free in a soluble manner. In

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See page 37.

No. II. Fritt we do not get this, but the converse. If we have to deal with an excessive quantity of badly combined silicate of lead, and a small one of borax, this mixture, under the influence of heat, will be converted into a silicate of soda and a borate of lead, the latter being one of the most fusible compounds, soluble under certain conditions. But if we get the normal borate precipitated from the acetate of lead by a solution of borax, we will find this singular fact, that an addition of boric acid will harden it, and if the addition is still augmented it will require a much higher temperature to vitrify it, the result being a vitrified white mass almost as hard as flint glass, and almost insoluble.

It is plain that for that extra quantity of boric acid we must introduce a sufficient quantity of borax, and reduce the amount of lead. When this fact is grasped and acknowledged, it will be easy to understand what a great agent we have at hand in the borate of lead in making pottery glazes.

The solubility of the lead is of necessity the object we have in view. We must always remember that in all these definite mixtures we have to deal with at least four different silicates and three borates. In these complicated mixtures the chances of decomposition are very much lessened.

I here append the metallic oxides used in the preparation of those colors called enamelling colors with the different fluxes used. I may state that they all, approximately, contain about 58 per cent. of lead.

1. White opaque enamel—composed of oxide of tin and sometimes arsenic ... Flux (Borax and Lead).
2. Yellow—antimoniate of lead ... Lead Flux·

3.	Orange—oxide of iron, antimonic acid and tin...	Lead Flux.
4.	Red—proxide of iron	Lead Flux.
5.	Red Brown—proxide of iron ...	Lead Flux.
6.	Green—oxide of chrome	Lead Flux.
7.	Blue Green—oxide of chrome, carbonate of cobalt	Borax and Lead Flux.
8.	Rose Color—gold precipitated by chloride of tin	Boric Flux.
9.	Crimson—same as Rose Color, and added to it a small quantity of chloride of silver ...	Boric Flux.
10.	Blue—oxide of cobalt	Lead Flux.
11.	Turquoise Blue—oxide of copper ...	Alkaline Flux (sodic).
12.	Transparent Green—copper ...	Lead Flux.
13.	Black	Lead Flux.
14.	Brown	Lead Flux.

CHAPTER II.

STATISTICS.

WHEN we come to study the Registrar-General's report, especially regarding the effects of chronic lead poisoning, one fact stands out prominently. 20,705 women are employed in the Potteries, a great portion of whom come in direct contact with the lead; of these workers no mention is made in the annual report. Ware cleaners, groundlayers, majolica paintresses, litho-transfer printers, are all women. The processes are some of the most deadly ones encountered in the manufacture of pottery. In some of the manufactories, where small articles are made, the women are employed as dippers. Six out of the seven cases lately reported of blindness are women, hence we can see that the report, including only males from the ages of 25 to 65 years, tends to give rather a roseate view of these statistics.

Again, the age is too high. The special rules do not allow any child under 14 years to be employed in the dipping house, but at that age they are drafted in, and the lead exerts its poisonous effects very speedily on them. One case I will cite. A weakly boy, aged 14 years, went into the dipping house; in two months he was seized with epileptiform convulsions, and died from lead poisoning.

This case came under my care, and a short time after an inquest was held on another boy of the same age. These two cases have occurred within the last six months. They will not appear in the Registrar-General's report. Take the case of the lad I attended. The father said at the inquest that he was accustomed nearly every day to give this underfed, ill-clad child, large doses of sulphate of magnesia "to work the lead out of him." Almost from the first day he entered the dipping house there ensued symptoms of lead poisoning, and invariably it is so with most of these children.

Dr. Whitelegge, in his annual report, as Chief Inspector of Factories and Workshops, for 1896 (see subjoined table), gives us the number of half-time children as 640, and under 18 as 10,637; in all, 11,277 young persons employed in the manufacture of china and earthenware in our district. Regarding half-timers, I am pleased to say, in the opinion of the educational authorities, they are a disappearing number. How many of these young people come in direct contact with the lead we have no means of knowing, but that a goodly proportion of them do there is not the least doubt, especially in those portions of the pottery trade which do not require much technical skill.

Another fallacy let me point out. In comparing the statistics of lead poisoning in the Registrar General's Report for the years 1890-92, he estimates the number of male adult potters (see subjoined table) as 31,881, and estimates his lead poisoning statistics on these figures. Very few of the adult male pottery artisans, between the ages of 15-65, come in contact with the lead. If we take one-twelfth or 2,500 as the number of dippers and glost placers, we can then see where the fallacy creeps in. All lead workers, file makers, plumbers, painters and glaziers, come

without any doubt in direct contact with the lead, and their figures will stand examining; but the comparative figures for the adult male potter must be based on about 2,500 artisans, who do come in contact with the lead as a glaze. For instance, none of the following men have anything to do with the glaze, viz. :—The odd men working on a manufactory, saggar makers, clay makers. throwers, turners, handlers, flat and hollow-ware pressers, biscuit firemen, biscuit cleaners, printers and transferrers, kilnmen, tile pressers, modellers, mould-makers, engravers, painters and enamellers, joiners, bricklayers, engine-men, packers, carters, clerks, and many others engaged in a pottery factory. One other fact that strikes us amongst the comparative mortality statistics, is the number of deaths due to the diseases of the circulatory system. For all males the number is 132. For the colliers, the other great industry in our district, it is 124; for potters, 227; that is, it is nigh double in both instances. Remembering that we now have to deal with adult males of 25-65 years of age, it is only the dippers and glost placers we can include in this category. It is the glost placer who mainly contributes to this excessive mortality. His work consists chiefly in filling the saggars with the ware after it has been dipped; very often he cleans the ware by brushing off the superfluous glaze. A saggar filled with ware varies in weight from 45 to 95-lb. This has to be carried on his head or shoulders, and placed in the glost oven, which is generally about 30-ft. high. They are placed by him tier upon tier, or, as they are technically called, "in bungs."

After being fired, these ovens are drawn quickly; sometimes they are so hot that the workmen have to use gloves to prevent their hands being scorched. Inside the oven the temperature may reach 120° F. or more; outside it may reach zero. These sudden transitions are repeated

every time a loaded saggar is withdrawn. The sudden muscular strain involved is very great in lifting and carrying the saggar.

Rheumatic affections are the first results, and we know how in general rheumatism tends to deteriorate the heart and its valvular arrangements. The next result being that the sudden transitions from extreme heat and extreme cold tends to disorganise the rhythmic action of the heart, and finally ends in a perversion of the whole circulatory system. This, in my opinion, is the reason for the high rate the potter occupies in the statistics for diseases of the circulatory organs.

The abnormal number—333—due to phthisis, given under the section of chronic lead poisoning, is indeed great, the average of all occupied males being 185; and among the list of deaths from respiratory diseases, the potter is *facile princeps*, with the alarming total of 668 against that of 221 of all occupied males. As this treatise does not cover the whole ground in pottery manufacture, I cannot enter into an explanation of those alarming figures; sufficient it is to say that lead, in the form of dust irritant particles, does not enter in such a quantity into the working lives of the dipper and glost placers to account for their being entered into this list. Other causes, which would exhaust another treatise, exist to account for them.

Dr. Tatham says in his 55th supplement to the Registrar-General's report—"At all age groups in Table I. the death rate of the workers are above the standard, and at the groups 45, 55 and 65, they are more than double the standard. The comparative mortality figures of potters is enormous; it amounts to 1,706, and is exceeded only by the figures of the London publicans, and in the industrial districts by those of the dock labourer (whose death rate

may be often ascribed to their habits and not to their occupation), lead workers and file makers." Compared with the standard figures for occupied males, the mortality of potters, at ages from 25–65 years, is in excess by 79 per cent. of the entire mortality figures from all causes, which has been already given as 1,706. Not les than 1,001 is contributed by phthisis and other diseases of the lungs. Dr. Tatham further says: "That potters do not appear to be an intemperate class." I agree with this; but on the other hand maintain, that the publicans and dock labourers would have, I am sorry to say, a much lower place in these statistics if the women workers were included, and the age lowered from 25 to 13 years. From the latter age, to the age limit of 50 years, of all industries in this country the potters' trade is the most destructive to human life.

In 1895 an Act was passed rendering it obligatory on manufacturers and doctors to notify all cases of lead poisoning contracted in a factory or workshop. A fee of 2s. 6d. is paid to the medical practitioner for doing so. This Act came into force on January 1st, 1896, and during the year 1,030 cases of lead poisoning were reported as follows:—

Earthenware and China	432
Smelting of Metals	56
Glass	14
Tinning and Enamelling	35
File Making	20
White Lead	239
Paint and Colours	93
Coach Making	15
Other Industries	126

For future legislation, many good results may ensue from this Act.

The number of lead poisoning cases reported from the Potteries in 1896 amounted to 382. They were divided as follows:—

Dippers	78
Glost Placers	70
Ware Cleaners after Dippers, and Dippers' Assistants	78
Majolica Paintresses	42
Printers' Transferrers	10
Groundlayers	48

This is the first outcome of a very useful Act. Mr. Cramp, H.M.'s Superintending Inspector of Factories in the Midland Division, during the year 1896, gives a further number of 631 cases of lead poisoning—males, 364; females, 267. More than half of these cases came from the Potteries. He states: "The requirements of this section have brought to light some lamentable cases of great suffering from the effects of lead poisoning, such as paralysis of the wrists, fits, blindness, deaths—and should, I think, be supplemented by some means of preventing women, or especially young girls, from working in the lead processes, in cases which, from the first attack, it is made obvious that they are very susceptible to the ill effects of lead in the system."

Some supplementary figures may be of service in understanding better the deleterious effects of lead dust in the form of the carbonate.

Prof. Gautier, in his able treatise on "Le Cuivre et le Plomb," page 246, cites two factories making white lead, each employing 45 workmen. The one in Paris, using the wet process, sends about 11 workmen yearly to the hospital, for lead poisoning. The other factory, at Clichy, sends 179, where the dry process is used, and the lead in the form of

dust is given out in great volume. From this factory, in nine years, 1873 to 1880, the following cases were sent :—

Return of lead poisoning from the factory at Clichy.

		Cases at the Hospital for each 100 workmen.
For 3 years, 1873 to 1875	...	546
1876	...	400
1877	...	333
1878	..	278
1879	...	500
1880	...	464
Average for the eight years	...	451 per cent.

This dust is disseminated in the manufacture of pottery, where the raw lead is added at the mill to be ground with the fritted materials.

EFFECTS OF CHRONIC LEAD POISONING.

	No.	Plumbism	Diseases of Urinary System	Diseases of Nervous System	Gout	Phthisis	Circulatory Diseases	Respiratory Diseases
Lead Worker	2,072	211	161	232	..	148	272	397
File Maker	7,225	75	104	212	4	402	204	423
Plumber	166,135	21	81	131	13	165	123	218
Painter and Glazier ..	—	18	83	132	9	232	147	225
Potter	31,881	17	63	123	1	333	227	668
Glass Maker	21,865	12	63	155	9	295	157	445
Copper Worker	8,252	8	60	85	..	294	186	406
Coach Maker	37,243	7	68	105	7	189	134	250
Gasfitter, Locksmith	19,169	6	50	108	5	223	104	205
Lead Miner	5,609	5	41	62	..	380	142	325
Printer	75,962	3	52	98	4	326	133	214
Cutler	17,059	3	56	91	..	382	167	518
Wool Manufacturer	85,754	3	45	100	1	191	131	256
Mean of the above	..	13	66	117	5	248	146	287
Occupied Males	..	1	41	82	2	185	126	121

ANNUAL REPORT OF CHIEF INSPECTOR OF FACTORIES & WORKSHOPS, 1897.

Report for Year 1896.

Nos. employed in 1895, sex and age. Children (half-timers), between 11 and 14. Young persons between 14 and and 18, but including some between 13 and 14, who have attained a certain educational standard. Adults over 18.

No. of Factories	Children employed as half-timers		Persons under 18 years		Persons above 18 years		Totals.		
	Males	Females	Males	Females	Males	Females	Males	Females	
Staffordshire, 378	370	270	4,967	5,690	19,872	14,745	25,209	20,705	45,914
England and Wales, 885	402	273	7,321	6,659	30,057	17,479	37,780	24,411	62,191

DR. TATHAM'S SUPPLEMENT TO THE 55TH ANNUAL REPORT OF THE REGISTRAR GENERAL.

Comparative Mortality of Males, 25—65 YEARS OF AGE, in different OCCUPATIONS, from ALL CAUSES and from SEVERAL CAUSES, **1890-91-92.**

	CAUSES OF DEATH																				
	All Causes	Influenza	Alcoholism	Rheumatic Fever	Gout	Cancer	Phthisis	Diabetes	Diseases of Nervous System	Valvular Diseases of Heart	Aneurism	Other Diseases of Circulatory System	Bronchitis	Pneumonia	Pleurisy	Other Diseases of Respiratory System	Hernia	Diseases of Liver	Other Diseases of Digestive System	Bright's Disease	Other Diseases of Urinary System	Plumbism
All Males ..	**1,000**	34	13	7	2	47	192	7	102	24	6	102	88	107	7	22	3	29	26	28	16	1
Farmer, &c. ..	**506**	37	4	5	2	34	81	11	41	11	1	54	15	36	3	11	1	22	20	17	11	—
Potter, Earthenware, &c., Manufacturer	**1,706**	42	9	8	1	35	333	9	123	43	6	178	376	135	8	149	3	32	31	45	18	17
Coal Miner ..	**925**	33	4	7	0	36	97	4	67	23	3	94	114	122	7	26	3	17	23	18	12	0
Nail, Anchor Chain & Iron and Steel Manufacturer	**1,301**	48	12	7	1	46	195	7	113	31	6	125	164	248	10	28	5	30	25	31	16	—

CHAPTER III.

The Scientific Aspect of Lead Poisoning.

WHEN Sir James Paget defined disease as the consciousness of possessing an organ, he laid down a great truth. The harmonious working of all that complicated mechanism which we know as man is the sum total of health. Disorganise one part and discord follows quickly.

The toxic influence of lead disturbs this beautifully balanced organisation. The age of 15 to 45 years is generally regarded as the period when the system reaches its highest point of vitality. It is not so with the potter. He generally dies during, or at least at the end of this period. If he works in the lead processes he is maimed and crippled, for lead does not strike one physiological organ, but like the Harpy of old—

> "Nihil non tetigit, et nihil non tetigit,
> Quod non defilavit."

The rosy, oxygenated blood is the first object of its baneful touch, and instead of being a bounteous stream, carrying sap and substance to renew and fertilise the working tissues, it is poisoned at its source, and foul and corrupt it carries the poison, depositing it here and there in the tissues.

The kidneys make an early effort to eliminate the poison, and we have an increase of urine as the result in the primary stages of the poison. The liver, that staunch line of defence against all toxic agents, is enfeebled, but gradually this organ is overpowered, and lead enters fully into the tissues. A goodly part remains inert, but under the influence of any subtle agency it is set free, and we have its dynamic action shown by the sudden onset of epileptiform convulsions, blindness, and very often death.

A differentiation should be made in Lead Poisoning. Like Epilepsy, I would divide it into two classes :—

I. Saturnina Mitior.
II. Saturnina Gravior.

The symptoms of Saturnina Mitior—

1. Cachexia.
2. Constipation.
3. Slight blue line on gums.
4. Sweetish taste in the mouth.
5. Slight colic.
6. Anæmia in women, with accompanying symptoms of a minor character.
7. Pains of an undefined character in the limbs and trunk.
8. Loss of appetite and vomiting.
9. Polyuria.

Saturnina Gravior—

1. Cachexia and emaciation of a marked character.
2. Acute colic prolonged.
3. Fœtid breath.
4. Paralysis of arms and limbs.
5. Blue line well marked.
6. Acute pains in the head.

7. Disturbance of vision.
8. Abortion.
9. Suppression of urine.
10. Epileptiform convulsions.

Initium Turbandi omnia e sanguine ortum est. The blood is the primary factor in lead poisoning. The cachexia of the lead worker is soon manifested, and anæmia in women workers with its concomitant symptoms of menstrual derangements, palpitation, etc., soon appears. The great vaso-motor system becomes engaged, and reflex impulses of a morbid character are the consequences. After the cachexia or synchronous with it comes the lead colic or Colica Pictonum, which derives its name from the storing of wine in vessels glazed with alquifoux or galena, the wine dissolving out a portion of the glaze from the vessels. Its intensity is very great and in acute cases seems to engage a goodly part of the nervous system controlled by the splanchnic centres.

If we look briefly at the process of digestion, we can trace it to its source.

From the first inception of food into the mouth, till it passes away as fæces, a harmonious sequence of reflex acts follow. The salivary glands are stimulated in the mouth, the blood vessels dilate, and there is an outpouring of salivary juice, great or less in amount according to the nature of the food taken. The bolus of food is then grasped by the pharyngeal muscles, and the muscular fibres of the œsophagus; the constrictor fibres at the cardiac opening of the stomach relax, and the food finally passes into the stomach to be digested. After being subject to a peculiar churning movement in the stomach, by which the food is mixed with the gastric juice, the pyloric valve opens and it passes out.

The whole tract is composed of circular and longitudinal fibres, and their combined action constitutes the peristaltic action of the intestines. For its proper and harmonious working a definite and due amount of blood is necessary, as well as an ample amount of the different secretions. Between the two muscular coats is the plexus of Meissner, to control and regulate the orderly movements of the intestines. The whole being directly under the care of the great sympathetic system of nerves, composed of chains of ganglia or nerve centres, containing fibres, some called vaso-motor or blood controlling, from the brain, and also a goodly proportion from the spinal system.

In health the digestive processes go on unrecognised and unknown. On the ingestion of an irritant poison, like lead, this process is disturbed and pain is manifested. The rhythmic action of the circular and longitudinal fibres is impaired, and we have then a perverted peristalsis. Excessive action of one part without a due correspondence of the parts co-related. To decrease this perverted action in lead poisoning, causing pain, we mechanically apply pressure and we get relief, or we administer opium, which soothes and checks the peristaltic action of the intestines.

"How does lead act on the system?" This is the *crux medicorum* of modern medicine. The alkaloids and other mineral poisons work out for themselves a distinct line of action, but lead poisoning shows itself in many and multifarious ways.

Four main theories have been maintained—

1. The muscular.
The Nervous { 2. The peripheral degeneration.
3. The centric theory.
4. The vaso-motor.

Sufficient it is to mention such names as Charcot, Schift, Vulpian, Ranvier, Ferrier, Phillipeaux, Duchenne, Erb, Remak and Oliver, who have studied the question both in its physiological and pathological state. The question is one replete with antagonistic ideas. Into this vortex of opinion I will not go.

Researches innumerable have been made, and volumes written on this question, but still it remains unsolved.

Regarding the muscular theory, the contention is that lead has a special affinity for this tissue; that its specific effect is shown by the paralysis resulting, and the colic which involves the involuntary muscular fibres of the intestines. Regarding its action on the voluntary muscles, the paradox of the dropped hand has not been solved, and the question remains an open one.

Amongst male adult potters, such as dippers and glost placers, chronic lead poisoning is invariably the rule, in contra-distinction to the acute symptoms which are shown amongst the women workers. The dropped hand is caused by the paralysis of the extensor muscles of the forearm, the supinator longus remaining intact. The muscles implicated are supplied by that portion of the brachial plexus of nerves called the musculô-spiral. The nerves of the flexor muscles are derived from the same roots, and are termed the median and ulnar nerves. The supinator longus muscle escapes, its nervous supply being derived from a branch of the musculo spiral nerve before it divides into the posterior interosseous and the radial nerve. Why the extensor muscles should be attacked and the flexors and supinator longus are left unimpaired is a paradox for those advocating the muscular theory. The workman afflicted with it is most helpless, as he cannot lift up anything. It is the commonest form of paraylsis met with in the Potteries.

For those who advocate the specific action of the lead upon nervous tissue, two great theories are held. First the Wallerian theory, where the nerve centres are affected, but the main portion of the nerve, the cylinder-axis, is left intact. Secondly, the peripheral degeneration, where the cylinder axis is attacked, the nerve centres remaining untouched. Erb and Remak strenuously advocate the Wallerian theory, the majority of the other writers holding the opposite view.

The ground would be well cleared for the solution of this problem if we could agree to take the action of lead—

1. On the Brain.
2. On the Sensorio-motor apparatus (including the voluntary muscles).
3. Its action on the Involuntary Muscles (including the vaso-motor system).

Professor Michael Foster, in his work on Physiology, speaks of the "intrinsic molecular nutritive processses of nerve and other tissues," and there is no reason to doubt that an inhibition of these processes, both in the centres and in the nerves, may account for a good deal of the mischief wrought by lead poisoning.

Regarding the vaso-motor theory, he further states "that a maintenance of arterial tone is one of the automatic functions of the spinal cord." This action is also disturbed by lead poisoning. Writers speak of spasm of the blood vessels, caused by its toxic effects. The degenerative changes in the blood itself have been dealt with, and the pathological changes produced thereby. I need not here discuss the amount of lead deposited in the system. Divergie, as the result of a *post-mortem* analysis of a man

who died of lead Encephalopathy, gives us the amount found in the tissues:—

Stomach ...	...	30 milligrammes.
Intestines ...		a good deal—amount lost.
The Lungs ...	...	not weighable.
Kidneys (2448 gr.)	...	2 milligrammes.
Gall Bladder and Bile	...	4 ,,
Muscles (500 gr.)	...	26 ,,
Blood (214 gr.)	...	50 ,,
The Teeth ...	...	1 ,,

Prof. Oliver states that after death lead has been found in the brain. Prof. Bedson found in one of his cases 4·04 milligrammes of metallic lead, and 3·41 in another. Mr. Wynter Blyth reports a case where 99·7 milligrammes of lead were found in the cerebrum, and 17·4 in the cerebellum. Gower reports a case where five grains of lead were found in the brain. Prof. Vulpian and Reynaud also describe two cases where lead was found *post mortem*.

Its Action on the Organs of Generation.

Women are more amenable to the action of lead than men. As an ecbolic it takes a leading place. Few if any of the women in the Potteries who come in direct contact with the lead, carry children to the full time. When we consider its destructive action on the red blood corpuscles, the anæmia resulting, with its varying range of symptoms, we can easily trace the disorders accruing from its ingestion on the processes of menstruation and gestation. M. Paul, who has investigated the influence of Lead Poisoning on the fœtus, says "That women workers in the lead frequently abort; that the father

may cause abortion, even when the mother is not a lead worker. In 123 pregnancies, 73 children were born dead; of these 64 were abortions, 4 premature births, and 5 born at their full time. Of the 50 born alive, 20 died the first year, 8 the second, 7 the third, one later, and only 14 reached the age of 10 years. From the workers' own observations in the Potteries, Emp Plumbi is used as an abortive. The plaster is scraped off and taken rolled up in the form of pills. Prof. Oliver says in his able work on Lead Poisoning, "Lead workers miscarry in much larger proportion than other women, and the children born generally die in convulsions. One of the cases out of many which have come under my observation I will cite.

Mrs. F——, married, aged 29 years, ware cleaner, formerly a transferrer, left her work because she got higher wages in the dipping house. Period of work 4 years. Number of miscarriages, three. For the last miscarriage I attended her about three months ago. She was seized with epileptiform convulsions. Ordinary signs of lead poisoning present. Convulsions lasted three days, during one of which she was delivered of a dead child, eight months old. After delivery she had complete loss of speech for four days, then her speech gradually returned, and she finally recovered. There was only a slight trace of albumen in the urine.

Its Action on the Respiratory System.

Unless the potter comes in contact with the lead in a pulverised state, I am not aware that the average worker is prone to lung lesions. In a process unconnected with the lead—that of china scouring—the mortality is enormous.

As I have stated in a former chapter, the dipping sheds in a goodly number of the old fashioned factories were very squalid. No sunlight ever penetrated there; no cleanliness was observed; the floors were never brushed; nor were the walls or utensils ever cleansed. *Autres temps, autres mœurs*, and let us hope better and happier results in the mortality statistics. By the new rules the floors have to be swept whilst the artisan is absent; the walls have to be white-washed; I wish I could state that the windows have to be kept clean.

The ware cleaners and glost placers inhale the dust in the form of the silicate and carbonate; groundlayers and majolica paintresses, also litho-transfer printers, inhale the dust formed by the colour compounds—the composition of which I have stated in another chapter of this work.

Regarding its action on the heart, I would refer the reader to the chapter dealing with Statistics.

Lead Encephalopathy.

This is one of the graver forms of lead poisoning. After working for some time in the lead processes, either as ware cleaners, dippers, majolica paintresses or litho-transfer printers, pains in the head of a lancinating character are complained of, and vomiting direct and reflex results. The visual organs are disturbed, a feeling of malaise and helplessness is then described, and suddenly, in many cases, an epileptiform seizure ensues, and complete loss of vision is the result.

The following cases, some of which I have seen, have lately happened in the Potteries.

Sarah Tittle, aged 29, married, sixteen months in the employ of a firm of tile manufacturers, was first in the majolica department, and lately in the dipping-house; after six months as dipper, she experienced the ordinary symptoms of lead poisoning, a short time afterwards she ceased work on account of her head symptoms. Epileptiform convulsions ensued, she became completely blind, and delirious. She died.

Gertrude Lambert, aged 17 years, employed in a dipping-house twelve months ago, she complained of vomiting and malaise, and gave up her work. Treated for lead poisoning. She is now completely blind.

George Thomas Smith, aged 16 years, two years employed in a dipping-house as assistant. Pains in the head complained of, he was treated at the Heywood Hospital, Burslem, and also at the North Staffordshire Infirmary. He is totally blind.

Gertrude Cartlidge, aged 17 years, employed for a year and a half in a dipping-house. Vision disturbed, pains in her head, epileptiform convulsions. Result—blindness.

In one of these cases a true form of epileptiform amaurosis was experienced, at first a temporary loss of sight, then recovery, and finally, under treatment, another outburst, ending in complete blindness.

Nearly all these cases could be described under the head of Optic Neuritis, the pathological consideration of which I need not enter upon. Dr. Althaus, in his work on "The Value of Electrical Treatment," discusses the prognosis of such cases. "In most cases of Neuritis," he states, "the prognosis is favourable except where the inflammation attacks highly specialised structures, such as the expansions of the optic or auditory nerves, which easily succumb to pressure by the effusion." This effusion, according to Oliver and other

writers, is frequently observed in the sheath of the Optic Nerve, being caused by the pathological changes produced in the blood and the blood vessels, by the action of the lead poison.

The paralysis of the voluntary muscles, produced by lead, under suitable treatment, very often improves, proving that it is at the periphery and not at the centres that the poison exerts its effects.

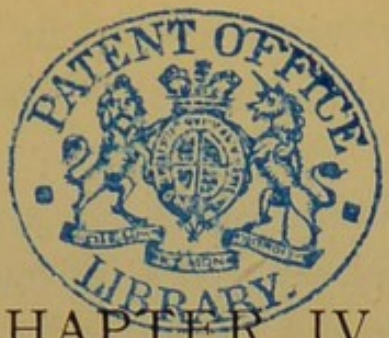
Four factors may be counted upon in the production of these grave cases of blindness :—

I. The employment of women as dippers.

II. The keen competition in the trade, necessitating the use of cheaper materials, one of which is a large amount of raw lead in the glaze.

III. The new litho-transfer processes.

IV. The question of a living wage—the woman worker having to do three times the quantity of ware she did in former times, necessitating her coming in direct contact with a larger amount of the lead compounds—her wages being to-day the same in amount.



CHAPTER IV.

The Diffusibility of the Lead Compounds.

THE Lungs, the Stomach, and the Skin are the principal organs by which lead enters into the system. The Kidneys are the principal organs by which it is eliminated. The main object of this work is not to prevent lead quâ lead from being utilised in the ceramic art, but to point out how its effects can be minimised, if not altogether prevented. Every branch of trade has its risks; but we can point with pride to the beneficial changes produced by the substitution of wet for dry grinding in Sheffield, and the use of amorphous phosphorus in the match-making industry. Furthermore, the simple process in the manufacture of white lead, of damping it during its manipulation without by any means interfering with this industry—as we have seen by Gautier's figures—has been very happy in its results.

We have to deal with the artisan as we meet him, and there is no doubt that he is habitually careless. Ordinary and in the Potteries Special Rules have been made for him. Still he falls a victim to lead poisoning. The miner carries his matches into the midst of his explosive compounds. Take the dipper; his hands and arms, his clothes, his hair, and beard are covered with pulverised

glaze. His food, wrapped up in an handkerchief, is deposited in his place of work. Carelessly he eats his food in this condition.

The woman worker wears an apron which is impregnated with lead, and, at every movement, lead dust arises from it. She does not take it off when she ceases from work to get her meals. She is supposed to do so, but she does not.

The lead compounds that perchance do enter in this manner into the stomach I have dealt with in a former chapter. Their solubility in the stomach we will now discuss.

The conclusions of Dr. Laurie are very important. Under the direction of the Home Office he conducted a series of experiments to determine this point. I append the results :—

Materials used	Percentage of Raw Lead in Fritt	Percentage of Borax put in Fritt	Percentage of Metallic Lead dissolved from 100 parts of material used	Percentage of the whole amount of Lead present in the material which was dissolved	Remarks
Lead Sulphate	...	..	1·21	1·77	
Glaze from Dipper's tub, made up of two Fritts	..	..	6·67	..	A mixture of Fritt No. 1 and 2, with flint and stone
Fritt No. 1	16·0	28·8	5·41	33·8	
Fritt No. 2	30·0	10·7	1·13	3·7	This Fritt analysed, and found to contain 30·3 per cent. of lead
Majolica Fritt	60·0	none	7·78	12·9	This Fritt is a silicate of lead, free from borax
Fritt No. 3	28·9	not known	5·61	21·6	Analysed, and 26·0 per cent. of lead found.
White Lead	..	..	41·23	..	That is, the acid dissolved the carbonate till saturated. More acid would have taken up more carbonate.
Seven grammes of a common tea cup ground up	..	..	0·21	..	

One point must be remembered in pottery manufacture—that there are two principal forms of lead used. The silicate, got, as we have said before, by making a glass either with the red oxide or carbonate; and the white lead or raw lead added at the mill. Regarding this silicate, made in the proper proportions, if we refer to Fritt No. 2 we can see then the point regarding the solubility of this lead compound. Thirty per cent. of lead, in my opinion, being far in excess of what might be used practically.

Regarding the white lead: the analysis speaks for itself. We include Dr. Oliver's tables on this lead compound.

The lead, on its entrance into the stomach, is acted upon by the secretions thereof.

Composition of Gastric Juice.

(Kirke.)

		Human Gastric Juice.	Dog's Gastric Juice.
	Water	994·40	971·17
	Solid Constituents ...	5·59	28·82
Solids	Ferment	3·19	17·50
	Hydrochloric Acid ...	0·20	2·70
	Chloride of Calcium ...	0·06	1·66
	,, of Sodium ...	1·46	3·14
	,, of Potassium ...	0·55	1·07
	Phosphate of Magnesium Calcium and Iron	0·12	2·73

Ten to twenty pints of Gastric Juice are secreted daily, at a temperature about 100° F., by a healthy adult. The free acid in the juice is Hydrochloric, and other acids, such

as lactic, acetic, and butyric, are not unfrequently found. The amount of free hydrochloric acid may be generally stated as ·2 per cent.

Regarding the solvent action of this free acid upon the carbonate of lead, there is no shadow of a shade of doubt. It is an unstable salt, and, being so, readily unites in the stomach with the free acid, and forms the soluble chloride. The silicates are all more stable salts, and possess the power of remaining, *ceteris paribus*, insoluble; and herein constitutes their safety. A short period of work in the presence of the carbonate, and all the major symptoms of lead poisoning are manifest; a long period of work in contact with the silicate, and with precautionary measures, no evil results will accrue.

The series of experiments made by Dr. Oliver settles this matter conclusively.

Experiments.

Salt of Lead used. Lead Carbonate. Reagent used. (*a*) Gastric Juice, natural, obtained from Gastric Fistula in a dog. (*b*) Gastric Juice (artificial Mercks).

Time of digestion, 3 hours. Temp., 100° F.

A. Gastric Juice (*a*), natural. One part of filtered gastric secretion, mixed with two parts of water.

	Amount of Carb. of Lead.	Condition of Digestion.	Amount of Lead Dissolved.
(*b*)	15·4 grs.	154 grs. of dil. G.J.	·00312 grs. per oz. of G.J.
Nov. 2	15·4 ,,	154 ,, ,,	·00206 ,, ,,
Nov. 5	15·4 ,,	154 ,, ,,	·00298 ,, ,,

(*b*) Gastric Juice, artificial.

	15·4 grs.	154 ,, ,,	·001916

B. To show that the active agent in effecting the solution of Lead Carbonate in Gastric Digestion is Hydrochloric acid.

Experiments in Parchment Membrane.

Amount of Lead Carbonate	Amount of Pepsin	Amount of H.C.L. in terms of solution	Lead in grs. per oz.		Total dissolved grs. per oz. of solution.
			Diffused	Non-diffused	
15·4	15·4	·3	4·22	1·25	5·47
15·4	7·7	·3	3·28	2·05	5·38
15·4	3·85	·3	3·32	2·16	5·48
15·4	Nil.	·3	3·56	2·31	5·87
15·4	15·4	Nil.	Nil.	Nil.	Nil.

The results obtained are not intended to be compared with the experiments made with natural and artificial Gastric Juice.

II. Digestion Experiments.

(*c*) Action of natural Gastric Juice upon lead when albumen is being digested.

	Amount of Lead Carb.	Condition of Digestion.	Amount of Lead dissolved.
Nov. 1	15·4 grs.	154 grs. dil. G.J. 200 grs. of diluted Albumen	·00048 grs. per oz. G.J.
Nov. 2	15·4 ,,	,,	·00057 ,, ,,
	15·4 ,,	,,	·00048 ,, ,,
Artificial Gastric Juice.			
	15·4 grs.		·00048 ,, ,,

If we compare the amount of lead dissolved when food is present and when fasting, we are enabled to see the reason for the statement that the lead worker should not begin work till after the breakfast hour, an albuminate

of lead being formed which is not very soluble after a meal. On comparing the table given of the respective strengths of the gastric secretion in man and the dog, we can also see that in the dog the amount of free hydrochloric acid is far in excess.

The abuse of alcohol in this respect may also be considered. The breakfast of the drunkard is very scant. The favourite beverage of the adult worker in contact with the lead in the Potteries, is fresh beer. According to Dr. Pavey,* beer contains water, alcohol and variable quantities of carbonic and acetic acids. Carbonic acid is another great solvent of lead, this, together with the free acid in the stomach, must dissolve any lead very readily.

Professor Oliver says, in concluding his experiments, "a few hours work at a time and frequent meals are the corollaries to be drawn from these experiments, and that no worker should be allowed to enter the lead factory without first having had a substantial meal." On this point I am fully in accord with Dr. Oliver.

The lead salts, entering by way of the lungs into the system, are the carbonate and silicate in a pulverised form. Glaze dries very quickly, and after dipping, if the ware is rubbed by the fingers, or scraped with a tool, dust is evolved. Ware cleaners and glost placers inhale the dust in this fashion. The other lead compounds as dust will be found in the chapter dealing with the metallic oxides in the preparation of enamelling colors. The new litho-transfer process is especially one pregnant with dangerous consequences in this respect.

The carbonate entering the lungs is acted upon by the moist secretions, and the excess of Co_2 always present,

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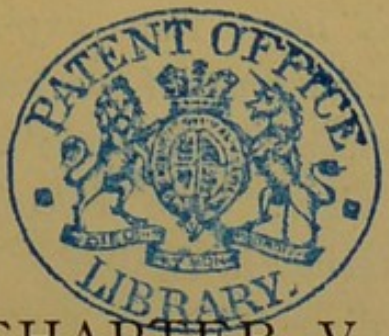
*Food and Dietetics.

a soluble bicarbonate of lead is formed. The silicates are too fixed to be acted on to such a large extent, but indirectly may be a cause for irritant lung mischief.

Lead also enters the system by the skin. Conclusive experiments have been made to prove this. Animals have been inuncted with a preparation of lead, and symptoms of lead poisoning have followed. The dippers hands and arms are continuously plunged into the liquid glaze during his work. The lead penetrates into the glands, and is there acted upon by the carbonic acid, water, and oleaginous materials contained in the sweat, and is absorbed, no doubt, in a small proportion.

Sulphur baths prove how great an excretory organ the skin is by the production of minute black spots containing sulphuretted lead.



CHAPTER V.

Precautions against Lead Poisoning.

IN dealing with such an insidious and deadly substance as lead in the manufacture of ceramics, our first care must be the well-being of the artisan—child, woman or man—who, unfortunately, have to come in contact with it. Our next, that the measures proposed should not interfere with the efficient working of this large industry. That lead, in any form, if taken in minute quantities, is a poison cumulative in its effect, there is no doubt.

From experiments made by Professor Gautier and others, it has been proved that a healthy adult is capable of eliminating 8 to 10 milligrammes of lead a day, and if the individual is kept healthy no poisonous effects result. That $\frac{1}{20}$ part of a grain of lead in a gallon of water, if drank for a short time, can produce poisonous effects, is on record. Mr. H. Guinean de Mussey, in the Dublin Quarterly Journal of Medical Sciences, says—"thirteen out of thirty-eight people at the Chateau de Clairmont, were poisoned by this water containing in solution the carbonate of lead." In a "charge," as it is termed in the Potteries, for the making of glaze, $1\frac{1}{2}$ cwts. of carbonate of lead is often added at the mill, the fritted lead being ground in

addition. This has been fully explained under the head of glazes. The life history of workers in the manufacture of white lead at home and abroad is a sad one, from an hygienic point of view. The Potter's history, in contact with the same material, is similar.

That we can dispense with lead altogether in potting is a very open question. That we can minimise the amount used there is no doubt whatever. That the raw lead or carbonate of lead, or lead in a free state, should be prohibited by legal enactment is a step I would strenuously advocate, both in the interests of the manufacturer and the artisan. In all the glazes and colors, especially in the cheaper kinds of ware known as Jet, Rockingham and Majolica ware, all the lead should be fritted.

In all those processes in which lead appears in a pulverised form, such as ware cleaning, groundlaying, litho-transfer printing, I would first insist upon efficient exhaust ventilation, and if possible, would make compulsory the wearing of a proper respirator, more especially where women are employed. The respirator should cover both nose and mouth.

I would urge, as far as possible, that in every manufactory an approved system of ventilation should be enforced. If the air at the inlet is required heated, artificial means can easily be used, such as steam pipes, etc. If air is warmed up to 60° F. a large volume can be endured without any evil effects. If this fact is grasped and acted upon for the inlet air, the driving out of the unhealthy products of potting becomes fairly easy of solution. Sylvester's system is one I would advise, with the addition of such a fan as Blackman's. In the model factory, which is yet to be built, electricity will be the main factor, in first giving a light by which colors may be manipulated,

and from which we do not get the foul products which emanate from gas. Secondly, the motive power used may be utilised in a double sense ; first, to generate and store the current needed, and having done so, its powers can be transferred to render efficient the means of ventilation. The older factories, built without any regard to sanitation or cubic working space, are hard to deal with. In some of these places the dipping-house is saturated with glaze, and all sunlight is denied entrance through the windows being covered with the mixture. I would at least let in the sunlight, and make the floors of hinged trellis pattern, so that the superfluous glaze would then fall below the floor level, and could then be removed by damping, so that no dust need be evolved.

I would prevent, by local bye-laws, any new factory being built, or any factory which has been closed being re-opened until, in the opinion of the medical and factory officials, such steps as they consider necessary, from an hygienic point of view, shall have been satisfactorily carried out.

Lavatories, with an ample supply of water, should be insisted upon. In the Special Rules, formulated in 1893, they are looked on as essentials. I am sorry to say in many manufactories the effective means for washing and the amount of water used is limited. In others everything is provided, soap, nail brushes, overalls, etc., and there is no doubt that the artisans employed in the lead processes, in a goodly number of instances, are most careless in the use of these things provided for their benefit. For youths there may be some excuse, but for adults there is none, and a penalty is the only means of getting them into habits of cleanliness so essential for their well being. Custom is everything with the working man.

Regarding Age and Sex.

Under the special rules any child under 14 years is prohibited from coming in direct contact with the lead process. This age is too low, and when we see the disastrous effects produced by the action of lead upon these children, many of whom are puny and delicate, coming from squalid homes, and starting their work in the early morning oftentimes without a meal; we must not be surprised at the consequences. Large and increasing doses of sulphate of magnesia are given them to counteract the constipating effect of the lead. Children of this age are naturally careless, and the full force of this poisonous agent soon strikes them down. Adults should be employed for this work in the dipping-house, and they should be gradually brought in contact with the lead. A good rule existed years ago in this district. Apprenticeships were served before they became dippers. The man, so to speak, was salted before he came in contact with the lead. The dipper getting the highest wages was selected from the glost placers. Now-a-days, I am sorry to say, youths are employed in this branch, and in some small factories, where small articles are made, women are employed as dippers.

Women, and especially young girls, should be excluded from the dipping-house altogether. The effect of lead upon women is very bad. Her uterine and nervous functions are quickly vitiated. If married, maternity is denied them. The history of many women working in contact with the lead is a continued series of abortions.

In other lead processes, giving employment to the greater portion of female labour, I would strive to minimise its effect by first of all fritting all the lead compounds

and insisting most strictly upon the rules for cleanliness and ventilation being strictly carried out. In all processes where lead dust is evolved a respirator should be worn; the eating of fruit, confectionery, &c., whilst at work, should be prohibited by the imposition of a fine.

Regarding the male adult workers, who are generally employed in the mixing house, the dipping-house, and as glost placers, one great and debateable question arises. If an adult male worker has contracted lead poisoning, should he be prevented from again entering upon this class of work? In this matter I cannot do better than quote Professor Armand Gautier. Writing on the effects of lead poisoning, he writes: "Instead of this constant drugging to counteract the evil effects of the lead, it is preferable to follow the example of some masters who take an intelligent interest in the welfare of their working men. A doctor visits them once a week at least. From the time the first symptoms are shown, the workman is put into quarantine. He does not go to work again until, after a suitable treatment, the symptoms have entirely disappeared; but if by irregular conduct, drunkenness, natural carelessness or special idiosyncrasy he is again attacked, he is deemed incapable of continuing this work, and he must find other employment."

The work of the dipper is one of the most lucrative in the pottery industry. The women workers earn good wages, but it is far better for these artisans, if through any of the above causes they fall victims to the lead, to leave such work before they become permanent cripples at an early period of their lives.

The lead worker should be a selected artisan, the process of selection being left to the medical inspector. A trial of three months should be given, if after this an indiosyn-

crasy or greater tendency to be attacked by the lead manifests itself, the artisan should be prevented from following the work. The artisan, by leaflets or written rules, should be made acquainted with the dangerous tendency of his occupation, the main ideas to inculate being the great need for cleanliness, both with regard to his person and the clothes he wears, the danger of the lead dust in any form being particularly insisted upon. A good meal should always be taken before beginning their work, and the abuse of alcoholic liquors should be pointed out.

A dining-room should be provided in all factories, and proper cooking facilities should be arranged. The imposition of a small weekly charge on the artisans would solve this difficulty. As before stated, the Potteries may be looked upon as one large town stretching about ten miles in length ; large numbers of the artisans work away from their homes in one or other of these towns. If cooked food cannot be obtained at his place of work he resorts to tinned goods, and here again it may be in a minor degree a source of lead poisoning is met with.

The hours of work should be no longer than eight hours duration in the lead processes. All work in the dipping-house should not commence until after the breakfast hour.

Regarding medical and other official supervision, it should be of a very watchful character in all the processes wherein lead enters. I would insist upon artisans producing once a week, on entering the factory, a clean bill of health, by tally or otherwise, they being first instructed in the primary symptoms of lead poisoning.

The Treatment of Lead Poisoning.

Regarding the treatment—a great deal has been written concerning the use of sulphuric lemonade and other antidotes of this nature to render the lead insoluble in the stomach. They might well be cast on one side. There is no doubt if the artisan is dirty and careless a fairly large amount of lead may enter by his stomach. Good food, eaten with clean surroundings will obviate this. The lungs are the principal means by which lead enters into the system ; entering by the mouth and nose it becomes deposited in the lung tissue, a portion of it being dissolved by the Co2 always present in the lungs. After working, even with a respirator, it is always necessary to rinse the mouth well with water, and to cleanse the nasal tract by blowing and washing.

The skin moreover, of the dipper (whose hands and forearms are immersed in the liquid glaze), no doubt contributes its quota. After work the hands and arms should be rubbed with wet sand to detach the dry glaze, and afterwards well washed with running water.

The medical treatment consists principally of prophylactic and alterative treatment. For the colic there is nothing to equal opium in full doses. I invariably give adults a two grain opium pill. Warmth applied to the epigrastrum in the shape of a warm, heavy linseed poultice made with poppy-head water, and bound tightly on the abdomen, for pressure tends to relieve lead colic. Warm enemata, containing a small quantity of turpentine, can also be administered with advantage. When the spasmodic symptoms have abated, which they generally do in a day or two, I find the following mixture of great service :

Recipe—

Potassium Iodidi	...	...	1 drachm
Magnes. Sulph.	...	...	4 drachms
Tinct. Nuc. Vom.	...	...	1 drachm
Tinct. Card Co.	...	...	2 drachms
Aqua destill. ad	...	...	6 ozs.

Fiat Mist—

One tablespoonful to be taken four times a day.

The diet to be light and easily assimilated. Abstention from work in the lead is necessary for one month whilst under treatment.

In the graver cases, where we have reason to suspect that there is an accumulation of lead in the system, the treatment by Iodide of Potassium, which is "par excellence" the great alterative agent in lead poisoning, must be conducted with due precaution. The Iodide, without doubt, has a solvent action upon the lead in the system, rendering active what before was partly inert, and symptoms of a dynamic character consequently follow. I have seen professionally, cases of chronic lead poisoning, presenting symptoms of a minor character, converted by this treatment into cases of a graver character.

The treatment by Sulphur Baths is also of service. In all the towns comprised under the name of the Potteries, the local authorities have built and arranged an excellent series of baths. If they would have, in addition, Sulphur Baths, it would be a great boon to people who come in contact with the lead.

There are several benevolent institutions also in the district, connected mainly with convalescent homes at the seaside, which are greatly appreciated by the potters when debilitated from lung disease. If some portion of these funds could be diverted to Harrogate or Strathpeffer, for the

benefit of those solely sufferingfrom lead poisoning, it would be an onward step. At Harrogate, the system of heating the natural waters, by passing it through coils of glass enclosed in thermic chambers, is excellent, as none of the sulphur products are volatilised and the water is heated at the same time to an agreeable temperature. However, a a very good substitute for these baths can be had at home, by mixing two ounces of potassa sulphurata with thirty gallons of water, heated to a temperature of 98° F.

The old-fashioned mixture of brimstone and treacle is by far the best purgative for women and children. The confection of sulphur B.P. is the purgative I generally select for lead workers—it is given in full doses of 120 grains.

For the treatment of lead palsy, electricity of both kinds and massage are the best appreciated measures.

CHAPTER VI.

FINAL REMARKS.

Leadless Glazes.

TO revolutionize in a day the vast industry built up by many hands and fertile brains in this district, is impossible.

Extremes are bad. A great writer, commenting on the art of the potter, says: "The manufacture of ordinary pottery is in the hands of individual workmen devoid of technical knowledge. Their handicraft is carried on as it was in the times of the Arabs or the days of King Solomon. The potters of our period use the same raw glaze as they did in those times." The 'black glaze' of our modern potter is the representative of those glazes used in days of yore. To go to the other extreme. Our intention is not to prove that a glaze completely devoid of lead cannot be utilized—far from it. We have seen ware, which for perfect glossiness and adaptility for printed colors under the glaze, as well finished in every respect as if it had a complete complement of lead.

Time is the great test of all glazes, for the atmospheric influence is a factor which even the glass maker as well as the potter must take into consideration.

The Eureka cry of the potter in this respect is yet to come; for the great mathematician who solved the 47th problem, did not do it in a day. It was a succession of theorems and propositions, after which the solution came as a fitting finality. So it is with the potter. The tradition of Astbury calcining a flint to cure a disease in the eye of his horse may stand. But in the fierce competition and the greater technical knowledge of our rivals on the Continent, we want something more than chance discovery. Our technical knowledge, especially in chemistry, must be developed. Thus—

"The stepping-stones for higher things."

The solution of this problem on the line of the leadless glaze is possible; but we lack the potter, and we, above all, lack the chemist. The great bulk of our trade is in earthenware. Regarding recipes for glazes, as I have stated before, a work might be filled with them, but the individual potter, in this respect, is best left to his own resources. I give, for instance, a recipe for an earthenware glaze, which is practical and altogether devoid of lead. I do not for one moment conceive that by doing so that it will solve the problem, no more than if I gave a thousand receipes for glazes; that so doing I solve the art of the potter. Still it may stimulate the minds of those working in this direction.

Earthenware glaze without lead:—

	lbs.	oz.	dr.
Borax	32	5	1
China Clay	4	12	1
Whiting	19	0	1
Felspar	28	8	2
Flint	10	10	3
Carbonate of Barytes	4	12	0
lbs.	100	0	0

My contention is, that it is not necessary to exclude lead altogether from the ceramic industry, but that a small quantity of this material is essential to the perfect manufacture of pottery; and, finally, that it will, in a boracic fritt, resist decomposition when brought into contact with a weak hydrochloric or other acid found in the human system. This, I maintain, is the solution of this great problem, pregnant with hope to the working people, amongst whom I have spent many happy years of my life.