

ON
BRASS-FOUNDERS' AGUE.

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DURING a brief holiday visit to Birmingham in the autumn of 1858, I devoted my leisure to visiting the workshops of the various workers in metal, for which that town is famous, with the view of endeavouring to determine whether any causes connected with its manufacturing industry could account for the very large mortality from pulmonary disease among its inhabitants. While visiting the brass-founders' shops, I learned that this class of operatives are liable to suffer from a well-defined form of ailment, known among themselves by the name of ague, and to which I have therefore applied the term "Brass-founders' Ague" at the head of this paper. Since that time I have also had the opportunity of making further inquiries on the subject among brass-founders in Wolverhampton, Sheffield, and Leeds, and likewise on two subsequent occasions in Birmingham. Although I have not been able to pursue the investigation so fully as might have been done by some medical man resident in Birmingham, yet as no one else has taken up the subject, I trust the result of my inquiries may be thought sufficiently interesting to justify their being communicated to the Society.

After completing my own researches I found that Thackrah has mentioned this disease of brass-founders in his admirable 'Essay on the Effects of Arts, Trades, and Professions, on Health and Longevity,' published somewhat more than thirty years since ; but he does not appear to have followed out the inquiry, his only notice of the subject being contained in the following passage :—"The brass-melters of Birmingham state their liability also to an intermittent fever, which they term the brass-ague, and which attacks them from once a month to once a year, and leaves them in a state of great debility. As a preventive, they are in the habit of taking emetics."

Several French physicians have noted the occurrence of symptoms analogous to those spoken of by the brass-founders of this country, among the same class of operatives in France ; but though the facts related are in perfect accordance with those elicited by my own inquiries, the subject is left in the greatest uncertainty by the latest French writer with whose works I am acquainted. M. Blandet, in a communication to the Academy of Sciences, quoted in the '*Annales d'Hygiène publique et de Médecine légale*' (vol. xxxiii, p. 462), describes some symptoms to which copper-founders are liable. These hitherto unnoticed symptoms, he says, manifest themselves in the afternoon or on the morrow of the casting-days, and consist chiefly of weariness, muscular pains, oppression, headache, vomiting, and shiverings lasting for three or four hours and terminating in febrile reaction and profuse sweating. These symptoms, he adds, appear to be the result of intoxication from zinc, which enters largely into the composition of bronze, brass, and other alloys of copper. M. Blandet correctly states that this ailment is aggravated by an imperfect draught in the chimney of the furnace, by a contrary wind beating back the smoke into the workshop, by the closing of the latter in cold weather, and by the pouring out of the molten metal in the middle of the workshop.

In a subsequent paper published in the '*Annales d'Hygiène publique et de Médecine légale*' (vol. xxxiv, p. 222),

M. Blandet relates the case of M. Edmond Soyez, who, after having been employed in casting an alloy of copper, containing one tenth part of zinc, from 4 o'clock a.m. to 9 p.m., that is to say, during seventeen hours, began at 3 p.m. to suffer from intoxication caused by zinc, commencing with anorexia and a disgust for both solid and liquid food. At 10 o'clock p.m. he felt extreme weariness, and, on retiring to bed, he suffered agonising pains in the shoulders, elbows, and wrists. At 11 p.m. trembling and shivering set in, and lasted until 1 a.m. The teeth chattered, the skin was cold, and the respiration difficult. The lower limbs became painful, and the joints of the toes so powerfully contracted that the patient was unable to extend them. There were also cramps in the legs. Vomiting, at first of yellow, afterwards of green and bitter matters, commenced at a quarter past 11, and continued until 1 a.m., when an entire change occurred; the shivering ceased, the skin became hot, and the face red, and delirium accompanied by noises in the ears, set in. This fever, an hour afterwards, was followed by drowsiness, which lasted until morning. Wearied and feeble the following day, M. Soyez could, nevertheless, eat his food, but he still suffered from headache, and the roots of his hair were excessively tender. During the next night he experienced profuse sweatings, and on the following morning all morbid phenomena had disappeared. A founder who had worked all day with M. Soyez appears to have suffered in the same manner as his master. In a note by M. Guérard, which immediately follows the paper of M. Blandet in the same volume of the '*Annales*,' the symptoms experienced by M. Soyez are attributed to cerebral congestion, the consequence of assiduous and long-continued work near to several hot furnaces, and of two hours' vomiting during the night. M. Guérard then proceeds to describe the case of a copper-founder who had suffered on two occasions from symptoms not very unlike those of M. Soyez, but less regular in their course, unaccompanied by the hot stage, and attended by abundant salivation, by continual trembling of the upper extremities,

with inability to grasp objects firmly, and by constipation. These attacks are attributed by M. Guérard to the copious drinking of tepid water, *i. e.* of water kept in the workshop, and consequently warmed by its atmosphere, and he adds that he had more than once witnessed similar results from the intemperate use of watery drinks by persons of very diverse professions. In a still more recent paper, likewise published in the 'Annales d'Hygiène' (vol. xlvii, p. 26), M. Bouchut says that the makers of oxide of zinc for paint suffer from attacks similar to those described by MM. Blandet and Guérard, as occurring among copper-founders when employed in making alloys containing zinc. M. Bouchut says that there are none of the workmen employed in making zinc-paint who have not many times experienced nervous phenomena characterised by nocturnal agitation, with or without fever, but which yet do not prevent them from resuming their work on the following day.

In a still later work, Tardieu's 'Dictionnaire d'Hygiène publique et de Salubrité,' it is stated, as the result of inquiries made by MM. Rayet, Grisolle, and Chevallier, that of the manufacture of zinc-paint exercises no hurtful influence on the health of the workmen, and that, as regards the phenomena described by M. Bouchut, such as weariness, nocturnal fever, headache, nervous agitation, and evanescent intoxication, further experience, which may now be considered definitive, enables us to regard them as altogether chimerical, or, at least, as ill-defined and founded on a false analogy.

As often happens in subjects of this nature, much of the evidence I obtained during my investigation in reference to brass-founders' ague, appeared at first to be of a very contradictory nature. In certain establishments the disease was entirely unknown, while in others almost every caster had repeatedly suffered from it. Indeed, it was only after persevering inquiry, in more than thirty brass-casting shops at Birmingham, besides several in each of the other towns already enumerated, that these apparent contradic-

tions became reconciled, and they now afford the most conclusive evidence relative to the cause of the symptoms from which the casters suffer. These symptoms have, as the name implies, some resemblance to an imperfect paroxysm of ague, but they differ from true intermittent fever in that the paroxysms occur in no regular sequence to one another, but at irregular and uncertain intervals, each paroxysm being, in fact, independent of those which may have preceded or followed it, and distinctly traceable to exposure to the fumes of deflagrating zinc. This is, unquestionably, the efficient cause of the symptoms, though other circumstances, arising either from the peculiar state of the caster or the conditions under which he works, materially contribute to promote or prevent the development of the attack. Brass-casters who have had personal experience of the disease entirely agree in their account of its symptoms, more than seventy of them having described the disorder in almost identical terms. These symptoms are a sense of malaise and weariness, or, as one very intelligent man termed it, *nervousness*; a feeling of constriction or tightness of the chest, and, in some rare cases, nausea commencing during the afternoon of a day employed in casting, followed towards evening, or at latest when getting into bed, by shivering, sometimes succeeded by an indistinct hot stage, but invariably by a very definite stage of profuse sweating. The sooner the latter follows the setting in of the cold stage, the shorter and milder is the attack, and the less likely is the caster to be incapacitated for work on the following day. Headache and vomiting frequently, but by no means always, accompany the attack, which, at the worst, is ephemeral, and rarely, if ever, prevents the caster from pursuing his occupation; but the attacks are, in some cases, of frequent occurrence, and men engaged in this employment are seldom long-lived, though the ailment which most evidently shortens their days is chronic bronchitis, or, as they term it, *asthma*. Persons who have but lately adopted the calling, or who only work at it occasionally, and regular casters who have been absent from work for a

few days, are reported to be more liable to suffer from this disease than those who work at it continually. The following evidence of individual casters, in illustration of the subject, is selected from a mass of similar information, on account of the intelligence of the men by whom it was given.

Mr. C—, slip-caster, deposes that when he has been absent from the casting-shop for a day or two he is apt to be affected by the fumes of zinc on returning to work. These produce nervousness, or a sensation throughout his whole frame which he cannot describe, but which makes him aware that he is about to have a paroxysm of metal-ague. On returning home, or during the night, he feels nervous, becomes cold, and has chattering of the teeth. The cold sometimes passes into a hot stage, but whether this happens or not, the attack invariably passes off with a profuse sweating. He feels indisposed on the following day, but not incapacitated for work. Persons who have but recently begun to work in the casting-shops always suffer severely from this disease. He has found the use of stimulants during the attack injurious, but milk is decidedly beneficial.

Mr. V— has been a brass-caster for twenty-five years. Often suffers from brass-ague. The attacks commence with a sense of constriction and tightness of the chest, accompanied by cough and nausea. These are greatly relieved, and the attack perhaps cut short, if vomiting supervene. These premonitory symptoms are followed by trembling and chattering with cold, even though close to the fire, subsequently giving place to profuse sweating. On the following day he is quite well. Is, in general, only liable to these attacks after "playing" for a day or two ; but sometimes, in foggy weather, when the fumes cannot escape freely from the shop, has suffered from them, even though he may have been working continuously. Milk is found very efficacious, both as a preventive and cure, but gin, tobacco, lobelia, and tartar emetic, are likewise used by the casters as remedies during the attack.

Mr. J—, brass-caster, has had the ague "hundreds of

times," and was selected by his master for my examination, as the most experienced, trustworthy witness in a very large establishment. The attacks, he said, usually come on after being off work for a time. The earliest symptoms are tightness and oppression of chest and shortness of breath, followed, in the evening, by shivering and copious sweating. He feels out of sorts the day after an attack, but is not rendered incapable of working.

Mr. W— says that he is subject to brass-ague, which he has not observed to occur especially after a temporary cessation from work. When about to have an attack, he experiences, during the afternoon, a sense of weariness, attended by aching of the joints and tightness of the chest, with nausea. These are followed in the evening or at night by shivering, which terminates in sweating. He generally employs means to promote sweating, but has found stimulants decidedly hurtful. In heavy weather, when the fumes do not pass off freely, men are more liable to suffer from metal-ague than in clear, bright weather, when the fumes escape rapidly into the atmosphere.

Mr. T—, master brass-founder, describes the ague as beginning with tightness and oppression of the chest, with dyspnoea and loss of voice, followed by shivering, a hot stage, and profuse sweating. These symptoms only occur when the metals are being mixed to make brass, the usual practice in this shop being to cast the brass into ingots or bars, which are remelted as required for use. It is only during the former of these processes, and not when brass is remelted for casting, that he and his men are liable to suffer from metal-ague.

— Farmer, æt. 26, brass-caster during eleven years, has frequently suffered from brass-founders' ague. The paroxysms usually occur after being "at play" (*i. e.* off work), for a day or two. The first sensation experienced is tightness of the chest, followed towards evening, or at bedtime, by trembling and coldness, and, subsequently, by heat and sweating. He is not quite free from discomfort on

the following day. Has found milk useful in preventing an attack.

— Lipper, æt. 33, brass-caster, has frequently had ague, which, for the most part, comes on at night after his return from the casting-shop, and generally when he has been off work for a few days. The symptoms are shivering, followed by a hot, dry skin, and afterwards by sweating. For these attacks he usually takes some hot stimulant, such as gruel with rum in it, to accelerate the sweating stage.

It was stated by several witnesses that brass-founders who survive to old age are liable to suffer from paralysis agitans. Of the correctness of this statement I am unable to speak with certainty. Indeed, the evidence obtained on this subject is by no means conclusive; only one well-marked case of this disease in a brass-founder having fallen under my observation; but I was assured by the manager of an extensive factory in Birmingham where a large proportion of zinc is used in the making of brass, that nearly all the casters in his employ become more or less "shaky." The case referred to is that of a man named Joshua Parkes, æt. 69, who was said to be the oldest brass-caster in Birmingham. He had given up casting for nearly two years before I saw him, in consequence of being afflicted with shaking palsy, which he alleges to be a common consequence of his occupation. In his case the palsy is not very severe, though quite bad enough to prevent him from raising a glass steadily to his lips; looks stout and well; intellect perfect; has had the metal-ague scores of times. When he was working as a caster he did not dare to get into a cold bed, as the doing so invariably brought on shivering. In general felt some premonitory symptoms the day before an attack, which prepared him to expect its accession. These consisted of dyspnœa, tightness of chest, and general malaise, which were followed at night by shivering, succeeded by sweating. With the exception of the inconvenience arising from their unsteadiness, he has the free use of his hands, but, unless supported, they are constantly agitated. The son of Mr. Parkes, who works in the same factory with

his father, has also a slight shaking of the hands, and, according to the foreman, nearly all the casters in this employ are more or less tremulous.

And now as regards the cause of this curious malady. The men themselves attribute it to inhaling the fumes of deflagrating zinc, or *spelter*, as it is more commonly called in the casting-shops, and there can be no doubt, from the facts about to be adduced, that this opinion is perfectly correct, for, on the one hand, iron-founders, puddlers, furnace-men, and several other operatives, are exposed while at work to conditions exactly similar to those of the brass-founders, except the liability to inhale fumes of zinc, and yet none of these suffer from symptoms analogous to metal-ague; and on the other hand, brass-founders suffer from this peculiar ailment in almost exact proportion to their liability to inhale these fumes. In order to render this perfectly clear, it appears desirable to describe briefly the process of making brass. This is done in crucibles or pots plunged into a sunken furnace, and covered, in order to exclude the air. The copper is first placed in the crucible, and as zinc, the other principal ingredient of brass, deflagrates at the temperature at which copper melts, it is only added shortly before the end of the process, when the copper is perfectly molten. When, after the metals are melted, the crucible is uncovered, for the purpose of stirring them together, and more particularly when it is lifted out of the furnace and the molten brass is being poured into moulds, the zinc deflagrates, and a dense, white smoke is formed, which, almost instantaneously, fills the atmosphere of the casting-shop. This smoke is rapidly converted into snow-like flakes and white powder, consisting of the oxide of zinc, which remains for some time diffused through the atmosphere of the shop, and in ill-ventilated casting-places, collects upon the rafters and ceiling in the form of a dense, white incrustation. The quantity of fumes given off depends mainly upon the proportion of zinc employed in making the brass, which varies with the purpose for which the brass is intended. Moreover, a much greater quantity is given off when the metals

are mixed to make brass than when brass ingots are merely remelted. The proportion of the fumes contained in the atmosphere of the casting-shops likewise varies with their size and ventilation, the fumes being more concentrated and remaining longer in small and ill-ventilated, than in larger and better ventilated, shops. Many of the modern shops are loftier than the older ones, and, besides having unglazed windows, are usually provided with an opening in the roof, in order to favour the rapid escape of the fumes. The rapidity with which these pass away depends also, in a considerable degree upon the weather, their escape being quicker in clear, bright weather than in foggy or heavy weather.

The evidence which at first appeared so contradictory was, on further inquiry, fully explained by the facts that have just been related, viz., that brass-founders are not all equally exposed to the cause of this curious malady, and, viewed under this aspect, that evidence affords conclusive proof that the fumes of deflagrating zinc are really the sole cause of this complaint. A few men who use but little zinc in their castings, or cast but rarely, altogether escape the disease. Others, who only remelt brass bars, suffer comparatively little, and of those who mix the metals they suffer most who employ the largest proportion of zinc in this manufacture. Other things being equal, men who make heavy castings suffer more severely than those who cast smaller articles. It was likewise clearly ascertained that men who work in large, airy, well-ventilated workshops, suffer less than such as work in smaller and ill-ventilated places. Some of the casters cover the mouth and nostrils with a handkerchief while casting, a precaution which tends to prevent them inhaling the fumes, and these men, if they do not altogether escape, at least suffer in a slighter degree than others in the same shop who neglect this practice.

When men have suffered repeatedly from this ailment, as is the case with most old casters, they become so susceptible that a very trifling cause suffices to induce an attack, even though they may not have experienced the symptoms

which, during the latter part of the day, usually usher in the paroxysm. Thus, getting into a cold bed very often produces shivering, followed by sweating, and very slight disturbances of the health are apt to bring on a paroxysm of this complaint. The men themselves have a very strong belief in the prophylactic and curative influence of milk, which many of them habitually drink for this purpose, and they assert that the occasional use of emetics has a tendency to prevent the disease. I may add, in conclusion, that this disease is entirely unknown among operatives, such as makers of galvanized iron, who work over molten zinc when the temperature is not high enough to cause deflagration and oxidation of the metal.