

want to learn how reactions run in the organism, and there is abundant evidence to show how little a mere knowledge of the constitution of substances and a consideration of laboratory possibilities can help on such knowledge. The animal body usually does the unexpected.

But if the organic chemist will get into touch with the animal, it is sure that the possession of his special knowledge will serve him well. Difficulties and peculiarities in connexion with technique may lead the professor of pure chemistry to call his work amateurish, and certainly his results, unlike those of the physical chemist, will not straightway lend themselves to mathematical treatment. He may himself, too, meet from time to time the spectre of Vitalism, and be led quite unjustifiably to wonder whether all his work may not be wide of the mark. But if he will first obtain for us a further supply of valuable qualitative facts concerning the reactions in the body, we may then say to him, as Tranio said to his master :

The mathematics and the metaphysics
Fall to them as you find your stomach serves you.

All of us who are engaged in applying chemistry and physics to the study of living phenomena are apt to be posed with questions as to our goal, although we have but just set out on our journey. It seems to me that we should be content to believe that we shall ultimately be able at least to describe the living animal in the sense that the morphologist has described the dead ; if such descriptions do not amount to final explanations, it is not our fault. If in "life" there be some final residuum fated always to elude our methods, there is always the comforting truth to which Robert Louis Stevenson gave perhaps the finest expression when he wrote :

To travel hopefully is better than to arrive,
And the true success is labour.

THE NECESSITY FOR INTERNATIONAL REFORMS IN THE SANITATION OF CREW SPACES ON MERCHANT VESSELS.¹

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THE hygiene of dwellings has received great attention during recent years, and praiseworthy advances have been made in the direction of improving the sanitation of houses, but unfortunately the hygiene of "crew spaces" has to a great extent been neglected. New vessels are still being built which contravene the most elementary principles of domestic hygiene, and as a vessel may sail during its lifetime under several flags, the question is essentially an international one. The hygiene of crew spaces has been sadly neglected, both nationally and internationally, in spite of the fact that the conditions under which crews live are far worse than those which obtain in workshops and factories and dwellings ashore where they are subject to laws and by-laws and regulations in every direction. The programme of the Fourth International Congress includes the subjects of the hygiene of passenger ships, sailors' homes, and men-of-war, but the hygiene of crew spaces of the mercantile marine was not referred to, and I am therefore very pleased to accept the kind invitation of the President of the Congress to draw the attention of the Congress to this important question.

In Great Britain and Ireland the Board of Trade have had the supervision of the hygiene of all new merchant ships, and that standard has been accepted, with minor reservations, by most continental countries ; but of late the subject has received considerable attention on the part of the maritime nations of Europe, and those countries are demanding a higher standard of hygiene in some respects than obtains under the English Board of Trade. The housing conditions in one country, however bad, will not necessarily affect the inhabitants of other countries, as each country is practically self-contained ; but when we come to consider marine hygiene we find that it concerns all nations which "go down

to the sea in ships," for marine trade is international in character. Not only do vessels visit foreign ports to a great extent, but the crews are largely cosmopolitan in character, and it is not an uncommon thing to see half-a-dozen European countries represented among the crew of a vessel.

Every Government looks after the interests of its subjects when abroad, and in order to ensure this consuls are appointed in all foreign ports of importance. No maritime country can therefore afford to ignore the hygiene of the vessels of other countries as long as their sailors serve upon the vessels of other nations.

Owing to the keen competition which exists in the merchant service vessels are designed with the view of carrying as much cargo as possible, in consequence of which the accommodation provided for the crew is frequently most unsatisfactory, not only in the forecastles but also in the officers' quarters. Shipowners generally entrust the design and construction of the crews' quarters to the ship-builders or surveyors, and undoubtedly far better accommodation could be provided for the crews at a very small extra cost, and it is a source of satisfaction to sanitarians to find that there is a growing tendency and desire on the part of shipping companies to provide better housing for the men on board their vessels. Reforms in this direction would, however, be much more rapid if the subject received international consideration. It is evident from a letter which I received recently from a Norwegian Customs official, who takes a great interest in the subject, that endeavours are being made to hold an international congress on the subject.

Although vessels are built under the supervision and according to the requirements of the Board of Trade, when they visit a port they come under the observation of the Port Sanitary Authority, and in England these authorities endeavour to remedy insanitary conditions which may exist on board as far as this is possible under the circumstances. The Port medical officers of health are fully alive to the necessity for a thorough revision of the standard of hygiene of crew spaces. In support of this statement I beg to quote from the annual reports of other medical officers of health.

1. Dr. D. S. Davies, in his report to the Bristol Port Sanitary Authority for 1911, says :—

The nature of the living accommodation provided for seamen and firemen in tramp and other ships, as noted in previous years, is very variable. In some, fair space is given, with seats, tables, and lockers in the living space used for sleeping purposes, and in a few others a messroom is provided, whilst in some others the bare regulation space, with unlined iron surfaces of bulkheads, sides, &c., is allowed, some without seats or tables, the sleeping bunks, which are chiefly arranged in tiers, being available only for all purposes. A very few were provided with a bathroom, which is a great boon, especially to firemen. The best and most comfortable conditions were found chiefly in foreign-owned ships, with a few exceptions.

The lighting of some crew spaces inspected was very indifferent, but, having been passed by the surveyors when the ship was constructed, it is difficult to enforce additions, but there is room for improvement in many cases in the size and number of light ports. Defective ventilation, such as is usually provided, occurred in nine instances, all in foreign ships, chiefly of the small class. The usual request was made for remedy, but without success up to the time the ships left the port.

Leakages into living spaces was again one of the chief causes of complaint, and these occurred in 55 cases, which was an increase of 10 on last year's result. Bad drinking-water supplies were found in 16 ships and the necessary steps were taken to clean tanks and renew supplies ; this number being an increase of five on last year.

2. In his annual report for 1911 to the Port of London Dr. Herbert Williams drew attention to the matter as follows :—

It may be said that the crews' quarters on vessels are habitually overcrowded, when judged by the lowest standard of accommodation which exists or is permitted on shore, which cubic capacity is, in the case of common lodging-houses occupied by day and night, 400 cubic feet, whereas seamen may only have 72 cubic feet per head. The conditions under which seamen on vessels live are particularly favourable for the dissemination of pulmonary tuberculosis, and it would seem that until the legislature takes some more practical interest in the welfare of seamen, pulmonary tuberculosis will continue to be a cause of much mortality amongst this class of men. I have pointed out before that the conditions of life on vessels for seamen can be much improved, especially in new vessels, without much addition to the prime cost of construction. The crews' quarters should be situated above deck, preferably in the after-part of the ship. This position will enable their quarters to be provided with skylights and adequate means of ventilation. Ventilation means the regular supply of fresh air to the inhabited spaces, without the creation of a draught. The present regulations of the Board of Trade merely insist on the provision of a ventilator, which is often situated over a berth, and is generally stopped up from below, or the external opening is covered up with canvas. Complaints are made of the degeneracy of seamen found on British ships. They can, indeed, do little else but degenerate under the present conditions. Persons who travel by steamer, and are enabled to sleep in state-rooms below deck, are often only too cognisant of the imperfect ventilation found in ordinary steamers, even under such favourable circumstances, where the state-room is inhabited usually only for a few hours at night. They can easily imagine the condition of the seamen shut up in

¹ A paper read at the Fourth International Congress for the Hygiene and Salubrity of Dwellings, held at Antwerp, August 31st to Sept. 7th, 1913.

quarters below deck which are practically in constant use as a sleeping, living, and dining room, generally dark, dirty, damp, and encumbered with clothing. In some of the smaller vessels the men have even to provide and to keep their food in their quarters.

3. In the course of his annual report, 1911, Dr. E. W. Hope, the medical officer of health at Liverpool, remarks under the heading, "Diseases Incident upon Sailors; Sanitation of Vessels":—

The diseases to which sailors are peculiarly liable fall under four headings: (a) Those which are caused by the peculiar stresses of the work; (b) those attending the vices to which sailors in foreign ports are particularly addicted: alcoholism and venereal diseases; (c) tropical diseases, including malaria, beri-beri, &c.; (d) those associated with the peculiar environment of the sailor, such as damp forecastles contaminated water-supplies, and the close association of the sick with the healthy in the confined quarters on shipboard.

It is against the latter classes of disease that the efforts of the Port Sanitary Authority for improving the sanitation of vessels are directed.

The defects are classified under three headings as arising from: (a) Faulty construction; (b) wear and tear; (c) lack of cleanliness and nuisance.

A large number of the defects included under the third heading that are found on British ships arise from the crews having been paid off and the forecastles being unoccupied. This is specially applicable to the tramp class of vessel. In the case of ships of foreign nationality or carrying "native" crews the crew are at the time inhabiting quarters where filth or nuisance exists.

For many years I have personally drawn attention to the deplorably insanitary conditions which exist on board merchant vessels. Among the matters referred to in those reports which still demand attention are the following:—

Regulations for ensuring a higher standard of hygiene on the part of both masters and other members of the crew.

The inadequate attention frequently given in the designing of the crews' spaces on new vessels to the elementary principles of domestic hygiene; the accommodation provided on many new vessels being very unsatisfactory and antiquated.

The desirability of the appointment of an Inter-Departmental Committee of the Board of Trade and Local Government Board for considering the whole question of the hygiene of the merchant service.

Ventilation (Annual Report 1912).—This is often very unsatisfactory. The minimum requirements are two ventilators. One deck ventilator and an opening over the door of the forecastle leading into the alleyway is the usual type provided. Unfortunately, in cold weather the only deck ventilator is frequently utilised for the stove pipe. The alleyways leading to the officers' and engineers' quarters are also frequently very badly ventilated. This affects the ventilation of the rooms leading from such alleyways.

Chain lockers.—The filth which is taken on board from docks, wharves, &c., on the anchor chain ferments and gives rise to effluvia, and precautions are necessary to prevent such effluvia contaminating the forecastles, through which these chain lockers usually pass from the forecastle deck above. When these chain lockers are made of wood, as they frequently are, the joints soon separate and allow of effluvia to enter the forecastles from these enclosed spaces.

Ship stores.—The space provided for ship stores is generally very scanty, consequently if there are two water-closets for the men, one of them is often converted into a paint locker, lamp room, or rope stores, &c.

Cubic space.—This could, with advantage and without perceptibly affecting the commercial value of the vessel, be materially increased. When we consider the nature and quality of the ventilation usually provided, 120 cubic feet per head cannot be considered satisfactory.

Floor space.—This is also very inadequate in many modern vessels, including those recently built, so much of the space being taken up with bunks, seats, tables, lockers, pipes, stoves, weekly stores, and the trunks of the crew. Under such conditions it is very difficult to keep forecastles clean and wholesome.

Lighting of crew spaces.—The value of light in domestic hygiene has been thoroughly established, and the Board of Trade Regulations state that every space appropriated to the use of the crew must be properly lighted. The standard upon which surveyors are to judge the adequacy of the lighting is the ability to read the print of an ordinary newspaper in any part of the space when the ship is new and the paint clean. Few vessels would pass such a standard under ordinary working conditions. Most vessels have the bunks fixed against the sides of the vessels, the upper row being placed 6 to 12 inches below the portholes, consequently the lighting of the lower parts of the forecastles is obstructed by these fittings, and in some parts is hardly sufficient to make darkness visible. A great portion of the floor space in particular is very dark. This naturally leads to neglect

in respect to the cleansing of those spaces. This interference with the efficient lighting of the forecastles is not the only objection to the practice of placing the bunks against the ship's side; it also interferes with the use of the portholes as ventilators, as the occupiers of the upper bunks just under the portholes object to the wind and rain beating upon them when the portholes are open. The use of white paint or enamel greatly improves the lighting of crews' spaces; it also renders any dirt visible and draws attention to the necessity for more frequent washing of the woodwork, &c. Lime washing is compulsory in some Indian ports. Unfortunately, its cleansing properties are evanescent and more than counterbalanced by its perishable nature. It cannot be washed or cleaned, is rough, harbours dust, and soon peels off and falls on the bunks, food, &c.

Lavatory accommodation.—The standard of decency in this respect is very low. The type of water-closet so often provided on vessels, even on some of the newest, has long since been condemned by sanitary officials, whilst the lack of facilities for ablutions does not conduce to cleanliness of person. These rough trough-closets, as a rule, are not provided with valves, consequently in rough weather they are liable to get flooded by sea water, in which case the contents get washed on to the floor, or may foul the occupier.

Forecastles.—Continental shipowners in particular are realising the advantages of housing the crew under the "poop" aft instead of in the forecastle forward. In many of the second-hand vessels purchased by continental shipowners from British owners the crew have been transferred aft. The poop provides far more commodious, comfortable, convenient, and much lighter quarters than are available forward. The British Board of Trade have recently revised their instructions to their surveyors who supervise the building of new vessels, but most of the improvements take the form of suggestions, and are not compulsory.

Tuberculosis.—A great fight is being carried on throughout Europe against tuberculosis. One of the great forces in this fight is the provision of healthy houses. The living conditions obtaining on our merchant vessels, more especially the inadequate lighting, ventilation, and cleansing, place the crews at a great disadvantage when exposed to infection from companions suffering from consumption. The disease is certainly very prevalent among sailors and firemen, but correct statistics are unavailable, as many sailors die abroad at sea, and are therefore not included in British vital statistics. Thirty-nine out of 165 cases of sickness which occurred during the voyages or after arrival of vessels at a neighbouring port during 1912 were cases of phthisis. Those men, with the exception of those who died at sea, would have to be dealt with ashore; the conditions of living at sea is therefore a matter which vitally concerns us all, and every endeavour should be made to improve the hygiene of our marine services.

We must bear in mind that the conditions of living on board merchant vessels would be greatly improved by the exercise of stricter discipline and supervision on the part of the masters and officers. International regulations should be framed for ensuring satisfactory domestic sanitation on the part of masters and men. Public health regulations are enforced in connexion with all important trades ashore. This lack of supervision is common to all nationalities more or less, as will be seen from the following summary of the insanitary vessels which were discovered at Newport during the years 1898 to 1908:—

Country.	Average per cent. (insanitary).	Country.	Average per cent. (insanitary).
Denmark	10·5	France	18·5
Norway	11·11	Russia	19·5
Germany.....	11·27	Belgium	20·9
Sweden	11·4	Portugal	22·59
Austria	13·27	Spain.....	26·2
Great Britain.....	13·99	Greece	29·8
Holland	18·3	Italy	32·7

The trade unions which look after the interests of sailors and firemen can assist in this matter not only by educating their members to a higher standard of cleanliness, but also by promoting any reforms which will give masters the power to enforce any rules for better hygiene in the forecastles, which now frequently are rendered unfit for habitation by the action of one or more careless members of the crew.

The Congress has the advantage of meeting in one of the great ports of Europe, and a visit to the docks at Antwerp would satisfy every inquirer on this subject that the matter can only be dealt with satisfactorily by international action. The question of uniformity of action in dealing with the dangers of invasion by cholera, yellow fever, and plague has been the subject of an International Conference which led to a common basis of action, and those regulations are now undergoing international revision. This fact proves that such subjects can be dealt with successfully, and the case for international regulations is much stronger when we consider marine hygiene, as it deals with the everyday life of those who live at sea under very depressing and unsatisfactory conditions which tend to lower the standard of work and to drive self-respecting individuals to seek employment ashore. Such a Conference should not be confined to Board of Trade officials, but should include all interests concerned, in order that the regulations might be satisfactory from the point of view of owners, masters, crew, the Board of Trade, and public health officials.

I sincerely trust, therefore, that this Congress will decide to further the appointment of a small international conference on the subject, and that the Permanent International Committee will, after the Congress, keep it under consideration until definite action is taken in the matter.

Newport, Mon.

THE DETECTION OF SMALL AMOUNTS OF GLUCOSE IN URINE.

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It has been repeatedly demonstrated that by the application of Fehling's test alone one cannot with any certainty demonstrate the existence of a small amount of glucose in a specimen of urine. I have elsewhere enlarged on the fallacies of the test.¹ Briefly stated, they are. 1. Urates reduce Fehling's solution. 2. Creatinine reduces Fehling's solution and also forms a soluble compound with cuprous oxide,² thus preventing the detection of a small amount of sugar. 3. Sodium hydroxide, if present in excess, destroys a small amount of glucose.³ 4. Conjugated glycuronates are hydrolysed to reducing substances by sodium hydroxide. 5. The mixed solution is unstable, and if kept suffers auto-reduction on boiling. 6. The solution is reduced by lactose, a normal constituent of the urine of women during the period of lactation. 7. The solution is reduced by pentoses, which, however, are rarely found in urine.

In the case of a large number of samples of urine as much as 0.5 per cent. of glucose can be added without producing, when tried with Fehling's test, anything more than the greenish cloud that is seen with specimens that can be shown, by more suitable methods, to contain no more than the average normal amount of glucose. It cannot be too strongly urged that for the detection of small degrees of glycosuria Fehling's method is extremely unreliable, and the use of the reagent is almost certain to lead to erroneous conclusions.

In choosing a method to supersede Fehling's one must not lose sight of the fact that normal urine contains a small amount of glucose. The percentage calculated by different methods varies between 0.03 and 0.08. I certainly think that the latter is too high for the samples I have tried, but the exact figure is not material. It is of the greatest importance to be able to determine any excess of glucose, however small, above the normal. Macleod⁴ emphasises this point. "If there really is an excess of dextrose, however small, it indicates that something is amiss with the utilisation of carbohydrates in the organism; it is a danger signal which if heeded and the proper treatment applied, may unquestionably enable us to stave off the incidence of what might afterwards prove a deadly diabetes."

From an extensive series of experiments that I have made I am convinced that of the great number of tests that have so far been devised Benedict's⁵ is the most satisfactory one to use in the great majority of cases. The substitution of sodium hydroxide by sodium carbonate overcomes the first four of the objections to Fehling's solution, and the use of sodium citrate instead of Rochelle salt renders the mixed solution perfectly stable. In fact, the only serious objection to it is that it gives a marked reaction with lactose.

As has been pointed out elsewhere,⁶ a greyish precipitate of urates and phosphates may appear and lead to a slight amount of indecision.

Nylander's test when correctly applied⁷ is also valuable in a negative sense—that is to say, a negative reaction indicates that the condition of glycosuria does not exist. But a positive test is yielded by other substances, and so cannot be relied upon as an indication of the condition of glycosuria.

The phenyl-hydrazine test for demonstrating the presence of glucose is very reliable when correctly performed. But it is almost too delicate. A large number of normal urines yield undoubted crystals of the glucosazone. In this connexion it may be pointed out that the most sensitive method of performing the test in my experience is as follows:

To 10 c.c. of the protein-free urine in a test-tube add six drops of glacial acetic acid, enough solid phenyl-hydrazine-hydrochloride to cover a shilling, and twice this amount of solid sodium acetate. Heat to dissolve and filter into another test-tube. Immerse this in a boiling water bath for 40 minutes. Turn out the flame and allow the tube to cool in the bath for an hour.

I find that the addition of the acetic acid markedly increases the ease with which crystals can be obtained. Binet⁸ uses acetic acid after the use of lead acetate, but I find that the previous precipitation of the urine by lead is of very doubtful advantage.

During the course of another investigation I had occasion to use blood charcoal for the purpose of decolourising urine. I noted the fact that urates and creatinine are adsorbed with great readiness. In many of my experiments I obtained a filtrate containing only about 1 per cent. of the urates and 3 per cent. of the creatinine of the urine, and in some I apparently removed the whole of these substances that so markedly interfere with Fehling's test.

The adsorption of glucose from pure solution by blood charcoal has been studied by Rona and Michaelis.⁹ They find that the addition of 10 per cent. of acetic acid or of 15 per cent. of acetone prevents the adsorption of glucose by charcoal. Andersen¹⁰ confirms this for glucose in urine.

I have investigated the adsorption of glucose and lactose from water and urine under a variety of conditions. Some of the results are given below. The charcoal used was Merck's pure blood charcoal. The adsorptions were conducted at room temperature for 1½ hours in each case. The sugar was estimated by a sensitive polarimeter using both the sodium yellow and the mercury green.¹¹

Glucose.

Per cent.	Per cent. charcoal.	Per cent. adsorbed from water.	Per cent. adsorbed from urine.	Per cent. adsorbed from 10 % acetic acid.	Per cent. adsorbed from urine + 10 % acetic acid.
1.78	6.35	55.5	50.2	1.1	1.7
0.91	4.5	52.5	27.9	0	0.8
0.49	5.0	63.8	31.2	—	—
0.49	5.0	65.0	44.9	—	—
0.36	4.6	65.0	42.2	0	0

Lactose.

1.80	6.35	88.9	77.5	17.9	6.6
0.91	4.5	97.5	76.5	5.3	4.8
0.51	5.0	100.0	86.5	—	—
0.51	5.0	100.0	92.5	—	—

⁵ Stanley R. Benedict: *Journal of Biological Chemistry*, vol. v., 1909, p. 485.

⁶ Macleod, loc. cit., p. 20.

⁷ Cole, loc. cit., p. 161.

⁸ P. Binet: *Jahresbericht für Tierchemie*, 1892, p. 506.

⁹ Rona and Michaelis: *Biochemische Zeitschrift*, Band xvi., 1909, p. 491.

¹⁰ Andersen: *Ibid.*, Band xxxvii., 1911, p. 262.

¹¹ I am indebted to Professor Pope for his courtesy in allowing me to use his apparatus, and to his assistant, Mr. Williams, for help in making the observations.

¹ Practical Physiological Chemistry, S. W. Cole, third edition, 1913, p. 161.

² Hugh MacLean: *Biochemical Journal*, vol. i., 1906, p. 111.

³ S. R. Benedict: *Journal of Biological Chemistry*, vol. iii., 1907, p. 101.

⁴ J. J. R. Macleod: *Diabetes: its Pathological Physiology*, 1913, p. 16.