

The radius of gyration is also calculated from the former set of values of J and compared with those of Rankine, whose radius of mean collision area, as would naturally be expected, is greater than that of the radius of gyration.

The moments of inertia obtained above are thought to have reference to the rotation of the molecule about a line at right angles to the line dropped from the heavy atom on to the plane of the hydrogen atoms and passing through the centre of mass, but in the case of ammonia another and smaller moment of inertia was discovered ($J = 0.35 \times 10^{-40}$). This emerged from a consideration of the band at 10.55μ mentioned above, which forms an exception to the usual tripartite bands in these gases. It is shown in Fig. 2. Thus it has a double Q branch, cloven, with a missing rotation member reminiscent of the bands of the halogen hydrides. The wave-number spacing between most of the rotation fringes is similar to that occurring in bands of the main sequence of bands of ammonia, but there are exceptions, or disturbances. The wave-number difference between the disturbance on the R branch (g) and the centre of the two Q branches (f), thence to a disturbance on the P branch (e), and thence to an isolated band beyond (d), is 160 wave-numbers, this last band having a wave-number four times that of a so-called rotation band of ammonia

found by Rubens and Wartenberg about 160 wave-numbers (63μ). It is therefore considered that there is here the imposition of another rotation system, and as its moment of inertia is much less, it is attributed to the rotation of the hydrogen atoms round a line dropped perpendicularly from the nitrogen on to the plane of the hydrogen atoms.

Finally, it may be said that while the structure of the three molecules, ammonia, phosphine, and arsine appears to be essentially similar, yet there are features in the infra-red absorption spectrum of ammonia which differ from those of the other two, and while the spectra of phosphine and arsine are very like one another, yet they themselves have features not possessed by ammonia.

As most of the work on these gases was conducted at pressures varying from one to one-sixteenth atmosphere, an opportunity was afforded of observing the effect of pressure on the intensity and on the area of the bands. In view of statements in the literature that such a law as that of Beer, which provides for an exponential decrement of intensity with pressure, does not hold for such a case as this, it was of interest to find that when the bands were well resolved this law was obeyed with remarkable accuracy. This would point to the absorption of the imposed radiation by a comparatively small fraction of the total number of molecules present in the gas.

Health and Sanitation in India.

AN Appendix to the Report of the Royal Commission on Agriculture in India has recently been published,¹ consisting of a concise survey of conditions in each of the presidencies and provinces, eleven in all, of British India. One section of each such survey is devoted to public health and sanitation, and of these it is proposed to give a brief account. The Native States are not included in the survey.

The chief feature brought out by these sections of the volume is the tremendously heavy incidence of certain microbial diseases, such as malaria, cholera, and kala-azar, and the high mortality, or in the case of malaria, the severe deterioration in physical well-being and efficiency caused by them.

As regards malaria, the official figures of deaths directly due to this disease are undoubtedly far too high. Thus in the United Provinces about one million (out of a population of $46\frac{1}{2}$ millions) are reported as dying every year of malaria; but "the village watchman [who is the registration authority] ascribes every case of death which he cannot understand to malaria"; still, the actual number of deaths cannot be less than 100,000 annually. The importance of malaria, however, lies rather (apart from the actual suffering) in the reduction of working efficiency, and in its being a predisposing cause of death from other diseases. Thus (again in the United Provinces) one-fourth of the total population get two attacks of malaria every year, and only

1 per cent receive proper quinine treatment; 25 per cent of the population are totally incapacitated for work for two months, besides having a lowered vitality for the rest of the year. The loss of efficiency for the 18 million workers in the agricultural population of 35 millions is put down at 50 per cent.

For six months of the year the delta of Lower Burma is practically entirely under water, and for months afterwards, shallow pools are left scattered about the country. What this must mean for malaria is easily apprehended; and it is not surprising to learn that malaria undoubtedly reduces the working efficiency of a large part of the rural population. In Bengal, too, it is said that for some three months in every year the capacity for labour of a large proportion of the inhabitants of rural districts, especially in western Bengal, is much impaired by attacks of malaria; and that malaria, in lowering the vitality of mothers, is one of the principal causes of the high rate of infant mortality from which Bengal suffers. Similar remarks are made regarding other provinces also.

Cholera is less widely distributed, and in most parts of India less constantly present than malaria. Bengal suffers more than any other province; the disease reappears year by year, and accounts on the average for rather more than 5 per cent of the total mortality. In the neighbouring province of Bihar and Orissa, the mortality rate from cholera is 2.2 per 1000, and the average mortality is nearly 90,000 annually (out of a population of 38 millions). Yet the disease is easily controllable, given a good

¹ "Royal Commission on Agriculture in India," Vol. 14. Appendix of the Report. Pp. vi+432+11 maps. (London: H.M. Stationery Office, 1928.)

water supply and the most ordinary sanitary precautions.

In Assam kala-azar is a special problem, and even takes precedence of malaria in importance; in the nineties of last century it took a terrible toll of life, leaving whole tracts deserted and uncultivated; the population of the district of Kamrup decreased during this period by 7 per cent, and that of Nowgong district by more than one-fourth. There is now an effective treatment; in 1925, 60,000 cases were treated, of which only 6365 died; twenty years ago, practically all the 60,000 would have been doomed to death.

Passing mention may be made of hookworm; in Madras, "in the wet districts, especially where rice cultivation is the main occupation, 80-100 per cent of the people are heavily infected with hookworm. This disease, though not immediately fatal, steadily undermines the physique of the population." In the eastern districts of the United Provinces, 86 per cent of the population are infected by hookworm. Plague we must pass over without comment.

The expectation of life in most provinces is about 21 years; in Madras, however, it rises to 26 years for males and 27½ for females; while in Burma, where the expectation is greatest, it is 31½ years for males and 32½ for females. A comparison with Great Britain may be made by saying that in the United Provinces the general death-rate is 2½ times as high as with us; this, of course, is largely due to the appalling infant mortality.

Along with the above facts must be considered the habits and conditions of life of the people. Of Madras it is said:

"Dwelling houses are badly constructed, devoid of light and ventilation. The houses of the very poor (and these unfortunately form the great majority) harbour both the human and the cattle population under the same roof; and cowdung and house refuse are accumulated in the close vicinity of the houses. In villages which have more than one source of water supply, no particular well or tank is reserved exclusively for drinking water, and pollution by washing, bathing, and by animal and human organic matter is universal. No system of drainage is in practice, with the result that pools form in every depression during the rainy season and stagnate in the hot weather. Of sanitary arrangements there are almost none, so that the soil in and around the village becomes polluted and all waterways are a positive danger. For medical assistance a villager may have to travel miles to the nearest dispensary, unless he is prepared to entrust himself to the administration of the 'quack.' Little wonder, then, that the deaths from preventable diseases reach appalling figures."

Most of this may be extended broadly to the whole of India; as most residents in India must have observed for themselves, the village pond serves for the village cattle to drink at and to wallow in, for young and old to bathe in, for washing the clothes of the village, for cleaning household vessels—and often for drinking also. In the general absence of any system of conservancy, the universal custom of the villagers is to go out in the early morning to relieve nature in the fields; in the larger villages and towns, the fields are not so easily reached.

Let me say, however, that it is unfair to bring a general charge of uncleanness against the Indian villager. The brass cooking-pots of the poorest Punjabi will invariably be kept polished and shining; the courtyards of their houses often look fit to dine off; their ablutions are, of course, far more frequent than those of a European workman; it is simply that they do not understand cleanliness in quite the same sense as an educated European. So it is noted in the present volume that the Burman is by habit scrupulously clean, and the houses are as a rule also kept in a tidy and orderly manner, though here (as elsewhere) there is a tendency to carelessness in the village surroundings.

It is scarcely possible to outline the official measures which exist for dealing with the conditions above described. In all provinces alike there is the regular medical service, with in each district a chief hospital and a number of subsidiary hospitals, a civil surgeon, and a number of assistant surgeons; and in all provinces, too, there is now a department of public health, with a director and a number of subordinate officers. But the organisation of the public health service varies too much from province to province to allow of any short or general description. A few points may be selected for comment.

The inadequacy of the public health staff is acknowledged in several provinces. Thus in Burma, though the department is said to have been very substantially strengthened, it still appears to consist only of the director with two assistant directors, and in most districts the civil surgeon combines the functions of health officer with his own proper duties; recently, 16 sub-assistant surgeons (officers of a lower grade than the assistant surgeons, who have not gone through the medical course for a degree) have been placed at the disposal of the department, "but this number must be very much increased if any impression is to be made on the province." In the Central Provinces, there are no district health officers, and want of funds is complained of; "there is a Village Sanitation Act which is applied to a few villages, and funds are collected and spent on cleaning village sites, wells, etc. But no schemes of an extensive nature can be carried out." In Assam, where it is said that, next to kala-azar, malaria is probably the most potent enemy to human life, *in a few localities* (italics are mine) special antimalarial measures such as the clearance of jungles and undergrowths, the improvement of drainage, and the treating of sheets of water with kerosene, are being carried out by Government and by tea companies. In Bihar and Orissa "it is not easy to get district boards to realize their responsibilities, and the percentage of the board's expenditure on sanitation to their total income shows no tendency to increase."

A serious fact is the shortage and high price of quinine. This drug is generally available at the post offices, where it is sold at or below cost price. In Bengal it is reported that the total amount so

sold is very small—from 0·7 to 2 grains per individual per annum in different parts, while on the scale of the Italian consumption 8 to 20 times, and on that of the Greek, 30 to 90 times, as much should be consumed. It must be added, however, that distribution of quinine is also carried out by local authorities, antimalarial societies, and other agencies, and the total amount so distributed is now somewhat greater than that purchased through the post offices. In the United Provinces it is said that the chief requirement for combating malaria is a very much larger quantity of quinine, available at a very much lower price; "in 1921, the total stock available for the whole of India was 160,000 lbs.; double this quantity would be required for the United Provinces alone." In Madras "people are well aware of the value of quinine as a specific against this disease, and were it available in sufficient quantity, and at a price within the means of the people, it would be widely used. But in present conditions the cost of any scheme of general distribution is prohibitive." The actual price charged, in Assam for example, is 4½ annas (about 5d.) for 80 grains; the amount of quinine required, according to modern ideas, for the adequate treatment of even a single attack of one member of a family makes a large hole in a monthly income of, say, 20-30 rupees.

The official agencies are in many provinces doing a large amount of propaganda work, and are endeavouring to instil into the people the elements of hygiene, and the knowledge of the causation of disease and of simple measures for its prevention. In Assam much work is done by the kala-azar staff among the public and in the schools by means of lantern lectures and the distribution of bulletins, pamphlets, and pictorial posters. In the Punjab the village schoolmaster has been enlisted for propaganda. In the Central Provinces lectures are given by health publicity officers. The institution of 'Baby Weeks' and 'Health Weeks' appears to have become very generally popular throughout the country; in Madras, for example, the 'weeks' are run according to a model programme drawn up by the Director of Public Health; "the movement has appealed to the general populace in an extraordinary manner, substantial evidence of which is forthcoming in the increasing volume of funds raised by private subscription."

Unofficial agencies are also responsible for much good work in certain provinces. Foremost come the antimalarial societies of Bengal, which began in 1917, and comprised at the end of 1926 some 300 registered and 700 'live' unregistered societies. These seek to awaken the villagers to the necessity and the possibility of improving the health of their villages by their own efforts; they believe in practical work, and undertake to kerosene ditches and tanks, excavate drains and track out malaria 'carriers' for remedial treatment. In Madras in 1927 numerous lectures were delivered, posters and leaflets were distributed, and in some cases lanterns and slides were provided; presumably the greater part of this activity was due to private enterprise.

The series of provincial surveys which we have been considering has an informative purpose only, and is not intended either to emphasise the seriousness of the conditions or to put forward plans for dealing with them. Speaking in the most general terms, which alone is possible here, measures for alleviation must proceed on three lines.

(a) The continued prosecution of research in preventive medicine—a matter which is more especially the charge of the Government of India and provincial governments. There is no doubt that the governments on the whole, and especially the Government of India, recognise their duties in this respect; the maintenance of the Central Research Institute at Kasauli as well as other more recent institutions, the establishment of the School of Tropical Medicine in Calcutta, the appointment of the kala-azar inquiry, etc., are sufficient evidence of this.

(b) The provision of larger funds for more adequate staffing of the public health departments of the several provinces, and for the carrying out of pure water, drainage, and other health schemes. But sanitation must take its place along with administration, justice, police, education, public works, etc.; and therefore the possibility of such a provision depends in the first place on the economic prosperity of the country; all measures that increase this prosperity—the improvement of agriculture, the provision of more adequate communications, etc.—tend also to increase the possibility of doing more for the public health.

(c) Lastly, the most important factor in the improvement of the public health must be the education of the people. The Indian people have now, through the elected members of the provincial councils, as well as through the district boards and municipalities, a considerable voice in the disposal of provincial and local funds; expenditure on sanitation may not at once produce spectacular results—a gradual diminution of the death-rate, even if it is apprehended, is not a matter that makes an immediate appeal—and may involve violence to age-old customs; money is therefore not likely to be voted for sanitation until the people have been taught to appreciate the benefits that adequate sanitation bestows.

Much, very much, can also be done by the people, even apart from expenditure of public funds, if, as is happening in many places, they can be induced—by lectures, lantern demonstrations, exhibitions, lessons in school, posters, pamphlets—to take an interest in health matters and act for themselves. Possibly more potent, though acting more slowly, than all else would be the penetration of the masses of India by a rational system of general education, which would alter the habit of mind of the whole population, and lead them to substitute for the ideas of chance and fate that of cause and effect, to think backwards from the facts of disease and debility to the conditions of which they are the natural and necessary consequence, and to exchange the insouciant attitude of to-day for a reasonable activity directed to shaping their own welfare.

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