## LOSS OF NITROGEN FROM SEWAGE

THE major part of the nitrogen present in food materials ultimately finds its way into sewage. The daily discharge of sewage from the major cities of India, with an aggregate population of about 45 millions, may be estimated to be about 450 million gallons and this would contain roughly 90 tons of nitrogen in combination. This, in turn, would be equivalent to 425 tons of ammonium sulphate per day or 1,54,760 tons per annum. If similar discharges from the smaller towns and major villages are included, the total equivalent of nitrogen would be considerably more. The aggregate amount of nitrogen would thus be considerably more than the amount of the synthetic fertiliser proposed to be manufactured in the country.

In our earlier communications,[1–3] we have drawn attention to the loss of nitrogen from Indian soils. Even nitrogen fixed from the atmosphere is not stable and is steadily lost.[4,5] We have observed that nitrogen of sewage is also rapidly lost. The loss occurs under all conditions—aerobic, semi-aerobic and anaerobic—though the extent of loss is variable and seems to be at a minimum under controlled aerobic conditions. It takes place in treatment tanks, during land irrigation and during sewage farming. During intensive aeration, there is an initial conservation as observed by Fowler and associates[6]; but when the aeration is prolonged, there is steady loss of total nitrogen (over 75 per cent.). Under anaerobic conditions, represented by the septic tank, a very large part of the nitrogen occurs as free and saline ammonia and this is rapidly lost on exposure to air. Similar changes occur during land filtration, the sewage being largely septicised before reaching the beds. There is also heavy loss of nitrogen during sewage farming. The soil accumulates very little nitrogen even after several years of farming. The loss is quite heavy, even allowing for the removal of nitrogen in the form of crops. The following results illustrate the position in regard to three farms (**Table I**).

TABLE I

*Nitrogen contents of soils under sewage for varying periods*

| | Calculated quantity of sewage nitrogen (N) applied to soil per acre in lbs. | Calculated quantity of nitrogen removed by grass in lbs. | Nitrogen retained in the soil as determined by analysis (in mgm. per 100 gm. of air-dry soil, taken from 0–9") | Quantity of nitrogen retained in the soil per acre as calculated from the analytical* figures in lbs. | Calculated loss of nitrogen per acre in lbs. rounded | | The loss of nitrogen from sewage in terms of ammonium sulphate per acre in lbs. rounded | |
|---|---|---|---|---|---|---|---|---|
| | | | | | During the whole period | Per annum | During the whole period | Per annum |
| *Madura Sewage Farm* | | | | | | | | |
| (*a*) Virgin soil from the area adjoining the Madura Sewage Farm | Nil | Nil | 47·8 | .. | .. | .. | .. | .. |
| (*b*) Under sewage for 18 years | 64,800 | 18,000 | 97·2 | 894 | 46,000 | 2,600 | 2,16,000 | 12,000 |
| *Bangalore Sewage Farm* | | | | | | | | |
| (*a*) Virgin soil from the area adjoining the Govt. Sewage Farm | Nil | Nil | 24·4 | .. | .. | .. | .. | .. |
| (*b*) Under sewage for about 25 years | 90,000 | 25,000 | 58·2 | 676 | 64,000 | 2,600 | 3,03,000 | 12,000 |
| *Experimental Plots at the Institute* | | | | | | | | |
| (*a*) Virgin soil from the area adjoining the Sewag Fearm | Nil | Nil | 87·9 | .. | .. | .. | .. | .. |
| (*b*) Under sewage for 2½ years | 9,000 | 2,500 | 107·1 | 384 | 6.000 | 2,400 | 29,000 | 12,000 |

* Taking one acre as being equivalent to 2 million pounds of soil.

The figures given in the above table, excepting the analytical data, represent approximate calculations. The farms referred to receive a minimum of 15,000 gallons of sewage per acre per day. This would correspond to 3,600 lbs. of nitrogen per acre per annum. Allowing for a maximum cropping of 120 tons of grass per annum (which has not been possible under the conditions at Bangalore), the nitrogen thus removed would correspond to 1,000 lbs. The total nitrogen removed in drainage would approximate to 500 lbs. The major part of the remaining nitrogen is lost.

The loss goes on with continued day-to-day application to soil. Even in the absence of drainage and crops, there is steady loss as may be seen from repeated application at four-day intervals. The added nitrogen should have contributed 32 mgm. per 100 gm. of soil at the end of 24 days, but actually it was found to be only 5 mgm. per 100 gm. There was a tendency for the nitrogen level to remain stationary after the first fortnight, thereby showing that, under normal conditions, the rate of destruction tends to increase.

We have found that the major part of the nitrogen is lost in the form of ammonia. This occurs most rapidly when septicised sewage is spread over the soil on a warm day. If this loss could be prevented or, at any rate, the nitrogen made fully available to the immediate crop, there will be greater return in the form of plant food.

If the ammonia could be neutralised in some simple and automatic manner, there will naturally be less rapid loss from the soil. An alternative would be to ensure the presence of a dense vegetation that will continuously utilise the nitrogen of the sewage. Fodder and forage crops, as also leafy vegetables, respond best to sewage, but even these could not utilise all the nitrogen. There will be greater economy—without sacrifice of yield—if the same crops could receive diluted sewage. At least double the area could also be brought under sewage farming and the loss of nitrogen could be considerably reduced. If all the three steps, *viz.*, neutralisation of ammonia, dilution and a dense leaf crop could be combined, the loss could then be further reduced.

If the sewage is to be subjected to any pretreatment, then the most efficient system would be to intensely aerate and then to remove the sludge. The sludge would conserve the maximum amount of nitrogen and if it can be dried without reverting, then nitrogen loss will be at a minimum. The effluent will then contain only a small fraction of the total nitrogen. In this respect, the Activated Sludge Process is the most attractive among those so far devised.

S. C. PILLAI.
R. RAJAGOPALAN.
V. SUBRAHMANYAN.

Department of Biochemistry,
Indian Institute of Science,
Bangalore,
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1. Sreenivasan, A., and Subrahmanyan, V., *Jour. Agri. Sci.*, 1935, **25**, 6. 2. Subrahmanyan, V., *Nature*, 1937, **139**, 884. 3. Sreenivasan, A., and Subrahmanyan, V., *Proc. Nat. Inst. Sci.*, 1937, **3**, 219. 4. Bhaskaran, T. R., and Pillai, S. C., *Science*, 1939, **90**, 595. 5. —, *Jour. Ind. Inst. Sci.*, 1945, **27A**, 1. 6. Fowler, G. J., *Ibid.*, 1920–21, **3**, 227.

# REVIEWS

**Notes on Microscopical Technique for Zoologists.** By C. F. A. Pantin. (Cambridge University Press), 1946. Pp. viii + 1-73. 6*Sh.* net.

There are many books available for guidance in microscopical technique but most of these, while exceedingly helpful to the experienced student, are often confusing to the beginner. A large variety of techniques is often described without judicious emphasis on whether a procedure is best suited for routine or for research on specific problems. This was largely the result of the high standard of scholarship maintained in the first and subsequent editions of Bolles Lee's *Microtomist's Vade Mecum* which was the precursor of many similar publications. The present book gives an account of methods found most satisfactory at the Zoological Laboratory, Cambridge, during the course of routine instruction and research.

The book is divided into a section describing the general methods of observation for living objects, fixation, sectioning, staining and reconstruction and another devoted to special methods for the demonstration of nerve cells. cytoplasmic inclusions and other specific constituents. This is followed by an appendix giving methods of preparation of saline media and cultivation of organisms. A very commendable feature is the emphasis given throughout these notes to the Chemical and Physiological principles on which the different methods are based. Most of these have been brought up-to-date and the improvements in microscopical technique effected by British workers in recent times have been incorporated. The descriptions given are brief and lucid. In a work of this kind one is bound to feel that something or other might have been added with advantage to those already included but this is no fault of the author who was confronted with choosing a few successful methods from a large number for the special benefit of students and those starting research in Zoology.

Pantin's book deserves a place in every laboratory bench where its frequent use as a guide for microscopical work seems assured.

N. K. PANIKKAR.

**THE B.D.H. Book of Organic Reagents.** (Ninth and Enlarged Edition.) (The British Drug House, Ltd., Graham Street, London N-1.) Pp. 196. Price 4/6.

With the development of the utilization of micro-methods in analytical chemistry, recent years have witnessed the use of innumerable organic reagents which are becoming increasingly important in delicate analytical practice. In the book under review, which is the ninth and enlarged edition of the Book of Reagents, published in 1932, directions for the use of 71 of the important organic reagents are given. Adequate descriptive matter relating to spot tests as applied to micro-analysis, clear working details for many colorimetric determinations, a number of methods of analysis in which organic reagents are used, new and improved directions for the use of many of the organic reagents utilized in analytical practice, comprehensive and up-to-oate bibliography to include relevant methods in published literature appended for each reagent and finally alphabetically listed index of compounds are the salient features of this useful book.

Organic reagents such as dihydroxy-tartaric acid osazone included as a reagent for the detection of calcium in the previous edition, has been omitted since experience has shown that it had but limited value over more orthodox methods. Phenyl-thiohydantoic acid used for the determination of cobalt, phenylamino-benzene-azo-benzene sulphonic acid employed for the colorimetric determination of magnesium, have been omitted for similar reasons. Four additional organic reagents, *viz.*, tri-keto-hydridine hydrate for the determination of free amino acids, 8-hydroxyquinaldine useful for the gravimetric determination of zinc, benzyl-isothiourea hydrochloride for the characterization of sulphonic acids, *p*-nitro-benzene-azo-orcinol for the evaluation of minute quantities of beryllium in alloys are included.

The book has been skilfully compiled; not merely rearranging the matter previously published, but significant changes in the methods previously published, new and improved directions to include up-to-date procedures in analytical practice have been incorporated. This book can be unreservedly recommended to chemists and workers associated in conducting delicate chemical analysis.

M. S. MUTHANA.

**Snow Balls of Garhwal.** (The Universal Publishers Limited, Lucknow), 1946. Pp. 87. Price Rs. 3-12-0.

Notwithstanding the uninterrupted march of modern science and concomitant economic and cultural progress the effects of which are strikingly and prominently visible in the different strata of societies influenced and moulded by such progress, there exist even to-day specifically patterned tribes and sections of humanity living in hills and jungles their own curious lives untouched by the forces that constitute the so-called modern civilization scientific and systematic study of which is bound to throw considerable light on the evolution of mankind in general and the penetration of civilization in particular to the nooks and corners of social organizations. Thus, from the standpoint of Sociology and Anthropology, the studies brought together in the volume under notice are bound to be of immense interest to all students of mankind. The volume under notice stands in TWO parts. The FIRST part opens with a discussion and constructive elucidation of the basic and essential characteristics of the different tribes by D. N. Majumdar, who, writing under the heading "*Malaise* of Culture", points out that there are "over THIRTY-MILLION