Ophthalmology," Melanowski; "The muco-cutaneous junction of the lid-margin and the distribution of the tear fluid," Eugene Wolff; "Is tobacco amblyopia a deficiency disease?" Schepens; "Some recent developments in artificial eyes," Fincham; "Two cases of exogenous tubercular conjunctivitis displaying Parinaud's conjunctivo-adenitis syndrome," Healy; "Proliferation of the epithelium of the lens," Samuels; "Detachment following inflammation," van Heuven; "Four patients showing two types of hereditary cataract in one family," Lloyd Johnstone; "The state of the retina in diabetes mellitus," Ballantyne; "Partial thrombosis of central vein," MacRae; "Resection and recession in treatment of squint," Marshall; "Divergent strabismus," Duthie; "Retinal vascular changes studied in bulk," Loewenstein; "A binocular ophthalmoscope for the examination of detachments of the retina," Schepens; "Binocular scotometry," Zade; "Pituitary tumour: deep x-ray irradiation," J. H. Young; "A case of osteopetrosis (Albers-Schonberg as described in 1904)," J. N. Wheeler; "Conservation of the wounded eye, excluding retained foreign bodies," Goulding; "The organization of army ophthalmology in India," Bridgeman; "Lime burn of conjunctiva and cornea treated with amnio-

plastin graft," Lavery; "Ocular and general manifestations resulting from the manufacture of sesquisulphide of phosphorus," Fahy and Lavery. *A. L.*

A Short History of Ophthalmology. By Arnold Sorsby. Second Edition. 1948. London: Staples Press Ltd. Pp. 103, with diagrams. Price 8s. 6d.

In an introductory chapter the author traces the science of ophthalmology from the Babylonian period of 2,000 B.C. through the Egyptian, Greek, Arabian, and dark-age periods, to the modern era of rapid advance which began in the seventeenth century. In the succeeding chapters the anatomy, physiology, and pathology of the eye, cataract, glaucoma, and therapeutics are followed over a similar course. There are further chapters on spectacles, the ophthalmoscope, and British ophthalmology.

In spite of the large amount of information condensed into ninety-one pages, the book is readable. It is sufficiently comprehensive to provide a working knowledge of the subject for the general reader and to form a framework for those whom it may stimulate to learn more. It has the added advantage of easily fitting a pocket. *A. L.*

BRITISH AND FOREIGN OFFICIAL PUBLICATIONS

Industrial Fluorosis. A Study of the Hazards to Man and Animals near Fort William, Scotland. By John N. Agate, G. H. Bell, G. F. Boddie, R. G. Bowler, Monamy Buckell, E. A. Cheeseman, T. H. J. Douglas, H. A. Druett, Jessie Garrad, Donald Hunter, K. M. A. Perry, J. D. Richardson, and J. B. de Weir. 1949. M.R.C. Memorandum No. 22. London: H.M. Stationery Office. Pp. viii+131. Illustrated. Price 4s.

The sequence of events which commonly leads to a detailed study of a hazard in industry begins with suspicion that a particular operation (or group of operations) bears a significant correlation to the incidence of pathological effects observed in the operators. It is probably very rare for the sequence to begin with unsought-for effects on animals. Inasmuch as animals are involved in routine toxicological studies, their contribution is usually to confirm the pathological effects or to offer facilities for the analysis of the disturbances brought about by the toxic product. There is, however, a sense in which animals should enter first in the sequence by yielding information on the materials involved, before adverse effects on workmen can result from exposure to them. Such an approach to industrial toxicology is not easy but is becoming more generally recognized. The traditional way of waiting until disease or death is reported among exposed workers is still too frequently adhered to.

This Report to the Fluorosis Committee deals with the results of four years' work on the hazard of fluorosis in an aluminium factory in Scotland, from the manage-

ment and personnel of which no complaint of illness or poisoning had been made. A considerable literature existed on the toxic effects of fluorides which, whether exhibited in factories as dust and fume or in the water ingested by populations living in areas with high concentrations of fluorine, lead to striking changes in the skeleton, teeth, and ligaments. Had it not been for the fact that in 1943 and 1944 various crofters and farmers from the areas round the factory complained of a mysterious debility of their sheep and cattle, the present study of men and women in the factory might not have been undertaken. Although it is fair to say that the careful clinical and radiological observations on factory operatives and on inhabitants in the surrounding country did not bring to light marked or disabling degrees of fluorosis, sufficient deviation from normality was discovered to suggest that the earlier stages of the disease had already been reached in a high percentage of the workers.

The chemical hazards (gaseous and particulate fluorides) arising in the electrolytic separation of aluminium from alumina (Al_2O_3) dissolved in a bath of fused cryolite (Na_3AlF_6) may be divided into those arising from the electrolytic furnaces and discharged into the working room, and those discharged from the factory from the fume extraction plant. The latter appear as a cloud rising from the factory and, according to the wind prevailing, give rise to different patterns of concentrations in the atmosphere. The curves of concentration gradient from the furnace rooms in the factory to one mile into the surrounding country were more or less identical for

gaseous and particulate fluoride. The fall is steep, so that at two hundred yards from the factory the concentration is about 15 per cent. of the mean concentration in the furnace rooms, and at one mile it is only 3 per cent.

Many analyses were made of soil samples up to seven miles from the factory, at which distance to the north-east the fluorine concentration was still over four times the control values, the prevailing wind being south-west. At some three miles to the north-west the fluorine content was at control levels. Correspondingly the fluorine content of grass samples was highest in the north-east regions and this is, of course, the main source of excessive fluoride ingested by animals grazing in pastures round the factory area.

The high fluoride deposition on (and to a high degree penetration into) the pasture lands led to severe dental lesions and bone fragility in the animals, the former being established only in animals which had access to the fluoride contaminated pastures before their permanent teeth had formed. The bone dystrophy, however, occurred even in animals coming to the pastures late in development.

The dental changes, mottling, distortion, deformity of the incisors, and excessive wear of the cheek teeth led to selective abrasion so that the teeth developed long points and, by interlocking on opposing jaws, prevented the lateral grinding movements which are essential to the process of chewing the cud. The consequent chronic indigestion and distension of the rumen led to a form of starvation with debility and emaciation. Enormous quantities of fluorine were found in the teeth, mandibles, and ribs, the ratio to maximum normal values being from about 20 to 90. The investigators take the view that fluoride absorption is not in itself the cause of the debility and loss of weight, but that these arise from the failure of successful cud chewing due to dental disease, since mature animals put on the contaminated pastures remained unaffected.

Multiple fractures of ribs, mandible and pelvis in the affected animals were recorded. The assimilation of fluorine in some peculiar way leads to weakening of bones. Some evidence from animal experiments indicates that fluorine brings about disturbances in calcium and perhaps phosphorus balance; thus, bones of pigs fed on fluorine contained low calcium and high phosphorus: rats fed on fluorine retained much less calcium and rather less phosphorus, and excreted far more calcium in the faeces than did controls. Some evidence has also been obtained that an increased dietary calcium (0.23 per cent. raised to 0.73 per cent.) can diminish the assimilation of fluorine added to the diet: this effect is especially noticeable in the teeth and soft tissues. A fivefold increase of dietary phosphorus had no such effect when calcium was maintained constant.

Whilst a great deal has been reported on the pathological effects of fluorine in both man and animals, it is still far from clear why the fluorine becomes deposited in bones and teeth, how calcifications take place in ligaments, and what stimulates the formation of exostoses.

In Part V of the Report to the Fluorosis Committee very interesting measurements are given of the strength of bones (breaking stress, bending moment, and modulus of elasticity), taken from fluorotic and control animals. Strong evidence is given of a relation between the reduction in breaking stress and fluorine content of bone. The bending moment remains high until the bones contain very high fluoride: the breaking stress, however, falls steadily with rise in fluoride. Since the breaking stress $\propto$ bending moment/ δ^3 , where δ = smallest external diameter, it is reasonable to suppose that as the fluoride

content rises there is some "compensating" increase in the transverse linear dimensions of the bone. Such an alteration of the bone would be useful in balancing the loss of strength and exostoses could, as the authors say, be regarded as a local over-activity of this process. Although teleology is not the heresy it used to be, one should be cautious in using such terms for a process which must in the last analysis surely be chemico-physical, it being merely fortunate that the fundamental properties of bone permit a "compensation" to be established. Teeth cannot "compensate," and so the animal finds little comfort in the teleology of bone.

The team handling the clinical and radiological side of the investigation soon met the stupidity (from which none of us can claim full immunity) which is the heart-break of every mass investigator. Many refused to co-operate at all, and many of those who did co-operate dropped out as the investigation proceeded. Various subterfuges had, therefore, to be employed to make even the elementary statistics collected yield comprehensible conclusions. There could be no doubt that the workers in the less modern furnace rooms inhaled a good deal of fluoride and correspondingly had a high urinary excretion of fluoride. Some of the older men who had been exposed to high concentrations of factory fumes for many years showed gross radiological abnormalities of the accepted fluorosis type. But the authors are cautious about minor degrees of abnormality and prefer to group them as abnormal x-ray appearances and to seek correlations with them. It was then found that of the furnace workers 25 per cent., of the general factory workers 8.3 per cent., of the local residents 4 per cent., and of the local school children 0 per cent. of those x-rayed showed abnormalities. *No case of clinical disability was found*, but the investigators consider that the x-ray findings are a sufficient warning of developments likely to come. Considering, however, that they radiographed thirty-three men of ages 30 to over 50 who had been fully exposed in the furnace rooms for a mean time of twenty-four years and of whom 66.7 per cent. (misprinted twenty-three years and 33.3 per cent. in Report, Table XXXVIII) showed abnormalities but no clinical disabilities, the outlook for the other workers does not seem too gloomy.

"Within the factory there was very little evidence of organic disease of a general nature and still less of abnormal physical signs which could be attributed to occupation. The same high standard of fitness was seen also in the residents from the surrounding district."

A careful dental examination of a large number of adults and children living in the areas round the factory revealed no abnormalities among the adults and, although 5.6 per cent. of the children showed mottled teeth, this figure did not differ sufficiently from that found in other areas to make it significant. Among the workers in the factory the dental findings did not suggest any effects of fluorine.

There is some feeling of anticlimax in this Report, a happy anticlimax in that the serious disabilities which could reasonably have been expected among the workers were not, in fact, found. The authors' conclusions are mild, and they go no further than to admonish people to keep themselves and their animals away from the contamination and to recommend the factory management to reduce the amount of fluorine to which their workers are exposed.

An uncritical review of the literature and a description of the analytical method for the determination of small quantities of fluorine are appended to the Report.

M. W. Goldblatt.