disruptive elements. The biology of the work, however, greatly diluted as it is, shows us Swammerdam at his best. He appears to have started work on the mayfly as early as 1667. The anatomy of the small nymph is beautifully worked out, and in this respect Swammerdam is clearly superior to Malpighi. In addition, the curious life-history, in which the brevity of the adult stage is contrasted with the exceptionally long larval period, is laid bare for the first time. This work is also included in the "Biblia Naturæ".

The posthumous "Bible [not Book] of Nature" owes its name probably to its sponsor Boerhaave, and the detailed and accurate plates are the work of an artist employed by the author. One of the Ephemera plates, however, is signed "Auctor del". In all, eight editions were published, including German, French and English translations. It is impossible in this brief notice to refer to more than a few of the topics which are investigated in this stupendous work. Its plan, based on selected types, is monographic, comparative and experimental, and it is undoubtedly the foundation of our modern knowledge of the structure, metamorphosis and classification of insects. In addition, there are valuable observations on Crustacea, Mollusca and the life-history and anatomy of the frog in both larval and adult stages. Swammerdam spent some five years on the hive-bee, dealing with the anatomy, life-history and general economy of that much investigated animal, and his account of it is the most trustworthy and comprehensive we have had from any one man. It would, in fact, rank high even if judged by modern standards. In 1668 Swammerdam had already discovered by skilful dissection that an insect larva, pupa and imago may *at one stage* of the life-cycle exist simultaneously one within the other like a nest of boxes, and he had also studied experimentally the conditions which induce and regulate moulting and metamorphosis. His consequent assumption that no new parts are formed, and that the perfect insect is there *all the time*, led him to adopt the Preformation doctrine, the long and evil reign of which lies so heavily on his reputation. Swammerdam severely criticizes Harvey's views on metamorphosis, esteeming him at "little less than nothing", and stating that his work on generation contains almost as many errors as words. Harvey's philosophy of generation may have been, as Vallisneri says, "encrusted with Aristotelian pitch and heavy with rust", but it was the deadly blight of Preformation that stopped the clock.

Swammerdam accidentally stumbled upon the mimetic resemblance of certain Diptera to bees, and he found that some Lepidopterous egg masses might give rise to flies instead of caterpillars, which is the earliest record of egg parasites. He observed also in the case of the frog the first cleavage of the ovum, and noted the cellular structure of later stages. He admits, however, that blood corpuscles had been known for "some years" before he saw them, but does not give the source of his information, which could scarcely have been Leeuwenhoek. He certainly found the oval blood corpuscles of the frog before Leeuwenhoek. His ingenious neuro-muscular preparation (1668) by which he studied the relation of muscle and nerve, and the nature of muscle contraction and the nerve impulse, enabled him to refute the current belief that muscular action was due to a material substance reaching the muscle via the nerves, and in his experiments on the contraction of the heart and muscle he invented a form of plethysmograph. These results alone would entitle him to be regarded as one of the founders of experimental biology. But to the discoveries which are to be found in the "Biblia Naturæ" there is almost no end.

Chemical Exploration of the Stratosphere*

By Prof. F. A. Paneth

OUR prospect of finding differences in the chemical composition of the air is, of course, better the higher the sample is obtained in the stratosphere. An important part of the whole research is therefore the collection of air samples from great altitudes. For this purpose, sending up automatic devices in unmanned balloons is the most efficient method. Aeroplanes cannot attain sufficiently high altitudes; even Squadron Leader F. R. D. Swain in his record flight last September reached only 15 km., and the inconveniences of an airtight suit preclude complicated scientific operations. Balloon ascents in closed gondolas, as introduced by A. Piccard in 1931, give more freedom for observations, and can attain greater heights. A year ago, Capt. Stevens and Capt. Anderson in a stratosphere flight arranged by the National Geographic Society and the U.S. Army Air Corps reached 22 km.; but it cannot be said that the scientific results of the expedition justified the immense costs. The varying conditions of the atmosphere make numerous observations necessary, and only the cheap flights of sounding

* *Continued from p.* 182.

balloons can be repeated frequently enough; moreover, they can ascend far higher than manned balloons. (Heights of more than 30 km. have been recorded.) Fig. 2 shows the altitudes so far

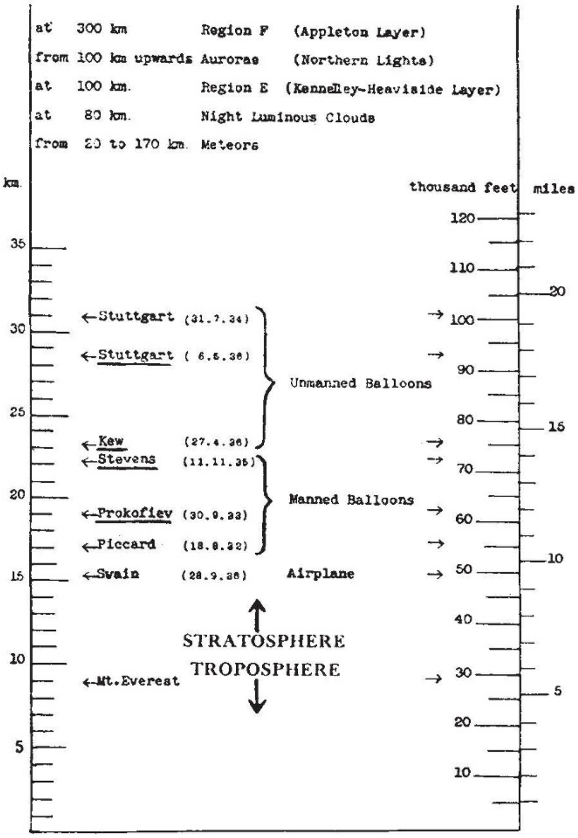

Fig. 2.

CHART OF STRATOSPHERE FLIGHTS. AIR SAMPLES WERE OBTAINED ON THOSE WHICH ARE UNDERLINED.

reached by the most successful flights of aeroplanes, manned and unmanned balloons. The flights from which air samples have been brought back are underlined. A number of other air samples collected by sounding balloons are not recorded in the figure; the heights attained can be seen in Table 3.

For the automatic sampling quite a simple device is sufficient. The one used in the joint work of the Meteorological Office of the Air Ministry, and Dr. Glückauf and I working at the Imperial College of Science and Technology, is represented in Fig. 3. A detailed description has been given by Mr. L. H. G. Dines of the Upper Air Section of the Meteorological Office, who launched the balloons from Kew Observatory[1]. The device comes into operation after the sounding balloon has burst at the top of its flight; an extension of an evacuated glass bulb is then broken, and air is sucked in while the vessel, attached to a parachute, begins to fall; after an interval of 10–15 sec. the extension is sealed again. In Fig. 3 on the right-hand side are to be seen the parachute, the bamboo cage and the aluminium cylinders which contain the glass vessel and a Dines barothermograph; on the left side are the glass vessel (volume about 500 c.c.), and the electrical arrangement for breaking the extension and for sealing the bulb again; this latter is effected by means of a heating coil which surrounds the lower part of the glass stem and fuses a particular kind of sealing wax contained inside. If the mechanism functions satisfactorily, the pressure of the air inside the vessel should correspond within certain limits to the highest value of the barographic record.

These flights have been in progress since 1935. From the first results, published a year ago[2], it was concluded that up to 18 km. no definite change in the chemical composition of the stratosphere occurred, but that at a height of 21 km. the relative amount of the light gas helium is already distinctly increased. During the past year, this has been confirmed by further successful flights reaching more than 23 km.[3] Similar investigations

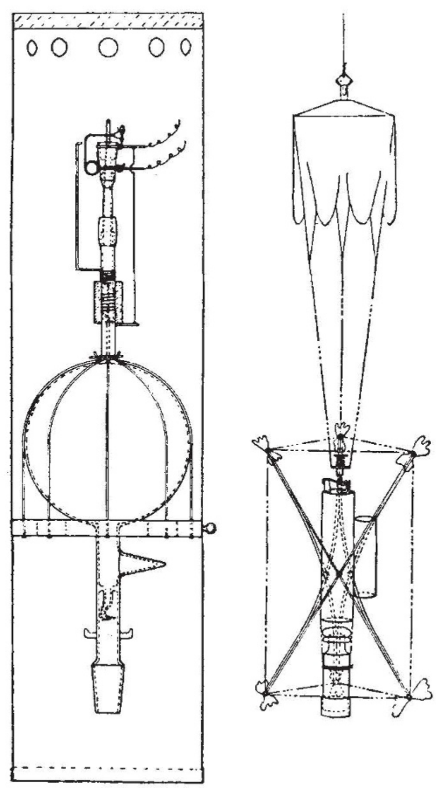

Fig. 3.

APPARATUS FOR SAMPLING STRATOSPHERE AIR.

have lately been carried out by Prof. E. Regener in Stuttgart[4], using larger balloons; in his samples, one from a height of more than 28 km., he determined the oxygen content and found deficits, in good agreement with the helium surpluses detected in the London flights. The only two air samples obtained by manned stratosphere balloons also confirm our finding: a sample collected over Russia by Prokofiev in 1933 at a height of 18·5 km., and analysed by A. A. Čerepennikov and by A. B. Moskvin, showed no variation in its composition[5]; but the air brought back by Capt. Stevens from 21·5 km., and analysed with great accuracy by M. Shepherd[6] of the National Bureau of Standards in Washington, revealed a slight oxygen deficit.

TABLE 3.
HELIUM AND OXYGEN CONTENT OF THE ATMOSPHERE AT VARIOUS ALTITUDES.

Height in km.	Helium[2,3]		Oxygen	
	Per cent by vol.	Variation (per cent He)	Per cent by vol.	Variation (per cent O_2)
0	$5 \cdot 27 \times 10^{-4}$	0	20·945[8]	0
			20·92[4]	0
9–16·8			20·92[7]	0
14·5			20·89[4]	−0·14
16·7	5·30	+0·5		
18·5	5·31	+0·7	20·95[5]	0
			20·84[4]	−0·38
19			20·87[4]	−0·24
21	5·64	+7·0		
21·5			20·895[6]	−0·24
22	5·49	+4·1	20·57[4]	−1·7
	5·53	+5·1		
23·4	5·49	+4·2		
24			20·74[4]	−0·86
28–29			20·39[4]	−2·5

In Table 3 all reliable data about the helium and oxygen content of stratosphere air are brought together. In addition to the results already mentioned, the figure found by Lepape and Colange[7] for the average oxygen content of samples collected between 9 km. and 16·8 km. is also included; they observed no deviation. According to the same authors the helium plus neon content at this height varies considerably (as much as 57 per cent), and on the average is increased by 27 per cent; the method applied was, however, not reliable. Our results show the constancy of the helium, and therefore *a fortiori* the neon, content at these heights within one per cent.

The deviations in the helium and oxygen content of the higher layers of the stratosphere, revealed by the figures in Table 3, from those in the troposphere, are in the direction to be expected if at a height of about 20 km. winds are no longer efficient enough to ensure a complete mixing of the atmospheric gases. The 'light' gas helium is present in a higher, the 'heavy' gas oxygen in a lower, percentage. The difference is more marked in the case of helium; this is in good accord with the greater density difference between helium and the main atmospheric gas, nitrogen (see Table 2).

Here, however, the possibility of generalizations ends. Calculation shows that a height of 1 km. in an undisturbed atmosphere should lead to an increase of the helium value of more than 13 per cent, and to an oxygen deficit of about 1·6 per cent. Now neither the London nor the Stuttgart samples show a gradual change in the composition of the air in proportion to altitude; and the changes found are much smaller than would be expected if from 20 km. onwards there were perfect quietude. This leads to the conclusion that there is by no means a sudden change in the conditions of the stratosphere at this height, but that the influence of air currents becomes only gradually less, and is dependent on weather conditions. We cannot therefore expect exact correspondence between the helium and oxygen values of air samples, collected on different dates and from different geographical areas; we intend to determine both values for one and the same air sample in order to test whether the changes found are actually due to gravitational separation.

It may be mentioned that air samples from heights of 18·5 km. and from 21·5 km. have been analysed for hydrogen by Čerepennikov, Moskvin and Shepherd. Even at these heights none was found. Previously meteorologists, misled by unreliable chemical analyses, took for granted the presence in the troposphere of measurable quantities of hydrogen, and demonstrated by calculations that the upper part of our atmosphere should therefore consist almost entirely of hydrogen. Some even went so far in hypothetical speculations as to postulate the presence there of a still lighter element, christened 'geocoronium' or 'zodiakon'. This, and particularly the 'hydrogen sphere', is still mentioned in many text-books. G. Ch. Lichtenberg, professor of physics in Göttingen a century and a half ago, must have had similar cases in mind when he wrote: "Perhaps Hamlet is right that there are more things in heaven and earth than are dreamt of in our philosophy; but on the other hand it may be said that there are a good many things in our natural philosophy books of which neither in heaven nor on earth any trace can be found."

When we started work two years ago on the helium content of stratosphere air, it was quite unknown whether it would be possible to reach a layer where any variations from the composition of ordinary air occur. The only accurate figure about stratosphere air then available, the oxygen analysis of air from 18·5 km. height, collected and analysed by the Russian investigators, showed not yet the slightest difference from ordinary air. Since last summer, we have been certain that from about 20 km. upwards the composition of air changes to a measurable extent. Much further work will be necessary before we are able to formulate the rules governing these changes. But as the question of stratospheric air movements may be also of some practical importance for weather forecasting and for aeronautics, we hope to continue, and to extend, our researches.

[1] L. H. G. Dines, *Quart. J. Roy. Meteorol. Soc.*, **62**, 379 (1936).
[2] F. A. Paneth and E. Glückauf, NATURE, **136**, 717 (1935).
[3] Details of the new flights will be published later.
[4] E. Regener, NATURE, **138**, 544 (1936).
[5] Report of the Central Geophysical Observatory U.S.S.R. Short abstract of the Russian publication in NATURE, **133**, 918 (1934).
[6] M. Shepherd, private communication.
[7] A. Lepape and G. Colange, *C.R.*, **200**, 1871 (1935); NATURE, **137**, 459 (1936).

Obituary Notices

Sir John Bland-Sutton, Bt.

SIR JOHN BLAND-SUTTON, BT., president in 1923–25 of the Royal College of Surgeons of England, and consulting surgeon to the Middlesex Hospital, who died on December 20 last, was born in 1855. Since John Hunter, no pathologist-surgeon of equal eminence has arisen in Great Britain, and like his prototype he approached surgery through the study of anatomy and comparative anatomy. Like Hunter, too, he was brought up in the country, and school played a less prominent part in his education than his own sharp eyes and sceptical curiosity. Unlike Hunter, he was not an experimentalist. He was more preoccupied with naked-eye form than with histology or physiology, though he always studied morphology in relation to function and to the evolutionary process.

It was not until he was twenty-three years of age that Bland-Sutton, already a skilled naturalist, first determined to be a surgeon. Poverty in youth teaches a man that independence, the power to help others, free choice, and the avoidance of jarring contacts are unattainable unless one does something that the world needs and is willing to pay for. In surgery Bland-Sutton found a field for his talents and for applying his mastery of anatomy and pathology. He entered as a student of the Middlesex Hospital in 1878, and in the following year was appointed demonstrator of anatomy. As an anatomical teacher he achieved great popularity, and in 1886 he was appointed assistant surgeon, becoming surgeon in 1905 and consulting surgeon in 1920. Throughout life, he remained devoted to the Middlesex Hospital, to which in 1914 he presented the complete pathological institute which bears his name. It was significant of his forward outlook that the space allotted to the museum in the new building was reduced so that more scope could be given to the experimental and histological laboratories.

In 1896, Bland-Sutton was appointed surgeon to the Chelsea Hospital for Women, and it was in gynæcological surgery that he made his name. For years this branch of surgery was practised by physicians—a curious anomaly having its roots far back in history. Spencer Wells and his successors at the Samaritan Hospital had broken through the tradition, and some obstetric physicians were good surgeons, *vixerunt fortes ante Agamemnon*, but the main credit for bringing pelvic surgery up to the level of general surgery unquestionably belongs to Bland-Sutton. He more than any man disestablished the 'couch-invalid' formerly seen in so many families—generally a woman with fibroids, an ovarian tumour, or the sequelæ of pelvic inflammation. Striding into this field where the crop had been ripening through many tedious years of invalidism and inaction, he rapidly acquired a very large and beneficent practice. His operating afternoons at the Chelsea Hospital for Women attracted surgeons from all over the world. At the same time, in his capacity of surgeon to the Middlesex Hospital, the hospital in which he was nurtured and which he always loved, he continued the practice of general surgery.

As an operator, Bland-Sutton was rapid and safe, though some critics considered him lacking in the refinements of technique. His results were excellent. Surgeons, like the clergy, may perhaps be divided into two classes, ritualists and evangelicals. Some love complicated instruments and elaborate technique; Bland-Sutton liked to reduce his instrumental and aseptic outfit to the minimum essential for the job in hand. Moreover, as a pathologist he realized that Nature is the real surgeon, while the surgeon is a kind of 'plumber's mate' to Nature. He never wasted time in doing things that Nature would do better herself. Perhaps in sewing up the abdominal wall with a single layer of sutures he sometimes trusted her too much.

Bland-Sutton had a vigorous common-sense mind which always led him to seize on the essentials of a subject and to press direct to a conclusion which was generally the right one. His mental vigour always seemed to maintain a constant level, so that in the spare quarters of an hour which most men waste, he could add a few lines to any paper he was writing. *Nulla dies sine linea* was a favourite quotation. His mental energy demanded satisfaction in constant work, and needed no whipping up to the task. Few men have done more work in a lifetime, and few have done it better. He said he could only learn by the eye, and noted in himself an entire absence of the mathematical faculty, nor I think did music appeal