records may be suspended until more detailed accounts of the observations are issued. There is, however, abundant evidence in the book to show that the main base is abnormally windy, and perhaps to justify the claim that it is the windiest place on earth. The "Roaring 'Forties" must give place to the "Shrieking 'Sixties." The author explains the power of the wind as due to the torrent of air rushing outward from a high pressure area around the south pole; but it is difficult to reconcile this theory, as now stated, with the experiences of Amundsen and Shackleton.

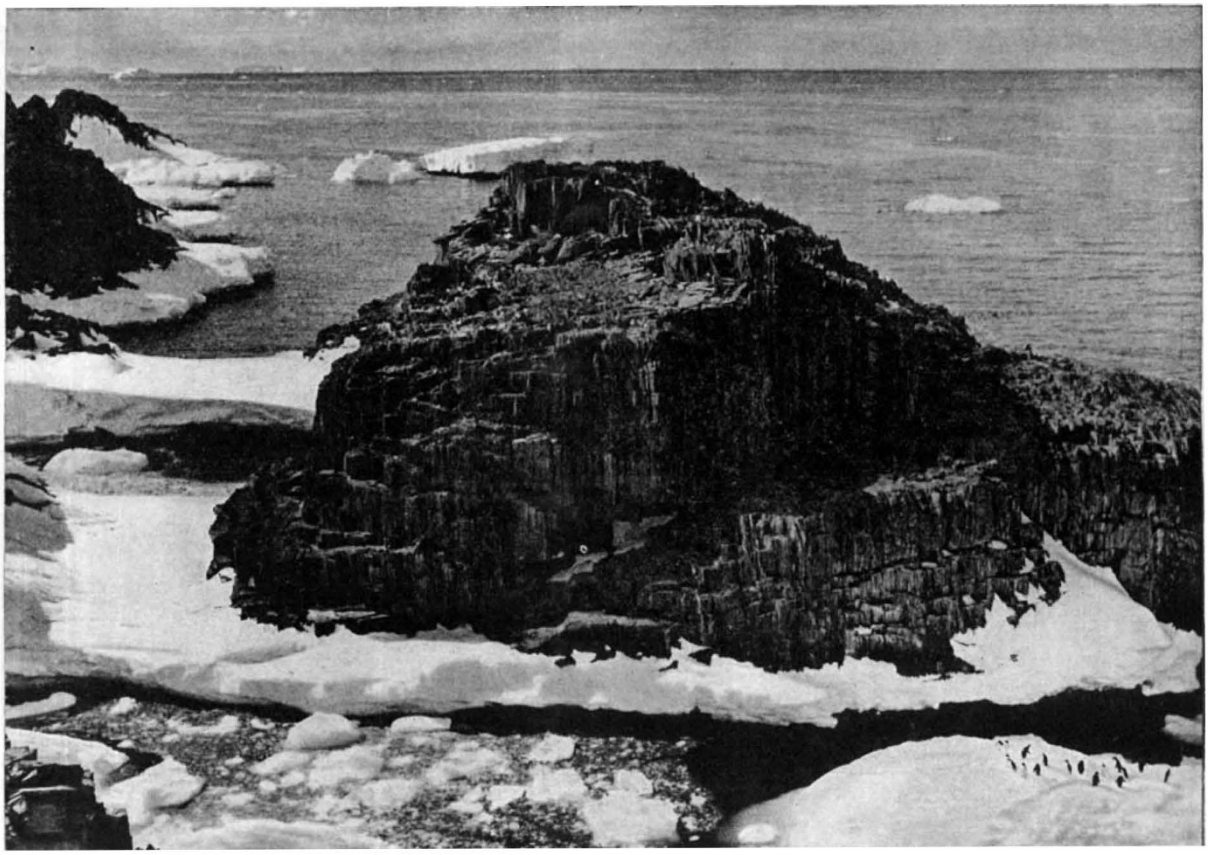

FIG. 2.—A view of a rocky stretch of the Adelie land coast west of Commonwealth Bay. From Sir Douglas Mawson's "The Home of the Blizzard." (W. Heinemann.)

The book, like much Antarctic literature, must have its usefulness restricted by its bulk; private students can scarcely afford the book space for such cumbrous volumes, a fact the more regrettable in this case owing to the exceptional beauty of the illustrations. Colour photography has been used with excellent results, and those of the starfish show the great value of this process in biology. The work includes only preliminary notices of the scientific results, but it shows that the Australian Expedition must rank as one of the most successful of modern antarctic expeditions.

J. W. G.

RECORDING RAIN GAUGES.

OF mechanical devices for the registration of rainfall there is no end, and from the early date of most of them it is scarcely too much to say that in this direction there is no new thing under the sun. Up to 1898 Mr. G. J. Symons had described and figured in "British Rainfall" no fewer than forty-five different patterns of self-recording rain gauges, and now there are at least a dozen more. Very few of these have proved fully satisfactory. The diversity between the various forms consists mainly in subordinate details. With the exception of Mr. W. J. E. Binnie's electrical drop-counter and Wild-Hasler's over-shot water wheel, I cannot find more than three principles which have been applied singly or in combination for the automatic recording of rainfall by a pen writing on a rotating drum. These are (1) the double tipping-bucket on a fixed pivot; (2) the descending counterpoised receiver, and (3) the ascending float.

Tipping-bucket rain gauges are amongst the oldest forms, and they have been constructed to record directly or through an electrical device, by an escapement wheel, a cam in the axle of

which raises the pen by a step at a time, the value of the interval shown by the step being the capacity of the bucket, which empties as it tips. The best instrument of this type is that in use by the United States Weather Bureau, which has a bucket tipping with one-thousandth of an inch of rain, and so gives a fairly continuous line, even in moderately light showers. Attractive and well-made tipping-bucket rain gauges have been put on the market by the firms of Negretti and Zambra, and Pastorelli and Rapkin, of London, and by Richard Frères in Paris. These tip with one-hundredth of an inch, or sometimes with half that amount, but are useless for measuring duration of any but heavy rain, though under careful inspection fairly satisfactory for measuring amounts. The amount of rain can always be measured more accurately by means of a direct reading rain gauge of the Snowdon or Meteorological Office pattern, of which the former is, in my opinion, better as well as cheaper.

The only scientific purpose served by a recording rain gauge is to furnish a measure of duration and intensity. The two types of gauge involving the respective use of a counterpoised receiver or of a float give their record in the form of a continuous curve. Each type has several modifications rendered necessary by the practical convenience of using a shallow drum while retaining an open scale. Where expense and space are no objects rain gauges of unimpeachable accuracy can be made on either principle by having a drum deep enough to record the whole rainfall of the wettest day possible with the necessary degree of magnification.

FIG. 1.—New Casella recording rain-gauge.

In order to keep the moving parts compact and the drum small, the capacity of the receiver is in practice usually limited to from 0·20 in. in the case of a counterpoised vessel to 0·50 in., or rarely 1 in., in the case of a float, and an automatic contrivance for emptying the vessel whenever it fills has to be employed. This is the weak point of most recording rain gauges, for when the receiver has to be emptied five times for every inch of rain it is subject to much friction and wear, and when it empties only once or twice for an inch of rain the time of clearing is appreciable and introduces a risk of error.

The Beckley rain gauge made by Mr. Hicks and used in the observatories of the Meteorological Office for about forty years is the best example of a counterpoised receiver writing directly on the drum as it sinks vertically and discharging automatically by means of a self-starting syphon. The Casella recording gauge, which has been in use at Camden Square for about thirty-five years, is undoubtedly the best example of the counterpoised receiver emptying by automatic tipping when it comes to the lowest point. It writes by means of a system of levers on a drum with a horizontal axis. A modified form of this gauge (Fig. 1), recently introduced by Messrs. Casella at a low price, has a simpler mechanism, the receiver only tipping far enough to start a syphon, through which it is emptied, while the pen writes on a vertical drum by means of a hinged piece at right-angles to the main lever, thus securing a curve with approximately rectangular co-ordinates.

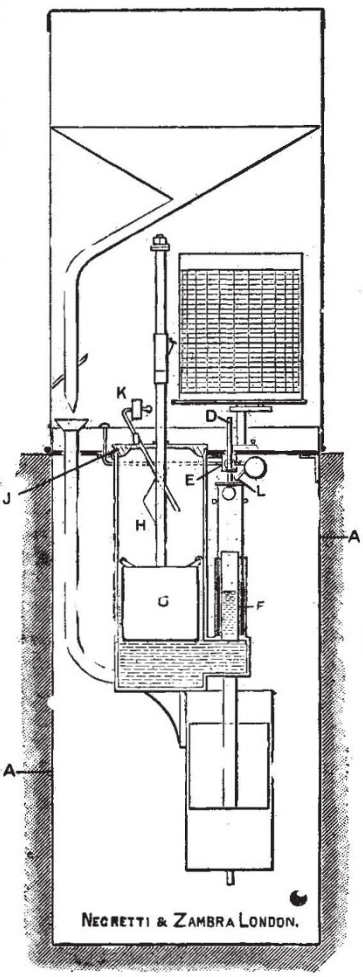

FIG. 2.—Section of Halliwell standard recording rain-gauge.

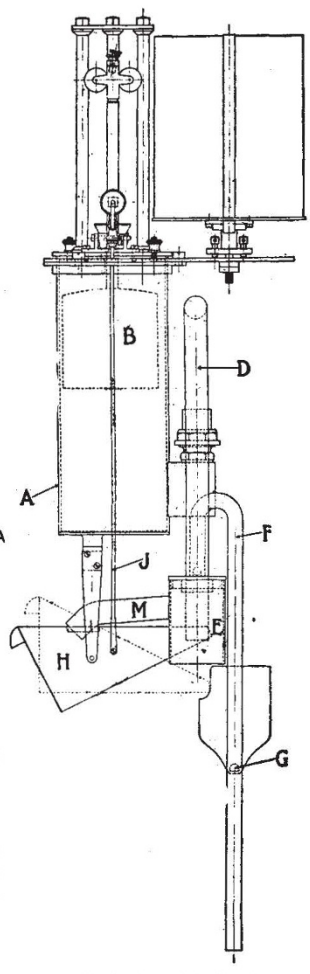

FIG. 3.—Mechanism of the Fernley recording rain-gauge.

Of float rain gauges the best of which I have had experience is the improved form of the Halliwell rain gauge (Fig. 2) first constructed by Mr. F. L. Halliwell with the advice of Mr. Baxendell, the well-known director of the Fernley Observatory,

Southport, and now manufactured by Negretti and Zambra. The theory is to make use of a pen actuated directly by a rod rising with the float (G), the receiver emptying by means of a syphon of large bore (F) started by being dropped a little by the action of a trigger (K) set off by the float rod when the receiver is full, and reset automatically by the escaping water entering a lower cylinder. In its first form this instrument was troublesome, sometimes failing to discharge, sometimes discharging too soon, but these difficulties have now been overcome, and when it is in careful hands I know of no better recording gauge. It gives an exceedingly clear and steady trace, and is much more sensitive to light rain than the Standard Casella gauge, while its less frequent discharges and rapid emptying give great accuracy in the case of heavy falls. The main drawback is the employment of mercury in connection with the syphon.

The Fernley recording gauge (Fig. 3), also constructed by Messrs. Negretti and Zambra, is the most recent product of Mr. Baxendell's ingenuity, and I have had it under observation along with the Casella and Halliwell gauges at Camden Square for six months. The record it produces is as clear and sensitive as that of the Halliwell gauge, from which it differs only in the simpler method of starting the large-bore syphon, avoiding the use of mercury. This is accomplished by the interposition of a small tipping bucket (H) filled with water. The bucket is tipped by a trigger actuated as in the Halliwell gauge, and discharges into the lower part (E) of the long leg of the syphon, which is started by the water pump action thus set up. The mechanism is certainly simpler than that of the Halliwell gauge, and the action is perhaps more certain than that of the first form of Halliwell. The principle is sound, and was employed in Osler's famous recording gauge of 1837.

The difficulty presented by all accurate recording instruments of different types is to ensure comparability, so that regional variations in duration and intensity may be worked out. To insist on the use of one make of instrument would hamper progress and discourage that competition between inventors and instrument makers on which so much depends for the progressive improvement of practical details. As the result of many years' experience I have formulated the requirements of a satisfactory recording rain gauge for general use, as follows:—

(1) A recording rain gauge is not a labour-saving contrivance which will work by itself for a week or more. The time scale should be so open that a drum of reasonable size cannot include more than the record of twenty-four hours, and it must be visited daily and the pen set to the correct time every morning.

(2) If a recording rain gauge is to be generally adopted its price must be less than 10*l.*, substantially so if possible, hence great size and elaborate mechanism must be avoided.

(3) The depth scale must be magnified at least four, and preferably eight times, and to avoid the inconvenience of having a very high drum some mechanical arrangement must be made by which the pen, on reaching the end of the chart, returns to zero automatically.

(4) The usual method of bringing the pen back to zero by emptying the receiver when half an inch or less of rain has been accumulated necessitates the use of uncertain or complicated mechanism, hence the receiver should be large enough to contain at least four inches of rain, and the automatic return of the pen should be secured by some device unconnected with the discharge.

(5) Friction is the only other serious practical difficulty, and this should be minimised by having as few moving parts as possible and these with the shortest bearings compatible with rigidity.

It was in order to meet these views that Messrs. Casella introduced their modification of their old standard recording gauge, but though most of the conditions were complied with, No. 4 was not. The Hyetograph (Fig. 4) devised at the same time by Negretti and Zambra, carries out my views more nearly than any other gauge I know; but it has not quite overcome the difficulty of friction in the float chamber, though when signs of this appear a very slight adjustment puts things right. Its curve also presents the inconvenience common to those of the ordinary barograph and thermograph of being referable to a straight co-ordinate for time and to the arc of a circle for amount.

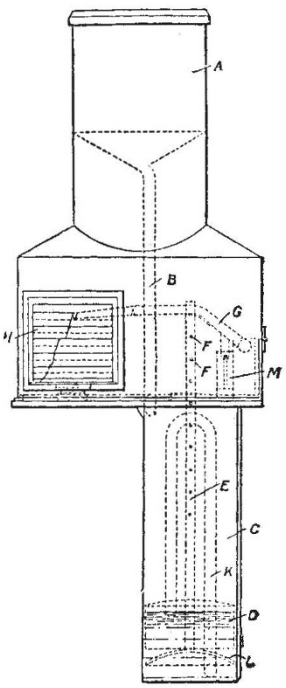

FIG. 4.—Section of Hyetograph.

Its advantages are that the receiver takes four inches of rain without overflowing, an amount which, it is true, may be exceeded in twenty-four hours in any part of the country, but which cannot be expected to be exceeded twice in a lifetime at the same place. It is emptied by a syphon actuated by suddenly depressing the float by hand, and should be so emptied each morning when the amount collected exceeds a small fraction of an inch. The pen drops on reaching the top of the chart by the edge of a plate fixed on the pen lever dropping from a peg (F) on the float rod (E) on to another peg below, an oil brake (M) at the short end of the lever (G) absorbing the shock. The record is thus not interrupted so long as rain is falling. During snow, a night-light placed in the instrument under the funnel ensures instantaneous melting.

I may perhaps be allowed to mention that neither the British Rainfall Organisation nor I personally have any financial interest in any rain-measuring appliances, and we thus retain perfect freedom for the helpful criticism of all such instruments.

HUGH ROBERT MILL.

INSECT PESTS AND WAR.[1]

WAR is associated in the popular mind with the summoning of armies, the thunder of the guns, and the carnage of blood-stained battle-fields. Patriotism is manifested in personal sacrifice in many directions, some public, many unsuspected. All cannot help in the direct attack on our enemies, but all are able to assist in preventing disease that plays so important a part in the progress of a campaign. Horrible as are the features of any war, times arise when the destructive "minor horrors," or insect pests, that are the inevitable accompaniment of the concentration of large numbers of men, assume a major import. The victims of the typhus now ravaging Serbia know this only too well. It is, then, a patriotic action on the part of Dr. Shipley to have set forth the life-histories of many noxious and disease-carrying arthropods, as well as certain leeches, together with very practical hints as to their prevention, in his book, "The Minor Horrors of War."

At the present time there is an undoubted need for the dissemination of knowledge regarding the *rôle* of various pests, both insect and others, in a simple yet practical form. The advantage is considerably increased when the information is presented in a lucid manner, with numerous illustrations, and in a style that may perhaps be best described as fully human. The accounts of the habits of lice, bugs, fleas, flies, mites, ticks, and leeches, which all have a share in injuring man, are set forth in a form that arrests the attention, stimulates personal interest, and, at the same time, by humorous interludes, neither repels nor disgusts the reader. The practical side, as before mentioned, is kept in view throughout.

Lice undoubtedly are unpleasant, but to ignore their existence does not minimise the danger arising from their presence. At least two diseases that are known to occur in certain areas of the present war zone are transmitted by lice (Fig. 1). Relapsing fever is due to a spirochæte that develops in the body-louse. The spirochæte reaches man when, in his endeavour to alleviate the irritation due to the insect, he scratches his skin. Simultaneously, he crushes one or more of the unwelcome insects, and spirochætes are unwittingly rubbed into the slightly damaged skin. Troops operating in Africa understand how easy it is to touch the eyes to remove sand or dust, and a finger soiled by a crushed louse has been shown to convey relapsing fever when so used. Typhus fever also is spread by lice, and there is no need to dwell on the fearful rapidity with which this fell disease may spread.

It must be remembered that the irritation of the body due to insect pests reacts on the mind, and is manifested in mental restlessness and lowered spirits. The clearly expressed preventive measures recommended against lice will doubtless be appreciated during the present campaign.

Bugs are very undesirable intruders in houses, and troops operating in India and Persia have reason to fear their attentions. Ticks occur in the Eastern theatre of war, and also in African territory where other troops are engaged. One tick, *Ornithodorus moubata,* transmits *Spirochaeta duttoni,* the cause of a more severe form of relapsing fever. The young tick is unlike the adult, and being so much smaller, is more easily overlooked, and is therefore more dangerous, especially as it may be born infected. Knowledge of its life-history, as set forth by Dr. Shipley, is important.

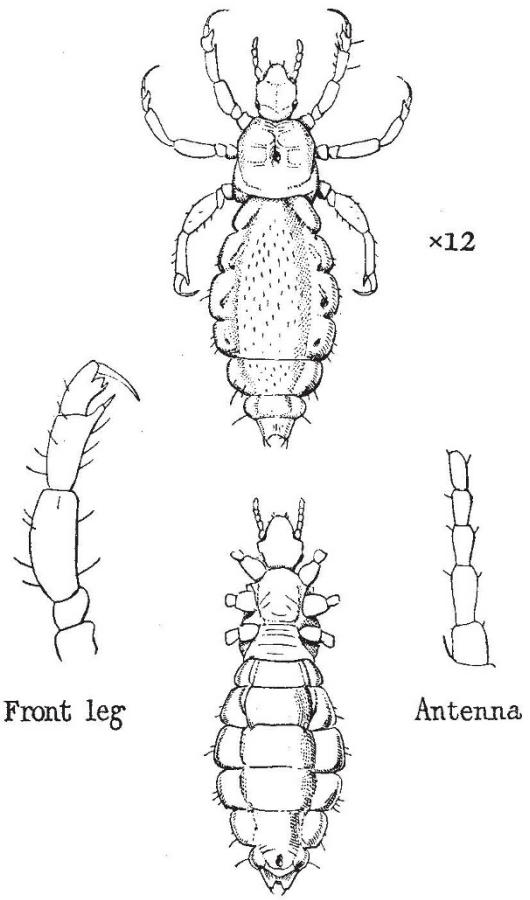

FIG. 1.—*Pediculus vestimenti.* The louse. Dorsal and ventral views. From "The Minor Horrors of War."

Mites are small relatives of ticks, and those that infest man are often known to soldiers and field-workers by the name of harvest mites. The habits of these small pests, as well as those of the "itch insect," together with the modes of dislodging them, are facts that should be better

[1] "The Minor Horrors of War." By Dr. A. E. Shipley. Pp. xvii+166. (London: Smith, Elder and Co., 1915.) Price 1*s.* 6*d.* net in paper covers, 2*s.* net in cloth.