Notes of Travel, a Vade Mecum

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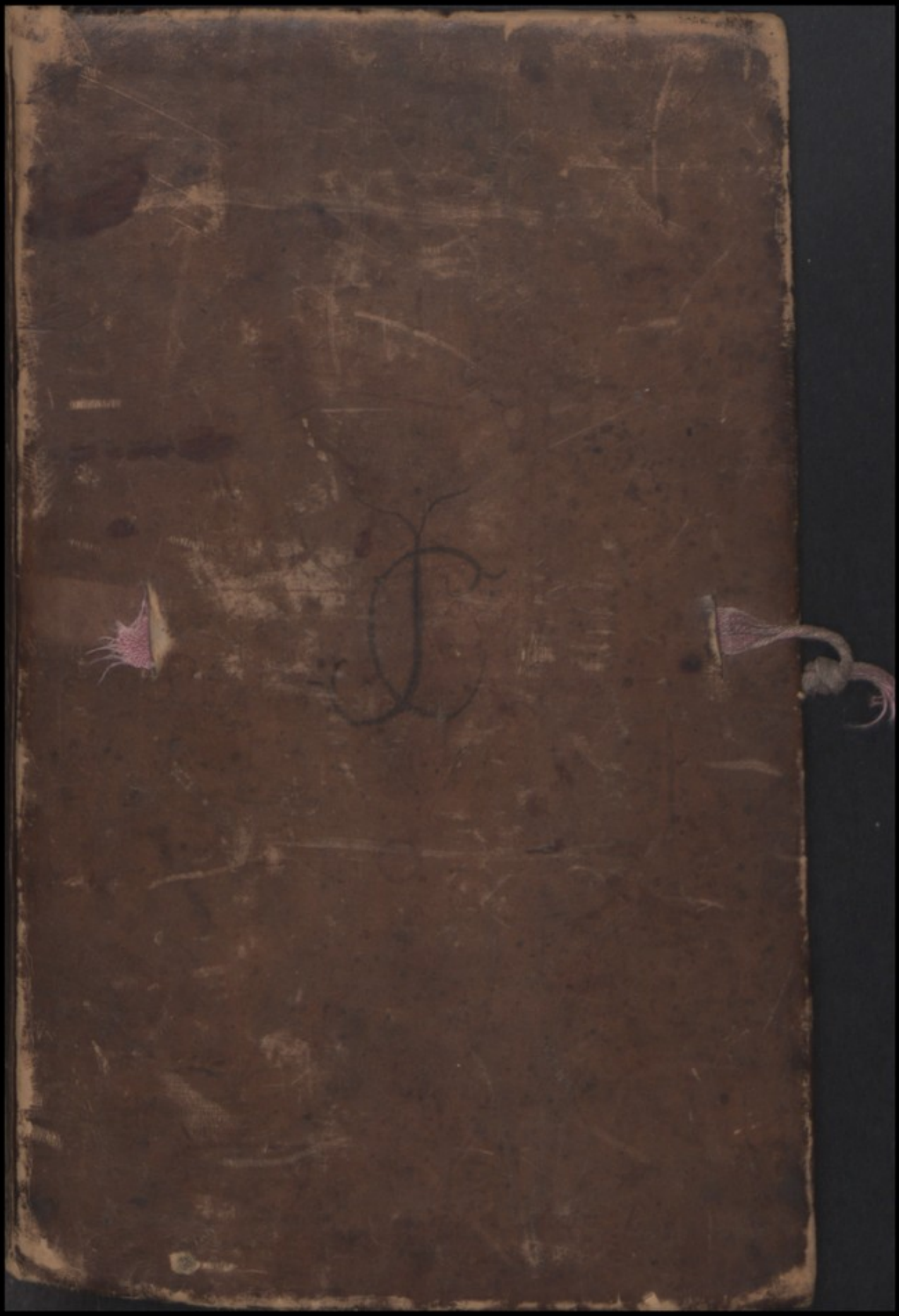

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HINTS TO TRAVELLERS.

(Third and Revised Edition, December, 1871.)

By Admiral Sir George Back, F.R.S., Vice-Admiral Collinson, C.B., and Francis Galton, Esq., F.R.S.

Introduction.

Applications are frequently made by travellers to the Royal Geographical Society, for instructions by which they may make their labours useful to Geography.

The Council have always shown themselves disposed to pay considerable attention to such applications, when they proceed from persons who are zealously engaged in preparing themselves for arduous enterprises.

If a specific question be addressed to the Council on some particular instrument or point of equipment, they usually refer it to a Fellow of the Society, whose experience might enable him to afford a satisfactory answer. But a question of a more general nature, on the best instrumental outfit for an inexperienced traveller, is of such frequent occurrence, and demands so lengthened a reply, that the Council thought proper some years ago to appoint a Committee* for its full consideration. The Report of that Committee was printed in vol. xxiv. of the Journal of the Society, and was extensively circulated under the title of 'Hints to Travellers.' When this edition became exhausted, we were requested to take the opportunity of making a thorough revision of the work. This we did, and now that the second edition is out of print, we have again carefully

* This Committee consisted of Admiral FitzRoy and Lieut. Raper, R.N., and contained papers by Admirals Smyth and Beechey, Colonel Sykes, and Francis Galton, Esq.

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revised the pamphlet. The present edition of the 'Hints to Travellers' will therefore form the answer of the Council, to whomsoever may request information, on the subject of which it treats.

The following remarks are to be understood as addressed to a person who, for the first time in his life, proposes to explore a wild country, and who asks, "What astronomical and mapping instruments, and other scientific outfit ought I to take with me? and what are the observations for latitude and longitude, on which I should chiefly rely?" To this end we give a list of instruments, books, and stationery, complete in itself, so that an intending traveller may order his outfit at once. He would then be satisfied that no object of real importance had been omitted, that he had bought nothing superfluous, and that the different items corresponded together in power and in their several uses.

Lists drawn up by different travellers of experience would undoubtedly vary, for there is considerable difference in their practice; but an explorer would never do wrong, who followed to the letter the list we are about to give. His danger lies in adopting scattered hints from many sources, and starting with instruments which, though severally good, are, when considered as a set, incongruous and incomplete; and, secondly, in trusting to the advice of observers who have little experience of the bush.

The outfit we recommend, based on the use of sextants and the mercurial horizon, would suit an explorer in any part of the world, who desired the means of bringing back as good geographical results as the earlier explorers of large tracts of land have ever yet succeeded in obtaining. And in this list, professedly compiled for an inexperienced observer, simple and well-known instruments alone find a place. We are very far indeed from thinking that makers of sextants have yet met all the wants of land travellers, but we *know* that good results may be obtained by such instruments as are to be bought from

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of the sea horizon; secondly, because the mercurial horizon gives a double altitude, and therefore double precision to the result; so that a sextant of 3 inches radius on land has the efficacy of one of 6 inches at sea; and, thirdly, because the unsteadiness of the ship interferes with the free use of the inverting telescope.

3. The sailor carries Greenwich time with him by means of his chronometers. A landsman cannot trust to chronometers. He must find Greenwich time by the independent means of lunars, satellites, occultations, or moon-culminations.

4. Positions in the open sea, that cannot be determined by astronomical observations, are roughly laid down by Course and estimated Distance from the last fixed station. On land, they can be laid down with great accuracy by triangulation.

5. The unsteadiness of the ship makes observation of the satellites, or of occultations of stars, an impossibility to sailors, while they are exceedingly easy and convenient to land travellers.

6. Magnetic variation has to be found constantly at sea, owing to the rapid change of position and the iron in the ships. On land but few, though careful, observations are required (avoiding magnetic rocks).

General Remarks on Observing.—Endeavour with much forethought to *balance* your observations. Whenever you have to take a star's altitude for time east, select and wait, if you have time to do so, for another star as nearly as may be of the same altitude west, and use the same telescope, horizon roof, &c. If a meridian altitude be taken north, choose another star of similar altitude, and take it south; so also with lunars. In this way your observations will be in pairs, and the mean of each pair will tend to be independent of all constant instrumental and refraction errors; and by comparing the means of these pairs, one with another, you will know your skill as an observer, and estimate with great certainty the accuracy that your results have reached. Never rest satisfied with your observations, unless you feel sure that you have gained means of ascertaining the limit beyond which you certainly are not wrong. Weight all your observations; that is, when you write them down, put "good," "very good," "doubtful," &c., by their sides.

Nature of Observations:—

For Latitude—

1. The meridian altitude of the sun or stars is the simplest and safest. Altitudes of stars in pairs, N. and S. of the zenith, at or very near to the meridian, afford the perfection of accuracy.

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It is to be understood that several altitudes should be read off, and time noted during the 5 or 10 minutes before and after the meridian passage.

2. The altitude of the Pole-star is a ready method in the northern hemisphere, but only available with an ordinary sextant and mercurial horizon between the N. lats. of about 15° and 60°. Nearer the Equator it is too low for the mercurial horizon, and nearer the Pole it is out of the range of the sextant.

3. By three altitudes of the sun or a star taken near the meridian, at *equal intervals of time*, and not necessarily restricted to the same side of the meridian. (*Chauvenet.*)*

4. When the sky is partly clouded, secure whatever stars you can surely identify, in case the meridian altitude should be lost. Almost any two stars, with the interval noted, are sufficient for the determination of the latitude, by the more or less troublesome calculations described in works on navigation. It is better to observe one or two additional stars as a check against mistake.

For Longitude by lunars, &c.—

Whenever you intend to observe for longitude, make a regular night of it; working hard and steadily, so as to accumulate a mass of observations, at a limited number of stations.

1. Lunar distances. No method is more serviceable than these. They should be made in pairs, with stars E. and W. of moon, and nearly equidistant from it. Also the thermometer and barometer (or its equivalent, a thermometer in boiling water) should be noted, and the refraction corrected accordingly; because, if thermometric and barometric corrections be omitted, in observations made on a high and heated plateau, there will be serious errors in the results.

---

* Let a_1, a_2, a_3, be the three altitudes (it is better that none of them should be more than $\frac{1}{2}$ hour from the meridian); A the required meridian altitude; then if

$$q = \frac{[\frac{1}{4}(a_1 \backsim a_3)]^2}{a_2 - \frac{1}{2}(a_1 + a_3)}, \quad q \text{ being expressed in seconds of arc, } A = a_2 + q.$$

The meridian altitude being thus determined, the latitude can be found in the usual manner. (This is a slight but convenient modification of Chauvenet's formula, by Admiral Shadwell.)

(*Example*)

$a_1 = 43°\ 8'\ 20''$ $\quad a_2 = 43°\ 15'\ 30''$ $\quad a_3 = 43°\ 4'\ 0''$

$\frac{1}{2}(a_1 + a_3) = 43\ \ 6\ \ 10$

$a_2 - \frac{1}{2}(a_1 + a_3) = \quad 9\ \ 20 = 560''$

$\frac{1}{4}(a_1 \backsim a_3) = \quad 1\ \ 5 = \ 65''$

hence $q = \frac{65^2}{560} = 8''$, and $a_2 + q = 43°\ 15'\ 38''$

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A complete pair of lunars, made wholly by one person, consists of the following observations, *in addition to those for latitude.* None of them may be omitted.

An hour before beginning to observe, get everything in perfect order; see that the lamp is well trimmed, its air-holes free, and that it is filled with oil. Also rehearse the expected observations, that no hitch may occur after they have commenced. Then let the hand and eye have ample time to repose, and go on as follows:—

1. Read thermometer in air.
2. Adjust horizon-glass, if necessary.
3. Two pairs of observations for index error.
4. Three altitudes for time, star E.
5. Three altitudes for time, star W.

A
6. Five lunar distances, star E. of moon.
7. Five lunar distances, star W. of moon.
8. Three altitudes for time, star W.
9. Three altitudes for time, star E.

10. Two pair of observations for index error.
11. Read thermometer in air.
12. Read barometer (or its equivalent, as thermometer in boiling water).

The series A may be repeated over and over again, so long as the eye and hand can be surely depended on.

2. Occultations give the longitude with great accuracy, but those of stars of the fifth and higher magnitudes, which are easily seen with an ordinary telescope, very rarely occur. Stars of the sixth magnitude are given in the Nautical Almanack, and are less unfrequent; but it requires a good telescope, such as that mentioned page 11, to see them. With such an instrument, many stars not mentioned in the Almanack may be seen occulted under favourable circumstances,—that is, when the moon is not too bright, and when it is her dark limb which occults. A careful traveller should make it a point, when at any important station, to turn his telescope on to the moon, as soon as it is dark, to see if there be a probability of any such occurrence, for it is easy, after a little practice, to tell whether the moon is likely to sweep over any star visible within three or four hours of her position. Before your departure, or when you have leisure, calculate for yourself, or get some one to calculate for you, all the stars you could by any possibility see occulted. Shadwell's Tables for facilitating the approximate prediction of occultations and eclipses at any particular place (Bate, 21, Poultry) are very convenient for this purpose. Out of the list in the Nautical Almanack, perhaps

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not one quarter are available,—the occultation occurring either when the star is below your horizon or in the daytime.

3. Jupiter's satellites occur somewhat more frequently than occultations. They give fair results, and are most convenient approximations to a traveller; for they require no calculation at all, except for local time.

Notes on Observing with a Sextant. By FRANCIS GALTON, F.R.S.

It may save trouble to others if I mention here the way which, after many trials, I adopted of observing with a sextant. During the daytime I made out a list of the stars that culminated at convenient hours, and their expected altitudes. I set my watch by sunset, if it was very wrong, and took care that the minute hand went in correspondence with the second hand; that is to say, that the minute hand was truly over a division when the second hand pointed 0 seconds. If they did not go together, I moved the minute hand till it was rightly set. Then I spread my rug north and south in an open spot of ground, trampling down the bushes and long grass round it. Next, when the time of observing approached, I lighted my lantern and set it on the ground in front of my rug; to this I brought all my instruments, and first spreading a small cloth to the right of the lantern, I set my horizon on it, filled it with mercury, and covered it with a glass. The cloth was to catch any mercury that might be spilled. I then propped up my watch to the left of the lantern, laid down my note-book, with the leaves tied open, and taking out my sextant, adjusted it to the expected altitude, and screwing on the telescope, which always was kept at my focus, I laid myself flat down on the rug. Then taking off the roof from the horizon, if there happened to be no wind, and turning the glare of the lantern away from my eyes, and upon the watch, I made an accurate contact of the star with its reflected image; then looking quickly round, I observed the watch. I now turned the lantern towards me, changed hands with the sextant, read off and wrote down, then turned the lantern back on the watch, and recommenced. For a meridian altitude I read off and wrote down about ten observations, both time and altitude, beginning a little before the star reached the meridian, and continuing after it had perceptibly sunk; it was thus easy to estimate the meridian altitude with accuracy. For greater refinement, in order to measure an important base-line, I occasionally protracted these altitudes, and drew a curved line through them with a free hand, to guide my judgment in estimating the meridian altitude. For lunars, I took time with my second sextant before beginning; also two or three times during the progress of the lunar, and finally at the close of all. I was thus very independent of the good going of my watch, for, by observing every half-hour, no watch that went at all could go far wrong.

KNORRE'S *Method of bringing the Reflexion of a Star from the mirrors of the Sextant, into contact with the Reflexion of the Star in the Mercurial Horizon.*

In the observation of the altitude of a star with the artificial horizon, it requires some practice to find the image of the star reflected from the sextant mirrors; and sometimes, when two bright stars stand near each other, there is danger of employing the reflected image of one of them for that of the other. A very simple method of avoiding this danger, by which the observa-

f. 6r

tion is also facilitated, has been suggested by Professor Knorre, of Russia. From very simple geometrical considerations it is readily shown that at the instant when the two images of the same star—one reflected from the artificial horizon, the other from the sextant mirrors—are in coincidence, the inclination of the index-glass to the horizon is equal to the inclination of the sight-line of the telescope to the horizon-glass, and is, therefore, a *constant angle*, which is the same for all stars. If, therefore, we attach a small spirit-level to the index-arm, so as to make with the index-glass an angle equal to this constant angle, the bubble of this level will play, when the two images of the star are in coincidence, in the middle of the field of view. With a sextant thus furnished, we begin by directing the sight-line towards the image in the mercury; we then move the index until the bubble plays, taking care not to lose the image in the mercury. The reflected image from the sextant mirrors will then be found in the field, or will be brought there by a slight vibratory motion of the instrument about the sight-line.

It is found most convenient to attach the level to the stem which carries the reading-glass, as it can then be arranged so as to revolve about an axis which stands at right angles to the plane of the sextant, and thus be easily adjusted. This adjustment is effected by bringing the two images of a known star, or of the sun, into coincidence; then, without changing the position of the instrument, revolving the level until the bubble plays. (*Extracted from Chauvenet.*)

Silvering Sextant Glasses—

(Extract from 'Nautical Surveying,' by Admiral Sir E. Belcher, pp. 9, 10.)

The *requisites* are clean tinfoil and mercury (a hare's foot is handy)—lay the tinfoil which should exceed the surface of the glass by a quarter of an inch on each side, on a smooth surface (the back of a book), rub it out smooth with the finger, add a bubble of mercury, about the size of a small shot, which rub gently over the tinfoil until it spreads itself and shows a silvered surface, gently add sufficient mercury to cover the leaf so that its surface is fluid. Prepare a slip of paper the size of the tinfoil. Take the glass in the left hand, previously well cleaned, and the paper in the right. Brush the surface of the mercury gently to free it from dross. Lay the paper on the mercury, and the glass on it. Pressing gently on the glass, withdraw the paper. Turn the glass on its face, and leave it on an inclined plane to allow the mercury to flow off, which is accelerated by laying a strip of tinfoil as a conductor to its lower edge. The edges may, after twelve hours' rest, be removed. In twenty-four hours give it a coat of varnish made from spirits of wine and red sealing-wax. It may be as well to practise on small bits of common glass, which will soon prove the degree of perfection which the operator has attained.

Observations for Azimuth.—The true bearing of a heavenly body may be obtained by means of a sextant either from observations of altitude or from the apparent time. As the formula for obtaining the latter does not appear in many works on Navigation, it is given :—

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Time.	Azimuth.	Month.	Day.		
H. M. S.	° ′	° ′ ″			
		Co. Lat. P. Dist.			
		Sum.			
		Diff.			
		½ Sum.	Cosec	Sec	
		½ Diff.	Sine	Cosine	
		½ Hor. ∠	Cotang	Cotang	
			Arc 1 = Tang		
Cor.			Arc 2.	Tang Arc 2	
	App. time				
	Hor. ∠		⊙ true Az. (= Arc 2 − Arc 1.)		
			⊙ mag. Az.		
	♄		Variation.		
	½ hor. ∠ in Arc.				

Note.—Arc 2 is of the same affection as the ½ polar disc. and Co. Lat.: when one is acute so is the other, and v. v.

Add arcs 1 and 2, when polar disc. is greater than Co. Latitude.

Subtract " " less " "

The angular distance between the Pole-star, which is only 1° from the Pole, and any object on the horizon, affords an approximate and simple method of obtaining the true bearing: the formula for the reduction of the oblique to the horizontal angle is—

Reduction of Angle.

✵ and obj.	Cosine
✵ Alt.	Secant
Red. Angle	Cosine

The bearing of the Pole-star at all times, or any other celestial object, when near the meridian, affords aproximate means of obtaining, without calculation, the variation of the compass.

For Base Lines.—By Difference of Latitude—For base-lines the more rapid methods of attainment are alone suitable to explorers in wild countries. None of these measures is more accurate and speedy than that obtained by meridian altitudes of the same heavenly body (sun or star, not the moon) at different stations by the same observer with the same instruments. If the stations are on the true meridian, or nearly so, their difference of latitude is their distance; and if they are otherwise situated, their true bearing and their difference of latitude give the distance between them.

By Micrometer or Sextant, and Short Base. Should the traveller carry with him an astronomical telescope, it is advisable that it should be fitted with a micrometer for measuring small angles; care is, however, requisite in seeing that the board or object used for the base is accurately measured, and that it is at right angles to the line of sight. In the absence of the micrometer, the sextant will give a very fair approximation; the angle should, however, be measured both on and off the arc. Rochon's micrometer has been used with great effect in the geological survey of Canada.

Artificial Horizons.

Mercurial Horizon. — Altitudes taken by its means are thoroughly reliable only when the reflexions have been observed from the uncovered mercury; for it is difficult to procure glass, large enough for the cover, which does not sensibly distort the reflexions. Glasses made by Mr. T. E. Butter, 4, Belvidere Crescent, Belvidere Road, Lambeth, have a high reputation. The errors introduced by the interposition of glass may be partly got rid of by reversing the cover between each pair of observations.

When observing for "equal altitudes," morning and evening, be sure that you have the same face of the cover opposite to you on both occasions. One of the faces of the cover should be marked for this purpose.

The trough should not be less than 3¼ inches inside length, because the convex border of the mercury is useless, and its surface is foreshortened to the observer.

Captain George's Horizon. — A very ingenious, small, and handy mercurial horizon has been contributed by Staff-Commander George, R.N., Curator of Maps at the Royal Geographical Society, and is made by Messrs. Gould and Porter, successors to Cary, optician, No. 181, Strand. It consists of a disc of glass floating on mercury, in a vessel which it nearly fits, and it has an arrangement (applicable also to the common mercurial trough) by which the mercury is introduced, ready filtered, from an attached reservoir, and afterwards withdrawn, in a manner that saves a great deal of trouble. The glass floats without touching the sides of the trough, and the whole of the mercury below it is serviceable. A very small trough on this principle gives as wide a field of view as a large trough used in the ordinary way. There is yet another advantage, in that the reflexion of the glass causes its under-surface to be optically raised; therefore the edges of the trough cut off proportionately

less of the field of view. Also, at very low altitudes, the reflexion from the upper surface of the glass, which may rise above the edges of the trough, becomes so bright as to materially reinforce, and even supersede, the reflexion from the mercury below. Hence very low altitudes may be observed with this instrument. It has, besides this, the great advantage of peculiar steadiness, both when people are walking near it and during wind.

As regards its accuracy, when the glass is of the best workmanship, the mercury pure, and its surface quite clean, the results leave nothing to be desired; but, unless these conditions are *scrupulously observed*, errors of five, or more, minutes in the double altitude, or of half that amount in the single altitude, may be easily introduced. For these reasons, and as the instrument is a new one, we have not recommended that a traveller should be wholly dependent on it; but we recommended that one should be taken for occasional use, especially for purposes of azimuth by the sun, to be taken on mountain-tops (see p. 21), for detached expeditions, where a heavier instrument would be a serious incumbrance, and for the determination of heights on hills whose altitudes are too low to come within the range of an ordinary mercurial trough. We recommend that its glasses be examined and approved before it is taken, and that it be used discreetly.*

Before introducing the mercury into the trough, cleanse the trough thoroughly from dust, which will otherwise rise to the surface of the mercury, and, when setting the glass afloat, take exactly the same precautions as in silvering sextant glasses (*see* p. 17), by putting paper or thin silk first on the mercury, and the glass upon that, and then carefully withdrawing the paper from under the glass.

Compasses.

Prismatic Compass.—The prismatic compass is one of a traveller's most useful instruments. Its graduations should be engraved on an aluminum ring, both on account of the clearness of the divisions and the lightness of the material. When using it, if you have no tripod, make a pile of stones and

* If the traveller should ever doubt the performance of one of these horizons, he may easily test its accuracy by means of any telescope mounted on a stand, and furnished with cross wires. He should direct the telescope down towards the mercury and intersect with the cross wires the reflexion of some clearly defined fixed point; then reverse or otherwise disturb the horizon, and, after it has again settled to rest, observe whether the cross wires continue to intersect the point. It is safer to select a point at some distance, else, if the level of the mercury be raised or lowered during the trial, the results would be vitiated.

lay the cover of the compass on the top, with its bottom upwards; this makes a smooth table for the azimuth compass itself to be moved about on. Be on guard against magnetic rocks; it may happen that the bare peaks of high hills, which are the best of places for observing from, and which a traveller often makes great sacrifices to reach, will be found so magnetic as to make compass observations worthless. A small sextant should always be taken up on these excursions. It is of little use in a wild country to devote much time to getting accurate bearings, as the landmarks themselves are rarely well defined: the main endeavour should be not to mistake one hill for another, to judiciously select good angles, and to carry on more than one independent scheme of triangulations at the same time, by comparison of which the accuracy of the whole may be tested. It is surprising how much work may be thrown away by want of judgment; and also how much may be done, with very little trouble, by a person who has acquired a good eye and memory of country.

It is, perhaps, hardly necessary to call attention to the fact, that in prismatic compass-cards the south pole of the magnet is necessarily placed under the 360°, and the north under the 180°, because in these instruments the reading is from the nearer edge of the card towards its centre, whereas in an ordinary compass the reading is from the centre of the card towards its outer edge. It follows from this that the same compass card cannot be used indifferently with or without a prism. Moreover the figures intended for use with a prism, have to be drawn not like ordinary figures, but like figures seen in a looking-glass, in order that the reflection in the prism may show them straight.

Pocket Compasses.—The patterns on these cards have been greatly improved of late years. Until recently it was scarcely possible to meet with a compass capable of being read in a dim twilight, which is just the time when it is of most importance to a traveller. Representations of three cards, each of which has its advocates, are given here. They are of the larger size, already recommended in "outfit," viz. 2 inches in diameter. Fig. 3, called the Rob Roy Canoe pattern, is decidedly less distinct in the twilight than the others, especially than Fig. 1, but some travellers have preferred it on account of the legibility of the N.E., S.E., &c.

The better cards are made either of talc covered with paper, or of mother-of-pearl. Both of these materials are heavy and their weight, of course, tends to injure the point on which they turn, especially if they happen to receive a jar when they are resting on the point, and also to make their oscillations sluggish. These disadvantages are, however, less serious than those

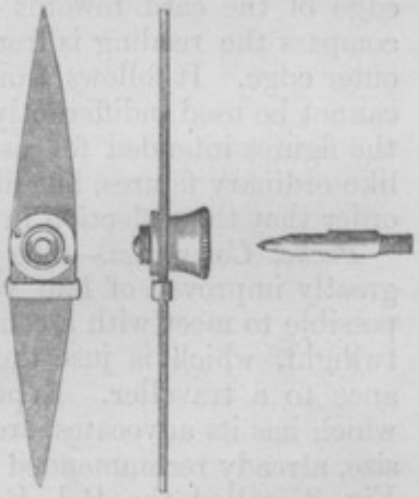
which attend the use of a common card, which warps with heat, and is spoiled by a wetting.*

A pocket compass suspended on gimbals practically comes to rest much more quickly than one that is held in the hand. This

Fig. 1.

Fig. 2.

Fig. 3.



Plan, Section, and Pivot of Needle.

* A disc of aluminum foil, procurable at Johnson, Matthey, & Co., 77, Hatton Garden, London, is only one-ninth part the weight of a mother-of-pearl card of the same size. It seems equally good as regards durability, and it can be shaped and lettered in any desired manner by embossed stamps or by perforations. But I have not yet succeeded in fashioning it into a clearly legible card. Perhaps some instrument-maker may be more successful.

Mem.—To read a compass or a watch in the twilight, when it is a little too dark for unaided vision, *use a strong magnifying glass.* Its effect in giving distinctness is extraordinary.—F. GALTON.

f. 9c

advantage is specially noticeable when it is growing dark, and when consulted on the side of a hill, for in either case it is difficult to judge of horizontality. It is most important to a traveller, whose caravan is on the march, that he should lose very little time when he is consulting his compass.

Watches.

Mr. J. Brock, chronometer maker, 21, George Street, Portman Square, who has usually been applied to by the Council of the Royal Geographical Society, to furnish the watches given by them to various travellers, has furnished the following information at the instance of the authors of this pamphlet:—

The description of Watch most useful to a Traveller. By J. Brock.

The description of watch I should recommend as suitable for a traveller, or anyone who requires a good timekeeper that will stand a certain amount of rough wear without getting out of order, is a 14 or 16 size, full-plate lever watch, with an *adjusted** compensation-balance and *tempered* balance-spring, cap over the works, sunk-seconds dial. Great care should be taken in marking the minutes upon the dial-plate, that they are exactly equal, or the traveller will have some difficulty to determine to which minute the seconds belong. The case should be of silver, without springs to open it, or hinges. The back that shuts over the part through which the key passes to wind up the watch, also the front that holds the glass, should snap tightly upon the other part of the watch-case. The glass should be of thick plate-glass, not less than one-eighth of an inch thick. The case, on account of the closeness of the fittings, will then be impervious to the dust, and would not easily allow water to get to the works.

A watch of this description cannot be sold for less than 16*l*., if the works are of a quality necessary for good performance, and the various adjustments are properly attended to, and is the lowest standard of watch that any traveller ought to be satisfied with.

A chronometer will keep more regular time in different positions than the watch I have described, but in rough wear I consider it more likely to break down, as it certainly is not so strong in construction as the lever watch. An ordinary watchmaker, with care, could put the lever watch in order, but few are competent to repair a chronometer.

Watches of any construction will be more regular in their daily variation, if care is taken to keep them in the same position during each 24 hours; that is, when in the pocket, the same hour should always be uppermost; and they should be worn the same number of hours each day; and if laid down at night, let them be so every night.

No one can alter the regulator of a chronometer but a competent watchmaker, but anyone may be able to alter that of the lever watch. The chronometer is certainly the best instrument for anyone who requires a correct

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* Many watches have compensation-balances applied to them which have never been tested in the least, and have only the appearance of being adjusted, without the result. An ordinary watch, if mechanically correct, will vary nearly one minute per day for every ten degrees' change of temperature—J. B.

F. 9v

timekeeper; and with the recent improvements, is quite suitable for the pocket, but not so good for general purposes and rough wear as the lever watch.

On Carrying Chronometers. By Admiral Sir George Back, F.R.S.

It is impossible to avoid jolting pocket chronometers or watches when worn about the person.

On three Arctic (overland) expeditions, mine (frequently two chronometers) were suspended in cloth pockets, hung round the neck by a strong narrow silk ribbon, and kept in their places by two other ribbons tied round the waist; the whole was secured by the waistband of the trowsers, which was made with six holes (three on each side), to lace behind. A silk string, passed through eyelet-holes round the top of the pocket and tied, secured the chronometer in its place, and prevented wet and dirt from reaching it.

When travelling in summer, the chronometers were taken off at night and placed carefully in a hat, horizontally, or else in some blanket, under the upper part of the blankets forming the bed, where they were more out of the way of accidents; but in winter they were worn all night against the body, to protect them from the effects of the cold.

We (Franklin, Richardson, Kendall, &c.) never complained of finding "fluff," in the cloth pocket, and I do not know of an instance of the chronometers getting wet.

Franklin fell between two pieces of ice into the water, over-head, and sunk fully two feet, and the two chronometers were not injured.

I do not recommend "Macintosh" for the pockets. In cold, *freezing* weather, our Macintosh cloaks became stiff as planks; and in very sultry weather, portions of the caoutchouc oozed through. Common linen or washed chamois leather would do for lining.

On a Composition for keeping Watches or Compasses watertight. By James Brock.

The method that I should recommend for preventing water from penetrating watch-cases, is the application of a preparation of beeswax and resin to the several parts where it is possible for the water to pass. The preparation I recommend should be composed of equal parts and well mixed. If it is for a very hot climate, the quantity of "resin" should be slightly increased. It may be kept prepared, and when wanted, a portion melted and applied to the several parts with a small brush or feather. If the watch is an ordinary *open-face*, with a snap bottom, the parts that should be attended to are—1st, the glass. Apply the preparation round it, and rub it in with the thumb, by which means it will be worked into any cavity. 2nd, open the glass and apply it round the part of the case upon which the glass shuts (be careful that you apply it to all the joints of the case), close the glass and squeeze it down tightly; what is squeezed out may be cleared away with the nail or a piece of wood. 3rd, open the back (where the watch is wound up) and apply the preparation in the same manner as just named. The case will require a little more force to open it, and the back should be attended to frequently. If the watch has a *hunting* (or double) case, or a *bottom that opens with a fly-spring*, the difficulty of keeping out the water is much increased, as there are so many openings into the case for the springs, &c. I should recommend that the springs be removed (which is easily done, as they are all screwed in), and that the holes through which they pass, also the *screw holes*, be stopped up with the preparation; also *remove* the *push-piece* from the pendant (this is done by taking out the screw, which passes through the bow), and stop up the hole from which it has been taken; but care should be used in doing so, as it is

f. 10r

essential that it should be stopped *below* the hole through which the screw of the bow passes. The bow may then be returned. The preparation should now be applied to the glass and the shutting parts, in the manner before described. The hunting cover will keep shut by nature of the preparation.

Barometers and their Substitutes.

The travellers for whose use these remarks are prepared, being possessed of sextants or theodolites, would measure mountains by triangulation from a distance, which is at once by far the simplest and most accurate method of doing so. But they also require, for the purposes of physical geography, to ascertain the height of the country where they are travelling, above the sea-level; and whenever they have to observe lunars on elevated plateaux, a knowledge of the barometric correction for refraction is essential to them. For these latter purposes, explorers must have recourse to barometers, or to their more or less imperfect substitutes.

A single barometric observation made in regions where the barometer ranges, as with us, through two or more inches, even in ordinary weather, is unreliable to half that extent; that is, to more than 1000 feet, in calculating altitudes; but the mean of several observations taken at chance intervals, at repeated visits, and during ordinary weather, is not likely to be far amiss. In tropical regions the barometer is very much more steady than with us, and the heights deduced from the observations of travellers are proportionately more to be depended on.

If a second station can be established, for simultaneous observations, at 100 or even at 200 miles' distance, their relative heights can soon be determined with some accuracy by the barometer, because the meteorological waves are so vast, that there is seldom a difference, in ordinary weather, even in these latitudes, of a quarter of an inch (or say 250 feet of calculated altitude) between two stations 100 miles apart.

The readings of barometers and boiling-point thermometers, when they are erroneous, nearly always err in the direction of assigning too great elevations, for the barometer, when air or damp gets into the tube, is depressed, and the thermometer, when heated by imperfectly-boiling water, stands lower than it should.

The barometric instruments are,—

1. *Barometer.*—For reasons already given (p. 10), no description of portable barometers is inserted here; but it must be recollected that *empty* glass tubes can be carried without much risk, and that they can be filled with mercury when required, and be set up or used temporarily as barometers. The method of doing this is as follows: —

To fill a Glass Tube with Mercury for a temporary Barometer.

Take the ladle used for melting lead for bullets, and scour it bright with sand. Prop the tube at a slightly inclined angle on the forks of two sticks, planted in the ground, and rake embers of the camp-fire below it. Turn it till thoroughly warm—almost too hot to touch. Strain the mercury through paper twisted into a cone. Boil it in the ladle. Heat some more mercury in a cup, and let everything cool again. When cool enough to handle, set the tube on end, upon a cloth, to catch overflows of mercury. Fill the tube to overflowing. Put the finger firmly on the top and reverse the tube, plunging the end that is closed with the finger, into the cup of mercury. Then remove the finger gently. If, on inclining the tube, the mercury rises to the top with a sharp tap, it has been filled to the exclusion of all air, and it will do. All that now remains, is to measure with a rule from the top of the mercury in the tube, down to the top of that in the cup. It will be found convenient to have two marks scratched on each tube—the one an inch from its open end, and the other at 30 inches' interval from the one below. Then if the lowermost scratch be brought level with the surface of the mercury, the distance from the uppermost scratch has alone to be measured, and this can easily be done. It will also be convenient to arrange some simple gear to hold the tube upright, after it has been filled, as it may be desirable to keep the barometer in action after it has been made, and not merely to take a single reading, and then to empty the tube. A power of doing this becomes necessary in conducting simultaneous observations, as when a party is detached to take barometric heights in the neighbourhood. It would be easy to arrange fittings inside the box, in which the tubes are packed, for that purpose.

The operation of filling a tube should be practised at home in comfort, with a properly-made barometer for comparison, and plenty of mercury to fall back upon, before trusting oneself to the difficulties of the open field. If mercury is spilt on the ground, it may always be recovered by patience and skill, aided with a little digging, whenever the globules run down out of sight.

Probably the safest way of packing empty glass tubes would be to slip india-rubber bands over them to prevent their striking together, and to pack them among plenty of stuffing in a long light box, well protected by leather pads on the outside edges against concussion.

2. *Aneroid.*—An excellent instrument for giving moderate differences of elevation in neighbouring places, as in the process of laying down the contour lines of a country, but quite unreliable for absolute heights, because its index error is apt to change to any amount without the traveller being able to ascertain, much less to make a just allowance for, the change.

3. *Boiling-point Thermometers.*—These have the great merit of portability without risk, and of a pretty constant, but not absolutely constant, index error; consequently, they are largely used by travellers. Though the operation of boiling a thermometer is very simple in theory, it is very troublesome in practice over an ordinary camp fire. Colonel Grant, who had, together with Captain Speke, great experience in the manipulation of these instruments, speaks very highly of the effectiveness of the boiling apparatus which he took with him from the Geographical Society, and which was fitted into the bull's-eye lantern he used for reading off his sextant at night. The "shade"

f. 11c

was removed out of the lantern, and the boiling apparatus was put into its place. It was a copper cup, set in a jacket pierced with air-holes. An horizontal tube with a screw nozzle pierced the side both of the jacket and of the cup, and the thermometer was passed through this tube. The thermometer passed through a cork fixed into the middle of a screw which was screwed into the nozzle. It requires, however, very careful trimming of the lamp to obtain sufficient heat to boil the water thoroughly. We are, as yet, unable to recommend any compact apparatus fit to be used with a lamp fed with common oil, which shall act with certainty in the hands of an average traveller. It is essential to accuracy, and also to the steadiness of the mercury in the thermometer, that its bulb should not touch the boiling water, but be thoroughly enveloped in the steam which issues copiously from it.

Apparatus, to be used with spirits of wine, is made by Casella, 14, Hatton Garden. A small "Russian furnace" is by far the most powerful kind of spirit-lamp, and the best for out-of-door work; it consumes no more spirit than the common lamp.

A tin pot, with a sliding tin cylinder inside, with holes for escape of the steam, and which admits of being pegged at the desired height, suffices, when a common fire is the source of heat. The thermometer is passed through a cork which is pressed into a hole in the lid, which fits firmly (like the lid of a pill-box) on the top of the inside tin cylinder. The fire must be made of bright clear embers to avoid trouble with smoke, and the pot must be securely propped on stones or hung like a gipsy kettle, for fear of a fall and of destruction to the thermometer.

The thermometer should be observed after the water has been boiling freely, but not too tumultuously, for three or four minutes; and at least four or five readings should be taken, at half-minute intervals. Though pure water ought to be used, yet any water that is not very hard will suffice for a traveller's ordinary need.

Having obtained the boiling points, it remains to determine the value of the indication of barometric pressure from the following Tables, which are fairly approximate, and will serve in the absence of Guyot's collection or others. Supposing the thermometer to have been boiled at the foot and at the summit of a mountain, deduct the number in the column of "total altitude of feet" opposite the boiling point, as observed below, from the similar number corresponding to the boiling point above: this gives a roughly approximate height, which must be corrected for the temperature of the air between the two stations, in order to obtain a more nearly correct altitude. This correction is made by multiplying the nine hundredth part of

the altitude already obtained, by the difference between the sum of the temperatures at the two stations and 64°. This correction is *additive* when the sum of temperature exceeds 64°, otherwise it is subtractive. This latter is the case, when the mean temperature of the air at the two stations is below the freezing point:

	°	Feet.
Boiling point at summit of the hill	204·2	= 4027
„ its foot	208·7	= 1690
Approximate height		2337

Temp. of the air below ..	75°
„ „ above ..	83
Sum	158
	64
	94

Also $\frac{2337}{900} = 2{\cdot}6$ (nearly enough.)

For the correction, 94 × 2·6 =	244 (additive.)
Approximate height	2337
	2581 feet, corrected altitude.

TABLE I.—To find the Barometric Pressure and Elevation corresponding to any observed Temperature of Boiling Water between 214° and 180°.

Boiling Point of Water.	Corresponding Height of Barometer.	Total Altitude in Feet from 30·00 in. or the Level of the Sea.	Value of each Degree in Feet of Altitude.	Proportional Part for One-tenth of a Degree.	Boiling Point of Water.	Corresponding Height of Barometer.	Total Altitude in Feet from 30·00 in. or the Level of the Sea.	Value of each Degree in Feet of Altitude.	Proportional Part for One-tenth of a Degree.
°		Feet.	Feet.	Feet.	°		Feet.	Feet.	Feet.
214	31·19	−1013	..	..	196	21·71	8407	543	..
213	30·59	507	−504	..	195	21·26	8953	546	..
212	30·00	0	−507	..	194	20·82	9502	548	55
211	29·42	+ 509	+509	51	193	20·39	10053	551	..
210	28·85	1021	511	..	192	19·96	10606	553	..
209	28·29	1534	513	..	191	19·54	11161	556	..
208	27·73	2049	515	..	190	19·13	11719	558	56
207	27·18	2566	517	52	189	18·72	12280	560	..
206	26·64	3085	519	..	188	18·32	12843	563	..
205	26·11	3607	522	..	187	17·93	13408	565	57
204	25·59	4131	524	..	186	17·54	13977	569	..
203	25·08	4657	526	..	185	17·16	14548	572	58
202	24·58	5185	528	53	184	16·79	15124	575	..
201	24·08	5716	531	..	183	16·42	15702	578	..
200	23·59	6250	533	..	182	16·06	16284	581	..
199	23·11	6786	536	..	181	15·70	16869	584	..
198	22·64	7324	538	54	180	15·35	17455	587	59
197	22·17	7864	541	..					

When the boiling point at the upper station alone is observed, we have no option but to *assume* 30·00 inches, or a little less, as the average height of the barometer at the level of the sea. The altitude of the upper station is then at once approximately obtained by inspection of Table I.; correcting for assumed temperature of the air at the sea level. The serious inaccuracy to which the above assumption may lead, and its possible prevention by repeated observations at intervals extending over a considerable period, has already been pointed out.

The small but complete tables, next page, will be especially useful to those who carry a mountain barometer and are anxious to make accurate determinations, but are not furnished with larger tables. These are calculated by Loomis, and are extracted from Guyot's collection.

Part I. gives the altitude, subject to correction, for the temperature of the air, and for the other influences which are the subjects of Parts II. III. IV. and V.

Method of computation.—(1) Take from Part I. the two numbers corresponding to the two barometric heights; (2) from their difference subtract the correction found in Part II., with the difference between the thermometers that are attached to the barometers (*Mem.* this correction is not wanted for aneroids, for their works are mechanically compensated for temperature); (3) multiply the nine hundreth part of the value already obtained by the difference between the sum of the temperatures at the two stations and 64°. This correction is additive when the sum of the temperatures exceeds 64°, otherwise it is subtractive; (4) for further precision take corrections from Parts III. and IV., also from Part V., when the lower station is so high as to bring the case within the range of that table:—

(*Example*)	Upper Station.	Lower Station by Sea.
	°	°
Thermometer in open air	70·3	77·5
Thermometer in barometer	70·3	77·5
Barometer	23·66	30·046
Latitude 21°.		
Part I. gives for 30·046 inches		27,649·7
Part I. gives for 23·66 inches		21,406·9
Difference		6242·8
Part II. gives for 77°·5 − 70°·3 (=7°·2)		−16·9
Approximate altitude		6225·9
$\frac{6225\cdot9}{900} + \{77°\cdot5 + 70°\cdot3 - 64\} = 6918 \times 83\cdot8$		+579·7
Nearly correct altitude		6805·6
Part III. gives for above altitude and latitude 21 ..		+13·3
Part IV. gives for above altitude		+19·3
Part V. is not used in this case		0·0
Correct height above sea		6,838·2 feet.

PART I.

ARGUMENT, THE OBSERVED HEIGHT OF THE BAROMETER AT EITHER STATION.

Inches.	Feet.	Diff.	Inches.	Feet.	Diff.	Inches.	Feet.	Diff.	Inches.	Feet.	Diff.
11·0	1396·9	236·4	16·0	11186·3	162·8	21·0	18291·0	124·1	26·0	23871·0	100·3
11·1	1633·3	234·3	16·1	11349·1	161·8	21·1	18415·1	123·6	26·1	23971·3	99·9
11·2	1867·6	232·3	16·2	11510·9	160·8	21·2	18538·7	122·9	26·2	24071·2	99·5
11·3	2099·9	230·2	16·3	11671·7	159·8	21·3	18661·6	122·4	26·3	24170·7	99·1
11·4	2330·1	228·2	16·4	11831·5	158·8	21·4	18784·0	121·8	26·4	24269·8	98·8
11·5	2558·3	226·2	16·5	11990·3	157·9	21·5	18905·8	121·2	26·5	24368·6	98·4
11·6	2784·5	224·2	16·6	12148·2	156·9	21·6	19027·0	120·7	26·6	24467·0	98·1
11·7	3008·7	222·4	16·7	12305·1	155·9	21·7	19147·7	120·1	26·7	24565·1	97·6
11·8	3231·1	220·5	16·8	12461·0	155·1	21·8	19267·8	119·6	26·8	24662·7	97·3
11·9	3451·6	218·6	16·9	12616·1	154·1	21·9	19387·4	119·0	26·9	24760·0	97·0
12·0	3670·2	216·8	17·0	12770·2	153·3	22·0	19506·4	118·5	27·0	24857·0	96·6
12·1	3887·0	215·0	17·1	12923·5	152·3	22·1	19624·9	118·0	27·1	24953·6	96·2
12·2	4102·0	213·3	17·2	13075·8	151·5	22·2	19742·9	117·4	27·2	25049·8	95·9
12·3	5315·3	211·6	17·3	13227·3	150·6	22·3	19860·3	116·9	27·3	25145·7	95·5
12·4	4526·9	209·8	17·4	13377·9	149·7	22·4	19977·2	116·4	27·4	25241·2	95·2
12·5	4736·7	208·2	17·5	13527·6	148·9	22·5	20093·6	115·8	27·5	25536·4	94·8
12·6	4944·9	206·5	17·6	13676·5	148·0	22·6	20209·4	115·4	27·6	25431·2	94·5
12·7	5151·4	205·0	17·7	13824·5	147·2	22·7	20324·8	114·8	27·7	25525·7	94·2
12·8	5356·4	203·3	17·8	13971·7	146·3	22·8	20439·6	114·4	27·8	25619·9	93·8
12·9	5559·7	201·7	17·9	14118·0	145·6	22·9	20554·0	113·8	27·9	25713·7	93·4
13·0	5761·4	200·2	18·0	14263·6	144·7	23·0	20667·8	113·3	28·0	25807·1	93·2
13·1	5961·6	198·7	18·1	14408·3	144·0	23·1	20781·1	112·9	28·1	25900·3	92·8
13·2	6160·3	197·2	18·2	14552·3	143·1	23·2	20894·0	112·4	28·2	25593·1	92·5
13·3	6357·5	195·7	18·3	14695·4	142·4	23·3	21006·4	111·9	28·3	26085·6	92·1
13·4	6553·2	194·3	18·4	14837·8	141·6	23·4	21118·3	111·4	28·4	26177·7	91·9
13·5	6747·5	192·8	18·5	14979·4	140·9	23·5	21229·7	110·9	28·5	26269·6	91·5
13·6	6940·3	191·4	18·6	15120·3	140·0	23·6	21340·6	110·5	28·6	26361·1	91·2
13·7	7131·7	190·0	18·7	15260·3	139·4	23·7	21451·1	110·0	28·7	26452·3	90·9
13·8	7321·7	188·6	18·8	15399·7	138·6	23·8	21561·1	109·5	28·8	26543·2	90·5
13·9	7510·3	187·3	18·9	15538·3	137·9	23·9	21670·6	109·1	28·9	26633·7	90·3
14·0	7697·6	186·0	19·0	15676·2	137·1	24·0	21779·7	108·7	29·0	26724·0	89·9
14·1	7883·6	184·6	19·1	15813·3	136·5	24·1	21888·4	108·2	29·1	26813·9	89·6
14·2	8068·2	183·3	19·2	15949·8	135·7	24·2	21996·6	107·7	29·2	26903·5	89·3
14·3	8251·5	182·1	19·3	16085·5	135·0	24·3	22104·3	107·3	29·3	26992·8	89·1
14·4	8433·6	180·8	19·4	16220·5	134·3	24·4	22211·6	106·8	29·4	27081·9	88·7
14·5	8614·4	179·6	19·5	16354·8	133·7	24·5	22318·4	106·4	29·5	27170·6	88·4
14·6	8794·0	178·3	19·6	16488·5	132·9	24·6	22424·8	106·0	29·6	27259·0	88·1
14·7	8972·3	177·2	19·7	16621·4	132·3	24·7	22530·8	105·6	29·7	27347·1	87·8
14·8	9149·5	176·0	19·8	16753·7	131·6	24·8	22636·4	105·1	29·8	27434·9	87·6
14·9	9325·5	174·8	19·9	16885·3	131·0	24·9	22741·5	104·8	29·9	27522·5	87·2
15·0	9500·3	173·5	20·0	17016·3	130·3	25·0	22846·3	104·3	30·0	27609·7	86·9
15·1	9673·8	172·4	20·1	17146·6	129·7	25·1	22950·6	103·8	30·1	27696·6	86·7
15·2	9846·2	171·3	20·2	17276·3	129·0	25·2	23054·4	103·5	30·2	27783·3	86·4
15·3	10017·5	170·2	20·3	17405·3	128·4	25·3	23157·9	103·1	30·3	27869·7	86·0
15·4	10187·7	169·1	20·4	17533·7	127·7	25·4	23261·0	102·6	30·4	27955·7	85·8
15·5	10356·8	168·0	20·5	17661·4	127·2	25·5	23363·6	102·3	30·5	28041·5	85·6
15·6	10524·8	167·0	20·6	17788·6	126·5	25·6	23465·9	101·8	30·6	28127·1	85·2
15·7	10691·8	165·9	20·7	17915·1	125·9	25·7	23567·7	101·5	30·7	28212·3	85·0
15·8	10857·7	164·8	20·8	18041·0	125·3	25·8	23669·2	101·1	30·8	28297·3	84·7
15·9	11022·5	163·8	20·9	18166·3	124·7	25·9	23770·3	100·7	30·9	28382·0	84·4
16·0	11186·3		21·0	18291·0		26·0	23871·0		31·0	28466·4	

PART II.

CORRECTION DUE TO T—T′, OR THE DIFFERENCE OF THE TEMPERATURES OF THE BAROMETERS AT THE TWO STATIONS.

This Correction is Negative when the Temperature at the Upper Station is lowest, and vice versâ.

T—T′.	Correction.	T—T′.	Correction.	T—T′.	Correction.	T—T′.	Correction.	T—T′.	Correction.	T—T′.	Correction.
Fah't.	Feet.	Fah't.	Feet.	Fah't.	Feet.	Fah't.	Feet.	Fah't.	Feet.	Fah't.	Feet.
°		°		°		°		°		°	
1	2·3	14	32·8	27	63·2	40	93·6	53	124·1	66	154·5
2	4·7	15	35·1	28	65·5	41	96·0	54	126·4	67	156·8
3	7·0	16	37·5	29	67·9	42	98·3	55	128·7	68	159·2
4	9·4	17	39·8	30	70·2	43	100·7	56	131·1	69	161·5
5	11·7	18	42·1	31	72·6	44	103·0	57	133·4	70	163·9
6	14·0	19	44·5	32	74·9	45	105·3	58	135·8	71	166·2
7	16·4	20	46·8	33	77·3	46	107·7	59	138·1	72	168·6
8	18·7	21	49·2	34	79·6	47	110·0	60	140·4	73	170·9
9	21·1	22	51·5	35	81·9	48	112·4	61	142·8	74	173·3
10	23·4	23	53·8	36	84·3	49	114·7	62	145·1	75	175·6
11	25·8	24	56·2	37	86·6	50	117·0	63	147·5	76	177·9
12	28·1	25	58·5	38	89·0	51	119·4	64	149·8	77	180·3
13	30·4	26	60·9	39	91·3	52	121·7	65	152·2	78	182·6

PART III.

CORRECTION DUE TO THE CHANGE OF GRAVITY FROM THE LATITUDE OF 45° TO THE LATITUDE OF THE PLACE OF OBSERVATION.

Positive from Lat. 0° to 45°; Negative from Lat. 45° to 90°.

PART IV.

CORRECTION FOR DECREASE OF GRAVITY ON A VERTICAL.

Always Positive.

PART V.

CORRECTION DUE TO THE HEIGHT OF THE LOWER STATION.

Always Positive.

App. Alt.	Latitude. 0° / 90°	10° / 80°	20° / 70°	30° / 60°	40° / 50°	45°	Height of Barometer at Lower Station. 16 in.	18 in.	20 in.	22 in.	24 in.	26 in.	28 in.	App. Alt.
Feet.	Feet.	Feet.	Feet.	Feet.	Feet.	Feet.	Feet.	Feet.	Feet.	Feet.	Feet.	Feet.	Feet.	Feet.
1000	2·6	2·5	2·0	1·3	0·5	0	2·5	1·6	1·3	1·0	0·8	0·6	0·4	0·2	1000
2000	5·3	5·0	4·1	2·6	0·9	0	5·2	3·1	2·5	2·0	1·5	1·1	0·7	0·3	2000
3000	7·9	7·5	6·1	4·0	1·4	0	7·9	4·7	3·8	3·0	2·3	1·7	1·1	0·5	3000
4000	10·6	10·0	8·1	5·3	1·8	0	10·8	6·3	5·1	4·0	3·1	2·2	1·4	0·7	4000
5000	13·2	12·4	10·1	6·6	2·3	0	13·7	7·8	6·4	5·0	3·8	2·8	1·8	0·8	5000
6000	15·9	14·9	12·2	7·9	2·8	0	16·7	9·4	7·6	6·0	4.6	3·3	2·1	1·0	6000
7000	18·5	17·4	14·2	9·3	3·2	0	19·9	11·0	8·9	7·1	5·4	3·9	2·5	1·2	7000
8000	21·2	19·9	16·2	10·6	3·7	0	23·1	12·5	10·2	8·1	6·2	4·4	2·8	1·3	8000
9000	23·8	22·4	18·3	11·9	4·1	0	26·4	14·1	11·4	9·1	6·9	5·0	3·2	1·5	9000
10000	26·5	24·9	20·3	13·2	4·6	0	29·8	15·7	12·7	10·1	7·7	5·5	3·5	1·7	10000
11000	29·1	27·4	22·3	14·6	5·1	0	33·3	17·2	14·0	11·1	8·5	6·1	3·9	1·8	11000
12000	31·8	29·9	24·4	15·9	5·5	0	36·9	18·8	15·3	12·1	9·2	6·6	4·2	2·0	12000
13000	34·4	32·4	26·4	17·2	6·0	0	40·6	20·4	16·5	13·1	10·0	7·2	4·6	2·2	13000
14000	37·1	34·9	28·4	18·5	6·4	0	44·4	21·9	17·8	14·1	10·8	7·7	4·9	2·3	14000
15000	39·7	37·3	30·4	19·9	6·9	0	48·3	23·5	19·1	15·1	11·5	8·3	5·3	2·5	15000
16000	42·4	39·8	32·5	21·2	7·4	0	52·3	25·1	20·3	16·1	12·3	8·8	5·6	2·7	16000
17000	45·0	42·3	34·5	22·5	7·8	0	56·4	26·6	21·6	17·1	13·1	9·4	6·0	2·8	17000
18000	47·7	44·8	36·5	23·8	8·3	0	60·5	28·2	22·9	18·1	13·8	9·9	6·3	3·0	18000
19000	50·3	47·3	38·6	25·2	8·7	0	64·8	29·8	24·1	19·2	14·6	10·5	6·7	3·2	19000
20000	53·0	49·8	40·6	26·5	9·2	0	69·2	31·3	25·4	20·2	15·4	11·0	7·0	3·3	20000
21000	55·6	52·3	42·6	27·8	9·7	0	73·6	32·9	26·7	21·2	16·1	11·6	7·4	3·5	21000
22000	58·3	54·8	44·7	29·1	10·1	0	78·2	34·5	28·0	22·2	16·9	12·1	7·7	3·7	22000
23000	60·9	57·3	46·7	30·5	10·6	0	82·9	36·0	29·2	23·2	17·7	12·7	8·1	3·8	23000
24000	63·6	59·8	48·7	31·8	11·0	0	87·6	37·6	30·5	24·2	18·5	13·2	8·4	4·0	24000
25000	66·2	62·2	50·7	33·1	11·5	0	92·5	39·1	31·8	25·2	19·2	13·8	8·8	4·1	25000

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On Observations with Theodolites or Altazimuth Instruments.

By Colonel J. T. Walker, R.E., F.R.S., Superintendent of the Great Trigonometrical Survey of India.

In the opening pages of these Hints, lists of instruments have been given which travellers of little experience are recommended to provide themselves with, and the sextant has been more particularly recommended, as the traveller will have opportunities of practising with it under the tuition of the officers of the ship which is conveying him to his destination. The suitability of this instrument for observations, both on land and sea, is thus a great advantage for any person who has not had an opportunity of learning the use of his instruments before starting on his expedition; and should he not have a sufficient knowledge of the methods of reducing the observations and calculating the results, he will find the simplest and easiest rules for his guidance in the several works on navigation, which are specially written for the reduction of observations with sextants by persons possessing little or no knowledge of the principles on which the rules are based. The inexperienced traveller can scarcely be expected to attain much accuracy in his observations and reductions, but should he explore unknown regions, he may be able to acquire valuable information, the immediate interest of which may be very considerable; but his work will necessarily be of a preliminary nature, and be liable to be largely corrected, or altogether superseded, by the operations of subsequent explorers.

But the extent of the regions of *terra incognita* in which inexperienced travellers can operate with the greatest advantage is constantly becoming more and more narrowed and diminished, and geographical science now-a-days frequently requires that the rough outlines which have hitherto sufficed for her purposes should not only be amplified and filled in, but rectified by more exact and reliable observations. The traveller must, in such cases, be provided with an instrument of greater capabilities than the sextant, and he should have thoroughly learnt the use of this instrument and the method of reducing the several kinds of observations which may be made with it before he commences operations. If he has no better instruments nor greater skill than his predecessors, his results may differ widely from theirs, but they will not be more worthy of confidence, and, while causing much perplexity and inconvenience to geographers, they will only exhibit with certainty the degree of uncertainty that is still attached to the problem under investigation.

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An altazimuth instrument—or a theodolite possessing a complete vertical circle as well as a horizontal circle—is in many respects superior to a sextant. 1st, it measures horizontal angles directly, thus avoiding the labour of reducing oblique angles to the horizon; and a round of several angles can be measured with far less trouble than with the sextant. 2ndly, it measures small vertical angles of elevation or depression of objects which frequently could not be seen by reflection from a mercurial horizon for the measurement of the double angle by a sextant. 3rdly, its telescopic power is usually far higher than that of a sextant. 4thly, it may be so manipulated as to eliminate the effects—without in the first instance ascertaining the magnitudes—of certain constant instrumental errors, such as excentricity, collimation, and index errors. And 5thly, the influence of graduation errors may—when great accuracy is required—be reduced to a very considerable extent by systematic changes of the zero settings of the horizontal circle.

The disadvantages of the altazimuth instrument as compared with the sextant are its greater cost and bulk and weight; but in many instances these disadvantages will be more than counterbalanced by its superior capabilities.

Messrs. Troughton and Simms have favoured me with the following details regarding the cost, weight, and telescopic powers of these instruments as constructed by themselves:—

Instrument.	Weight of with Box.	Weight of Stand.	Price.	Telescopic Powers.	Readings of Verniers.	Details.
	lbs.	lbs.	£ s. d.			
7-inch (radius) sextant	7		12 0 0	5 to 10	10″	*
Artificial horizon ..	5 to 10					
4-inch (diameter) transit theodolite	13½	9	23 0 0	9 „ 12	1′	Without transit axis level, and lamp.
5-inch „ „ ..	25	10	32 10 0	12 „ 15	30″	With transit axis level, and lamp.
6-inch „ „ ..	31	12	40 0 0	12 „ 18	20″	Do.

* The weight of a tripod stand, as described in "Outfit" (p. 8), would be additional.

The Messrs. Casella construct certain very light and cheap altazimuth instruments, with 3-inch circles, power 5, weight with box 4 lbs., weight of stand 3½ lbs. divided to 1′, price under 20*l*.

For astronomical observations the sextant is decidedly preferable to very small altazimuth instruments, but the latter are to be preferred for the measurement of horizontal angles and small elevations or depressions.

The traveller must necessarily adapt his equipment to his requirements and the facilities he will possess for carrying his instruments about. He may find it convenient to employ

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a sextant for astronomical, and a very small light altazimuth for terrestrial observations. But, whenever practicable, an altazimuth of moderate size, which may be used as a universal instrument, would undoubtedly be the most convenient and satisfactory.

The instrument which I would recommend for geographical explorations, as being well adapted for astronomical and for terrestrial observations, and not very bulky, is the 6-inch transit theodolite by Messrs. Troughton and Simms: several of these have been used in explorations connected with the operations of the Great Trigonometrical Survey of India, and have given great satisfaction, being sufficiently accurate for all desirable purposes, and not too heavy to be easily carried. These instruments are adapted for determinations of time and longitude by the method of zenith distances, and also by that of meridional transits; the former being best suited for the traveller when he can only devote a few hours to the operations, the latter when he is halting for a long time at one place: the two methods lead to strictly independent results, so that when both are employed they serve to check each other. The instrument is also well suited for latitude and azimuth observations; in fact it can be employed in any of the investigations which an explorer may have to undertake by means of astronomical observations. On the other hand, as an instrument for the measurement of terrestrial angles, whether horizontal or vertical, it is very valuable, and far superior to any sextant, not only being more conveniently manipulated, but possessing telescopic powers which permit of the detection and identification of objects that would often be sought for in vain with a sextant.

Trigonometrical operations are, as a rule, far simpler and more easily reduced, and lead to more accurate results than astronomical observations. A continuous triangulation, or a traverse with measured angles and distances, is necessarily impossible when the explorer has to pass through a country very rapidly; but he may frequently remain for several days at one place, and may then have opportunities of greatly extending the scope of his operations by executing a triangulation. Suppose him to be in view of a range of hills which he may not have an opportunity of exploring, distant say 50 to 100 miles; he may have already endeavoured on his line of march to fix points on the range by bearings, but from the absence of prominent landmarks has found a difficulty in identifying the points observed, and thinks he may have mistaken one hill for another in consequence of their changes in appearance as viewed from positions at some distance apart. If, during his

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few days' halt, he can manage to do a little triangulation, he may fix the general outlines of the entire range relatively to his halting-place with very respectable accuracy. He has first to measure a base and determine by triangulation the positions of three stations lying in a direction nearly parallel to that of the range, and at distances of 2 to 5 miles apart; then at each of these stations he must measure the angles between the other stations and a series of points on the entire length of the range;* though no very prominent landmarks may be visible, still the telescope will show a number of objects—trees, masses of rock, and peculiarities of the ground—sufficiently clearly to permit of their being recognized at stations of observation which are so close to each other; and though the triangles will be very acute-angled, the angles may easily be measured with sufficient accuracy to give the distances of the points on the ranges from the stations of observation with a small percentage of error, whenever the marks are fairly identified; and as there will be two triangles to each point, and, therefore, double values of the side common to both triangles, any mistakes—whether of identity, or of reading, or calculation —will be at once shown up.

The 6-inch transit theodolites of the Indian Survey which have been used in military expeditions and explorations are specially provided with a pair of micrometers in the eyepiece of the telescope, for the purpose of measuring small angles, and more particularly those subtended by objects of known dimensions, by means of which the distance between the object and the observer is readily deduced. The system of micrometers is moveable through an angle of 90°, so as to permit of the measurement of either a horizontal or a vertical object. With the aid of this appliance, the instrument can be employed in carrying on a traverse without using any direct measuring apparatus, such as a chain or perambulator, the distances to the

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* He should make a sketch of the outline of the range in his book of observations; and as he will probably be unable to ascertain the names of the hill summits at such a distance from them, and many of them may have no names, he had better number them in the order in which they are observed, and refer to them always by these numbers, until he can confidently replace a number by a name. Exaggerated sketches of the outlines of the objects intersected by the telescope are frequently of use to facilitate identification on proceeding to the next station.

The positions of places situated within or beyond the range of hills, which are invisible to the traveller, but are known to his native guides and assistants, may frequently be determined by making a native point the theodolite, as a gun, in the direction of the place, and state its distance beyond or on this side of the range. The guides will often be found to possess a remarkable knowledge of locality, and I have frequently known the independent pointings of different men towards distant invisible objects to coincide together very closely, as was shown by the readings of the azimuthal circle.

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back and forward stations being determined by measuring the angles subtended by poles of known length, which are set up at the stations. In hilly and broken ground, in crossing rivers or other obstacles, and generally wherever a direct measurement is impracticable, this method of procedure is most convenient. It was adopted by Captain Carter, R.E., in his survey—with one of these instruments—of the line of country passed over by the British army in the Abyssinian expedition. Captain Carter carried a traverse from Adigerat to Magdala, a distance of nearly 300 miles, without any break of continuity, the daily rate of progress averaging 5 miles, and being occasionally as much as 8 miles. The difference of latitude between the origin and terminus as determined from these operations only differed by about a quarter of a mile from the value determined astronomically.

Whenever a halt occurred in the movements of the army, the instrument was used as a theodolite in triangulating to fix the positions of all hills and other prominent objects around the halting-place; it was also used for various astronomical observations.*

Remarks on the Manipulation of Altazimuth Instruments.

Observations with these instruments should always be made in pairs, with the face of the vertical circle alternately to the right and left of the observer. Thus, supposing that in the first observation, or round of observations, the face of that circle is to the right of the observer, the telescope should be immediately afterwards moved through 180° in azimuth, and turned over in altitude, which will bring the face of the circle to the left of the observer, and then a second observation, or round of observations, should be taken; the mean of the two measures, face right and face left, will be free from collimation, index, and other instrumental errors.

In measuring horizontal angles between objects of nearly the same altitude, as landmarks not much above or below the

* These instruments being furnished with a pair of micrometers, which can be used either horizontally or vertically, are all the more valuable for astronomical observations; for the micrometers give two additional wires over which the stars may be observed, and these wires can be set at pleasure to any distance from the fixed wires in the diaphragm which may be best suited to the rate of movement of the star. For pairs of observations—face right and face left—no reductions to the centre wire are necessary; and thus greater accuracy is obtained with very slight additional trouble of observing, and still less of computing.

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horizon, a change of face is not absolutely necessary, and may be dispensed with if the observer is hurried; but when such angles are measured between objects of very different altitudes —as a terrestrial referring mark and a star—and whenever altitudes are measured, whether of terrestrial or celestial objects, the observations should invariably be taken in both positions, alternately "face right" and "face left," and the final result deduced from the mean, in order that the instrumental errors may be eliminated. There is no necessity to determine the magnitude of these errors, as in the sextant; in an instrument which has to travel far over bad ground the adjustments are liable to alter from time to time, but they are not likely to alter in the interval between two consecutive observations, and the errors arising therefrom will be eliminated in the mean of the pair.

In what follows regarding *astronomical* observations with these instruments, a complete observation will be understood to imply the mean of a pair of observations, one with face right, the other with face left, taken continuously without any considerable pause between them, the entire operation being considered as one observation.

Determinations of Time, Azimuth, Latitude and Longitude, with a Transit Theodolite.

The transit theodolite may be employed either as a transit instrument or as an altazimuthal instrument; it is adapted for all astronomical observations, excepting those of "lunar distances," which can only be performed by a sextant or a reflecting circle, and occultations, which require larger telescopes.

Thus a description of each of the various kinds of observations which can be made with transit and altazimuth instruments, with full details of the methods to be employed in the corresponding reductions, would fill a volume, and be much more than is required for a book which merely purports to give hints to travellers. Those who wish to learn full particulars of each of the several methods of observation, and of the reductions, cannot do better than study Chauvenet's 'Spherical and Practical Astronomy,' which is one of the most valuable works on the subject in the English language: it gives ample instructions for observations of all kinds, the rudest and most hurried, as well as the most refined and elaborate, and it supplies corresponding formulæ—approximate as well as rigorous—for the reduction of the observations.

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As these Hints are merely intended to indicate the simplest and most expeditious methods by which a traveller who is able to carry a suitable altazimuthal instrument about with him can take the astronomical observations which are essentially necessary for his geographical explorations, they will be restricted to determinations of time, latitude and longitude, by the measurement of zenith distances, and of azimuths by horizontal angles; formulæ—some approximate but all sufficiently rigorous for the purpose, and adapted mostly from Chauvenet—will also be given, for the reduction of the observations.

Latitude Observations, the time being unknown.—The instrument being duly levelled and brought approximately into the meridian, set the telescope on any star—or on the sun—when approaching culmination, and follow it until the maximum altitude is reached; take the zenith-distance reading on the vertical circle, change face quickly, and make a second observation; the mean of the two will be a "complete observation" of zenith distance. Two or three pairs of observations may be taken to circumpolar stars, as their zenith distances will not alter sensibly during an interval of a quarter to half an hour; for other stars the observations should be restricted to one pair, and stars should not be observed when within 25° of the zenith. A single pair of observations with the 6″ transit theodolite should give a determination within 20″ of the truth; greater accuracy may be obtained by observing additional stars, more particularly when the stars are selected so as to form pairs of nearly equal distance from the zenith, north and south.

Latitude Observations, the time being known.—(1.) Observe the zenith distance of the Pole-star in any position, and reduce to the meridian by the tables in the 'Nautical Almanac.'

(2.) Take circum-meridian observations of the zenith distance of any star, alternately face right and face left, and note the time of each observation; compute the reduction of the zenith distance at the time of observation to the distance on the meridian, and take the mean of the reduced results as the determination of the meridional zenith distance. Three or four pairs of observations may generally be made in succession to the same star; but the nearer the star is to the zenith the more accurately should the times be known—it is not desirable, therefore, to observe stars within 10° of the zenith. Here, too, pairs of north and south stars of nearly equal zenith distance will give the best results.

Time.—Take pairs of observations of the zenith distance of a star, noting the chronometer time of each, and adopt the mean of the times as the time corresponding to the mean zenith distance, with which, the latitude of the place, and the star's declination, the star's hour angle must be computed by either of the well-known formulæ: thus the local time and the chronometer error will be determined. For these observations stars are most favourably situated which are easterly or westerly, and not very near either to the horizon or to the meridian; and greatest accuracy is obtained when two stars are observed at nearly the same altitude, one to the east, the other to the west. With a pair of observations the chronometer error should be determined within 1 second when a 6″ transit theodolite * is used.

* At a trial of one of these instruments for the Indian Survey, the results of six pairs of observations on east and west stars fell within an extreme range of 0·4 of a second of time; the stars were, however, observed on the wires of the two micrometers, as well as on the fixed wire of the diaphragm. (*See* footnote, page 36.

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Longitude.—Take pairs of observations of zenith distance on a star for the determination of the local time and chronometer error, then take other pairs of observations of zenith distance on the moon; in each instance adopt the mean of the chronometer times as that of the "complete observation" of zenith distance. Both moon and star should be easterly or westerly, and not very near either to the meridian or to the horizon. The operations should commence and close with star observations, in order that the chronometer rate may be duly ascertained and allowed for. Ten pairs of observations to the moon and six to stars ought not to occupy more than four hours, and they should give a very fair result, probably within 8 miles of the truth. The effect of instrumental errors will be materially reduced when the stars and the moon are on the same sides of the meridian and at nearly the same zenith distance; if time permits, observations should be taken both east and west of the meridian, and both before and after full moon.

Azimuth, time and latitude being unknown.—Observe the angles between a referring mark * and a star when the star is at the same altitude east and west of the meridian; several pairs of observations may be taken at consecutive altitudes, half with face right and half with face left. Or the angles may be measured between a referring mark and a circumpolar star at the times of its maximum elongations east and west. The mean of the two angles at opposite positions gives the angle between the star and the meridian, and thence the azimuth of the referring mark, without any calculations whatever. In the first case, however, an interval of several hours must be allowed to elapse between the observations east and west; and as twelve hours must necessarily elapse between the opposite elongations of a circumpolar star, few stars will ordinarily be visible at both elongations.

It may therefore be desirable to adopt a third and more expeditious method, as follows:—Measure the angles between the referring mark and *two* circumpolar stars at their respective elongations, selecting stars which are nearly in opposition or nearly in conjunction, and will attain their maximum elongations at nearly the same time, that the observations may be completed quickly; then with the observed value of the angle between the stars, and the given declinations of the stars, the azimuths of both may be readily computed, as shown at page 18.

Azimuths, latitude being known.—Observe the angle between the referring mark and a circumpolar star at maximum elongation, and compute the azimuth of the star. To stars near the pole two or three pairs of observations, face left and face right, may be taken before the star moves sensibly from the position of maximum elongation.

Azimuth, latitude and time being known.—Any star may be observed in any position, but the best results will be obtained when a circumpolar star is observed at a short distance from the elongation; the angle between the position of the star at the observation and at the elongation may be computed by the formulæ at page 18.

General Remarks.—The observed zenith distances should always be corrected for refraction; barometer and thermometer readings should, therefore,

* A good referring mark may be made of a cross with a hole of $\frac{1}{4}$ to $\frac{1}{2}$ an inch in diameter in the centre, to which observations can be taken by day and by night, being rendered visible at night by a bull's-eye lantern placed behind the hole and directed to the observer. The stem of the cross should be vertical, and driven firmly into the ground. The distance from the station of observation should be at least half a mile, and the station should be marked by a pin driven into the ground, over which the theodolite must be carefully centered whenever set up for horizontal observations.

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be taken during the observations, for the better determination of the refraction. When no barometer is at hand, the height of the station of observation should be given, as deduced by the boiling point or otherwise, or even approximately estimated. It may be well to remember that in determining latitude errors of refraction may be eliminated by observing pairs of north and south stars of the same zenith distance.

Formulæ and Examples.

Latitude by Circum-meridian Observations of a Star.

Let ϕ be the true latitude, ζ the true zenith distance on the meridian, ζ^o the observed zenith distance corrected for refraction, δ the declination of the star,* ϕ_o an approximate value of ϕ, $= \delta \pm \zeta_o$, t the hour angle of the star.

$$\text{Put } A = \frac{\cos \phi_o \cos \delta}{\sin \zeta_o} \text{ and } m = \frac{2}{\sin 1''} \sin^2 \tfrac{1}{2} t.$$

$$\text{Then } \zeta = \zeta_o - Am, \text{ and } \phi = \delta \pm \zeta.$$

The values of m are tabulated in Chauvenet's 'Astronomy.'

Alternative forms of m, adapted for various logarithmic tables.
$m = \text{cosec } 1''$ versin t.
$= \cdot 00055 t^2$, when t is given in seconds of time.
$= 2t^2$ nearly, „ „ minutes „

Supposing n observations to be taken, then, since A is constant,

$$\zeta = \zeta_o - A \frac{m_1 + m_2 + \ldots + m_n}{n}.$$

Example.—Circum-meridian Observations for Latitude to β Ursæ Minoris, North of the Zenith.

Face.	Circle Readings.†			Mean Zenith Distances of Pairs of Observations.			Chronometer.			t in Minutes of Time.	t^2.	Data.			
		°	′	″	°	′	″	H.	M.	S.				H.	M.	S.
Left	Alt.	64	10	20	35	47	38	14	45	47	7·2	52	Æ of Star ..	14	51	14
Right	Z. D.	35	45	35					47	1	6·0	36	Chron. Error	+	1	46
„	„	35	45	0	35	47	5		48	55	4·1	17	Chron. Time of Transit	14	53	0
Left	Alt.	64	10	50					51	30	1·5	2				
„	„	64	11	0	35	47	8		54	37	1·6	3				
Right	Z. D.	35	45	15					56	22	3·4	12		°	′	″
„	„	35	45	30	35	47	25		57	43	4·7	22	δ	= 74	46	37
Left	Alt.	64	10	40					58	48	5·6	34	ζ_o	= 35	48	5
„	„	64	10	30	35	47	40	15	0	18	7·3	53				
Right	Z. D.	35	45	50					2	10	9·2	85	ϕ_o	= 38	58	32
	Mean				35	47	23				Mean ..	31·6	log cos ϕ_o ..			9·8906
	Refraction ..					+	42						log cos δ			9·4192
	ζ_o =				35	48	5				31·6 × 2 = 63·2.		log cosec ζ_o ..			0·2330
	$-Am$ =					−	22						log A..			9·5429
	ζ =				35	47	43	$\phi = 38° 58' 54''$.					log 63·2			1·8007
													log Am			1·3436

For the above formula t should be less than 20 minutes, and ζ greater than 10°.

* When the sun is observed the declination corresponding to the mean of the times of observation should be used.

† The circle readings will be alternately altitudes and zenith distances ± the index error of the instrument, which error is eliminated in the mean of a pair of observations.

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Longitude by Lunar Zenith Distances.

The local time and the chronometer error having been determined from the star observations

Let ζ_0 = the observed zenith distance of the moon's limb.
Θ = the local sidereal time of the observation of ζ_0.
L_1 = an assumed value of the longitude.
ΔL_1 = the required correction of L_1.
L = the true longitude = $L_1 + \Delta L_1$.
ϕ = the latitude.

Find the Greenwich time corresponding to Θ and L_1, for which take

δ = the moon's declination.
π = the moon's equatorial horizontal parallax.
S = the moon's geocentric semi-diameter.
} from the 'Naut. Alm.'

Let S_1 be the moon's apparent semi-diameter, and π_1 the corrected parallax;

$$\text{then } S_1 = S + \Delta S, \text{ and } \pi_1 = \pi + \Delta\pi;$$

and the values of ΔS and $\Delta\pi$ may be interpolated from the tables below, which are abridged from Chauvenet.

Also put $\delta_1 = \delta + e^2 \pi_1 \sin\phi \cos\delta$, in which $\log e^2 = 7{\cdot}8244$; and let r be the refraction for the apparent zen. dis. ζ_0;

$$\text{and let } \zeta_2 = \zeta_0 + r \pm S_1,$$
$$\text{and } \zeta_1 = \zeta_2 - \pi_1 \sin\zeta_2;$$

then the hour angle, t, is found from the equation

$$\sin^2 \tfrac{1}{2}t = \frac{\sin\tfrac{1}{2}[\zeta_1 + (\phi - \delta_1)] \sin\tfrac{1}{2}[\zeta_1 - (\phi - \delta_1)]}{\cos\phi \cos\delta_1},$$

after which the moon's right ascension, $\mathcal{R}$, is found by the formula

$$\mathcal{R} = \Theta - t.$$

The Greenwich mean time corresponding to the moon's $\mathcal{R}$ must be found from the 'Nautical Almanac'; with this and the local mean time a value of the longitude is determined, which, however, is approximate only, as t is computed with an approximate value of δ depending on the assumed longitude. Put L_2 for the approximate value of the longitude which is thus determined, and

Values of ΔS, always +.							Values of $\Delta\pi$, always +.			
Apparent Zen. Dis. of Moon.	Horizontal Semi-diameter.						Latitude.	Equatorial Parallax.		
	14′ 30″	15′ 0″	15′ 30″	16′ 0″	16′ 30″	17′ 0″		53′	57′	61′
°	″	″	″	″	″	″	°	″	″	″
0	13·7	14·6	15·6	16·7	17·7	18·8	0	0·0	0·0	0·0
10	13·5	14·4	15·4	16·4	17·5	18·6	10	0·3	0·3	0·4
20	12·9	13·8	14·7	15·7	16·7	17·7	20	1·2	1·3	1·4
30	11·8	12·7	13·5	14·4	15·4	16·3	30	2·7	2·9	3·1
40	10·5	11·2	12·0	12·8	13·6	14·4	40	4·4	4·7	5·1
50	8·8	9·4	10·1	10·7	11·4	12·1	50	6·2	6·7	7·2
60	6·9	7·3	7·9	8·4	8·9	9·5	60	8·0	8·6	9·2
70	4·7	5·1	5·4	5·8	6·1	6·5	70	9·4	10·1	10·8
80	2·4	2·6	2·8	3·0	3·2	3·4	80	10·3	11·1	11·9
90	0·1	0·1	0·1	0·1	0·2	0·2	90	10·6	11·4	12·2

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put β = the increase of δ in a unit of time } at the Greenwich mean time
and λ = „ AR „ } of the observation of the moon;

$$\text{also let } a = \frac{\beta}{15\lambda}\left\{\frac{\tan\phi}{\sin t} - \frac{\tan\delta}{\tan t}\right\};$$

$$\text{then } \Delta L_1 = \frac{L_2 - L_1}{1+a}, \text{ and } L = L_1 + \Delta L_1.$$

These formulæ are demonstrated in Chauvenet, vol. i. pages 383 to 385; and when several observations have to be reduced, they entail less labour of computation than any other formula.

Example.—In latitude $\phi = 38^\circ\ 58'\ 53''$ and assumed longitude $L_1 = 5$ h. 6 m. west of Greenwich, on May 2nd, 1849, the moon being east of the meridian, the zenith distance of the moon's upper limb was observed to be $57^\circ\ 47'\ 28{\cdot}5''$, when the local mean time was 5 h. 33 m. 21·6 s., and the local sidereal time $\Theta = 8$ h. 16 m. 14·61 s.

Approximate Greenwich mean time,
10 h. 39 m. 21·6 s.

for which we find from the 'Naut. Alm.'

δ	= + 3°	47′	47·6″
S	=	15	16·4
π	=	56	3·1

and from the tables on page 22 we find

ΔS	=	+ 8·1
$\Delta\pi$	=	+ 4·4
$e^2\pi_1 \sin\phi \cos\delta$	=	+ 14·1

ζ_0	= 57°	47′	28″·5
r	=	+ 1	30·9
S_1	=	+ 15	24·5
ζ_2	= 58	4	23·9
$-\pi_1 \sin\zeta_2$	=	− 47	38·1
ζ_1	= 57	16	45·8
δ_1	= 3	48	1·7

With these values of δ_1, ζ_1, and ϕ we find—

	H.	M.	S.
t =	− 3	19	53·64;
but Θ =	8	16	14·61;
whence the computed AR =	11	36	8·25.

	H.	M.	S.
The corresponding Greenwich mean time for this value of the AR is	10	39	48·7
The local mean time is	5	33	21·6
Whence the approx. long. L_2 is	5	6	27·1

For the Greenwich mean time 10 H. 39 M. 48·7 S. { increase of AR in 1 M. = 2·014 S. = λ.
„ δ „ = 10″·01 = β.

Whence $a = -0{\cdot}3317$; and since $L_2 - L_1 = +27{\cdot}1$ s.,

$\Delta L_1 = 40{\cdot}6$ s., and L = 5 H. 6 M. 40·6 S.

Formulæ for the reduction of Azimuth Observations.

(1.) When a star is observed at an elongation.
Let A be the azimuth, δ the declination, ϕ the latitude.

$$\text{Then } \sin A = \frac{\cos\delta}{\cos\phi}.$$

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(2.) When a star is observed at a short distance from the elongation.
Let t be the hour angle at the time of elongation,

$$\text{then } \cos t = \frac{\tan \phi}{\tan \delta}.$$

Let $d\,t$ be the difference between the hour angles at the times of elongation and of observation, and dA the corresponding difference of azimuth.

$$\text{then } \tan \mathrm{dA} = -\,2 \sin^2 \frac{d\,t}{2} \sec \phi \cot \delta \operatorname{cosec} t\,;$$

whence if $d\,t$ is expressed in *minutes of time*, and κ is a constant,

$$\log \kappa \text{ being } = \cdot 29303 + \log \sec \phi + \log \cot \delta + \log \operatorname{cosec} t,$$
$$\mathrm{dA}'' = -\,\kappa\,(d\,t)^2.$$

(3.) When two stars are observed at their elongations.
Let their azimuths be A_1 and A_2, and their declinations δ_1 and δ_2,

$$\text{then } \sin A_1 = \frac{\cos \delta_1}{\cos \delta_2} \sin A_2.$$

The value of $A_1 + A_2$ or of $A_1 - A_2$ is given by the observations, $A_1 + A_2$ if the stars are at opposite elongations, $A_1 - A_2$ if they are at the same elongation. Suppose that we have

$$A_1 \pm A_2 = m,$$
$$\text{then } \cot A_1 = \cot m \pm \frac{\cos \delta_2}{\cos \delta_1} \operatorname{cosec} m,$$
$$\text{or } \cot A_2 = \cot m \pm \frac{\cos \delta_1}{\cos \delta_2} \operatorname{cosec} m.$$

Adjustments of the "Everest Theodolite, improved, by Grover." (Furnished by Captain Pratt, R.E.)

It is stated that this theodolite is likely to be adopted into the service of the Royal Engineers. It is therefore thought advisable to describe its adjustments. The instrument is made by Cooke and Sons, York.

1. *Correction for Parallax.*—Adjust the eyepiece to distinct vision of cross hairs, and correct for parallax by means of the object-glass screw.

2. *Making the Level of the Horizontal Limb parallel to that Limb.*—Clamp the tribrach* to axis, and unclamp the horizontal vernier-plate. Move the latter so that the horizontal limb's level may be over, or parallel to, two foot-screws. By means of these screws bring the bubble to the centre of level. Turn the vernier-plate round 180°, and correct the level's error half by

* Modern instruments are set on a tribrach, or 3-armed support, at the top of the stand, instead of being screwed on to the top of it. This is a great improvement in many ways.

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the foot-screws and half by the level's capstan-headed screws. Turn the vernier-plate back to its original position; and if the bubble is not now exactly in the centre, correct as before. Repeat the process till accuracy is obtained.

3. *Levelling the Instrument*, i. e., *making its vertical axis truly vertical.*—Clamp the tribrach to axis, and unclamp the horizontal vernier-plate. Level the horizontal limb's level by the foot-screws. Turn the horizontal vernier-plate round 90° and re-level. This will make the vertical axis approximately vertical. Then bring the bubble of the vertical limb's level to the centre of bulb by the two antagonising screws at bottom of vertical vernier-plate. Turn round 180°; and if the vertical limb's level is disturbed, correct half of the error by the foot-screws and half by the two antagonistic screws. Turn the horizontal plate 90°, and repeat the process till accuracy is obtained.

If the bubble of the level attached to the horizontal plate is now disturbed, bring it to centre of bulb by the capstan-headed screw, so as to make it an index of horizontality.

4. *Collimation.*

(a) *Vertical Collimation.*—Unclamp the vertical limb, and make its level horizontal by means of the antagonising screws. By means of the vertical limb's tangent-screw get the horizontal spider-line to cover some well-defined distant point. Read off the angle on the vertical verniers.

Reverse the instrument on its bearings, re-level, and re-intersect the same object. If now the vertical verniers read as at first, the vertical collimation is correct. If not, the mean of the readings is the true angular deviation from the horizontal. By means of the vertical limb's tangent-screw make the vertical verniers read this true deviation, and intersect the distant point by means of the antagonising screws.

This will disturb the level of the vertical limb. Restore its horizontality by means of the capstan-headed adjusting screws. The verniers should now read the same angle in both positions of the transit axis. If not, repeat the process till accuracy is obtained.

(b) *Horizontal Collimation.*—Intersect some well-defined distant point with the spider-lines. Reverse the instrument on its bearings. If there is any deviation from the intersection, correct half with the tangent-screw of the horizontal limb and half with the capstan-headed screws which move the diaphragm. Reverse the instrument on its bearings, and repeat similar corrections till accuracy is obtained.

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Meteorological Instructions for the use of inexperienced Observers.

(Extracted chiefly from a Circular issued by the Meteorological Society.)

The chief object of an inexperienced meteorological observer should be to obtain data whence an accurate table may be compiled, of the following character:—

Place.				
Lat.	Long.		Elev^{n}.	
	Mean temp.	Monthly range.	Rain, &c.	Periodical winds.
Jan.				
Feb.				
Mar.				
April				
May				
June				
July				
Aug.				
Sept.				
Oct.				
Nov.				
Dec.				
Year				
No. of years' observation				
Hours and mode of observation ..				

The original observations should be carefully preserved, in order to give evidence of the sufficiency of the data whence the printed results have been obtained, and to afford opportunity of investigating such anomalies, as may at any future time call for inquiry.

The following instructions show the minimum of effort with which trustworthy results can be obtained. They are especially intended for residents. Travellers on the march must act up to the spirit of them, as nearly as they can.

Observations on Heat.

1. *To Expose Thermometers.*—The instruments must be placed in a carefully selected position, or all their results will be vitiated. Choose an airy place, where there is continuous, dense, and ample shade. There set up a box of not less than 2 feet in height, width, and depth. It must be constructed precisely on

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the principle of an ordinary meat-safe; that is to say, it must be roofed (and better still, double roofed) from the rain, and have perforated sides, whether of gauze, trellis-work, or Venetian blinds, through which the air may pass with perfect freedom. It must be fixed on a stand or be suspended 4 feet above the ground. The thermometers should be hung on supports placed in the middle of the box, except where otherwise mentioned in the 1st method, § 3.

2. *Monthly Mean Temperatures.*—The average of the daily means, taken by one of the methods described in the next paragraph during an entire month, gives the monthly mean. If occasionally a day or a month be dropped, a gap must be left in the record, and no attempt be made to fill it.

3. *Daily Mean Temperatures.*

1st Method: This is the more accurate, but requires observations to be made *twice* in each day.

Procure a jar or box, of not less than 8 inches in length, width, and depth; fill it with dry sand, and set it in a properly exposed box (§ 1). Place a thermometer upright in the middle of the sand, with its bulb buried from 3 to 4 inches below its surface. Note its readings twice a day, at intervals of twelve hours, say at 9 A.M. and 9 P.M.; the mean of these readings may be accepted as the daily mean.

2nd Method: By observations made *once* in each day.

Hang a maximum and a minimum thermometer on supports, as described in § 1, and note their readings once daily, either in the morning or in the afternoon, and readjust the indexes. The mean of the maximum and minimum usually differs from the mean temperature of the day by less than half a degree; but occasionally (as at Barnaul in Central Asia) the difference exceeds $1\frac{1}{2}^{\circ}$. The liability to a constant error of this amount is too serious to be passed over without investigation, especially as the approximate correction due to each month can be readily ascertained by making occasional use of the 1st method as a standard of comparison. When the year's work is completed, it will be easy to estimate the corrections due to the several months, and to apply them to the monthly means obtained by this 2nd method.

4. *Monthly Range* is the difference between the lowest and highest readings during the month.

5. *Yearly Means,* whether of *temperature* or of *range,* are the averages of the monthly means.

"The enclosure of a maximum and minimum self-registering thermometer in a large cask of dry sand, which might be opened and read off twice a year, would also probably afford a very accurate mean result."—*Sir John Herschel.*

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Rain, Snow, and Dew.

6. These must be measured by a Gauge, which should be placed on the ground or on a low stand in an exposed situation. The relation of the units of length and weight is such that the tenth of an inch of rain falling into a vessel whose mouth is a circular area of about two inches and nine-tenths in diameter (1·4467 inch radius) will weigh an ounce (Troy). Every medicine-chest contains a fluid ounce (Troy) measure; and, failing this, it will suffice to mark the space occupied in a small vessel by 480 drops of water, whose weight is one fluid ounce. A properly made rain-gauge and graduated measure is, however, preferable to any makeshift.

Wind.

7. Practised observers rarely use a weathercock, but watch the way the clouds (when any) are drifting. These are far steadier in their course than anything driven by the surface-currents of wind. For the requirement of the tabular statement now desired, it will be sufficient to note the prevalence of periodical weather.

Photography.

Photography for Travellers and Tourists. By Dr. Pole, F.R.S.

[Reprinted, by permission, from 'Macmillan's Magazine' of 1862, and revised by the Author, 1871.]

Doubtless, the idea must often have occurred to almost every traveller, what an advantage it would be if he could himself take photographs, where he likes, of what he likes, when he likes, and how he likes. But such an idea must soon have been dismissed, from the supposed incompatibility of this with ordinary travelling arrangements. The usual notion of photographic operations comprehends a fearful array of dark rooms, huge instruments, chemical paraphernalia, water, and mess, which no sane person, out of the professional photographic guild, would think of burdening himself with on an ordinary journey, and which only a practised adept could use if he had them; and so the idea of a traveller's taking views for himself on his tour is generally dismissed at once as an impracticable chimera.

Now, it is the object of this article to show that such a view of the matter is a delusion, and that any traveller or tourist, gentleman, or lady, may, by about a quarter of an hour's learning, and with an amount of apparatus that would go into the gentleman's coat pocket, or the lady's reticule, put himself or herself into the desirable position we have named.

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It is not our intention to write a treatise on photography; but we must state generally what the operations are, in order to make our explanations intelligible.

The process, then, of taking a photographic picture consists essentially of three main divisions, namely—1. Preparing the plate; 2. Taking the picture; and 3. Developing the image; and the most common and best known arrangement of these is as follows:—A glass plate of the proper size is coated with collodion, and made sensitive to light by dipping in a bath of a certain solution. It is then, *while it remains moist*, placed in the camera obscura, and exposed to the image formed by the lens; after which, *but still before the plate has had time to dry*, it is taken out, and treated with certain chemicals which have the property of developing the image so obtained. The plate is then what is called a "negative;" from which, after it has been secured by varnish, any number of impressions or "prints" may be taken at any time.

Now, it will be seen by the words we have printed in italics, that, according to this method of operation, the whole of the three parts of the process must be performed within a very short space of time; and, since the first and third require to be done in a place to which daylight cannot enter, a dark room, supplied with a somewhat extensive assortment of chemical apparatus, must be provided *close to the place* where the picture is taken. This method, from the necessity of the plate remaining moist, is called the *wet* process. It is always employed for portraits, and has the advantage not only of great beauty of finish, but of extreme sensitiveness, requiring only a few seconds' exposure in the camera.

The wet process was the first, and, we believe, for some time the only collodion process in use. But, in a happy moment, it occurred to somebody to inquire whether it was really indispensable that the plates should be kept *moist* during the whole operation; and it was found that, by certain modifications of the process of preparing them, they might be allowed to *dry*, and that some time might elapse between the preparation and the exposure, as well as between this and the development. The immense advantage this promised to landscape photography led to extensive investigation; and several processes have now been perfected which will secure this result. Plates may be prepared at any convenient time and place, and may be carried about for months, ready for use at a moment's notice; and, after the picture is taken, they may also be kept some time before development. The only price we pay for this advantage is the necessity for a little longer exposure in the camera; which, for landscapes, is of no moment at all.

The bearing of this discovery on our more immediate subject will be at once apparent, as it gets rid of the necessity of providing, on the journey, for the preparation and development, with all their cumbersome and troublesome apparatus, and limits what is necessary to the simple exposure, or taking of the picture. And another advantage of still more importance follows from this—namely, that the plates may be prepared and developed, not only in another place, but by another person. The knowledge, care, and skill required for photography, as well as the stains and all other disagreeables attending it, refer almost exclusively to the preparation and development; the exposure to take the view is an operation of the simplest kind, which anybody may learn in a few minutes, and which is attended with no trouble or inconvenience whatever.

Limiting, therefore, the traveller's operation to the taking of the picture, let us consider what this involves. The first question which affects materially the portability of the necessary apparatus, is the *size* of picture to be taken. We are accustomed to see very large and beautiful photographs of scenery and architecture; but these would be impracticable for the traveller, as the dimensions of the plate increase so materially every portion of the apparatus.

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Differences of opinion and of taste may exist as to the degree of inconvenience it is worth while putting up with; but the writer of this paper, after considerable experience, has come to the conclusion that the smallest size in ordinary use—namely, the *stereoscopic* plate—is by far the most eligible one for travelling. The object is not to make large and valuable artistic pictures—that we must always leave to the professional man—but it is simply to preserve faithful representations; and this may be done as well on the small as on the large scale, and with infinitely less trouble. For, though the size is small, the delicacy of detail procurable with well-prepared plates, even in a large extent of view, is something marvellous, as may easily be seen in some of the magnificent stereoscopic views that are to be had in the shops; besides which, the stereoscopic effect gives an air of reality to the view which greatly enhances the value of the representation.

The camera for the double stereoscopic plate has been reduced, by ingenious contrivances, to a very portable size; but the writer has generally preferred to use a single plate of $3\frac{1}{4}$ by $2\frac{3}{4}$ inches, which is more handy and more easily manipulated. By taking two views of this size, and shifting the camera a few inches for the second one (for which purpose a simple contrivance may easily be introduced on the top of the stand), a stereoscopic picture will be obtained when prints from them are mounted side by side in the usual way. The camera for either the double or the single plate may be hung round the neck by a strap, and will be little inconvenience, while the stand will fold up into a straight stick, that may be carried in the hand. A stock of plates, enough for a day's work, may be carried in the pocket. The tourist can thus walk about without the slightest sense of incumbrance, and is prepared, at any moment, to take a view, either single or stereoscopic, of anything he sees—an operation which will occupy him from five to fifteen minutes, according to the light, and the time he may take to choose his position.

Considered as adding to the baggage of the traveller, these things are hardly worth mentioning—as, with the exception of the stand (which travels well in company with an umbrella), they will all lie snugly in a spare corner of a portmanteau. The stock of prepared plates will, of course, be regulated by the traveller's probable requirements during the time he is away.*

If the operator chooses to go to a little extra trouble, it is highly satisfactory to be able to *develop* the plates on the journey—which may conveniently be done in the evenings, at a hotel or lodging; and the apparatus for which adds very slightly to the bulk of the preparations. A small case of bottles, together with one or two small loose articles, are all the author takes with him. The development of a plate takes five or ten minutes, and is a process easily learnt; and the satisfaction of being able to see the same evening what one has been doing in the day is quite inducement enough to do it. But still, we repeat, this is not *necessary*, as the development may be left to another person and to another time.

We think we have shown how every traveller or tourist may be his own photographer, with much less trouble and difficulty than is generally supposed; and we must add that this is no untried plan. The writer of this article has been much in the habit of travelling; and, for years past, when he has gone on a journey, the little camera has been put into the portmanteau, as unassumingly and as regularly as the dressing-case. It has travelled in all sorts of countries, and has cast its eye on scenes which camera never looked at before; it has been a never-failing source of interesting occupation and amuse-

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* Extract from letter by Rev. F. W. Holland: "I have found india-rubber bands most useful for packing negatives. A band slipped round each end of every alternate plate will keep them from contact, and they may thus be packed together without fear of injury."—Ed.

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ment, and has recorded its travels in hundreds of interesting views, some of much excellence, and very few otherwise than successful.

But it may be asked, Since the advantage and usefulness of this plan are so undeniable, how is it that we do not see it in more frequent use? Simply for the reason that the dealers in photographic apparatus have never yet had the enterprise to establish a manufacture and sale of dry prepared plates, in such a way as to insure their popularity.

The manufacture and sale of photographic apparatus and chemicals is now a very large branch of commerce; but many of the tradesmen who prosecute it appear to have a much more earnest view towards the profits of the business than to the advancement of the art—for, since the death of poor Mr. Archer (to whom we owe almost entirely the present state of photography, and who lost a fortune in its improvement), nearly every advance made has been by private individuals. We must not be misunderstood. There are many people who profess to sell dry plates, and these may often be found to possess many of the requisites they should have; but few can be depended on, and *none* combine all the qualities which are necessary to give the system the full benefit of its inestimable value. Some will not keep long enough before exposure; some will not keep at all after exposure; some fail in sensitiveness; some spoil soon after they are opened; to say nothing of the constant liability to stains, irregularities, blisters, and all sorts of troublesome and annoying defects, which not only spoil the operator's work, but—what is of more importance—destroy all reliance on his operations, and so discourage him from undertaking them. We are not sure whether some dealers may not be obtuse enough even to encourage defects, from the short-sighted notion of increasing the sale; but this we can say—that we know no maker who will guarantee the sincerity of his wish to make good plates, by consenting to allow for them if they turn out bad ones. If this state of things arose from imperfection in the art, we should not grumble, but could only urge improvement; but this is not so. It is well known that dry plates *can* be made,* satisfying all the conditions we have named, and which, with care and system in the manufacture, might be rendered thoroughly trustworthy. It is only the indolence or obstinacy of the trade that prevents their becoming regular articles of commerce.

We do not wish, however to discourage the traveller who may wish to adopt this admirable aid to his wanderings; for the object to be gained is so important that it is worth striving a little for. In the present state of the matter, he must either learn to prepare his own plates—which, after all, is no great exertion—or, if he buys them, he must at least learn to *develop* them, and must, at the same time, lay in with them a certain stock of patience and temper to meet disappointment; and we can assure him that, even at this price, he will find himself amply repaid. But we again urge that the case ought not to stand thus. The application of the dry processes to portable photography offers a boon almost inestimable to, but yet quite unappreciated by, the traveller and the tourist; and it only needs the zealous and earnest co-operation of the dealer, by so conducting the manufacture as to render it perfect and trustworthy, to raise this application into a branch of commerce of an extent, importance, and profit, little inferior to any in the trade.

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* Extract from letter by Dr. Kirk: "The dry collodion process, which I believe will now supersede almost all others, had not made much progress when we went out; but in order to test it I took with me plates, prepared and sensitised in England in January, 1858, which, when tried at various times, continued to yield pictures up to August, 1863, having been kept sensitive all the interval at Teté on the Zambezi."—Ed.

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On the same Subject. By the Rev. H. B. George, formerly Editor of the 'Alpine Journal.'

It would scarcely be possible for travellers, even if skilled in the art, to obtain many photographs on an expedition which went beyond the limits of civilization, unless trustworthy dry plates could be procured. With them there is nothing to hinder travellers from taking photographs anywhere, and all needful knowledge can be acquired in an hour. And inasmuch as pictures taken on very small plates can now be enlarged with considerable success, the bulk of plates which must be carried is too small to be any burden; the plates of the Liverpool Dry Plate Company (which may be trusted, so far as the writer's experience goes, very thoroughly) weigh about 1 lb. per dozen, each plate giving two pictures.

The best apparatus for a traveller's purposes is known as Edwards' miniature apparatus, and is manufactured by Messrs. Murray and Heath, of 69, Jermyn Street. (N.B. Lane, of Hatton Garden, has patented one called "Multum in Parvo," which looks promising, but does not answer very well for rough work, and depending, as it does, entirely on Mackintosh cloth, is ill suited for hot climates. Messrs. Murray and Heath are introducing a new miniature camera, to take pictures 4 inches by 3 inches, instead of 2½ inches square, which packs very conveniently; but the writer has had as yet no opportunity of trying it. It is a question for each traveller whether the greater size of the pictures compensates for having to carry twice the weight of glass or for the loss of the possibility of taking stereoscopic pictures.) The camera is a cube of about 3½ inches, and the ordinary landscape lens fits inside it when packed up. This is better for rough work than any folding camera, which becomes useless if a fold cuts or wears through. The dark slide in which the plates are carried contains two plates back to back, on each of which two pictures can be taken. The writer's experience is, that two such slides, or eight pictures, are amply sufficient for a day's work, unless it is really devoted to photographing. A bit of black velvet to cover the camera is the only other thing necessary during the day. The store-box of plates, out of which the slides are filled at night, and into which the used plates are returned, will, of course, remain with the baggage. Pedestrians who are apt to quit their heavy baggage for several days at a time will find it convenient to have a small zinc box to hold about a dozen plates. Such a box, when full, weighs some 18 ounces, and, with the two dark slides, furnishes an ample provision of plates for several days. No other apparatus is absolutely necessary, except a stand for the camera; but it is highly desirable to take a second lens, with which pictures can be taken more rapidly. The ordinary Grubb lens, which requires an average of four minutes' exposure for dry plates, is best for landscapes, but useless for portraits, and not well adapted for buildings; a Ross lens should therefore be taken also in a separate case. Very possibly the Steinkeil or some other lens may be found to answer all purposes sufficiently well. The writer speaks only from his own experience. A little plate with a curved groove along it will make it possible to take stereoscopic pictures with this camera; and it is convenient to use this for views which are of sufficient importance to make a second attempt worth while. The whole of the above apparatus weighs less than 5½ lbs., and can be packed in a leather case measuring 7½ in. by 7½ in. by 4 in.

The stand is of very great importance, especially to the pedestrian, and various plans may be adopted according to the nature of the expedition. One rule, however, holds good in all cases: do not have the camera to screw directly to the stand, but let it screw on to a saddle-shaped clamp, to fit across the head of the stand, secured there by a set screw. The little clamp takes up no appreciable space, and the risk of the screw being injured on a

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journey is removed. The stand may be an ordinary wooden tripod, which serves as a rather cumbrous walking-pole; a better thing is a small tripod, which fits round and serves to steady a pole with a flat head, over which the clamp goes. Such a tripod may be used alone when convenient, and is very handy on mountain tops, &c., where the height of the camera above the ground does not signify. The writer has carried such a tripod on an ice-axe, and finds that it interferes scarcely at all with the facility of using the axe. It might be adapted to any pole carried for other purposes, provided only the pole can have a flat head, or the clamp is altered accordingly.

The dry plates will keep almost any time before exposure, and for months after it, so that travellers may bring their plates home for development. But any one starting on a long journey will do well to learn how to develop his own plates (an easy thing enough), and carry with him the necessary apparatus, which weighs very little. Thus he will be able to see how he has succeeded, and correct the times of exposure accordingly; besides, the plates, when once developed, are safe from injury through accidental exposure to light.

The worst enemy of the dry-plate photographer is dust. He should not only keep his camera most carefully clean, wiping the lenses very frequently but also gently brush the plates over with a camel's-hair pencil whenever they are moved into the dark slides and back into the store-boxes. The boxes should be fastened up very carefully, both to exclude light and dust, and also to prevent their being opened by servants or through any inadvertency. It is, of course, necessary to keep a register of the views taken, and the best mode of doing this is by marking on each plate a number corresponding to that in the traveller's journal. This may be written at the time of changing in pencil on the rough back of the plate, but when it comes to be developed must be scratched on the corner of the collodion film. The dark slides should be numbered also for convenience of reference. The record of views taken ought to note, besides the date and subject, the hour, length of exposure, and state of weather.

The rules for determining the right length of exposure are simple in outline, but cannot be reduced to a formula. The operator must decide on the exact time required in each case by his own instinct; but the general principle is, that the greater amount of light received on the lens the more rapidly will the picture be printed; that is to say, a distant view requires less time than a near object, and an object bright in itself or brightly illuminated less than a dark object. Moreover, the amount of light diminishes in proportion to the distance from midday, and to the amount of cloud in the sky. As a rule, the morning is better than the afternoon; it seems also that as one goes higher the time of exposure tends to diminish. When in doubt, it is well to expose a little more: for if a plate is under-exposed, the picture is not there; if it is over-exposed, the picture is there, though more or less burnt, and a little management in developing will correct much of this.

There is no avoiding the ever-present difficulty that near and far objects, foreground and background, require, for perfection, different exposures. All we can do is to assimilate them as nearly as possible. If there is a great distance to be taken, choose a brightly-illuminated foreground: on a mountain top, for instance, prefer snow to rocks. Disturb the snow a little, if possible, to break its uniform surface; but rocks will not print themselves distinctly till the distance is burned. Similarly, it is impossible to obtain a satisfactory photograph of what is to the eye most attractive—a distant view framed in the branches of some closely overhanging tree; one must be sacrificed to the other. The scale ranges from a minute and a half, on snow, under a bright sun, for a very distant view—such, for instance, as one from the summit of Mont Blanc—to five minutes, or occasionally even more, for a deep ravine on a dull day, or a dark object very near at hand.

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The outfit for an explorer should be:—

Camera with Grubb lens, } or some equivalent.
Ross lens, in a case, }

Extra lenses should be taken for safety on long expeditions.

4 dark slides. (See that they all work easily in the camera, and keep them as much sheltered from the sun as possible to prevent their warping. It is desirable to keep them wrapped up in black or yellow cloth or oil-silk.)

1 small zinc store-box, as above.

Wooden store-boxes, as many as may be required: those of the size usually made hold 36 plates or 72 pictures each.

Stand, according to circumstances.

2 or 3 clamps to fix camera on stand.

Plate for taking stereoscopic views.

Some black velvet, and plenty of india-rubber bands for holding the velvet over the camera.

Hints on the Projection of Routes. By Staff-Commander C. George, R.N., Curator of Maps R.G.S.

For outdoor or field work the easiest method is by the plane projection, the data thus obtained being transferred to a Mercator's projection at the first halt or stopping station.

In the plane projection one equal length is assigned to all the degrees of latitude and longitude. It was first adopted on the erroneous supposition that the earth's surface is a plane. It is still the best for the traveller to use in his early attempts to project his journey, while the objects are still in sight. This projection is available as far as 20° on either side of the Equator;—beyond the parallel of 20°, and as far as 60°, Mercator's projection is preferable;—between 60° and the Pole, the distortion of both the plane and Mercator's projection is so apparent, that a polar or circular projection must be adopted.

Sheets of paper ruled into squares by strong lines and subdivided by finer ones, afford great assistance in map work.

For *outdoor* work, the scale of 1 inch to 1 mile is amply large enough to register every particular of one day's journey on a sheet 12 inches square:—the *indoor* or table-plan may be reduced to 10 miles to the inch, and plans for transmission home may be again reduced to 1 inch to 1 degree, when the larger plans cannot be sent.

The chief point aimed at by the following directions is to draw more attention than has hitherto been given to the "*true bearing*" of objects, for the following reasons:—

1st. Any object whose true bearing is *east* or west, must be in the same LATITUDE as the place of the observer.

2nd. Any object whose true bearing is north or south, must be in the same LONGITUDE as the place of the observer.

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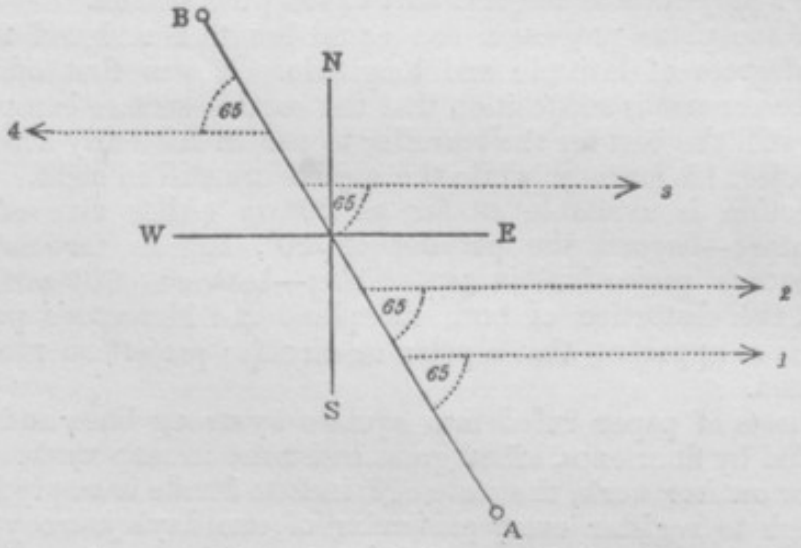
While travelling in a northerly or southerly direction from a station whose latitude is known, and carefully noting the distance and direction travelled, it is only necessary to watch when objects come to the "true" east or west; and their latitude is obtained.

When travelling in an easterly or westerly direction from a fixed station, noting distance and direction, it is only necessary to watch when objects come to the true north or south, and their difference of longitude can be obtained, by using Table B, p. 62, from the station left.

Thus, suppose a traveller passes from A, whose latitude is known, towards some distant hill, B; his route making an angle of 25° with the meridian. He sets his sextant to 65° (65° + 25° = 90°), or to 115° (180° − 65°); then as the objects 1, 2, 3, and 4, successively come into contact with B or A, as the case may be, he ascertains with precision the moment when they are truly E. or W. of him; and so, knowing the distance he has travelled from A, he can readily calculate or protract their latitude.

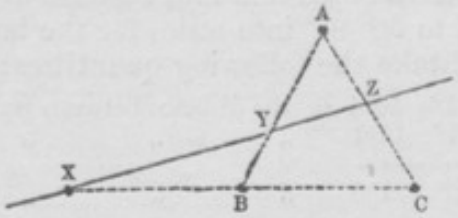


When the traveller, as will frequently be the case, has to deviate from the line of route, his position can be determined by compass or true bearing of any object, and an angle to a second object. Or he may have recourse to transit observations; that is to say, whenever two fixed objects come in line, an angle to a third object will determine the position with great accuracy.

Observe, that in travelling along X Y Z, the hills A B C can be mapped; for at X, or thereabouts, the bearing of B from C can be determined; at Y that of A from B; and at Z that of A from C; and so on for any number of hills. And it is very

f. 25c

important to recollect that it is not necessary to catch these lines of sight precisely; for by taking bearings twice, and the intermediate course approximately, there are sufficient data for



protracting out upon paper the required bearing. Thus, as soon as the peak of a distant hill is about to be occulted by the shoulder of a nearer one, a bearing should be taken; and again another one as soon as it has reappeared on the other side, and the intermediate course noted.

The advantage of this method of filling up a field-sketch will become more apparent as experience is gained. A third and accurate method of fixing the position is in general use among marine surveyors, but has hitherto been but little resorted to by land travellers, viz., by the angles subtended between three known objects. The instrument called the station-pointer is generally used for this purpose, but the position may also be found with a pair of compasses and a protractor, or, more simply, as follows, by means of a protractor and a sheet of tracing-paper. Draw a line through the centre of the paper; place the protractor on it near to the bottom of the sheet; lay off the right-hand angle to the right, and the left-hand angle to the left of the centre line; rule pencil-lines, radiating from the point over which the centre of the protractor has been placed, to the points that had been laid off; then place the paper on the plan or map, and move it about until the three lines coincide with the objects taken; prick through the points that lay beneath the centre of the protractor, and the observer's position is transferred to the plan. When possible, the centre object should be the nearest.

To Construct a Map on Mercator's Projection.

On a sheet of cartridge paper, 13 inches by 20, it is proposed to construct a map on Mercator's projection, on a scale of 10 miles to an inch equatorial—*i. e.* 6 inches to the degree of longitude.

Limits of the Map { Lat. 31° to 33° N.
Long. 34° to 36 E.

Draw a base-line, find its centre, and erect a perpendicular to the top of the paper; the extremes of longitude 34° and 36°

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added together and divided by 2, give 35° the central meridian, and which is represented by the perpendicular; on each side of it lay off 6 inches, and erect perpendiculars for the meridians 34 and 36; divide the base line into 10-mile divisions, and the part from 35° 50′ to 36° 00′ into miles for the latitude scale.

From Table A, take the following quantities:—

Lat. 31° to 32°	=	1°	10′·4	=	the distance between parallels	31°	and	32°
„ 32° to 33°	=	1°	11′·1		„ „ „	32°	„	33°
		2°	21′·5		„ „ „	31°	„	33°

Having thus obtained the distances between the required parallels, divide the map into squares of 10 miles each way, and the map is ready for the projection of the route.

The following is to explain what has been said on the subject of "true bearing" and the traveller's route, also to exercise him in the use of his protracting instruments, in laying down his route and observations, &c., and to draw his attention to objects noticeable around him; the field of exploration is supposed to be Palestine, and by comparing his sketch, with a map of the same, he will at once see his proficiency. The following symbols have been used:—

∠'s signifies angles.
△ a station in the triangulation.
⊕ „ fixed by latitude.
⊕ „ „ longitude.
⊕ „ „ lat. and long.
⊙ „ „ true bearing.
R. t. „ „ right tangent.
L. t. „ „ left „

The Field Book.

At No. 1 △.

From a village on the bank of a river in lat. 31° 00′ N. and long. 35° 17′ E., proceeded to an elevated position No. 2, and camped; the route was N. 6. E. by compass, the variation being 6° westerly: distance 5 miles.

At No. 2 △.

Early in the morning, when the sun was its own diameter above the horizon, measured with a sextant the angle between the northern limb of the sun and a distant high peak to the N.E.; the time being taken at the same moment, showed the watch to be about 5 min. slow.

With the azimuth compass several observations were made of N.E. peak; the needle being deflected after every observation, gave the mean reading of N. 36° 40′ E.; this object, of which the "true bearing" had been obtained, was, as is usually the case, then made "zero," and a round of sextant angles taken to conspicuous objects.

(A.)—TABLE TO CONSTRUCT MAPS ON MERCATOR'S PROJECTION.

°	0	1	2	3	4	5	6	7	8	9
		° ′	° ′	° ′	° ′	° ′	° ′	° ′	°	° ′
0		1 00	1 00·1	1 00·1	1 00·1	1 00·2	1 00·3	1 00·4	1 00·5	1 00·6
10	1 00·9	1 01	1 01·2	1 01·5	1 00·7	1 02	1 02·2	1 02·6	1 02·9	1 03·3
20	1 03·6	1 04·1	1 04·5	1 04·9	1 05·5	1 05·9	1 06·5	1 07	1 07·7	1 08·2
30	1 09	1 09·6	1 10·4	1 11·1	1 12	1 12·8	1 13·7	1 14·6	1 15·7	1 16
40	1 17·6	1 19	1 20·1	1 21·4	1 22·7	1 24·2	1 25·6	1 27·1	1 28·8	1 30·6
50	1 32·4	1 34·3	1 36·4	1 38·6	1 40·8	1 43·4	1 45·9	1 49	1 51·4	1 54·8
60	1 58·3	2 01·8	2 05·8	2 09·9	2 14·5	2 19·14	2 24·7	2 30·5	2 36·8	2 43·8
70	2 51·3	2 59·8	3 09·1	3 19·6	3 31·3	3 44·6	3 59·8	4 17·1	4 37·4	5 01·1
80	5 29·5	6 03	6 46·4	7 40·3	8 51·1	10 27·7	12 47·9	16 29·6	23 4·3	39 42·2

USE OF THE TABLE.

Find in the Table the required parallel: the tens at the side, and the units at the top. At their intersection, will be found, in degrees and minutes, the distance of the required parallel from the next less degree; to be measured from the scale of longitude on the map in progress.

Given the parallel of 30°—required that of 31°.

30 at the side, and 1 at the top, intersects at 1° 09′·6, the required distance of the two parallels.

Given the parallel of 31°—required that of 33°.

32° = 1° 10′·4
33° = 1° 11′·1

2° 21′·5 the distance between the 31° and 33° parallel.

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∠'s and Observations.

Latitude by ☉'s N. and S. of zenith	31°	5′	30″	N.
True bearing of N.E. peak	N.	30	40	E.
Compass „	N.	36	40	E.

For height of △. Temp. of boiling-water 208°·6. Aneroid 28°·16
Temp. of air (in shade) .. .. .. 71°·00

N.E. peak, and r. t. of lake to the eastward	53°	40′
„ near point on opposite side of lake ..	22	00
Two conical peaks in line and N.E. peak	30	40
Village on the sea-coast	85	05
Direction of this range	102	30
L. t. of near range	110	30
R. t. „	30	40

Remarks at this △. In the direction of N. 6 E. by compass were noticed two distant conical peaks in line, which at once determined the direction of route; it was also observed that the near range in the direction of the line of route was higher than No. 2 △, and on the way three streams would have to be crossed.

Proceeded onwards—

At No. 1 stream, ∠ between conical peak and N.E. peak	31°	10′
„ No. 2 „ „ „	32	00
„ No. 3 „ „ „	35	15

All these streams run eastward, towards the lake.

Arrived at the foot of No. 3 △, encamped for the night; had travelled, by estimation, N. 6 E. 12 miles. Observed for lat.

At No. 3 △, top of Range.

The morning amplitude was not obtained, the sun being obscured by clouds; waited half an hour until the sun had risen 15°, and then obtained a set of azimuth observations.

Latitude by ☉'s N. and S. of zenith	31°	14′	N.	
True bearing of N.E. peak	N.	37	10	E.
Compass bearing „	N.	43	10	E.
N.E. peak, and the low range of yesterday	125°	0′	to	174 30
„ and r. t. of lake	88	00		
β „ point on opposite shore of lake	53	30		
„ tongue point in lake stretching northward	23	30		
No. 1 village on sea-coast and N.E. peak	101	50		
No. 2 „ „	63	00		
Direction of this range „	153	30		

Remarks.—This bearing (β) is east true, therefore the point on opposite side of lake is in the same lat. as △ No. 3, and having been crossed by a true bearing from No. 2 △, it becomes a fixed point.

From this ∠ was obtained a good view of the lake (see Sketch-book) for that portion to the southward of east; from thence it appeared to run northerly, somewhat parallel to the line of route, with a breadth of 8 or 10 miles, and numerous feeders running into it from both sides, and nearly at right angles to the coast-line of the lake. In the direction of the intended route-line there appeared a great number of streams, all of which will be fixed

by angle between the conical peaks in line and N.E. peak; the line of route was kept by measuring angle between the third △ and the conical peaks, subtending ∠ of 180°.

Travelled on for the next two days, crossed several streams and fixed them; they apparently rose on the high land to the westward, and all running towards the lake; made about 25 miles northing, and then arrived at the nearest of the two conical peaks that had been kept in line.

At No. 4 △ South Conical Peak.

Lat. by ☉'s N. and S. of zenith	31° 41′ N.
True bearing of N.E. peak	N.76 0 E.
Compass „	N.82 0 E.
For height of △. B. W. 208°30. Aneroid	28°00
Temp. of air	67·00
North conical peak to N.E. peak	76°00′
No. 1 village on sea-coast and N.E. peak	180·20
No. 2 „ „	124·10
Large town to northward on the western slope of the North conical peak and N.E. peak	78·10
Mouth of large river falling into northern end of lake, and N.E peak	4·10

Remarks.—This was the highes △ yet visited. From it were seen several rivers running from the high range westward of the line of route towards the sea, therefore it is the dividing range between the lake and the sea.

Travelled on 6 miles to the northernmost of the two conical peaks, taking care to keep in line between the conical peaks, and when there make it a recruiting △, and visited the town on the western slope.

∠'s at No. 5 △ North Conical Peak.

Lat. by ☉'s N. and S. of zenith	31° 46′ N.
True bearing of N.E. peak	N. 90 00 E.
Compass „	S. 84 00 E.
For height of △. B. W. 207°00. Aneroid	27°18
Temp. of air	69·00
A sharp peak and N.E. peak	33°25′
N.E. peak and No. 3	90·00
Tangents of distant range running this way, and N.E. peak	95·30 / 101·35
A point on the sea-coast and N.E. peak	102·00
N.W. peak, and N.E. peak	87·15
„ a sharp peak	53·50

Remarks.—Finding by the true bearing that N.E. peak was in the same latitude as this △ No. 5, the line of route was altered to go to N.E. peak.

At 10 miles' distance travelled, observed that the west shores of the lake were south true ⊕.

At 16 miles travelled, arrived at the mouth of a river seen from No. 4 △ running into the lake from the north.

∠'s at Mouth of River.

Eastern shores of the lake	South (true) ⊕
No. 3 △, and last △ No. 5	63·30
Last △ No. 5, and run of large river, running north	92·40
Distant range to the N.W., runs to this △, ∠ to No. 5 △	64·30

Travelled on to the N.E. peak, or No. 6 △.

∠'s at No. 6 △ N.E. Peak.

Distance travelled from No. 5 △, 24 miles east (true).

Lat. by ☼'s N. and S. of zenith	31° 46½′ ⊖
True bearing of sharp peak to northward	N. 3 30 E.
Compass „ „	N. 9 30 E.
For height of △. B.W. 211°00. Aneroid	29°42
Temp. of air	73·00
No. 5 △ and sharp peak	93°30′
No. 3 △ and No. 5	52·50
N.W. peak and sharp peak	24·50
„ No. 5 △	68·40

Proceeded northward to sharp peak No. 7 △; travelled 17 miles, crossed several streams, apparently the feeders to the large river running northward, fixed them by angles subtended between No. 5 △ and No. 6 △.

∠'s at No. 7 △ Sharp Peak.

Lat. by ☼'s N. and S. of zenith	32° 03½′ ⊖
True bearing of a peak N.W.	N. 30 30 W.
Compass „	N. 24 30 W.
For height of △. B.W. 202°00. Aneroid ..	24°58
Temp. of air	74·00
N.W. peak, and flat-top mountain	49°20′
„ No. 6 △	145·35
No. 5 △ and N.W. peak	92·30

Travelled on towards N.W. peak; at 15 miles came to the large river running to the south.

∠'s at Large River.

N.W. peak, and flat-top mountain	92° 20′
Flat top mountain, and No. 7 △	90 40

At the distance of 26 miles, observe that No. 7 to flat-top mountain measured 59° 30′ ⊖.

At 30 miles' distance came to an elevated △, when the south end of a range to the westward measured 59° 30′ to N.W. peak, this gave the lat. of that part of the range, and at 44 miles came to N.W. peak.

∠'s at No. 8 △, or N.W. Peak.

Lat. by ☼'s N. and S. of zenith	32° 42′ N. ⊖
True bearing of flat-top mountain	S.60 30 E.
Compass „	S.55 0 E.

For height of △. B. W.	210°·50	Aneroid	29°·00
Temp. of air			76·00
S. end of a lake to the east, and flat-top mountain ..			29° 30′
No. 5 △, and sharp peak No. 7 △			33·40
„ „ 6 △			24·05
No. 5 △, and point on sea-coast			113·00
„ t's of near range			100·50 / 26·30

Travelled east (true) towards the lake.

At 15 miles came to the lake, out of which flowed the large river going to the south. Height by B.W. = 213·25°.

Considering the large size of this river, and having already fixed the extreme and a midway △, decided upon returning southward and examine the river on the route back.

∠'s at South side of Lake on West bank of River.*

No. 8 △ and No. 7	99°	10′
No. 7 △ and flat-top	32	00

∠'s at large Affluent from the Eastward.

No. 8 △, and No. 7	118°	40′
No. 7 △ „ flat-top	39	50

∠'s at large Affluent from the Westward.

Same objects	146°	00′
	58	10

∠'s at large Affluent from the Eastward.

Same objects	79°	00′
	94	30

∠'s at sharp Bend of River.

No. 7 △ due east (true)	°	⊖′
No. 8 △, and No. 7 △	104	10
No. 7 △, and No. 6 △	67	30

Arrived at former △, river running into lake from the northward. Height by B.W. = 214·5°.

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* These angles projected on a piece of *tracing-paper* will form a very good station-pointer, to determine this and the following △'s.

(B.)—Given the Departure, to find the Difference of Longitude.

	0	° 1	° 2	° 3	° 4	° 5	° 6	° 7	° 8	° 9
°										
0		1·0001	1·0006	1·0013	1·0026	1·0038	1·0055	1·0075	1·0098	1·0125
10	1·0154	1·0187	1·0224	1·0261	1·0306	1·0353	1·0403	1·0457	1·0514	1·0578
20	1·0642	1·0711	1·0785	1·0864	1·0946	1·1034	1·1126	1·1224	1·1326	1·1434
30	1·1547	1·1666	1·1792	1·1924	1·2062	1·2208	1·2361	1·2521	1·2690	1·2868
40	1·3054	1·3250	1·3456	1·3673	1·3902	1·4142	1·4395	1·4663	1·4945	1·5242
50	1·5557	1·5890	1·6242	1·6616	1·7013	1·7435	1·7883	1·8361	1·8871	1·9416
60	2·0000	2·0626	2·1301	2·2027	2·2812	2·3662	2·4586	2·5593	2·6695	2·7904
70	2·9238	3·0716	3·2361	3·4204	3·6280	3·8637	4·1337	4·4454	4·8097	5·2406
80	5·7587	6·3925	7·1856	8·2057	9·5664	11·475	14·334	19·108	28·653	57·307

Use of the Table.

Find in the Table the required parallel, the tens at the side and the units at the top: at their intersection will be found a quantity which, multiplied by the departure, gives the "diff. of longitude."

The departure from the meridian on the parallel of 34° was 25 miles—required the diff. of longitude.

$25' \times 1{\cdot}20 = 30'\ 00$ the diff. of longitude.

In the parallel of 60° the departure was 30 miles.

$30' \times 2 = 60$ miles, or 1 degree.

In the parallel of 35° N. the route was N. 40 W., 37 miles' distance.

By Traverse Table, 40° course, $\overset{\text{Dis.}}{37} = \overset{\text{Dep.}}{23{\cdot}8} \times 1{\cdot}22 = \overset{\text{Miles.}}{29{\cdot}03}$, diff. of longitude.

f. 28v

f. 29c

Table for Rough Triangulation without the usual Instruments and without Calculation. By Francis Galton, F.R.S.

A traveller may ascertain the breadth of a river, or that of a valley, or the distance of any object on either side of his line of march, by taking about 60 additional paces and by making a single reference to the Table on the following page.

Suppose he is travelling from A to Z (Fig. I.), and wishes to learn the distance from A to C; and, it may be, also the angle A. Let him proceed as follows (referring now to Fig. II.).

1. Leave a mark at A. 2. Walk 10 paces towards Z, and make a mark, calling the place *m*. 3. Walk back to A. 4. Walk 10 paces towards C. 5. Walk to *m*, counting the paces to the nearest half-pace. (This gives the measurement of the line *a* (Fig I.), which is the chord of the angle A, to radius 10.) 6. Walk 80 paces towards Z; make a mark, calling the place *n*. 7. Walk 10 paces towards Z, calling the place B; this completes 100 paces from A. 8. Walk 10 paces towards C. 9. Walk to *n*, counting the paces to the nearest half-pace. (This gives the line *b*, which is the chord of the angle B, to radius 10.)

Now enter the Table with *a* at the side and *b* at the top, and read off the distance A C, and the Angle A if also required.

If the Table be entered with *b* at the side and *a* at the top, it gives B C (and B).

Of course the units need not be paces: feet, furlongs, miles, hours' journey, or anything else will do as well; and the units of A B need not be the same as those of *a* and *b*. Also any multiple or divisor of 100 for A B may be used, if the tabular number be similarly multiplied.

Examples.

a (in paces).	*b* (in paces).	A B.	A C.	Angle A.	B. C.	Angle B.
				° ′		° ′
5	6½	100 paces	67 paces	28 58	53 paces	37 56
5	6½	50 miles	33½ miles	28 58	26½ miles	37 56
10½	7	100 paces	68 paces	63 22	92 paces	41 0
10½	7	1000 paces	680 paces	63 22	920 paces	41 0

Particular care must be taken to walk in a straight line from A to B. It will surprise most people, on looking back at their track, to see how curved it has been, and how far B *n* is from

TABLE for rough Triangulation without the usual Instruments and without Calculation. By FRANCIS GALTON, F. R.S.

		Angle.	5	6	7	8	9	10	11	12	13	14
			0 ½	0 ½	0 ½	0 ½	0 ½	0 ½	0 ½	3 ½	0 ½	0 ½
		°										
5	0	28 58	57 60	64 67	70 73	75 78	81 84	87 89	92 95	98 101	105 109	113 118
	½	31 56	55 59	62 65	69 72	74 78	81 84	87 90	93 96	100 103	107 112	116 122
6	0	34 56	54 57	61 64	68 71	74 77	80 84	87 90	94 97	101 105	110 115	120 126
	½	37 56	53 56	60 63	67 70	74 77	80 84	87 91	95 99	103 108	113 119	125 132
7	0	41 0	52 55	59 63	66 70	73 77	81 85	88 92	96 101	106 111	117 123	130 139
	½	44 4	51 55	58 62	66 70	73 77	81 85	89 94	98 103	109 114	121 128	136 146
8	0	47 10	50 54	58 62	66 70	74 78	82 86	91 95	101 106	112 118	126 134	144 156
	½	50 20	49 53	57 61	65 70	74 88	83 88	92 98	103 109	116 123	132 141	153
9	0	53 30	49 53	57 61	66 70	75 79	84 89	94 100	106 113	121 129	139 150	
	½	56 4	49 53	57 62	66 71	76 81	86 91	97 103	110 118	126 136	147	
10	0	60 0	48 53	57 62	67 72	77 82	88 94	100 107	115 123	133 145		
	½	63 22	48 53	58 63	68 73	78 84	90 97	104 112	120 130	141 154		
11	0	66 44	49 53	58 64	69 74	80 86	93 100	108 117	127 138			
	½	70 12	49 54	59 65	70 76	83 89	97 105	113 124	135 147			
12	0	73 46	50 55	60 66	72 79	85 93	101 110	120 131				
	½	77 22	50 56	62 68	75 81	89 98	106 117	128 141				
13	0	81 6	52 57	64 70	77 85	93 103	113 125	138 155				
	½	84 56	53 59	66 73	81 90	99 109	121 135	150				
14	½	88 52	55 62	69 77	85 95	106 118	132 148					
		92 56	57 65	73 81	91 102	114 129	145					
15	0	97 10	60 68	77 87	99 110	126 143						
	½	101 36	64 73	83 95	108 123	141						
16	0	106 16	60 79	90 105	121 140							
	½	111 12	76 88	103 120	141							

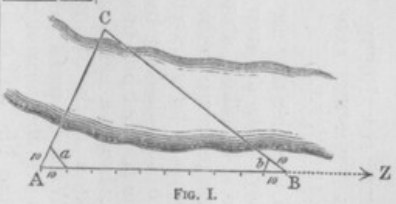

FIG. I.

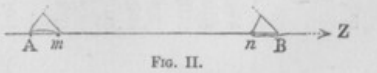

FIG. II.

To find A C and angle A:—Enter with *a* at the side and *b* at the top.

To find B C and angle B:—Enter with *b* at the side and *a* at the top.

F 29v

f. 30r

pointing truly towards A. It is always well to sight some distant object in a line with Z when walking towards it.

The triangle A B C must be so contrived that none of its angles are less than 30°, or the chords of the angles at A and B will not be found in the Table. These cases cease to give reliable results when the measurements are rudely made, and have therefore been omitted.

Should a traveller have no Tables by him, he can always *protract* his measurements to a scale on a sheet of paper, or even on the ground, and so solve his problem. If real accuracy be aimed at, it is clear that it may be obtained by careful measurements of the base and chords, combined with a rigorous calculation, as was first suggested by Sir George Everest, formerly Surveyor-General of India. (See 'Journ. R. Geog. Soc.,' 1860, p. 122.)

Measurement of the Number of Cubic Feet of Water conveyed by a River in each Second.

The data required are—the area of the river-section and the average velocity of the whole of the current. All that a traveller is likely to obtain, without special equipment, is the area of the river-section and the average velocity of the *surface* of the current, which is less than that of its entire body, owing to frictional retardation at the bottom.

To make the necessary measurements, choose a place where the river runs steadily in a straight and deep channel, and where a boat can be had. Prepare a few floats, of dry bushes with paper flags, and be assured they will act. Post an assistant on the river-bank, at a measured distance, of about half the estimated width of the river, down stream, in face of a well-marked object. Row across stream in a straight line, keeping two objects on a line in order to maintain your course. Sound at intervals from shore to shore, fixing your position on each occasion, by a sextant-angle between your starting-place and your assistant's station, and throw the floats overboard, signalling to your assistant when you do so, that he may note the interval that elapses before they severally arrive opposite to him. Take an angle from the opposite shore, to give the breadth of the river.

To make the calculation approximately, protract the section of the river on a paper ruled to scale in square feet, and count the number of squares in the area of the section. Multiply this by the number of feet between you and the assistant, and divide

[30]

by the number of seconds that the floats occupied, on an average, in reaching him.

Important rivers should always be measured above and below their confluence; for it settles the question of their relative sizes, and throws great light on the rainfall over their respective basins. The sectional area at the time of highest water, as shown by marks on the banks, and the slope of the bed ought also to be ascertained.

EXAMPLE.

DISTANCE FROM SHORE.	Starting-place.								Opposite Shore.	
Whence the boat started, measured in feet	0	90	160	240	330	420	500	600	700	780	
Depth at those distances measured in feet..	0	2	3½	4	4	5½	7	6½	3½	0	
Time required for float to drift opposite to assistant, measured in seconds	—	48	50	40	33	29	27	30	50	—	Average. 38·4

Distance of assistant, in feet, 150.

By proctracting the data in the first two lines, on ruled paper as described above, it will be found that the area of the section is 3260 feet or thereabouts; this, multiplied into 150, gives 489,000 cubic feet of water as the contents of the river at any given moment between the line of soundings and the assistant. As this amount passes by in 38·4 seconds, the number of cubic feet per second is the former number divided by the latter, which gives 12,734.

It must be distinctly understood that this number is only roughly approximative, and that is excessive. However, with the above data, an engineer would be able to make a somewhat better calculation. In the meanwhile, the traveller might consider the flow of the river in question, to be between 10,000 and 13,000 feet per second.

PAPER SQUEEZES OF INSCRIPTIONS. By the Rev. F. W. HOLLAND.

Some paper for "squeezes" should be taken, where inscriptions are likely to be met with. Many kinds of paper are suitable for this purpose, but that used by engravers is perhaps the best, since it combines a good substance and strength, with sufficient power of absorption. The process of taking squeezes is very simple. All dust or dirt should first be removed from the inscription with a rough brush. The paper should then be cut

F. 31

LONDON:

PRINTED BY WILLIAM CLOWES AND SONS, STAMFORD STREET,

AND CHARING CROSS.

p. 62.

ditch round a house, bad for fortification against Indians - a strong wire fence, wires 6" apart at bottom, 9" above 6' high - Invaders cannot lay over. Wires loose at top -

Strong iron gate.

Tower to house + Embattled

Plenty of look holes + Every side of + capable of defence -

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V. Galton +
von Helcha

Flagon with neck

f 33r

Notes of Travel

Marcy's Overland from Expeditions
Lord's at home in the Wilderness
Wolseley Soldiers Pocket-Book
Bain's & Lords Shifts of Camp Life
Gordons Manual of Sanitation
Beelon's Birdnests & Bird Stuffing
Gardner's Animal Stuffing
Galton's Art of Travel
Smithsonian Institute
Hints to Travellers
admiralty Manual
Steven's Directions in Nat: History
Shekarry's Wrinkles.

" Other books by Trek:
? A. a Levison

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114

Travellers' Vade Mecum.
Clothes, tools, Natural History & General
Stores & apparatus.

New Expansive Cover for this book
bind it the same as the "Index" with
fresh leaves inserted. The cover
with lappets to wrap inside & a
large pocket all to be made out
of solid leather. This kind of
binding would do well for loose
note books & a machine to hold tapes
etc whilst binding should be made

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note books & a machine to hold pipes
etc whilst binding should be made

any good optician. We therefore urge a young explorer to make *these* his mainstay; and if he takes other instruments, to do so more for the purpose of testing and reporting on their performances, than of relying in entire confidence upon them. Again, it is hazardous for a man hastily preparing himself for a journey, to order new apparatus from a maker; he cannot be sure that it will be well made or ready in time, and he may have to set sail in the possession of a strangely-shaped instrument—very delicate, difficult to pack—whose adjustments he has not had opportunity of mastering, and on which it is unlikely he will obtain information after his departure; whilst, if he determines on buying a sextant, and other well-known instruments, he may make his selection out of great numbers that are always to be found on sale, and practise himself in their use, under the tuition of the officers of the ship, during the whole of his voyage from England. It is therefore our object to give a list of instruments with which we advise a traveller of little experience to provide himself, and which will be found thoroughly adequate to do his work.

It should be borne in mind that travellers can seldom attain accuracy in their observations, perhaps hurriedly made, during a first exploration. Latitude within $\frac{1}{4}$ of a mile, and longitude within $\frac{1}{4}$ of a degree, is a somewhat better result than is usually obtained.

Outfit.

Examination of Instruments.—Let every Instrument be tested and its errors determined and tabulated at the Kew Observatory. This is done for a trifling fee. The following are some of the present charges, they have undergone occasional small changes:—Ordinary thermometers, 1*s.*; boiling-point thermometers, 2*s.* 6*d.*; ditto, very carefully, by the method of "calibration," 5*s.*; marine and portable barometers, 10*s.*; prismatic compasses, 2*s.* 6*d.*; superior sextants, 5*s.*; Unifilars, dip circles, and other magnetic instruments are also verified. The carriage of the instruments to and from the Observatory to be paid. Address—"Superintendent of the Kew Observatory, Richmond, Surrey." The establishment lies ten minutes' walk from the *Richmond* railway station, and is reached through a farm-yard, leading into a large meadow. This observatory was established and conducted by the British Association, but is now maintained through a large donation, made by J. P. Gassiot, Esq., F.R.S., and is under the direction of a Committee appointed by the Royal

Society. Any persons ordering instruments from opticians may direct them to be previously forwarded to Kew for verification.

Packing.—It is difficult to give general rules, because the modes of transport vary materially in different countries. Inquiry should be made by the intending traveller at the Royal Geographical Society's rooms, as to what would be the best for him. The corners of all the instrument cases should be brass-bound; the fittings should be screwed, and not glued; and the boxes should be large enough to admit of the instruments being taken out and replaced with perfect ease. Instrument-makers are apt to attend overmuch to compactness, making as much as possible go into a small solid box, which can easily be put on a shelf; but this is not what a traveller wants. Bulk is rarely a difficulty to him, though weight is; and, above all, it is most important that he should be able to get at his instruments easily, even in the dark. Also a large light box suffers much less from an accidental concussion than a small and heavy one. Thermometers travel best when slipped into india-rubber tubes. A coil of such tubing will serve as a floor, to protect a case of delicate instruments from the effects of a jar. Horse-hair is of use to replace old packing, but it has first to be prepared by steeping in boiling water, twisting into a rope, and, after it is firmly set, chopping it into short pieces. The hairs retain their curvature and act as springs. Instruments travel excellently when packed in *loose, tumbled* cloths.

Sextant for regular work—

A sextant of 6-inch radius, light in weight, by a first-rate maker, divided on platinum, to ten minutes. It must have a moveable ground-glass screen in front of the reading-off lens, to tone down a glaring light. (As regards a level, attached to the arm, see 'Knorre's Method,' &c., p. 16.)

The handle must be large and convenient; the box large enough to hold the instrument with its index clamped to any part of the arc, and the place for the telescopes long enough to allow of their being put into the box when set at focus, with their tubes pulled out.

Stand, a stout tripod stand, such as is employed for photographic cameras of moderate size, fitted with a universal joint and a counterpoise. The use of this, when kneeling or sitting on a low stool, vastly increases the facility of making delicate lunar observations.

Sextant for detached expeditions, and for taking altitudes when the other sextant is in use for lunars—

A sextant of 3-inch radius, graduated to half-degrees, in a leather case, fitted to slip on to a leather belt, to be worn round the waist, when required.

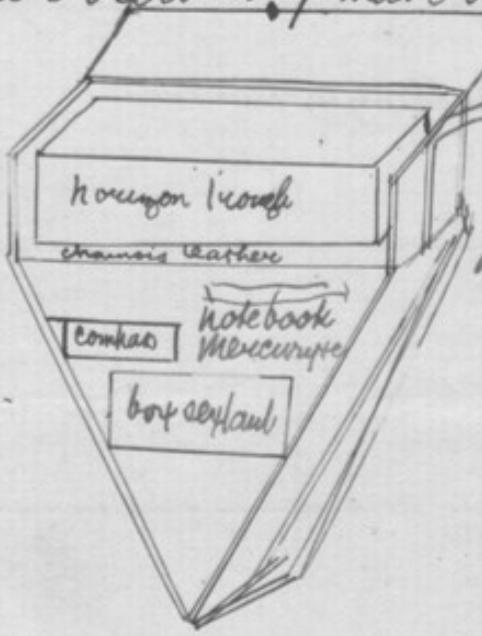
Mercurial Horizon—

One of the usual construction. Its trough must not be less than 3¼ inches, inside length, and of the usual construction for filtering the mercury when it is poured in. The glass screen should fold, and be large enough to cover the trough without touching it. It must be by a first-rate maker, for inferior glass distorts the image. *Reserve:* one spare glass and an iron 3 or 4 ounce bottle of mercury.

One of Captain George's small horizons (*see* p. 19) to use on detached expeditions and occasional purposes.

Capt. George double box sextant by far the best (Gord + Barnes)

"Portable Observatory" made by Casella for Barnes



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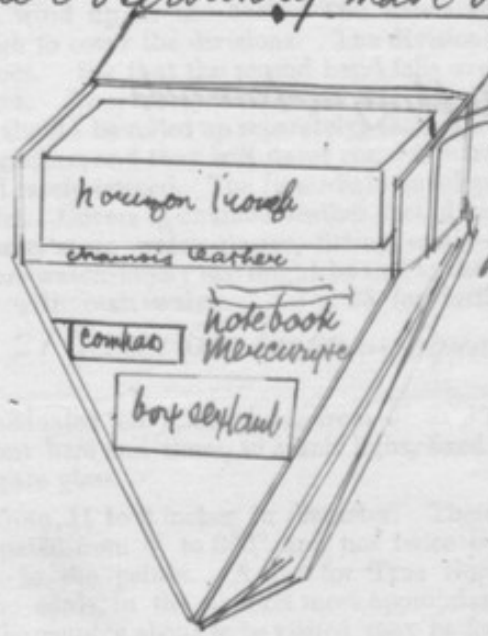
Chauvenet says he never troubles himself about the purity of the mercury. He allows it with a small quantity of tin + when about to use it scrapes the surface gently with a piece of card + thus removes the dross to the side

P 35r

Capt. George double box sextant by far the best (Egrét + Barnes)

"Portable Observatory" made by Casella for Barnes



all the instruments to have waterproof cases.

UNIVERSITY COLLEGE LONDON
GALTON
PAPERS

Chauvenet says he never troubles himself about the purity of the mercury. He allows it with a small quantity of tin & when about to use it scrapes the surface gently with a piece of card thus removes the dross to the side

Good strong hunting watch black ground white figures.
Bro

×~~Thoroughbred compass~~. ~~Mapping instruments~~
~~Sold~~

own note size
large $8\frac{1}{2}$" × 11"
small $8\frac{1}{2} \times 5\frac{1}{2}$
a smaller & very thin one
~~I had~~ made
about $\frac{1}{2}$ the
last size is
$4\frac{1}{4}$

× a special pocket with instruments
must better; it can be
[illegible] with [illegible]
[illegible] on the field are no use
while consulting in the way calling
against every [illegible] or obstruction
one leaves [illegible] string weights
in the most [illegible] that
[illegible] is across the [illegible] the bell is
barrels even where the [illegible]
[illegible] by horses ears like
[illegible] [illegible] [illegible]
drag about [illegible] [illegible]
[illegible] [illegible] to [illegible] them
up.

Watch—

A good strong silver watch, not too heavy, with an open face and a second hand: it must wind up at the back. The hands should be black steel, long enough to cover the divisions. The divisions should be very clear and distinct. See that the second hand falls everywhere truly upon the divisions. *Reserve:* at least two other watches of the same character; these should be rolled up separately, each in a loosely-wrapped parcel of dry clothes, and they will never come to harm; they should be labelled, and rarely opened. The immediate envelope should be free from fluff or dirt. Covers of chamois leather should be washed before use. Half-a-dozen spare watch-glasses, fitting easily—two to each watch. Three spare watch-keys; one might be tied to the sextant-case, one wrapped up with each watch. *See* p. 23 for further particulars. Brocks, 21 George St, Portman Square

Compass—

A prismatic compass, graduated on aluminium, from 0° to 360°, with a shield of brass cut out here and there, to admit light, fixed over the glass. *Reserve:* one spare glass.

Two pocket compasses, from 1½ to 2 inches in diameter. Their needles must carry cards graduated from 0° to 360°, and not twice over from 0° to 180°, in addition to the points. A line for True North, temporarily marked on the cards, in the position most appropriate to the magnetic variation at the country about to be visited, may be found convenient. These compasses should be light in weight, have plenty of depth, and be furnished with catches, to relieve the needle from its pivot when not used. The needles should work steadily and quickly: such as make long, slow oscillations are to be avoided. Cards, half black and half white, are recommended. (*See* p. 20 for further particulars.)

Lantern—

To be used with oil, and furnished with a large wick. See that there is abundant supply of air from air-holes in the *sides*; these are essential when the lantern is set upon the ground. Also that all the internal fittings can be removed and cleaned, and that they are solidly made, not merely soldered. It should be furnished with a reflector, to throw a clear light forwards and *downwards*. A good lantern is *most* important. A small ball of spare wick. Oil of the best quality. Wax tapers, for use on detached expeditions.

Thermometers—

Three short and stout boiling-point thermometers, and a small copper vessel, to fit into the top of the lantern, to boil the water in. (*See* p. 26.)

Three ordinary thermometers, which should be graduated from 10° or more below the freezing- to above the boiling-point.

Standard thermometers, at a charge of 1*l.* each, graduated at the Kew Observatory, may be obtained thence, on the application of any Fellow of the Royal Society, or Member of the British Association.

Aneroids—

Large pocket size (2½ inches across), capable of working without fracture over the highest mountain pass that is expected. Two are required, because simultaneous observations are important. Recollect that such observations, taken even at a great distance apart, are of value; because

the variation of the barometer, even in the latitude of England ordinary weather, hardly ever exceeds a quarter of an inch in a hun miles. Aneroids are excellent for most differential observations, unreliable for absolute ones. They are uncertain at high altitudes.

× *Mapping Instruments*—

A small case of drawing instruments, containing, among other things, l compasses, beam-compasses, drawing-pen, and rectangular protracto

Protractors: one circular, of metal, of 5 or 6 inches in diameter; of horn, 5 inches, all graduated, like your compasses, from 0° to 36

A graduated ruler of 1 foot or more, in metal; 2 dozen artists' l Medium size measuring tape, say 12 yards; pocket ditto, 2 yards.

Memorandum.—We have designedly omitted from this list both c *nometers* and *mountain barometers*, on account of their proved difficult transport without injury, and the frequent disappointments they have cau even to very careful travellers.

Stationery—*Jackie says* 7 × 4 1/4

An artist's board, not less than 8 inches by 13, made of light, well-seaso mahogany and what cabinet-makers call "framed," to rule and d upon.

ruled with ruler 2 faint red lines down the middle (each side) 150 pp

Plenty of good ordinary paper. Note-books (not "metallic," for prep paper wants strength, and the leaves of such books are constantly out and lost; they are also damaged by wet). They should be a one size, say 5 inches by 3½, or larger. A leather pouch, secure the waist-belt, having a flap buttoning easily over, to hold the note-b in use.

or quarto

Two (or three) MS. books of strong ruled paper, foolscap size, each wi leather binding; the pages should be numbered, and journal obse tions, agreements, and everything else of value, written in them.

A sheet of blotting-paper cut up and put here and there in the ledgers

Transparent cloth or paper. } For tracing.
Carbonised paper. }

Marquois's scales, for ruling parallel lines at definite intervals.

Blank maps, ruled for the latitudes and longitudes of the proposed rou

Plenty of brass pens and holders; also fine drawing-pens (steel crowqu and holder. FH pencils; HB ditto.

Penknives. India-rubber cut up in bits.

Ink-powders of a kind that do not require vinegar. Red ink.

Paints for maps, viz., Indian ink, sepia, lake, cobalt, gamboge, oxgall, small tin case.

A dozen sable paint-brushes.

Materials for "squeezes," if travelling where inscriptions may have t copied. (*See* p. 66.)

why Black?

Books—

Raper's Navigation Tables; or, in default of these, either Inman's Norie's.

Weale's Tables are convenient from their compactness.

Shadwell's Cards of formulæ. (Potter, 31, Poultry, London. 2*s*. With the help of this little publication the traveller, who has mathematical knowledge, will thoroughly understand what he is ab and he may dispense with the usual cumbrous navigation tables, fining himself to ordinary tables of logarithms. But we have rec

No. of Mail.		Miles.	Start.	Arrival.	Date.
20.	Ascend rough kanyon, and descend to barren and saleratus plain. Towards south of valley over bench-land, rough with rock and pitch-hole. "Cold Springs Station" half built, near stream, fuel scarce.	25	A. M. 8·15	P. M. 4·15	Oct. 15
21.	At west gate 2 miles from station good grass. After 8 miles, water. Two miles beyond is middle gate, water in flumara, and grass near. Beyond gate 2 basins, long divides, winding road, to "Sand Springs Valley," bad water, little grass.	35	A. M. 9·50	P. M. 2·30	Oct. 16
22.	Cross valley, 10 miles to summit, over slough inundations, and bad road. Summit shifting sand. Descend 5 miles to Carson Lake, water tolerable, tule abundant. Round S. side of lake to sink of Carson River Station, no provisions, pasture good, fuel scarce.	25	A. M. 11	P. M. 9	Oct. 17
23.	Cross long plain. Ascend very steep divide, and sight Sierra 50 miles distant. Descend to Carson River. Fort Churchill newly built. Sutler's stores, &c.	25	A. M. 9·30	P. M. 7·15	Oct. 18
24.	Carson City. Carson City lies on the eastern foot of the Sierra Nevada, distant 552 statute miles, according to Captain Simpson, from Camp Floyd. The present itinerary reduces it to 544, and, adding 44 miles, to a total of 588 from Gt. S. L. City.	35	A. M. 11	P. M. 10·30	Oct. 19

ITINERARY

Of Capt. J. H. SIMPSON's Wagon Road from Camp Floyd to Genoa, Carson Valley, U. T. Explored by direction of General A. G. JOHNSTON, commanding the Department of Utah between the 2nd May to 12th June 1859.

Places.	Intermediate Distances. Miles.	Camp to Camp. Miles.	Total from Camp Floyd. Miles.	No. of Camp.	Wood.	Water.	Grass.
Camp Floyd, wood and grass in vicinity .						W	
Meadow Creek	18·2	18·2	18·2	1			
Cross Meadow Creek (Rush Valley), mail station ¼ mile	1						*
Spring ⅛ mile to right of Gen. Johnston's Pass, just after passing summit. This spring furnishes but little water, even in the spring, and in the summer would be most probably dry . . .	8·9	9·9	28·1	2	W	W	G

f. 37r

Places.	Intermediate Distances. Miles	Camp to Camp. Miles.	Total from Camp Floyd. Miles.	No. of Camp.	Wood.	Water.	Grass.
Simpson's Springs, mail station	16·2	16·2	44·3	3	W	W	G
Summit, Short-cut Pass	21·6				Willow		
1·6 miles below summit	1·6	23·2	67·5	4	Sage		very little grass
Tolerable grass skirting low range of rocks on right of road	7·8						G
A little grass, sage in valley	4·8				S		G
Devil's Hole, water slightly brackish	6·7					W	
Fish Springs, mail station	5·4	24·7	92·2	5	Ctw	W	G
Warm Springs	3·4				G W	W	G
Grass in considerable quantity of good character	26·4	29·7	12·19	6			G
Alkaline spring to right of road, water not drinkable	1·						
Sulphur springs, water abundant and palatable	1·5	2·5	125·	7	W, S	W	G
Spring, Pleasant Valley, mail station	13·4	13·4	138·4	8	W	W	G
East side Antelope Valley		12·5	150·9	9	W	W	G
Spring Valley, good grass on west bench and slopes		19·	169 9	10	G W	W	G
Cross marsh, road takes up a fine stream, grass all along	3·5						
Leave Creek	3·5				W	W	G
Spring, copious, grass fine	2·8				W	W	G
East side Steptoe Valley, mail station	1·3	11·1	181·0	11	W	W	G
Steptoe Creek; dry in summer	6·5						
Mouth Egan Cañon	6·8	13·3	194·3	12	W	W	G
Spring, source of Egan Creek	1·8				W	W	G
West side of Butte Valley. Mail station, a very small spring, barely sufficient for cooking purposes, near top of hill; grass on N. side of same hill	16·2	18·1	212·4	13	W	W	G
Spring 1 mile west side of summit of range	12·	12·	224·4	14	W	W	G
Ruby Valley, mail station	9·2	9·2	233·6	15	G W	W	G
Smith's Fork, Humboldt R. Huntingdon's Creek	14·4						
Small mountain stream	3·3	17·6	251·2	16	G W	W	G
Spring left of road	1·2				G W	W	G
Near west foot of Cho-kupe Pass	5·8	7·1	258 3	17	G W	W	G
Spring in Pah-hun-nupe Valley	7·8						
Do. west side of Pah-hun-nupe Valley	5·6	13·3	271·6	18	S, W / G W	W	G
She-a-wi-te (Willow) Creek	14·9	14 9	286·5	19	S, W	W	G
Bed of Nash R. water in pools, probably not constant	11·6						
Small spring, grass on mountain side, 2 miles off	5·9	17·5	304·	20	S, W	W	G
Wons-in-dam-me, or Antelope Creek	7·	7·	311·	21	W	W	G
Creek	4·3				S, W	W	G
Creek west side of Valley	9·5	13·7	324·7	22	S, W	W	G
Wan-a-ho-no-pe (Netwood trap) Creek	13·6						
Do. do. do.	4·6	18·2	342·9	23	S, W	W	G
Simpson's Park, according to topographer, Lt. Putnam and guide, Col. Reese	4·9	4·9	347·8	24	S, W	W	G

vide Road Map in Mission to Persia
and Cost Book with Henry & Co. Blanford
Chd has copied see over

Triangular compasses ivory rule with 8 lbs. all wrapped
up in chamois lined leather case

"Capt. George's New Patent Mercurial Barometer for the Express
use of Travellers for measuring altitudes accurately, without
danger of derangement" Gould & Porter (Carry) 181 Strand. also other
instruments for travellers.

v. over sketching etc.

one very thin papered Journal to have brevis of all obs: to be
kept about the person so as to guard against loss. Thin sermon
paper

Log book. printed form 5½ inches high 9 inches wide open along
the narrow sides of the page. v. Gallon p 28
p 1 & 2 ruled 3 & 4 blank
Calculation book.. size of Log book
Journal Book.
Catalogue book.

- ie. Engravers paper, rough brush, soft close brush, store of paper
a few brushes & pair of large scissors also thin paper &
v. other end of this book. solid black lead such as the squares
used to clean slates etc.

In "Mission to Persia" (626) ~~says~~ ~~of the~~ says
he used 'perambulating wheels' *: chronometers
were a 'perfect bore' & constantly out of
order vide over.

* see new ed. of Hints to Travellers

Itinerary from Goldsmid's "Eastern Persia"

Date	Stage	Distance in miles	Direction
Dec 24	Bágú	24	E.N.E
25	Kala'h i-Kázi	12	N:E
Jan 5	Makun Caravanserai	36	14 N by W 12 N by E 10 N E

Perambulating wheels used <u>vide</u> note on previous page

Light binocular invaluable for night work
Hand heliostat. Galton's (Dronglaw & Simms) *

? Instrument (Heliostat) for flashing signals in Zulu war,

† The new military haversack on the belt behind should be copied.

* See pattern used by Military in Afghan: + Africa

mended that all travellers should be furnished with those navigation tables, because they afford at a single reference what otherwise requires additional trouble to obtain.

'Nautical Almanac' for current and future years, strongly bound.

Three or four almanacs, such as that of Hannay and Dietrichsen. They give a vast deal of information, are useful to take on detached expeditions, also to cut tables out of.

Tables for barometers and boiling-point thermometers, to be procured at the instrument-maker's, or cut out from Guyot's elaborate meteorological tables, published by the Smithsonian Institution, New York.

Celestial Maps (uncoloured) pasted on calico (and learn how to use them).

The best maps of the country you are going to visit, that are to be obtained.

Admiralty Manual for the use of Travellers.

Mem.—Chauvenet's Astronomy (New York, 2 vols.) is one of the most complete and thorough of the mathematical works on geodesy and astronomical observations.

These + Others carried in Knapsack or haversack

Additional Instruments, not necessary, but convenient.

Theodolites. (See p. 32.)

Telescope—

A large naval or deer-stalking telescope, for observing eclipses of Jupiter's satellites and occultations of small stars. It should not be less than 2 feet focus; it should have as large an object-glass as possible, astronomical eyepieces of from 45 to 60 magnifying power, and be fitted with a micrometer. (*See* p. 19.) The traveller should test it on the satellites, and be himself satisfied that he can see them perfectly well through it, before concluding the bargain. An ordinary telescope is wholly inadequate for that purpose. A clamp, with a universal joint and a cutting screw, to force into a log of wood, to support the telescope. The tripod stand already spoken of (*Sextant*) may easily be adapted to hold the clamp, but be sure that the telescope, when so arranged, can be pointed to stars directly above head, as well as to those nearer the horizon. A solid stand and easy movements are necessary to a powerful telescope, because slight tremors destroy its usefulness and the star or planet has to be watched and followed persistently, often in positions very inconvenient to the observer.

Plane table is very useful and almost essential for careful surveys of small tracts of country and for those topographical details which interest an antiquary. That by Lendy is one of the best, and its adjuncts are very complete. It would replace the artist's board mentioned above. The same tripod stand would serve for this that is used for other instruments.

Stop-watch, or pocket chronometer.

Pedometer.

Empty barometer tubes, and an iron bottle of mercury for filling them, to be used at a few important stations. (*See* p. 26.)

Pocket level (Abney's), with a mirror to show where the bubble is, when it is held to the eye. It serves as a clinometer, as well, for the measurement of slopes.

Maxima and minima thermometers.
Rain gauge.
} For meteorological observations, *see* p. 45.

Extracts from a Letter from JOHN KIRK, M.D., F.L.S., &c.

When Dr. Livingstone and I crossed the mountains and reached Lake Shirwa, our outfit was as follows: one 6-inch sextant, one mercurial horizon, one pocket chronometer, two prismatic compasses, one pocket compass, one field-glass, one aneroid barometer, two common thermometers, two boiling-point thermometers (the brass apparatus commonly supplied is quite superfluous), botanical paper, arsenical soap, one wide-mouthed bottle containing spirits of wine, pocket-lens, knives, note-books, water-colours, mathematical tables, nautical almanack, and wax candles.

The sextant and horizon were under the care of one man. They are on no account to be contained in the same box, partly from the danger of escape of mercury, but more especially to avoid the severe shock which so heavy a weight receives when placed on the ground, or should it happen to strike against a rock or tree; and these are contingencies to be expected. When carried, the limb should be very lightly clamped on the arc. We found no better plan when on the march than having the sextant and horizon fastened to opposite ends of a bamboo or stick, and carried over the shoulders of one of the porters. All the other instruments not carried by ourselves were packed among the other baggage. We read off the sextant by the help of the wax candles, which, from the stillness of the nights, we were able to use in the open air. On a short journey such an outfit is all that can be desired.

SEXTANT OBSERVATIONS.

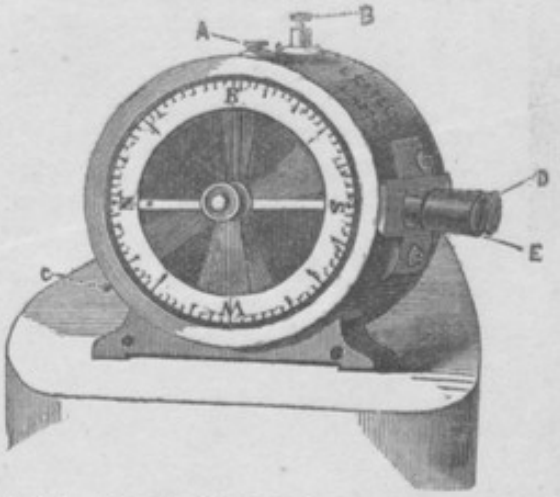
The learner must recollect, that although the sextant, almanack, and logarithmic tables taken by land travellers are identical with those used at sea, yet the observations of the landsman and his whole method of ordinary work have quite a different character to those of the navigator. Therefore much will be found in works written for the use of navigators, which the landsman does not want, and, on the other hand, the problems he most requires are not those to which such works give most of their space. This is owing to several reasons, of which the following are the chief:—

1. A sailor is obliged to measure his altitudes from the sea horizon, which is rarely distinct in the night time, and therefore he mainly depends on the sun. The landsman is obliged to measure his altitudes from the mercurial horizon, and mainly observes stars; because the double meridian altitude of the sun is frequently out of the range of his sextant, and a mid-day halt may be inconvenient. The use of stars and the mercurial horizon introduces difficulty on the one hand, and great refinement on the other.

2. In an ordinary sea voyage, the accuracy required for the mapping of a country is of no use; neither could the sailor attain to such accuracy, if he wished it. First, because of the uncertainty of the effects of refraction upon the apparent position

This Instrument is now made with one lens to the by
D & E has a Telescope for observing the object. . . .

5



CASELLA'S POCKET ALTAZIMUTH,

IMPROVED AND MODIFIED BY THE KIND ASSISTANCE OF

FRANCIS GALTON, Esq., F.R.S.,

Altitudes, Azimuths, Compass-Bearings, Clinometric Degrees and Levels,

All obtainable by a strong and handy, but accurate little Instrument, whose diameter is 2½ inches, thickness 1¼th inch, and weight 5½ oz.

Description.—The Altazimuth contains: 1. An unusually good Azimuth Compass, with Aluminium Disc; 2. A Weighted Disc for altitudes. Both these are graduated on their edges, and are read off through lenses, in a far more simple manner than the ordinary prismatic compass. The Instrument is ready for use immediately the catches, that hold the discs, are released. 3. One face of the Aluminium Disc is plainly engraved, to serve as a good ordinary compass. 4. One face of the Weighted Disc is divided, to serve as an ordinary Clinometer, the box of the Instrument being furnished with a fiducial edge.

A. Stops or liberates the compass, on being made to slide backwards or forwards.

B. Acts similarly on the Clinometer, on being pushed in or drawn out.

C. Is to be pressed in as a steady pin, before reading the compass.

D. Is the lens of the compass; and E. is that of the Clinometer. To adjust these lenses, screw them a little, in or out, as required.

To Use the Instrument.—Hold it vertically for altitudes, horizontally for azimuths, and so direct it that on carrying the eye from the hair line to the object about to be observed, they may be exactly in line. Then read off the division covered by the hair line.

Accuracy of Performance.—The performance of an Azimuth Compass is well known and appreciated. That of the Weighted Disc must clearly be far more delicate, inasmuch as the directive force of gravity is enormously greater than that of terrestrial magnetism. Both discs are graduated to degrees. A careful observer will read off to tenths.

Index and other Errors.—The principle of the weighted Disc admits of these being discovered, checked, and eliminated. Two different readings may be obtained from the vertical circle, by observing with the Clinometer's face first to the left and then to the right—the mean of these is clearly independent of index error. Again, by taking similar observations of the image of the object, as reflected in water, &c., two additional readings may be obtained; making four readings in all, or one on each quadrant of the disc. The mean of these four must be almost wholly independent of instrumental error. A skilful observer, anxious to make the most of this little Altazimuth will therefore find it superior in reliable value to Instruments of far greater bulk, weight, inconvenience, and pretensions. An intelligent traveller furnished with the Altazimuth may, by its use alone, map his country, take the height of mountains, and the dip of strata, and correct his position by very respectable astronomical observations. For, reckoning his accuracy of observation as being correct to one-tenth of a degree, his latitudes will be right to six miles, and his longitudes, by occultations, or (if he has a telescope) by Jupiter's satellites, to within thirty miles.

F.41r 7

THE TRAVELLER'S

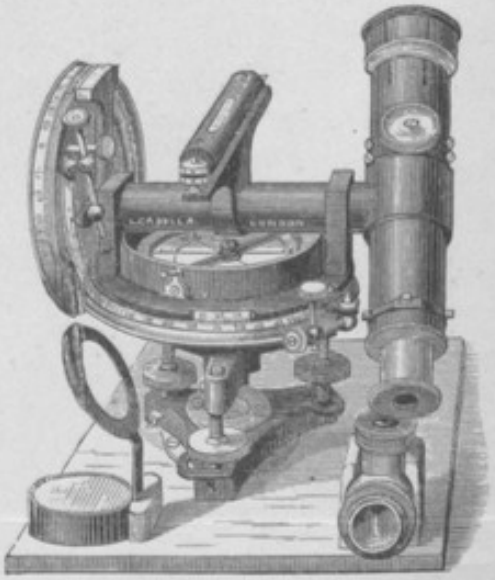
TRANSIT THEODOLITE,

ARRANGED AND CONSTRUCTED BY

L. CASELLA,

FOR ALPINE AND MILITARY SURVEYING AND OCCASIONAL ASTRONOMICAL OBSERVATIONS.

In designing this instrument the object has been to condense into the least possible bulk the smallest instrument with which useful results can be obtained. Its Telescope gives it the advantage of optical power, and it has complete 3-inch circles, both horizontal and vertical, with verniers shewing to one minute; it can therefore be used not only as a Theodolite for terrestrial surveying, but also as an *Altazimuth* for determining time, latitude, and azimuth, astronomically. It will be found convenient in use, its Diagonal Eyepiece admitting of Zenith Stars being observed with perfect facility. It is supplied with a reflector for illuminating the wires at night, with a dark glass for solar observations, with a finely divided level, a compass, and with the means of performing all the adjustments necessary in such instruments. It packs in a mahogany case, 4 inches by 5 inches, and 6¾ inches long (outside measure), the whole weighing only 3½ lbs., a light tripod staff is also added.



A paper descriptive of the instrument was read at the meeting of the British Association at Exeter, 1869, in section E, by Lieut.-Col. A. Strange, F.R.S., Inspector of Scientific Instruments, India Department.

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Instrument Maker to the Admiralty, the Ordnance, the Indian, American, and Russian Governments,

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The above with Transit Telescope in centre & double adjustment to Horizontal circle . . . . . £ 17-17-0

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unsalvable for
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Sketching. Portfolio with folding case tin frame + pocket to hold quarto sized paper. 1. folio size. Good strong haversack (canvas or leather) with leather straps. Pocket for colors, water bottle etc ½ quire whatmans paper ½ sketching cartridge; ½ linked board, light drab cool + warm greys. 6 HH; 12 H + 4 HB. 2 knives. Compact sketching box with cakes in pans or collapsible tubes. 3 brocon sable pencils in flat german silver cases 1. 3 + 6. Sepia, chinese white, red, blue, yellow give considerable range. Others in order of usefulness:- Indian yellow, carmine, french blue yellow ochre, light red, R. blue, gamboge, rose madder, cobalt raw sienna burnt sienna, emerald green, scarlet lake, crimson do, purple do, cadmium yellow brocon madder, purple do, mars orange, paynes grey, vermillion vandyke brown set of 1-6 sables, 2 of 1, 2 + 3 extra + 2 large swans quills for skies. Tripod camp stool (easle?) 15" by 11" best size for knapsack but if too large 11 by 7½ by bottom, sides + strap or continuous piece 2½" canvas. Large size tubes 4 to ½ oz

Kirk used Camera with great success. Outfit (George, in Hentsloj. Geogr. Socy)

Camera with Grubb lens } or some equivalent
Ross lens, in a case
Extra lenses for safety
4 dark slides wrapped up in black or yellow cloth or oil-silk
1 small zinc box for stores
Wooden store boxes to hold 36 pictures each.
Stand, 2 or 3 clamps to fix cameraon stand
Plate for taking stereoscopic views, black velvet + i. r. rings.
best apparatus is Edwards minature (Murray + H. 69 Jermyn St
Camera 3½" wt of pocket appar: 5½ lbs

Strong writing desk. Good H H pencils + thin foolscap paper with carbonized paper. allows of copies
note book with £ S. d columns.

One of the Indian despatch (cross) boxes and best (Parkins + Gotto) Corner Chancery Lane. Some are made with patent copying presses [like the one I had in the East]

f. 45r

PART I.
TRAVELLERS' COMPANION.

"I will hear what God the Lord will speak."—Ps. lxxxv.

THESE PASSAGES SELECTED FROM GOD'S WORD,

ARE WELL SUITED TO MEET THE FOLLOWING CASES OF NEED,—	PORTION. "Thy word is true from the beginning, and every one of thy righteous judgments endureth for ever. I rejoice at thy Word as one that findeth great spoil." Ps. cxix. 160, 162	PRAYER. The Lord is nigh unto all them that call upon him in truth. He will fulfil the desire of them that fear Him: he also will hear their cry and will savethem." Ps. cxlv. 18, 19	TEXT FOR MEDITATION "He sent his word and healed them, and delivered them from their destructions." Ps. cvii. 20.
When suffering under pains of body.	Ps. cii. Isa. xxxviii. Job ii.	Ps. xxv. 18, cxix. 75, 76.	Lm. iii. 31, 32. Nahum i. 7. Isa. xliii. 2.
Loss of Sight.	Isa. xliii. 1—16. John ix.	Ps. cxix. 18.	Micah vii. 8. Isa lx. 19, 20. 2 Cor. v. 7.
Loss of Hearing.	Isaiah xxxv. Isaiah xxix. 18—24.	Ps. cxix. 133.	Mark vii. 37. 2 Cor. iv. 17, 18.
When bedridden, or unable to attend a place of worship.	Isa. xli. 17, 18 Ps. lxiii. Mark ii. 1-12	Ps. xxxix. 13.	1 Pet. iv. 19. Matt. xviii. 19, 20.
Under temporal privations.	Matt. vi. 19—34.	Psalm lvii. 1. Matt. vi. 11.	1 Pet. v. 7. Jas. ii. 5. Phil. iv. 6, 19.

	PORTION.	PRAYER.	TEXT.
When suffering from unkindness of friends.	Isaiah l. 5—10. Psalm lv.	Luke xxiii. 34.	1 Pet. ii. 23. Rom. xii. 19.
After having given way to bad temper, cross words, &c.	Zep. ii. 10.-11 James iii.	Psa. xix. 14.	Matt. xii. 36. 1 Pet. iii. 8—13.
When in such distress as not to know what to do, or which way to look.	1 Kings viii. 35—53. 2 Sam. xxii. Psalm xlvi.	Luke xviii. 13. 2 Chron. xx. 12.	Hos. xiii. 9. Isa. xlv. 22. Acts iv. 8—12.
When filled with fears and unbelief.	Acts iii. 19 to end. Dan. ix.	Psa. lxi. 2. Heb. iv. 14—16.	Eph. ii. 8. John xiv. 23. Matt. xvi. 16, 17.
When the heart is hard, and the mind dark, and yet light and comfort are wished for.	Ezek. xxxvi. 25—38. Isaiah lxi.	Psalm iv. 6, cxix. 107.	Isa. xli. 17. Rev. iii. 20. Isa. l. 10. Jer. vii. 23.
When there is no heart for God's Word, yet a sense of the danger of such a state.	Heb. iv. Luke xiii. 34 to end.	Deut. iii. 24.	Eph. v. 14. John v. 40.
When anxious about their own souls.	Eph. ii. Luke xii. 1—40.	Psa. lxii. 5. O Lord, grant for Christ's sake, that I may be fully satisfied that I am born again of thy Holy Spirit.	2 Pet. iii. 9. John i. 29. Gal. i. 3, 4.

	PORTION.	PRAYER.	TEXT.
When concerned for the souls of others.	1 Sam. xii. 23. Matt. v. 44.	Luke xxii. 32. Acts. vii. 60.	Acts xii. 5. 1 Tim. ii. 1. Jas. v. 19, 20.
When doubtful whether Christ died for *them*.	1 Tim. ii. 1 John ii.	Mark ix. 24.	Rev. xxii. 17. Titus ii. 11.
When anxious to give up sins that shut out God.	Zech xiii. Jer. xxvi. 1—15. Isaiah i.	Psalm xxxii. 1, 2, 5.	Micah vii. 18, 19. Matt ix. 2—6 Isaiah xliv. 22, 23.
Such *must* be given up. Such *can* be given up.	Matt. xxvii. 3—5. Luke iii. 2, 3. Acts ii. 37, 38.	Acts viii. 22. James iv. 8—10.	Ps. xxxviii. 18. Luke xvi. 30, 31. John xvi. 24.
When particular sins trouble the conscience.	Acts ii. Micah vii. 18, 19. Ex. xxxiv.	Psalm xxxii. 2—5.	Isaiah i. 18. Luke vii. 47, 48. Isa. xliii. 25. Heb. viii. 12.
When tempted to doubt.	Psalm lxii. John xx.	Psalm cxix. 133—135.	Luke xix. 10. Neh. ix. 20.
When unprepared for death and judgment.	Ezek. xviii. 19 to end. Matt. vii. 7, 8.	Psalm li. 7—10.	Ezek. xviii. 32. Matt. xxii. 41, 43.

	PORTION.	PRAYER.	TEXT.
When anxious for true repentance.	Hos. vi. 1—3. Isaiah xlv.	Num. xiv. 17, 18.	Isa. lv. 1—3. John v. 40. John xi. 25, 26 Luke xi. 9, 10.
When under the idea that their safety depends on anything *they* can *do*.	Isaiah ii. 10 to end. Jer. xvii. 5—14.	Psa. xxxiii. 22.	Job xix. 14. Eccles. vii. 20 Prov. xx. 9.
Or that their *own goodness* can procure them favour at the hands of God.	2 Cor. x. 17, 18. Isaiah xii.	Psa. xix. 12, 13.	Gal. vi. 30. Rom. x. 3. Luke xvii. 10
When they would be satisfied that they have an interest in the death of Christ.	John x. Isaiah xiv. 20 to end.	Matt. xxvi. 41.	Rom. vii. 24, 25. John xx. 31. 1 Pet. i. 7, 8.
When in the habit of giving way to Drunkenness.	Nahum i. 1—10. Matt. xxiv. 48—51.	Psalm lxix. 13—15.	Eph. v. 8. Deut. xxi. 20, 21. Gal. v. 21.
On keeping the Sabbath-day holy.	Nehem. x. 28—31, xiii. 15—23.	Ps. cxix. 37.	Jer. xvii. 21—25. Isaiah lviii. 13, 14.

N B.—Copies may be had of S. W. SILVER, *Cornhill.*

f. 48r

PART II.
TRAVELLERS' COMPANION.

Division.....

Section.....

Lat......

Long......

A.—PHYSICAL GEOGRAPHY, &c.

A 1. General description of the Country—the features of the Surface, Mountains—Height of line of perpetual snow—Hills, Plains, Coast-line of the explored portions—Character of beach.

A 2. Number of acres cultivated or capable of culture, distinguishing the portions occupied or settled and the unsettled districts—and also the Arable from Pasture Land: (note, all Forest, Bush, Jungle, &c., may be considered as land capable of culture)—Marsh and Peat Lands.

A 3. SOIL.—General character and varieties of Soil, sandy, clayey, peaty, or rocky.

A 4. WATER SUPPLY.—Rivers navigable or not—Lakes, Hot and Cold Springs, Wells, whether these supplies vary much at different seasons—whether generally sweet or not, and if not, whether it arises from salts or from vegetable putrefaction—and if distributed generally over the country or only in certain parts—and irrigation practised or might be.

B.—CLIMATE.

B 1. TEMPERATURE.—General remarks on the weather—highest (usual) temperature in shade in Summer and lowest in Winter—several returns from various districts, *i.e.* Highlands, Lowlands, Coast, Plains, &c.—Variations sudden or extreme—Day and Night variation—Frosts severe.

B 2. RAIN, &c.—Amount Wet and Dry Seasons—Number of days Rain falls in a year—How distributed—Subject to long Droughts or long periods of Rain, Floods, Snow, Hail, Ice, Dew, Fog.

B 3. Wind, &c.—Storms of Wind, Thunder, &c.—Any peculiar or dangerous Winds—Hot or Cold, and at what seasons and duration.

C.—MINERAL PRODUCTS.

C 1. Metals.—Extent and depth of Mines in alluvial and valley deposits as Gold or Tin—Quantity and quality of Ores—Whether smelted in Colony or not—Number of persons engaged in Mining, &c.

C 2. Coal.—Quality and quantity—Persons engaged, &c.—Cost per ton to Consumer, whether used for domestic or manufacturing purposes, or exported.

C 3. Building Materials.—Kinds of Rock—Sandstones—Limestones—Marble—Slate—Brick and Tile—Earths, &c.

C. 4. Other Mineral Products. — Fireclay and Potters' Earth—Sand for Glass, &c.—Salt—Gypsum—Phosphatic deposits—Lignite—Medicinal *i.e.* Drysaltery, &c.—Precious Stones, &c.

D.—FOOD PRODUCTS.

D 1. Uncultivated. — Fish — Game — Wild Fruits, Roots, Bulbs, &c.—Stating whether it be likely that any Wild Fruits or Vegetables might, by Cultivation, be improved.

D 2. Cultivated.—Agricultural—General Report on kinds of Cereals, Beans, Peas, and Root Crops, &c., grown, produce and cost per Acre—Whether Crops are precarious, more or less so than in England—Also Fodder Food grown only for Home Consumption or Export — *Vegetables* (Table) kinds grown, those that succeed best, those European kinds tried but do not succeed—Those *peculiar to the Colony* particularly mentioned.—*Fruits*, European grown, &c., as above.—Any other Vegetable Produce, Starches, *i.e.* Arrowroot, &c., used for food, peculiar to the Colony.

D 3. Food.—(Vegetable)—Wine or other Beverages—Tobacco or substitutes.

f. 49r

D 4. Food. — (Animal) Cultivated — (Domesticated) Animals for Food—Specially mentioning those peculiar to the Colony.

E.—CLOTHING.

E 1. Clothing. — (Animal) Wool — Whether extensively and profitably grown—Alpaca, Goat or other Wool.

E 2. Silk.—Kind of worms cultivated, and *name* of the plants they feed on—Cost of produce per lb.—Description of the modes of culture, spinning, &c.

E 3. Furs, Skins, Leather, &c., both Cultivated and Wild.

E 4. Any other Animal produce (Feathers, &c.) used for Clothing.

E 5. Vegetable.—Cotton, Flax, Hemp, Jute (and other Hemps,)—Kinds grown—Produce and Cost per Acre—Much or little cultivated, &c.—Other Fibres, either cultivated or collected from Wild Plants—Barks or other Vegetable Products that are or might be used for Clothing.

F.—PRODUCTS, ARTS AND MANUFACTURES.

F 1. Animal Products used in Arts and Manufactures.—Fats, Oils, Wax, Bones, Horns, Ivory, Glue, Insects, &c.—Whether cultivated or Wild, especially anything new or that might be useful, Medicinal, &c.

F 2. Vegetable Produce.—Fibrous substances used other than for Clothing, such as Ropes, Mats, Paper, Basket Work, &c.—Medicinal Plants—State if any Fibrous Plants adapted for Paper-making exist in abundance, and likely to prove available for the purpose.

F 3. Exudations.—Gums, Resins, Oils, Caoutchouc, Dyeing and Tanning Pigments—Medicinal products, specially mentioning those of true local value—State if many products exist in the forest requiring further examination by Naturalists, Chemists, &c.

F 4. Timber.—Size, quantity and various qualities—whether useful for House or Ship Building—Cabinet Work—Means of transport to Ports, &c.—Cost at Ports per cube foot.—If any have been introduced and grown from other countries, mention those that succeed or otherwise.

F 5. Other products useful in Arts and Manufactures, as Vegetable Ivory, &c.

G.—HABITATIONS, MEANS OF TRANSPORT, &c.

G 1. Houses, of what usually built—Number of storeys.

G 2. Towns, large or small.

G 3. Houses in Villages—or singly.

G 4. Roads, character of.

G 5. Postal arrangements.

G 6. Railways, Telegraphs, &c.

G 7. Canals or Rivers for Transport.

Perhaps *Social Statistics* might form a separate Paper.

SOCIAL STATISTICS.

H 1. Population—Race or Races—Increase or decrease, and whether much immigration—Latest published tables of Rate of Mortality, &c.

H 2. Religion, Sects, means of Divine Worship, Churches, &c.

H 3. Government, Army, Police, Law, &c.

H 4. Education Schools—Public and Private.

H 5. Public Institutions, Hospitals, &c., Charities.

H 6. Scientific Institutions, Libraries, Museums.

H 7. Social position of the People—their Occupation, Amusements, Vices, Health.

H 8. Estimation in which foreign residents are held—Administration of Justice in cases where foreigners are concerned, &c.

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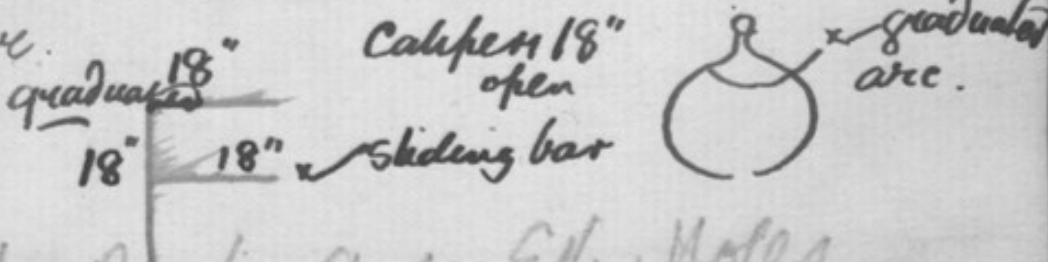

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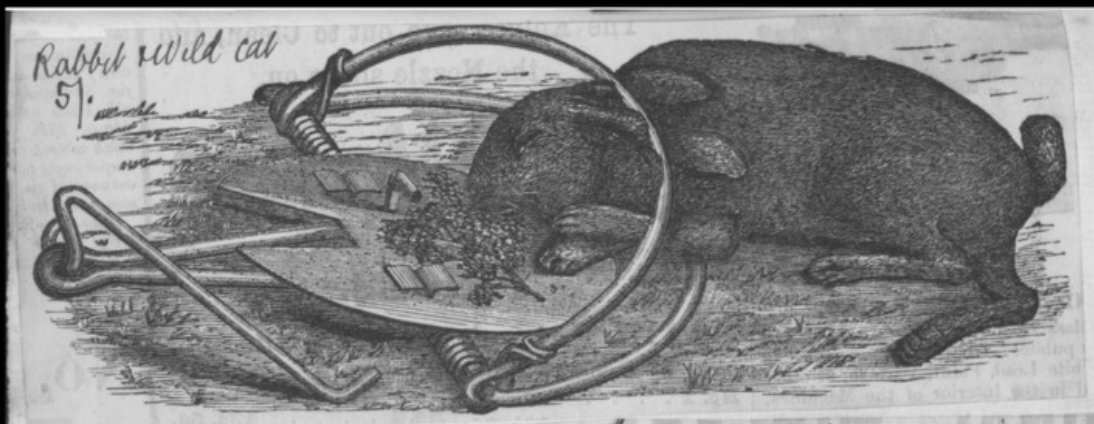

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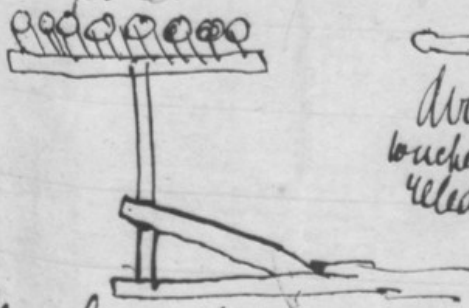

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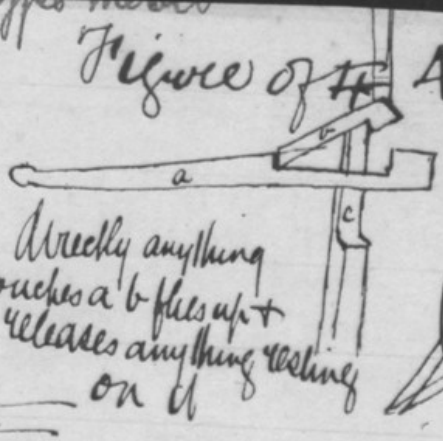
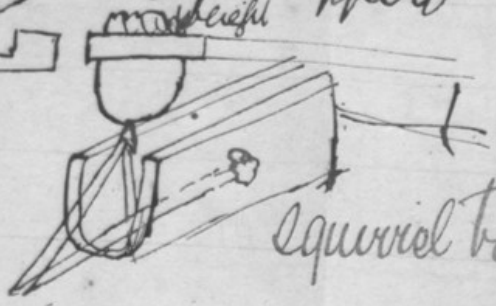


A trap support



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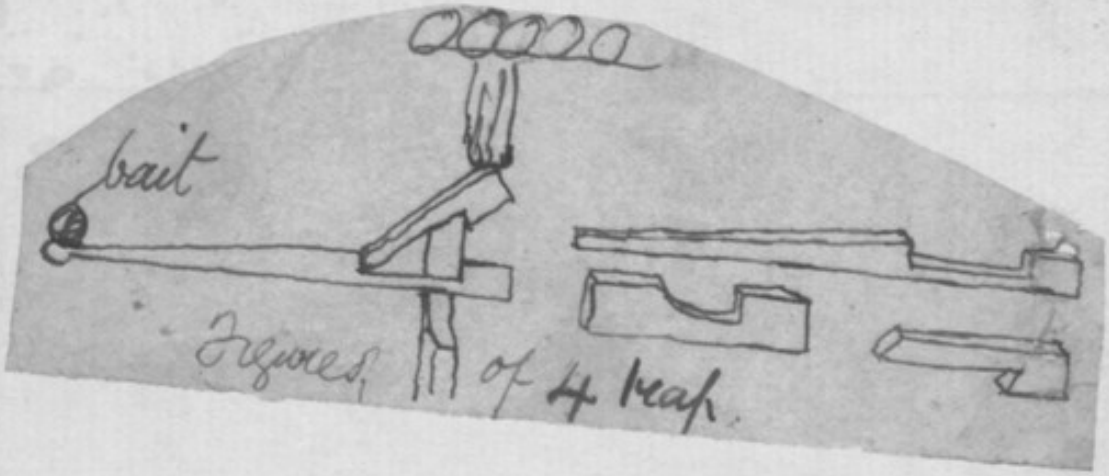
Natural History. Trapezoid 449. v. p 233



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Baron Miklucho Maclay
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J C

"The Shekarry"
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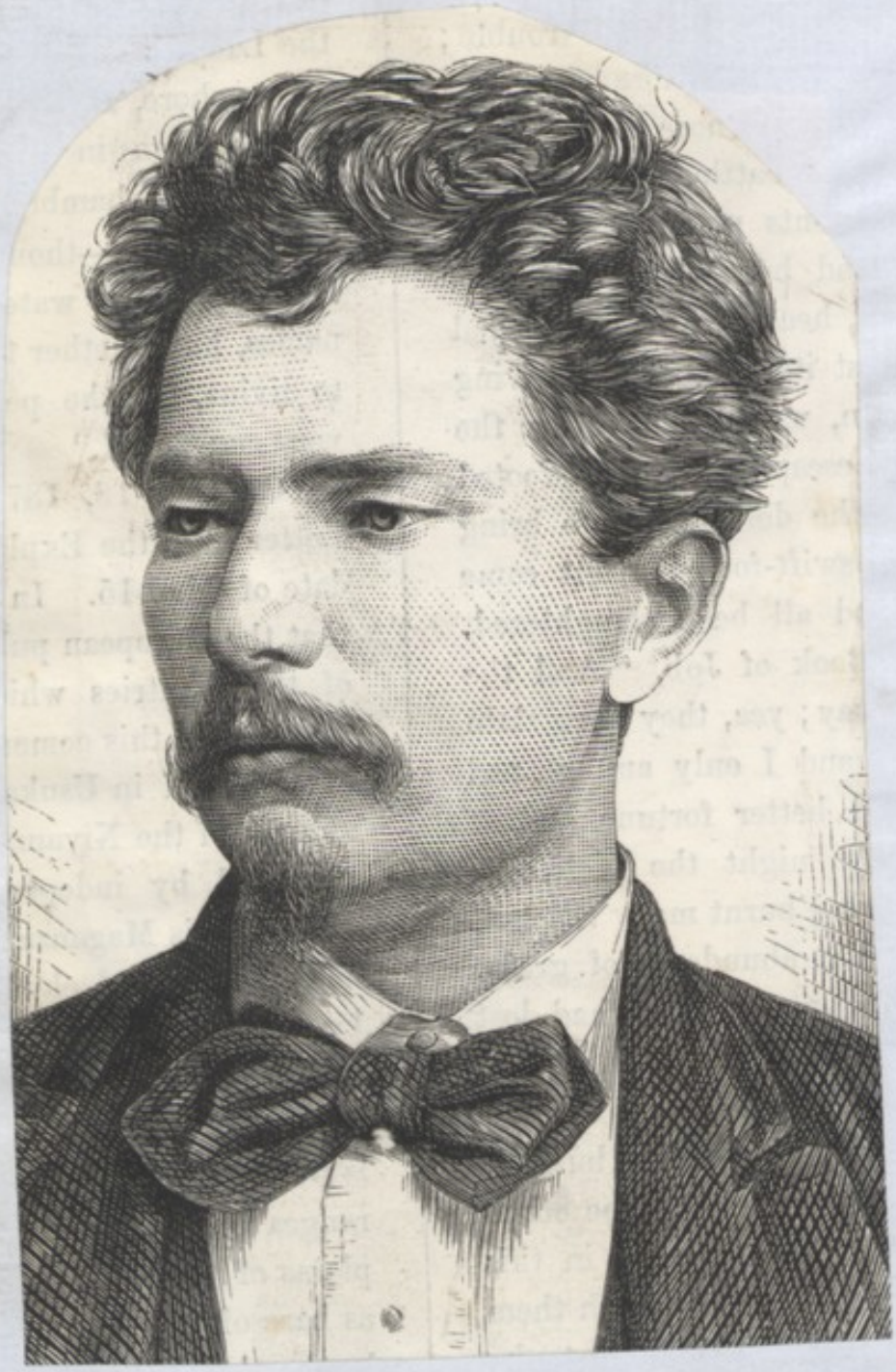
F. 77v



1872

f. 78

Henry M. Stanley

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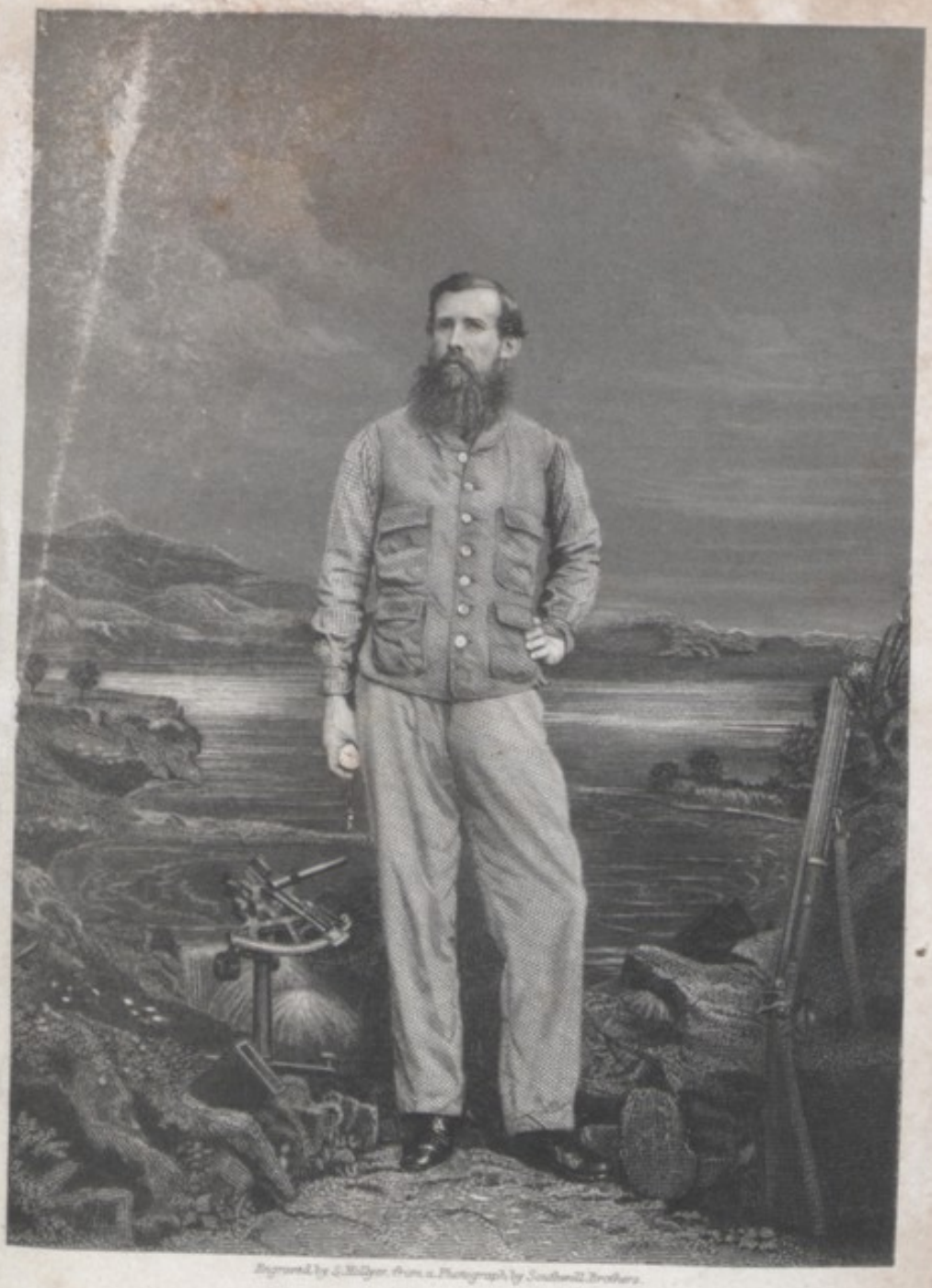
F. 79 65

1878.

f. 80 67



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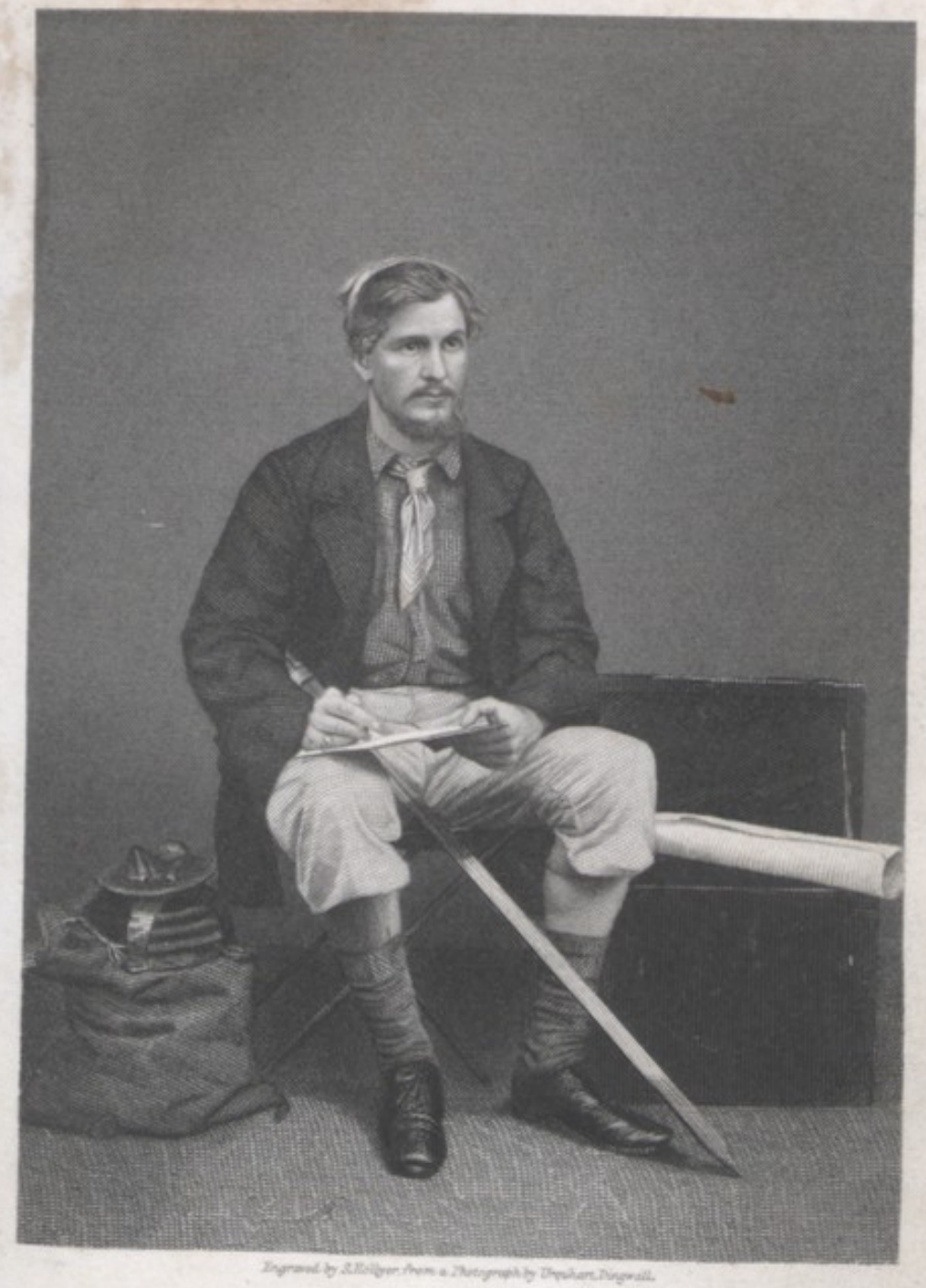
J. H. Speke

F.81 69

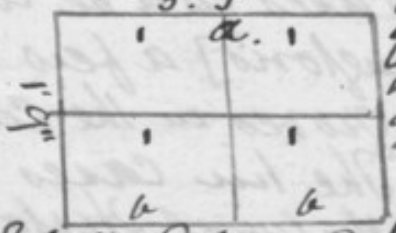


Engraved by S. Hollyer from a Photograph by Brophart, Kingsville.

U. S. Grant.

General remarks. Smaller water cans than those used in Singapore. Map & chart case, log line life buoy &c. One small case for clothes, &c for 3 or 4 days. This saves trouble of opening larger parcels. Small spare ammunition case. Gun case to hold all, with cases, tools &c complete.

Box (form of)



with drawers & an extra door slipping into brass sockets at b. b. by means of a pin & locked at a. These can be had ready made.

Mr. Carrington had his packing cases made extra strong with fillets of soft wood screwed on the edges. These when varnished can be stood on their sides can be used as cupboards & with a board on top as a table.

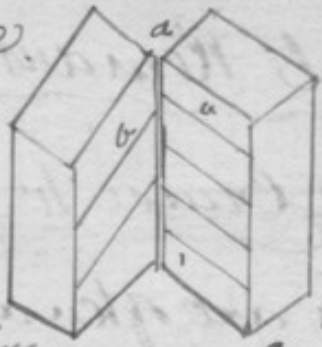
Clothes if changed at night & hung up to dry & dusted after the morning sun has been on them remain sweet & clean. A sleeping suit of flannel is necessary for cleanliness & promoting comfort. In a tropical climate it is not [illegible] that one gets sopping wet from rain or perspiration that one gets fever but from the actual fact of sitting & cooling in one's wet clothes. When the work or journey is over strip & quickly rub with a dry towel & jump into dry warm clothing taking a hot cup of tea coffee or a little grog & avoid draughts. This is the secret of preserving health!

A table [illegible] bedding from carpenter. Could be made to form a small top. To form a large table would only require pieces screwed on [illegible]

f. 845 75

Travelling bookcase.

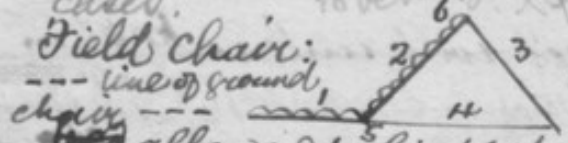
doors opening at back & front + a partition down the middle. Shelves moveable.



a. hinges.
b. shelves.
When opened will form one continuous bookcase, can be shut too & locked. If made light can be slipped into another case, the taller can be used as stand + used if there are 2 or 3 moveable shelves

vide also Carrington's packing cases.

Field chair:



--- line of ground, chair ---

1. foot, 2 back, 3 stay, 4 cord.

If the cord be undone & the ~~bed~~ allowed to lie flat it forms a bed for the ground or if ferules at 5 can be supported on a trestle. The parts 1 + 2 can be padded or a moveable cushion be used. A pillow might be slung at 6. The whole folds up & only weighs ~~2 or~~ 3 or 4 lbs. 1 + 2 can be solid boards or only framework or canvas stretched from framework. This would be a good plan + a small table with folding legs to fold up altogether.

Steps with hoops are better for holding 2 + 3 together than pins.

The above field chair could be stuffed with cork + thus serve as a mattress or life belt by having the back easily detached or only having strong frame work to which the mattress strapped.

x To be hinged with leather strap [the word] be having holes cut in a piece of tin or iron can be screwed on [illegible] or [illegible] would do for a drawing box [illegible]

General Remarks.

Notes of Cruise to Carimons:

Cigars are often asked for by Malays so take a good stock - Common matches are very liable to get wet, unless kept in a good case. Dry wax is screwed top bottle for matches On a voyage it is very necessary to seperate what is wanted on voyage & what not & each distribution of articles kept seperate as clothes, books, papers, medicines, tools, ammunition & packed in Come-atable parcels - these smaller parcels can fit in larger boxes

Medicines

Hooks, lines & net very useful.

Hat pegs, hooks &c very useful if folding or can be suspended by string - straps to hang guns up.

Of clothes, good canvas shoes with strong broad soles are excellent. Sole boots of leather are unbearable. Gambal shirts with pockets are Exceedingly useful & comfortable. Woollen trousers for ship-board and camp [not jungle work] are Equally useful & comfortable. Trousers Coming only down to above the knees are Exceeding useful for bathing & wading through water - as light drawers they could be worn if warmth be required under canvass trousers.

English flag - lanterns, light haversack & as knapsack combined is very useful as it can be put out of the way of bunks &c & does not impede travelling.

Leather or tin or iron bucket - basins, plates & frying pan &c. Another cloth

F. 85ar 77

Outfit, Stores etc

(v. Gallon for lists & weights)

1. Clothing

can be added to tent & useful for Enlarging, ground sheet, Extra tent or hammock.

The stock of clothes &c I took was much too large - if running short one can turn too & wash the dirty ones.

A clinometer, prismatic compass &c much wanted - a station pointer would be useful.

The pockets in coats should be much larger & knives &c are sometimes in the way round the waist - higher up the body in special pockets should be tried as otherwise they keep slipping about.

large A large metal can is needed for large specimens & a man to carry all your specimens &c

The knapsack & bag carried by yourself & followers should contain necessaries for emergencies as food (in tins &c) surgical & medicinal remedies &c.

A larger belt knife is needed.

Order some of the prepared flax cloth for coats etc (J Nichols)

Each parcels should be carriable by one man with ease.

Currys, Rice & fowls are a good standby but tins meats &c should always be carried as sometimes fowls, fish & vegetables cannot be obtained.

(Compressed) vegetables to be used for soups &c

Large books (specimens & coats) to take overland to Cape & different clothing (suitable for various parts)

(Belt) like those small axes with short handles

Strong jackets, long coats etc can be bought at Turkish D.t
* Indian Gauze vest shirt tied round body

Mr Davidson who has travelled much on the Peninsula says Canvas shoes [or canvas top boots with laces or or buttons] + leggings of the same material with long woollen stockings Canvas coat + Crimean shirt is the best * dress. Canvas dyed brown. Keep loins well protected [broad web belt with pockets] Plenty of tea - after march have tea, bathe + change clothes. [jacket + pajamas to below the knee to button on to jacket - of flannel] Shakespear wide short Jondra. Fore + aft hunting Cap light slate or light brown color. Tabe to button on to coat. Jacket 3 in below hip - 5 pockets for hunting knife, teles cope, powder flask, bullets caps + light brown corderoy best for trousers as it keeps out spear grass + is not easily torn. Have them loose down to the knee + below tighter to go over Wellington boots. * prefered part of moleskin

leggings waterproof. Dressing gown
~~gloves~~ Havercacks constantly strong round in front when stooping [letter in pair] a small one to slide on the belt * + one for shoulder. Watch, revolver, knife, Compass as high up as possible. Short cape very light or poncho. * + flannel night sack

~~Skinning~~ Of all the various materials recommended ~~Travelling~~ for clothing, moleskin is one of the best. Suits should be made with plenty of pockets with tappets + buttons. Jackets of the pattern of single clothes. At many of the cloth [outfitters] shops sleeved jackets, vests + c can be bought ready made. Overcoats can also be obtained. a few yards should be taken for mending + c Vide Gilmour note.

f. 85br

W. NICHOLLS,

MANUFACTURER OF INDESTRUCTIBLE

FLAX AND LEATHER

SHOOTING JACKETS,

LIGHT AND COOL,

For Covert Shooting,

Australia, South America,

& New Zealand.

163, FENCHURCH STREET.
LONDON.

Nett Cash Price List.

	£	s	d
Prepared Flax			
Suits	4	18	
Adjustable Game Pockets		15	0
Flax leggings from		12	6
Flax Caps "		10	6
Money Belts "		7	6
Bedford Cord Breeches "	2	2	0
Bedford Cord Trousers "	2	0	0

UNIVERSITY COLLEGE
GALTON
PAPERS

W. NICHOLLS,

MANUFACTURER OF THE INDESTRUCTIBLE PREPARED

LEATHER AND PATENT FLAX CLOTH

SHOOTING JACKETS,

LEGGINGS AND WATERPROOF GAITERS

FOR COVER SHOOTING,

For the Mountain, Field & Farm,
The Bush & Gold Diggings.

BEDFORD CORD & BUCKSKIN
HUNTING BREECHES,
RIDING TROUSERS &c.

163, FENCHURCH STREET.
LONDON.

f. 85bv

Nett Cash Price List.

		£	s	d
Buckskin Hunting				
Breeches	from	4	4	0
Prepared Tan Leather				
Shooting Suits	"	8	10	0
Long Leather				
Leggings	"	1	1	0
Short ditto	"		12	6
Shoe Gaiters	"		10	6
Real Buckskin				
Braces	"		7	6
Driving Gloves	"		4	6

f. 86r

NETT CASH PRICE LIST.

	£	s.	d.
Prepared Flax Shooting Jackets ...	2	10	0
Prepared Flax Shooting Trousers ...	1	10	0
Prepared Flax Shooting Waistcoat		18	0
Flax Leggings, from		12	6
Flax Caps		10	6
Money Belts		7	6
Bedford Cord Breeches, from ...	1	10	0
Bedford Cord Trousers	1	14	0
Buckskin Hunting Breeches	4	4	0
Leather Shooting Jacket	3	3	0
Leather Shooting Waistcoat	1	10	0
Leather Shooting Trousers	2	10	0
Leather Shooting Breeches	2	2	0
Long Leggings, Leather, from ...		12	6
Short ditto		10	6
Shoe Gaiters		7	6

Deb Hatter hat

f. 86r 79

Clothing. I know of no good quality belonging to a leather suit when wet like tripe & shrinks enormously (Cohen)
Colour dark grey waistcoat & jacket with as many pockets as tailor can put in.

Under do.

Flannels - wool or merino Indian cotton
Drawers - bad: flannel is far preferable * linen is bad: wool or merino for cold * vest the skin long cloth for hot
Shirts (ordinary with collars) made of large
[illegible] woollen
[illegible] Twill, or blue
[illegible] pockets & watch
[illegible] & one under
[illegible]). I generally went
[illegible] buttoned up & the throat
[illegible] is a comfort & keeps out
[illegible] tweed (Scotch)
[illegible] for ordinary wear
[illegible] pattern with plenty
[illegible] button up to throat
[illegible] like drill & trousers
[illegible] tapped up the legs
[illegible] knee breeches
[illegible] drill
[illegible] sleeves & without
[illegible] with 4 or more pockets with flap
Covers inner pocket for papers. Macintosh
watch pocket
Jaeger Jaeger long, loose buttoning up front
& secured with a cash
Norfolk style

f. 86r

NETT CASH PRICE LIST.

	£	s.	d.
Prepared Flax Shooting Jackets ...	2	10	0
Prepared Flax Shooting Trousers ...	1	10	0
Prepared Flax Shooting Waistcoat		18	0
Flax Leggings, from		12	6
Flax Caps		10	6
Money Belts		7	6
Bedford Cord Breeches, from ...	1	10	0
Bedford Cord Trousers	1	14	0
Buckskin Hunting Breeches	4	4	0
Leather Shooting Jacket	3	3	0
Leather Shooting Waistcoat	1	10	0
Leather Shooting Trousers	2	10	0
Leather Shooting Breeches	2	2	0
Long Leggings, Leather, from ...		12	6
Short ditto		10	6
Shoe Gaiters		7	6

Deer Stalker hat

f. 86v

SECTION OF THE INTERNATIONAL EXHIBITION, 1862.

WILLIAM NICHOLLS,

MAKER OF INDESTRUCTIBLE

FLAX & LEATHER SHOOTING JACKETS,

(LIGHT AND COOL)

For Covert Shooting, Australia, South America, New Zealand.

Sole Manufacturer of the Indestructible Prepared

Leather & Patent Flax Cloth Shooting Jackets, Leggings, & Waterproof Gaiters for Cover Shooting.

For the Mountain, the Field, and the Farm; for the Bush and the Gold Diggings.

BEDFORD CORD & BUCKSKIN HUNTING BREECHES.

RIDING TROUSERS.

163, FENCHURCH STREET.

Clothing. I know of no good quality belonging to a leather suit when wet like tripe & shrinks enormously (Cord)
Colour dark grey woollen coat & jacket with as many
pockets as tailor can put in.

Under do.

Flannels - wool or merino Indian cotton
Drawers - bad idea & pyjamas * next the skin
wool or merino for cold long cloth for hot
Shirts several (with collars) made of large
size & shrunken material, woollen
of grey colour do Oxford Twill, or blue
shirting. Two breast pockets & watch
pocket near shoulder & one under
each arm ? (Garibaldi). I generally went
without a necktie as my coat buttoned up & the throat
Outer clothing. Vest leather col. tweed (scotch)
or Waterford frieze for ordinary wear
Jacket shooting coat pattern with plenty
of strong pockets. button up to throat if
necessary. Also white drill
Trousers 1 or 2 pairs strapped up the legs
with leather (cavalry)
1 or 2 pairs hunting knee breeches
Oxford cord
moleskin do white drill
Waistcoats long with sleeves & without
long with 4 or more pockets with flap
covers inner pocket for papers. Maimlock
watch pocket
Garberdine long, loose buttoning up front
& secured with a sash
Arabian style

a broad web belt strong could have a number of pockets buttoned on sewn on to put in number of articles. The soldiers valise could be fastened on to it

Overcoat of a piece of waterproof Canvas 8 ft by 7 ft 6 with long slit in centre with eyelet-holes round edges - used as cloak, groundsheet & coverlet & tent.

double canvass inside riding trousers.

flannel (blue or grey) bodice & knee trousers (thick) loose inside thing - buttons up to throat - drawers button to bodice & secured with braces.

Macgregor speaks highly of Treds' cum helmet & combination of pith & felt

Trousers with good broad bands to lie behind instead of straps & buckles.

clothes (trousers, & coat can be made of waterproof canvass. The leg of the trousers having below the knee a double thickness which can be made of gaiter pattern (the outer thickness & thus be laced up when required. Coat with wrists & Blouse cut short to clear the saddle, neat, cool & easy. button up to throat & stand collar

Leather coat! Jersey or guernsey frock. serge dress.

sheepskin coat for cold weather.

soldiers new valise instead of old knapsack.

leather for bootmending

Gaiters are bad [if of leather but flaps good & necessary]

Housewife. strong material, needles, thread, tailors sewing needles, wax, canvas needles, close & twine, a palm, awls for cobbling, wax, needles, rivets in metal tube.

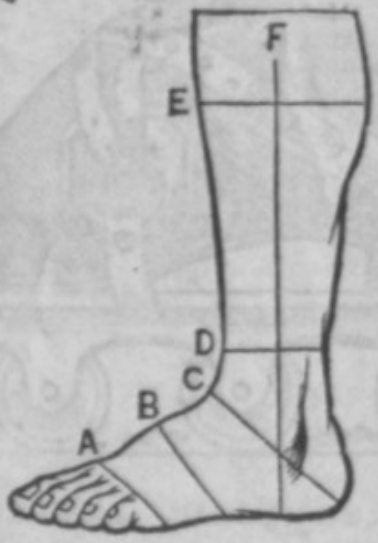
Boots of waterproof canvass made very high of like Chapelle's hair shooting pattern & flat cap

Boots & gaiters in one: of canvas

canvas low shoes (women & halfcut leather & boots (laced for ankle & instep)

THE FIELD says:

"It is a decided improvement on all existing plans, and the BEST BOOT with which we are acquainted."



Instructions for measurement, with outline of foot standing.

DEAN'S

NEW FIELD BOOT

(Registered),

MADE OF PORPOISE LEATHER

(THOROUGHLY WATERPROOF)

For Shooting, Fishing, Wading, and Hunting

39, Cheapside, London, E.C.

THIS novelty can be easily fitted to any description of boot or shoe, has no pegs or screws, a common floor or carpet without injuring them in and so perfectly imitates the ordinary skate that ...ies or gentlemen can accomplish themselves for ... and receive all the benefit derived from that ...xercise. They are admirably adapted for children, ...em in the possession of the most delightful home ...ent extant. There can be no more acceptable ...t this season of the year than a pair of Morton's "Champion" Floor Skates.

...e Skates are made in various sizes as under, fitte ...ere with straps, &c.:

..., long	8s. 0d.	No. 4, 10in. long	11s. 6d.
...an. „	9s. 6d.	No. 5, 11in. „	12s. 6d
...0in. „	10s. 6d.	No. 6, 12in. „	14s. 0d

...Trade, Gymnasiums, Schools, &c., supplied. Al... must be accompanied by P.O.O., payable to G. & J ...on, Chief Office.

Socks good supply of woollen. do long stockings for knee breeches & few dozen heelless cotton for slip shod weather.

handkerchiefs white cotton not col.d as servants steal them.

braces made by saddler of racehorse surcingle I never wear them: if made broadly around the waist they are less liable to slip down bamboo or wicker helmet - muggy

soft felt wide brim. thick fur cap with tartan waterproof cover. scotch cap glengarry felt sweater or pith hat.

Coat blue cloth pilot below knees well lined leather lined pockets horn buttons

gloves strong driving & hedging do lined with gauntlets.

Caps 2 real scotch shepherds (flannel night cap + glengarry regular sea sou'wester with flaps + oil.d canvass overalls.

Cloak P.R. long with hood. Inverness cloth.

Wickham says his waterproof speedily wore out he thinks stout horse rugs would be best.

Boots Butchers knee; oconnans broad sole, lace up front nail: waterproof cording; wading; brown leather shooting boots, no nails or heel. Slippers. Brushes blacking grease in leather

Summer boots

laces white horse hide (carters) & well answer many purposes

waterproof lacings. Wooden clogs for wading round the ankle can be thinner leather (cocoa hide)

shoemakers wax * & dubbing † & do tools & the last on which shoes were made. iron foot

* A pair with loops of thin leather coming up the instep which can be rolled down if need be.

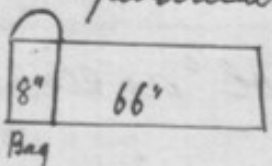
*. resin 4 3
beeswax 2
lard 2
fat 3/4

†. oil 1/2 pint
beeswax 1 oz 3 1/2
turpentine 1/2 pint
resin 1/2

F. 89v

Sleeping Bag. ~~rug~~ rug when laced up to form one.

Army Officers Valise. Waterproof bed sheet ending in a cylindrical shaped bag which holds the kit & forms pillow.



a piece of curved sewn on the bed part tacked all round & this may be stuffed with straw, leaves etc. If the sheet be wider it will allow of a margin to fold ~~up~~ over.

Sleeping Clothes. Blanket at once made up into a loose coat trousers & cap, pockets ad lib & a tape in the trouser band

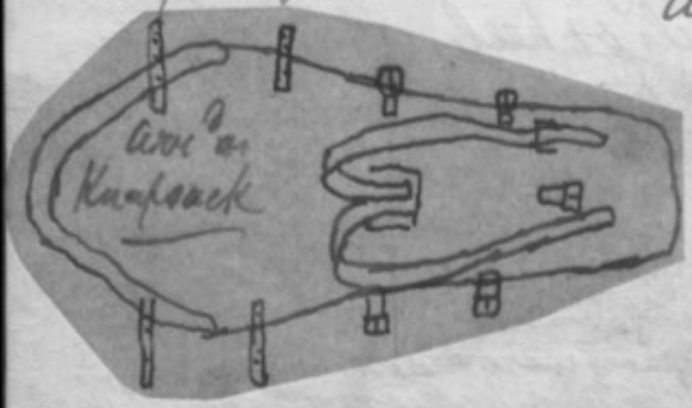
Sleeping bag. drugget bags cord brown holland. Macintosh sack very loose is very good. To have piece to fold over head & breast a bag combined with tent [umbrella] would be the smallest & lightest arrangement compat: with efficiency *.

Cord. 2 side poles 7 or 8 ft long of tough wood, ferruled in centre with galvanized iron. Supported on 3 pairs cross legs & canvas sewn in a pipe at ends slipped over it. Poles to be of same length as tent poles & bedding frame exc as tent cover. Small stuffed mattress hair (or cork) Good large w'proof ground sheet to wrap up bedding & should be wider

Strong thick waterproof sea bag with lock & chain & mouth. ~~Knapsack with "Boggle" fastening.~~
JR & G.P. ground sheets for sleeping & covering

Capt. Ward's cork life belt or inflatable JR. which can be used as a pillow.

* Macintosh lined with drugget with hood & means to button loosely under the chin & Galton found it excellent ~~for plan & Gabions~~.



"A hammock light my
coach shall be,
The rustling trees my
canopy"
£

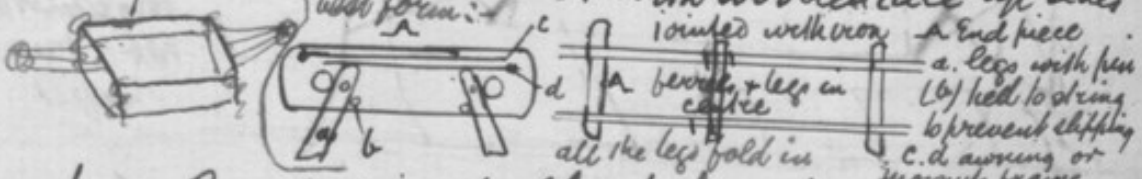
f 90r 83

Bedding Russian duck 9' by 8' waterproofed 2 in: hem° edges with brass flanged eyelet holes. In centre 16" longit: slit with laceholes + flap + will answer for ground sheet, hammock, tent, carpet, roof + haversack. Have 2 or 3.

(Benton likes Bullock trunks with iron frame bedstead)

Mattress small cork (answers as life belt for 2 or 3 (Birch, 3 + 4 Dock Lb) if coco: at bottom with macintosh could be formed into a cuff the tent or bed. holes letting the bottom keeping it flat + form.

bedstead 2 bench rods jointed with legs centre of strong canvas (2 sides to fold) sewn in pipes. all carried in bag or better rolled up. ~~Do away with elaborate claws~~. or with wooden lace up sides



Trunks Regulation bullock trunks or copper of size for mule or human porterage.

Chair Sack cross legged stool strong with canvas seat do with back + canvas lashed on folding

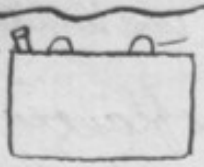
Hammock We Quires. ~~Advised~~ iron bedframe with only canvas between — The ground sheet will do away

Hammock As above or 12 or 12 ft long. + knotted on to 2 ropes to do away with elaborate claws which harbor insects.

blankets 2 quilted with chintz or cretonne or cotton on both sides to keep cleaner. Buffalo robe or blanket

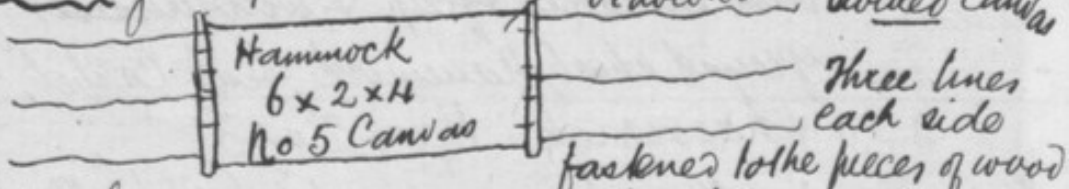
or 2 Buffalo robes + a pr of Esquimaux sleeping mattresses such as used by the Chyennes or lined with cork. This together with a light canvas chair which can be used as a bed is necessary on high-paved as the heat of the carriages is so great at times that one is obliged to sleep on deck. In a very simple bed consists of 2 or 3 boards about 2 ft wide + 2 ft high

Waterbottle. Made of No 5 Canvas

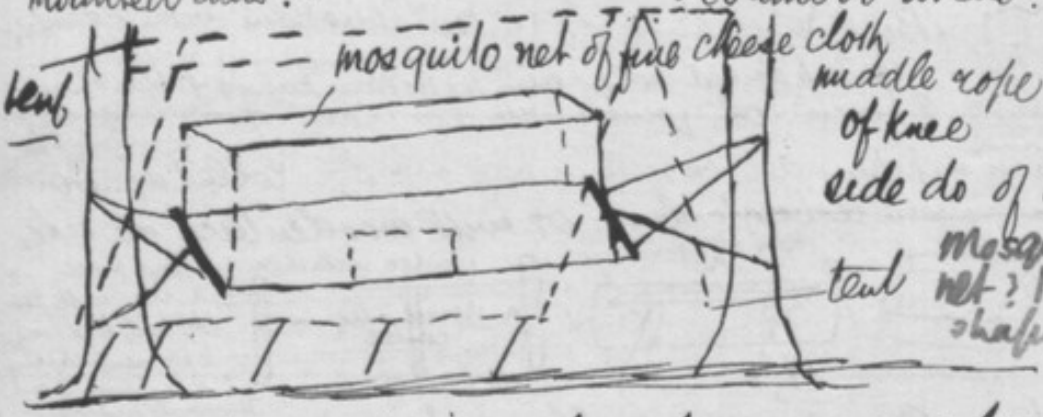


Bedding Capt. Douglas

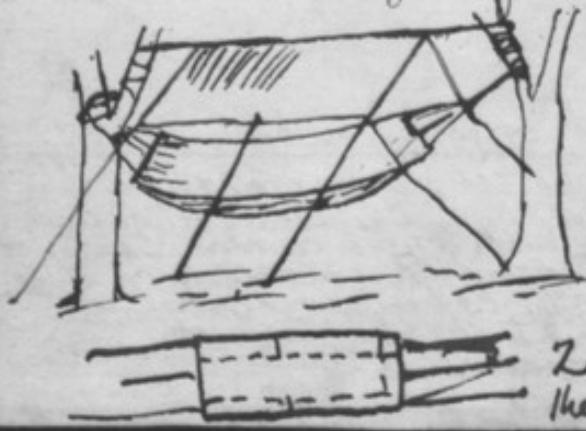
Should have bag at head which answers as pillow or do on the oiled canvas



Mounted thus :-



The net made in a bag form a ring forming the bottom & at the side a small flap to open to get in. Over all is a small tent ; the ridge rope being a little above the curtain & reaching some distance below the hammock & secured with guy ropes & a fly flap at end 10 ft by 9.6 to open in fine weather. Angle of tent 45°.



The Karrys bivouac W'proof canvas 8 x 7. 6 - eleb in centre - this does for tent, cloak, ground sheet, covering &c. eyelet holes all round.

2 bags on each side & 1 at head the side ones not meeting so as to allow of doubling -

Waterbottle. Boot & Co Dolby's 22 Camberwell Green
answers as life buoy — should have 2 openings one small for drinking metal loop for slinging

Hold all dressing Case. Comb, hairbrush, toothbrush, clothes brush, bootbrush, metal soap box, scissors, sponge in bag, shaving tackle
Yellow + marine soap. Towels. Always have a good supply of soap

Table 2 mahogany boards 9" broad hinged lengthways + resting on a stand. A box the top + bottom opening + supported by legs. Box 2 ft long 1 ft sq ends would give 3' by 2'. Such a box could hold canteen ~~box~~ books etc on shelves the sides could slide out or legs could turn out to support back + front. a thin inner shelf back + front can be put in.

loops for poles – each side

* Capt. Douglas form. lined with cork + end flaps – best kind. Can then be used on ground. Blanket cord with chunk of cologne doubled, sewn along one end + 2/3 of side.

pocket
pocket

ie: Canvas. say 3.6 long, 3.6 broad with head bag. like officers valise + mosquito net.

* The Canvas jungle clothes (-vi-76) are too thin + one gets soaked at once. Get some of the duck of which Office Mil: jackets are made + get it lined. Same shaped jacket 2 in: longer.. with plenty of flapped pockets.

Own Tents: 1 sheet 8 x 8. for Hall + waterproofing to all seams
1 tent. ridge 7'. 3". side & base 4'
with ropes Complete.
Instead of strong fastenings for the front flaps, use strong leather straps. The eyelet holes to be strengthened with leather.

* or good holeskin or Nichols prepared flax Australian 2nd hand

* strong bag. Lining has come
* strong bag — the same shape as the front "Drawings Hold all"

says his equipment consisted of
Abyssinian tent & P.R. boat by Matthews of Rockupon
Shropshire throughly good & useful.
Saddles with 2 girths breast straps breaching
& crupper & at top there were toggles & loops
so that loads could be put on & off instan-
taneously. Double barrel 12 bore rifle & 12
fowling piece all by Lang & right good weapons
they were.
Butcher's knives, steel, chopper & saw.

UNIVERSITY COLLEGE LONDON
GALTON
PAPERS

f. 92r

African Travels.
Speke & Grant

APPENDIX A.

List of Personal Kit taken with us from England for the Expedition.

12 blankets (grey Crimean) and 2 pairs scarlet do., from Grindlay & Co.'s ; 73 lb. weight.
4 leather bags for shooting apparatus, from Grindlay & Co.'s.
1 set of bits in box handle, do.
1 spring balance to 60 lb., do.
2 iron beds, from Brown & Co.'s, Piccadilly ; 28 lb. each.
2 belts for revolvers, from Grindlay.
2 watering bridles, do.
4 packs playing-cards, do.
2 iron chairs, Brown & Co.'s ; each 12½ lb.
1 digester for soup, Grindlay & Co.'s. ; 15 lb.
4 eye-preservers (glass and wire).
24 flannel shirts, from Grindlay & Co.'s.
12 pairs flannel trousers, do.
1 large housewife, do.
4 hats, wideawake and glazed, from Grindlay & Co.'s.
12 ink-powder packets (black and red), do.
India-rubber and India-rubber rings, do.
6 japanned tin trunks, weights 13, 14, and 17 lb., from do.
8 table knives, 6 sailors', 24 three-bladed (Rogers') for skinning specimens, from Grindlay & Co.'s.
6 pairs leather leggings, short and long, from Grindlay & Co.'s.
2 pewter mugs without glass.
1 medicine chest, containing Brown's blistering tissue, plaster, quinine, lunar caustic, citric acid, jalap, calomel, rhubarb, blue pill, colocynth, laudanum, Dover's powders, emetic essence of ginger ; 30 lb.
2 mosquito netting.
2 hair pillows.
12 pocket-handkerchiefs.

2 penholders.
6 dozen pencils, Winsor & Newton's, &c.
1 2-feet rule.
2 white serge sheets.
12 pairs shoes, Simnett.
6 dozen socks, half woollen, Grindlay & Co.'s.
2 pairs stirrup-leathers.
4 iron stools, Brown's, and 2 sketching do., Winsor & Newton's.
7 saucepans (a nest of block-tin), Grindlay.
16 table spoons, 8 table do., 8 tea do.
12 sail-needles, large and small.
2 lb. mustard and cress seeds.
2 tents (7 by 7, and 7 feet high).
Tools—2 hammers, 2 saws, pincers, files, chisels, &c.
8 pairs trousers, drill, unbleached.
2 oval tin teapots.
40 lb. tea, from Sterriker.
2 gingham umbrellas, half carriage size, with white covers, Grindlay & Co.'s.
4 waistcoats of Scotch tweed, Grindlay & Co.'s.
2 veils (green), do.
4 waterproof sheets (white), about 10 feet square, Grindlay & Co.'s.
1 photographic instrument for collodion, Bland & Long.

Instruments for Observing ; weight 228 lb.

3 sextants of 8½ inch radius, Troughton & Simms.
2 stands for do., do.
2 artificial horizons.
1 chronometer (gold), Barraud & Lund.
1 do. (silver), Parkinson & Frodsham.
1 lever watch (B. & Lund), with double-detaching second-hand.
1 do. (Dent), with split second-hand.
1 do. (Jones).
3 prismatic compasses, cardless, with platinum rings, T. & Simms.
2 magnetic compasses (pocket), Eliot.
1 telescope, 1 rain-gauge (travellers'), and 1 rain-gauge (Livingstone's).
6 boiling thermometers.
1 maximum and 1 minimum thermometer, Casella.
1 Massey's patent log ; 10 lb.
2 bull's-eye lanterns, with vessels to fit for boiling thermometers, Casella.

Mapping and Drawing Instruments.

2 reams mapping paper, Malby & Sons.
Tracing paper, black and white, Winsor & Newton.

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1 circular brass protractor, Eliott ; 1 parallel ruler on rollers, Eliott.
1 case mathematical instruments, Eliott.
1 pocket-compass, 1 50-feet measuring tape, one drawing-board.
½ ream open foolscap, graduated in squares.
2 boxes of water-colours, Winsor & Newton.
4 block sketch-books, 2 Clifford's.

Books.

1 Raper's 'Navigation.'
1 Coleman's 'Nautical and Lunar Tables.'
4 log-books, 12 field-books, and 5 longitude do., F. Galton, Esq.
4 Nautical Almanacks, 1860-61-62-63.
Tables for measuring breadth of rivers, Galton.
Maps of Africa, all the recent, foreign and English.

Rifles—Arms and Ammunition—Revolvers.

2	single rifles, Lancaster's elliptical,	.		40 bore.
1	single	Blisset,	. .	4 do.
1	do.	do.	. .	16 do.
1	double	do.	. .	20 do.
1	do. smooth	do.	. .	12 do.
1	do. rifle	do.	. .	(?) 10 do.

1 six-barrelled revolving Colt rifle.
1 Whitworth sporting rifle.
1 double smooth-bore by —— . . 12 do.
2 Tranter's revolvers ; 8 lb. each.
500 rounds for each barrel.
50 carbines, with pouches, sword-bayonets, and belts, Royal Artillery pattern 1860 ; each 13 lb.
200 rounds to each carbine ; caps in complement.

Presents.

1 watch by M'Cabe, in sword-belt, for Zanzibar sultan.
3 gold-enamelled lever watches, by M'Cabe.

REMARKS UPON THE ABOVE KIT.

On reaching Egypt we still had a suit of clothes, a single rifle, and some bullets each. Except the scientific instruments, everything else had been given away as presents or was worn out. I may remark that we found nothing wanting in this outfit to make it complete and excellent in every

respect. The iron beds and chairs of Messrs Brown & Co. of Piccadilly, were admirable. The digester, very useful. The japanned tin cases stood the wear and tear of the journey to the last; they are recommended as superior for travelling to trunks or portmanteaus, made of wood or leather. Crimean blankets, and sheets of white serge, also sheets of waterproof, are indispensable upon such a journey. The stout lacing-shoes, made by Messrs Simnett, Bishopsgate Street, resisted the wet even without blacking. The nest of block-tin cooking-pots, although in constant use, lasted for two years, so also did our single canvass tents. Our shepherd-tartan waistcoats (both back and front of the same material) were so strong, that at the end of the journey they did not appear to have been much worn. The suits of flannel, though comfortable, were liable to be torn in going through thorny covers.

The scientific instruments were little damaged by the journey, as they were always placed in the hands of trustworthy porters.

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Arctic pocket mirror, green veil Bag could include strip of toggles (bone) rings, needles, felsire. Reindeer fur bag to sleep in, knife stone, lamp, copper soup pot, iron snow melter, bearskin sleeping bag belt, cobblers wax. (resin 4 oz beeswax ÷ 3 pitch 2 oz and when melted ¾ 3 good fat.

Brown & Co.
very useful.
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superior for
of wood or
e serge, also
h a journey.
Bishopsgate
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THE ZULU WAR.

IN ZULULAND WITH COLONEL PEARSON.

[From a Military Correspondent.]

EKOWE, NEAR THE EMLALAZI, ZULULAND,
Jan. 28, 1879.

King's kraal at Ulundi. It was the intention of Colonel Pearson to establish an entrenched post as a *point d'appui* to our invading army. On the following day our colonel was followed by our rear division, escorting our heavy baggage, a necessary though inconvenient *impedimenta*, as it contained stores and ammunition. Our column of waggons, I am ashamed to say, extended for five miles, and it took the officers in charge all their time and the services of three horses each during the day to supervise its progress from inspan till outspan. Again, two days later, came the commissariat; and here imagination fails to describe the difficulties we encountered. The subject of transport is one that must be considered in any future operations, as it is to this cause I unhesitatingly attribute any delay or breakdown in our campaign which may have taken place. The waggons must or ought to be stronger than those we employed; the animals should be proof against sickness caused by climate, the tulip plant, and the tsetze fly, and this can be avoided by choosing one's own season for marching. The employment of mules would be much preferable to that of oxen, although in many books I have read the converse is stated, the Dutch being infatuated in regard to the superior qualities of the latter. Mules, for instance, have this advantage over oxen. They can travel 25 miles a day with ease, while 12 or 15 a day with oxen is considered good work; but in contradistinction to this, it must be remembered that a mule costs twice as much as an ox, apart from the cost of feeding. The mule must, of course, be fed on forage carried for him or bought on the road, while the ox will feed on the veldt, except during the three winter months, when his services are not often required. Two kinds of mules can be procured about Pretoria—the Montevidean and the home-bred animal. The latter is generally preferred, although no doubt the former is most tractable. We had immense trouble in selecting our oxen, as none but those bred in the sour veldt of Natal or Zululand were of any use for our hard work; and, as a rule, these will live where the others would die. The usual load we use here is 7,000lb., placed on a waggon weighing 3,000lb., and drawn by 16 or 18 oxen. The cost for oxen used to be about 9*l*. each, but now they are double that amount. Each waggon, with dissel boom and yokes complete, costs at least 180*l*., so you may imagine the amount our commissariat have to pay for the hire per month. The cost of mules will average 20*l*. each, and mule waggons 100*l*., with harness at 5*l*. for each animal. Our waggons here are much too heavy, and lighter ones would have enabled many of our difficulties to be overcome.

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[PORTABLE EDITION FOR THE POCKET.]

TREATMENT OF THE APPARENTLY DROWNED.

ROYAL NATIONAL LIFE-BOAT INSTITUTION.

Incorporated by Royal Charter—Supported solely by Voluntary Contributions.

PATRONESS—HER MOST GRACIOUS MAJESTY THE QUEEN.
VICE-PATRON—HIS ROYAL HIGHNESS THE PRINCE OF WALES, K.G.
Secretary—RICHARD LEWIS, of the Inner Temple, Esq., Barrister-at-Law.

DIRECTIONS FOR RESTORING THE APPARENTLY DROWNED.

THE leading principles of the following Directions for the Restoration of the Apparently Dead from Drowning are founded on those of the late DR. MARSHALL HALL, combined with those of DR. H. R. SILVESTER, and are the result of extensive inquiries which were made by the Institution in 1863–4 amongst Medical Men, Medical Bodies, and Coroners throughout the United Kingdom. These Directions have been extensively circulated by the INSTITUTION throughout the United Kingdom and in the Colonies. They are also in use in Her Majesty's Fleet, in the Coast-guard Service, and at all the Stations of the British Army at home and abroad.

I.

Send immediately for medical assistance, blankets, and dry clothing, but proceed to treat the Patient *instantly* on the spot, in the open air, with the face downward, whether on shore or afloat; exposing the face, neck, and chest to the wind, except in severe weather, and removing all tight clothing from the neck and chest, especially the braces.

The points to be aimed at are—first and *immediately*, the RESTORATION OF BREATHING; and secondly, after breathing is restored, the PROMOTION OF WARMTH AND CIRCULATION.

The efforts to *restore Breathing* must be commenced immediately and energetically, and persevered in for one or two hours, or until a medical man has pronounced that life is extinct. Efforts to promote *Warmth* and *Circulation*, beyond removing the wet clothes and drying the skin, must not be made until the first appearance of natural breathing; for if circulation of the blood be induced before breathing has recommenced, the restoration to life will be endangered.

II.—TO RESTORE BREATHING.

TO CLEAR THE THROAT.—Place the patient on the floor or ground with the face downwards, and one of the arms under the forehead, in which position all fluids will more readily escape by the mouth, and the tongue itself will fall forward, leaving the entrance into the windpipe free. Assist this operation by wiping and cleansing the mouth.

If satisfactory breathing commences, use the treatment described below to promote Warmth. If there be only slight breathing—or no breathing—or if the breathing fail, then—

TO EXCITE BREATHING—Turn the patient well and instantly on the side, supporting the head, and—

1.—INSPIRATION.

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Excite the nostrils with snuff, hartshorn, and smelling salts, or tickle the throat with a feather, &c. if they are at hand. Rub the chest and face warm, and dash cold water, or cold and hot water alternately, on them. If there be no success, lose not a moment, but instantly—

To Imitate Breathing—Replace the patient on the face, raising and supporting the chest well on a folded coat or other article of dress.

Turn the body very gently on the side and a little beyond, and then briskly on the face, back again, repeating these measures cautiously, efficiently, and perseveringly, about fifteen times in the minute, or once every four or five seconds, occasionally varying the side.

[*By placing the patient on the chest, the weight of the body forces the air out; when turned on the side, this pressure is removed, and air enters the chest.*]

2.—EXPIRATION.

The foregoing two Illustrations show the position of the Body during the employment of Dr. Marshall Hall's Method of Inducing Respiration.

On each occasion that the body is replaced on the face, make uniform but efficient pressure with brisk movement, on the back between and below the shoulder-blades or bones on each side, removing the pressure immediately before turning the body on the side.

During the whole of the operations let one person attend solely to the movements of the head and of the arm placed under it.

[*The first measure increases the expiration—the second commences inspiration.*]

*** The Result is *Respiration* or *Natural Breathing*;—and if not too late, *Life*.

Whilst the above operations are being proceeded with, dry the hands and feet, and as soon as dry clothing or blankets can be procured, strip the body, and cover or gradually reclothe it, but taking care not to interfere with the efforts to restore breathing.

III.

Should these efforts not prove successful in the course of from two to five minutes, proceed to imitate breathing by Dr. Silvester's method, as follows:—

Place the patient on the back on a flat surface, inclined a little upwards from the feet; raise and support the head and shoulders on a small firm cushion or folded article of dress placed under the shoulder-blades.

Draw forward the patient's tongue, and keep it projecting beyond the lips: an elastic band over the tongue and under the chin will answer this purpose, or a piece of string or tape may be tied round them, or by raising the lower jaw, the teeth may be made to retain the tongue in that position. Remove all tight clothing from about the neck and chest, especially the braces.

To Imitate the Movements of Breathing.—Standing at the patient's head, grasp the arms just above the elbows, and draw the arms gently and steadily upwards above the head, and *keep*

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1.—INSPIRATION.

them stretched upwards for two seconds. (*By this means air is drawn into the lungs.*) Then turn down the patient's arms, and press them gently and firmly for two seconds against the sides of the chest. (*By this means air is pressed out of the lungs.*)

Repeat these measures alternately, deliberately, and perseveringly, about fifteen times in a minute, until a spontaneous effort to respire is perceived, immediately upon which cease to imitate the movements of breathing, and proceed to INDUCE CIRCULATION AND WARMTH.

2.—EXPIRATION.

The foregoing two Illustrations show the position of the Body during the employment of Dr. Silvester's Method of inducing Respiration.

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IV.—TREATMENT AFTER NATURAL BREATHING HAS BEEN RESTORED.

To Promote Warmth and Circulation.—Commence rubbing the limbs upwards, with firm grasping pressure and energy, using handkerchiefs, flannels, &c. [*By this measure the blood is propelled along the veins towards the heart.*]

The friction must be continued under the blanket or over the dry clothing.

Promote the warmth of the body by the application of hot flannels, bottles, or bladders of hot water, heated bricks, &c., to the pit of the stomach, the arm-pits, between the thighs, and to the soles of the feet.

If the patient has been carried to a house after respiration has been restored, be careful to let the air play freely about the room.

On the restoration of life, a teaspoonful of warm water should be given; and then, if the power of swallowing have returned, small quantities of wine, warm brandy-and-water, or coffee should be administered. The patient should be kept in bed, and a disposition to sleep encouraged.

GENERAL OBSERVATIONS.

The above treatment should be persevered in for some hours, as it is an erroneous opinion that persons are irrecoverable because life does not soon make its appearance, persons having been restored after persevering for many hours.

APPEARANCES WHICH GENERALLY ACCOMPANY DEATH.

Breathing and the heart's action cease entirely; the eyelids are generally half closed; the pupils dilated; the tongue approaches to the under edges of the lips, and these, as well as the nostrils, are covered with a frothy mucus. Coldness and pallor of surface increase.

CAUTIONS.

Prevent unnecessary crowding of persons round the body, especially if in an apartment.

Avoid rough usage, and do not allow the body to remain on the back unless the tongue is secured.

Under no circumstances hold the body up by the feet.

On no account place the body in a warm bath unless under medical direction, and even then it should only be employed as a momentary excitant.

By order of the Committee,

RICHARD LEWIS,
Secretary.

Royal National Life-boat Institution,
London, January, 1878.

The Committee desire to acknowledge with gratitude the liberal support which they have received from the British Public during the past few years, a support which has enabled them to establish their present great fleet of 267 Life-boats on the shores of the United Kingdom, and they earnestly appeal to all classes of their countrymen to continue to aid them in upholding and perpetuating so great and truly national a work.

The number of lives saved, either by the Life-boats of the society or by special exertions, for which it has granted rewards since its formation, is 25,423; for which services 92 Gold Medals, 386 Silver Medals, and £54,200 in cash have been given as rewards.

The expense of a Life-boat, its Equipment, transporting-carriage, and boat-house, averages £900, in addition to £70 a-year needed to keep the station in a state of efficiency.

Donations and *Annual Subscriptions* are earnestly solicited, and will be thankfully received by the Bankers of the Institution, Messrs. Willis, Percival, and Co., 76 Lombard Street; Messrs. Coutts & Co., 59 Strand; Messrs. Herries, Farquhar, and Co., 16 St. James's Street, London; by all other Bankers in the United Kingdom; and by the Secretary, at the Office of the Institution, 14 John Street, Adelphi, London, W.C.

LONDON: PRINTED BY WILLIAM CLOWES AND SONS, STAMFORD STREET AND CHARING CROSS.

Medicine

In the Prussian service each stretcher has a pocket attached to the under part of the head rest & contains:

2 six yd rollers; 2 eight do; 12 compresses each 9 inches sq; 1 mitelle (a 4 cornered bandage) & triangular bandages; 3 yds splint material; 5 packages of charpie; 1 packet sponges; ÷ packet of pins; 1 field tourniquet; 1 kidney shaped pus basin; 1 scissors; 1 piece of sticking plaster (8" × 4"); 1 bottle vinegar (4 oz); 1 small tray, each cot has a bottle of water

charpie is unravelled linen: cotton wool, lint or german tinder also used

v. Esmarch's book.

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Friars Balsam.
Starch. Gum.
Calamine Oint: 2nd.
Flour
Linseed meal
Mustard:
Olive Oil.
Citric ~~Bark~~ acid 1/2lb
Chloral
Goulard's Extract. 1 oz:
Calomel
Hyd: potash 4 oz
Alum:
Seidlitz
Gallic Acid: haemorrhage.
Ch: Quon & Tunine 4 oz
Sp hit: ether
~~Ammon~~ Arom: 4.
Iodide Potash. 4 oz.
Colocynth Comp 2 oz:
Bicarb Potash 4 oz:

Liq Ammoniae ~~1 lb~~ 2 oz: 1 pint.
Chlorodyne. 2 or 3 small bottles
Condy's Fluid. 1 bottle.
Sumac caustic.
Cream Tartar. ~~4 oz~~ 1 lb.
Dovers powder. 4 oz:
Camphor: Ess: Ginger. 4 oz:
Gregory's powder: 4 oz:
Ipec: powder. 4 oz:
James' Powder. 4 oz
Tinct. Opium. 4 oz:
Magnesia carb 2 oz:
Ess: peppermint 4 oz:
Quinine 2 bottles
Carb: soda 1 lb
Sugar of lead: 6 oz:
Sulph Zinc 4 oz:
Sp: Nitre (sweet) 1/2 pint.
Tinct: Catechu: 4 oz:

~~Dil~~ Sulph: Acid: 1/pint
Gallic Acid 2 oz:
Chloroform 2 oz
Chloral 2 oz
Acetate of lead 4 oz
Carron Oil
Camphorated Spirit
Oil
Turpentine
Spanish Fly
Mustard leaves.

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FAMILY MEDICINE CHESTS

Fitted with Drugs and Chemicals of guaranteed purity.

COMPANION TO THE FAMILY MEDICINE CHEST,

Containing a List of the Drugs, &c., with their Properties, Doses, and the Diseases for which they are suitable.

MEDICINES.	*DOSES.*	*EFFECTS.*	*DISEASES PROPER FOR*
Æther	30 dps to 1 dm	anti-spasmodic	cramp and flatulence
Antimonial Powder ..	3 to 8 grains	sudorific	inflammatory fever
Aromatic Confection..	15 to 30 grains	astring & cordial	diarrhœa
Bark, Peruvian, Pwdr.	20 to 60 grains	tonic	ague, weakness
Calomel	1 to 4 grains	alterative & purg	bilious affection
Camphor Julep	2 to 4 table-spf.	ditto & febrifuge	nervous fever
Castor Oil, cold drawn	4 to 8 drachms	purgative	colic, constipation
Chalk, mixture	2 table-spoons	antacid	looseness, acidity
Cream of Tartar	1 to 4 drachms	aper and alterat	eruptions, &c.
Elixir of Vitriol	10 to 12 drops	stomachic	febrile diseases
Electuary Lenitive ..	2 to 3 drachms	gently aperient	constipation

THE ABOVE ARE ADULT DOSES.

INLAND MONEY ORDER RATE.

No single Order granted for more than £10.

Not exceeding. £ s. d.	Charge s. d.	Not exceeding. £ s. d.	Charge s. d.	Not exceeding. £ s. d.	Charge s. d.
0 9 11	0 2	4 19 11	0 6	8 19 11	0 10
1 19 11	0 3	5 19 11	0 7	9 19 11	0 11
2 19 11	0 4	6 19 11	0 8	10 0 0	1 0
3 19 11	0 5	7 19 11	0 9	— —	—

CHARGES FOR INLAND TELEGRAMS.

Addresses are sent free.

No. of words not exceeding.	Charge s. d.	No. of words not exceeding.	Charge s. d.	No. of words not exceeding.	Charge s. d.
20	1 0	30	1 6	40	2 0
25	1 3	35	1 9	45	2 3

And 3d. for every additional five words.

If no special instructions are given, Telegrams are delivered according to circumstances in the following manner, viz.:—If the addressee resides within one mile of the Terminal Telegraph Office, or within the limits of the Town Postal Delivery, the Telegram will be delivered free. Beyond those limits, and if the whole distance to be traversed be under three miles, a charge of 6d. per mile, counting from the delivery office, will be charged; and if the distance be over three miles, the Telegram will be delivered by Horse Express at the charge of 1s. per mile, except in the case of a Telegram to Ireland, where the charge is 8d. a mile.

If the receiver of an Inland Message doubts its accuracy, he may have it repeated on paying half the cost of its transmission to him. In the event of an error having been made, the amount paid for repetition will be refunded on application to the Secretary.

Telegrams re-directed from town to town charged at the ordinary tariff rate, but in such cases they must not have been opened.

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Hints for the Sick Room.

1.—A sick room should be kept very sweet and airy, and there should never be a close smell in it; if the weather s warm enough, the door or window should be open; if cold, there should be a fire, and the chimney should never be stopped up.

2.—It should be made very dark, by a blind over the window; but bed curtains should not be drawn close.

3.—It should be very clean. All chamber vessels should be removed as soon as used, and if there is any bad smell, a little chloride of lime or disinfecting powder should be put into them; some should also be kept in a plate under the bed.

4.—The sick person's face, hands, and feet should be washed regularly with warm water and soap. The hair combed every day. Washing the face with warm water will often ease headache, and make a restless patient sleep. Never be afraid of putting on clean sheets or clean body linen; they cannot give cold if well aired at the fire before they are put on.

5.—When a person lies long in bed, take great care that the back and hips are kept clean and dry. If any place looks red and tender, dab it twice a day with brandy or spirits of camphor, and arrange their pillows so as to take the weight off the tender parts. If the skin comes off, apply cold cream or Spermaceti ointment.

6.—The room should be kept very quiet; there should be no talking or gossiping; more than one or two people make it close and noisy. and disturb

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the sick. Neighbours should not be too anxious to see the sick person, unless they can do some good.

7.—Never give gin, rum, or other spirits, unless ordered by the surgeon; sick people always feel weak, but yet such things given at a wrong time would only make them worse. You may always give good broth or beef tea with safety.

Barley Water.—Take two ounces of pearl barley, wash it *clean* in cold water, then boil in two quarts of water down to two pints, and strain, flavour and sweeten to taste.

Bran Poultice.—Fill a bag of calico or flannel with bran; pour boiling water over it; put it in a coarse towel, and wring it dry; put it on as hot as can be borne.

Mustard Poultice.—Mix Mustard into a paste in water at blood heat; apply between old linen, and let it stay on fifteen minutes, if it can be borne so long; but never longer, especially if the patient is a child. Mustard leaves are most convenient, and are sold ready for use, only requiring to be first dipped in warm water.

Warm Bath.—This should have a temperature of from 92 deg. to 100 deg. If you have no thermometer to judge by, plunge in your arm up to the elbow, and make the water of such a heat as shall feel comfortable to it. It is a very good and safe remedy for children's complaints; a child may remain in the bath ten or fifteen minutes, and should then be dried with a towel and wrapped in a warm blanket. It increases the fulness of the pulse, accelerates respiration, and produces perspiration. It is of great use in inflammation of the stomach, bowels, or bladder.

f. 98 dr

COMPANION TO THE MEDICINE CHEST.—*Continued.*

MEDICINES.	*DOSES.*	*EFFECTS.*	*DISEASES PROPER FOR*
Tinct. of Benzoin	15 to 30 drops	stimu and expect	chronic pulmny affecn
,, Cardamoms..	1 drachm	stomachic	indigestion, flatulence
,, Peruvian Brk.	1 to 2 drachms	stomachic, tonic	indigestion
,, Iron, Muriat..	10 to 30 drops	tonic	general weakness
,, Rhubarb	4 to 6 drachms	aper and carmin	constipation, colic, &c
,, Senna	6 to 8 drachms	purg and stomac	ditto
Wine, Antimonial....	2 to 6 drachms	emetic dose	
,, ,, ...	30 to 60 drops	sudorific	colds
,, Ipecacuanha ..	20 to 40 drops	relaxing	coughs, &c.
,, ,, ..	4 to 8 drachms	emetic	croup—powder better
,, Steel.....	2 to 4 drachms	tonic	debility

THE ABOVE ARE ADULT DOSES.

FOR CHILDREN.

The proportion for Children may be calculated pretty correctly from the following tables:

14 years and above, two-thirds of a dose.
7 years .....one half ,,
5 years .....one-quarter ,,
3 years.....one-sixth of a dose.
2 years.....one-eighth ,,
1 year .....one-twelfth ,,

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COMPANION TO THE MEDICINE CHEST.—*Continued.*

MEDICINES.	*DOSES.*	*EFFECTS.*	*DISEASES PROPER FOR*
Essence of Ginger ..	10 to 30 drops	stimulant	indigestion, flatulence
Ipecacuanha Powder.	25 to 30 grains	emetic	croup, &c.
Laudanum	10 to 20 drops	anodyne	acute pains
Lavender, Comp. Spt.	30 to 60 drops	cordial	fainting, depression
Magnesia, Calcined..	20 to 60 grains	absorb and aper	heartburn and acidity
Mercurial or Blue Pill	3 to 10 grains	alterative	biliousness
Nitre, Sweet Spirit of	20 to 60 drops	diur. and febrifu.	fevers
Paregoric Elixir	½ to 2 drachs.	anodyne	cough, asthma, &c.
Peppermint, Essence	3 to 6 drops	carminative	colic flatulency, &c.
Rhubarb Pwd., Trky.	20 t. 30 grains	aperient	constipation
Salts Epsom, Purifd...	4 to 8 drachms	purgative	constipation
Senna, Sweet Ess. of..	2 to 4 drachms	purgative	worms and constiptn.
Quinine.....	1 to 2 grains	tonic	general debility
Soda, Carbonate of ..	20 to 40 grains	antacid	heartburn and acidity
Spirit Sal Volatile....	20 to 40 drops	anti-spasmodic	nervous headache, &c.
Syrup Rhubarb	2 to 3 drachms	carminative	flatulence, cramp
Squill, Oxymel or Syr.	1 drachm	expectorant	dry cough
Sulphur, Flwrs. or Mlk	1 to 2 drachms	alterative	eruptions, piles, &c.

THE ABOVE ARE ADULT DOSES.

Medicine & Stores. medicines in bottles or zinc pill boxes stamped at the bottom. Mixed so that one common measure for dose.

Sponges, flannel, lint, calico rollers, diachylon plaster & spreader, cooling cerate (beeswax & pure fat), g.p tissue & gutta percha, thicknesses, & splints. millboard 18" in long 6" in wide for leg 15" x 4" arm bandages 3 in wide 6 or 8 ft long. Instruments.

Livingstones fever cure: of Jalap resin, calomel, gum resin, & rhubarb equal & 2 drops of Card. Inct. Essence of ginger, brandy (best) quinine in wine or spirits. salts. senna, Jalap, opium Inct & gum Chlorodyne, chloroform, emetics, sudorifics, dovers powder, Eyewash (sulph: zinc & diacetate of lead) spanish fly blistering plaster, Inct arnica glycerine, lunar caustic, vinegar, citric acid, ipecac: wine. soda, potash tart. acid. spongio piline, steel probe, bullet forceps, incisor tooth forceps, Bells sharp pointed tooth elevators.

Pocket case:- Lint, Compresses, rollers, sticking plaster silk, small sponge, tourniquet, scissors, tenaculum, entire needles, lancet, dressing needles, lancet, dressing forceps, scalpel, g.p tissue or oil silk.

Medicines vide "First Help in Accidents" Compendium of Domestic Medicine, & Companion to the Medicine Chest" (Savory & Moore)

Dr. Sassoon of Turkish Med: Res & Lucy says that Liebigs Extract is best stimulant even better at times than brandy. Also that perchloride best styptic & friars balsam excellent India rubber tubing or elastic bandage best tourniquet

Insecticides - Ammonia

Books: Shaw's Medical Remembrancer or Hints for Emergencies Ed: Hutchinson
Naval Medical Guide (Admiralty)

Drugs:-

Quinine
Warburg's Tincture
Sulphuric Ether
Liq: Carbonis Detergens
Black Drops
Crude Opium
Gelatine Disks [Savory & Moore]
of Belladonna (for Ophthalmic use)
Pilula Colocynth Co., Collodion
Nit. Arg - Sulph Zinci
Zinc - Oleat sebt
Plaster (like Court but adhesive by
melting [Maw & Sons]) called Isinglass
Plaister.
Permanganate Potash
Pocket Filter, (Teste Dr. Conroe)
Savory & Moore's Metallic Splints
excellent
S & M. Moore's Medicine Chests used by Stanley
India rubber tubing (small) or strong
webbing makes best bandaging for wounds
vide Esmarch also Military Med & Surg Essays
At Kings & other hospitals they have strips
of canvas with seven holes to admit two
poles of wood a piece of iron clues
keeps the poles a light. The poles slip through
the eyes of the iron bars. This is one of the best
litters for carrying.

X. Dr Wm Hammond Phila. Pa. Lippincott & Co 1864

f. 100

PRESERVATION OF HEALTH ON THE GOLD COAST. —The following suggestions have been furnished to the *British Medical Journal* by an experienced medical officer: —"1. Good water being of the first importance, the following rules should be observed as far as possible. The water should be boiled and filtered, but the best way to use water, and for thirst, is to drink it with tea. It is strongly recommended that all ranks fill their water-bottles with tea, and use it in preference to plain water. Water should always be drunk in moderation when the body is heated. The less a soldier drinks when on the march the better. 2. Flannel shirts should invariably be worn. No linen or cotton shirts should be used. The most experienced officers in such climates have all recommended flannel. The best writers on the hygiene of the tropics (Chevers, Jeffreys, Moore) all recommend flannel. From experience at Rome and the West Coast of Africa, it is protective against malaria. 3. All ranks are warned against intemperance. The men who drink spirits to excess are the first to fail when strength and endurance are required, and they are less likely to recover from disease, wounds, and injuries. 4. Great care should be paid to the feet. At the close of a day's march every man should bathe his feet, and wash his socks whenever they are soiled. If the feet chafe, rub the socks with common soap where they come in contact with the sore places. Rubbing the feet with oil or fat of any kind before marching is a good remedy. If blisters form on the feet, they ought not to be opened during the march, but at the end of the time a needle and thread should be drawn through, and the fluid will gradually oose out. 5. An old and experienced soldier eats and drinks as little as possible while marching. The young soldiers are warned against eating the contents of their haversacks and using their water-bottles on the line of march. It is a bad habit, and causes more suffering in the end. 6. At the halt, or at the end of a day's march, the heated men should not uncover themselves. They should take off their valise and belts, but keep on their clothes for an hour. Then they may be taken off, well shaken, and dried. This will prevent the danger of chill and exposure. 7. Quinine, as a daily article of diet and not as a medicine, is recommended. It should be taken every morning, to the extent of as much as will lie on a halfpenny. 8. Men should never march on an empty stomach. Tea or coffee and bread should invariably be taken before commencing the morning's march or work. 9. Camp fires should be allowed whenever admissible. They purify the air, prevent annoyance from insects, dry clothing, and are a security against chilliness during the night. 10. Perhaps in no expedition ever undertaken by this country will greater vigilance be required over health matters than on this to the West Coast of Africa. It behoves, therefore, all ranks to aid and assist the commanding officer in maintaining the battalion in the highest physical efficiency."

e in years gone by had made, but which h
eared now to have forgotten. In proof of
se would be made of the powers conferred on
Government by the Bill, M. Christophle
arious repressive acts put in force against n
ipal authorities within the last few months.
Baragnon retorted by showing up certain ac
he Government of the 4th of September, invei
gainst demagogues and civil funerals, said tha
pponents had liberty on their lips but not in
earts, told some good stories, made his fri
augh, and irritated his opponents to such an ex
hat they seemed resolved to drown his voice,
M. Buffet's utmost exertions and most threate
exhortations were inadequate to restore order.
nothing disturbs M. Baragnon, who is ever bl
nd buoyant, and whose chief claim to the o
f Under Secretary for the Home Department
robably his oratorical intrepidity, and the
confidence with which he rattles on, defying
nterruptions, making jokes and launching
sonalities, heedless of the rubs he gets in retu
In his way he is a useful man, much more rema
able for audacity than for discretion, and posses
of a remarkably tough epidermis. When yes
day exposing the shortcomings of the men of the
f September, he was reminded how on that day
Nismes, he astonished the oldest Republicans
his noisy zeal in their cause. All things by tur
he evidently, for the time being, identifies hims
with the party whose tenets he has temporarily
poused. He told some lively anecdotes yesterd
about Mayors parading the streets arm in arm w
women wearing a red cap and representing
goddess of liberty ; about others who issued b
lesque decrees dismissing themselves ; of anot
who knowingly celebrated marriages within the p
hibited degrees, &c. It cannot be said that he
much seriously to support the Bill, for which so
graver speaker on the Ministerial Bench will p
bably to-day or to-morrow stand up. But,
before said, since it is certain to pass, this deba
which is expected to last at least three days, mig
with advantage have been curtailed.

A letter from the Empress Eugénie to the Bish
of Troyes, published in the Bonapartist *Ordre* a
widely reproduced, has excited a certain interest

F.101c 93

Plenty of old gloves for
Ancient skulls

THE CAUSES OF DISEASE IN TROPICAL COUNTRIES.

A PAPER under the above title was read before the Society of Arts on Tuesday last by Mr. A. W. Mitchinson, the African traveller whose name has been recently mentioned in our columns, and both the paper itself and the discussion which followed—in which the Rev. Horace Waller, Captain Foote, of the Naval Brigade, Dr. Thynne, Dr. Hyde Clarke, Dr. Mann, and others took part—presented many features of interest to travellers and residents in the tropics.

Starting on the theory that the drawbacks of what is usually called "climate" are more frequently owing to the ignorance and want of sanitary precautions on the part of travellers in hot countries, the lecturer pointed out certain indiscretions which were often committed by even experienced persons—such as the use and abuse of alcohol; the neglect of proper clothing; the choice of improper sites for camping and settling; the omission of all care for the proper disposal of drainage and refuse. Many of our towns in Tropical Africa he asserted to be built in situations where drainage was impossible, to be surrounded with accumulations of the filth of years, and to be entirely neglected in a sanitary point of view. He asked whether the death-rate of Bathurst—33 per 1,000—could be called large under such circumstances, or could be fairly attributed to the "horrid African climate." He considered that there was no such thing as "climate" in the abstract, that meteorology had little to do with climate, and that diseases incidental to the tropics should be attributed to physiological and psychological causes rather than to meteorological phenomena.

As an example of his arguments, he showed how men busily occupied—in any climate, whether tropical or otherwise, whether natives or not—were always more healthy in body and mind than men who gave way to the despondency and lassitude which want of companionship and want of regular employment and of incentives to work often caused. He instanced the experiments made with a view to ascertain the increase of electricity in the human body after reasonable exertion, and stated the extraordinary fact which had come under his own observation that, on lightly striking oxen or even natives, that were accustomed to work, with a whip, several electric sparks would be produced, while none would be observed when lazy cattle or men were subjected to the same operation. He advised generally a moderate dietary, eating only when hunger showed its necessity; the avoidance of all indigestible foods, which, though eaten without danger in Europe, are often fatal in hot countries; and a determination not to give way to despondency, but to keep body and mind actively employed. The practice of planting a row of trees between a village and a marsh or swamp, which was frequently adopted by natives on the West Coast of Africa, proved efficacious in keeping off malaria.

In the discussion which followed the Rev. Horace Waller gave some useful hints to travellers. He stated for certain that it was always safer to camp out among the reeds and on the mud-banks of a river than on the tempting-looking sandy beaches which exist in most rivers, but which, though generally so fair on the surface, are full of miasmatic poisons. Thick light clothing should be worn over the stomach, and mosquito curtains proved an invaluable protection against malaria; and at night chills during sleep should be particularly guarded against. The speaker especially denounced the use of quinine as a prophylactic, urging its use only when absolutely required.

Captain Foote recounted his experiences of fever in tropical countries, but supported the use of quinine and the moderate use of stimulants.

Dr. Thynne, after prolonged medical experience in various hot climates, thought that "climate" was everything, and that it was difficult to conceive of a climate being "good" in which such minute precautions had to be taken as were prescribed for life in Africa. He opposed the use of stimulants, but found them necessary in certain cases.

Dr. W. B. Richardson, who presided, ably summed up the results of the paper and of the debate, and, while himself differing from some of the physiological arguments adduced by the author, warmly complimented him on the value of his contribution and on his manner of dealing with so wide and interesting a subject.

Arms & Ammunition

Mohr "Zambesi" & Ammon: forties: found to be good in tsetse-sickness.
Elephants Rhinoceros etc killed with bullets made of ¼ of lead to 1 of tin or quicksilver.
Never camp on damp ground for sake of being near to water. The cost of an Entire journey viz passage money, Equipments, hotel expenses etc for 26 months etc Everything included amounted to £1500.

Adams Martini - "Zeller Rifles for rabbits, rooks, deer &c wonder of cheapness, accuracy & compact workmanship"
Purdey of Oxford St well spoken of in several papers on the Exhib of 1878 (Paris)
Colts revolving rifle (5 chambers) with apparatus can be purchased under £4. a case of 6 under £2.10. each

A writer in Silver's "Colonial News" says that the Sporting Martini-Henry Rifle is far superior in every respect to Colts Revolving Rifle
The Remington magazine pistol is the size of Colts Deringer & can be carried in the pocket the un-noticed.

Rifle used by Mr. Carver -
Bland's Keepers Gun 6 & 9 guns
strongly spoken of by Capt Douglas & Davidson

Lord's Equipment:- 1 good strong double b. m. loader 12 bore
1 Purdy's rifle to carry 1 oz bullet
1 Colts revolver
2 large-sized powder flasks, copper caps with pig skin & worsted with metal strap loops. Double shot-belt of good leather & provided with brass chargers fastened with spring & chain. In 1 carry duck shot & the other 6 or 8. Old fashion'd chargers not patent! Bullets & wire cartridges (Eley's) Oil. Worp for cleaning. 2 spare mainsprings, 2 sets of tumbler fittings, 3 pair inverted nipples bouched with platinum
Strong leather gun case. Waterproof cover Cartridge
~~Gun~~ Eight gun for bird-dust shot } implements & paper.

No 12

Stout strong bowie knife or short sword bayonet (Martini) - Spear heads ◇ can be fastened on bamboo. 9 ft long the best length -

The old Shekarry thinks that Westley Richards are the best guns & rifles he recommends No 12!
a box fitted on the belt is best for cartridges -

Mr Davidson thinks a 10 bore the best as it does for large or small game (double m.l broad bellied)

Shakespear (wild sports of India) had a 400-grooved rifle (made by Wilkinson Pall Mall, 30 in length 10½ lbs weight steel swivel ramrods & swivel steps & 10 bullets to the lb broad & a Westley Richards pat. grooved 12 & 4 lbs 26" barrel 20 bullets to lb. The Wilkinson he found to be best & used it to kill tiger etc. Nine bullets are ½ oz & 4 to 1 lb lb best. 1 oz bullet is almost if not quite heavy enough. His bullets he kept seven in cloth & greased. He thinks a revolving rifle of large bore would be best Hunting shears 8 ft long. always carried a sword His shikar knife in a breast pocket. sword 39 in long flat handle (not basket) & highly curved

* Uncle Wally as Black Keepers Gun

Arms If only I be taken let it be a plain, strong, muzzle loader double b.[l] smooth bore 11 or 12 gauge. bar.[l] 2'.6" wt 8½ lbs, side locks, ramrod pipe large size. Extra nipples + springs.

bullet moulds of exact size.

rifle do. long knife to fix on gun, or Martini-Henry sword (said, sword + bayonet combined)

Revolver Adams best! muzzle loader

with butt, which can be used as a case for shot etc or tools.

Colts next. Army size 4½ lbs most formidable. muzzle loader. For best Tranter breech loader perhaps good as any (Baines) Lefaucheaux-pattern smooth b. double bar.[l] 9½ in bar.[l] 14 bore for horses (do.) Baines says that adams' patent had not the power of Colts but the recent trials have proved Adams' the best

rifle to carry ball of from 2 to 6 oz hardened with tin, mercury or type metal.

small revolver + dirk to button on trousers or used out of sight.

Few common guns for servants from £10 Buck ≤ 5 shot do £12

Colts Revolving rifle. Marey & others speak fit as excellent. his revolver army size as most formidable

Winchester better than Colts.

Wickham carb.[l] double bar.[l] gun & Snider rifle + Eley's wire cartridges.

spare stock to gun.

Breech loaders - if taken should be convertable in muzzles

Leetch's (Margaret St, Oxford St) Breech loader, Buck speaks of as being perfectly safe, very simple + can be used with special cartridge or loose powder + shot + very little likely to be put out of order by the roughest treatment very efficient & S. Main.

Gun case

Namaqua sling case

Lancaster's oval grooved Rifle is said to be less fouling than any other. Whitworths can be used with hardened bullets.

Sir S. Baker (Nile Tributaries)

There cannot be a more convenient size than No 10 for a double rifle for large game. Hurls 3 oz conical bullet & 7 dr of powder. 6 dr. will kill a buffalo. Although a breechloader is a luxury, I would not have more than a pair of such rifles in a wild country as the damp &c is against them. Ammunition for these should be rolled up in flannel (10 each parcel) & each parcel sealed in seperate tin canisters. Rub I should decidedly provide myself with 4 double-b. muzzle loaders No 10 as my regular battery, old fashioned 2 grooved barrels being by far the best.

A small handy double rifle such as my 'little Fletcher' 24 bore (Enfield) not exceeding 8½ lbs is very necessary as a constant companion & breach loading.

Knives like butchers but bell knife should be hard & back of blade rough to sharpen other knives on.

Boxes always strong japanned metal.

Couple of large umbrellas with double long spike ends & rings to peg down. (Harpaulins)

W'proof calico sheeting in abundance & no vulcanized i.r. goods. Quart syringe for injecting salt water into meat - few powerful for traps & twice for springs.

Good indian ink for rubbing up as required.

Note books &c of tinted paper - Burning glass flint & steel &c - lucifers dangerous.

Large supply of mercury for hardening bullets.

Gridiron even better than frying pan - iron skewers

Rifles No 10 Rifles are wonderfully powerful weapons & exceedingly handy. weight 14 lbs - hardened bullet & 7 dr powder

Powder, Caps etc

4 lb best sporting powder; 2 lb rifle do
2000 best caps for gun nipples alike; 250 pistol caps
2. 28 lb bags of shot (6) if only 1 size be taken it should be these
1. " " (4) } in sail-canvas bags.
1 " " B.B } 10 oz most convenient (Egalton) nos 8 & 11 for boys
6 bags ordinary mercurial wads & 6 extra felt do for powder wads.

3 Eykes p. flasks 1 lb hold 1 lb & 2 medium, tinned copper & coº with hogskin.
Double shot belt.
Ely's wire cartridges invaluable
Brass mould for casting buck shot abt size of garden peas. 1 oz with 3½ dr powder for close quarters
Ammunition boxes 8" sq 3" high inside measurement

Packing case for guns etc. Stout elm, lined with sheet lead stout division in centre shot at one end & the powder wads & caps at other. Pack tightly with tow, close on lid & screw down. 2 cleats at bottom
Stick coº with flannel & anointed with mercurial ointment to be inserted in gun.

Tents

In the Sibley a fire can be lighted, it is most commodious & comfortable: has an iron tripod in centre pole to hang kettle on. But the tent is heavy to walk after trying all I prefer (Lord) "dog kennel" or "gable ended" tent of 10 ell size. Uprights 6 ft ridge 7 ft. Each of these ferruled in centre with strong galv. iron both ends shod with iron caps or thimbles riveted on. Ridge pole to have cone shaped hole or ~~eye~~ iron ~~piece~~ eye riveted on. Tent pegs [3 doz 2 mallets (iron or wood)] with a cord through them.

Calico or canvas is sufficient for all practical purposes. Eglinton 3 poled tent but heavy (1). Next to this is a small marquee (2). Pyramidal shaped duffy (3) can hang under, as tent (3a) wt. 2 5 10 7 4 0 lbs. For small tent nothing better than 'dog kennel or gable end'

1. Punjab Hill Tent (Eglinton's) see p 100

F.105 br

PIGGOTT BROTHERS,

THE GIPSY TENT.

	£	s.	d.
9 feet by 7 feet	4	10	0
12 ,, 7 ,, ...	5	10	0
13 ,, 10 ,, ...	9	0	0

Second Hand Tents often in Stock.

59, Bishopsgate Without, London.

PIGGOTT BROTHERS,

THE BOATING TENT.

	£	s.	d.
7 feet by 6 feet	2	10	0
9 ,, 6 ,, ...	3	0	0
12 ,, 7 ,, ...	5	0	0

Second Hand Tents often in Stock.

59, Bishopsgate Without, London.

UNIVERSITY COLLEGE LONDON GALTON PAPERS

PIGGOTT BROTHERS,

THE TRAVELLERS' TENT.

	£	s.	d.
9 feet square	8	0	0
11 ,, ,, ...	10	0	0
13 ,, ,, ...	12	10	0

Second Hand Tents often in Stock.

59, Bishopsgate Without, London.

f. 105 bv

PIGGOTT BROTHERS, LONDON.

THE BELL TENT.

	£	s.	d.
20 feet circumference	3	3	0
27 ,, ,, ...	3	14	6
30 ,, ,, ...	4	4	0
36 ,, ,, ...	5	5	0
40 ,, ,, ...	6	6	0

Second hand Bell Tents from 50s.

Waterproof Horse Loin Cloths.

Lined Check. If lined Tilting 6d. each extra.

2ft.	by 3ft. 6in.	5s. 6d. each, Straps.	3ft. 6in.	by 5ft.	8s. 6d. straps, thongs.
2ft. 6in.	,, 3ft.	6s. ,, ,,	3ft. 6in.	,, 4ft. 6in.	9s. ,, ,,
3ft.	,, 3ft. 6in.	6s. 6d. ,, ,,	4ft.	,, 4ft.	9s. ,, ,,
3ft.	,, 3ft. 6in.	7s. ,, ,,	4ft.	,, 4ft. 6in.	9s. 6d. ,, ,,
3ft.	,, 4ft.	7s. 6d. ,, ,,	4ft. 6in.	,, 4ft. 6in.	10s. ,, ,,
3ft.	,, 4ft. 6in.	8s. Straps & Thongs.	4ft. 6in.	,, 5ft.	12s. 6d. ,, ,,

PIGGOTT BROTHERS LONDON

THE CANOPY TENT.

	£	s.	d.		£	s.	d.
6 feet square, white	3	0	0	7ft. 6in. square, white	3	10	0
ditto striped No. 1.	3	10	0	ditto striped No. 1.	4	10	0
ditto do. No. 2.	4	0	0	ditto do. No. 2.	5	0	0

FLAGS.

ROYAL STANDARDS.	£	s.	d.	UNIONS AND ENSIGNS.	£	s.	d.
2 yards long	2	10	0	2 yards long	0	8	6
3 ,, ,, ...	3	3	0	3 ,, ,, ...	0	15	0
4 ,, ,, ...	4	15	0	4 ,, ,, ...	1	4	0
5 ,, ,, ...	6	5	0	5 ,, ,, ...	1	13	0

PIGGOTT BROTHERS, LONDON.

Ritchie's Patent Portable Canvas Summer House.

9 feet square.	£	s.	d.	11 ft. square.	£	s.	d.
White, trimmed either blue or red, with either blue or red ceiling	5	0	0	White, trimmed either blue or red, with either blue or red ceiling	6	0	0
Striped, any colour, with any colour ceiling	6	0	0	Striped, any colour, with any colour ceiling	7	0	0

f. 106r

BELL TENT,

British Army Regulation Size.

ABOUT 40-FT. CIRCUMFERENCE.

The Pole Jointed, and the whole made to pack in one Valise.

Price, £5 10s. Valise, 5s.

SMALLER SIZE BELL TENTS,

ABOUT 32-FT. CIRCUMFERENCE.

Price, £4 5s. Valise, 5s.

SECOND-HAND BELL TENTS FREQUENTLY IN STOCK.

BENJAMIN EDGINGTON'S CRIMEAN CAMP BEDSTEAD,

SIMPLE, STRONG, AND VERY PORTABLE.

Light Hair Mattresses and Pillows.

WATERPROOF VALISES TO HOLD BEDSTEAD AND BEDDING.

VERY USEFUL FOR CLOTHES.

ADDRESS—

BENJAMIN EDGINGTON,

2, DUKE STREET, LONDON BRIDGE, S.E.

(No other Establishment.)

f. 106v

BENJAMIN EDGINGTON'S

PATROL TENT.

This Tent, which is similar in shape to the Emigrant Tent, is strongly made of stout material, for use by surveying and exploring parties, or other purposes where a tent for one or two persons is required. It is also a suitable Tent for small boating parties.

Large Size, ABOUT 6 FT. 9 IN. LONG, 6 FT. WIDE, 6 FT. HIGH.

Price, packed in Waterproof Valise ... ... £3 15s.

Small Size, ABOUT 6 FT. 9 IN. LONG, 4 FT. 6 IN. WIDE, 4 FT. HIGH,

Price, packed in Waterproof Valise ... £2 12s. 6d.

Extra Light Tents, with Bamboo Poles, &c., made to order.

ADDRESS—

BENJAMIN EDGINGTON,

2, DUKE STREET, LONDON BRIDGE, S.E.

(No other Establishment.)

f. 107 r

BENJAMIN EDGINGTON'S

TENTE D'ABRI,

Similar in shape to that used in the French service, the roof being made in two parts, if desired, so that the weight can be divided between two persons. Made from stout Duck.

SIZE, ABOUT 6-FT. 9-IN. LONG, 7-ft. WIDE, 4-FT. HIGH.

Price, in Bag, complete ... ... **£2 5s.**

INDIA RUBBER GROUND SHEETS,

WHITE, SIZE, 6-FT. BY 3-FT. . . ... **8s.**
„ 7-FT. BY 4-FT. 6-IN. ... **14s.**

CAMP STOOLS AND CHAIRS IN GREAT VARIETY.

ADDRESS—

BENJAMIN EDGINGTON,

2, DUKE STREET, LONDON BRIDGE, S.E.

(No other Establishment.)

f. 107v

BENJAMIN EDGINGTON'S
NEW BOATING TENT

It is strongly made of stout material, firm, and easily erected in rough weather, being pegged down before the poles are raised. Few pegs are required, and fewer projecting lines, and there is sufficient height inside to afford comfortable head room.

Small Size, 10-FT. LONG, 7-FT. WIDE.

Price, in Valise, complete **£3**

Medium Size, 11-FT. LONG, 8-FT. 6-IN. WIDE.

Price, complete **£4**

Large Size, 13-FT. 6-IN. LONG, 10-FT. WIDE.

Price, complete **£5 5s**

Portable Camp Canteens and Cooking Apparatus.

ADDRESS—

BENJAMIN EDGINGTON,

2, DUKE STREET, LONDON BRIDGE, S.E.

(No other Establishment.)

f. 108r

THE EMIGRANT TENT.

This Tent is simple in construction, most commodious and economical, and has been largely sold for use on the Diamond and Gold Fields, being strongly made and packed in one Valise, the poles, pegs and every requisite included.

PRICE—Nine feet square - - -	**£5 10 0**
Eleven feet square - - -	**8 0 0**
Thirteen feet square - -	**12 0 0**

Canvas Valise to contain Tent complete, 5s. to 10s. extra.

An Outer Fly, for additional protection from the heat of the sun, can be fitted to any of the above at an extra charge.

BOATING TENTS.

Small Patrol Tents, similar shape to the above, suitable for Boating or Canoe Parties, Prospecting, &c.—light and portable.

Tentes d'abri, of French and Improved Patterns.

TENTS FOR ENGINEERS.

Strong and Commodious Tents of New Patterns, suited for Employés on Railway Works, Foreign Surveys, &c.

Can be seen erected at B. EDGINGTON'S Establishment, 2, Duke Street, London Bridge.

BENJAMIN EDGINGTON'S

Improved Military or Travelling Tent,

(See opposite page).

Capable of resisting the strongest winds, easily and expeditiously erected, and very portable.

THIS Tent is very superior, in every respect, to the Round Tent of the British Service; and a Prize Medal was awarded to the Maker at the Great Exhibition in London, in 1851.

Its figure is a pyramid, and the angles are strengthened from the head of the Tent by a stout rope, to which the canvas is "bolted," and which, being secured by strong iron pegs to the ground, constitutes the principal support of the Tent. A porch is formed at each end, sustained by a light 6 ft. pole, giving entrance to the Tent, and affording the great advantage of a thorough draught of air. There is also ventilation at the top. The centre pole is divided into three parts—the small poles into two. The whole (including poles, pegs, and every requisite) is packed in one valise.

The two porches, and the very complete *ventilation*, are improvements of great value, while the ease and rapidity with which the Tent can be erected (two men being sufficient), and the resistance it offers both to wind and rain, render it almost invaluable in any climate.

The Tent being pegged down before the pole is erected, is a great advantage in windy weather.

This Tent is specially adapted for surveying and railway engineering expeditions, and is made for these purposes 9, 11, and 13 ft. square, weighing respectively 90, 112, and 136lbs. complete.

For troops or workmen, the Tent is also made 15 ft. square, capable of containing sixteen men with knapsacks and rifles. The men can lie with their heads in the centre of the Tent, instead of at the sides, against the wet canvas, as in the Bell Tent.

The larger sizes can be fitted with a stove, as shown on page 28.

Instructions for erecting the Tent.

Observe how the Tent is packed, to save trouble in repacking. The poles being jointed must be put together. There are four iron pegs for the corners, and one for each of the porches. The wooden pegs are for the bottom and the side lines of the Tent. Having spread the Tent out, carry the two distant lines, which are attached to two of the corners, across the open sides or porches, and make them fast at the opposite corners. The Tent being then flat on the ground in the form of a square, peg down the four corners with iron pegs, taking care that each side is drawn perfectly tight. Pass the spindles of the small poles through the holes at the top of the two open sides or porches; put the ornaments with the lines attached over the spindles, and draw the lines out, securing them to iron pegs five feet in front of the Tent. Get under the Tent, pass the spindle of the large pole through the top, place on it the ornament with the small flag, then raise it to its proper height. Draw the sides of the porches out, and make them fast to the iron pegs to which the lines are secured, and to the lines themselves. In bad weather, fasten the small lines with hooks to the eyes at the sides of the Tent, and secure them with wooden pegs to the ground.

The Tent can be seen erected at No. 2, Duke Street.

f. 109a

Laid open on the ground, ready for packing with Blankets (or ½ Sack Fearnought), Under Vest, Flannel Shirt, Towel, Sponge and Bag, Soap Box and Soap, Comb and Brush (combined), Socks, pair of Boots, Woollen (or Silk) Nightcap, Pants, &c., for a change.

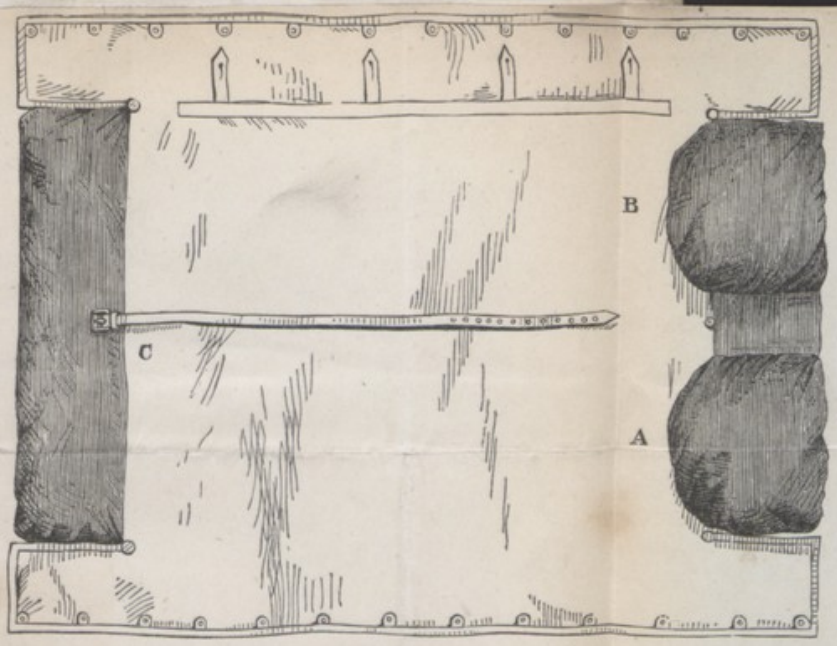


FIGURE 2.

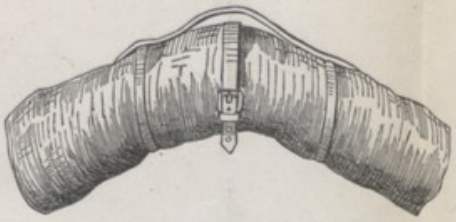
In use on Active Service or Travelling.

Sleeping on the Ground without Tent or Bed.

☞ NOTE,—When in use, as shown in Fig. 2, the head, feet, and body may be sufficiently enveloped to afford good protection from wind, rain, or damp, and at the same time giving abundant ventilation; the pocket A (as filled with change of underclothing, &c.) forming the pillow, the pocket B receiving and covering the head.

FIGURE 3.

Packed as a Valise, with Blankets, Change of Underclothing, Boots, &c., rolled into pocket C (the side flaps having been folded in before rolling), and ready for fastening to pommel of saddle for travelling.



PRICES:

In Double Strong Waterproofed Twilled Camlet—weight, 7 lbs. £2 15 0

OR

Extra Proofed, and eight inches wider when folded—weight, 11 lbs. £3 10 0

THOMAS WHITE, Camp Furnisher, Aldershot, Sole Manufacturer.

No. 1.—Ash frame-work turned and varnished, hammock of coloured ticking, waterproof tent, and packing-bag complete .. .. £3. 5s.

No. 1A.—The same as No. 1 without the tent £2. 10s.

No. 1B.—The same as No. 1A without the hammock £1. 10s.

No. 2.—Ash frame-work, plain turned; hammock of strong canvas, waterproof tent and packing-bag complete .. .. £2. 10s.

No. 2A.—The same as No. 2 without the tent £1. 15s.

No. 2B.—The same as No. 2A without the hammock £1. 0s.

A brown waterproof canvas bag fitted with brass ferrules and lacing can be supplied to contain either of the above qualities at the extra price of 7s. 6d.

Purchasers of the "Gwynfè" framework can have their hammocks fitted for it at a small extra cost. f. 1096

No. 1.—Ash frame-work turned and varnished, hammock of coloured ticking, waterproof tent, and packing-bag complete .. .. £3. 5s.

No. 1A.—The same as No. 1 without [illegible]

No. 1B.

No. 2.-
strong
compl

No. 2A.-

No. 2B.-

A bro
ferrules
of the ab

Purcha
their han

F. 109c

INSTRUCTIONS

For fixing the "GWYNFÈ" Hammock.

Join the socketed end of the stretcher BC, taking care that the notch and stud fit into each other. Open the supports IJ to the full extent allowed by the cord, and with their pointed ends down connect them one at either end, to the stretcher BC, by placing the steel pin through the sockets.

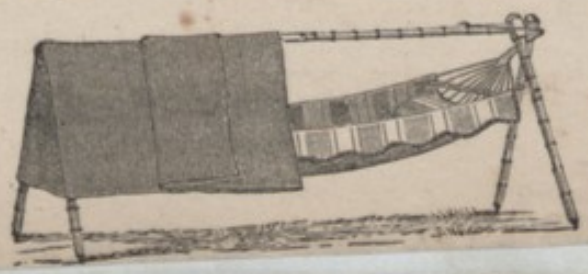
The frame will then stand upright by itself.

Pass the loop F (at either end of the hammock) between the cord and the joint of the supports IJ, place the brass fly-nut E over the steel pin, and the remainder of the loop F over the hook A.

Place the two small stretchers in the four corner holes of the hammock, fix the pillow in position, and draw the covering over the stretcher.

If necessary the tent can be fastened at the corners and in the centre by means of the strings and buttons, care being taken that the brass ferrule fits over the steel pin at either end.

The best way to get in is by sitting gently down in the centre of the hammock first, and then quietly leaning back to the horizontal position, always avoiding to put any but a light hold on the stretcher.



Awarded THE ONLY PRIZE MEDAL FOR HAMMOCKS at the Paris Universal Exhibition, 1878.

F.109d

The "GWYNFÈ" patent Hammock-Tent.

This Hammock-Tent has been specially designed to meet the want so long felt, by officers and others, of a portable weatherproof shelter and sleeping place in time of war, but is equally available for other and numerous purposes.

The framework of this Tent consists of six short pieces of ash or bamboo (or other light and suitable material), tipped at both ends with metal in such a way that when fitted one into the other (an operation which at the most takes one minute) they form a compact secure and portable frame to which the Hammock is slung, and over which the material forming the Tent is thrown.

The Hammock itself may be made of either canvas, twine or grass—to suit the convenience of the user, and the Tent may be constructed either of india-rubber sheeting, or waterproofed canvas.

The operation of taking the Tent to pieces takes less time even than that of putting it together, and can, by placing the pieces of framework side by side, and rolling the Hammock and Tent neatly round them, be formed into a light and portable parcel, not more than 6 in. diameter in the widest part.

The "GWYNFÈ" is entirely independent of ropes, trees, pegs, screws, or other supports, such as are necessary for Hammocks now in use, and can be placed in any position, or readily removed to another, on grass as well as on rock, on the floor of a room as well as on the muddiest soil. It is equally suitable for the field in war, or for the lawn in peace, for the tired soldier, or the luxurious dilettante. It is invaluable as an accessory to field hospital appliances, and can even be used as a manger for foraging horses.

In the late Russo-Turkish war it was found that the mattrasses in general use by the officer engaged, were no protection whatever from the dampness of the ground, the inclemency of the weather, or the irritating attacks of hungry insects, against all of which the "GWYNFÈ" Tent is absolute shelter.

It is now a universally recognized fact that the mobility of troops is one of the most essential elements of success in war, and the baggage of both officers and men has, in consequence, been reduced to a minimum of weight and space, the necessity, therefore, for some more light and portable shelter than the appliances now in use, renders the great want of some such arrangement as the "GWYNFÈ" Tent the more apparent.

The "GWYNFÈ" is equally necessary to the health and comfort of sportsmen, gamekeepers, flock and herdsmen, squatters, ambulance surgeons, invalids—in fact, to all who have to camp out, whether from necessity or pleasure, the "GWYNFE" provides luxurious ease, and absolute immunity from the weather.

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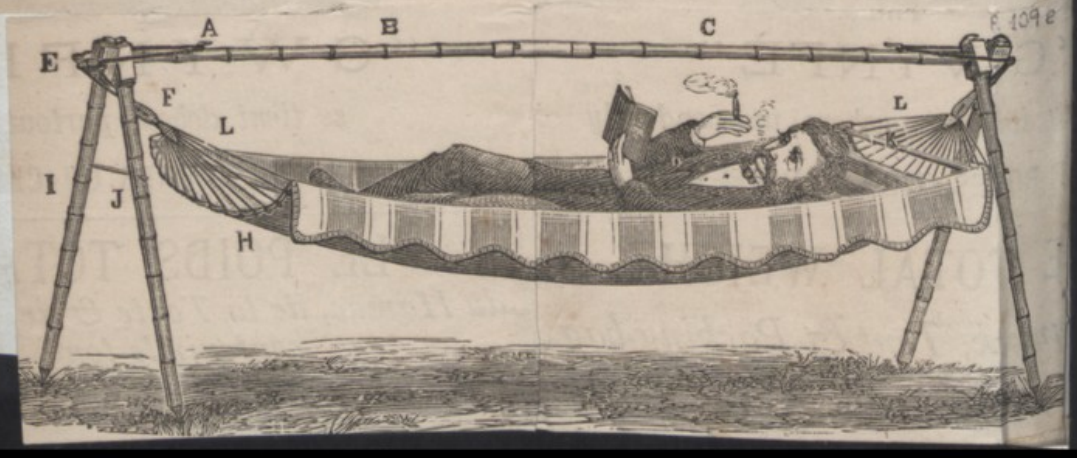
F.109e



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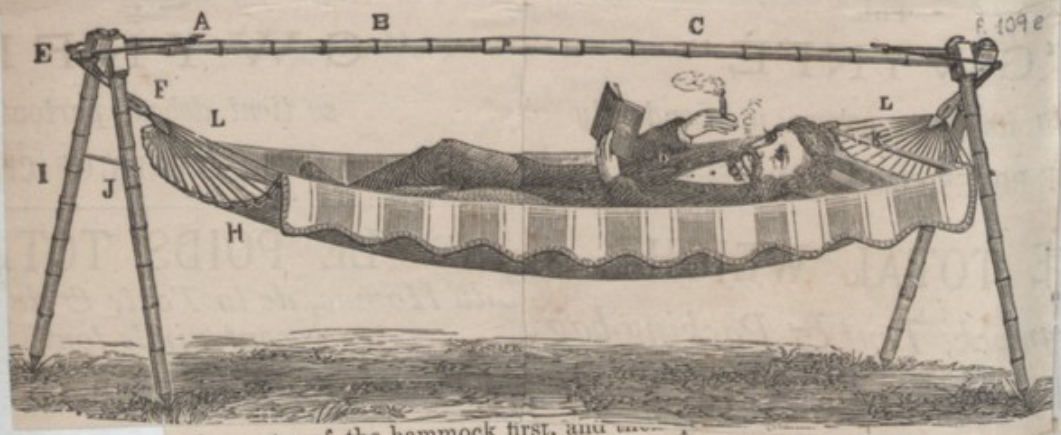
F.109e



the centre of the hammock first, and

back to the horizontal

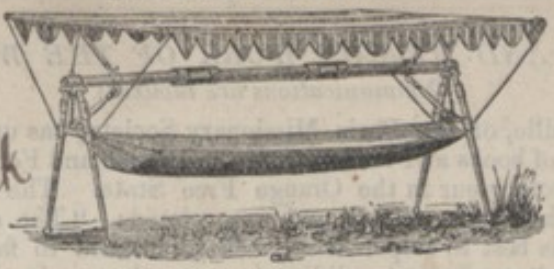
any but a light hold on

F.109f

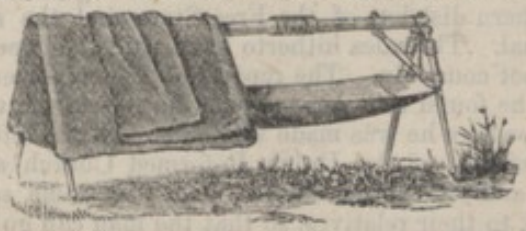
The "GWYNFÈ" folded for Carriage.

TURNER'S PATENTS.

Pakkee Hammock



Stands in its own length, without ropes or pegs, and is the best pattern ever invented for campaigning and other purposes. It is exceedingly strong, yet light and portable.



ILLUSTRATED PRICE LISTS on application to the SOLE AGENTS,

S. W. SILVER & CO.,

SUN COURT, 67 CORNHILL, LONDON.

F. 109 g

110r 103

For all ordinary purposes of travelling in an American axe, 3" auger, couple of gimlets, stout clasp knife full of little tools, case knife (pork butchers) of good steel riveted to handle & a strap over handle. (Lord)

Mining Tools Gold etc.

Cornish picks, steel borers with cockscomb ends, steel gads or wedges boring steel gads & gad steel in bars, blasting powder, safety match in coils, heavy hammers, portable forge & smiths tools, shovel blade pick heads & sticks of ash &c. Iron wedges tipped with steel, wooden beetle (mallet) blasting bags, (ie screws with holes through them frame saws, a few rope blocks, grindstone.

Weights & measures. Cups &c made to hold definite quantity
steel yard
measuring tape
rule

Rope for climbing &c No 2 Italian hemp or 3 flax (Buckingham 33 Board St, Bloomsbury)

Ice axe No 2.

English colors.
Card made waterproof bottom & sides & then used as a punt.

Tools of "File hardness".

Knives. butchers (sailors) in case, soft steel & bone - better than "hunting" knives. American skinning knives.

Small hand axe with hammer head also (Sloop)

American wedge do belt & heavy (lbs)

Belt tomahawk Fireman's axe? 2 bill hooks in l. case.

Hand saw medium size "green timber". with shut up saw in handle.

Frame do.

3 chisels $\frac{3}{4}$, $\frac{1}{2}$ & $\frac{1}{4}$ & 1 cold chisel

3 gouges - do - 3 gimblets, 6 brad awls to 1 handle.

6 shoemakers awls

$1\frac{1}{2}$ shell auger with eye handle. Folding reaping hook or scythe.

1 screw driver $\frac{1}{2}$ in

1 riveting hammer $\frac{1}{2}$ lb. spade, mallet, pickaxe, adze.

1 pincers, mortice chisel, turkey stone,

1 strong bell hangers pliers

3 hand saw files, 1 rat 1 flat 1 half round.

Stout shears & scissors, washita stone, 1 rasp, 1 soldering iron solder, resin, small ladle, nails, screws, lump tacks, iron & steel & copper wire. hydroch. acid, tin, sal ammoniac

spring balance, rope ladder. & bellows.

cold chisels punches drills reamers, countersinks, brass wire thick rule & tape. anvil, tongs, sledge hammer.

In roll up case. If too many set in box 9" long wide deep 3" 2 $\frac{1}{2}$"

several small files, chisels, awl blades, screw driver hammer head, pliers, sail needles, hand vice, watchmakers drill & bits blowpipe, solder, resin, Copper & brass wire, watchspring. saw, cold chisel, sweet oil, ans

pieces of iron $\frac{1}{8}$ in thick as cheeks to prevent heads flying off

Branding iron small & large

small set of tools fitting into one handle in roll up case

Tobacco cigars lights lobe rolled up in a waterproof
& sheeting or canvas so that in case of heavy rain
or wading or swimming they are not injured. Odd
pieces of waterproof can be bought very cheap.

"Ditty bag." Needles: sail, roping, packing, duck sewing; sail makers thimble + palm, sail hooks, rubber pierced, horne, thread; silk, worsted, cotton in skeins wooden thin wood buttons (horn of diff. sizes + pearl [large]) beeswax, tape, huns, bodkin, scissors etc.

small bellows, small pump + hose, canvas + leather bucket, do small with cord for letting down rocks + deep wells. Leather, straps, rope, buckles, D's S's, padlock, butchers steel. Tube + other cork screws.

Waterproof comp. white wax 1 oz sp turp 1 oz quart.
dubbing oz ft oil ½ pint, ½ pint beeswax, 1 oz sp turp ½
burgundy pitch ½ resin.
Indian rubber solution. naptha etc
Leather, awls, hemp, wax, iron foot, last etc for mending shoes + boots. Castor oil best preservative for leather of all kinds, boots, harness, bags. Boot brushes in case.

Matches lights etc. Candles. lamp. russian or metal light + oil.
in metal box
Wax matches, tube + cap strike a light with chain agate + cotton slow match. flint + steel. Piece of brimstone

Candles (price vegetable wax), plenty of wick, candle moulds
bulls eye + other lamp.

Tobacco + cigar cases of w'proof cloth to double over + tie round

Common oil skins
Regimental cloak
Cork life belt with compartments for food, brandy, weapons etc

top with string
flap flap
pocket

At some of the Marine Stores (Tooley St etc) very often are to be seen lots of Military stores (canteens etc) which are in good order + very cheap.

Australian swag bag

The Malays etc sometimes use a small box ÷ into two parts, one being lined with tin. In this is placed an earthenware or iron furnace (chauffer) In the other division is kept the charcoal, pots etc + a fan. Their food baskets consist of 3 or 4 trays made of rattan which fit into each other an iron rod passes through the handle + is secured by a lock

small sheet-iron cooking stove is light + handy.

Tin lined baskets for food + specimens with locks + hasps for carrying.

Save the dripping + have tins with lids to keep it sweet + clean. Some of the common breakfast + dinner cans used by workmen are capital, as they have lids + handles + are cheap + strong.

Small poker, shovel (strong) etc. meat hooks etc

Bill hook + axe for wood cutting + chopping.

Each servant should have a parang + axe

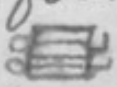
If about to reside a few strong + good table cloths dish cloths etc wanted, Bedding sheets etc, Counterpane similar to those on children's bed. a few good aprons + one or two leather (pioneer or brewers) aprons, a few yds of waterproof canvas (mail bag) for making up as required (clothes bags, havers sacks etc) some of present white clothes could be canned.

Wrought iron saucepans, jugs etc same as used for children at home) different sizes

A common iron canister can be made into a fore place thus :- in centre a few triangular cuts are made + bent inwards for lid to rest on + form a bottom. The true bottom forms the ash-hole.

Take plenty of condiments + seasoning agents as pepper (white + black) pimento, mustard, nutmegs, mace cloves, ginger, curry powder, ketchup etc the dry condiments in tins well papered round a small cookery book or a copy of the Family Herald cut up to suit the purpose, in a small form.

Or a small one made of wrought iron bars of a square form the sides to take apart or hinged



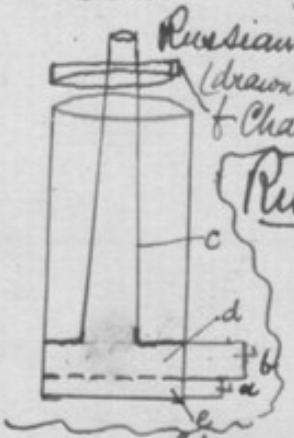
2 wires bent thus make a good light + cheap support for kettles etc

Food p. Gallon.

Cooking. Knives, forks with riveted handles, iron + wooden spoons, 2 wooden bowls with copper rim let in. Horn or metal cups.

Frying pan with parasol joint. Enamelled iron plates in flat leather pouch. Tin canisters for pepper + salt. Meg Mervilles cooking pot. Crock. All blaze pan ie 2 copper bowls inverted the lower with a rim. copper bad

(Lord) tin mug + frying pan! 1 cup + saucer 3 plates (cheese soup + dinner) 2 drinking cups without handles. wash basin slop basin 2 good riveted knives 4 spoons. Candlestick to screw together like a tobacco box (the box to hold candles + the stick to slide out. Frying pan handle to detach. Few stout canisters to hold tea sugar + c + tea pot. all to pack in strong wicker baskets of equal size made like a fishing basket lengthened with a lock woven in + coo. inside + out with tarpauling. 3' long, 1'.6 wide. If possible take a wrought iron camp kettle to hold 2 gallons + a small iron oven 8 or 10 in dia. Take yeast powder (Preston + Merrill's best). Matersek in leather case.



Russian Samovar. a, b. doors; c, ash pit; d. stove; e. chimney (drawn too large) with telescopic joint; f. lid-burns wood or + Charcoal + can be suspended with a chain if necessary.

Russian Camp + spirit can.

Fire baskets to stick in the ground. or iron chauffer to fold up.

Wrought iron kettle with large lid which can be used as a frying pan. size of crown of ~~hat~~. Iron pot short legs. Lids all fastened with hasp + hinged in some way. Welsh rabbit Coffee pot. 1 pint tinned fitting in quart tinned for tea or coffee pot.

Chinese tea pot rattan case + tin tea pot to fit.

? ~~What~~ cooking apparatus ~~for~~ chopping Cook cuts.

2 or 3 saucepans; frying pan, tea kettle; curry stone + roller; knives; iron pot ○ with 2 ears on each side; earthenware chatties; ladels made of iron + cocoanut. to hang pots in

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Enamelled frying pans, plates cups & saucers
Sport kettles etc very strong & cheap at
J Michel 471 Oxford St, London.

Pack saddle swivel centre to as to fit any sized back - lashed with rope or pens on top - to keep steady.

See Levison sketch. v. BM. Ticket

Large roomy hunting saddle with number of Ds, 2 soft leather holsters + valise to rest behind the saddle flap at rear double rows of Ds - Basil leather next to the horse 2 saddle cloths + 2 quilted cotton do woven horsehair 2 or 3 pairs substantial hunting stirrups with wide straps or screwed in, large stirrup irons, bridle strong head bridle with iron ring + coil of rope reins + bit to unstrap (shifting head collar pattern) 2 plain strong snaffle + 2 segundras of medium power. No more buckles than absolutely necessary

Plenty of Ds, Ss etc + leather lurch pins + union links

Breast strap + traces (artillery pattern)

Antifriction pads 7" long 4½" wide 2½" thick.

Spare webbing for girths.

Strong wicker hampers with padlocks + lined + cord with waterproof for articles wanted on journey.

Packs Gregory's pear shaped bags

Dog collars with spikes. Horse hobbles.

Corn sack + nosebag.

Saddle bags - have outfit bags + boxes of size + form for horse or mule back.

vide tools.

F.116c v. Gallon, Wolseley Soldiers Pocket Book

Horses. Mules &c Harness etc. Curry comb, brush &c.

(115)

Pack saddles. Gregorys v. Gallon.

English saddle (riding) restuffed with plenty of D's excellent.

~~Australian pack saddle~~

Macay thinks highly of the Grimsby Pack saddle

" " " " Californian Riding saddle.

but Burton thinks not as too expensive. Lord thinks it lobe the best - for hunting dangerous animals he likes "Indian bads"

Cross tree pack saddle.

Sarcals. Russian hemp & hide

Packsaddles Lord says none should be used having a scrap of iron or wood as trees etc: he likes aparejo and looks upon it as nearer perfection than any other. He recommends a 'ridge' or gable end each cushion 3'6" long 2'6" wide the ends joined with a sharp edge so as to clear animals back & stuffed with dry grass & sticks. Wt 30 lbs [Rows of D's or 2 bolts with D's riveted on & stuffing along ~~D's~~ strongly fastened to top & bottom of flap the flaps could have a large bag* sewn to it & the ~~leather~~ ~~saddle~~ saddles could be taken out ready made but not stuffed. The "housing" are blankets, sweat cloth & cozona. Strong halter with moveable mouth piece & rope & lariat round throat (leaving head or fastened to) Blind logs over eyes. Lariat to trail on ground with clip knob round the throat or ~~end~~

* Canvas would do so that only 2 pieces of skin leather will be required

Never pack all of any essential store on one animal lest if the animal be lost all store be thus lost

Old Shekarry says waterproof silk is the very best to put next the horses back

Earl of Mayo (Bourke, Rev. Lord 1876
Eve. 7907 bbb) Sport in
Abyssinia. says:

Packing boxes after pattern of Infantry carpenter's tool box.
2 Tents. 1 three poled by Egerton known as Punjab Hill Tent found best for rough work. Union Jack + iron tent pegs
Iron camp bed, blanket of large size lined with silk
Rest of provisions for 3 Europeans for 4 months. Purchased at Army + Navy Co: Stores Victoria St. + found excellent.
1½ doz tins of cabin biscuits (Peek + Frean's.
1½ " " German rusks (excellent)
2 lb " small tins Cocoa + Milk (Epps's found Excellent)
½ doz small bottles currie powder
1½ doz pots marmalade
½ " tins of plum pudding
One middle piece of bacon cut up + hermetically sealed in tins.
1 doz tins ox tail soup
½ " " Pâte de foie gras
3 " " Cambridge sausages
1½ " " sardines (never be without them)
2 tin opening knives
14 lbs yellow ("primrose") soap
8½ pints bottles Worcester sauce
6½ " Harvey's
28 lbs preserved potatoes
3 bottles best French vinegar
14 lbs tea in pound canisters
1 doz bottles mixed pickles
18. 2 doz pots Liebig's Extract meat.

Purchased on the spot plenty of onions rice potatoes, salt, pepper, mustard, coffee sugar
For all necessary cooking, a common frying pan [illegible] size a gridiron 3 sizes of saucepans of strong tin in shape of milk pails good tin kettle, soup ladle, 2 butcher's knives with these can go anywhere. Knives & forks purchased at Thornhills. The forks (2) tied on a stick answered as a fish spear. Knives cleaned with wood ashes

English hunting saddles ord well for mules & snaffle bridles were much better than those of the country.

He recommends silver cups or bowls to drink tea, soup &c out of. also for water as one can judge of its clearness.

16 bore Purdey rifle found to be excellent. Never be without wire cartridges.

Skin or canvas bags much better for carrying than boxes which hurt the backs of mules & beasts.

Plenty of good sole leather. 2 spare heads. Eat plenty of fresh vegetables as preserved provisions become nauseating. Learn a little butchering. Always wear a thick sash or flannel belt. [Helmets of stitched felted cloth like Fisher had]

Nothing like an Express bullet for deadliness

Sickles for cutting grass for animals beds etc.

copper dangerous galvanized iron or block tin

Water-carrying

For animal carriage barrels are useless. Copper vessels 20 in long 12" broad & 8" thick are best having strong loops to pass straps through & means of fastening vent with fitted pipe can be used for distilling. Tinned inside. Waterbags for ship etc No 1 Canvas 2 ft long 18" wide. Double canvas the outside one being well soaked in boiled linseed oil.

Pocket filter. (silicated) or others.

American well borer? (Nortons. Small pumps & canvas hose

Canvas or firemans bucket (leather) leather bucket to hold quart with long line coiled up in it for deep wells etc

Gallon recommend square macintosh bags 18" deep 10" sq fitted into basket compartments. Each hold 8 lbs water

[good block tin or galvanized iron fitted in panniers & locked

There are small buckets made of galvanized iron (for children at sea-side?) which would do well with strong cod-line rolled up on a stick or a very strong tinned one (double block).

* Small milk cans very strong & good Can be used for packing when not in use

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MR. H. M. STANLEY'S BOAT.

Boats. v. Gallon. Collapsible boat &c or otherwise. one folding up like an umbrella canvas or macuboch sides for ferrying articles across. (Ide looks.)

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PATENT FOLDING BOATS.

OFFICE—55 GRACECHURCH STREET, LONDON, E.C.

Boats on View at Crystal Palace, North Terrace.

Models of Life-Saving Apparatus at Sea received for Exhibition.

These Boats are built (in sections) of wood or other suitable materials, joined together by flexible hinges of leather, or other substances, according to requirements.

They are most suitable for Exploration Parties, Ships, Yachts, Pleasure Boats, Fishing and Shooting Punts. One has been supplied to Keith Johnston, Esq., for his new African Exploration, weighing only 95 lbs., 13 feet long, 3 feet 6 inches wide; will carry ten men; shuts up into 6 inches in thickness.

A 10-foot Skiff will carry three persons; weight 50 lbs.; shuts up into 5 inches in thickness. Price £10.

N.B.—Inside measurement given in all cases; can be fitted up as required. BOATS of ALL SIZES can be obtained, and of any strength. Persons desirous of obtaining one or more of these Boats are requested to give their orders immediately, to ensure having them for the approaching season. In all cases they can be fitted with cork, to render them unsinkable.

BERTHON BOAT COMPANY (LIMITED).

Not only can the smallest yacht or steam launch carry, without inconvenience, its own dinghy; but the dinghy itself is far more safe, buoyant, and generally seaworthy than ordinary boats, while, at the same time, it can be stowed within a space of a few inches wide.

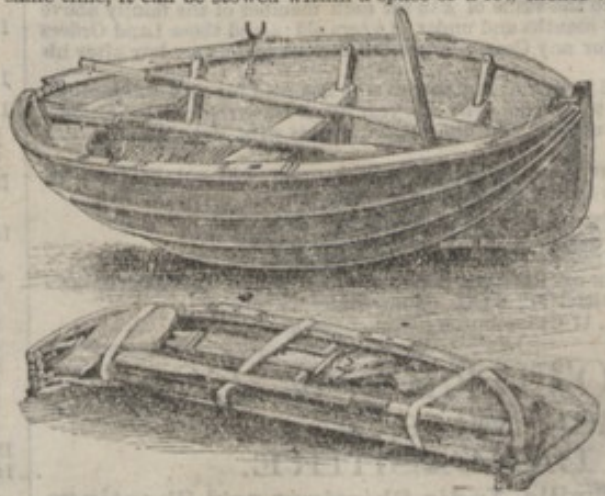

Illustration of the Berthon Boat ready for use and collapsed for carrying.

Boats of this kind are now made in great numbers for fishing and shooting on lakes and rivers. They can be carried with great ease to waters quite inaccessible to other boats, while their remarkable stability when afloat renders them admirably suited for the rod or gun.

For purposes of exploration the Berthon Boats are now extensively used. Large Berthon Boats have recently been supplied by the Company to the Royal Engineers for pontooning purposes and to all H.M. Troopships.

Testimonials received more than bear out the truth of the unusual advantages claimed for these Boats.

PRICES.—DINGHIES FOR SMALL YACHTS, &c.

	Length.	Breadth. Open.	Shut.	
No. 1 ..	8ft.....	3ft. 6in.....	5½in...	£10 10s.
No. 2 ..	9ft.....	3ft. 9in.	6 in. ..	£12 12s.

FISHING AND SHOOTING BOATS, WITH SCULLS, &c. COMPLETE.

No. 1 ..	7ft.....	3ft. 6in.	5in. ..	£8 0s.
No. 2 ..	9ft.....	4ft. 4in.	6in. ..	£12 0s.

Gigs and larger Boats to order.

Boats can be seen and purchased in London of MESSRS. EDMISTON & SON, 14 Cockspur Street; J. C. CORDING & Co., 19 Piccadilly; BOWNESS & BOWNESS, 230 Strand; in Plymouth, of W. HEARDER, 195 Union Street; and at the Company's Works, Romsey, Hants.

What Expedition?

The eighteen boats which have been built for the expedition by Mr. John White of Cowes have given much satisfaction. The builder has received an order to construct a number of similar little craft for the Emperor of Russia. Two small folding, or "collapsible" boats on the principle invented by the Revd. E. L. Berthon of Romsey, are to be taken for use, more es=-pecially, in crossing the ice cracks when travelling at a distance from the ship. We must give some par=-ticulars of these handy portable boats, one of which may easily be carried by a man holding it un=-der his arm, but which will safely bear the weight of four men in the water, being, in fact, a perfect life-boat. It consists of a framework of light timbers, all longitudinal covered with a double skin, which is made of the strongest woven hemp, per=-fectly waterproofed. The two sides of the boat are contrived to fold against each other almost flat upon the line of the keel, as upon a hinge, so that their joint thickness, when closed, is but a few inches, like that of an empty

collapsing

collapsing portmanteau if it may not even be compared to an empty portfolio. But when the boat is opened and expanded which takes place automatically in the manner of a parachute by releasing the sides from their catches or fastenings as it is lowerd from the davits over the ship's side, it at once assumes its proper boat-shape, with ample breadth of beam as well as depth of hold. This form is rigidly secured in another instant by putting in the floor of the boat, an open wooden framework, nearly oblong, which is extremely light but which supports the weight of as many stout men as can stand and staunch upon it. Two sort rods or stays, on each side of the boat, are next inserted rather aslant than perpendicularly, between this bottom framework and the gunwale. By this simple arrangement without any transverse benches, which may be used, if desirable, in boats of larger size, the entire hull becomes as stiff, practically, as though its sides were constructed of

of wood or iron. As the skin is double, with a space of three or four inches, when the boat is expanded, & between the inner and outer skin there is sufficient air in the hollow sides and bottom, admitted by an orifice from inside the boat, to render it as buoyant as any kind of life-boat yet devised. Indeed it cannot be sunk, and when purposely capsized will right itself immediately, nor would it sink with a hole in any one part, as the hollow space in the sides and bottom is divided into several water-tight compartments. The boat is easy to row or paddle and easy to sail. Its performance on the Thames, near the Temple Pier, Essex-Street, two or three weeks ago, was seen with admiration by hundreds of spectators and this was re-peated in the basin of the Crystal Palace Gardens on whit-Monday. Dr. Pullen, jun., son of the agent for the

~~proof~~ Halcyon

Palenlee (who is the Reverend Vicar of Romsey, Hampshire), managed his little craft on these occasions with remarkable ease and address. Four persons were safely carried in it, and there was scarcely room for more to sit comfortably, but its floating power could have supported a still greater burden. The dimensions of this boat were 8 ft. 6 in. long by 3 ft. 6 in. broad, weighing 48 lb with their bottom boards in, and folding into a thickness of 4 in., so that the boatman, when ashore, could tuck it up under his arm to walk home with it. The two boats supplied to the admiralty for the Arctic expedition are but 7 ft. in length, and weigh only 35 lbs, but will carry two or three men. They are to be conveyed on sledges, for the purpose of crossing the ice-creeks frequently met with: but if a larger number of such boats were provided for every ship at sea, they might be the saving

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of many lives. The inventor has ordered boats of different sizes to be constructed, up to one 32 ft. long and 12 ft. wide fitted with masts and sails, to carry a hundred and sixty men. With this vessel, it is said he intends to make a trip up the Channel, from Southampton water, and rounding the North Foreland, come up the Thames to London.

The Illustrated London News

May 25th 1878

The *Queenslander* reports a lecture by the Rev. C. R. Fairey, delivered in a Congregational church at Brisbane, giving an account of his voyaging alone in the canoe *Evangelist*, which he exhibited to the audience. The canoe was built in February 1877, in the yard of Messrs. Searle & Co., Lambeth, under the supervision of Mr. John Macgregor, the inventor of the famed *Rob Roy* canoe. She was designed as an "ocean canoe," and was exported by Mr. Fairey for special mission work on the coasts and rivers of Australia. She is 12 ft. long, 28 in. beam, and 12 in. in depth; is fitted with lockers for provisions and charts, and with india-rubber air-chambers, which make her a lifeboat. The canoe is built of English oak, mahogany, and cedar; is decked fore and aft, and carries a light mast and lugsail. The person sailing her sits on the flooring, and by means of an ingenious tiller arrangement steers with his foot. The little vessel sails, under favourable circumstances, at the rate of seven or eight knots an hour, and Mr. Fairey uses a single-bladed paddle to propel her, working it on one side only, and using the rudder to keep her on a straight course. A waterproof cabin, constructed to stretch on light posts when the boat is used as a sleeping-place, is part of her equipment, and also a *Rob Roy* cuisine, which boils water in the short space of 3½ minutes. The net weight of this wonderful little vessels, sails and fittings, is about 80 lbs. In February last she made her first voyage, which was round the iron-bound north and east coasts of Tasmania, a distance of 300 miles. On the voyage Mr. Fairey called at various places, holding services and distributing books, &c. He was the guest of an isolated family on Forester's Peninsula during three days while it was blowing too hard for his little craft, and finally he arrived at Hobart Town, after having experienced all kinds of weather during the voyage. Mr. Fairey intends, if circumstances permit, to make a missionary voyage in the *Evangelist* down the Murrumbidgee and Murray rivers.

MR. PARKER GILMORE, the well-known author of "The Great Thirst Land," writes to the *Daily News* to confirm all that has been said of the soldierlike instincts of the Zulus. He condemns serge, corduroy, and white helmets for the troops, recommending instead moleskin and tweed caps. For a country of thorn bush, we think, his advice reasonable. As to horses, he predicts that between the tsetse, snakes, horse-sickness, poison-root, and change of diet, there will not be ten per cent. alive of the embarked troopers two months after arrival.

AFRICAN ELEPHANTS AND THE ZULU WAR.

THE important question of the subjection of the African elephant to the service of man as a beast of burden, to which we have frequently drawn attention, has attracted the notice of many influential gentlemen, and, among others, of Mr. Frank Buckland, who makes the following observations in *Land and Water*:—"Among the many important questions of practical natural history which have been lately before the public, that which just now mostly engages general attention is the utilisation of the indigenous elephants of Africa for carrying out the operations, whether civil or military, of Europeans on that continent. The utilisation of these powerful brutes would be of the greatest importance in the construction of roads and telegraphs; while for the purpose of transport during the Zulu war, especially in places where horses cannot go, on account of the tsetse fly, their employment would be of advantage. It seems strange that we English have never thought of domesticating the African elephant. It is probable that in ancient times these animals were more or less domesticated. . . . The African elephant at present is valuable only for its ivory, and vast quantities of ivory are imported to London. . . . The idea is now seriously entertained of domesticating this animal, instead of, as hitherto, encouraging its extermination. I am informed by a gentleman lately returned from the Sudan that he has seen elephants quite tame at Kassala. They were not made to do any hard work, but the boys used to ride them about the streets. The Arabs catch calf elephants, not full-grown, but they have as yet no idea of taming them. Gordon Pacha is trying the experiment of taming African elephants with the help of some Indian mahouts. My friend thinks that it would be advisable to get from India experienced elephant-tamers to teach the Arabs how to make them docile. As regards local hunters who would carry out the training lessons taught them, my friend names Barhard Kohn, dealer in animals, Kassala, and Abou Do, an Aggahr sword hunter, who was with Sir Samuel Baker, to be found at Hannan village; also Idris Mohammed Agheab, a keen sportsman, to be found at Macbrab, on the Settik. I have consulted my friend, Mr. Bartlett, of the Zoological Gardens. He seems to think that, although the African elephant is good-tempered, intelligent—even more so than the Indian—and tractable, yet he is of a very restless and fidgety disposition. He considers that the natives of Africa have not been able to domesticate this animal on account of want of proper appliances, but that if the proper means can be found to subdue him he may be made as tractable and useful as the Indian species. Here, then, we have a problem before us which may be of the greatest advantage to the British troops and engineers in Africa. At the same time the employment of native elephants could not fail to give a great blow to the African slave trade, because the ivory trade is now a cloak for the slave trade, and because African elephants might eventually supersede slaves as beasts of burden. I am glad to find that influential and useful paper *The Colonies and India* has taken up the idea of utilising African elephants, and is calling the attention of those who know best about the subject to this novel and important advance in the attempt to promote civilisation in Africa, through the means of the largest and most powerful of mammalia which the Creator has placed in that country, and which we human beings have hitherto not attempted to utilise."

We understand that on Saturday last a consultation was held upon this subject at Mr. Buckland's house in Albany Street, between the Marquis of Bute (who has warmly taken up the idea), Mr. Bartlett, of the Zoological Gardens, and Mr. Gerald Waller. Two courses were decided upon as a preliminary step:—1st, to write to Mr. Sanderson, Inspector of Elephants to the Indian Government, to get his opinion as to the advisability of sending trained elephant-catchers and elephants already tamed to Zanzibar; 2nd, to consult, through Mr. Bartlett, with Mr. Haarkenbeck, the well-known dealer in animals, of Hamburg, as to the possibility of sending his Nubian hunters to catch young African elephants and take them on to Zanzibar to be tamed. These Nubians must know how to catch African elephants, as they brought over several of them, although small, last summer to the Alexandra Palace, where two of them still remain. Information is much wanted as to the possibility of training African elephants, and our correspondents in Africa would be rendering a great service to humanity in furnishing us with practical hints on the subject.

ZULULAND—A FEW WORDS OF ADVICE.

To the Editor of "The Colonies and India."

Avoid chills of an evening after a hot march by keeping in motion till a fire is lighted, and you can either change your clothes, or allow yourself gradually to cool before the fire. The autumn, with its heavy evening dews, is specially dangerous. Retire to your tent and keep within it after sundown, and till the dew is off in the morning, if possible.

Stimulants taken in moderation are generally beneficial, but I should specially recommend a small liqueur glass of brandy with quinine every morning on rising, and every evening while cooling or waiting for dinner.

Six bottles of brandy lasted myself and four others for many weeks, taken systematically in this way.

Never move out of a morning without taking a meal, whatever it may be.

The bed should always, when practicable, be removed from immediate contact with the ground, even if only by means of a thick layer of grass, which is always attainable. The tent should also be well closed, and if without a tent, the head covered with a sheet at night.

Part of the Zulu country, that bordering on the coast, is somewhat unhealthy, and these precautions will be the more necessary if the campaign is extended to the neighbourhood of Delagoa Bay.

I have, as before stated, travelled through the country at all seasons, and it is my belief that, as has been proved in the case of myself and my companions, there is but little danger when anything like ordinary care is used.

With regard to horses, I should recommend that light blankets and tarpaulins or waterproof sheets should be provided to protect the loins during the heavy rains at night. In warm weather, the blankets need not be used.

Horses should not be allowed to graze at night, or in the morning, or evening, and should at those times be kept with their nose-bag on, whether there is corn in them or not.

The Boers have a belief in the efficacy of garlic as a preventive to disease, and they strew it on the manger, as well as tie a bit to the centre of the curb when travelling. A medical man who lived in a most unhealthy part informed me that during five years he had allowed his horses to run at all seasons, and adopted no other precaution than giving each horse on alternate days a minute dose of arsenic. This he found sufficient to counteract the effect of malarious poison.

I do not consider that English horses, if in sound health on landing, will run greater risks than those bred in the Colony, if they are only protected from the effects of sudden changes of weather.

Trusting that these few remarks may serve some good purpose, and apologising for the haste with which I have from circumstances been forced to write,

I am, &c.,

1 Suffolk Place, Pall Mall. GEO. P. MOODIE.

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Sport in East Africa.—The following particulars, received from a competent authority at Zanzibar, under date of May 31 last, may be of use to enquirers on this subject:—"It is quite impossible to combine either exploring or trade with shooting in this part of Africa; the difficulties and dangers are too great. But if any one wants shooting only, by all means let him come; but he should not delay a day if he wishes to have any sport this year. He should bring nothing but his guns, and perhaps a spare double-barrelled for a present to a chief. No trading will be possible, and horses will not stand the fly, though I believe further north they would get into a better country in this respect. I have brought out an English thoroughbred as an experiment, and it stands the climate well; but Somali ponies from Aden would be more suitable for shooting. Waggons have not succeeded in East Africa. Any one coming here must engage his servants and buy his stores at Zanzibar. Our consul-general, Dr. Kirk, is always ready to assist and advise English gentlemen coming out."—*Field.*

a part of this (the Gospels) to be cut out
better copy on the notes.

A CHAT ABOUT THE CAPE AND THE TRANSVAAL,

WITH USEFUL HINTS TO EMIGRANTS' WIVES, INVALIDS,

AND OTHER TRAVELLERS.

By Mrs. Carey-Hobson.

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II.

In these days, when schools of cookery are so well attended, it is scarcely necessary to say that every lady should know how things ought to be done, even although she may not have to do much in the way of cooking herself.

The bread generally eaten at the Cape is made from wheat meal produced in the country, passed through a sieve which allows the finest portion of the bran to go with the flour. The bread is particularly good and sweet. You make your yeast by boiling hops and adding sugar, flour, salt, and a portion of the yeast of a former making. I forget the proportions; but you will have no difficulty in learning them there, though I think the dried German yeast used now in the South Kensington schools would save much trouble, at all events, in the early part of your Colonial life.

If you have a coloured woman who can make bread—and most of those who understand cooking can do so—she will probably use leaven; but this is apt to make the bread sour, which the yeast does not.

There is another method of making bread by means of what is known as "salt-rising," much prized by some as being very sweet and wholesome.

Salt Rising for Bread.—1 table-spoonful of salt, 3 table-spoonfuls of flour, with sufficient water to make it the consistence of cream; this must be mixed over-night, and the cream-like mixture covered with flour, and allowed to stand in a warm (though not hot) place. In the morning make it up with about 4 lbs. of meal or flour. It may be baked soon after it is made.

I have had coloured cooks who could make very excellent cakes, and indeed almost anything that I once took the trouble to teach them; but only one, and she was a *rara avis*, who could make pastry. That always fell to my lot.

Most amusing mistakes will at times occur between mistress and maid if you are not particular in showing, as well as explaining, everything to your Hottentot.

One woman that I had was at first rather apt to fancy she understood everything, and would answer "Ya, Missus! ya, Missus!" when she really knew nothing at all of the matter.

The first Christmas after she came to me, we had a large party of visitors in the house, and I determined that the pudding should be a good one. So, with the assistance of a Kafir boy, whom I had had several years, I prepared and mixed all the ingredients the day before, with the exception of the cream and new milk. I explained this to her, as I thought, fully; and, as I was never an early riser myself, I told her to put it on early in the morning, that it might boil all day.

When I came out to breakfast on Christmas morning, I paid a hurried visit to the kitchen. The large copper was steaming away in fine style.

"Well, Katchy, I see your pudding is boiling already!"

"Oh! ya, Missus! ever since the sun was up it boils so. I put it on in the jar because I think it will look pretty."

"The jar, Katchy?" I looked, and found that my large gallon jar of mince-meat, that Katélo and I had made as good store for the year, was in the place where the pudding ought to be!

Katchy was as sorry as I, and perhaps more so, for the mistake was soon rectified, the pudding none the worse, and a merry laugh we had over it at the breakfast-table.

The coloured servants seldom sleep at the house, with the exception, perhaps, of a nursemaid, and that not always. They go to their own huts in the evening, and return between six and seven in the morning. On this account I was never without an "Ena," although I had, as I have said before, a Kafir lad always at hand; but it was an exceptional case, and you would find it very awkward if you required a little hot water for an emergency, and could not make a fire. I think a small stove would often be found of great use; but you must on no account trust it to the Hottentots, except to clean and put quite away after it has been used, or you would probably find that one woman had "only just carried a little tea up to the hut in the kettle," and another "didn't think missus would want the pan, and had put that bit of pudding in it for her child"; while even the lamp might have been used if they happened to be short of candle. Naturally improvident, "the morrow" never troubles them.

As to special preparations for the voyage there is little to be said. The time is but short; from twenty-two to twenty-five days between Plymouth or Dartmouth and Cape Town soon passes away, after which two more bring you to Port Elizabeth and so on, if you are going on to Natal. Nevertheless, the month may as well be passed in comfort as not. I was very glad of a small feather bed and pillow that I had to fit my berth, as those provided, though good, are very hard. Keep out a few pillow-cases also.

I was told to be sure to take insect-powder for use on board, but I never needed it, for the vessels are kept beautifully clean.

And, while on this subject, I may as well say that, in a warm climate like that of the Cape, it might be expected that insect vermin should be troublesome, unless care be taken; and I have known many remedies resorted to without the effect of keeping the bedsteads quite free. But I had paraffin used, applying it with a feather freely; and always by way of a preventive, not waiting for bugs to breed first! With this treatment constantly repeated, I never experienced any trouble.

Deck-chairs are useful, but you will do well to buy those at Madeira, if you know the vessel will have to stop there; if not, take them with you.

One thing indispensable to comfort is a good cabin-bag. This, if made of strong "navy canvas," will serve for any subsequent bullock-waggon journey, where also it would be an immense comfort. Strong cord loops at the top are sufficient for use in the cabin, where you can have brass-headed screws or hooks; but strings will be necessary for tying it up to the cross-bars in the waggon-tent.

A canvas bag for boots and shoes will be found useful; high heels should be discarded on board ship.

Two canvas bags for soiled linen, one about four feet long, and the width of the canvas. At the top may be made a row of long holes corresponding with each other; a leather strap is attached to one end and a loop to the other; the strap is threaded through the holes two at a time, thus fastening the sides together and then padlocked to the loop.

This is to remain in the passengers' hold, and your *smaller* bag of dirty clothes emptied into it every week. There is always a regular day when the passengers may have access to a box, or put anything away.

As to dress, the old plan of having a large stock is, of course, no longer necessary or expedient.

An old black silk for general use, and one of grenadine for use when it is very warm, will be found invaluable for board-ship wear. In the Colony you will find light prints and muslins the most pleasant and useful for morning and every-day use. Otherwise, ladies dress there much as they do at home; so if you leave all your pretty things behind you, you will repent having done so.

If you are anything of an artist, a never-ending source of pleasure to you in travelling will be your sketching materials. Besides a block, be sure and have a

rough book in which you can make pencil sketches rapidly and roughly, merely putting notes as to colour. I always found it the most useful kind of thing in waggon travelling.

The best work of reference for a botanist to have is Harvey's *Flora Capensis*, to which great additions have been made by Professor MacOwan, of the Gill College, Somerset East, in the Colony. Dr. J. C. Brown has also published works of great interest in that way. For general information concerning the country no books are equal to the Handbooks upon South Africa published by S. W. Silver & Co., Cornhill.

A pocket-filter will be appreciated when you come to a "vley" of "good fresh rain-water," "Lekker (nice) water," your Hottentot will call it; but to your untutored eye it will have much the appearance of tea with a good deal of milk in it. As to the old adage, "A man must eat a peck of dirt before he dies," I fear that some of our great African travellers must have had more than double that quantity of sand and mud to digest in the course of their explorations. However, the water in these holes is really very sweet and good when filtered. A small quantity of powdered alum will clear a cask of water; but I had a curious recipe given to me by a woman who kept a road-side "hotel." I found the water as clear as crystal, though I knew that her supply was from these muddy rain-water "vleys." Of course I asked her how she managed it.

She showed me a bag of peach stones that had been collected under the trees where the women dry the fruit. And when her large butt was filled with water she said she *slightly cracked* about half-a-dozen and threw them into the water.

This in South Africa, where peach stones can be picked up in any fruit garden, is simple and worth remembering.

An old Scotch plaid should never be despised, be it ever so threadbare; excellent curtains may be made from it if you want to divide one part of the waggon from another at night, pinned up to the waggon tent with what are called blanket pins, a store of which you should always carry in your waggon-bag, as well as a ball of twine and a packing-needle.

The "kombaarss" is a great institution in South African travel. A half-worn middle-sized blanket is covered on both sides with a good dark crétonne; this forms a covering or quilt for the bedding that is always spread upon a kind of framed network called a "kartel," which is swung in the bullock waggon, forming a couch or seat in the daytime, and a bed at night. A white quilt would look dirty the second or third day of your journey, while the dark "kombaarss" has at least the advantage, while looking more day-furniture-like, of not showing the dirt. Your pillows must also be covered with crétonne, having white cases to slip on at night; and remember that, although the days are very hot, the nights are often exceedingly cold; you must not, therefore, travel without rugs or blankets.

India-rubber baths are generally recommended to travellers. I prefer one made of tin, with a lid if you like, but a good sized foot-bath is the best form for waggon use. If by any means the tin is injured, a little solder and the soldering iron, which some one may have among his tools, will put it to rights; but an india-rubber one is unmendable in that country; added to which, the heat of the climate often produces a disagreeable smell in india-rubber goods. Do not on any account travel without a "portable commode," or convenience of some kind.

Besides the barrel of water for drinking purposes, which is always carried with the waggon, have a common quart bottle full in one of the compartments of your bag, together with a small bason either of common crockery or enamelled metal to drink out of. For bullock-waggon travelling never leave out any of the pieces of your breakfast or tea sets; the very best for such use are the common little basins used by the coloured people, and called by them "Kommetjis;" having no handles, they pack in beautifully, a fold of cloth and a bason alternately; the same with plates. Two or three kitchen table-cloths will be found handy; one to be kept for spreading on the grass, and another for packing up the crockery; for dishes have three enamelled iron pie-dishes. As for the cooking utensils, there will be the "stew-pot," or camp kettle; two kettles, one of which you must insist upon being kept for boiling the water for your tea only, and the other to be used for coffee. A tea-pot, but no further coffee-pot is needed. These can all be bought in any Colonial town. The method of making coffee on the road is as follows:—When the water boils, the quantity of dry coffee is put into the kettle on the top of the water; the mixing and fining process is then performed by pouring out a cupful and putting it back into the kettle; this is repeated three or four times; the kettle is then placed on some hot ashes near the fire and the coffee allowed to settle. A gridiron, frying-pan, corkscrew, and a tin-opener are also indispensable, as well as a couple of bags made of loose cheese cloth, one for raw the other for cooked meat. When you require supplies it is customary in passing a Dutch farmhouse to send in two or three shillings, and ask as a *favour* if they can spare you fresh meat, milk, eggs, butter, or whatever provisions you may require; for the butter it is well to have a covered earthenware jar, and for the milk a tin can with a lid, or bottles. You will soon appreciate the reason for the recommendation of lids to everything, for the flies are extremely troublesome, and so thirsty that nothing in the way of liquid escapes them. I have had two or three flies at a time quarrelling over the ink in my pen as I wrote or endeavoured to do so. Milk-jugs require lids, and small wine-glass covers like those made of fine basket-work in India are useful. Meat covers of fine wire netting and a perforated zinc safe are requisites in a house, though not in travelling.

I should strongly advise the intending traveller to take a stove from either Rippingille's in Holborn (near the Viaduct), or Porter's, at 11 Oxford Street (near Tottenham Court Road); both have been tried with great success, and have been found of especial service in such districts as the Diamond-fields, and those parts where wood, being very scarce, is one of the most expensive articles in house-keeping. In travelling—sometimes not even obtainable—people using dry cow-dung as a substitute. But among the fittings, I should have—besides the lamp belonging to the stove, which in both cases burns mineral oil only, such as paraffin or kerosene—one in which olive oil could be burnt, as well as one for methylated spirit, which can be distilled from grapes, peaches, common figs, or even prickly pears; or, failing either, I think if three short wicks were fastened triangularly to a framework of wire and placed in a saucer of common tallow, it would serve the purpose of a lamp.

(*To be continued.*)

A Phenomenon.—The Soleure *Tagblatt* announces that "in the Zooplastic Museum, which is located in the Bishop's Palace, in Soleure, there is now to be seen a singular rarity. This is a white chamois, with red eyes, white horns and hoofs, and a snow-white fleece. It seemed to be about two years old, and was shot in the Savienthal, in the Grisons. It is the second specimen of the same kind which has been forthcoming in our Alpine world within the last thirty years." Tschudi refers to the first specimen in his *Sketches of Nature in the Alps* thus:—"About the end of the year 1853 a chamois was shot which was milk-white, even to its feet, with red eyes. It was about a year and a half old. In proportion to the size of the animal, the fleece was very thick and warm, especially about its beautiful, muscular neck. Its little horns were as smooth as if made by a turner, very little bent, and little more than an inch long."

A CHAT ABOUT THE CAPE AND THE TRANSVAAL,

WITH USEFUL HINTS TO EMIGRANTS' WIVES, INVALIDS,

AND OTHER TRAVELLERS.

By Mrs. Carey-Hobson.

I.

As an old colonist, I have several times been applied to by ladies going out with their husbands to the South African Colonies for information as to the nature of the country and its people, as well as to what things it would be advisable that they should take with them, what they would require to know and to do as colonists, as travellers, or it may be as ladies about to engage in the work of tuition.

I have therefore thought that it would not be amiss to make public a little of my own experience in these matters, for the benefit of these ladies who may not number "an old colonist" among their friends; premising that, although written primarily with reference to the South African Colonies, most of the general information will apply equally to other Colonies possessing a similar climate.

Many valuable Handbooks have been published for the use of intending colonists, but ladies hunt through them in vain for hints of such minor matters as have been deemed of too little importance for insertion in such books. But to a woman to whose mind there is a charm in being able to make even a bullock-waggon on the Karroo desert or an unpretending Colonial residence as home-like as possible to all those belonging to her, these are the "trifles" that "make the sum of human things," and, as such, are more than "trifles" to her.

It is at such a time that she naturally says: "If I could but meet with some woman who had been through all this herself, how much weariness of thought as to what ought to be taken and what left behind, besides a hundred other little matters, I should be spared!"

I shall be glad if I am able to personate in a slight degree this wished-for individual, and thus be of some use to ladies about to visit a country that I have learnt to consider as much my own as dear Old England.

Under the head of preparations much, of course, will depend upon the ultimate destination of the enquirer.

For instance, if you are about to take up an assured position at once in Cape Town, Port Elizabeth, Graham's Town, or any town of like nature, you will find that you can obtain everything you require quite as well, and in many cases better, than you can in country towns in England. You will live there much as you would do at home, and my "preparations" are scarcely applicable or necessary in such a case.

But, if you are about to travel in the country—following that up perhaps by settling down as a regular "colonist"—you will find the mode of life very different from that to which you have been accustomed in the old country, and soon be able to realise the feelings with which an old lady friend once said to me, "Well! my dear, this is certainly the other side of the world. The Antipodes to England, practically, though not quite actually."

One very necessary thing in going to a new country, especially where there are peoples of different nationalities, is to divest yourself of acquired prejudices. One of the greatest follies of which a new comer can be guilty is to "give herself airs" of fancied superiority towards those with whom she is brought in contact, or to find fault with everything about her, comparing it invidiously with what she has left behind; if you cannot do this, it will be wiser to stay at home, for you would in such case find so many annoyances as to make life unendurable.

I remember once, when travelling in a bullock-waggon hired from a native, that we were overtaken in the middle of a bare plain by a regular South African thunderstorm; the lightning was so constant and terrific that the frightened oxen absolutely refused to proceed, and they were removed from the yoke; the rain came down as if just fresh from the tropics in torrents, and continued to pour without intermission the whole of the night. This to an African traveller, although he is more often troubled by a lack of water than by too much, would have signified but little. With his lamp and his books, and plenty of good bedding, he is accustomed to make his waggon his home for the time being; but unfortunately we had trusted to the Hottentot owner, and he, thinking it was fine summer weather, had neglected to put the waterproof sail-covering under the other one, which we found, when too late, allowed the rain to run through as though it were a sieve.

There was not a dry spot anywhere. All we could do was to make the best of it. So there we two ladies sat or leaned among the pillows, with a large umbrella open over us to screen our shoulders, until the dawn of day, when the rain ceased. One of the men brought us some hot coffee; the oxen were put to ("inspanned," as it is called); and in about a couple of hours' time we found ourselves at the farmhouse of a Dutch Boer.

Good old Mynheer Bosch and his kind-hearted, pretty-looking wife and daughter, how thoughtful and good they all were! We were soon in dry clothes, with a good breakfast before us, Mr. Bosch saying as he left us, "My dear children, do not trouble yourselves about your things. I have seen to it all, and have told your driver that I have a great mind to send him to prison! The black creature! how could he dare to forget the under-sail when he had 'Christemenschen' in the waggon!" And, when we looked out, we found a couple of women were occupied in spreading out beds, bedding, and clothing in the hot sun, and the farmer and his son as busy as they could be, making the waggon perfectly watertight by the addition of a good tent-sail of their own, which the man was to return on his way home. I instance this merely as one of dozens of kind, hospitable acts that I have experienced at the hands of Dutch Boers. It is true that they are not all alike, and that things are somewhat altered since the Diamond discovery; but, if people will show themselves friendly, they will be sure to make friends wherever they go in the Colony, and will find ready helpers in every difficulty.

I had one other experience of travelling in a bullock-waggon without a gentleman as escort, and then we unexpectedly needed assistance and found it. We were a party of four ladies, and had been visiting at some distance from home, travelling in a small horse-waggon drawn by only six oxen. As we neared the Great Fish River on our return, we found several waggons outspanned, and were greeted with the intelligence that the river was impassable on account of the floods from up country. There is a good bridge there now, but there was none then.

A fine tall old Dutchman who was taking some heavy loads of timber into market, came to the waggon and said, "Ladies, you must outspan and make yourselves comfortable here, for the river will not be passable for two or three days, and with your nutshell of a waggonette, not for a week." All this time one of my friends just fresh from England was pulling away at my sleeve, and saying, "Oh, my dear, don't talk to him! How dreadful to have to pass the night here; let us go into the bush and be quite alone." Of course I knew that would not do, so, nodding to her as if she had said something very good, I replied to him in Dutch, "Thank you, Mynheer; will you be so good as to let our people 'outspan' somewhere near your own waggon?"

"You are right, my child," said the old Boer; "many of these people are very rough and get drunk at night; but I will take care of you."

And, indeed, he did so—seeing in every way to our comfort, supplying us when

we ran short with home-made bread and sausages from his own store, saying that his old vrouw always made him enough to carry half of it home again.

There is in man's nature a certain chivalry always ready to be called forth when required by unprotected woman. The third morning we heard that the river was passable for large waggons with long teams of oxen; we went down to watch the exciting scene of one of them crossing in this way. Now, I thought, we shall lose our friend; but presently he came up and said, "My children, I cannot leave you here alone. So I have arranged with your servant that everything out of your waggonette shall be put on my heavy timber waggon. I have plenty of oxen, and we shall all get through safely, towing the little waggon behind us."

This was done, and with thirty-six oxen in the yoke, the two leaders being out on the other side before the waggon was in the river, we went through. It was an anxious time, the water still rolling down like a sea, red and thick with mud, the greater part of the long span of oxen swimming with natives on either side urging them forward with shrieks and yells, the drivers standing on every jutting point of the banks wielding their long whips.

I ventured one moment to look behind at the empty waggonette; it was floating, now and then toppling over first on one side and then on the other. I looked again; the water was rushing through it up to the cartel or framework upon which we should have been sitting! Did I not feel grateful to our Boer friend for having so kindly taken possession of us? And when we all thanked him most heartily he said—

"Ah! you are not of the proud or upstart sort; it has been a pleasure to me to do what I could."

But now to our preparations for a Colonial life. I have said, entertain no prejudices.

Do not allow yourself to look down upon others because they live in a different manner or do things in a different way from that which you have been accustomed to consider the right one.

Look upon every one as a friend until he has proved himself an enemy.

You will meet with many annoyances, and there will be many home comforts and Old World sources of pleasure that your heart will long for in vain. Realise all these things before you start; but once having "put your hand to the plough" let there be no "turning back," and above all, no discontented expressions. Make the best of everything.

You will find all useful knowledge of great service to you. Most young men in going to a Colony take a good box of tools; but many of them do not know a chisel from a screw-driver! and have never troubled themselves to take a lesson in carpentering.

So also with many ladies: they know that they may probably have to live fifty, or may be a hundred, miles from a dressmaker for themselves, or a tailor for their growing boys. So they provide themselves with a sewing-machine, but never even think of taking a few lessons in dressmaking, cutting-out, &c., &c., nor of getting together a number of good, well-fitting patterns, which are best cut in white lining, as the dressmakers have them in England. It is well also to have a *good* pattern of your husband's or boys' trousers. You might possibly some day have to make a pair with your machine as I have been obliged to do, and had to rip up the seams of a London made pair to cut them out by.

If it be possible to obtain a little practical medical knowledge, do so. You can, at all events, institute a prescription-book and insert all those that have proved useful to yourself, husband, or children; of course making notes against each, as to the particular illness, age, sex, &c., of the patient; the name of the medical man in full, as they usually sign only initials. All this will recall the time of prescription to your mind, and enable you to judge of the advisability of using the same again; not that I suppose any lady reading this, would do as a woman did that I once asked what she had been giving to her child who had a very bad cough, and "seemed to get worse" though she had given it "nearly a whole bottle of physic." "It were some stuff, ma'am, as a doctor give my husband when he had the *diarree*, so bad!" And remember that it would be of little use having the prescriptions if you cannot read them, or, when read, have not the drugs to make them up.

Before you leave home your medical man will doubtless write your prescriptions out in good plain English, and give you a list of the medicines necessary for you to take, which be sure to include with the usual scales, weights, measures, &c., &c., in your medicine-box.

There are in the Colony men of talent among the medical practitioners; men able and attentive, and upon whom I would rely in almost any emergency, but they may be at a great distance. It is therefore to be understood that these hints are for those who are quite out of the way of medical advice, or until such can be obtained.

For instance, suppose a child attacked by croup, you send a man off immediately thirty or forty miles for the doctor; the horse must be fed, the doctor "must just tell two or three patients where he is going;" it is some time the next day before he can arrive, by that time the disease has taken such hold that there is but slight hope of recovery, if any. Whereas taken at once, croup powders given, hot fomentations applied to the throat and chest, and due care taken, the patient would be far on the road to recover by that time.

Then, again, your Hottentots will often come to "Missis" with "so a bad headache" or "so sore-eyes," rheumatism, and all other ills that flesh is heir to. You will soon know what to give them in any ordinary case and save yourself and them much trouble; you will of course have some book of domestic medicine to refer to; but I subjoin two or three simple remedies which I have found useful in treating the coloured people as well as members of my own family. Ophthalmia is unfortunately very prevalent especially among the coloured people. So my first recipe shall be:—

For Sore Eyes.—Dissolve 30 grains of sulphate of zinc in half a pint of water, add 6 drops of laudanum. With this bathe the eyes frequently, dropping a little into the eye two or three times a day, insisting that both rag and used lotion shall be thrown away after, at the most, two or three applications.

I always found that the best preventive against sore eyes both in adults and in children was a cold sponge bath every morning upon rising. With infants this is impracticable. Their bath must be tepid; but great care must taken to keep the child away from contagion, and especially from allowing flies to settle in the corner of the eye, for they undoubtedly convey the disease.

It has generally been found that those farmers who have their sheep kraals, stables, &c., at a distance from the house escape the plague of ophthalmia.

It is worthy of remembrance that flies flock into the house about a quarter of an hour before the sun goes down; it is disagreeable to have to shut windows, doors, &c., at the most pleasant part of the day, but I always found it efficacious in keeping the house free; a quarter of an hour after sundown the flies will have settled, and you will then be able to enjoy the cool of the evening. The most simple and effectual thing we use for the destruction of flies is a little black pepper boiled in milk, and placed in plates in those parts of the house where the flies are troublesome. If poison be used, the chickens suffer in consequence, as they are apt to pick up the dead flies that are swept out by the servants.

Never travel without a bottle of arnica, and have it very handy, so that you can get to it without loss of time; in the case of a fall or sprain it is invaluable both for man and horse. Put a teaspoonful of arnica into nearly a tumblerful of water,

Date.	BIRDS.				f. 134	INSECTS.		TREES AND PLANTS.		Mean Temperature.	Fall of Rain in inches.	f. 135 r
	Migrants arrive.	Sing.	Build.	Migrants depart.	Species captured.	Mode of capture.	Situation.	Foliation of	Blossom.			Wind.

No. of Specimen.	Name of Species.	Locality and Date.

Natural History & other note books

Form of keeping notes so that no necessary Enquiry may be lost sight of.

or may be a series of numbered questions.
at beginning of book

UNIVERSITY COLLEGE LONDON
GALTON
PAPERS

Anthropology

&

Anthrometry.

Smithsonian Miscell: Colls.
160

Instructions relative to the
Ethnology & Philology of
America by Geo. Gibbs.
Washington 1862.

Crania of natural or
artificially formed &c
Specimens of art. &c
Shell beds - forests
around coast ruins of
trees. measure
superincumbent mass
Stratification, collect
shells: height of water
mark &c. objects of
human art deposits with
found &c
Caverns Examine floor
recent remains remove
earth & Examine at
measured depths - sieves

level ne

Ethnological Inquiry.

present condition & past history to be sought

Names of tribes own name or given by others — meaning

Geogl position — of tribe

Numbers of individuals men women & children increased or decreased

Physical constitution size proportion facial angle features, color skin hair beard, eyes strength, sup organs particularly developed — corporeal faculties developed, climate to duration of life

[draw out in tabular form]

Writing picture or other + materials
colors + implements used.
old writing, monuments
etc - meaning given by
natives etc.

Dress materials, colors,
fashion, painting, tattooing
etc.

Food kinds how prepared
agriculture
hunting etc. drinks

Dwellings permanent or
movable, materials, form
by whom made migration
any common buildings
set apart + for what
purposes.

Arts Pottery, basketry, material
how manufactured, ornamentation, stone,
iron &c. weapons
special men for special
manuf: or the several
method of manufactures.
spinning, weaving &c
dyeing, leatherwork, fur arts
netting animals, drawings
paintings, carving, music
& m. instruments Sharing
fork &c

Trade - how carried on
Customs, materials
Statistics -

Religion belief, objects of
worship, &c. Supreme
& Inferior beings. Good
& bad, future state, priests
&c

Government - heads of - law, councils, judges &c representation, how supported. crimes etc

Social life Slavery, marriage division of labor, ceremonies, birth, death, marriage

War Customs, weapons mode of warfare

Medicine when attends to it - method of treatment in medical & surgical cases - medicines & instruments used - diseases etc

Literature songs.
tales, fables, historical
legends &c Codices &
how preserved.
Calendar & Astronomy & Hieroglyphics
History of tribes etc.
Antiquities Earthworks, use.
Structure & contents size
form, structure, contents

Philology

native or primitive & introduced
vocabularies in each dialect.
grammatical construction,
[good grammar.
man, woman &c relationship
parts of body, natural
objects, colors, time, numerals
pronouns, verbs &c

Orthography

V

2.0

A. as long in father & short in German hat (nearly as in Engl. what)
E. as long in they ("long a" in face) short in met
I. " " marine short in pin
O " " go, short in home, whole (as generally pronounced in the N'ern States)
U. as long in rule (oo in fool) short in full (oo in good) U as in union, pure to have &c; to be written yu
Â as in all (aw, au in brawl, taught)
a " " fat
u " but (o in love oo in blood)
AI. " " aisle ("long i") in pine)
AU. as ow in now oo ou in loud

ā long ă short o͝u nasal

Consonants

B. as in English blab
C. not to be used Excepting in the compound ch; write k for hard S for soft.
D. as in Engl did
F. " life
G. " gig never for soft as in ginger write j
H. as " how, hoe, handle
J. " judge M " mimic
K " kick N " noon
L " lull P " pipe
Q not to be used: for qu use kw
R " rear X not to be used write k s
S " sauce or gz as in way, Example
T " light Y " in Eng you, yew
V " vow Z " zeal, buzz
W " wayward

Ñ as in Engl singing
SH. " shall, shoe
ŁH as Ł in azure, ł in fusion
CA. " Church
ϑH " thin, # truth
DH as th in the, with
KH a hard guttural aspirate
like German ch in ach, loch,
buch + sometimes approaching
that in ich, recht, bücher
GH. a sonant guttural aspirate
(arab ghain); other compounds
like the clucks in Chinook to
be repres. by kl tkl, tlk &c
according to their analysis

Particulars

hair care taken, change by ~~time~~ age, food, mode of life muscles, age, mixture of race, pulsations, reflections all measurements from adult males.

---

1. Name 2. Tribe
3. Mixed blood & proportion
4 Country occupied
5. Subsistance: hunting, fishing &c. Habits riding, foot, canoe travels
6. Articles of usual food.
7. Age by estimation & by testimony
8. State of general health
9. Weight in lbs & ½ lbs
10. General complexion.

11. Hair, color + texture (Family)

12. Eyes, color
    a. oblique or not
    b. distance between outer angles over root of nose.

13. Teeth
    a. how many each
    b. ground down by hard food
    c. imposing incisor teeth of the 2 jaws rest on each other, or overlap
    d. Customs.

14. Entire height without shoes

15. Head.
    a. largest circum: around
    b. distance between orifices of ears over top of head
    c. distance from root of nose over top of the head to base of skull.

16. Arm.

a. Length outside from point of shoulder cap to tip of middle finger.

b. Length from same to point of Elbow when bent

c. Length from point of elbow to lower end of ulna

d. Length from lower end of ulna to tip of middle finger

e. Largest girth of arm

f. " " forearm

g " " hand.

17. Distance from upper centre of breast bone to end of middle finger, arm extended

18. breadth of shoulders behind

19. Girth of neck

20. Girth of chest around nipples
    a. full inspiration
    b. after Expiration
21. Girth of waist
22. Girth around hips on
    level with the head of thigh
    bones.
23. Leg
    a. height from ground to top
       of hip bone, outside
    b. height to knee joint outside
    c. " to crotch inside
    d. largest girth of thigh
    e. largest " " leg.
24. Foot.
    a length from top of great toe
      to extremity of heel
    b. girth of instep
    c. " around heel & instep

f. 162

Manual of Ethn Enquiry.

Brit Assn.

Taylor & Co London 1852

Phys: Characters.

Form, size weight. height
diff: between men & women
odour. Head skeleches
a profile front face
3. view looking down
from top of head. - Form
& size.

Skulls. observe:—

a. Is the os frontis divided by
a middle suture?

b. As the skull bones, thick
heavy, light dense &c.

c. Are the sutures much indented
?

d. Are ossa Wormiana frequent
If so, in what sutures do
they occur?
e. Does the squamous bone
well abut on the frontal
bone?
f. Open some crania to
ascertain if there be large
frontal sinuses; if so
state the condition of ossi-
fication, & also of the
teeth.
g. Observe the bones of the
face their relation to
each other & to the cranium
h. What is the form of the outer
orbitar process?
i. Is the palatine arch flat
or vaulted?
j. Does the upper jaw project
forwards.

k. What is the form of the lower jaw?

l. What is the shape of the chin?

m. What is the relative position of the ossa nasi to ungues?

n. What is the situation of the foramen magnum?

o. What is the state of development of the paroccipital processes?

p. Observe the number position character & usual form of the teeth.

q. Have they any artificial means of modifying the form & appearance of the teeth?

r. Number of lumbar vertebra ascertained

8. Measure length of sternum
+ that of the whole trunk
9. Idea of rel: magn: of
chest + abdomen
10. Character of pelvis
in both sexes
11. Form of foot
12. " of scapula: breadth
+ length + the relation
of clavicle to it
13. Peculiarities in blood
vessels.

Albinos - history + character
Varieties - distinctions + result
of intermixtures
longevity phys + intell
character

Language

Translate or have trans:
1st Genesis & Lords Prayer
& out of St Luke.
Selection of Words: 1. those
having no Equiv in our own
2. those which imperfectly
correspond: but take
a. Names of natural phy: objects
as water, fire &c
B. Phy: qualities as red blue,
round, heavy &c
γ Events, actions conditions &c
to fall walk, eat, sleep
δ family relationships father &c
ε Numbers as high as they can
ordinals & cardinals.
Destributives Multiplicatives
& Proportionals.
Numeral & Adverbs?

ξ Personal pronouns
η Particles as preps: conjunctions &c
Ellis Ethnic Alphabet
useful. use ' for
acute accent.
area of spoken language
variations, dialects &c
—
Grammar
ιγ a. Plural forms of nouns
+ the Dual of the first
β Cases of Nouns
γ adjectives: inflections &
rules of concord

§ Pronouns: forms: dual?

25. Compound words: formation

26. Order of words in sentence

27. Subject before predicate?
the cause & the effect?
peculiarity in the statement
of propositions.

Individual & Family Life.

28. Ceremonies at birth

29. Infanticide? cause

30. Children forsaken? cause

31. } rearing of children: art. &
32. } modifications of kinship?

33. Education & rearing:
moral & physical

34. Sports & amusements of children

35. [illegible] Puberty

36. Number of families large or small: Exceptions

37. At births, number one or more. proportion of sexes

38. Children easily reared?

39. Senses: deficiency or perfection.

40. Age of bearing: time of suckling.

41. Menstrual period & time of utero-gestation

42. Ceremonies at diff: periods of life?

44B) Chastity: customs, history & sacred stones?

44S

45. Marriage cerem. & customs

46. } Polygamy
47. } Divorce
48. } Widows

49. Food - sources how obt? cooking, forbidden food drink, etc

50. Dress ornament tatooing

51. Amusements, dances games &c

52. Gambling.

53. Longevity

54. Treatment of sick nature of diseases methods of treatment, magic, medicine

55. Animals - Dreams

56. Entozoa.

57. Disposal of dead-
58. customs &c (worship) implements &c deposited

59. Residing bodies?

60. Future state

Buildings & Monuments

61. Habitations kinds collected or separated plans of temples & villages.

62. Monuments. use how constructed & of what

63. Remains in them

Works of Art

64. ... To be coll?
ancient + modern:
difference between.
Commercial, Saleable products.
Trade + barter.
65. People carrying on
Trade + channels of
outlet.
66. Age of any trades. +
67 Changes - recent or ancient
68. Extent + ingenuity
of works of art. history
+ Examples - Makers.

Details to Accounts

Government & Laws.

69. Form of governing body

70. Chiefs their function

71. Class ordered: Class

72 Their power: of M. &

73 Methods of Guarding

74. Laws how made known & Enforced: property land: labor &c

75. By whom laws framed Especially ancient ones

76. Alteration or addition to laws.

77. Observance

78. Methods of punishment trials &c

79. Judges — trials how conducted.

80. Prisoners how kept & punished.

81. Crimes: punishment commutation.

Geogr. & Statistics.

Social Relations

Religion, superstitions &c

E. Mathieu
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Catalogue de
Instruments Anthropo-
-logiques

Write for one also
Instructions Générales
pour les Recherches
anthropologiques (
Société D'Anthropologie
de Paris [?] par Broca
Paris Victor Masson et fils
Place de l'Ecole de Medecine

Observation Anthropologique
sur le Vivant N°

Lieu précis d'observation —
Longit — Lat — Alt —
Nom du sujet — Âge —
Age — Sexe — Nation ou Ethnie —
Race —

NB. Là où il y a un point
d'interrogation on soulignera
l'adjective que doit être sa
réponse

Taille mesurée Poids Kilog

Le sujet est-il maigre gras ou
moyen ?

Force de traction au dynamomètre ?
Pulsations par minute puls
Respirations par minute resp.

Détails descriptifs

Colleurs { Peau : parties nues / parties couvertes
Cheveux
Barbe
Yeux

Les cheveux sont-ils lisses ondés, bouclés, frisés ou laineux ?
La barbe est-elle abondante, rare ou nulle ?
La peau est-elle glabre, en peu velue ou très velue ?

Forme et volume des nez.
Lèvres : (la Grosses, minces ou fines ?
sont-elles droites, ou renversées ?

Sevres : sont-elles { 1° grosses, moyennes ou fines ?
2° droites ou renversées en dehors ?

Dents : sont-elles { 1° grandes, moyennes ou fines ?
2° saines, usées ou malades ?

Dents incisives : sont-elles verticales ou peu obliques ou très-obliques ?

Remarques particulières

Mesures de la tête

a. Crane

1° Diametres: minimum

antéro-postérieur: maximum

— iniaque

Transverses: pariétal maximum

— temporal max

— biauriculaire

— frontal minimum

Vertical sus-auriculaire

2° Courbes

Occipito-frontale totale

sa partie antérieure

Horizontale totale

sa partie antérieure

Transversale biauriculaire

3° Cordes auriculaires

Corde iniaque . . . millim

— bregmatique

— sus-nasale

— sous-mentale

4° Projection postérieure

B Face

1° Angle et triangle facial

Base du triangle facial

Longueur de la ligne faciale

Angle facial de Camper degr.

— alvéolaire degrés

2° Distance du point sous-nasal
au point alvéolaire millim.
au bord des incisives
au point sous-mental
à la racine du nez
au point sus-nasal
à la racine des cheveux

3°. Distances transversales
des deux apophyses orbitaires
Externes
Des deux commissures
internes des yeux
Des deux pommettes
Des deux angles de la
mâchoire inferieure
4°. Du point sous-mental
à l'angle de la
mâchoire
5° De la racine du nez à
l'angle de la mâchoire

Mesures du tronc et des membres.

X

du conduit auditif
du bord inférieur du menton
de l'acromion
de l'epicondyle
de l'apophyse styloïde du radius
du bout du doigt médius
de la fourchette sternale
du mamelon
de l'ombilic
du bord supérieur du pubis
du raphé du périnée
de l'épine iliaque antéro-supérieure
du bord supérieur du grand trochanter
de la ligne articulaire du genou
du sommet de la malléole interne
de la saillie du mollet

*1° Hauteurs au-~~dessus~~ dessus du sol : millim

2° Membre supérieur

La grande envergure...
Le grand empan
Le petit empan
Longueur du pouce (face dorsale)
Longueur du médius (face dorsale)

3° Tronc

Distance des deux acromions
Longueur de la clavicule
Largeur du thorax
Circonference du thorax
sous les aisselles
à la ceinture
Distance des deux épines iliaques
Idem des deux grands trochanters

4° Membre inférieur

Circ. maxima de la jambe (molle)
" minima de la jambe (sus-malléol.)
Longueur du pied : totale
——— pré-malléolaire
Longueur du gros orteil (face dorsale)
3 Hauteur du vertex au-
-dessus du sol, le sujet
étant assis.

Feuille abrégée d'Observation. No —
Lieu précis de l'observation — Long-lat-alt —
Nom etc same as preceeding

NB. là où il y a un point &c.

Taille milim numeros.

Couleurs
- Peau : parties nues
- — parties couvertes
- ~~cheveux~~ Cheveux
- Barbe
- Yeux

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Les cheveux sont-ils lisses ondés, bouclés frisés ou laineux ?

Forme et ~~vol~~ volume du nez :

Lèvres : sont-elles { 1° grosses moyennes ou fines ? 2° droites ou renversées en dehors ?

Dents incisives : sont-elles verticales, en peu obliques ou très-obliques ?

Remarques particulières

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Mesures de la tête

A. - Crane

1° Diamètres millim

Antéro postérieur maximum

Transversal maximum

frontal minimum

2° Courbes.

Occipito-frontale totale

Horizontale totale

Transversale biauriculaire

617 1

B. Face

1° Angle et triangle facial
Base du triangle facial
Longueur de la ligne faciale
Angle facial de Camper degrés
alvéolaire

2° Distance du point sous-nasal
au point sous-mental
à la racine du nez
à la racine des cheveux

3° Distance transversale des deux pommettes

C. Mesures du tronc et des membres.

1°. Hauteurs au-dessus du sol

du conduit auditif
de l'acromion
de l'Epicondyle
de l'apophyse styloïde du radius
du bout du doigt du médius
de l'ombilic.
de l'épine iliaque antéro supérieure
de la ligne articulaire du genou
du sommet de la malléole interne

2° Membre supérieur
la grande envergure
le grand empan
3. Membre inférieur
longueur du pied : totale
——— pré-malléolaire
4° Hauteur du vertex au-dessus du sol, le sujet étant assis.

(Braca)

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1874.

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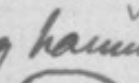
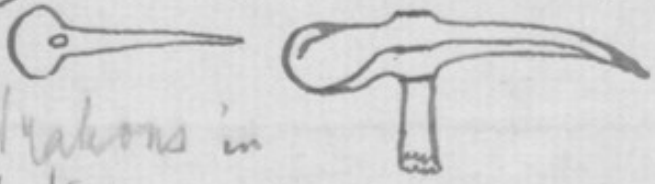
Geology cont.d

vide ante

Form of Geological

Taylor (Collecting & preserving) says the pocket hammering hammer  also used almost to exclusion of others. Ducks head for hard rocks. Platypus for clays



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LECTURES TO SCIENCE TEACHERS.

OUTLINES OF FIELD-GEOLOGY.

With an Account of the Use of Surveying Instruments and the Construction of Geological Maps.

BY PROFESSOR GEIKIE, LL.D., F.R.S., DIRECTOR OF THE GEOLOGICAL SURVEY OF SCOTLAND.

No questions are probably put so frequently to the field-geologist as these—"How do you know what lies beneath the surface soil? Do you dig or bore?" When he replies that he neither digs nor bores, yet can usually infer with considerable confidence what must be the nature of the rock underneath, his statement is received with a look of bewilderment or a half-incredulous smile. I propose in the two lectures to be given by me here to furnish such an answer to these popular queries as may enable you with a little practice to perform the geological operations which at first are supposed to be so occult. The term FIELD-GEOLOGY, which I would select as expressive of my subject to-day, points, as you will infer, to practical work in the open field, as distinguished from the researches which may be carried on in the library or laboratory. I wish to describe some of the methods by which a geologist obtains his information regarding the nature, position, arrangement and history of the rocks of a country. Such practical observation evidently underlies all solid research in geology. He who would pursue the theoretical parts of the science must either himself lay a foundation in good thorough

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field-work, or take advantage of the foundation which has, in this respect, been laid for him by others.

Field-geology may be pursued with various aims and in various ways. To some men it is little more than another name for holiday-making in the country—fresh air, healthy exercise, new or old charms of scenery, and a bag full of "specimens" to attest the scientific nature of the work. To others it is the solace and delight of busy lives, furnishing them not only with bright intervals of escape to the country, but with materials for much profitable thought and study when the ordinary duties and cares of life confine them to their work in town. To other men, again, it is itself the main occupation of life, whether they cultivate it for its own sake, or with a view to the economic applications of which it is susceptible.

There are few countries or districts where field-geology may not be cultivated, and where its healthful influence as an educational instrument may not be tested. A few days of intelligently guided observation in the field are worth far more to a pupil than many weeks of lectures and reading. But we seldom hear of such practical instruction, mainly because the teachers never received it, and have not had time, inclination, or opportunity to develop it for themselves.

1. Preliminary Considerations.—Necessity of a Map.

The results obtained by the geologist in the field from his investigation of the rocks may be set down either in writing, or in maps and sections. No one can follow the practical pursuit of the science without being conscious how much his work gains in precision when he is compelled to put it down upon a map. Not only is his information made more accurate when he requires to trace the exact lines of geological boundary, but he is led to search in nooks and corners of which he would not otherwise have suspected the existence, and thus he acquires a thoroughness of grasp which can be attained in no other way. The best field-geology is of that kind which careful and minute map-making requires. It is not, of course, imperative that an actual survey should be made by the geologist; but he must proceed in such a way

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that his observations, if tabulated and placed upon a map, would make that map a good geological one.

Since, then, the kind of work required in the preparation of geological maps illustrates most completely the nature and methods of field geology, I shall describe the construction of these maps as practised in this country. You will bear in mind that though you may never draw a geological boundary line, nor take any part in a geological survey, you cannot attain excellence in the practical pursuit of geology in the field without going through the training which, if need be, would qualify you for becoming professional geologists. How this should be the case will, I hope, become clear to you before we part company here.

Let us first consider what a "geological map" is. The meaning now attached to this term differs very much from that with which it was associated not very many years ago. In the early days of geology those who devoted themselves to this branch of science were mineralogists rather than what we should now call geologists. They termed their subject "geognosy," meaning thereby to indicate their object to be the increase of their knowledge of the minerals and rocks of the earth. They constructed what they called "geognostical maps," on which the positions of marked varieties of minerals and rocks were shown, but without any attempt at accurate, or even sometimes approximate, boundary lines, and with no hint whatever of geological structure, which we now regard as one of the chief objects of geological maps.

A perfect geological map should represent—1st. A full and accurate topography, with the form of the surface and heights in contour-lines, shading, or otherwise. The Ordnance Survey maps of Britain on the scale of six inches to a mile may be taken as an admirable example. 2nd. All geological deposits, from the most recent to the most ancient, which may occur in the district embraced by the map, with their boundary-lines accurately traced, and the relation of their distribution to the external form of the ground clearly depicted. 3rd. The geological structure of the region, that is, the relation of the rocks to each other, their inclination downwards from the surface, their curvatures and dislocations; in short, all particulars necessary to enable a geologist to apprehend the manner in which the rocks of the crust of the earth beneath the region in question have been built up. 4th. Information which

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may have special economic value, such as the nature and distribution of the soils, the position of available building materials, the direction, thickness, and extent of ores, coal-seams, or other useful minerals, the best sources of water supply, &c.

To fulfil these various requirements the map must evidently be not on too small a scale. If the scale is small, the attempt to crowd a great deal of information into the map may result in confusion of detail, and most of the beauty and usefulness of the work may be lost. In such cases it is better, where practicable, to subdivide the labour, putting the older geological formations on one copy of the map, the superficial accumulations and soils on another, the industrial information on a third, and so on. But without attempting to express all the detail possible, we may construct a correct and serviceable geological map of a district or country by generalising the information so as to give at a glance a broad and clear view of the distribution of the formations and the chief points of geological structure.

The Geological Survey of Great Britain and Ireland is constructed chiefly upon field-maps (Ordnance Survey), on the scale of six inches to the British statute mile, or $\frac{1}{10560}$ of nature, but some limited districts, where great detail is required, have been surveyed on the scale of twenty-five inches to the mile. The general geological map of the British Islands is published on the scale of one inch to the mile, or $\frac{1}{63360}$ of nature. A convenient scale for a generalised map of a country is ten miles to an inch. Of course the smaller the scale the less detail is possible, and the more care must be taken to select those geological features which are of prime consequence.

More important than the scale is the correctness of the topographical map which is to serve as the basis of the geological one. Unless the geography be accurately depicted, geological lines may be distorted, sometimes to an extent which seriously interferes with the value of the map. That you may see the importance of this point, let me draw your attention to two diagrams which represent the influence of correct and incorrect topography upon geological lines. You will observe that the same district is represented in both drawings; the streams and their tributaries are the same in both, but differ considerably in direction. A geologist

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trusting to the map A inserts the boundary lines between the formations 1, 2, 3, 4, and 5, guiding himself by the points of intersection of the different streams. If now he were to trace these same lines on a map with the correct topography, as shown in B, he would find them to present considerable

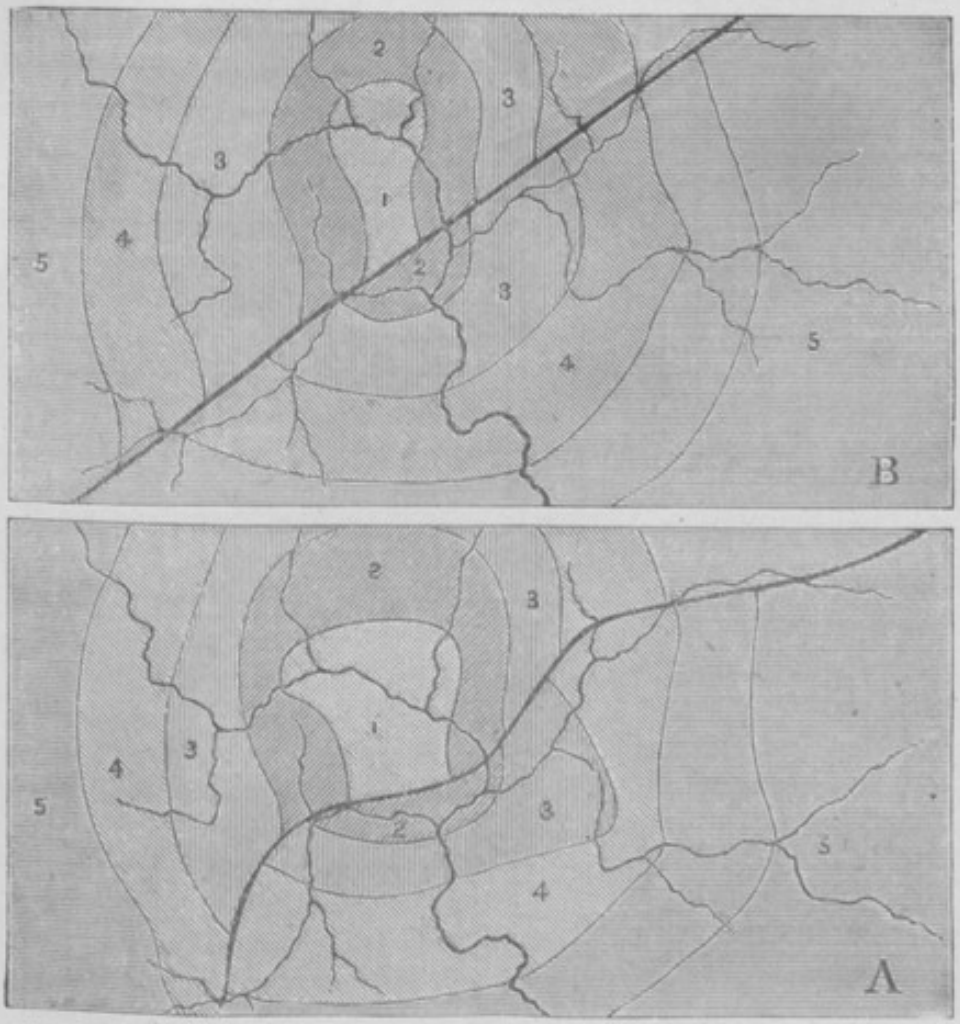

FIG. 1.—Maps showing the effect of incorrect topography in distorting geological lines.

differences from those on A, although crossing each stream at the same points on each map. In A his thick black line is a winding one, in B it is nearly straight. Should this boundary be a line of dislocation, you will see that by the one map he might be led to speculate upon a curved dislocation, in the other on a straight one.

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In this country we fortunately possess accurate Ordnance maps on various scales, so that except in those few and remote districts of which the Ordnance Survey has not yet been completed, we have a good topographical basis, and may reach any degree of finish and completeness in geological map-making. It is useful, however, to be able to construct our own rough field-map, or to correct a faulty one. For this purpose we avail ourselves of the ordinary methods of triangulation. We may measure, as accurately as practicable, a base-line along some level piece of ground, such as a river-meadow or a sea-shore. From each end of our measured line we take a bearing with an azimuth compass to some neighbouring object. The point of intersection of the lines of these two bearings gives the position of the object on the map. Having one or two triangles constructed in this way, we may continue triangulating the whole district and filling in the topography, so as in the end to produce a map which may not be quite accurate indeed, but which will probably serve our immediate purpose.

In those parts of the world where no good maps yet exist, geological and topographical surveying are sometimes conjoined. I may cite as admirable illustrations of this union the explorations of the river-courses of Canada by the late Sir William Logan, Director of the Canadian Geological Survey. He and his colleagues had to furnish themselves with canoes, attendant Indians, provisions, and hunting-gear, and push up unexplored rivers winding through the dense forests of the province. They explored, mapped, geologised, and hunted, laying down lines of traverse which served as the base for future more detailed topography, and did vast service in opening up the country. Still more elaborately topographical are the remarkable surveys at present carried out under Dr. Hayden, Geologist in charge of the Geological and Geographical Survey of the Western Territories of the United States. Year by year valuable reports, drawings, and photographs by that able observer and his associates make known the geography, geology, natural history, botany, meteorology, ethnology, and antiquities of thousands of square miles of previously unexplored or but partially explored land.

Having obtained or made as good a topographical map as may be attainable for his purpose, the observer is furnished with the first great requisite for geological surveying, and one

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of the most useful parts of the equipment of a field-geologist. Before he takes the field, however, let us consider the instruments or apparatus necessary for his work.

2. Accoutrement of a Field-Geologist.

Field-geology does not mean and need not include the collecting of specimens. Consequently a formidable series of hammers and chisels, a capacious wallet with stores of wrapping paper and pill-boxes are not absolutely and always required. Rock-specimens and fossils are best collected after the field-geologist has made some progress with his examination of a district. He can then begin to see what rocks really deserve to be illustrated by specimens, and in what strata the search for fossils may be most advantageously conducted. He may have to do the collecting himself, or he may be able to employ a trained assistant, and direct him to the localities whence specimens are to be taken. But in the first instance his own efforts must be directed to the investigation of the geological structure of the region. The specimens required for his purpose in the early stages of his work do not involve much trouble. He can detach them and carry them off as he goes, while he leaves the full collection to be made afterwards.

It is of paramount importance that the field-geologist should go to his work as lightly equipped as possible. His accoutrements should be sufficient for their purpose, and eminently portable. You may judge of the portability which may be secured when I tell you that I have on my person at this moment all the instruments necessary for carrying on a geological survey, even in the detailed manner adopted in the Geological Survey of this country. You observe, therefore, that a fully-equipped field-geologist need not betray his occupation by any visible implement. The want of such tokens of his craft often greatly perplexes rustic observers, to whom his movements are a fruitful source of speculation. I shall divest myself of my accoutrements one by one as I have occasion to refer to them, and describe their uses.

1. *The Hammer*.—This is the chief instrument of the field-geologist. He ought at first to use it constantly, and seldom trust himself to name a rock until he has broken a fragment from it and compared the fresh with the weathered

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surface. Most rocks yield so much to the action of the weather as to acquire a decomposed, crumbling crust, by which the true colour, texture, and composition of the rock itself may be entirely concealed. Two rocks, of which the outer crusts are similar, may differ greatly from each other in essential characters. Again, two rocks may assume a very different aspect externally, and yet may show an identity of composition on a freshly-fractured internal surface. The hammer, therefore, is required to detach this outer deceptive crust. If heavy enough to do this it is sufficient for your purpose; any additional weight is unnecessary and burdensome. A hammer, of which the head weighs one pound or a few ounces more is quite massive enough for all the ordinary requirements of the field-geologist. When he proceeds to collect specimens he needs a hammer of two or three pounds, or even more, in weight, and a small, light chipping hammer to trim the specimens and reduce them in bulk without running a too frequent risk of shattering them to pieces.

Hardly any two geologists agree as to the best shape of hammer; much evidently depending upon the individual style in which each observer wields his tool. This (Fig. 2) is the form which, after long experience, we have found in the Geological Survey to be on the whole the best. A hammer formed after this pattern combines, as you observe, the uses both of a hammer and a chisel. With the broad, heavy, or square end you can break off a fragment large enough to show the internal grain of a rock. With the thin, wedge-shaped, or chisel-like end you can split open shales, sandstones, schists, and other fissile rocks. This cutting or splitting edge should be at a right angle to the axis of the shaft. If placed upright or in the same line with the shaft, much of its efficiency is lost, especially in wedging off plates of shale or other fissile rocks.

A hammer shaped as I recommend serves at times for other than purely geological purposes. On steep grassy slopes, where the footing is precarious, and where there is no available hold for the hand, the wedge-like end of the hammer may be driven firmly into the turf, and the geologist may thereby let himself securely down or pull himself up.

The most generally convenient way of carrying the hammer is to have it in a leather sheath suspended from a waist-belt. The hammer hangs at the left side under the coat, the inside

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of which is kept from being cut or soiled by the protecting outer flap of the sheath. Some geologists prefer to carry the belt across the shoulders outside, and the hammer suspended at the back. Others provide themselves with strong canvas coat-pockets and carry the hammer there.

2. *The Lens.*—Even the most sharp-sighted observer is the better of the aid supplied to him by a good magnifying-glass. For field work a pocket lens with two powers is usually sufficient. One glass should have a large field for showing the general texture of a rock, its component grains or crystals,

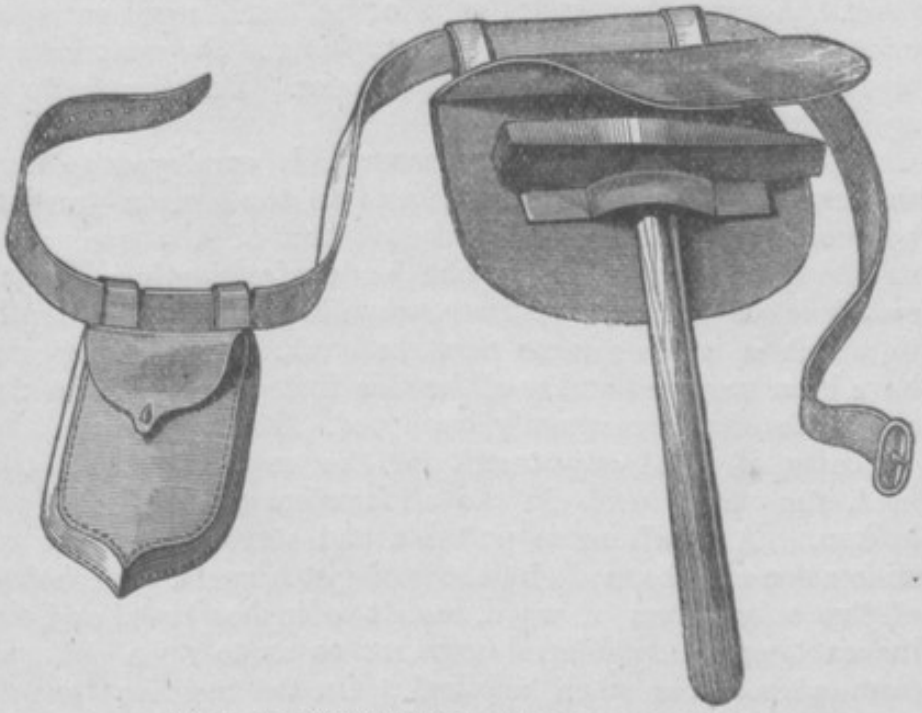

FIG. 2.—Geological hammer, compass-case, and belt.

and the manner of their arrangement; the other glass should be capable of making visible the fine striæ on a crystal, and the minuter ornament on the surface of a fish-scale or other fossil organism. Applied to the weathered crust of a rock, the lens often enables the observer to detect indications of composition and texture which the fresh fracture of the rock does not reveal. It sometimes suffices to decide whether a puzzling fine-grained rock should be referred to the igneous or the aqueous series, and consequently how that rock is to be coloured on the map.

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3. *The Compass.*—Any ordinary pocket compass will suffice for most of the requirements of the field-geologist. Should he need to take accurate bearings, however, a small portable azimuth compass will be found useful. This is the instrument employed in the Geological Survey. It is carried in a leather case or pocket hung from the waist-belt on the side of the body, opposite to the hammer. (Fig. 2.) The directions of the dip and strike of rocks, the trend of dislocations and dykes, the line of boundaries, escarpments, and other geological features are observed accurately, and noted on the spot at the time of observation, either on the map or in the note-book. A convenient instrument for light and rapid surveys, or reconnaissances, combines the compass and the next instrument I have to describe—the clinometer. I shall refer to it again.

4. *The Clinometer*, or dip-measurer, is employed to find the angle at which strata are placed to the horizon—an important observation in the investigation of the geological structure of a country, and one having frequently a special economic value, as, for instance, when it points out the depth to which a well or mine must be sunk. Various patterns have been proposed and used for this instrument. Formerly a spirit-level was commonly employed. But apart from the difficulty of rapid adjustment for the requirements of the field, the spirit levels in the clinometers were apt to get broken. A much more portable and serviceable form of clinometer may be made by the geologist himself. It consists of two thin leaves of wood, each two inches broad and six inches long, neatly hinged together, so as to open out and form a foot rule when required. On the inside of one of these leaves a small brass pendulum is so fixed that when it swings freely and hangs vertically it forms an angle of 90° with the upper edge of the leaf to which it is attached. An arc, graduated to 90° on each side of the vertical, is drawn on the wood, or on paper or brass fastened to the wood, so that when the leaf is moved on either side, the exact number of degrees of inclination is shown by the pendulum on the graduated arc. The corresponding face of the opposite leaf is hollowed out just enough to let the two leaves fit closely, and keep the pendulum in its place when the instrument is not in use. This form of clinometer, made of boxwood and bound with brass, may be obtained of instrument

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makers.[1] It is light and strong, and its durability may be understood from the appearance of the instrument which I hold in my hand, and which, though it has been in constant daily use for more than twenty years, is as true and serviceable as ever.

If at any time the geologist has occasion to lighten his equipment for some long mountain expedition, where every additional ounce of weight begins to tell by the end of the day, and where, therefore, for the sake of doing as much and holding out as long as possible, he should carry nothing that is not absolutely needful for his purpose, he may advantageously combine the pocket-compass and clinometer in the one instrument to which I have already alluded. This convenient instrument is about the size of an ordinary gold watch. It consists of a thin, round, flat metal case, shaped like that of a watch, and covered either with a common watch-glass or,

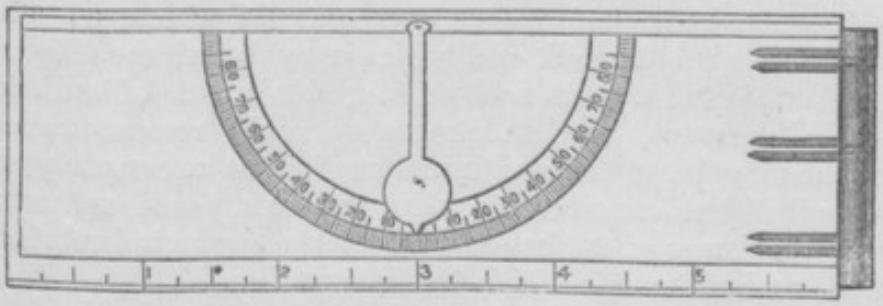

Fig. 3.—Clinometer.

still better, with a flat disc of strong glass. Instead of figures for the hours and minutes, the white enamelled face of this geological watch is that of a common pocket-compass. But the interval between each of the four cardinal points is divided into 90°. On the central pivot, just underneath the needle, a small brass pendulum is placed, and a straight-edge of metal is soldered on one side of the outer rim of the watch-case in such a position that the instrument will stand on it if need be, and the pendulum will then point to zero. A simple piece of mechanism passing through the handle enables the observer to throw the needle off the pivot, or let it down, as he may require.

[1] Messrs. Troughton and Simms, London, Mr. J. Bryson, Edinburgh, and Messrs. Spencer and Son, Dublin, supply this and the other instruments referred to in the text.

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5. *The Note-Book and Pencils.*—As it is impossible for a field-geologist to remember the details of all the observations he makes on the ground, or to insert them on a map, he regards a good note-book as an essential part of his apparatus. From the nature of his work he has frequently occasion to make rough sections, or diagrams, and if possessed of the power of sketching, he has abundant opportunity of aiding the progress of his researches by jotting down the outlines of some cliff, mountain, or landscape. Hence his note-book should not be a mere pocket memorandum-book. A convenient size, uniting the uses of a common note-book and a sketch-book, is seven inches long by four-and-a-quarter inches broad. Let me remark in passing that perhaps no accomplishment will be found so useful by the field-geologist as a power of rapid and effective sketching from nature. If he has this power in any degree, he ought sedulously to cultivate it. Even though he may never produce a picture, he can catch and store up in his note-book impressions and outlines which no mere descriptions could recall, and which may be of the highest value in his subsequent field-work. This is true of ordinary detailed surveys, and still more of rapid reconnaissances which may have their ultimate usefulness enormously increased if the observer can seize with his pencil and carry away the forms of surface as well as the geological relations of the region through which his traverse lies.

As every device which saves labour and time in the field, or which adds to the clearness of the work, is deserving of attention, I would refer here to the use of variously-coloured pencils for expressing at once, upon map or note-book, the different rock-masses which may occur in a district. Water-colours are of course ultimately employed for representing the geological formations on the finished map. But a few bits of coloured pencils carried in his pocket save the geologist much needless writing in the field. To a red dot or line he attaches a particular meaning, and he places it on his map without further explanation than the local peculiarities of the place may require.

This leads me to remark also that he necessarily adopts a system of signs and contractions on his map, not only to save writing, but to prevent the map from being so overcrowded with notes as to become hopelessly confused. Every field-geologist insensibly adopts contractions of his own.

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For the fundamental facts of geological structure, however, it is eminently desirable that the same signs and symbols should be used with the same meaning on all published geological maps. The subjoined diagram shows some of the signs used on the maps of the Geological Survey of Great Britain and Ireland.

Such are the few prime instruments required in field-geology. We may add others from time to time, according to the nature of the work, which in each region will naturally suggest the changes that may be most advantageously made. A small bottle of weak hydrochloric acid, carried in a protecting wooden box, or case, is sometimes of use in testing for carbonates, particularly in regions where rocks of different characters come to resemble each other on their weathered surfaces. When Sir William Logan was carrying on the survey of the Laurentian limestones of Canada, he received much help from what he called his "limestone spear." This was a sharp-pointed bit of iron fixed to the end of a pole or a walking-stick. He enlisted farmers and others in his operations, instructed them in the use of the spear, and obtained information which gave him a good general notion of the distribution of the limestone. The spear was thrust down through the soil until it struck the rock below. It was then pulled up, and the powder of stone adhering to the iron point was tested with acid. If, after trying a number of places all round, the observer uniformly obtained a brisk effervescence when the acid drop fell on the point of his spear, he inferred that the solid limestone existed below, and noted the fact on his map accordingly.

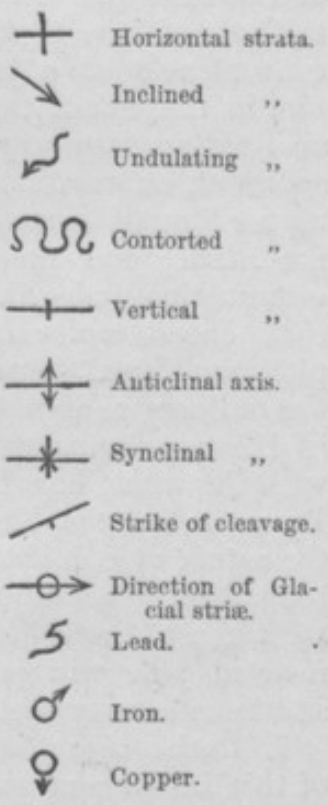

FIG. 4.—Some useful signs in geological surveying.

When the Geological Survey was busy with the great Wealden area of the south-east of England, my colleagues used what they nicknamed a "geological cheese-taster." It was indeed a kind of large cheese-taster, fixed to the end of a

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long stick. This implement was thrust down, and portions of the subsoil and of the clays or sands beneath were pulled up and examined. Similar devices must obviously suggest themselves, according to the nature of the work in different districts and countries.

In the course of his observations in the field the geologist will meet with rocks as to the true nature of which he may not be able to satisfy himself at the time. He should in such cases detach a fresh chip from some less weathered part of the mass and examine it further at home. The detailed methods of investigation, which may be pursued with all the conveniences of a laboratory in town, are not possible to him in the country. But he may subject his specimens to analysis in two ways, and obtain valuable, and perhaps sufficient, information as to their characters. He can easily fit up for himself a small and portable blowpipe box, a machine for slicing and preparing rocks, minerals, and fossils for examination under the microscope, and a microscope.

6. The *Blowpipe Box* should contain a common blow-pipe, platinum-tipped forceps, platinum wire, small bottles with the ordinary re-agents, and as many of the most useful parts of blowpipe apparatus as the space will admit, consistently with the whole box being easily packed into a portmanteau. By means of the blowpipe it is often possible to determine the nature of a doubtful rock or mineral, and to ascertain the proportion of metal in an ore. A young geologist should take with him to the field only the most essential apparatus and re-agents; he will gradually come to see by practice what additions he may best make to his equipment.

7. *Rock-slicing Machine.*—A convenient and portable form of this instrument is sold by Fuess, of Berlin. Where it cannot be obtained the field-geologist may succeed in preparing his slices by chipping thin splinters from the rock and reducing them upon a grindstone or whetstone. One side of the splinter is to be made as smooth and free from scratches as possible, which can be effected by polishing on a water-of-Ayr stone. This polished side is then cemented with Canada balsam to a piece of plate-glass. When quite firm, the upper side of the stone is ground down until the requisite degree of transparency is obtained. Considerable practice may be required, and many preparations may be spoiled before the observer becomes proficient. But the

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labour is well bestowed, for in no other way can he obtain the same insight into the internal texture and arrangement of the rocks with which he is dealing. He sees what are the component minerals of a rock, and how they are built up to form the mass in which they occur. He likewise can detect many of the changes which these minerals have undergone, and he thus obtains a clue into some of the metamorphic processes by which the rocks of the earth's crust have been altered.

8. *Microscope.*—This instrument should be, like the rest, as portable as possible. For most geological purposes high powers are not required, consequently a small microscope is sufficient.

It is sometimes of service, when working in a district where microscopic rock-sections are required, to carry a small collection of microscopic slices of selected or typical rocks or minerals for purposes of comparison. A series of fifty or one hundred slices can be packed in a box a few inches square.[1]

3. Character of Field-work.—Preliminary Traverses.

Having now examined the various parts of the equipments of a field-geologist, let us proceed to notice what use he must make of them. At the outset I would remark that while the mere possession of good instruments cannot make a geologist, the want of them will not prevent a skilled geologist from doing good work. The training of years enables him to judge of rocks and angles, of dip and trends of boundary so nearly accurately as to make him often independent of hammer, compass, and clinometer. In like manner long experience quickens his eye to detect geological evidence where a less practised observer, though searching for information, would fail to find it. This difference of training tells greatly in all preliminary surveys, reconnaissances, or rapid traverses of a country. The geologist who has already had many years of campaigning carries with him a faculty of grasping the salient features of geological structure, and directing his attention on the march to every available source of information which will help him to fill in the details of his

[1] Typical series of this kind may be had from Fuess, of Berlin, or from Tennant or Gregory, London; or Bryson, Edinburgh.

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section. If it were always practicable, the exploration of new regions, where the traveller is necessarily confined to his line of route, but where he has nevertheless to report on the geology of many thousands of square miles of territory, should be placed in the hands of men trained in geological surveying. That this arrangement would be of advantage you will, I think, admit when we have entered a little more into the details of field-work.

Though the geologist does not usually dig or bore, he avails himself of every artificial opening he can hear of as offering any information with regard to the rocks beneath the surface. Every natural exposure of rock comes under his notice. If there is a coast-line he makes a preliminary traverse of it to ascertain the general nature of the rocks. He ascends one or more of the stream-courses for the same purpose. If there is any commanding hill in his district, he makes an early excursion to its top, that he may gain some general idea of the form of the ground and the probable distribution of the geological formations, so far as may be indicated by the landscape. After such preliminary examination he has some notion of the probable character of the problems with which he will be called upon to deal. He then sets himself to examine the various natural and artificial sections in detail, carefully recording his observations at the time on his map and note-book.

The nature and conduct of these preliminary examinations not only vary with the character of the geology and physical features of the country, they differ according to the extent to which the country is settled and populous, or trackless and unexplored, according to the existence or absence of maps of the region to be examined, according to climate and other obvious causes. Such peculiarities as those which greatly affect the first general traverses of a country are apt to influence all the subsequent more detailed work.

As an illustration of the different conditions under which field-geology may be carried on, let me contrast the work of the Geological Survey of Great Britain and Ireland with that of the United States Geological and Geographical Survey of the Western Territories. In this long-settled and populous country we have abundant means of communication by road, railway, or steamboat between all or almost all districts. Villages and towns are scattered so numerously over the land that we seldom

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need be in any doubt as to obtaining good quarters and food. The penny-post and electric telegraph accompany us even into some of the most retired spots. Books, specimens, and instruments can be sent to us at a few days' notice. Of nearly every district in the British Islands we may procure detailed Ordnance maps by which to make our way over the ground, and on which to place the results of our geological observations. Besides, the main features and much of the detail of British geology are already known, and have been expressed with more or less precision upon published geological maps. We cannot, therefore, begin anywhere in this small country without some kind of general knowledge about the formations and structure of the district we may propose to examine.

There is still another element to be taken into account as determining the character and methods of field-geology in Britain — one which perhaps geologists themselves hardly sufficiently recognise—the climate of the country. I do not believe that any one who has not daily occasion to be out for many hours in the open air, and whose avocations make him to some extent dependent upon the weather, can have any proper notion of how good the average weather of this country is, and how few thoroughly bad days there are in the year, when he cannot secure even an hour or two of outdoor exercise. Our summers are seldom too hot to prevent the full use of a long July day. Our winters are so mild, and in many seasons bring so little snow, that if need be we may carry on field-work up to the end of December, and renew it at the beginning of January.

Such being the conditions under which field-geology may be prosecuted in Britain, it is evident that an observer may start for any district of the country alone and investigate its structure by himself. There is no occasion for combining a geological party, though that may be done if need be. In the organised field-work of the Geological Survey each officer has his own area assigned to him, and works out its geology himself, consulting, of course, from time to time his colleagues, who may be stationed in adjoining tracts, and arranging with them as to the joining-up of their various geological boundary lines.

The extent of ground which can be examined and mapped in a year by one of the geologists of the Survey varies, not

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only with the capacity of the surveyor, but with the nature of the ground, whether level, easily traversed, and with comparatively few geological sections, or rough and high, laborious to climb or cross, and abounding in streams and crags, all of which must be examined and mapped. A man might complete the survey of half a county lying upon the chalk of the south-east of England before another could get over more than a part of a single parish in such intricate geological and rough mountainous ground as that round Snowdon, or that in many districts of Scotland.

Let me place before you some statistics respecting the rate of work in the Geological Survey of Scotland—the branch of the Surveys of the United Kingdom with which I am more immediately connected. The average annual area of ground geologically examined and surveyed by each officer in the field is somewhere about 100 square miles. This amount is performed by an average daily walk of from ten to fifteen miles, exclusive of Sundays, holidays, wet days, and the time spent indoors in reducing the field-work and preparing it for publication. The part of the year devoted to actual surveying may be set down as about 200 days, or it may be perhaps rather more than that. We see, then, that one of the members of the Scottish Geological Survey walks about 2,000 or 2,500 miles in the course of the year. Every square mile of his completed map represents, therefore, on the average, about twenty or twenty-five miles of actual walking.

You can readily believe that with all the advantages for field-geology in Britain it should be possible here to construct the most elaborate geological maps. I would refer you to some of the published sheets of the Geological Survey of the United Kingdom for an illustration of what can be, and has been, done in this respect. I do not suppose that any such detailed geological work has been elsewhere attempted. The large maps on the scale of six inches to the mile, with which the field-work is now chiefly conducted, admit of almost unlimited detail. Every important or interesting stratum may be put down and traced on these maps; little dislocations of only a few feet in extent may be shown even when they are pretty closely crowded together; no feature of geological value need be omitted for want of space to express it. As illustrations of intricate and detailed geological mapping I may cite sheets 14, 15, 22, and 23 of the one-inch

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Geological Survey Map of Scotland, and the corresponding six-inch coal-field maps belonging to the same tract of the country.

Now with field-geology and map-making as possible, and as actually accomplished, in Britain, let us contrast the conditions under which work of this kind must be carried on in an unexplored region like the Western Territories of the United States. The survey of these vast tracts of the North American continent has been entrusted to my friend Dr. Hayden—one of the most zealous, active, and efficient geologists who ever undertook the task of pioneering through a new country. But the utmost skill and experience cannot alter the natural features of a country and its climate. The American survey requires to be carried on in a very different manner from ours, and I cite it as an excellent example of how field-geology can be prosecuted in new and previously unmapped regions.

As the topographical map of the country requires to be made, Dr. Hayden's survey is at once geographical and geological. His staff contains more topographers than geologists. It requires division into separate working parties, to each of which a distinct tract of country is assigned. From the higher hill-tops triangulations are made and outline-sketches are taken, so that a general map is traced and filled in. In this work the geologists co-operate, indicating to their associates the salient geological features of each region, and inserting these upon sections or diagrams, which, for beauty and effectiveness, are among the most remarkable geological sketches which have yet been produced.

Besides the scientific staff, however, provision has to be made for a foraging department; and sometimes, also, an escort has been needed, where the work lay in or near the territories of hostile Indians.

As a sample of the equipment of Dr. Hayden's survey, let me cite a few particulars from his Report for 1874, just received. The staff in the field was divided into seven parties. Of the organisation of these, the first may be taken as a type. It consisted of one assistant geologist as director, two topographers, two meteorologists, one botanist and collector, one general assistant, two packers, cook, and hunter. It would seem that there was thus only one geologist in the party, though probably one or two of the other members were

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able to lend him some assistance. Starting on the 20th of July, the party continued the campaign till the 27th of November. During that time it surveyed 4,300 square miles of new ground, which is probably an average of somewhere about forty square miles a day. This working party, therefore, though probably not much more than one geologist strong, accomplished in three days as great an area of work as one of my colleagues finds it possible to complete in a year. Such rapid surveying can of course be regarded as furnishing merely a kind of rough preliminary sketch of the geology of the territories, to serve as the basis for future detailed surveys. It may be taken as an example of broad generalised field-work on the one hand, while the Geological Survey of Britain stands at the opposite extreme, as a model of patient and elaborate detail. Obviously, such detail is at present wholly out of the question in such regions as those where Dr. Hayden is at work. He must be content to sketch the main outlines, and leave the details to be filled in by his successors. The manner in which he is fulfilling his task may be usefully studied, not only by beginners in field-geology, but by practised surveyors, who will cheerfully recognise the masterly character of the work which their American brother of the hammer is conducting.

4. Determination of Rocks and Fossils.—Tracing of Boundaries.

Whether field-geology is to be carried on rapidly and in a generalised way, or slowly and in detail, the same methods must be followed. I have supposed the geologist to have selected and reached his ground, and to have made a few preliminary traverses to gain some notion of the chief rocks and their arrangement. Let us follow his subsequent operations.

The brooks, ravines, sea-coasts, hill-sides, valleys, and mountains, in short every natural section or exposure of the rocks, will be carefully examined, and the observations made will be registered in note-book or map at the time. In the course of these rambles two points will have to be settled by him: first, the lithology and distribution of the rocks; second, their probable or actual geological horizon or date. A third question, viz. the position of the rocks with regard

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to each other, that is, the geological structure of the district, will early claim his notice. I shall treat of the latter subject under the 4th head—Determination of Geological Structure.

1. The determination of the nature of the rocks is obviously the first question which must be dealt with. Are they derivative or stratified rocks, and if so, are they conglomerates, sandstones, shales, clays, limestones, ironstones, or other varieties of this great series? Are they, on the other hand, crystalline or igneous rocks, and if so, must they be classed as granite, syenite, diorite, basalt, gabbro, serpentine, tuff, or other species of this family? Or are they metamorphic rocks, such as gneiss, mica-schist, or hornblende-slate? To be able to answer these questions, the observer must have trained his eye by the examination of good typical specimens of rocks. This is a kind of knowledge not to be obtained from books; it can only be gathered from patient and intelligent handling of the rocks themselves. In the field, the observer who has had this training in petrography can usually recognise the rocks he encounters. A pocket-knife, lens, and acid-bottle will assist him if his eye does not readily detect the characters of the stone. Should there be any doubt about the rock, he ought to compare a weathered surface with a fresh fracture; the former often revealing the component grains of the rock, owing to the more rapid decay of some of the ingredients. Minute quartz particles may be readily detected in this way.

It may happen that he still finds himself at a loss how to name the rock. In such a case let him take one or two small chips in his pocket, wrapping them in paper with a label inside, to mark their proper locality. When he gets back to his quarters in the evening he may submit one or two minute splinters of the rock to blow-pipe tests, or if these be inapplicable, or give no satisfactory results, he may proceed, in the manner already described, to prepare a slice of the stone for mounting on glass and submit it when ready to examination under the microscope. If, even after all these trials the rock still puzzles him, he had better give it some provisional name, and lose no more time over its determination, but proceed with his field-work, laying aside, however, some good typical specimens of the doubtful rock for subsequent more careful analysis either by himself or some experienced petrographer.

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It should be added that as the geologist gains experience he finds fewer and fewer of those puzzling rocks; his first rough or field determination becomes increasingly accurate, and he employs the blowpipe and microscope not so much to enable him to name the rocks as to solve interesting questions as to their composition and history.

A very short experience of geological work in the field suffices to show the observer that over wide spaces he cannot actually see what rock lies beneath him. He may get an admirable section laid bare in some ravine or brook, or by the shore of the sea; but beyond the limits of this section the ground may be deeply buried under vegetation, soil, sand, gravel, clay, or other superficial formation, and no other section may occur for an interval of, it may be, several miles. Yet he must form some conclusion as to the nature of the rocks between these places.

In cases of this kind information may often be obtained from an examination of the soil. What we call vegetable soil is merely the upper stratum of decayed rock mixed with vegetable and animal remains. It commonly betrays its origin by the still undecomposed fragments of stone mixed through its mass. In one tract, for instance, we may find it full of pieces of sandstone, to the exclusion perhaps of every other kind of rock. If the land has been under cultivation, the sandstone fragments may be of some size where they have been turned up by the plough. We should infer with some confidence that sandstone lay underneath *in situ*. If again the soil were a stiff red loam or clay, with few or no stones, it would indicate the existence of some red marl or clay immediately underneath. A sandy soil full of well-rounded, water-worn stones would show the presence below of some gravelly deposit. A stiff argillaceous soil, abounding in smoothed stones, many of them well-striated, would prove that a boulder-clay or till lay below. A profusion of fragments of some peculiar rock, a basalt, for example, or a diorite, or a porphyrite, extending in a definite band across a field or hill-side, would probably show us that a rock of that character existed *in situ*, somewhere in the immediate neighbourhood of the fragments. We require of course in all these cases to go carefully over the ground, and draw our conclusion only after we have exhausted all the evidence procurable.

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But you may remark that except on freshly-ploughed land the soil is not bare and exposed to our scrutiny ; that, on the contrary, it is commonly just as much concealed by its coating of vegetation as the hard rocks are by their covering of soil. Even under the most unfavourable circumstances, however, the geologist may be able to learn not a little of the information he needs. Where the ground has a slope he will probably have no great trouble in finding some little rut or trench which has been cut, or at least deepened, by rain, and where he will obtain access to the underlying soil, or even, it may be, to the subsoil and the still undecomposed rock below it. Where on the other hand the ground is too flat to hope for assistance from rain-action, he will look for traces of burrowing animals, by which the soil may have been thrown up to the surface. In Britain the common earth-worm, the mole, and the rabbit are excellent coadjutors in his work. The fine castings of the earth-worm give him at least the colour and general constitution of the soil, whether sandy or clayey. The heaps of the mole include the smaller stones in the soil, and permit an inference to be drawn as to the probable nature of the materials from the decomposition of which the soil has been formed. The extensive excavations of the rabbit lay bare not only the constitution of the soil, but often also the angular debris which rests immediately upon the solid rock.

From vegetation also the field-geologist learns to draw many a shrewd inference as to the character of the soil and rock below. A spring or line of springs will reveal itself by marshy ground or by a brighter green along a hill slope. The course of a limestone band or a basalt-dyke may be followed by the peculiar verdure of its vegetable covering, across a moorland where little or no solid rock may be seen. A ridge of serpentine stands up bare and rough, affording at best but an unkindly soil for plant-growth. Trees, too, change with the varying character of the rocks on which they grow. Each country presents its own local illustrations of these relations which must be gradually learnt and made to give their assistance to the observer's progress.

In judging of the probable character of the rocks underneath from the nature of the overlying soil, the geologist will of course be guided by the local circumstances in every case. For example, if the surface of the ground should present

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many rounded pebbles and boulders, he will not at once conclude that these fragments have been derived from the rock *in situ* below. Their rounded forms will rather raise a suspicion that they have been transported, and should many of them plainly show the characteristic smoothed surface of water-worn stones, they will be set down as derived immediately from some adjacent bed of gravel or conglomerate. The mere fact of a great variety of rock-fragments occurring over the surface at any locality suggests a mass of transported material, rather than the decomposition of the solid rocks underneath.

On the other hand, the occurrence of abundant angular fragments of rock on the surface at once arrests attention, as indicative of the vicinity of that rock *in situ*. The observer traverses the ground in all directions in search of any projecting knob of the actual rock itself. Failing to find it, he notes the position of these angular chips, and tries whether they can be traced further, so as to indicate by their distribution at the surface the probable trend of the solid rock underneath. In ascending a hill-side so covered with trains of detritus or vegetation that no rock can be seen in place, the geologist may learn much regarding the concealed rocks by examining the debris. He knows that the fragments of stone have all rolled down, and not up. When therefore, in his ascent, he observes that the angular chips of some particular rock, abundant enough below, no longer appear, he surmises that he must have crossed the limits of the solid rock which furnished the fragments. If in the course of subsequent examination he discovers that those fragments disappear about the same line all along the hill, he may regard his first surmise as probably correct, and draw a boundary line accordingly, even although he may never have seen the actual rock itself *in situ*.

Again, in the ascent of streams similar close observation and sagacious inference will often go far to supply the place of actual sections of rock. The use of the evidence in these cases, however, requires still more caution than on the bare hill-side, because the tendency of running water is to round the rock fragments exposed to it, and hence in the channel of a brook or river, it may not be always possible to distinguish between the pebbles which came as angular fragments from neighbouring solid rocks, and have been rounded by the

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attrition of the brook or river itself, and those which, derived from some old gravel, were already rounded and water-worn before they tumbled into the channel. A great abundance of fragments of one particular variety of rock, however, would suggest that they had not been washed out of some gravel bed, but had been derived from the waste of a solid rock lying somewhere further up in the drainage-basin of the stream. In such a case, moreover, the proportion of these fragments in the channel would probably be found to increase as the stream was traced upwards. Perhaps they might be observed, too, to become larger in size and less water-worn, the further they were followed up the stream. If they should suddenly cease, the observer should at once note the fact, as possibly indicating that the rock did not occur higher up, but had its upper limit somewhere near the point where the fragments in the stream disappeared. While these particular rock-chips ceased, others of some different rock might be found to increase in number, and another zone of rock might be shown and traced in a similar way.

In nothing is the highest type of a field-geologist better displayed than in the exhaustiveness and sagacity with which, in the absence of all other evidence, these various little indications of the geology of a district are sought for, found, and marshalled in their proper places, so as to bear witness to the distribution and probable structure of the rocks. Such an observer would be able in many cases to trace lines, with a near approach to accuracy, over ground which a less skilled student would pronounce to be a blank.

2. The determination of the geological age of the formations is a point of prime importance, which, if he has the facts and the knowledge, should be settled by the field-geologist. For the purposes of such determination he avails himself chiefly of fossil evidence. Since each great stratified formation of the earth's crust is distinguished by its own characteristic fossils, a method is obtainable of recognising the relative geological date of fossiliferous rocks. To determine and name fossils is the task of the palæontologist. As a rule the field-geologist can do this only to a very limited extent, though the greater his power in this respect the more valuable his services in the field. Part of his training, however, should consist in the study of as good a series of typical fossils as he can consult. He ought to familiarise his

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eye with the leading genera or more characteristic fossils of each geological system and formation. Knowledge of this kind, so portable when carried in the head ready for use, so bulky and difficult to transport and use when contained in many learned volumes, enables him to decide for himself as to the geological horizon of the formations. Should he be in doubt about the determination of his fossils, he must submit them to an expert in the subject.

For many purposes of field-geology it is not absolutely necessary, though it may be very desirable, that we should know the names and the zoological or botanical grade of the fossils. What we need to know in the field is that certain organic remains, whatever be their nature or names, occur in particular strata. We should be able to recognise them and use them as indices to mark out the strata, and thus to fix our geological horizon. William Smith, by whom this stratigraphical use of fossils was originally taught, knew little of the nomenclature or natural history of the fossils he dealt with. But he learnt to recognise them and to judge accurately of their position in the geological series, and he made as admirable use of them in tracing the outlines of the development of the Secondary rocks across England, as if he had been able to name and describe each species. Geology has made vast strides since his time. Though the field-geologist may use the fossils without any scientific knowledge of them, the sooner he obtains that knowledge the better for his work. The broad outlines of William Smith's days have to be filled in by more minute and exhaustive work now.

It is not merely in their bearing upon questions of stratigraphy that fossils claim the notice of the field-geologist. He treats them likewise as memorials of ancient conditions of physical geography. They show him at one place evidence of an old sea-bottom in the strata where marine remains are crowded together. At another locality they bring before him, in freshwater shells and other forms, the traces of long vanished lakes and rivers. At a third spot they reveal, by successive layers of compressed vegetation and hardened loam, the gradual depression and submergence of old forest-covered lands. In such cases they suggest the lines along which his further search should be prosecuted for additional corroborative testimony as to these ancient aspects of the district in which he is at work. The land-plants, for example,

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lead him to look for freshwater forms of life, for sun-cracked and rain-pitted surfaces among the clay-beds, while traces of former encroachments of the sea are indicated by layers of rock containing marine forms of life.

To be able to make the full use of fossils in the field it is not only desirable that the observer should know the species, as exhibited in good specimens in a museum and described in books. He must learn how they occur in nature, and discover after careful practice that it is not luck, but skill and good eyesight, which make the successful collector. Two observers may go over the same ground; one of them

FIG. 5.—Fossils standing in relief on a weathered surface of limestone.

diligently applies his hammer, breaks up innumerable blocks of limestone, finds not a single recognizable trace of a fossil, and, pronouncing the rock to be unfossiliferous, passes on; the other, recognising the calcareous nature of the stone, and, therefore its possibly fossiliferous character, puts his hammer in his belt, and betakes himself at once to the *weathered blocks*. He knows, as everyone soon does who attends to the subject, that in many cases a rock which is really highly fossiliferous may not appear to be so on a fresh fracture, where the whole texture of the stone may be uniformly crystalline. But when exposed to the slow corrosive influence of the

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weather, the different molecular arrangement of the calcareous matter in the organic remains and in the surrounding matrix begins to appear. Shells, corals, and crinoids stand out in relief on the weathered stone, showing even some of their most delicate sculpturing, while the surrounding limestone has been slowly dissolved and removed. In this way a rock which may have been supposed to be unfossiliferous by one observer is shown by another of greater training to be full of fossils. Old walls and buildings, the refuse heaps of old quarries, the angular blocks strewn at the base of a cliff—in short all surfaces of rock which have been lying exposed for a long while to the gentle influences of the air, rain, and frosts, may be made to yield their evidence as to the fossils in the rocks of a district.

5. Determination of Geological Structure.

If we could only recognise the rocks, where actually seen, but form no satisfactory conclusion regarding their distribution under a concealing mantle of vegetation or superficial detritus; if we could tell the arrangement and measure the thickness of strata only at the surface, but offer no opinion as to the prolongation of these strata underground, we should never know much about the crust of the earth, and certainly could do comparatively little to advance geological inquiry. Fortunately it is not only possible but comparatively easy to pronounce upon the subterranean arrangement of rocks from indications obtainable at the surface. We do not need to bore or dig. It is enough if we can avail ourselves of this surface evidence. How this is done, and how the field-geologist, from the determination of his rocks, proceeds to work out the geological structure of his district, let us now consider.

Horizontal Strata.—Outcrop.—In a region where the rocks are all horizontal, only the uppermost stratum may be seen, in which case an example of extreme simplicity of structure would result. There would then be no outcrop or exposed edge of any stratum to be traced, unless the surface of the ground should be so uneven as to expose the edges of lower strata. Except in tracts of low alluvium, however, horizontal strata have usually been more or less trenched by

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valleys and ravines, so that sections are laid bare of the underlying beds, while the surface of the country seldom rigidly corresponds with the surface of a stratum, but has been worn across it, so as here and there to leave "outliers" or outstanding portions of this upper stratum, and to lay bare the strata below. Where this has taken place in

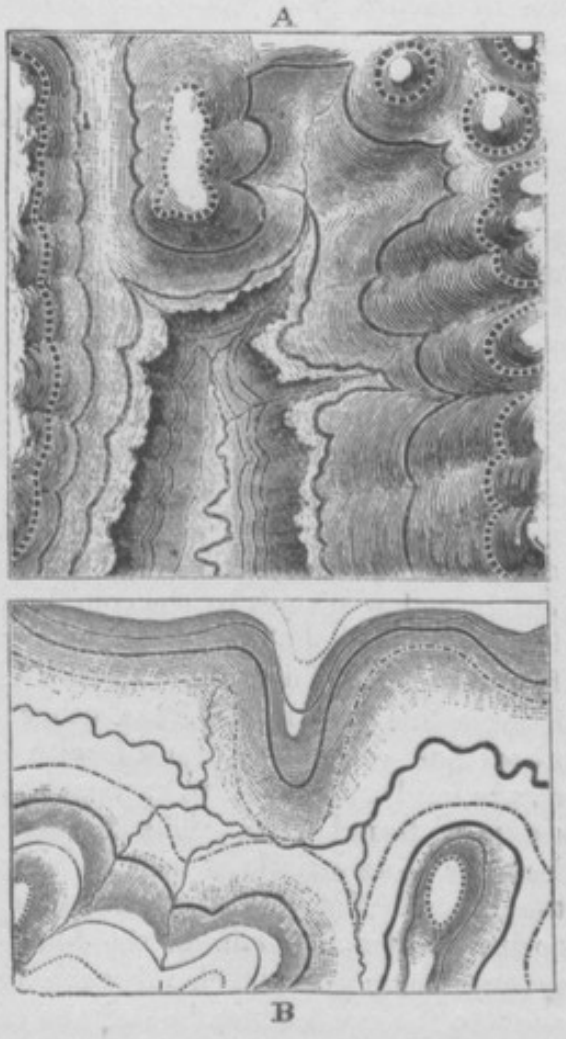

FIG. 6.—Sinuous outcrops of horizontal strata depending on inequalities of surface.

bare, hilly land, with abundance of exposures of the rocks, although the geological structure is still of the simplest possible kind, considerable practice and skill may be needed to follow the exposed edges or outcrops of the strata, and to delineate them accurately, and at the same time artisti-

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cally upon a map. The accompanying drawings (Fig. 6) may serve to illustrate how very tortuous the outcrops of perfectly horizontal beds may be, should the ground be much varied in outline, and especially by the occurrence of wide and deep valleys. In the uppermost map (A) a representation is given of horizontal rocks deeply trenched by valleys and ravines. In the lower map (B) the inequalities of the ground are much less, yet even in such a gently undulating district the outcrops of horizontal strata may evidently run in remarkably sinuous lines.

I have used the word artistic with reference to the tracing of geological boundary-lines, and have done so advisedly. Where the rocks are all visible the observer has only to follow nature, and the more faithfully he does so, the more graceful will his lines probably be. The curves produced by denudation, though often complex, are never awkward and inharmonious. Where the rocks are not seen, and where, therefore, the position of the boundary-lines must be inferred, the surveyor will follow the analogies of his district and run his boundaries with the same kind of flowing lines which he sees them to possess where they can be actually examined. Two men may map the same piece of ground quite correctly as regards its general structure, but the map of the one will show by the complexity of its lines and the fidelity with which they follow the varieties of the surface configuration, how faithfully and skilfully the work has been done; while the map of the other will indicate that its author has contented himself with marking the general structure, and has failed to express the relations of that structure to external form. The former map will in most cases be a far more artistic as well as accurate production than the latter. Not only in such simple work as the tracing of horizontal strata, but in all the details of geological map-making, the artistic eye and hand have scope to show their presence: to the great advantage of the maps in which they are applied.

Inclined Strata.—Dip.—Instead of lying quite flat, however, stratified rocks are usually inclined to the horizon. This inclination, called their *dip*, is measured as to its direction by the compass, as to its angle by the clinometer. To be sure of the true angle and direction, we must not be content with one small face of rock, but should go round a

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section until we determine the point satisfactorily. A face of rock, for instance, seen from one side, as in Fig. 7, may appear to be made of horizontal strata, which from another point of view are found to be considerably inclined. The direction of dip will always be at a right angle to the line along which the edges of the inclined beds appear horizontal. Failing, therefore, to find any actual section along the true line of dip, we should so place ourselves as to have the exposed edges of the strata running in horizontal bars in front of us. We may then take the direction of dip with

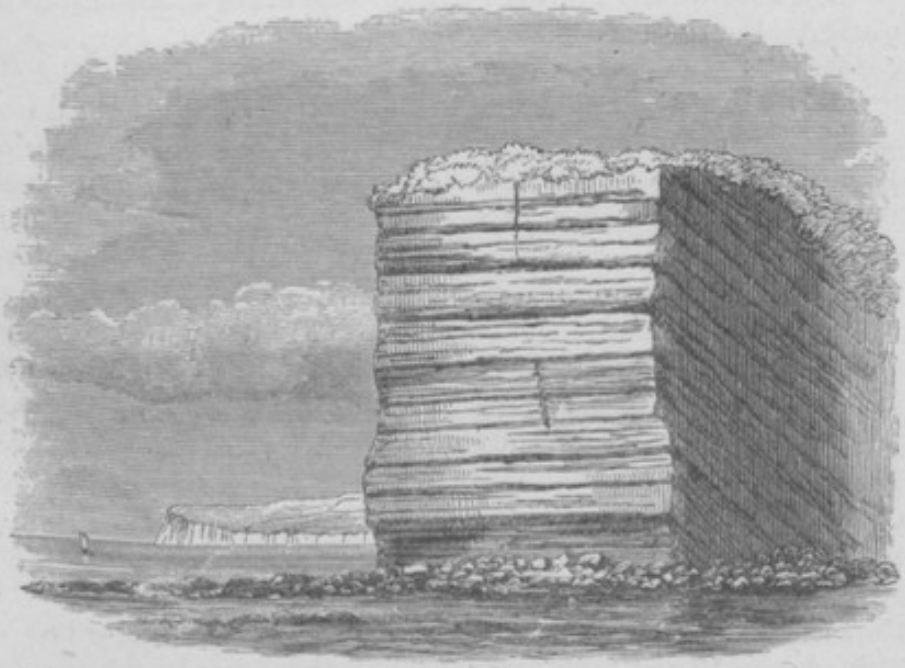

Fig. 7.—Inclined strata appearing horizontal when exposed at a right angle to the dip.

the compass, and determine from the mean of a number of observations taken with the clinometer on projecting ledges what must be the general average angle of dip. The best measurements of the angle of dip are made when we can place ourselves some little distance in front of a face of rock which has been cut in the true direction of dip. We can then place the clinometer in front of our eye, and make its edge coincide with the line of a particular stratum many yards in extent. Thus in one single observation we obviate the risks of error where only small ledges of the inclined beds can be used. Where the true dip cannot be directly

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measured we may, by measuring the apparent dip of two faces of rock inclined at a considerable angle to each other, obtain the true dip by calculation.[1]

Having ascertained these particulars, we insert the information in our note-book or map. The use of a map for the registering of observations on geological structure requires an amount of precision which might not be thought needful for the pages of a note-book, and secures in consequence the most careful and exhaustive kind of field-work. I shall, therefore, suppose in what I have to say on this part of my subject that we are required not only to make observations on geological structure, but to formulate them on paper, and to construct the geological map of a region.

The usual sign used on geological maps to express the dip of strata is an arrow pointing in the direction of inclination (the direction being found on paper by help of an ordinary protractor), with the number of degrees of angle shown in figures at the side of it. (See Fig. 4.) We place, therefore, an arrow at each point on the map where we ascertain the dip of strata. A glance at the map (Fig. 8) will show how this is done. Each arrow marks the site of the observation, and with its accompanying figures records the result. Where possible we enter beside the arrow some symbols, or contracted writing, to describe the nature of the rock, or any other particulars which it seems desirable to record. Further detail, where required, finds its place in the note-book.

Selection of Horizons.—Mapping of Outcrop.—As it is impossible on any ordinary map to represent every bed of rock, the geologist must decide what beds should be selected to be traced out. This cannot always be done until considerable progress has been made with the work. The selection must depend not merely upon the geological or industrial importance of the beds, but also, and not less frequently, upon the extent to which they are exposed and capable of being followed across the district. A particular stratum of no special interest in itself may come to have a high importance as a geological horizon or platform if it is easily recognisable, and from its thickness, hardness, or other peculiarity, stands

[1] Elaborate rules are sometimes given for measuring or calculating the dip. For almost all practical purposes, however, a good field-geologist can get his angle with the clinometer in the field by selecting, as he learns how to do, his points of observation.

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Fig. 8.—Map showing the data from which a completed geological map is made. (The top of the map is north.)

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out so prominently that it can be satisfactorily traced from point to point for a long distance. Such stratigraphically serviceable bands may be found in most districts of stratified rocks.

The outcrop may be marked at any particular locality by a short line beside the dip-arrow, or if the outcrop be a broad one, by two lines, one marking the base, the other the top of the band. The space between two such lines, in other words, the breadth of the outcrop, is determined by the thickness of the bed or beds, their angle of inclination, and the slope or contour of the ground. Among a series of vertical strata the breadth of the outcrop of a bed corresponds exactly with the true thickness of that bed. The more the angle of inclination lessens, the broader does the outcrop at the surface become. Hence, in tracing such a band across a country, attention must constantly be given to the variations of angle in the dip. Where the dip increases the band narrows in breadth, where the dip lessens the band widens. This is best seen on level or gently undulating ground; it is apt to be less distinctly shown where the ground is very uneven, and where therefore constant modifications of the line of outcrop are produced, as we have seen to be the case with horizontal strata. When strata are vertical no amount of surface irregularity makes any difference on their outcrop. They are apt in that position to run on for some distance with little deviation of direction, so that the outcrop of one of them might be marked by a straight bar or line (Fig. 8). The influence of the form of the ground tells more and more upon the outcrop in proportion as the strata approach the horizontal.

Strike.—The outcrop of a stratum, therefore, is the line which that stratum makes with the surface of the ground. This term outcrop is often spoken of as if it were the same as the term "strike." The latter word is applied to a line drawn at a right angle to the direction of dip. It is the general or average direction in which the stratum traverses the country. On a perfectly level piece of ground strike and outcrop must obviously coincide, and there must likewise be a complete coincidence among vertical strata. The more irregular the surface, and the less inclined the strata, the further must strike and outcrop depart from each other.

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Difference between Outcrop and Strike.—If you look at any good geological map of England and Wales, that by Professor A. C. Ramsay, for example, you will notice that the bands of the Oolitic and Cretaceous rocks, while retaining a tolerably persistent strike from south-west to north-east, across the breadth of the country, present a most sinuous and irregular edge. The direction of the dip, and consequently the trend of the strike, change but little, yet you observe that the outcrop is continually shifting to-and-fro. The strata really follow each other in parallel bands. If we could plane down the whole country to a dead level, these bands would be marked by alternate strips of clays, limestones, and sandy rocks. But instead of being a flat, the country undulates, and hence a series of gently inclined rocks of very various degrees of durability necessarily give a diversified set of outcrops. You could not study a better illustration of the difference between outcrop and strike, and of the marked inflence even of small ridges and hollows and shallow valleys upon the outcrop of strata where the angle of dip is low. The main facts to be expressed upon the map of such a tract of country are that the formations follow each other in a certain order and cross the region in a certain direction. Of course we might record these facts by simply drawing straight parallel strips across the map, each marking the position and relative breadth of one of the formations. This was the way in which the old geological maps on a small scale were constructed. The map of England and Wales in Bakewell's *Geology*, even so late as the edition of 1838, may serve as an example. But by such a style of mapping we entirely lose one of the valuable features of a geological map—the relation between the form of the ground and the nature and outline of the rocks below, that is, between scenery and geological structure. You may readily believe that this is too important a relation to be ignored without great disadvantage when the scale of the map at all permits it to be expressed. Besides, the omission deprives the map of the chief feature by which the skilled and artistic observer is distinguished from him whose eye and hand are less quick to seize upon and delineate the characteristic varieties of form which geological boundaries assume as the surface of a country changes from plain to hill, and as the rocks themselves alter in thickness and position.

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If we stand at the higher margin of a rocky valley, along the sides of which inclined beds of sandstone, limestone, or other stratified rocks are exposed, dipping gently down the valley, we observe that when the outcrop of each bed reaches the edge of the declivity, it does not go straight on to the corresponding outcrop on the opposite side. On the contrary, it descends the slope in a slant until it reaches the bottom of the valley, when it turns and mounts the opposite slope, thus forming a V-shaped indentation on the general line of strike (as in the valleys on the south side of the map, Figs. 8 and 9). Now the manner in which these windings of the outcrop of inclined strata and their relation to the form of the ground are expressed upon the geological map, is a good test of the skill and delicacy of a field-geologist's hand. Many observers are content to draw the lines of outcrop as straight bars across the valleys, thus making them coincident with the strike. On maps of a small scale, indeed, nothing else is possible. But where the scale admits of it, much advantage may be gained by faithfully depicting the curving outcrops. The map then tells its story at once, and brings the relation between geological structure and external form as vividly before the eye as a well-made model could do.

Construction of a Geological Map.—In Fig. 8 an attempt is made to convey some idea of the way in which the data are compiled and recorded in the construction of a geological map. The shaded parts of that figure represent what is actually seen by the geologist; over the blank portions he is supposed to have been unable to find any rock *in situ*. Fig. 9 shows the map as filled in and completed from these data. I shall have occasion to make frequent references to these maps in what follows.

It will be noticed that most of the observations occur along the stream-courses, these being the most frequent natural lines of section. At each point where the dip of strata has been taken, an arrow and number mark the direction and angle. The more important or stratigraphically serviceable beds have their outcrop marked in decided lines where it is actually seen. When the same stratum can be recognised in two parallel or adjacent streams or valleys, the outcrop may be drawn across the intervening ground, which of course should itself be searched for traces of the desired line. Where there can be no doubt as to the

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FIG. 9.—Complete geological map.

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direction and position of the outcrop, it may be drawn in with continuous lines. Where, however, though it is known to occur within certain limits, some doubt may exist as to its exact position, it should be expressed by broken or dotted lines.

Establishing a Stratigraphical order of Succession.—It will be seen from the map that in the streams at the lower part of the left side the same beds are recognised following and dipping under each other at corresponding intervals. In other words, the order of succession is found to be the same in the different streams. Bed A after an interval is followed by bed B, bed B by bed C, and so on. Even, therefore, where a blank space occurs, and, owing to some surface accumulation, a particular bed may not be visible in one of the lines of section, we can be tolerably sure of the place where, judging from the strata above and below, it would be seen if it came to the surface. We do not hesitate, therefore, to draw dotted lines across that place to indicate our belief. A geological map is thus derived, partly from what is seen, and partly from what can be legitimately inferred.

I would further direct your attention to the fact that while the order in which the beds occur remains the same in all the streams upon our map (Figs. 8 and 9), the spaces between them vary considerably. This difference may arise from one or other of three causes ; either (1) variation in angle of dip, or (2) variation in thickness of strata, or (3) inequalities in the level of the ground. We have already considered the effect of a decrease of inclination in increasing the breadth of a stratum or series of strata at the surface of the ground. It is evident that if the mass of strata between two known beds should swell out or diminish, the breadth of the space between their respective outcrops must correspondingly vary. Inequalities of the surface must influence not only the direction of the outcrops, as we have seen, but also their breadth. Where the angle of dip does not change, and the surface of the ground presents no marked inequalities, but where, nevertheless, a decided widening or narrowing of the interval between two outcrops occurs, we infer with confidence that the intermediate strata must increase or diminish in thickness.

Thinning away of Strata.—Overlap.—It sometimes happens that two lines of outcrop come together, owing to the

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complete thinning away of the intermediate strata, and the conjoined outcrops may then be traceable for a long distance without further change. Instances of this kind sometimes occur among the coal-seams of our coal-fields. The higher portions of a series of strata now and then steal over the lower, so as to constitute what is termed an "overlap." This structure cannot always be expressed in plan upon a map, but is made clear by a section. On the map group Em overlaps group D in the neighbourhood of the locality marked O. A section of this part of the district would be as in Fig. 10.

FIG. 10.—Section of an overlap.

Relation of Strike to Dip.—There is a further relation to be noted as we proceed, viz.—the constant dependence of the direction of strike upon that of the dip, and the consequent changes of strike as the direction of dip varies. The strike is of course a mathematical line cutting the dip at a right angle. If the dip is east or west, the strike must be north and south; if the dip is north or south, the strike must be east and west. You must not suppose, however, that the line of strike is always, or even most commonly, a straight one. It can only be so as long as the direction of dip continues unchanged. But a comparatively brief experience in the field suffices to show you how constantly the dip of strata varies, now to one side, now to another, every such variation producing a corresponding change upon the line of strike. Where the deviations are slight, and of local character, while the mean direction of inclination remains the same, we take that mean direction as governing the strike (as at band F in Fig. 9). Where, on the other hand, the dip is to different points of the compass in succession, we connect the arrows on our map by lines (as in band G in Fig. 9), and find that the strike becomes a curved, and even, it may be, a very sinuous one.

Faults.—We have been dealing hitherto only with such variations in the outcrop of strata as may arise from the

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form of the ground, from variations in the thickness of strata, or from changes in the direction and angle of dip. But the outcrop is often broken completely across, and even removed entirely out of sight, by those dislocations in the earth's crust to which the name of "faults" has been given by geologists. These lines of fracture generally form little or no feature at the surface, so that their existence would commonly not be suspected. They comparatively rarely appear in visible sections, but are apt rather to conceal themselves under surface accumulations, just at those points in a ravine or other natural section where we might hope to catch them. Yet they undoubtedly constitute one of the most important features in the geological structure of a district or country, and should consequently be traced with the greatest care.

You may perhaps hesitate to believe that a geologist can satisfactorily trace a line of fracture which he never actually sees. But a little attention to this part of our subject will, I hope, convince you that the mere visible section of a fault on some cliff or shore, does not afford by any means such clear evidence of its nature and effects as may be obtained from other parts of the region where it does not show itself at the surface at all. In fact you might be deceived by a single section with a fault exposed in it, and might be led to regard that fault as an important and dominant one, while it might be only a secondary dislocation in the near neighbourhood of a great fracture, for which the evidence would be elsewhere obtainable, but which might never be seen itself. The actual position (within a few yards) of a large fault, its line across the country, its effect on the surface, its influence on geological structure, its amount of vertical displacement at different parts of its course—all this information may be admirably worked out, and yet the actual fracture may never be seen in any one single section on the ground. A visible exposure of the fracture would be interesting; it would give the exact position of the line at that particular place; but it would not be necessary to prove the existence of the fault, nor would it perhaps furnish any additional information of importance.

The geologist, therefore, constantly finds evidence of far more dislocations than he can actually see. Those which appear, sometimes commonly enough on lines of cliff or

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coast-section, are apt to be but small and trifling. The larger faults—those which powerfully influence the geological structure of a country—are seldom to be caught in any such visible form. Now why is this? Different reasons may be assigned, each of weight. First of all, it is evident that along lines of great dislocation there must have been, on the whole, greater pressure and a greater grinding and fracture of the fissure-walls than in clean, sharp cracks, where the rocks have been displaced only a few feet or yards. This broken rock on the line of fault crumbles down more than the solid rock on either side beyond it, or is more easily excavated and removed. So that whether on a cliff or on a flat surface, the actual fault is apt to be concealed by superficial detritus. Then again, large faults often bring together rocks of considerably different degrees of durability. The less-lasting material decomposes, and its *débris* goes to cover the actual junction-line between the two formations. Another reason may be sought in the extensive deposits of gravel, clay, or other superficial materials which are spread over the surface of a country and conceal the solid rocks. A line of fault is one of weakness, presenting facilities for attack by the denuding forces whereby it is hollowed out, so as to become a receptacle for these superficial deposits.

In the consideration of faults, therefore, two questions obviously arise. How does a geologist recognise faults when he sees them? and how does he prove their existence when he does not, and cannot, see them?

I need not enter into any detailed answer to the first of these questions. The inspection of the section of a fault in nature will tell more in a few minutes than I could in an hour, and the lesson so received will be better remembered. A fault is not usually vertical, but inclined at a high angle. The rocks are commonly somewhat shattered on either side, the central parts of the fracture being filled with the broken rubbish. The breadth of broken material may vary up to a mass of many yards. If, on the face of a cliff, two different sets of rocks are brought together against each other along a steep line of junction, where they are both jumbled and broken, that line will almost certainly be that of a fault.

The inclination of the sides of the fault is termed its *hade*, and slopes away from the side which has been pushed up or in the direction of that which has gone down. This

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is a useful fact, as it enables an observer to note which is the up-throw or down-throw side of a fault. The hade ought therefore always to be noted, and in mining districts its angle of inclination may be conveniently recorded to explain the position of the same dislocation in the underground workings.

Unless the same bed can be recognised on both sides of a fault as exposed in a cliff or other section, it is evident that the fault at that particular place does not reveal the extent of its displacement. We should not be safe in pronouncing a fault to be large or small in the amount of its throw merely

Fig. 11.—Section of a fault.

from the visible section of it. One with a considerable amount of displacement may make little show in a cliff, while, on the other hand, one which, to judge from the jumbled and fractured ends of the beds on either side, might be supposed to be a powerful dislocation, may be found to be of comparatively slight importance. I may cite in illustration the section exposed on the cliff near Stonehaven in Kincardineshire, where one of the most notable faults in Great Britain runs out to sea. This fault lies between the ancient crystalline rocks of the Highlands, and the red sandstones and conglomerates of the Lowlands of Scotland. So powerful

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have been its effects that the strata on the Lowland side have been thrown on end for a distance of two miles back from the line of fracture, so as to stand upright along the coast-cliffs like books on a library shelf. Yet at the actual point where the fault reaches the sea and is cut in section by the cliff, it does not appear as a line of shattered rock. On the contrary, no one placed at once upon the spot would be likely to suspect the existence of a fault at all. The red sandstones and the reddened Highland slates have been so compressed and, as it were, welded into each other, that some care is required to trace the demarcation between them.

Let us consider the nature of the evidence from which the existence and position of a fault are inferred, though the actual dislocation itself does not appear in any exposure of rock. The upper part of the earth's crust for a variable depth is traversed by a circulation of water, which, descending from the surface and performing a circuitous underground journey, comes out again in the form of springs. The divisional planes by which all rocks are marked serve as channels along which the water oozes or flows. Of these planes, none offer such ready and abundant means of escape to the water as lines of faults do. Hence, in some districts the faults are traceable at the surface by lines of springs. Without some knowledge of the country we should not indeed be justified in inferring the existence of a fault merely from finding a linear series of springs. These might arise along the boundary between two different beds or sets of beds. The springs which issue at the base of the chalk are an illustration. But if, having ascertained that there is no such water-bearing boundary line in the district, we come upon a marked line of springs, we may surmise that they indicate the position of a fault, and may use them in confirmation of other evidence bearing on the existence of that fault. In unravelling the geological structure of a country, the observer may thus often be able, by means of springs, to localise a line of fracture, the existence of which he can demonstrate otherwise.

In the same way, a marked and abrupt change in the form of the ground along a definite line may serve to show the position of a fault. It is true that here again the junction of two beds or two series of rocks of different durability, such as sandstone or limestone upon clay, or gravels

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lying against granite, may give rise to a long straight or curving escarpment or slope. The mere existence of such a long line of bank would not of itself justify any conclusion or inference as to a fault, but might suggest, and, taken in conjunction with other facts, might help to prove the existence of the fault. Marked forms of ground have always some geological explanation. It is the province of the field-geologist to study them in connection with their causes, and to make use of them in elucidating the structure of the rocks, and the history of the physical geography of a country.

But by far the most important and satisfactory evidence for the existence and effects of faults is furnished by the grouping of the rocks with reference to each other, and can only be put together when the rocks have been examined with some care, in other words, when some progress has been made in unravelling the geological structure of the locality. The nature of this evidence will be most satisfactorily followed by reference to the diagram, Figs. 8 and 9.

It will be observed that several lines of fault are shown upon this map. Look first at that which crosses the streams on the left or west side. In ascending the most southerly of these streams, we notice that at first the rocks consist of various sedimentary deposits—sandstones, shales, and limestones. These strata dip toward the south-east, and the angle gradually rises as we proceed up the stream, until at the last place where they are seen the beds stand at an angle of 80°. A short way higher up we encounter rocks of an entirely different character; let us suppose them to be granite and crystalline metamorphic rocks. The gradual rise of angle and the almost vertical position of the strata would be regarded as sufficient to indicate the existence of a line of fault between the stratified rocks and the crystalline masses. The section in the next stream is very similar. It will be observed that while the general order of the strata is the same, some of the beds in the former section do not come out to view here, while, on the other hand, some appear here which were not found before. It is by thus piecing different contiguous sections together that the order of strata in a district is made out. The angle of dip in this second stream rises as before towards the higher ground inland, until angles of 70° to 80° are reached. It will be observed that the last rocks seen

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here lie beyond the line of those last seen in the first stream; also that the obscured space between them and the crystalline masses is narrower. We get deeper into the series and find that a lower part of it than was seen before now impinges upon the granitic masses. In the next stream similar evidence is obtained, only here a little ambiguity seems at first to arise from the fact that the strata, after gradually becoming vertical, dip as it were into or below the granite. This in reality is a reversal of dip. The strata have not only been thrown on end, but actually bent back upon themselves. No more convincing evidence of the existence of a powerful fault could be given. It should be noticed, too, that here again we have still lower parts of the series of stratified rocks placed on end against the granitic hills.

Now, having put these various data upon our map, we see that the point of junction between the two kinds of rock crosses the streams in a tolerably straight north-easterly line. There cannot be any doubt that the junction is a fault, for 1st, there is no trace of any conglomerates or other indications of an original base to the formation, lying upon and wrapping round the granite; 2nd, there is no evidence of the granite having been intruded through the rocks. The latter show no granite veins or traces of alteration. 3rd. The disturbed and even vertical position of the strata all along the straight line of junction proves that line to be a fault. 4th. The upturned strata are cut across obliquely by the junction-line, so that different horizons of them are successively brought against the crystalline rocks.

We cannot hesitate in such a case to treat the line as a fault, which we mark on the map by a strong pencil-line at each point where there is good evidence as to its approximate or actual position. We should search for further traces of the line in the intermediate ground, and here may be realised the use of a line of springs or of some definite bank or hollow on the surface of the ground, in enabling us to carry the line of the fault with confidence across a tract where no actual rock may be exposed. There could be, in the present instance, little hesitation in prolonging our strong pencil-line from point to point; if we felt any uncertainty as to its course through some part of the country, we should make the line there a broken or dotted one.

The side of up-throw or down-throw may either be fixed at

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once from our knowledge of the order of succession among the rocks, or may be determined at a later stage as our knowledge of the district increases. Thus, in the case which has just been under notice, if we knew that the granite series was older, that is, underlay the other, we should say that the up-throw of the fault was to the granite side. This direction might be marked on the map by a short bar placed perpendicular to the line of the fault, and on the down-throw side. In the completed map (Fig. 9), the fault might be shown by a strong black line or by a white line. The latter method is adopted on the maps of the Geological Survey, where fine lines of opaque Chinese-white are placed over the geological colours to mark the position of the faults.

From the example given in the diagram which we have been considering in detail, it appears that one indication of the proximity of a fault is a rapid rise in the angle of inclination of strata. It is common to find the beds on the down-throw side bent up against the other side, and this upturning may extend for a few feet or for more than a mile. The beds on the up-throw side, on the other hand, may sometimes be observed to be bent down against the fault. This arrangement is of course what might have been looked for, but it does not always occur.

Another feature which may be regarded as a tolerably sound proof of the existence of a fault, consists in a complete divergence of strike between the formations on either side of a given line, or, in the common parlance of field-geologists, when one series of strata strikes at or against another. This may be most easily understood by reference to the diagram (Figs. 8 and 9). Towards the south-east portion of that map, two different sets of strata may be observed to crop up in the various streams and natural sections. The strike of one of these is at D and C nearly north-west. Towards the north-east, owing to a change in the direction of dip, the strike swings round, until at last it is E.N.E. and W.S.W. Now, unless some fault occurs, we may confidently expect that the strata which strike north-west and south-east will be found to continue southwards, though they may eventually participate in some other change of strike, and wheel round as before. If, then, in the line of their strike, and at a comparatively short distance, in which they have no room to turn round, we encounter, as shown here, another and

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different series of rocks (F and G), we may reasonably infer that a fault intervenes, and may set about the search for further evidence of it. In the case supposed upon the map, the strata on the south side strike on the whole in a north-east and south-west direction. But close examination shows that some strata are cut out as they approach the junction-line; this plainly indicates the line to be one of dislocation.

A great many faults run with the dip, and are called *dip-faults* ($\phi\phi$ in Fig. 9); another series runs with the strike, forming *strike-faults* ($\phi'\phi'$ in Fig. 9). But as dislocation may occur in any direction, and cross dip and strike at any angle, these two series are not very sharply marked off from, but may pass into each other, or the same dislocation may be a dip-fault when looked at from one side and a strike-fault when viewed from the other (as at $\phi''\phi''$ and z z in Fig. 9). Owing to the way in which denudation has smoothed down the surface of the ground, a dip-fault has the effect of shifting the outcrop of a stratum so as to make it appear like a horizontal displacement. In the map, for example, the beds D and E dipping south are traversed by a dip-fault with a down-throw to the east. The line of outcrop is consequently shifted northwards on the side of down-throw. If the beds had dipped northwards then a down-throw to the east would have moved the outcrop southwards. A strike-fault, when it exactly coincides with the line of strike on both sides, makes no change in the line of outcrop, except in bringing two parallel bands closer together. It may carry some important strata out of sight, or prevent them from ever being seen at the surface at all. In the map (Fig. 9), for example, the bed C is completely cut out against the strike-fault ϕ' ϕ'. If it were not seen at the surface elsewhere, its existence could not be known unless from some underground boring.

To judge of the character and effects of faults upon the geological structure of a country, you should consult some good detailed maps, such as the large coal-field plans of the Geological Survey of Great Britain. It is good exercise, too, in the practical treatment of faults in field-geology, to study some coast section where the strata are considerably faulted, and where they are exposed in plan upon the beach as well as in section upon the cliff. A river-ravine in summer weather, when the water is low, sometimes furnishes

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admirable lessons in this as well as in other branches of the subject.

Unconformability.—When one set of rocks has been disturbed and denuded before the deposition of another series upon them, the latter is said to rest "unconformably" upon the former, and this kind of junction is known as an "unconformability." An extreme case of this structure presents little difficulty. It can be expressed so clearly upon a map as at once to tell its own story. Thus in Fig. 9 the sheet of rock H evidently forms a flat unconformable cake lying upon inclined and denuded strata. A section across this cake would disclose an abrupt junction of the horizontal beds on the edges of the steep and vertical series. But many cases occur where the discordance between the two series is far less strong, where indeed much care and labour may be required to make out an unconformability at all. For here again, as in the case of faults, the actual line of contact between the two groups of rocks is comparatively seldom seen. We must usually infer from their general arrangement and their relations to each other whether or not they are separated by an unconformability. In the diagram we have already used so much (Fig. 9) another and less violent unconformability is shown towards the north-west corner, where the series of beds K steal over the denuded outcrops of the series I.

In most cases it is possible so to express an unconformable junction upon the map as to make it readily apparent to the geologist. It should be the aim of the surveyor to neglect no item of evidence which will enable him to do this; for the more perfectly his map is self-interpreting, the more useful will it be. Hence where, as is so often the case, the ground is obscured by surface-accumulations, and a little liberty of choice is left to him as to the precise course along which to place his line of unconformability, he will draw his line in such a way as to show as clearly as may be that it is not a fault or an ordinary conformable junction.

In some districts, particularly in those where older formations are covered by more recent superficial accumulations, a double unconformability may often be seen. The accompanying diagram, for example (Fig. 12), represents what is exposed on a cliff section at Cullen, on the coast of Banffshire. The lowest formation consists of quartz-rock (*q*) in strata inclined at a high angle to the south-east. Their upturned

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ends are unconformably overlaid by red sandstones and conglomerates (*s*) dipping gently away towards the south-west. These beds are in turn unconformably covered by the glacial clays and gravels (*d*). This is an interesting and instructive section, inasmuch as it teaches us how rash it would be to form any conclusion as to the relative length of the intervals of time represented by the amount of discordance between unconformable formations. The break between the quartz-rock

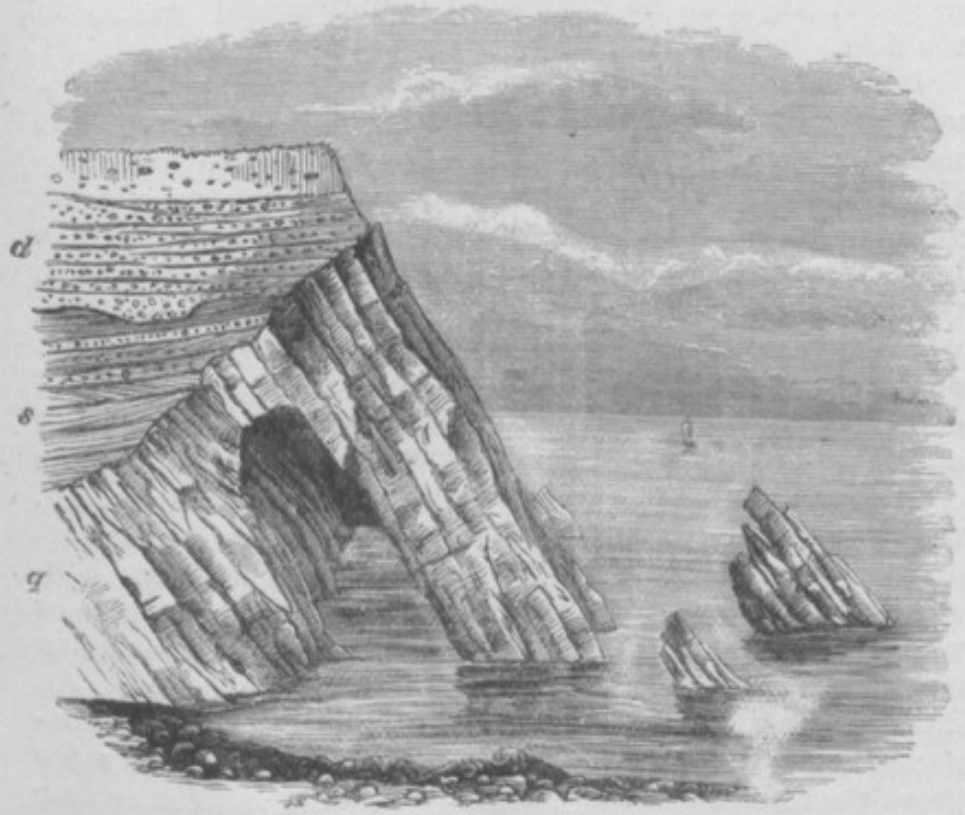

Fig. 12.—Double unconformability at Cullen, Banffshire.

and the red sandstones is apparently much more violent and complete than that between the sandstones and the glacial deposits. And yet there can be no doubt that in regard to geological age, the interval between the deposition of the quartz-rocks and that of the sandstones was greatly shorter than that between the sandstones and the overlying clays and gravels. It is evident indeed that sections might be found showing an apparently perfect conformability for a certain space between the sandstones and the glacial beds. Yet this

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local agreement in position would not be allowed to conceal the real and complete break between the two series of formations.

Igneous Rocks.—I have been speaking hitherto chiefly of the structure of the stratified rocks, although the same principles which serve to guide us in dealing with them are also in great part applicable to the igneous rocks. These latter, however, present some features of their own which mark them off in strong contrast with the former, and which the geologist can learn to distinguish only by actual practice in the field.

Igneous rocks for the purposes of field-geology are conveniently divisible into two great series—(1) the crystalline, including granite, syenite, with all the once melted rocks like the lavas; and (2) the Fragmental, including the consolidated volcanic ashes, tuffs, and conglomerates. The crystalline igneous rocks may either be intrusive or interbedded, that is, they may either have been intruded among the rocks with which they are associated, or they may have been poured out at the surface in sheets which in a great continuous series of deposits thus come to be interbedded between the strata below and those above them. It is of course evident that as these crystalline masses have all risen from molten reservoirs below, they were all originally intrusive in the earlier or deeper part of their course. Every interbedded sheet must have been connected somewhere underneath with the intrusive pipe or vein by which it rose to the surface, although the connection may have been subsequently destroyed or concealed. An intrusive mass, on the other hand, may never have been connected with the surface at all. Interbedded igneous rocks prove the former existence of active volcanic vents at or near the localities in which they occur. Intrusive igneous rocks may be due to ancient deep-seated movements in the crust of the earth which never gave rise to any of those surface manifestations which are usually held to be expressed by the term volcanic. An accurate discrimination between these two groups is of importance when the history of a volcanic district has to be made out.

I may briefly notice some of the main characters which distinguish the groups. An intrusive rock may occur in the form of a vein or dyke, a pipe or neck, a sheet, or an irregular amorphous mass. When it can be seen to intersect any of

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the beds of a series of strata, its intrusive character becomes at once apparent. But when it lies between stratified rocks, and assumes the form of a bed, some care is needed to make its intrusive character certain, for it might then be taken for an interbedded sheet. It is usually characterised by being much closer in grain near its junction with the other rocks than in the central parts of its mass. Again the rocks lying upon it are hardened, and sometimes exceedingly altered,

FIG. 13.—Upper surface of an intrusive igneous sheet.

while detached portions of them are now and then found to have been caught up and entangled in the crystalline mass below. A truly interbedded sheet on the other hand, is in fact a lava-bed which has been poured out at the surface, either on land or under water, and shows the distinctive characters of such a bed. Thus it is commonly rough and slag-like towards its top and bottom, and most compact about the centre. The beds lying upon it, having been

FIG. 14.—Upper surface of an interbedded igneous sheet.

deposited there after the emission of the lava, are not altered, have no portions of their strata entangled in the crystalline rock, but, on the contrary, may contain detached fragments of the latter.

Again, the position of the prismatic joints by which volcanic rocks are frequently traversed may sometimes suffice to indicate whether a rock is certainly intrusive or, possibly, interbedded. These joints start from the cooling surfaces

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of the original melted mass of lava. In a bed they are of course perpendicular to its upper and under surfaces; in a dyke or vein they vary according to the inclination of the mass, being horizontal when the dyke is vertical.

You will recognise the usefulness of such characters as these when you reflect that on the one hand they may enable you to trace the position of the volcanic vents or pipes; on the other, the course of the lava-streams which proceed from these points of emission. In the diagram, Fig. 9, the series of rocks marked P in the southern part of the map are examples of interbedded sheets and tuffs. They occur under circumstances very similar to those of ordinary stratified rocks. They dip one below the other in orderly succession, and are transverse by faults, like the beds of sandstone and conglomerate which lie below, between, and above them. In an actual volcanic cone, where only volcanic materials occur, a more complex arrangement is found. Lavas and tuffs there succeed each other in rapid alternations, often traversed by dykes or veins. Instances are comparatively rare where cones belonging to old geological periods have been preserved. It is not uncommon, however, to meet with what may be called the root or stump of the cone, from which all the over-lying pile of ejected materials has been worn away by denudation (V V in Fig. 9). This lower or downward prolongation of the original cone may consist either of masses of lava or other crystalline rock, or of consolidated fragmentary materials. In the latter case the tuff or agglomerate has sometimes become itself crystalline, owing, no doubt, to the long-continued upward passage of steam, hot vapours, and gases through the volcanic vent after the explosions ceased.

As illustrations of the way in which the structure of a volcanic region is worked out and expressed upon a map, I may refer you to the sheets of the Geological Survey of England and Wales, particularly 75 and 78, embracing the Snowdon region, and to sheets 22, 23, 32, 33, and 40 of the Geological Survey of Scotland, showing the development of the volcanoes of the Old Red Sandstone, Carboniferous, and Permian periods in the midland districts of Scotland.

Mineral Veins.—Like lines of fault, with which indeed they often coincide, mineral veins, that is, veins filled with segregated minerals of various kinds, different from the surrounding rock, do not in the majority of cases appear

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at the surface. Their existence must be determined from other evidence, therefore, than actual visible sections of them. If the geologist be at work in a district where veins of this kind occur, he should endeavour as early as possible to make himself familiar with the characteristic mineral substance which may constitute the chief part of the veins. Such minerals as quartz, barytes, calcite, and other "vein-stones," as they are called, are of common occurrence, but often exhibit local peculiarities by which they may be recognised and traced to their sources. Having examined the visible sections of some of the mineral veins, and learnt the way in which the vein-stones are associated with any metalliferous ore, he may be on the watch for evidence of the occurrence of the veins elsewhere. He follows with this view the same plan as that which I have already described with reference to the tracing of the limits of formations by means of scattered surface-fragments. In ascending a stream or a hill-side, he takes note of any marked number of pieces of vein-stone, and of the point beyond which they grow fewer or cease. Having thus got a rough indication of the existence of one or more veins, he proceeds to a more minute search over that part of the ground, and unless the rocks should be too much concealed, he may hope to meet with an indication of the actual outcrop of the vein. It is not always, nor perhaps often, safe to pronounce as to the commercial value of such a vein from surface evidence of this kind. The rock may need to be opened up, and boring or mining carried for some way below the surface before a reliable opinion can be expressed as to whether or not the vein may be worked to profit.

6. Construction of Sections.

The more clearly a geological map represents the structure of a country, the less need is there for any additional explanation, so that a perfect map, large in scale and detailed in execution, should be independent of sections or other assistance, except for data, which cannot be expressed upon a map. But such a map can comparatively seldom be constructed. We must be content with a small scale, an imperfect topography, and other defects which compel us to

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supplement the map with lines of section so drawn as to convey to the eyes of others exactly what we have ourselves seen or believe to be the geological structure of the district or country in question.

A section may either be horizontal or vertical, that is, it may show either what would be seen if a deep trench could be cut across hill and valley, so as to expose the relations of the rocks to each other, or else the arrangement and thicknesses of the rocks if we could pile them up into a tall column one above another in their proper order of succession. The vertical section is chiefly of use in detailed work, as, for instance, among coal-fields, where the various strata of one pit or part of a district are to be compared with those of another, or in localities like the coast-sections of the tertiary rocks of the Isle of Wight, where every stratum is exposed to view. Evidently a section of this kind requires good exposures of rock and careful measurements.

The horizontal section, on the other hand, must often be constructed where exposures of the rock are few, where minute measurements are impossible, and where the highest skill of the field-geologist is taxed to unravel the meaning of the facts he notes upon the surface, and to show their bearing upon the relations of the rocks below ground. The first point I would remark in the drawing of a horizontal section is, that where possible, the section should always be on a true scale, that is, the height and length should be on the same scale. Of course this is often impossible, for the ground may be low, and to show its true form in a section might require an extravagant and unnecessary length of paper. Still the geologist who would preserve, as he should, the relations between the external form of the ground and the structure of the rocks below it, will always endeavour to exaggerate the height of his sections as little as possible. I believe that nothing has tended so much to perpetuate erroneous notions regarding the physiography of the land as such distorted sections, sometimes almost grotesque in their exaggeration of natural forms.

As an example of the disregard which some able observers have had for truth of outline in their sections, let me place before you two sections of the same hill. On one of these (A), an eminent mineralogist, seems to have been content to represent in a kind of diagrammatic way the order of the

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formations, heedless of the utterly unnatural form of his hill. The other section (B) shows the true outline of the ground, on the scale of six inches to a mile, with the position of the rocks correctly inserted.

A further and familiar illustration of the effects of this neglect of the true proportions of the ground is offered to us by the case of the "London Basin." I presume most readers, when they meet with that phrase, think of a deep bowl-shaped hollow filled with clay and surrounded by a rim of chalk

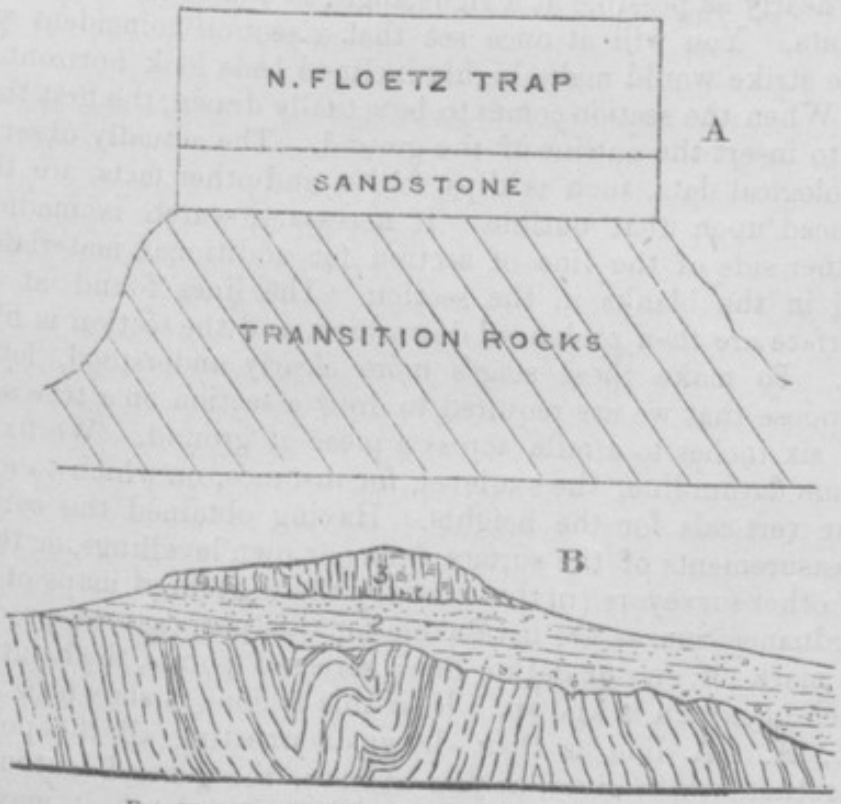

FIG. 15.—Illustrations of geological section drawing.

hills, and they probably recall one of the sections in popular manuals and text-books by which this impression was perhaps originally given to them. If, however, you construct a section across the London basin on a true scale, or if you examine that which has been constructed and published by the Geological Survey on the scale of six inches to a mile, you will find that so flat is the basin, so small the thickness of clay (500 feet) in proportion to the breadth of country

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over which it is spread (24 miles), that you need to look with some little care to be assured that there is really any basin at all.

The next point to be attended to in the construction of a horizontal section is the choice of the line of country across which it is to be drawn. It may be designed either to show the general structure of the country or the arrangement of the rocks in some particular part of it. In any case, while taking it over those portions of the ground where the structure is best seen, we should always bear in mind that it must pass as nearly as possible at a right angle to the strike of inclined strata. You will at once see that a section coincident with the strike would make highly-inclined beds look horizontal.

When the section comes to be actually drawn, the first thing is to insert the outline of the ground. The actually observed geological data, such as dips, faults, and other facts, are then placed upon that outline. If necessary, search is made on either side of the line of section for additional materials to fill in the blanks in the section. The lines found at the surface are then prolonged downward, and the section is filled in. To make these stages more clearly understood, let us suppose that we are required to draw a section on a true scale of six inches to a mile across a piece of ground. We fix on some datum-line, the sea-level, for instance, on which to erect our verticals for the heights. Having obtained the correct measurements of the surface from our own levellings, or those of other surveyors (in this country the contoured maps of the Ordnance Survey are invaluable for this purpose) we proceed to mark off on our datum line a series of points, the height of each of which is known. How this is done is shown in Fig. 16, A. A line is then drawn, connecting all the points together, which gives, as you observe, the general contour of the ground. To ensure greater fidelity of detail it may be well to walk over the ground with the plotted section in hand, so as to be able to fill in any little inequalities of surface, and at the same time to look once more for evidence as to the nature and structure of the rocks below. The drawing in Fig. 16 B, represents the outline as so modified by a visit to the ground. On this same drawing all the geological data are inserted which are supposed to be actually seen either on the line traversed by the section, or in the immediate vicinity of it. But a more extended examination of the district would

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no doubt supply many data not obtainable on the precise course of section, and permit the lines to be prolonged downward, and the whole section to be filled in somewhat in the manner shown in C. The section in Fig. 9, shows the structure of the country represented in the map, and illustrates the application of many of the terms which I have made use of in these lectures.

You may well believe how impossible it is to find a place here for all that might be said in the way of suggestions for

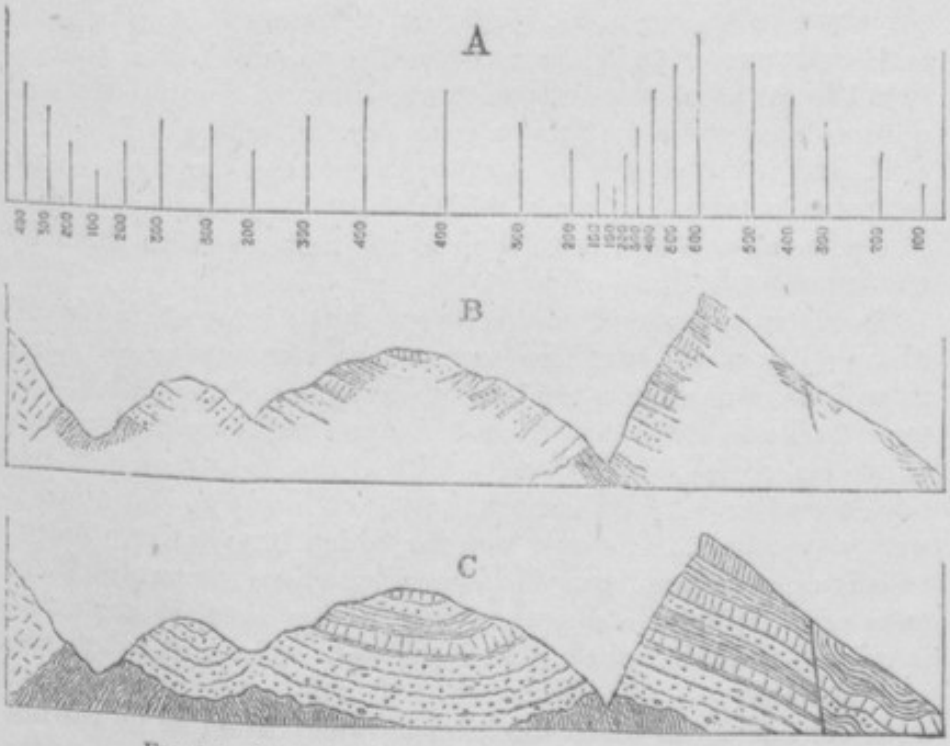

FIG. 16.—Stages in the construction of a geological section.

the field-geologist. There are still one or two parts of the subject, however, to which, at the risk of trespassing too long upon your patience, I should wish to be permitted to refer. I have been treating of the solid rocks and their underground structure. But they present some features to which I have not alluded, and which have a special interest in reference to the character and origin of diversities of landscape. One of the most familiar and important of these features presents itself in the form of what are called *joints*, that is the clean,

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sharp, and usually perpendicular or highly-inclined divisional planes by which all rocks are traversed. Every one who has looked into a quarry or railway-cutting, or has seen a coast-cliff or a river-ravine, has had many a joint under his eyes. They are familiar to the quarryman and miner, by whom their directions are always well-known, seeing that they determine the course along which quarrying and many mining operations proceed. When the geologist is engaged in hilly or mountainous ground, among crags and rock-pinnacles, or on exposed coast-cliffs, he should not fail to note with some care the trend of the different joints. He will soon find that they in each place run in two or more dominant directions. And a little further examination will usually suffice to enable him to connect the forms of the cliffs with the lines of joint. He will observe how one set of joints runs parallel with the face of a cliff, and is cut across by another series, and how the quadrangular buttresses of rock, which shoot up perhaps into spiry pinnacles at the top, have their shape first given to them by the intersecting lines of joint.

Another superficial character of much interest is found abundantly in the northern parts of the northern hemisphere, as well as in mountain-tracts in other regions of the globe—the smoothed and striated surfaces left upon rocks by the passage of sheets of ice across them. When the field-geologist has once seen this kind of surface, he is not likely to confound it with any other. The only one for which it sometimes might be mistaken is that termed *slickensides*, where the two walls or faces of a joint have slid upon one another so that each side is rubbed smooth, polished, and grooved. But a little practice and the study of good examples will soon give the observer such confidence in discriminating between them as he cannot acquire in any other way. He ought to take with his compass the direction of the groovings and striæ on the rock. If possible he should at the same time determine from which quarter the ice has moved. This may often be done by observing in what direction little prominences and the edges of angular projections are rounded off, and to which side the still rough and unstriated portions look. The ice must evidently have moved from the quarter to which the smoothed faces are presented and towards the quarter to which the rough parts are turned. This is shown in Fig. 17, where the arrow indicates the trend of the ice-movement. The way in

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which an observation of this kind may be indicated on the map is shown in the index of signs in Fig. 4. By a sufficient number of such observations in a district, the path of the ice across it may be very clearly expressed.

There is another useful method of supplementing this evidence from rock-striations as to movements of the ice; but it cannot usually be put into practice until after the observer has made some considerable acquaintance with the geology of the whole region. In countries which have been under ice, and where the rocks retain the characteristic ice-markings, the surface commonly presents abundant accumulations of boulder-clay, gravel, and other deposits belonging to different conditions of the long glacial period. A search through the

FIG. 17.—Ice-worn hummocks of rock, the arrow pointing in the direction of the ice-movement.

stones and boulders of those deposits will in most cases disclose the fact that these fragmentary materials have been moved a greater or less distance from their parent rocks. In the clays the stones are often as well striated as the solid rock below (Fig 18). Pick out at random two or three hundred stones from any section of boulder-clay or moraine-stuff, and note down the proportions in which each variety of rock occurs among them. You will find perhaps that 50 or 60 per cent. may have been derived from rocks in the immediate vicinity, that 20 or 30 per cent. have perhaps come a good many miles, while the remainder (usually small in size) may possibly be traced to some of the most distant rocks in the drainage-basin of the region. You learn from such an analysis the general

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direction of the ice-stream, and see that it agrees with the evidence furnished by the striæ on the rocks.

It is desirable that the field-geologist should remember that at any moment some of his observations may be found to have an economic use in the practical applications of geology. As he cannot always tell which may prove to be capable of this application, he should try to make them all as full and reliable as the evidence to be had will permit. I need not of course do more than allude to the value of any notes as to the position of metallic ores, seams of coal, or other economically valuable minerals. But not less important may be the apparently trivial question as to the direction and angle of strata at the surface, for the careful determination of these points may show the depth to which a well or mine may

Fig. 18.—Ice-striated stone from the boulder-clay.

require to be sunk. From what I have already said regarding the method of taking the dip, and protracting the angles on a section line, you can understand how the evidence of an experienced field-geologist should be of high value in questions of water-supply, and how it is that he can often tell the depth within a few feet at which any particular water-bearing stratum will be met with.

In fine, if I have succeeded in laying before you a definite picture of the aims and methods of field-geology, you will doubtless admit that though you may never become professional surveyors, nor claim in any complete sense the title of field-geologists, you cannot devote even a small portion of your time and attention to this subject without deriving a real and solid advantage from the pursuit. It accustoms you to habits of observation, provides you with a

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delightful relief from the cares and routine of every-day life, takes you into the open fields, brings you to the free fresh face of nature, leads you into all manner of sequestered nooks, whither hardly any other occupation or interest would be likely to send you, sets before you problems of the highest interest regarding the history of the ground beneath your feet, and thus gives a new charm to scenery which may be already replete with attractions. Even, therefore, should you never write a single sentence of geological description, or venture to put one geological line upon a map, you gain from the prosecution of field-geology many a happy and profitable hour, alike in the country to which the pursuit leads you, and in your own homes with quiet reflection on what you have seen and done in the field.

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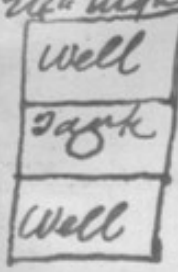

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? have these pages been noted

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Calico 18 in long 12 wide (cheap) for algae

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3. AN IRON WRENCH to loosen the screw-caps of the copper kettles, when too tight to be managed by hand.

4. TWO INDIA-RUBBER BAGS, one for each kettle. These are intended to be inflated inside of the kettles, and by displacing the alcohol cause it to rise to the edge of the brass cap, and thus fill the kettle. Unless this is done, and any unoccupied space thus filled up, the specimens will be washed against the sides of the vessel, and much injured.

5. SMALL BAGS MADE OF LINO, MOSQUITO-NETTING OR COTTON, of different sizes, and open at one end. These are intended, in the first place, to separate the specimens of different localities from each other; and, in the second place, to secure them from mutual friction or other injury. The number or name corresponding to the locality is to be marked on the outside with red chalk, or written with ink on a slip of parchment, and dropped inside. The specimens are then to be placed in the bag, a string tied round the open end, and the bag thrown into alcohol. The ink of the parchment must be dry before the slip is moistened in any way.

N. B. Fishes and reptiles over five or six inches in length should have a small incision made in the abdomen, to facilitate the introduction of the alcohol. Larger snakes and small quadrupeds may be skinned, and the skins placed in alcohol.

6. RED CHALK PENCILS for marking the bags.

7. PARCHMENT to serve as labels for the bags. This may also be cut up into labels, and fastened by strings to such specimens as are

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not suited for the bags. Leather, kid, buckskin, &c., will also answer this purpose.

8. FISHING-LINE AND HOOKS.

9. SMALL SEINES for catching fishes in small streams. The two ends should be fastened to brails or sticks (hoe-handles answer well), which are taken in the hands of two persons, and the net drawn both up and down stream. Fishes may often be caught by stirring up the gravel or small stones in a stream, and drawing the net rapidly down the current. Bushes or holes along the banks may be inclosed by the nets, and stirred so as to drive out the fishes, which usually lurk in such localities. These nets may be six or eight feet long.

10. CASTING-NET.

11. ALCOHOL. About five gallons to each travelling party. This should be about 80 per cent. in strength, and medicated by the addition of one ounce of tartar emetic to one gallon of alcohol, to prevent persons from drinking it.

12. ARSENIC in two-pound tin canisters. This may be applied to the moist skins of birds and quadrupeds, either dry or mixed with alcohol.

13. TARTAR EMETIC for medicating the alcohol as above.

14. COTTON OR TOW for stuffing out the heads of birds and mammals. To economize space, but little should be put into the bodies of the animals. The skulls of the quadrupeds had better be removed from the skins, but carefully preserved with a common mark.

15. PAPER for wrapping up the skins of birds and small quadrupeds, each separately. The paper supplied for botanical purposes will answer for this.

16. BUTCHER-KNIFE, SCISSORS, NEEDLES, AND THREAD, for skinning and sewing up animals.

17. BLANK LABELS of paper with strings attached for marking localities, sex, &c., and tying to the legs of the dried skins, or to the stems of plants.

18. PORTFOLIO for collecting plants.

19. PRESS for drying plants between the blotting-paper. Pressure is applied by straps.

20. VERY ABSORBENT PAPER for drying plants.

21. STIFFER PAPER for collecting plants in the field. The same paper may be used for wrapping skins of birds and quadrupeds, as well as minerals and fossils.

22. SMALL BOTTLES for collecting and preserving insects.

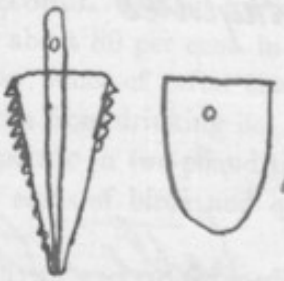
Small traps & springs for do. Steel traps 177
musk rat spear (sword stick) for dislodging
burrowing animals.
Emall &c

above proof (very) methylated

wood ashes better than peat?
chalk as an absorbent for blood
&c

Drying boxes of light wood to take 10 pieces perforated zinc + hook to hang up by folding doors.

JR. sheeting for covering specimens.

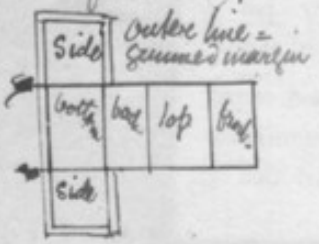
Stretching boards.  or tow or bent + inserted in the skin to keep distended whilst drying

brain scoop, files, cutting pliers, plaster of paris

Gardner (Oxford St) says best preserve:- 2 oz salts of tartar, 1 oz ammonia to scrub with hot water dry with sawdust + then pickle in 1lb oatmeal, 8 oz corr: subl: + 1 gall vinegar for 2 days.

For preserving:- 6 oz arsenic 3 oz corr: subl: 2 oz yellow soap 1 oz camphor 1½ pints spirit mixed, placed over slow fire stirred + kept in wide mouthed bottles. Oil of turpentine to remove shots + plaster of paris + chalk to absorb it

Specimen boxes cut out of flat card + kept flat till ready for use (Galton).



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23. GEOLOGICAL HAMMER.

24. DOUBLE-BARRELLED GUN AND RIFLE.

25. FINE SHOT for small birds and mammals. Numbers 3, 6, and 9, are proper sizes: the latter should always be taken.

26. A POCKET CASE of dissecting instruments will be very convenient.

27. BLOWPIPE APPARATUS for mineralogical examinations.

28. POCKET VIAL for insects.

29. BOTTLE OF ETHER for killing insects.

30. INSECT PINS.

31. CORK-LINED BOXES.

§ II. INSTRUMENTS, PRESERVATIVE MATERIALS, &c.

1. IMPLEMENTS FOR SKINNING.

The implements generally required in skinning vertebrated animals are: 1. A sharp knife or a scalpel. 2. A pair of sharp-pointed scissors, and one with strong short blades. 3. Needles and thread for sewing up the incisions in the skin. 4. A hook by which to suspend the carcass of the animal during the operation of skinning. To prepare the hook, take a string, of from one to three feet in length, and fasten one end of it to a stout fish-hook which has had the barb broken off. By means of a loop at the other end, the string may be suspended to a nail or awl, which, when the hook is inserted into the body of an animal, will give free use of both hands in the operation of skinning. Knife with hooked blade

2. PRESERVATIVES.

The best material for the preservation of skins of animals consists of powdered arsenious acid, or the common arsenic of the shops. This may be used in two ways, either applied in dry powder to the moist skin, or else mixed with alcohol or water to the consistency of molasses, and put on with a brush. A little camphor may be added to the alcoholic solution. There are no satisfactory substitutes for arsenic; but, in its entire absence, corrosive sublimate, arsenical soap, camphor, alum, &c., may be employed.

The proper materials for stuffing out skins will depend much upon the size of the animal. For small birds and quadrupeds, cotton will

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be found most convenient; for the larger, tow. For those still larger, dry grass, straw, sawdust, bran, or other vegetable substances, may be used. Whatever substance be used, care must be taken to have it perfectly dry. Under no circumstances should animal matter, as hair, wool, or feathers, be employed.

§ III. SKINNING AND STUFFING.

1. BIRDS.

Whenever convenient, the following notes should be made previous to commencing the operation of skinning, as they will add much to the value of the specimens:—

1. The length, in inches, from tip of bill to the end of the tail; the distance between the two extremities of the outstretched wings; and the length of the wing from the carpal or wrist-joint. The numbers may be recorded as follows: 44, 66, 12 (as for a swan), without any explanation; it being well understood that the above measurements follow each other in a fixed succession. These numbers may be written on the back of the label attached to each specimen.

2. The color of the eyes, that of the feet, bill, gums, membranes, caruncles, &c.

3. The date, the locality, and the name of the collector.

4. The sex. All these points should be recorded on the label.

Immediately after a bird is killed, the holes made by the shot, together with the mouth and internal or posterior nostrils, should be plugged up with cotton, to prevent the escape of blood and the juices of the stomach. A long narrow paper cone should be made; the bird, if small enough, thrust in, head foremost, and the open end folded down, taking care not to break or bend the tail feathers in the operation.*

When ready to proceed to skinning, remove the old cotton from the throat, mouth, and nostrils, and replace it by fresh. Then take the dimensions from the point of the bill to the end of the tail, from the tip of one wing to that of the other, when both are extended, and from the tip of the wing to the first or carpal-joint, as already indicated.

* Crumpled or bent feathers may have much of their elasticity and original shape restored by dipping in hot water.

Good. Pig skin case 2'6" long, 8" wide with pocket at one end 4" deep + width of case + 1 thin flap sewn on each side. Leather straps ½" wide sewn at intervals (looped). 2 pair scissors, 4 bladed knife, strong shutting up scalpel, pair bone nippers, few bent needles, 2 pairs strong forceps closing with spring. 2 camel hair brushes. Glass syringe [metal]. Shallow tin box to fit in pocket. This ÷ into 3. 1 large + 2 small, the larger to hold pow.d arsenic + the others 1 with camphor the other bichl. mercury (corr: subl:) Thin cake of Common soap. Tow, cotton, Chloroform, sponge, white lead, linseed flour, s/h sheet, oil black varnish for cov.g bottles. Straps for splints, plaster, lint, brushes, knives, lunar caustic &c all in one case —

Carbolic acid good quantity. 1 spoonful to 1 pint of water, and wash.

Sea Exploring glass tube 9" wide at top + 18" bottom glass fixed at bottom, 3 ft long.

Chloride Zinc Concent. sol 1 pt to 20 of water. Good preservative medium.

Botany.

Vide Taylor's Hints on Collecting

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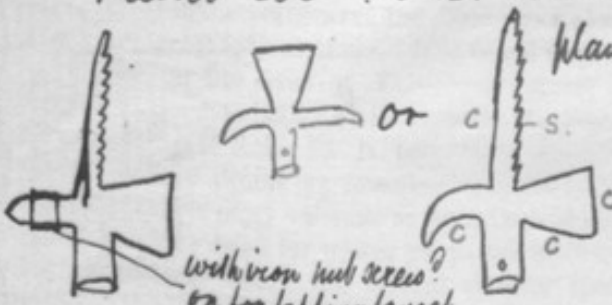
Plant coll? instrument Haarlem form (pruning saw etc)



Plant halbert C = cutting edge
S = Saw "
on staff with muskrat spear
+ shut up saw with knife back.

with iron nut screw? or for lopping lanceolate shaped-

Algae 1. small iron or tin ladle 2 in across with toothed rim + hollow handle.
2. small wire sieve with fine meshes + handle
3. Common iron spoon
4. Casparys' rake + attached rope length 10 distance between teeth $\frac{3}{4}$". line 50-100 ft long.
5 Oiled paper, wax cloth or vr oiled sheeting.
6. small bottles, lens.
7. Vasculum, hammer, mason's chisels + portfolio for Characeae
8. weed knife > + pipette

Fungi. 1. Bag or knapsack stiff sides or better still a large vasculum.
2. Ola book, 3 clips + pill boxes + vv. m. bottles thin
4. paper (1/4) 5 sharp strong knife. Garden trowel or carpenters gouge in leather case. Make drawings whilst fresh. collection of spores

Mosses. strong knife, chisels, waterproof bag or vasculum bottles

Ferns + Phanerogams. Long vasculum, strong knife + saw. Long triangular trowel in case + Billhook 15" long blades 7/8" across at 4 1/2" from handle.

Lichens. a solution of prussiate of potash for lichen color reactions Geol. hammer, pruning knife spatula

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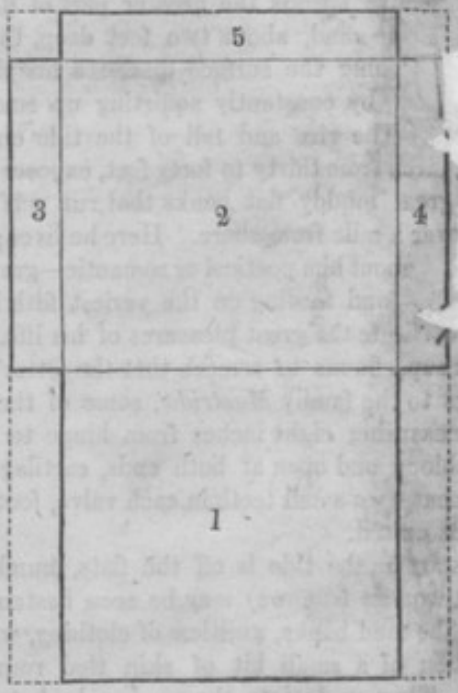
offer myself as a guide to give the benefit of my experience, and am induced to do this from having seen several papers on the mosses in various periodicals, evidently written by persons who had not studied what they wrote about; the advice given being rather calculated to mislead those who acted upon it. The first thing necessary (after making up the mind that, if anything is to be studied at all, it must be done in a proper, that is, in a *scientific manner*, and entails *real work*) is to provide a suitable text-book; and the only serviceable one in the English language on the British mosses is Wilson's "Bryologia Britannica." The next requirement is a microscope—we shall want two: a dissecting, and a good compound microscope; likewise a pocket-magnifier; we shall also require a *two-inch objective* to the microscope. Without good magnifying power no real good can be accomplished. The following are also requisite: a gross of glass sides, 3 inches by 1; a gross of india-rubber rings, ¾-inch diameter, *outside measurement;* an ounce of round, thin, glass covers, ⅝-inch diameter; some *dead*-black paper, and a steel punch, ¾ inch diameter; a bottle of Canada balsam; a bottle of glycerine, to be mixed with equal parts of camphor-water; a bottle of asphalte; and a Shadbolt's turn-table, for making shallow cells; half-a-dozen glovers' triangular needles, for dissecting; a few camel-hair brushes; and a small vice, to fix on the table (this last makes a splendid section-machine, by placing the object between two pieces of cork, and with a sharp knife or razor, made flat on one side, taking a thin slice of the cork and object together); a few quires of blotting paper, and a memorandum-book, complete our requirements.

Before collecting, it will be advisable to get a general idea of the FAMILIES and GENERA of the mosses; and this will be best accomplished by carefully studying the descriptions given by Wilson, at the same time constantly referring to his beautiful plates, until the *family-likenesses* are imprinted on our memory; and it is in addition a considerable help to enter into the memorandum-book all the most important parts of structure, and the principal distinguishing marks of the genera. We shall thus, from knowledge gradually and imperceptibly acquired, know when we get a *Sphagnum*, a *Weissia*, a *Tortula*, a *Bryum*, a *Hypnum*, &c.; and the genera more closely alike—as, *Trichostomum* and *Tortula*, *Racomitrium* and *Grimmia*, *Dicranum* and *Campylopus*—will also soon be easily distinguished.

Now for collecting; and all that is needful is a bag of good, strong material (such as lawyers use), a couple of newspapers torn into, say nine-inch squares, and a good, strong oyster-knife.

My advice is, eschew all *tin vasculums*. A moss having been found, take it carefully up (with the knife), wrap it in a piece of paper, and place it in the bag. The day's work finished, on arriving home we shall have clean, unbroken specimens, very different from the unsightly heap turned out from an ordinary vasculum. Having made out the names of several, we put the specimens into *cold* water, clean by means of a camel-hair brush, place on a white linen cloth, gently press them, and then lay on a sheet of blotting paper, with small slips bearing name, date, &c., cover with another sheet, and so on, put some l book on top to press—*avoiding too great a weight;* and when the specimens are dry, by means of gum fasten them on to the *inside* of the *second* leaf of a sheet of note-paper; write on *outside* of *first* ... the family at top, the genus in the middle, ... the species, habitat, &c., at the very bottom, commencing at extreme left hand. As, by the *slightest* ... mosses lose much of their character, it is requisite to have a quantity *unpressed*, but classified and arranged for reference. These specimens should be made up in paper bags formed of note-paper, thus—



Take half a sheet, turn up the lower edge to within half an inch of the top, fold the top over it, then turn the sides about half an inch over and inwards, open out the paper, and it will appear as represented in the above figure; cut away the dotted part, fold 1 on 2, then the sides 3 and 4 over that, and 5 over all. The bags thus formed will contain your unpressed specimens; write genus, species, habitat, on the outside of No. 1, and arrange in cigar box.

We now come to the most fascinating part of study, viz., the collection of microscopic dissections of leaves, capsules, peristomes, &c. These are as valuable even to the beginner. The first thing to be done is to take the ¾-inch punch, and cut a number of circles of dead-black paper; gum these upon the centre of the 3-inches-by-1 slides; when dry, take

1863

seaweeds v. Harvey (Nereis Boreali-Americana)

wire drying & coll? boards (Dr Zimmen's) or lattice
wood work
Mela book —

Zinc dishes for floating out. Cabics. blotting paper bowls, porcupine quills, camel hair brushes, brass forceps

Corr: subl: in spirit (camphorated) ½ dr. to 1 oz.
For Objects of perforated zinc of size to fit in the dish. All these can pack in the dish - Press with perforated or lattice tops etc with 4 iron bolts with thumb screws.

an india-rubber ring, dip a camel-hair brush in asphalte, and by it fasten the ring exactly over the circle of black paper; *reverse the slide*, so that the ring may dry and adhere evenly. Then take a few more glass slides, and by the aid of the "turn-table" make a circle of asphalte in the centre of each, apply another coat of asphalte when the first is dry, and we shall then have shallow cells for leaves, &c.

Let us now take a moss—say, the commonest species, such as *Funaria hygrometrica*, or common cord-moss,—select a few of the capsules (they are mature when of a fine golden-brown colour); take out a slide with an india-rubber ring on, the gum, our dissecting microscope, and two glovers' needles. We first gum all over the dead-black paper; place thereon, longitudinally, a capsule bearing calyptra, &c., and a small portion of the seta; another capsule with the calyptra off, showing the operculum side-view; another with the operculum off, presenting a side-view of the peristome. Then add upper half of capsule cut in two *transversely*, and placed upon end so as to show the peristome *in situ*. Now take one of the shallow cells made of asphalte, and fill it with glycerine and camphor-water; in this place leaves from the stem, branch, and perichætium; use another cell for the operculum, calyptra, and annulus, and another for the inflorescence. When the slides are finished, put a label on one end like this. The upper figures refer to the family, 58 to the genus, 1 to the species. These slides should then be arranged for ready reference in boxes. I find the shilling boxes holding two dozen most convenient, as they will stand on end, and can be placed like books on a shelf or in a book-case.

XXII.
58 · 1.
Funaria hygrometrica.
PERISTOME.

I have said nothing about manipulation, as that can be obtained in any work on the microscope; but would point out that the best method of dissecting the peristome is to run the smallest entomological pin you can get through the centre of the capsule; fasten it down to a piece of cork, cut it in two transversely, just below the mouth—nearly all the spores will come out; transfer that portion which has the peristome only to a slide with a little water, and gently brush away the few spores that may adhere; and then place on another slide, arrange, and finish off. If we place the whole capsule on a slide with water at once, we shall never get rid of the clouds of spores, and after fruitless endeavours to obtain a clear view of the peristome, be obliged to give it up as a bad job.

In conclusion, I need only remark that if the mosses are studied in the way I have endeavoured to point out, the student will in time have a most valuable collection; and in its formation will derive

f. 227 r

F. 227

SELF-HEATING BOX-IRON.—In last month's Notes and Queries I observe that "M." inquires for a simple apparatus "by which an iron may be quickly heated" for drying plants, "independent of the kitchen fire." There is such an apparatus to be obtained from Mr. Kent, 199, High Holborn (price 6*s.* 6*d.*), called the "Self-heating Box-iron," of which it is said: "It may be heated at pleasure in

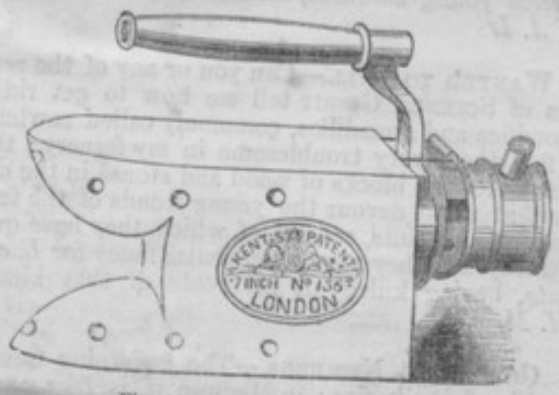


Fig. 225. Self-heating Box-iron.

"The Original Constitution of Plants & Vegetable Substances by Dr. G.C. Wittstein. Trans. Baron F. Mueller (Melb. McCarron Bird & Co

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three minutes without a fire, and will remain hot at a nominal cost for any length of time." Without any explanation of its object and utility, its very name must convey the idea that it possesses great advantages. This will, perhaps, answer your correspondent's purpose.—*W. Q. C.*

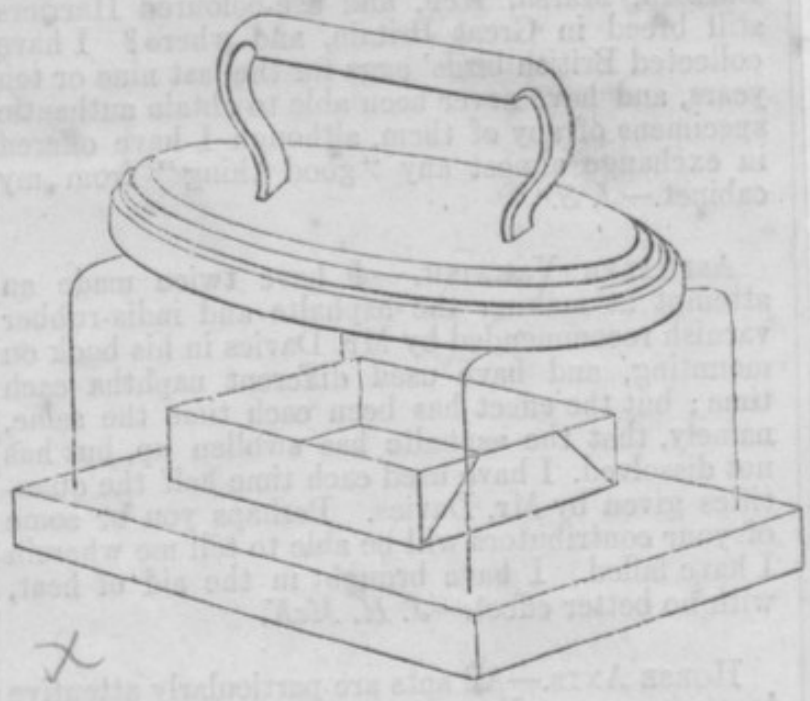

Fig. 226. Contrivance for Heating an Iron.

Ironing Plants.—Enclosed is a drawing of an instrument (fig. 226) made and used by myself for ironing botanical specimens, which will meet the travelling needs of your correspondent "M." The size of the apparatus depends on the size of the iron used, and the best shape is that indicated on the drawing. The footboard—1 inch thick, made of seasoned wood—should be rather longer, and 1 inch wider than the iron. Two pieces of iron wire $\frac{1}{8}$th inch thick should be bent twice at right angles, so that the ends being firmly inserted into holes $\frac{3}{4}$ inch deep, near the corners of the board, the iron may be supported 4 inches at least from the board. A small trough, made all in one piece, of thin sheet iron, serves to hold some spirit or wood naphtha,—few trials sufficing to ascertain the quantity requisi to heat the iron to the proper temperature. Whe travelling, the wires are removed, and, with th iron, laid flat on the board; the trough (containin a box of matches) packs under the iron handle. The whole is wrapped up in a stout piece of canvas, secured by a strap. The canvas, when properly folded, serves as a protection to the hand from the hot iron.—*J. B. Spencer.*

a a low dish like those used for [illegible]
(large patty tins) would do for the
sponge

Osteology - Flower's Osteology of Mammalia
Owen Compar: Anat: of Vertt Invertt
Huxley – do –
v. Childs No 117 &c: Gossip
on Macerating.

Ornithology. spiked boots + climbing straps 4 bags.

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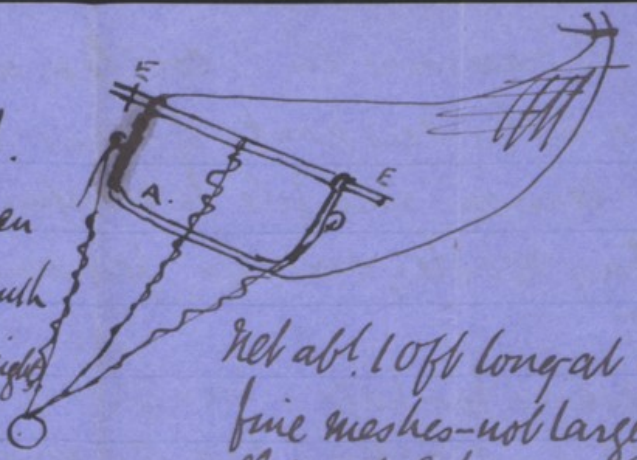
Keer drag for H.H.



A rod of iron long enough when bent to leave 8 ft for the mouth lengthways. & 16 inches side height through the holes a rod of wood light enough to always keep upright & bolted with pins

Net abt 10 ft long at end very fine meshes - not larger than coal sieve & of strong netting twine. End only tied with twine

Leads for fishing - Basket - Gaff (a good cod or hake hook lashed to a stick) - Spoon bait - baits - make them -

Harpoon arrow. Bow short & strong - arrow tipped with 4½ inch large sea fish hook straightened. fastened with waxed silk to the shaft & the line 30 yds fine prepared (2 or 3 looped on at ~~to~~

Outfit for abroad - Rod, winch, 2 strong deep sea lines, few lines round plait 5 to 9; few large sea hooks, & as large a quantity of Limerick & Kirby trout pattern, all sizes & 5, 6 & 7 sea & 4, 5, 6 whiting Pollock mouth pattern as possible. Few doz swivels No 4 brass, & 5 "O" brass

(cont'd). soft brass wire, tin of cobblers wax; carpet thread, few skeins of strong silk. few hanks of clear round eelworm gut. a small fine lennon-saw file to sharpen hooks. Pocket knife strong, netting needles, & meshes; few hanks of twine, scissors, gimp, spoon baits.

Dressing for lines – best glue ½ lb. water ½ pint, & warm gradually until dissolved. Boil line 20 minutes. Dry in the sun. ~~Boil~~ Boil in [half pound] catechu solution [to 1 pt. water] for ¾ h. hang it up to cool, wash in cold water, dry.

Finishing varnish – for whipped parts &c. Shellac ½ oz, naptha 2 oz mix & allow to dissolve. apply with brush.

Fishing. hooks. large quantity river & sea various sizes

~~rod~~ strong brass swivels; few hanks of stout gut & fishing lines, hemp or cotton sea lines, salmon lines - all lines to be barked or tanned

harpoon heads, trout spears.

Long trunk or bow net, seine net, twine &c, grapnels shark hook, dolphin grains.

Tinned iron fish hooks. (sea)

Sea do. (Lord) Lines round flail, waterproof? (for small & medium fish) Lloyds, Redditch. wooden frame roller

Rod. 4 jointed 18ft bamboo 2 tops canelancewood, stout rings, wood & wooden ball at end

Winch brass to hold 60 yds

Bolters stout deep sea line with hooks every 4 ft line floated with cork every 10 ft

Salmon & sea trout rod butt ash, next hickory, tops lancewood & split cane, large rings. reel to hold 100 yds of line (mixture of silk & horsehair) limerick hooks

Fish cage, shrimp net. sand net for pushing before you on sand

? Wrasses Sea Perches

Angling

Bottom fishing - rod strong & light average length bank rod 17 ft or 18 sometimes 24 ft. If furnished with 2 or 3 spare tops of diff. degrees of stiffness & length it will do for a general rod In rod more than 3 or 4 lengths. The butt piece bottom to hold spare tops. It may be fitted with a spike at bottom, ringed & fitted with 2 winches for trolling & fly fishing. Hickory is good, but better for a middle piece a sound wood ash or willow & the top cane or greenheart thorough good brass joints or spliced. They should be carefully cleaned & varnished at end of season with Copal varnish

For bottom fishing fine horse hair or gut is best. gut dyed bluish tinge

For fishing wrench line & for ordinary use in bottom fishing either horse hair, horse hair & silk or silk bell hair alone are best. For worm Hooks, for worm fishing the long-shanked hook perfectly round in the bend is best. For gentles, paste & grain the short shank, sneck bend hooks are preferred. Fine whipping is of fine silk waxed for salters use coarse small cork floats for general fishing, but for carp roach & chub a small quill must be used Cement for joining floats & keeping out the water at the lips use 1 oz beeswax; 5 oz of yellow resin in an earthenware vessel an oz of Venetian red & plaster of Paris Melt it boil slowly & then stirred until cold

a little melted sealing wax & the varnish generally enough for the floats. The liquid dyes are exceedingly good. Green is the best best color

Plummet lead is a rolled piece of lead

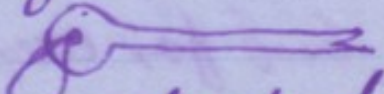
Panier basket or Creel French

Haversack waterproof cloth

filled with 2 buttons & strap 20 inches by 12 in deep division in centre

Drag hook

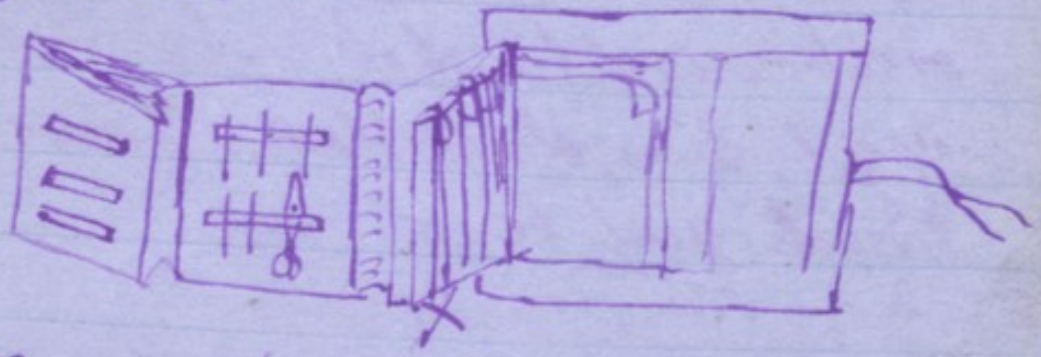
Clearing ring to slip over the rod to bottom of line & disentangle the hooks

Disgorger 

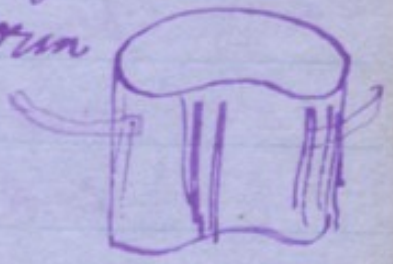
Gaff. a large sharp deeply barbed hook, similar to a large fishhook screwed in to the end of a rod for cutting away weeds

Landing Net close meshed

Anglers pocked book 7 in long 5 wide like a Tailors pattern book + many pockets.



Scissors, Knife, pliers, wax, float hooks, gut hair, waxed silk. thread barley, needles, fly materials + winder for six bottom lines.
Minnow or bait kettle fitted with brass Tentacular form



Waterproof stockings—
Waterproof for boots 3 parts of tallow 3 parts
yellow resin 1oz melted + rubbed in warm soles + tops. a little beeswax dissolved in turpentine + a little lamp black will give a good polish.

bait boxes for gentles, flannel bag for worms, small paste box or a piece of oiled silk, pieces of lead or a box of shot, extra lengths of gut, lines, spare float, float cds, reeds gaff &c. white way.

Bottom fishing

rod strong & light one or 2 tops in reserve.
lines of gut - for roach each hairs horse hair
very small float -
quill floats best for roach & carp
cork " " " perch, tench, bream & barbel

Trolling rod light, firm, strong & easily wielded. 12 ft answer every purpose 12 ffeet of bamboo or hickory. Top joint of greenheart thickory middle joint. 3 tops are necessary for the different width of river &c

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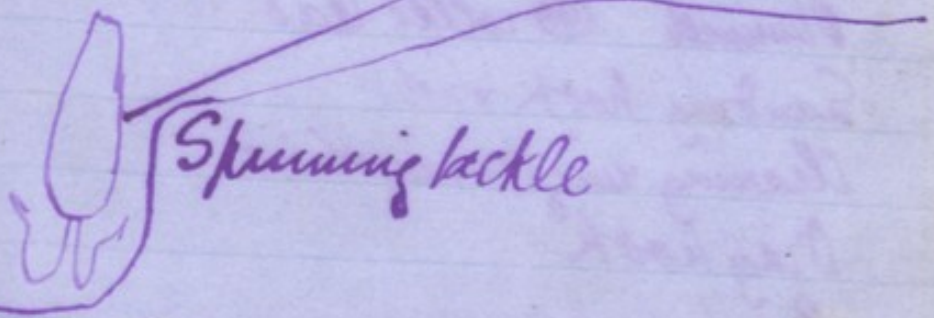
Best lines for the same is 50 to 80 yds of eight-plait dressed silk a series of gorge hooks, spinning flights, traces, swivels



Spinning tackle

Fly fishing. rod 10 to 12 ft long cliff size line only ab. 12 ft long ab size for first trial

Salmon rod - 18 ft long with winch holding 80 to 100 yds of best line of plaited silk the casting line of the strongest 3 ply twisted gut

In another work is the following
1. Rod 14 ft. 3 tops ie 1 stiff for bottom trolling & 2 for fly
2 reels or winches one holds 35 yds silk & hair for fly & the other 40 the strongest for bottom trolling

Creel, bait box 8 in long, 4 deep & 6 wide
landing net, wax, Knife, sharp point
scissors, pocket book

Hooks 8.9.10.11.12

Plummet ◎ rolled lead

Landing hook & net.

Clearing ring (brass) & line

Drag hook

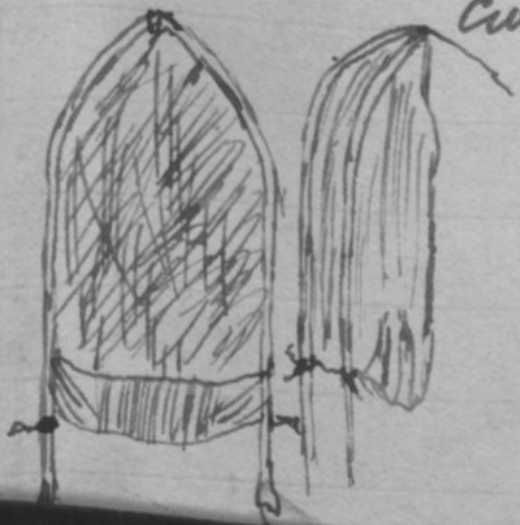
Bank runner

Disgorger

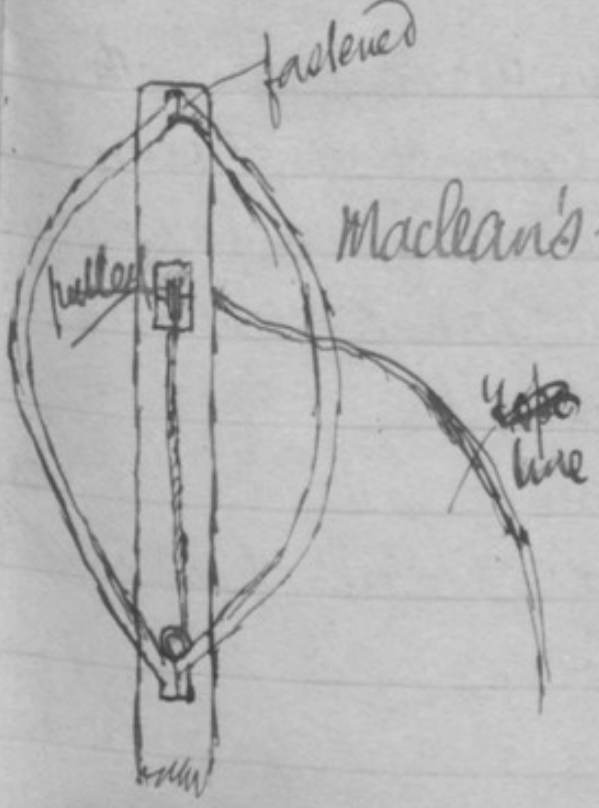
Chemistry set of apparatus for examination 197
of economic products etc

Fly net, Elastic net, bag net, landing &
forceps, digger. Phials, chip boxes
breeding cages pins, braces, pocket
boxes, Corkboxes. Benzine to remove
grease spots

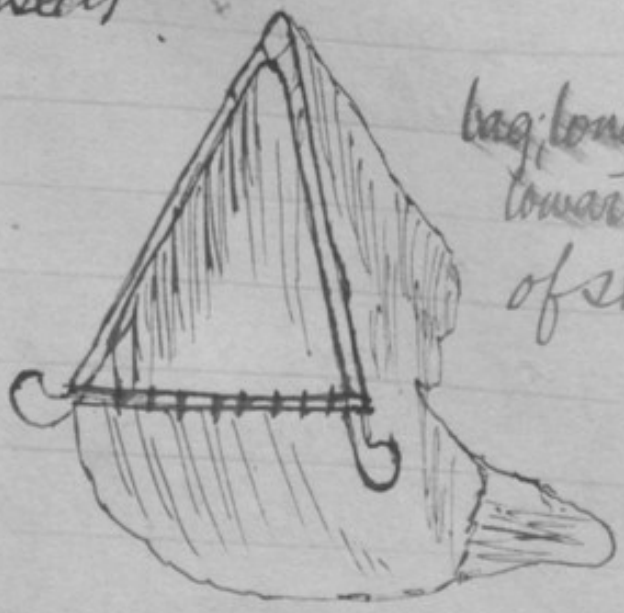
Fly net - rods 5 or 6 ft long jointed, last one
curved one of cane
Strong leather joint.
gauze of green or cobalt } Strong
Character



muslin or gauze 4 ft long
2 wide



Bag Net. (Paul's or Turnip net) for pushing along the ground: for grass & other ground insects



bag, long, loose tapering towards the end, made of strong glazed calico

UNIVERSITY COLLEGE LONDON
GALTON
PAPERS

F. 244v

Hoop net more in use than any other on the continent. Hoop, of iron, brass cane, or whalebone, circular & jointed with net of fine gauze or muslin 20 in in length

Landing net. Same as last but strong having small netting lined with gauze for water fishing, May be used for fresh water shells as well as insects

Forceps - 2 or 3 sizes:

handles 6-10-12 in long. Spare pieces of muslin.

Digger for digging at roots & tearing bark.

or a carpenters tool of the same shape but all iron

Entomology Strong landing + other notes (Jameson) 205

Pins 5, 14 + 11.

Drying Cages v. Bates Hints to Trav: p 68.

~~Lob~~ Sieve for insects v. p. 297 & 305
in Knaggs, Rye &c

Breeding cages.
Pins
Collecting box.
Prussic acid } for killing
Chloroform }
Setting boards. Thin deal boards with 2 side pieces of cork
Lantern & large net for night hunts
Umbrella net (sweeping) Cooke Image plan or Acadic net
Iron crook & long staff for high branches
Mallet (loaded) cov: with leather or gp
Nets netting: materials.
Lino, book muslin, silk gauze but crêpe lisse & grenadine are the best & strongest, black is good for night work & white for day. Length good less than length of arm & have a bottom to them
Y T tubing for fastening net to sticks
Samouelle's Entomol: Compendium
Kirby & Spence Introd: Entomol
Swainson's Naturalists Guide.

Boxes - Zinc box with plenty of pins & damped cork

Killing apparatus - Cyanide of potas: p 77 Knaggs.
" Oxalic acid pricked - Chloroform or benzole for.
Bag or Satchel " Ammonia
Sugaring & brush - sugar (lots); treacle; stale beer = aeq: boil to syrup - when wanted add a few drops of rum.

May be seasoned with ol. anis; ginger grass oil &c. rags dipped in these will answer equally well

P. small fragments of paper dipped in Cyanide of potass: sol: put in the boxes where the insects are will kill them

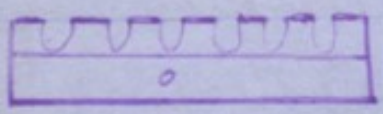
Pins. 10 & 8 useful sizes

Saddles - strips of wood $\frac{3}{4}$ to 5½ inches wide

Doubleday's Synonymic list

For pupae - box with moss

Pin box (dissecting)



Egg. Lava. Pupa. Imago –

Lava by beating, ~~sweeping~~ sweeping, searching, night work bagnet, plenty of boxes – each caterpillar should have a box with food & moisture

~~Sugar web muslin 4 ft long & nearly 2 wide supported on two light rods~~

9 inches	~~wide~~ long	opening in centre both top & bottom corked & always
6	wide	
3	deep	

soaked before use –

Box [gray perforated for insects]

saucer with carb. acid in which cyan: pot: sol is poured

Laurel leaves.

Paper saturated with sol: tart acid & dried may only be dipped in cyanide & Potass: & introduced into the box when death will ensue

44.

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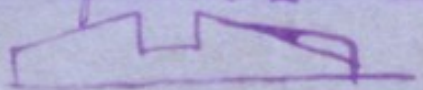
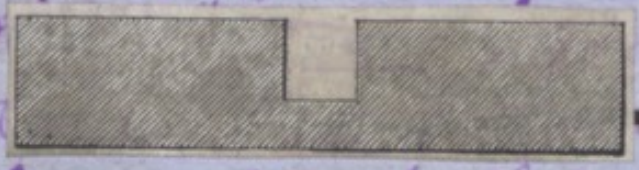
Setting boards

6 boards of soft deal 12 or more in length from 6½ – 2 in breadth.



make a groove in the centre of different depths & widths in the bo[illegible] small strip fr[illegible] ~~uniform~~



~~slope if slope at all is given~~

flat ins 12, 13, 8, 7. 10. – 4 most useful

Coleoptera – Kill them by putting them in

a bottle (the bottom cov[ered] with half an inch of sawdust in which some Cyan: potas is put. Pine wood sawdust free from dust & chips & damped with carbolic acid They will keep like this (alternately sawdust & cyan: p) for a length of time Large ones may be killed in spirit

2 or 3 sheets of white waterproof for shaking grass over ~~Weeds~~ can also be used as kneeling pad

Montague Browne. Practical Taxidermy Bazaar office 170 Strand well spoken of by field

Conchology and

v. Guyn Jeffreys Hints on Coll.g (Brit. Conchol v. 5.)

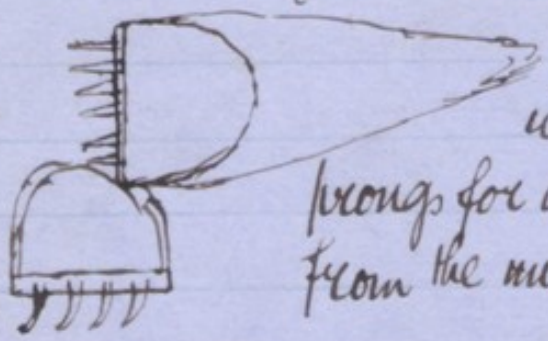
Landing net – v Entomology.

Caspary's rake v. Algae ~~with handles~~

Iron ladle —"—

—"— perforated."

Hammer & chisel. Small net with small mesh with the flat side armed with 3 or 4 iron prongs for detaching shells from the mud.

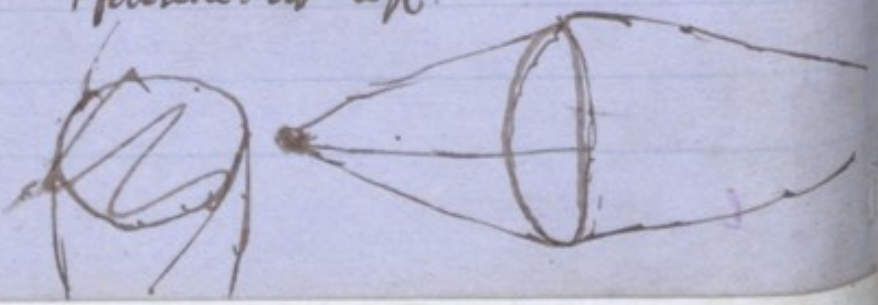


Trawling basket good for large shells

Rake with long handle for turning over weeds &c.

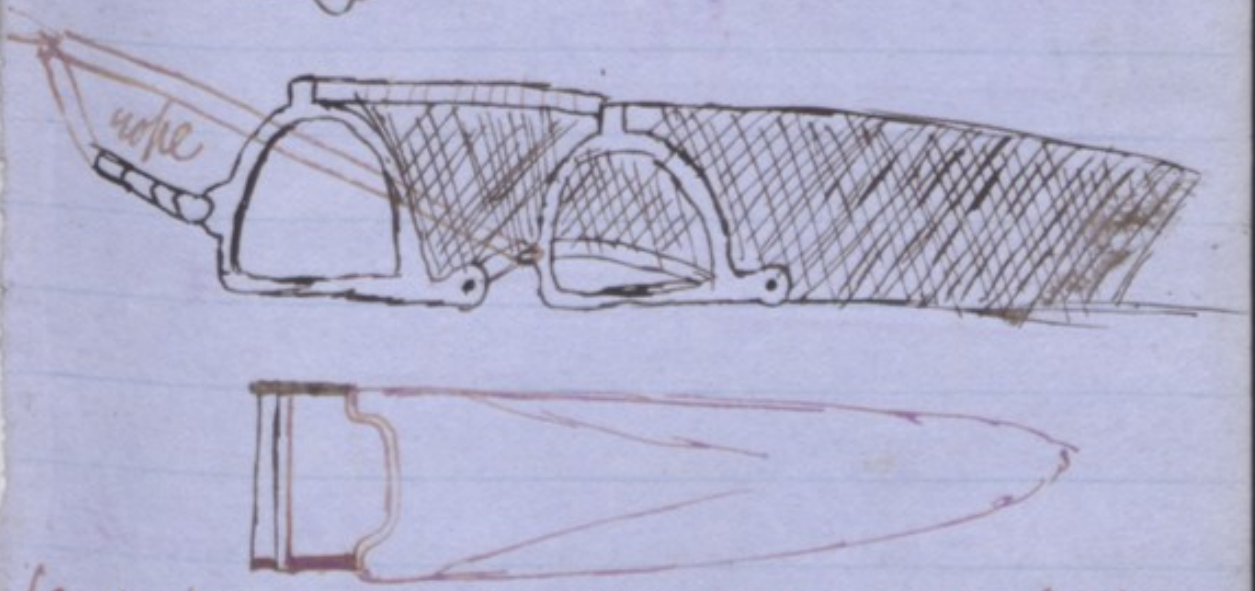
Spatulae in leathern cases.

Towing net (Mc Gillivray) bunting 2 ft deep fastned to hoop 14 in diameter 3 cords 18 in long at equal intervals & fastened at top.



Marine Zoology.

Trawling.



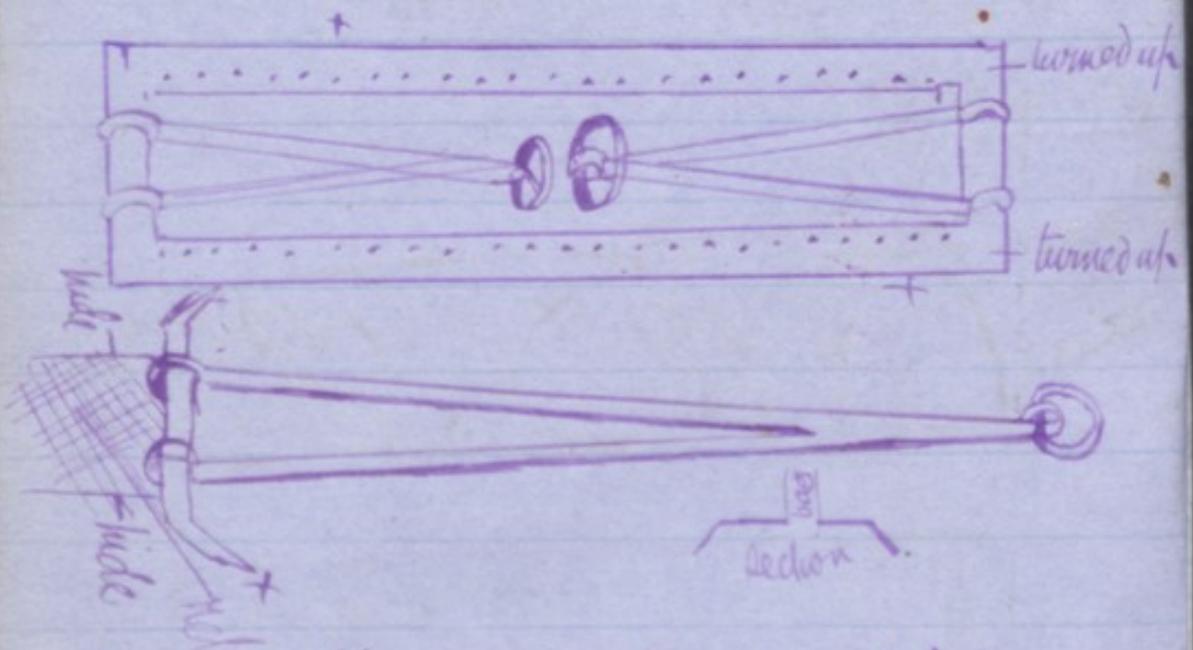
beam 40 to 50 ft in length – net 30 yds deep
but only used for commercial purposes.

Dredging

Bowerbanks dredge for a ~~small~~ private collector – Made of wrought iron with moveable joints to fold up + carry in the hand. bag of two pieces of raw hide connected at ends + bottom with netting made of cod line + fastened to the frame with copper wire passing through the inlet holes. Opening narrow to prevent large stones entering for plan see over

48.

f. 252 v



length of line double the depth of water
Contents of dredge $\frac{1}{4}$ inch sieve + one finer
made of copper wire

V. also M. Petit de la Saussaye, Journ: des.
Conchyliologie 1850 p 215 1851 pp 102, 226

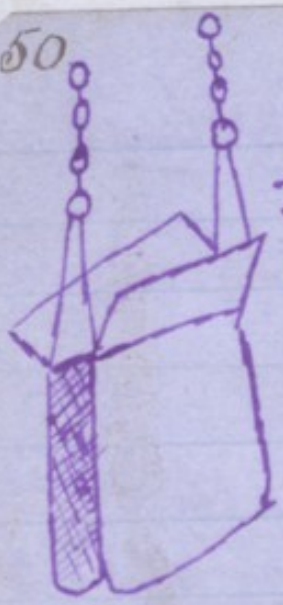
P.H. Gosse uses a wicker basket with
flat sides + bottom ÷ into compartments
Into 2 of these are fitted wide mouth jars
either glass or stone or white ware.
In a third compartment a small wide
mouth bottle. A fourth running the
whole length in which is a geologists
hammer with cutting edge + striking face +
cold chisels. A small crowbar or something
To move rock &c should be taken

253

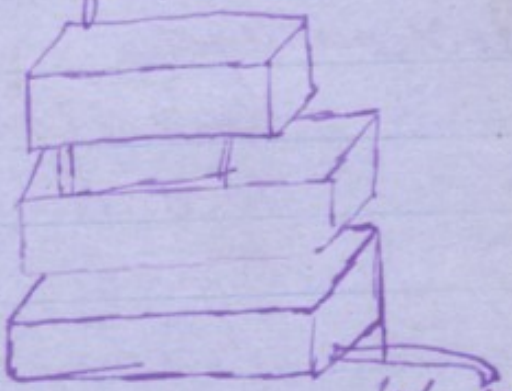
Get plenty of cheese cloth (fine & coarse) wire, T & Y pieces:

213

50



Highlep dredge the back & front made be made of thin sheet iron ends of net.



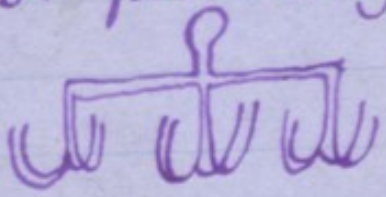
tube to carry

Dredging sieves

1 op. strong wire sieve coarse

2. zinc sieve ¼ in

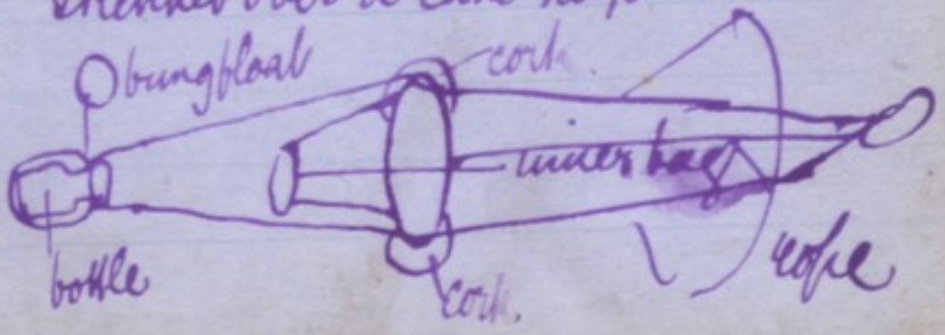
3. fine webbing –



hook Highlep

double conical bag

Conical surface net 'Cheese cloth' stretched over a cane hoop



F. 262c

to the requisite size, and laid upon it. With a soft close-haire brush, like a hat-brush, water should now be sprinkled upon the paper, and when thoroughly wetted, the brush should be used to press it into every portion of the inscription, so that a perfect impression may be taken. The paper should be left upon the inscription until thoroughly dry, and may then be rolled up without fear of spoiling the "squeeze." When the paper is thin, several sheets may be added, with the use of paste or rice-water, until sufficient substance be obtained. I have in this way taken excellent squeezes with merely whitey-brown paper. A store of paper, a few brushes, and a pair of large scissors for cutting the paper, are all the materials that are required.

Hints on the Collection of Objects of Natural History.

By H. W. Bates, Assistant Secretary R.G.S.

Travellers who intend devoting themselves specially to Natural History will generally possess all the requisite information beforehand. It is to those whose objects or duties are of another nature, or who, whilst on a purely geographical land-exploration, wish to know the readiest means of collecting, preserving, and safely transmitting specimens they collect that the following hints are addressed :—

Outfit.—Double-barrel guns, with spare nipples; and a few common guns to lend to native hunters—especially if going to the interior of Tropical America.

Fine powder in canisters, and fine shot (Nos. 8 and 11), must be taken from England: coarse powder and shot can be had in any part. A good supply of the best caps.

Arsenical soap, a few pounds in tin cases; brushes of different sizes.*

Two or three scalpels, scissors (including a pair of short-bladed ones), forceps of different sizes, for inserting cotton into the necks of birds' skins; needles and thread.

A few small traps, with which to capture small (mostly nocturnal) mammals.

Strong landing-net for water mollusks, &c. Two stout insect *sweeping-nets*.

* Most of the articles of a Naturalist's outfit can be obtained, at a few days' notice, of Mr. E. T. Higgins, Natural History Agent, 24, Bloomsbury-street, W.C.

f. 262v

Cylindrical tin box for collecting plants, with shoulder-strap.

A few dozens of small and strong broad-mouthed bottles; and a couple of corked pocket-boxes.

Insect-pins; a few ounces of each Nos. 5, 14, and 11.

Stone jars for reptiles and fishes in spirit; to fit four in in a box, with wooden partitions. If animals in spirit are to be collected largely, a supply of sheet-tin or zinc, with a pair of soldering-irons and a supply of soft solder, must be taken instead of stone jars. Cylindrical cases can be then made of any size required. By means of the soldering apparatus, also, empty powder-canisters and other tin vessels can be easily converted into receptacles for specimens.

A ream or two of botanical drying-paper, with boards of same size as the sheet, and leather straps.

A few gross of chip pill-boxes in nests.

A dozen corked store-boxes (about 14 inches by 11 inches, and 2½ inches deep), fitted perpendicularly in a tin chest.

A few yards of india-rubber waterproof sheeting, as temporary covering to collections in wet weather, or in crossing rivers.

A set of carpenter's tools.

An outfit may be much lightened by having all the provisions and other consumable articles packed in square tin cases, and in boxes and jars of such forms as may render them available for containing specimens. If the traveller is going to the humid regions of the Indian Archipelago, South-eastern Asia, or Tropical America, where excessive moisture, mildew, and ants, are great enemies to the naturalist, he should add to his outfit two drying-cages; for everything that is not put at once into spirits is liable to be destroyed before it is dry enough to be stowed away in boxes. They may be made of light wood, so arranged as to take to pieces and put together again readily; one, for birds, should be about 2 feet 6 inches long by 1 foot 6 inches high and 1 foot broad; the other, for insects and other small specimens, may be about one-third less. They should have folding doors in front, having panels of perforated zinc, and the backs wholly of the latter material; the sides fitted with racks to hold six or eight plain shelves, which, in the smaller cage, should be covered with cork or any soft wood that may be obtained in tropical countries. A strong ring fixed in the top of the cage, with a cord having a hook attached at the end by which to hang it in an airy place, will keep the contained

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specimens out of harm's way until they are quite dry, when they may be stowed away in close-fitting boxes. If this plan be not adopted, it will be almost impossible to preserve specimens in these countries.

Collecting.—The countries which are now the least known with regard to their Natural History, are New Guinea, and the large islands to the east of it, Northern Australia, the interior of Borneo, Thibet, and other parts of Central Asia, Equatorial Africa, and the eastern side of the Andes from east of Bogota to the south of Bolivia. In most of the better known countries the botany has been better investigated than the zoology, and in most countries there still remains much to be done in ascertaining the exact station, and the range, both vertical and horizontal, of known species. This leads us to one point, which cannot be too strongly insisted on, namely, that some means should be adopted by the traveller to record the exact locality of the specimens he collects. In the larger dried animals, this may be done by written tickets attached to the specimens; in pinned insects, a letter or number may be fixed on the pins of all specimens taken at one place and time—the mark to refer to a note-book. The initial letter, or first two or three letters of the locality, is perhaps the readiest plan; and when all the specimens taken at one place can be put into a separate box, one memorandum upon the box itself will be sufficient. Reptiles and fishes can have small parchment tickets attached to them before placing in spirits.

A traveller may be puzzled, in the midst of the profusion of animal and vegetable forms which he sees around him, to know what to secure and what to leave. Books can be of very little service to him on a journey, and he had better at once abandon all idea of encumbering himself with them. A few days' study at the principal museums before he starts on his voyage may teach him a great deal, and the cultivation of a habit of close observation and minute comparison of the specimens he obtains will teach him a great deal more. As a general rule, all species which he may meet with for the first time far in the interior, should be preferred to those common near the civilized parts. He should strive to obtain as much variety as possible, and not fill his boxes and jars with quantities of specimens of one or a few species. But, as some of the rarest and most interesting species have great resemblance to others which may be more common, he should avail himself of every opportunity of comparing the objects side by side. In most tropical countries the species found in open and semi-cultivated places are much less interesting than those inhabiting the interior of the forests, and it generally happens that the few

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handsome kinds which attract the attention of the natives are species well known in European museums. In botany, a traveller, if obliged to restrict his collecting, might confine himself to those plants which are remarkable for their economical uses; always taking care to identify the flowers of the tree or shrub whose root, bark, leaves, wood, &c., are used by the natives, and preserving a few specimens of them. But, if he is the first to ascend any high mountain, he should make as general a collection of the flowering plants as possible, at the higher elevations. The same may be said of insects found on mountains, where they occur in great diversity—on the shady and cold sides rather than on the sunny slopes—under stones, and about the roots of herbage especially near springs, on shrubs and low trees, and so forth; for upon a knowledge of the plants and insects of mountain ranges depend many curious questions in the geographical distribution of forms over the earth. In reptiles, the smaller Batrachia (frogs, salamanders, &c.,) should not be neglected, especially the extremely numerous family of tree-frogs; lizards may be caught generally with the insect sweeping-net; the arboreal species seen out of reach may be brought down with a charge of dust-shot. Snakes should be taken without injuring the head, which is the most important part of the body; a cleft stick may be used in securing them by the neck, and on reaching camp they may be dropped into the jars of spirits. As large a collection as possible should be made of the smaller fishes of inland lakes and unexplored rivers; Dr. Gunther, of the British Museum, has authorized me to say that a traveller cannot fail to make a large number of interesting discoveries if he collects a few specimens of the species he meets with in the lakes and rivers of the interior of any country.

It can scarcely be expected that specimens of the larger animals can be brought away by a geographical expedition, although some species are still desiderata in the large museums of Europe. Additional specimens of all genera, of which there are numerous closely-allied species (*e. g.* rhinoceros, antelope, equus, &c.) would be very welcome for the better discrimination of the species. If only portions can be obtained, skulls are to be preferred. In humid tropical regions entire skins cannot be dried in time to prevent decay, and it is necessary to place them, rolled up in small compass, in spirits. The smaller mammals, of which there remain many to reward the explorer in almost all extra-European countries, may be skinned, dried, and packed in boxes in the same manner as birds. The smaller birds shot on an excursion should be carried to camp in the game-bag, folded in paper, the wounds, mouth, and anus

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being first plugged with cotton. Powdered calcined gypsum will here be found very useful in absorbing blood from feathers, on account of the facility with which it can be afterwards cleared from the specimens. All plants, when gathered, are placed in the tin box which the traveller carries with him. Land and fresh-water shells may be carried home in a bag. All hard-bodied insects, such as beetles, ants, and so forth, should be placed, in collecting, in small bottles; each bottle having a piece of slightly-moistened rag placed within it, to prevent the insects from crowding and injuring each other. The hint previously given with regard to number of specimens must be repeated here. *Take as great a variety of species as possible.* The sweeping-net should be freely used (except in very wet weather) in sweeping and beating the herbage and lower trees. In collecting ants, it is necessary to open nests and secure the winged individuals of each species, which must be afterwards kept together with the wingless ones to secure the identification of the species. Bees and wasps may be caught in the net and then placed by means of small forceps in the collecting-bottle and afterwards killed in the same way as beetles and other hard-bodied insects. All soft-bodied insects should be killed on capture (by a slight pressure of the chest underneath the wings by thumb and finger) and then pinned in the pocket collecting-box. If the traveller has leisure and inclination for the pursuit, he may readily make a large and varied collection of these, and will do good service to science if he notes carefully the exact localities of his captures, altitude above the sea, nature of country, the sexes of the species (if detected), and information on habits. The delicate species should be handled very carefully and put away into the drying-cage immediately on return from an excursion. Spiders may be collected in bottles, and afterwards killed and pinned in the same way as other insects. Crustacea (shrimps, crawfish, &c.) in rivers and pools may be collected with the landing-net and afterwards well dried and pinned like hard-bodied insects except when they are large in size, when their bodies must be opened and emptied of their contents.

Preserving and Packing.—Previous to skinning a small mammal or bird, make a note of the colour of its eyes and soft parts, and, if time admits, of the dimensions of its trunk and limbs. It facilitates skinning of birds to break, before commencing, the first bone of the wings a short distance above the joint, which causes the members to lie open when the specimen is laid on its back on the skinning-board. The animal should be laid with its tail towards the right hand of the operator, and the incision made from the breast-bone nearly to the anus. A

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blunt wooden style is useful in commencing the operation of separating the skin from the flesh. When the leg is reached, cut through the knee-joint and then clear the flesh from the shank as far as can be done, afterwards washing the bone slightly with arsenical soap, winding a thin strip of cotton round it and returning it to the skin. Repeat the process with the other leg, and then sever with the broad-bladed scissors the spine above the root of the tail. By carefully cutting into the flesh from above, the spine is finally severed without injuring the skin of the back, and it is then easy to continue the skinning up to the wings, when the bones are cut through at the place where they had previously been broken and the body finished as far as the commencement of the skull. A small piece of the skull is now cut away, together with the neck and body, and the brains and eyes scooped out, the inside washed with the soap, and clean cotton filled in, the eyes especially being made plump. In large-headed parrots, woodpeckers, and some other birds, the head cannot thus be cleaned; an incision has, therefore, to be made either on one side or on the back of the neck, through which the back of the skull can be thrust a little away and then cleaned, the incision being afterwards closed by two or three stitches. The bones then remaining in each wing must be cleaned, which must be done without loosening the quill-feathers. It is much better to take out the flesh by making an incision on the outside of the skin along the flesh on the inner side of the wing. The inside of the skin must now be washed with the soap, and a neck of cotton (not too thick) inserted by means of the long narrow forceps, taking care to fix the end well inside the skull and withdrawing the empty forceps without stretching the skin of the neck and thus distorting the shape of the bird. Skins need not be filled up with cotton or any other material, but laid, with the feathers smoothed down, on the boards of the drying-cage until they are ready to be packed in boxes. In very humid climates, like that of Tropical America, oxide of arsenic in powder is preferable to arsenical soap, on account of the skins drying quicker; but it cannot be recommended to the general traveller, owing to the danger attending its use.

In mammals the tail offers some difficulty to a beginner. To skin it, the root (after severing it from the spine) should be secured by a piece of strong twine, which should then be attached to a nail or beam; with two pieces of flat wood (one placed on each side of the naked root), held firmly by the hand and pulled downwards, the skin is made rapidly to give way generally to the tip. The tails of some animals, however, can be skinned only by incisions made down the middle from the

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outside. The larger mammal skins may be inverted, and, after washing with the soap, dried in the sun: as before remarked, it is often necessary to roll them up and preserve in spirit.

The skins of small mammals and birds, after they are *quite* dry, may be packed in boxes, which must be previously well washed inside with arsenical soap, lined with paper and again covered with a coating of the soap and well dried in the sun. This is the very best means of securing the specimens from the attacks of noxious insects, which so often, to the great disgust of the traveller, destroy what he has taken so much pains to procure. Where wood is scarce, as in the interior of Africa, boxes may be made of the skins of antelopes or other large animals by stretching them, when newly stripped from the animal, over a square framework of sticks, and sewing up the edges; after being dried in the sun they make excellent packing-cases.

With regard to reptiles and fishes, I cannot do better than quote the following remarks sent to me by Mr. Osbert Salvin, who collected these animals most successfully in Guatemala:—

"Almost any spirit will answer for this purpose, its fitness consisting in the amount of alcohol contained in it. In all cases it is best to procure the strongest possible, being less bulky, and water can always be obtained to reduce the strength to the requisite amount. When the spirit sold retail by natives is not sufficiently strong, by visiting the distillery the traveller can often obtain the first runnings (the strongest) of the still, which will be stronger than he requires undiluted. The spirit used should be reduced to about proof, and the traveller should always be provided with an alcoholometer. If this is not at hand, a little practice will enable him to ascertain the strength of the spirit from the rapidity with which the bubbles break when rising to the surface of a small quantity shaken in a bottle. When the spirit has been used this test is of no value. When animals or fish are first immersed, it will be found that the spirit becomes rapidly weaker. Large specimens absorb the alcohol very speedily. The rapidity with which this absorption takes place should be carefully watched, and in warm climates the liquid tested at least every twelve hours, and fresh spirit added to restore it to its original strength. In colder climates it is not requisite to watch so closely, but practice will show what attention is necessary. It will be found that absorption of alcohol will be about proportionate to the rate of decomposition. Spirit should not be used too strong, as its effect is to contract the outer surface, and thus, closing the pores, prevent the alcohol from penetrating through to the inner parts of the specimen. *The principal point, then, is to*

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watch that the strength of the spirit does not get below a certain point while the specimen is absorbing alcohol when first put in. It will be found that after two or three days the spirit retains its strength: when this is the case, the specimen will be perfectly preserved. Spirit should not be thrown away, no matter how often used, so long as the traveller has a reserve of sufficient strength to bring it back to its requisite strength.

"In selecting specimens for immersion, regard must be had to the means at the traveller's disposal. Fish up to 9 inches long may be placed in spirit, with simply a slit cut to allow the spirit to enter to the entrails. With larger specimens, it is better to pass a long knife outside the ribs, so as to separate the muscles on each side of the vertebræ. It is also as well to remove as much food from the entrails as possible, taking care to leave all these in. The larger specimens can be skinned, leaving, however, the intestines in, and simply removing the flesh. Very large specimens preserved in this way absorb very little spirit. All half-digested food should be removed from snakes and animals. In spite of these precautions, specimens will often appear to be decomposing; but by more constant attention to re-strengthening the spirit, they will, in most cases, be preserved.

"A case (copper is the best), with a top that can be unscrewed and refixed easily, should always be carried as a receptacle. The opening should be large enough to allow the hand to be inserted; this is to hold freshly-caught specimens. When they have become preserved, they can all be removed and soldered up in tin or zinc boxes. Zinc is best, as it does not corrode so easily. The traveller will find it very convenient to take lessons in soldering, and so make his own boxes. If he takes them ready made, they had best be arranged so as to fit one into another before they are filled. When moving about, all specimens should be wrapped in calico or linen or other rags to prevent their rubbing one against the other. This should also be done to the specimens in the copper case when a move is necessary, as well as to those finally packed for transmission to Europe. These last should have all the interstices between the specimens filled in with cotton-wool or rags. If a leak should occur in a case, specimens thus packed will still be maintained moist and will keep some time without much injury. Proof spirit should be used when the specimens are finally packed, but it is not necessary that it should be fresh."

Land and fresh-water shells, on reaching camp, should be placed in a basin of cold water to entice the animals out, and then, after draining off, killed by pouring boiling water over them. They may be cleared of flesh by means of a strong pin

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or penknife. The operculum or mouthpiece of all shells which possess it should be preserved and placed inside the empty shell. Each shell, when dry, should be wrapped in a piece of paper and the collection packed in a box, well padded with cotton or other dry and elastic material.

The insects collected on an excursion should be attended to immediately on arrival in camp. When leisure and space are limited, all the hard-bodied ones may be put in bottles of spirit; and each bottle, when nearly full, should be filled up to the cork with a piece of rag, to prevent injury from shaking. Many species, however, become stained by spirit, and it is far better in dry countries, such as Africa, Australia, and Central Asia, to preserve all the hard-bodied ones in a dry state in pill-boxes. They are killed, whilst in the collecting-bottles, by plunging, for a few moments, the bottom half of the bottles in hot water. An hour afterwards the contents are shaken out over blotting-paper and put into pill-boxes—the bottom of the boxes being padded with cotton, over which is placed a circular piece of blotting-paper. The open pill-boxes should then be placed in the drying-cage for a day or two and then filled up with more cotton, the layer of insects being first covered by a circular piece of paper.* The soft-bodied specimens, which are brought home pinned, should be stuck in the drying-cage until they are dry, and then be pinned very close together in the store-boxes. The store-boxes, both bottom and sides, should each have inside a coating of arsenical soap before they are corked, and as they become filled, one by one, should be washed outside with the soap and pasted all over with paper. Camphor and other preservatives are of little or no use in tropical climates. In some countries where the traveller may wish to make a collection of the butterfly fauna, the best way is to preserve all the specimens in little paper envelopes. He should be careful not to press the insects too flat, simply killing them by pressure underneath the breast, folding their wings carefully backwards and slipping them each into its envelope. In very humid tropical countries, such as the river valleys of Tropical America and the islands of the Eastern Archipelago, the plan of stowing away even hard-bodied insects in pill-boxes does not answer, on account of the mould with which they soon become covered. There are, then, only two methods that can be adopted: one preserving them at once in spirits, the other pinning all those over a quarter of an inch long (running the pin through the right wing-case so as to come out beneath,

* The only preservative needed is a diluted wash of arsenical soap inside the pill-boxes, which, as in all other cases when soap is used, must be well dried afterwards, before the boxes are filled.

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between the second and third pair of legs); and gumming those of smaller size on small sheets of card, cut of uniform size so as to fit perpendicularly in racked boxes, like those used to contain microscopical slides, but larger. The cards may be a few inches square, and each may hold several scores of specimens, very lightly gummed down a short distance apart. After the cards are filled they should be well dried, and the box containing them washed outside with arsenical soap and pasted over with paper. All the pinned specimens should be placed to dry for a few days in the drying-cage, and afterwards pinned very close together in the corked store-boxes.

Plants are dried by pressure, by means of the boards and straps, between sheets of botanical drying-paper—the paper requiring to be changed three or four times. When dry, the specimens may be placed between sheets of old newspapers, together with the notes the traveller may have made upon them, each placed upon the object to which it refers. Bundles of papers containing plants are not of difficult carriage; but they require to be guarded against wet, especially in fording rivers and in rainy weather, and should be wrapped in skins or india-rubber sheeting until they can be safely packed in wooden boxes and despatched to Europe. Seeds may be collected when quite ripe and preserved in small packets of botanical paper, with a number written on referring to preserved specimens of the flowers. Dry fruits and capsules should be collected when in countries not previously explored by botanists, if the traveller has means of identifying the species to which they belong.

Fossils.—The collection of fossils and minerals (except in the case of the discovery of new localities for valuable metals) is not to be recommended to the traveller, if he is not a Geologist. Fossils from an unexplored country are of little use unless the nature and order of superposition of the strata in which they are found can be at the same time investigated. In the cases, however, of recent alluvial strata, or the supposed beds of ancient lakes, or deposits in caves, or raised sea-beaches containing shells or bones of vertebrate animals, the traveller will do well to bring away specimens if a good opportunity offers. If the plan of the expedition includes the collection of fossil remains, the traveller will, of course, provide himself with a proper geological outfit and obtain the necessary instructions before leaving Europe.

All collections made in tropical countries should be sent to Europe with the least possible delay, as they soon become dete-

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riorated or spoilt unless great care be bestowed upon them. Dry skins of animals and birds may be packed in wooden cases simply with sheets of paper to separate the skins. Shells and skulls should be provided with abundance of elastic padding, such as cotton. The boxes containing insects and crustacea should be placed in the middle of large boxes surrounded by an ample bed of hay or other light dry elastic material: if this last point be not carefully attended to, it will be doubtful whether such collections will sustain a voyage without much injury.

Travellers have excellent opportunities of observing the habits of animals in a state of nature, and these hints would be very deficient were not a few words said upon this subject. To know what to observe in the economy of animals is in itself an accomplishment which it would be unreasonable to expect the general traveller to possess, and without this he may bring home only insignificant details, contributing but little to our stock of knowledge. One general rule, however, may be kept always present to the mind, and this is, that anything concerning animals which bears upon the relations of species to their conditions of life is well worth observing and recording. Thus, it is important to note the various enemies which each species has to contend with, not only at one epoch in its life, but at every stage from birth to death, and at different seasons and in different localities. The way in which the existence of enemies limits the range of a species should also be noticed. The inorganic influences which inimically affect species, especially intermittently (such as the occurrence of disastrous seasons), and which are likely to operate in limiting their ranges, are also important subjects of inquiry. The migrations of animals, and especially any facts about the irruption of species into districts previously uninhabited by them, are well worth recording. The food of each species should be noticed, and if any change of customary food is observed, owing to the failure of the supply, it should be carefully recorded. The use in nature of any peculiar physical conformation of animals, the object of ornamentation, and so forth, should also be investigated whenever opportunity occurs. Any facts relating to the interbreeding in a state of nature of allied varieties, or the converse — that is, the antipathy to intercrossing of allied varieties—would be extremely interesting. In short, the traveller should bear in mind that facts having a philosophical bearing are much more important than mere anecdotes about animals.

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To observe the actions of the larger animals, a telescope or opera-glass will be necessary, and the traveller should bear in mind, if a microscope is needed in his journey, that by unscrewing the tubes of the telescope, in which all the small glasses are contained, a compound microscope of considerable power is produced.

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Draw out forms for next note book so that the various Enquiries may not be forgotten
Many are in this book already.

American traits. [mouse dc]

Natural History

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Instructions etc.

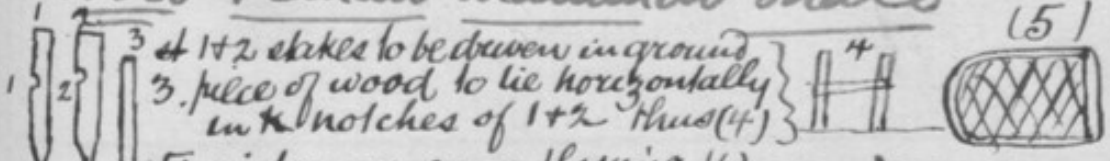
Carrying birds pass a pin through nostrils.

Shot & powder charges for small birds:
vide marked gauges - No 10 cut down.
dust shot spoils feathers. No 10 best
powder flask of sand to absorb blood.
purchase powder etc at native shops.
Make ball cartridges instead of Rifle do.
Tin boxes in wooden cases best for
travelling & preserving specimens
on the march.
Ammunition tin boxes holding ab.t 100 cartridges

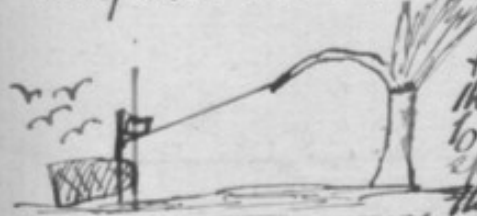
1 Months work for shekarry.

3 flasks powder (3lbs). 350 caps.
28 lbs shot (1 bag) should give 300
full charges (really 450) & should
give 180 preserved specimens.

Bird & small mammal snare



1 & 2 stakes to be driven in ground
3. piece of wood to lie horizontally
in notches of 1 & 2 thus (4)
(5) wicker or cane flooring. (6)
(6) string with noose & a piece of wood at (6).



The 2 stakes (1 & 2) are driven in the ground
& the cross piece as (3) is placed between
the notches the end of the string is tied
to a small branch or anything with a
spring in it & the noose end brought through
the stakes & underneath the cross bar.
The flooring is then put down, one end of
the sticks being put through it the other
end catching the cross bar, the uprights
not being too far apart as to let the flooring
pass between. The noose is then spread on the
flooring & the latter covered with leaves & food.

Anything pressing on the flooring releases the stick & the bird etc gets entangled in the noose, is drawn up in the air

Calico 18×12.
Goadby's Sols. 1 & 2.
Alcohol
Glycerine.
Cashpoo rake. 10" by 3 1/4 wide. double teeth 3/4 in apart. 100 lines
Oiled paper or vasculum
small bottles, sieves, & labels to fix on stick.
Place in fresh water a drop of Hydrochloric acid prevents putridity
or Note color & place in Spirit.

Diatomaceæ: in mud or on plants to clean: boil in hydrochloric acid or nitric & preserve in Sp.
Tin plates for lifting out algæ out of water
stearine paper best to put between algæ to dry.
[sprinkled with stearine & ironed.]
Blotting paper best for algæ
Characeæ should be dried at once if possible

Zoology (Owen)

Algae, Corallines etc horny or calcareous can be dried without washing, but not in the direct rays of the sun. delicate kinds kept in salt water till read to be dried. must be soaked in fresh water before drying.

Fleshy Corals.

Goadby's Sol No 1.

Bay Salt	4 oz
Alum	2 oz
Cor: Subl:	2 gr
Rain water	1 quart

To preserve Expanded, pour in slowly the sol: into the salt water in which they are collected or add a little Corr: Subl: very slowly.

Goadby's Sol: No 2.

Bay Salt	½ lb.
Arsenic	20 gr.
Cor: Subl:	2 gr.
Boiling rain water	1 quart.

Infusorial Animalcular.

Strain or filter (paper) sea water & preserve filtrate in bottles. Visible Acalephae in alcohol, glycerine or No 1. Note lat. long. time & temp. of sea.

Mineral Springs. bottles of water.

Sand, mud, Soundings etc. note as above

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Acalephalae, Medusae Selat: drown
Note colors etc. Immerse immediately
in No 1 of $\frac{2}{3}$ strength + transfer
to full strength.

Echinoderms, Asterias, Holothurias
et. glycerine or No 2. Soft
Holothurias in 1 or 2. the sol
to be gradually added or put in
weak sol: fresh

Ophiurae (brittle stars)
plunged instantly in glycer:
or cold fresh water. after an
hour can be dried or put in
sol:

Entozoa + Epizoa Note attachment.
No 1. Gly: or proof spirit

Serpulidae. No 2.

Cirripedia (Barnacles) Sp. or No 2.
Note blanks in sea, piles etc.

Crustacea

Soft or horny. No 1 answers.
hard or calcareous No 2 preferable.
larger ones kill in fresh water
& dried or put in vol:

Crab { & egg
varnish:
gum arabic 4oz
tragacanth 4oz
dissolve in 3 pints water.
add 20 gr corr: subl:
& 20 drops oil of thyme diss.
in 4oz alc.
mix and let it settle. The
clear is varnish, the sediment
a cement.
Planks in sea, piles etc.

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Insecta. Caterpillars in perfor: box
+ fed: note color, plant etc.

Mollusca.

Perforated tin bowl fix. to stick, with teeth
Water net. one two or three of the solid zinc ones best: can be had a various sizes: or galvanized iron.
Mc Gillivrays Dredge Net
Dredge Cr. Shells. A good rake hammer chisel &c
Long line with hooks & baits at every few yards.
Lobster pots - cleaves.

Dredging papers:-
Date .... Locality ... Depth ...
Distance from shore ... Ground ...

Name	No of thing effec	deaded	remarks
1. Littoral Zone - ie between tide mark			
2. Laminarian .. low water to 15 fathoms			
3. Coralline 15 to 50.			
4. Deep Sea Coral Zone 50 to 100 or more.			

Chlor: Zinc (Burnetts Sol. is concentrated & useful for forceps). It is now used largely in Brit Mus: for fishes in jars.
Chloride Calcium good for preserving soft sealing objects. permanently mild.
[saturate hydrochloric acid with marble.
Meat tins capital to encase bottles.

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Vertebrata

Fishes. Cartilaginous in sp, gly: or No 1.
hard spined No 2. but
spirit by far the best.
Note color & protect scales,
by wrapping in cotton
or muslin

Reptiles Sp: or Nol. f. 277 449

Mouth.

Length add other desiderata
Expanse as "crop" etc contents
Wing
Tail
Tarsus
bill from front
" from gape
Closed wing short of end of tail by

Central feathers Exceeding outer
by 0.25
outer tailfeathers short of
Central pair eg. 1.2. 0.9

mid toe + claw.

Itinerary

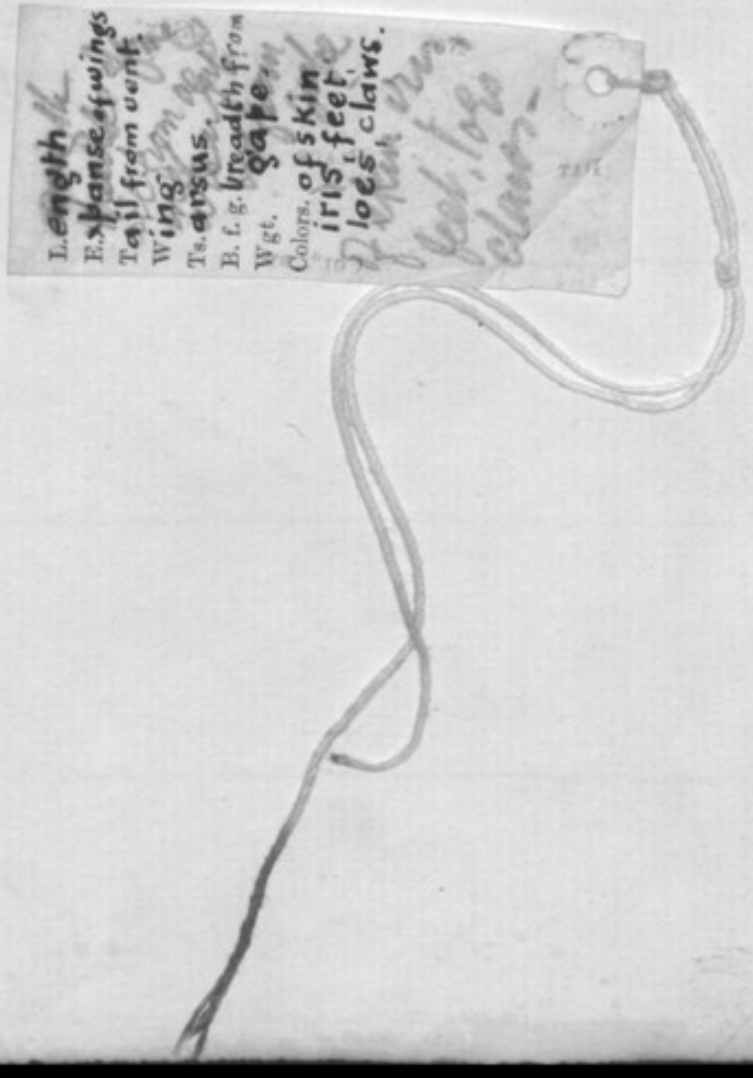
Stage	Distance in miles	Direction
Bágú	24	E. N. E.
Kala'h i-Ghazi	12	N. E.
Kaskan Caravanserai	36	14 miles N by W 12 N by E 10 N E

Calculating wheels used for distance.

F 978 x

f 279 251

Birds. Small sps in sp. jr:
large. save gullet, stomach or
gizzard, liver intestines, ovary,
oviduct, or male organs taken
out as low as the anus & with
the cloaca. also tongue, trachea
& lower larynx by themselves.
Heads of large birds entire.
Color of eyes, bill, legs, season
date, locality, sex, nest, Eggs.
& young birds.
Note domestic birds. Note
seeds in crops; parasites etc. 30a



Mammals small in sp or No 2.
Skins No 2. Soaking tubs or dishes (large square or oval saucepans with lids)

"zinc or galv: iron: meat dishes or like the ~~skeletons~~ anak punya washing bowl as there are no joins & a fall will not break them These do for a great variety of purposes & can be had in nests. Jam & pickle bottles are capital for specimens being strong & wide-mouthed & can be obtained almost in every port.

Some of the strong galv: iron ~~tins~~ cans used for paint of different sizes, can also be used for pails etc

skeletons of great moment.
skulls or Entire bodies of domestic animals.
head & brain in sp:
also oesophagus & stomach with portion of the duodenum Caecum & small portion of the ileum & colon.
If not too large cut off (after Exam: of length, contents circumscribed from the mesentery, the jejunum ileum & save the contents of the abdomen so as to have the liver, stomach, spleen, colon pancreas &c with their attachments as low as the pelvis.
Examine contents cleanse & put in sp or No1.
Heart & lungs together: if too large heart & vessels
Contents of pelvis: bladder: rectum organs of generation attached in natural state
Impregnated females Entire.
Young of very large animals, foetuses & abortions

Mammals cont.

Whales & other large animals.

Eyes with surrounding skin muscles & fat entire. Ears. Brain & sections of spinal chord. Male, female & 1 or 2 skulls. Supra-renal glands. Ganglions of sympathetic nerve. Beginning of aorta & pulmonary artery for the valves.

Mammae of females with surrounding skin, ovaria, uterus. Foetus if present to be taken with the whole of the uterus, vagina, ovaria &c. Penis of male to include anus.

Skin large quads: rubbed with or soaked in dried or sol of alum for 3 or 4 days & then washed with arsenical soap. Tin or lead foil labels (tin in esp!)

Note locality, nature of country, habits distribution, natal name, color of eyes, form of pupil, color of naked parts, form of head & muzzle, habitual position of ears & tail. Note of dissections - v. Ovalis

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ROYAL GARDENS, KEW.

INSTRUCTIONS FOR COLLECTING PLANTS AND SEEDS FOR THE GARDEN AND THE HERBARIUM, AND THE USEFUL PRODUCTS OF VEGETABLES.

I. HORTICULTURAL DEPARTMENT.

PLANTS for *cultivation* may be introduced,—1. As SEEDS, BULBS, and TUBERS, which are easily collected and transmitted: the *Seeds* to be gathered when quite ripe and each kind folded in dry paper, then enclosed as a parcel, or placed in a box, and kept in an airy part of the cabin during the voyage. *Bulbs* and *Tubers* to be taken, if possible, when the foliage is withered, and similarly packed.--2. CUTTINGS. Most *succulent* plants, should be severed where there is a constriction or articulation in the stem; and these, when carefully freed from extraneous moisture, will bear a long voyage, packed in a box, with paper wrapped about them, or any dry elastic substance to keep them steady.—3. ROOTED PLANTS: some of these, such as *small Cactuses, Aloes, Tillandsias, Zamias*, and the various epiphytal tropical *orchidaceous* plants will travel safely if placed in a box, like the cuttings just noticed, the larger kinds packed with straw. But others require a Wardian case, forming a small portable greenhouse. In it the young rooted plants should be established, in soil about six inches deep, the surface of the mass secured by a little moss and transverse splints (to confine the roots in the event of the box bring overturned); moderately watered; the glazed lid fastened on with screws and putty. The case must be placed on deck during the voyage, occasionally protected from the too powerful rays of the sun, and the contents will require no watering or attention unless the glass should be broken during the voyage.

II. MUSEUM DEPARTMENT.

THE COMMISSIONERS of HER MAJESTY'S WORKS, &c., having been pleased to form a MUSEUM of ECONOMIC BOTANY within the Royal Gardens, the Director solicits the co-operation of Her Majesty's Ministers and Consuls in foreign countries, of the Governors of Her Majesty's Colonies, of Officers in the Army and Navy, Merchants and Travellers generally, to aid in contributing specimens towards so desirable an object.—The design is to bring together in one spot and to exhibit such interesting vegetable products from all parts of the world, as cannot be shewn in the *living* plants of a garden, nor in the preserved ones of an *Herbarium*. The public may indeed see in our stoves the rare *Lace Tree* of Jamaica,

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the still rarer *Ivory Palm-Nut* of the Magdalena, the *Bread Fruit Tree* from the Friendly Islands, &c.; but the interest of these is greatly enhanced, if, within the walls of the same Establishment, the curious and beautiful Lace of the first, the fruit and ivory-like seeds of the second, and the celebrated bread-fruit of the third, can also be inspected.—Among the objects, therefore, which are to be collected and deposited, arranged and named in the Museum, are—1. FRUITS and SEEDS, especially those which are of *large* size, or possess any peculiarity of form or structure entitling them to notice. Many of these are naturally dry and require little care (except to be freed from moisture) previous to packing. Those that, when ripe, burst open into valves, or separate by their scales, as *Pine-cones*, &c., should be bound round with pack-thread. The soft and fleshy fruits can only be preserved in wide mouthed bottles, or jars, or casks, (according to size,) in alcohol, as rum, arrack, or in diluted pyroligneous acid or strong brine.—2. ENTIRE PLANTS, or parts of them. Many have a very *fleshy* character, and ought to be preserved entire, in alcohol; or portions of the stem and branches (according to their size) with flowers and fruit; such as those of *Palms*, *Stapelia*, *Rafflesia*, and others of a similar kind.—3. TRUNKS of TREES, portions and sections of them, especially when they exhibit any remarkable structure: as *Palms*, and many other *Monocotyledonous* plants, and *Tree Ferns*. Specimens of Wood should be in sections, a foot or more long, and about the average diameter of the tree. The kinds used in commerce for veneering, cabinet-work, or other useful purposes, or such as recommend themselves by their beauty, hardness, or any other valuable quality, are particularly desired *The scientific or other names should be attached, and specimens of the leaves and flowers to identify them.*—4. GUMS AND RESINS, VEGETABLE WAXES, especially those employed in the Arts or in Domestic Economy.—5. DYE STUFFS of various kinds.—6. MEDICINAL SUBSTANCES. These latter are of vast importance, and merit the attention of Travellers in every country. Of many it is not yet known, except to the natives who collect and prepare them, what are the particular plants that afford them, nor how they are prepared.—7. GENERAL PRODUCTS of VEGETABLES; *in the state of the raw material, and manufactured*. It would be extremely difficult, not to say impossible, to enumerate all of these which a Museum ought to contain; but the enlightened Traveller can form a pretty correct judgment. Such as are *useful to mankind* cannot fail to be interesting. It would be idle to send every *well-known* object of this kind, *Tea, Sugar, Coffee, Cocoa, Chocolate, Paper, Textiles, Platting, Basketwork, Clothing, &c.*; but there are states even of these familiar articles, which will prove both useful and instructive. Paper, for example, is made from an infinite variety of vegetable substances, and the different sorts are well worth collecting; from that afforded by the *Papyrus* of the ancients (which gives the name) to what is manufactured out of the inner bark of an East Indian *Daphne* (or Spurge-laurel), and another from the pith of a little known plant in China (the so-called *Rice-Paper*), or the leaves of a *Palm* in India, or *Straw* in North America. Of all such, the several states of preparation should be collected and exhibited, not only as objects of curiosity, but as exemplifying the progress of Art and Science.

In case of samples of timber, of various fibres, dye-stuffs, drugs, or any other vegetable product, it is of the first importance that there should be sent along with each example a dried specimen of the leaves and flowers of the tree or plant affording the same, marked distinctly with a corresponding number, so that the source of the product may be scientifically determined. Through want of such dried specimens accompanying the timbers, drugs, fibres, &c., which have been sent to the Royal Gardens, and to the International Exhibition, a large number are absolutely useless.

III. HERBARIUM DEPARTMENT.

In preserving *Plants* for the Herbarium, or Hortus Siccus, the object is to prepare specimens in such a manner that they may be thoroughly dried, the colours as far as possible retained, and such a degree of pressure given that they do not curl up in drying. For this purpose provide a quantity of paper of a common folio size, brown, or stout grey, moderately absorbent; the best is "*Bentall's Botanical Paper*," 16 inches by 10, folded; 15*s*. per ream; sold by Newman, Great Devonshire Street, Bishopsgate Street,

London. Two boards are requisite, of the size of the paper, one for the top, the other for the bottom, of each mass of papers. Pieces of paste-or mill-board placed between the papers, if the specimens are numerous or particularly thick or woody, are very useful. For pressure, nothing is better than a heavy weight on the topmost board, or, while travelling, three leathern straps and buckles; two to bind the boards and papers transversely, and one longitudinally. Thus provided, gather your specimens, if small, root and stem—if large, cut off portions of the branches, a foot or rather more in length, always selecting those in flower and in a more or less advanced state of fruit. Long, slender plants, as *Grasses*, *Sedges* and many *Ferns*, may be doubled once or twice. Place them, before they wither, side by side, but never one upon the other on the same sheet, taking care that one part is not materially thicker than the other, and lay over the specimens one, two, three, or more sheets of paper, according to its thickness or the thickness of your plants; and so on, layer above layer of paper and specimens, subjecting them then to pressure. In a day or two, according to the more or less succulent nature of the plants, or to the nature of the climate, remove them successively into fresh papers till the moisture is absorbed, and dry the spare papers in the sun or by a fire for future use.

A tin box or *Vasculum* is essential, made to shut close, to prevent evaporation, in which the plants will, if required, remain uninjured a day and night, especially if the box is well filled. Some very succulent plants, and those of the Heath and Pine tribe, are the better for being plunged into boiling water for an instant before they are pressed. A portfolio slung over the shoulder and containing a few quires of drying paper to receive the plant as gathered, is employed by many collectors.

When sufficiently dry, the specimens should be put into papers; one sheet or folio (more if the specimens be thick) between each layer of plants; aud thus a great many may be safely arranged in a small compass: and are ready for transport covered with oil-cloth or packed in boxes. *Mosses* and other *Cryptogamic* plants may be generally dried in the common way, those which grow in tufts being separated by the hand, so as to form neat specimens. Most *sea-weeds* require a slight washing in fresh water, and common blotting paper is the best for removing the moisture from this tribe of plants.

Parcels or Packages which may come by Her Majesty's Ships, or by any of the ROYAL MAIL, or PENINSULAR and ORIENTAL COMPANY'S STEAMERS, should be addressed:

"On *Her Majesty's Service*. For the Royal Gardens, Kew.

To the Secretary of the Admiralty, LONDON."

If by Merchant Vessels, or by private hands, to

"~~SIR WILLIAM JACKSON~~ HOOKER, Director;

Royal Gardens, Kew,

LONDON."

Botany. Instructions are in 257
separate book but could be placed
here

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DIRECTIONS

FOR COLLECTING AND FORWARDING

ORCHIDS, NEW AND RARE PLANTS, SEEDS,

&c., &c.,

IN TROPICAL CLIMATES,

BY

WILLIAM BULL, F.L.S., F.R.H.S.,

ESTABLISHMENT FOR NEW AND RARE PLANTS,

KING'S ROAD, CHELSEA, LONDON.

Residents and visitors in foreign countries have often great facilities for collecting plants (especially Orchids), seeds, &c., and would interest themselves in doing so if they knew their value in England, the assistance they would be giving to Botanical science, and also if they knew a satisfactory medium through whom consignments could be made. A gentleman, who has just returned to England, has expressed his regret at not knowing how much Orchids are sought for here, or even to whom he could have sent them, and impressed upon Mr. WILLIAM BULL (as many have done before) the desirability of drawing up a few suggestions, regulations, &c., about it. Mr. WILLIAM BULL, therefore, begs to observe—

1st.—That in all tropical and new countries there are many plants, and notably Orchids, many of which would be valuable, and in districts little explored quite new to science, consignments of which Mr. W. B. would be glad to receive, under the following arrangements.

2nd.—Such consignments should be disposed of to the best advantage, and the proceeds equally divided between consigner and consignee; but all consignments should reach consignee free of cost. Mr. WILLIAM BULL, however, would not object to pay cost of transit, freight, &c., such payments to be afterwards deducted from proceeds of consignments.

3rd.—As from the preceding paragraph it may appear at first sight that this arrangement would give an undue advantage to consignee, it may be as well briefly to say that Mr. WILLIAM BULL'S Horticultural Establishment and business is of gigantic extent, incurring an expenditure of many thousands a year, a large portion of which is incurred by representatives, merely for the disposal of Orchids and New Plants.

4th.—In making consignments, care should be taken that a shipping note be forwarded to consignee, or to either of Mr. WILLIAM BULL's Shipping Agents, as follows—

London: Messrs. R. SILBERRAD & SON, 5, Harp Lane, Great Tower Street.

Liverpool: Messrs. JOHNSON, GRAINGER, & Co.

Southampton: Mr. THOMAS HILL.

But packages could be forwarded through any other Shipping Agents, at the convenience of the parties shipping. Where consignments are made from the interior of a country, care should be taken that as little delay as possible occurs at the port of embarkation, for it has often happened that the delay of 20 or 30 days in transit has proved fatal.

5th.—In packing plants, Orchids especially, many kinds can be safely sent in close wooden boxes, without any packing material; care being taken that the plants are perfectly dry when packed (if moist they mildew and rot), and the box completely filled, so as to prevent their being rocked and bruised in transit. For a few Orchids and many other plants, it is necessary to use Wardian Cases, that is, cases with a slanting glass roof, a few strips of wood being nailed across the glass to prevent its being broken.

6th.—No rule can be laid down as to what plants should come in close boxes or in Wardian Cases. If a failure in the first instance, such could be guarded against afterwards.

7th.—If Wardian Cases are used, care should be taken that they stand on legs or blocks of wood, to raise them six inches from the ground, and that there are no holes in the bottom of the case; because such packages stand on deck, and without this precaution salt water is liable to penetrate through the bottom.

8th.—In sending Orchids in Wardian Cases, they can be attached to pieces of wood and nailed or fixed with wire (not string, as this rots) all round the inside of the case; and pieces of wood might also be nailed across the case with Orchids attached to them with wire. This mode of packing has been found desirable with some of the valuable Orchids from the East Indies, but the majority of Orchids can be sent in close wooden boxes. Plants, other than Orchids, would require to be planted into Wardian Cases and partially established before shipment; strips of wood being nailed between each row to fix and keep the soil and plants in position on the journey.

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9th.—There are plenty of Orchids in nearly all tropical countries of considerable value. An ordinary case would easily hold from two, three, to five hundred plants, and if their value averaged each one pound sterling, collecting them would become an easy and certain source for increasing income; of course there are many Orchids not so valuable, but there are a great number worth considerably more. Care should always be taken to send Orchids in as large masses as possible, because such are naturally better able to stand change of climate, journey, &c., and are of more comparative value here.

10th.—Most Orchids would be worth something, although it would not be advisable to keep some of them for disposal in the usual channels of trade; such could be sold by Auction, as also large consignments, or portions of the same, as may be desirable.

11th.—Consigners may always rely on a division of proceeds being equitably made, for, of course, the larger the amount that can be paid over, the more it would naturally interest and stimulate to other consignments being made, and so be mutually advantageous to both parties.

12th.—Where correspondents are residents, it would be desirable to keep a numbered duplicate plant of every kind sent, for reference in future consignments, and to prevent inferior kinds being sent the second time.

13th.—Consigners should always state in what way they wish remittances sent, or to what agents in England they wish payments to be made.

14th.—In the preceding paragraphs Mr. William Bull has often and especially alluded to Orchids, and simply because they are easily transmitted and always of some value; but there are many plants of a beautiful description, especially in little-explored districts, remarkable either for their flowers, fruit, or foliage, the latter often being beautifully variegated. Of these seeds might often be sent, and a letter merely costing the postage might perchance contain a packet of seed worth from £10 to £20. Seeds could not be valued on arrival, but these Mr. W. B. would raise in his extensive tropical houses, and, if the plants proved new, allow a fair value for them. Paragraph 11 is an assurance to consigners, and applies to seeds as well as to Orchids or other plants and bulbs.

15th.—There are many beautiful bulbous-rooted plants that it would be desirable to introduce, and doing so is a very easy matter; simply dig them up, cut off all their growth if they are not in a dormant state, dry the roots, and forward them in close boxes. Attractive plants might always be examined to see if they have a bulbous or tuberous root.

16th.—This paragraph contains most important instruction as regards collecting, viz. :—where practicable, to always forward a specimen of the flower and leaf of the plants. In Orchids this can seldom be done, because they are of too fleshy a nature, and only bloom at certain seasons, which is not the best time for collecting them; but, where possible, specimen flowers are always desirable. But in sending seeds of plants, it can easily be understood, when explained, that gentlemen who are not Botanists may send home most beautiful things; but, under artificial treatment, it may take many years to flower them here, and although a written description is all very well, and desirable, to determine a plant scientifically, or to introduce a new plant to commerce, it is positively necessary to see the flower, either dried or fresh. Mr. W. B. has often received seeds with a most graphic description, when a flower enclosed in a piece of blotting-paper in a letter would have been much better. Where colours are liable to fade, they could always be described. A quire of foolscap paper (or less) would hold an immense number of specimens, and this could always be nailed on the lid inside a box; but nothing can be more simple than sending a packet or two of seed and samples of them through the post.

17th.—In tropical countries seeds of Palms are very easily collected, and as easily sent in a small box; each sort should be put up separately. Specimens of these need not be sent—indeed, it would be almost impracticable.

18th.—It may be desirable to hint that many Orchids and plants that would be rare in England, are so common in some countries that shipping them to England might almost provoke a smile when suggested. But it should be borne in mind that many plants, where indigenous, are as common as weeds; and gentlemen who have returned to England have frequently remarked that some plants were so common, that they have not for a moment supposed they would be acceptable in England.

19th.—In the preceding paragraphs Mr. WILLIAM BULL has alluded to returning value in money, but he would always gladly return other plants or seeds in exchange that may be wished for, on receiving instructions to that effect.

If not interested in Plants or Horticulture yourself, Mr. W. B. would esteem it a favour if you would kindly hand this Circular to any friend who may be so.

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RAFFLES MUSEUM.

Specimens and Information desired relating to the Malayan Archipelago.

I. Vegetable Products.

A.—Specimens and information on vegetable products used as—

a. Food, such as grains, esculent vegetables, starches, edible fruits, saccharine subtances, &c.

b. Medicinal substances used for their real or fancied effects, charms, ordeals, and customs connected therewith.

c. Textile and paper materials, how prepared, with articles manufactured therefrom; whether bulky or not, and if means exist for preliminary preparation.

d. Dyeing and tanning materials, how prepared and used, with articles so treated.

e. Waxes, fats, fixed and essential oils.

f Gums, gum-resins, oleo-resins, balsams, &c; caoutchouc, gutta-percha; in the case of these, the following—

1. Samples of crude juice, without any preparation whatever, care being taken to place the same, immediately on collection, in *air-tight* vessels in order to guard against any spontaneous change taking place. If two such specimens can be sent, to one should be added a small quantity of liquor ammoniæ. Care should be taken to exclude light. (Strong tinned cans would be convenient vessels to send the milk.

2. Samples of gutta-percha or of caoutchouc, prepared in as many different ways as possible, such as with the aid of (*a*) artificial heat; (*b*) hot water; (*c*) natural heat. (*d*) alum; (*e*) liquor ammoniæ; (*f*) acetic acid?; (*g*) any plant, and also sending a small quantity of the plant so used; (*h*) fresh water; (*i*) salt water; (*j*) burning sulphur, taking care to note the time occupied, and all the steps of each process, using in every experiment an *uniform* quantity of the same milk.

3. Samples of the whey-like substance which separates from the caoutchouc and gutta-percha during its coalescence.

4. Samples of prepared caoutchouc and gutta-percha in the form or forms proposed to export it in, care being taken that it is as *clean* and *dry* as possible.

5. Information on the average yield of each kind of tree, and at different seasons, the best season for collecting, and the relative yield by simple tapping; (*b*) tapping. assisted by binding, and total destruction. Of course, in practice, the two latter methods should not be resorted to. A specimen of the stem showing methods of tapping would be interesting.

g. Woods likely to be useful in ship-building, for railway sleepers, in house construction, for cabinet work aud engraving, showing them by a horizontal section with bark *attached*, about 6 inches thick

Christ of Fenchurch St prepared cases ready for screwing together takes takes cases much space. One or two very small models might be taken

Models of Bull, Vestry or Nave might also be obtained —

or less; a slab from the centre, and also from the sap, and two or three billets 2½ inches square, 2-3 feet long from sound wood, so as to show figure, grain, lustre, colour, &c. They should not be varnished or polished. Information as to whether quick or slow growers, size, natural age, liability to insect attacks. The roots and boles are often useful for ornamental work.

h. Substances used for perfumes and incense, for miscellaneous purposes and customs connected therewith.

B.—Botanical specimens, as—

a Dried specimens of a branch of the tree, having the leaves, flowers, and fruit *attached*, loose flowers should be secured to prevent mixing, and fruits if liable to split open to be secured with string or wire to prevent shedding of seeds. The plants may easily be dried between sheets of any porous paper, care being taken to change the paper a few times at first, till the plants are perfectly dry. The specimens should be as characteristic as possible; leaves on different parts of a tree vary in some instances very considerably. Also section of the stem with the bark on.

b Specimens of leaves, flowers, and fruits, *attached*, preserved in a jar or bottle, in some spirit, as brandy, spirits of wine, or in acetic acid, or a solution of salt, care being taken that the mouth of the vessel be well secured to prevent leakage.

c. All the botanical specimens and the products should be gathered from the *same identical tree.*

d. When there is more than one kind of variety of tree yielding the same substance, complete specimens of each kind should collected and sent.

C.—Information as to—

a. Vernacular names whether generic or specific, whether the same name or different names are applied to the tree and its products; whether applied to other trees; their meanings and derivations, wherther pure vernacular, a corruption, an introduced or commercial name.

b Early navigation, trade routes commerce, locality where produced; how products are obtained and prepared; if the products of different species are mixed or not, the quantities supliable; number and distribution of the trees, effect of collection on life of plant; price, means of transport, and data on which any such opinions are based.

D—Climatic conditions under which the plants grow best as—

a. Meteorological observations as to heat, humidity, elevation &c.,
b. Soil in which each tree grows; whether they grow in exposed or sheltered spots; solitary or in clumps; on the skirts or in the depths of forests; by river banks or Savanahs &c.,

Parcels of seeds, or live plants or cuttiugs should always be sent if obtainable as such a collection of live plants would be highly interesting and valuable in the gardens.

II. Animal Products.

Used as or for—

A.—Food
B.—Saccharine substances as honey
C.—Furs
D.—Perfumes
E.—Fats and Oils
F.—Skins, parchment, leather &c.,
G.—Hair, bristles and feathers
H.—Horn, ivory bones &c.
I.—Dyes and pigments
K.—Silk
L.—Shells
M.—Corals, sponge &c.,

Also specimens alive or preserved of the Animals giving these various substances.

III. Mineral Products.

Such as Gold, silver, copper, lead, tin, iron and other minerals and rocks obtainable: Sections of mines and strata, specimens of soils &c. and any other Geological information.

IV. Machinery, Manufactures.

Illustrations or models of—

A.—Native Agricultural and Mechanical tools and implements
B.—Textile Manufactures as cotton, silk, &c.,
C.—Wood work as turning, cabinet work, ship building
D.—Stone work
E.—Rope and basket making, coopering, dyeing, painting &c.,
F.—Papermaking, printing, bookbinding &c.,

V. Ethnology &c.,

Illustrations or models of—

A.—Clothing, dwellings, weapons, domestic utensils, &c., skulls &c., illustrated by drawings or photographs if possible. Also information on Manners, Customs, Religion, etc.
B.—Antiquities. Such as old buildings, temples, remains &c.

VI. General Natural History Collections such as Insects, birds, shells &c.

Live Animals for the Zoological Gardens will be particularly acceptable.

All information given on personal knowledge should be distinguished from that given on the testimony of others.

Great care should be taken that the labels should be correctly and securely affixed to the specimens, and that the letter or other account should coincide with the numbers or names on the specimens.

For mineralogical specimens small canvas bags are better than paper, and if packed tightly with paper or grass will travel well.

Vegetable or animal substances should have camphor packed with them as a preservative from insects.

Vegetable substances can be preserved wet in strong brine or spirit.

Small Animals can be preserved in spirits, larger ones can be skinned and the skins rubbed over with arsenic paste or corrosive sublimate, alum, pepper &c. but arsenic is by far the best.

The undersigned will be happy to render every assistance in his power to any who propose collecting specimens for the Museum and all such donations will be thankfully acknowledged.

JAS. COLLINS.

Suggested Form for Collecting Information on Commercial Products, &c.

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I.—*Vegetable Products.*

A.—Specimens and information on vegetable products used as—

a. Food, such as grains, esculent vegetables, starches, edible fruits, saccharine substances, &c.

b. Medicinal substances used for their real or fancied effects, charms, ordeals, and customs connected therewith.

c. Textile and paper materials, how prepared, with articles manufactured therefrom; whether bulky or not, and if means exist for preliminary preparation.

d. Dyeing and tanning materials, how prepared and used, with articles so treated.

e. Waxes, fats, fixed and essential oils.

f. Gums, gum-resins, oleo-resins, balsams, &c.; caoutchouc, gutta-percha; in the case of these the following—

1. Sample of crude juice, without any preparation whatever, care being taken to place the same, immediately on collection, in air-tight vessels, in order to guard against any spontaneous change taking place. If two such specimens can be sent, to one should be added a small quantity of liquor ammoniæ. Care should be taken to exclude light. Strong tinned cans would be convenient vessels to send the milk.

2. Samples of gutta-percha or of caoutchouc, prepared in as many different ways as possible, such as with the aid of (*a*) artificial heat; (*b*) hot water; (*c*) natural heat; (*d*) alum; (*e*) liquor ammoniæ; (*f*) acetic acid ?; (*g*) any plant, and also sending a small quantity of the plant so used; (*h*) fresh water; (*i*) salt water; (*j*) burning sulphur, taking care to note the time occupied, and all the steps of each process, using in every experiment an uniform quantity of the same milk.

3. Samples of the whey-like substance which separates from the caoutchouc and gutta-percha during its coalescence

4. Samples of prepared caoutchouc and gutta-percha in the form or forms proposed to export it in, care being taken that it is as clean and dry as possible.

5. Information on the average yield of each kind of tree, and at different seasons, the best season for collecting, and the relative yield by simple tapping; (*b*) tapping, assisted by binding, and total destruction. Of course, in practice, the two latter methods should not be resorted to. A specimen of the stem showing methods of tapping would be interesting.

g. Woods likely to be useful in ship-building, for railway sleepers, in house construction, for cabinet work and engraving, showing them by a horizontal section with bark attached, about six inches thick or less; a slab from the centre, and also from the sap, and two or three billets 2½ inches square, 2-3 feet long from sound wood, so as to show figure, grain, lustre, colour, &c. They should not be varnished or polished. Information as to whether quick or slow growers, size, natural age, liability to insect attacks. The roots and boles are often useful for ornamental work.

h. Substances used for perfumes and incense, for miscellaneous purposes and customs connected therewith.

B.—Botanical specimens, as—

(*a.*) Dried specimens of a branch of the tree, having the leaves, flowers, and fruit attached (loose flowers should be secured to prevent mixing), and fruits if liable to split open to be secured with string or wire to prevent shedding of seeds. The plants may easily be dried between sheets of any porous paper, care being taken to change the paper a few times at first, till the plants are perfectly dry. The specimens should be as characteristic as possible; leaves on different parts of a tree vary in some instances very considerably. Also section of the stem with the bark on.

(*b.*) Specimens of leaves, flowers, and fruits, attached, preserved in a jar or bottle, in some spirit, as brandy, spirits of wine, or in acetic acid, or a solution of salt, care being taken that the mouth of the vessel be well secured to prevent leakage.

(*c.*) All the botanical specimens and the products should be gathered from the same identical tree.

(*d.*) When there is more than one kind of variety of tree yielding the same substance, complete specimens of each kind should be collected and sent.

C.—Information as to—

(*a.*) Vernacular names, whether generic or specific, whether the same name or different names are applied to the tree and its products; whether applied to other trees; their meanings and derivations, whether pure vernacular, a corruption, an introduced or commercial name.

(*b.*) Early navigation, trade routes, commerce, locality where produced; how products are obtained and prepared; if the products of different species are mixed or not, the quantities suppliable; number and distribution of the trees, effect of collection on life of plant; price, means of transport, and data on which any such opinions are based.

D.—Climatic conditions under which the plant grow best as—

(*a.*) Meteorological observations as to heat, humidity, elevation, &c.,

(*b.*) Soil in which each tree grows; whether they grow in exposed or sheltered spots; solitary or in clumps; on the skirts or in the depths of forests; by river banks or Savanahs, &c.,

Parcels of seeds, or live plants or cuttings should always be sent if obtainable, as such a collection of live plants would be highly interesting and valuable.

II.—*Animal Products.*

Used as or for—

A.—Food,
B.—Saccharine substances, as honey,
C.—Furs,
D.—Perfumes,
E.—Fats and oils,
F.—Skins, parchments, leather, &c.,
G.—Hair, bristles and feathers,
H.—Horn, ivory, bones, &c.,
I.—Dyes and pigments,
K.—Silk,
L.—Shells,
M.—Corals, sponge, &c.,

Also specimens, alive or preserved, of the animals giving these various substances.

III.—*Mineral Products.*

Such as gold, silver, copper, lead, tin, iron, and other minerals and rocks obtainable; sections of mines and strata, specimens of soils, &c., and any other geological information.

IV.—*Machinery Manufactures.*

Illustrations or models of—

A.—Native agricultural and mechanical tools and implements,
B.—Textile manufactures as cotton, silk, &c.
C.—Wood work as turning, cabinet work, ship-building,
D.—Stone work, &c.,
E.—Rope and basket making, coopering, dyeing, painting, &c.,
F.—Paper-making, printing, book-binding, &c.,

V.—*Ethnology, &c.,*

Illustrations or models of—

A.—Clothing, dwellings, weapons, domestic utensils, &c., skulls, &c., illustrated by drawings or photographs if possible. Also information on manners, customs, religion, &c.

B.—Antiquities. Such as old buildings, temples, remains, &c.

VI.—*General Natural History Collections, such as Insects, Birds, Shells, &c.*

All information given on personal knowledge should be distinguished from that given on the testimony of others.

Great care should be taken that the labels should be correctly and securely affixed to the specimens, and that the letter or other account should coincide with the numbers or names on the specimens.

For mineralogical specimens small canvas bags are better than paper, and, if packed tightly with paper or grass, will travel well.

Vegetable or animal substances should have camphor packed with them, as a preservative from insects.

Vegetable substances can be preserved wet in strong brine or spirit.

Small animals can be preserved in spirits, larger ones can be skinned and the skins rubbed over with arsenic paste or corrosive sublimate, alum, pepper, &c., but plain white arsenic is by far the best.

JAS. COLLINS, F.B.S. Edin.,
Late Government Economic Botanist,
Straits Settlements.
11, Arthur-street, Deptford,
London, S.E.

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microscope, will be seen to hold 500 millions. Linnæus, not being acquainted with the structure of these minute animals sufficiently well to enable him to distribute them according to their relations in his several classes, placed them at the end of his last class, Vermes, in a genus to which he gave the name of *chaos*. Müller first separated them as a distinct order, and gave them the name of *infusoria*, from the circumstance that the greater number of animalcules had been discovered in liquids, in which vegetable or animal matters had been dissolved by infusion. Müller based his arrangement of the different genera not on their varieties of structure, but on the differences of their external form. After some time, Dr. Ehrenberg of Berlin directed his attention to the subject, and made numerous observations on the internal structure of these animals by means of feeding them with particles of colouring matter, which he diffused in the water containing them. Pure indigo was the substance he employed. By the use of these means, he arrived at very interesting conclusions. He demonstrated, by means of a powerful microscope, the existence of distinct *digestive organs* in all the species. No distinct *muscular fibres* have been detected in the simpler or polygastric forms of infusoria, but in the rotiferous species they have. With respect to the other systems, discoveries equally interesting have been made by Ehrenberg. This observer has separated from what he calls the true infusoria several families of animalcules formerly included in the same class. The principal genera so separated are the *Spermatozoa*, *Cerearia*, and *Vibrio*, which are now considered to belong to the class Entozoa. The true infusoria have been separated into two distinct divisions: the *Polygastrica*, and the *Rotifera*, or wheel animalcules.

Habitat. These animalcules are not only met with in water containing large quantities of organic matter in solution, but in common sea-water, stagnant fresh-water, and well-water exposed for a short time to the air.

Origin. It has been supposed that they are generated spontaneously; but as they never are observed in fluids secluded from the air, we may suppose that ova of extreme minuteness are always floating in the air, and only require a proper medium to develope themselves. These animals live on fine particles of animal and vegetable matter held in solution in water, and the larger species devour the smaller animalcules.

The Preservation of Animal Substances.

Various processes are employed for preserving animal substances from undergoing decomposition.

1. *Drying in a stove or oven.* This is effected by the application of a temperature sufficient to cause the evaporation of all the moisture, without burning any of the external parts, or causing the juices to run out.

2. *The action of cold* is applied in the northern regions for the preservation of rein-deer tongues, fish, and other animal substances.

3. *Brine*, or *a solution of common salt*, is an efficient preservative agent. Dissolve one part of salt in two and a half parts, by weight, of water, and immerse the meat or other animal substance in this solution, placing a board on the surface of the liquor, loaded with a lump of salt, so as to ensure the entire submersion of the animal matter, and at the same time to keep up the strength of the brine by the solution of more salt to compensate for the dilution caused by the animal juices. After the animal substance has remained in the brine for three or four days, it is to be taken out and dried, by rubbing it with bran or pollard, or with dry salt; and it may then be packed in barrels with intermediate layers of large-grained salt, if intended for long keeping, or it may be hung up in a smoking-room. The addition of one ounce of saltpetre to each pound of salt will tend to preserve the red colour of the meat, and the further addition of a small quantity of brown sugar is said to improve its flavour.

The following pickle has been recommended for preserving meat, to which it is said to give a mild and excellent flavour:—

℞ Brown sugar,
Bay salt,
Common salt, of each ℔ij.
Saltpetre ℔ss.
Water, cong. ij. Mix.

4. *Packing in dry salt* is a mode of preservation sometimes resorted to. For this purpose, salting-tubs are used, having false bottoms perforated with holes. A layer of coarse-grained salt is first made, and then alternate layers of meat and salt. After a week or ten days, the meat is taken out, and again repacked with more dry salt. Sometimes the dry salt is merely rubbed into the meat.

5. *Bucaning meat* is a rude kind of smoking practised by hunters in the forests. Forked branches of trees are stuck in the ground, and by this means a grating of rods, two or three feet high, is made. The flesh, to be preserved, is cut into thick slices, and placed on this grating, while a fire is lighted underneath, so that the meat is rendered fit for keeping, partly by drying and partly by smoking it.

6. *Jerking meat, or charqui*, is a method sometimes resorted to in hot climates. It consists in cutting the lean part of meat into thin slices, and exposing these to the full action of the sun, turning the pieces when necessary until perfectly dried. The dried pieces are then pounded in a mortar, and put into pots.

7. *Olive oil* is sometimes used to preserve fish and other animal substances. Jars into which the substances to be preserved are put, are made quite full with the oil, and are then well closed, and the covers cemented down.

Alcohol is the agent most frequently employed for the preservation of animal preparations for museums, &c. When used alone, it is subject to the objection of its causing the contraction and hardening of the finer parts of animal substances, but this effect may be counteracted, at least in part, by the addition of a small quantity of ammonia. A mixture of equal parts of rectified spirit, sp. gr. 838, and of water,

may be used in ordinary cases, but the strength of the spirit must be regulated in some degree by the quantity of fluids contained in the animal substance.

9. *Solution of Corrosive Sublimate* is often used for the preservation of animal substances, but it renders them very hard. It is advantageously employed for dry preparations, and tends especially to protect them from the attacks of insects. It may either be used by injection, or by rubbing it over the surface. For the former mode of applying it, solution in water answers best; for the latter mode, solution in spirit.

10. *Alum* preserves animal substances very well for a certain time, but bones are attacked by it. A solution of one ounce of alum in eight ounces of water, when injected into veins and arteries, renders them capable of resisting decay for a long time. In the process of tawing skins, hereafter to be described, alum is used.

11. *Goadby's Solution* is a good substitute for alcohol, and has been found to answer well in a variety of cases. The following are Mr. Goadby's formulæ:—

A 1.

℞ Bay salt ℥iv., alum ℥ij., corrosive sublimate gr. ij., water, Oij. Mix.

A 2.

℞ Bay salt ʒiv., alum ʒij., corrosive sublimate gr. iv., water Oiv. Mix.

B.

℞ Bay salt ℔ss., corrosive sublimate gr. ij., water Oij. Mix.

BB.

℞ Bay salt ℔ss., arsenious acid gr. xx., boiling water Oij. Boil until solution is effected.

C.

℞ Bay salt ℔ss., arsenious acid gr. xx., corrosive sublimate gr. ij., boiling water Oij. Boil until solution is effected.

The solution A 1 is that which Mr. Goadby usually employs. A 2 is used in those cases where there is a tendency to mouldiness, and where the animal texture is tender, for the salt, if in too great quantity, sometimes destroys the tissue. B is used in cases where the animal substance contains carbonate of lime, as in those cases alum effects a decomposition. BB is intended for old preparations; and C, for preparations of this kind, in which there is a tendency to a softening of the parts. Professor Owen has found these solutions to answer better than alcohol for the preservation of nervous matter, and has employed them extensively in the museum of the College of Surgeons.

12. *Gannal's Solution* owes its efficacy to the presence of *Acetate of Alumina*. Its efficacy is similar to that of the solution of alum, and it is subject to the same inconvenience, arising from the action of the salt on some animal substances. It is made by dissolving one ounce of acetate of alumina in twenty ounces of water.

13. *Solution of Sulphate of Zinc* is used to preserve the muscles, teguments, and cerebral substances of vertebrata. It does not injure the bones, and does not become mouldy. It possesses the singular property of destroying all the parts of caterpillars but the teguments, and is therefore well adapted for the preservation of those larvæ which are not naked.

Solution of Chloride of Zinc. Sir William Burnett's Solution. A patent was taken out by Sir W. Burnett, in 1840, for applying a solution of chloride of zinc, one pound of chloride of zinc to a gallon of water, for the preservation of animal and vegetable substances. The substances to be preserved are immersed in the solution for a period varying from 48 to 96 hours, and afterwards dried in the air.

14. *Solution of Salammonic*, or *Chloride of Ammonium*, has been found to preserve the muscular substance of mammaliæ. The solution is made in the proportion of one part of the salt to ten parts of water.

15. *Solutions of Nitrate of Potash*, and of *Persulphate of Iron*, are effective preservative agents, but they change the colour of the preparations, and the iron salt attacks the bones.

16. *Naphtha mixed with water*, in the proportion of one part of the former to seven of the latter, is said by Mr. Babington to be a good antiseptic.

17. *Kreosote* preserves animal matter well, but renders the preparations brown. Sixteen drops of kreosote may be mixed with one ounce and a half of water.

18. *Essential Oils* are good preservatives of all parts but the fat, which they dissolve. Oil of turpentine is one of the best. They render many parts transparent if previously dried, which is sometimes advantageous.

19. *The Process of Tanning* is applied to the skins of animals, with the view of preserving and hardening them, and rendering them more fit for some economical purposes. This process consists in soaking the skins, from which the hair and grease have been previously removed by the application of lime, in a solution of tannic acid, together with some extractive matters derived from the barks of certain trees, more especially of the oak.

20. *The Process of Tawing* is also applied for a similar purpose. It consists in first soaking the skins in water with fresh slaked lime for several weeks, the water being changed two or three times during this period. The skins are then taken out and rinsed, and again soaked in water with wheat bran. After this, a paste is made as follows:—Eight pounds of alum and three pounds of common salt are dissolved in hot-water; to this is added twenty pounds of wheat-flour, and the yolks of about one hundred eggs, so much water being used as shall form a thin paste. A portion of this paste being diluted with water, the skins are soaked in the mixture, and pulled and stretched from time to time, and subsequently dried.

21. *Acids* are frequently required to dissolve the calcareous parts of animals, such as bones, shells, &c. Hydrochloric or nitric acid, diluted with four or five parts of water, may be used for these purposes.

22. *Alkalies* serve to convert grease into soap, to render it capable of drying, and to make the preparations cleaner.

1. *Weak Ley.*

℞	Carbonate of soda	℥iv.
	Quick lime	℥j.
	Water boiling	Ov.

Add the lime to the soda dissolved in the water, stir, and pour off the clear liquor.

Greasy bones, where the medulla oozes out, may be placed in this for a week or two, and when they begin to whiten, they are to be boiled for a quarter of an hour in the same ley, then well washed and dried. To saponify the spots of grease on the bones, cotton wool dipped in the ley should be laid on. The bones must not be left too long in the ley, as it will, after a time, attack the gelatine.

2. *Strong Ley.*

℞	Carbonate of soda	℥iv.
	Quick lime	℥j.
	Water boiling	Oiiss.

Proceed the same as before.

23. *Injections.* The various injections used by anatomists may be conveniently divided into three classes—viz., 1. Common injections; 2. Fine injections; and 3. Injections for corrosion. The first are used to fill large vessels. The following are some of the principal:—

COMMON INJECTIONS.

1. ℞ Tallow ℥xij., wax ℥v., olive oil ℥iij. Melt and mix.
2. ℞ Wax ℥xij., common turpentine ℥vj., tallow ℥iij., oil of turpentine ℥j. Melt and mix.
3. ℞ Spermaceti ℥ij., wax ʒj., common turpentine ℥j. A very penetrating injection.

FINE INJECTIONS.

These injections are used to trace the capillary vessels.

1. ℞ Gelatine ℥xij., water Ov. Mix, with a gentle heat. In winter only ℥vij. of gelatine must be used.
2. ℞ Canada balsam, vermilion, q. s. Mix.

INJECTIONS FOR CORROSION.

1. ℞ Bismuth ℥viij., lead ℥v., tin ℥iij. Fuse together. (*D'Arcet's.*)
2. ℞ Resin ℥viij., wax ℥x., common turpentine ℥xij. Melt together.
3. ℞ Wax ℥xvj., resin ℥viij., turpentine varnish ℥vi., vermilion ℥iij. Melt together. (*Mr. Knox's.*)

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VEGETABLES YIELDING PRODUCTS

EMPLOYED IN

MEDICINE, DOMESTIC ECONOMY, AND THE ARTS.

CLASSIFICATION OF PLANTS.

Among the several kinds of classification which have been adopted by different botanical writers, that of De Candolle has, perhaps, been received with the most general approbation. The arrangement of plants which that distinguished botanist has made in his Prodromus, so far as that work, which is not yet completed, extends, will be followed here. The vegetable kingdom is first arranged in two great divisions:—

1. *The Vascular,—Phanerogamous*, or *Flowering Plants;* and
2. *The Acrogens,—Acotyledons, Cellular, Cryptogamic*, or *Flowerless Plants.*

The flowering plants, which have spiral vessels, and distinct flowers and sexes, are again divided into *Exogens*, or *Dicotyledonous Plants;* and *Endogens*, or *Monocotyledonous Plants.*

Exogens are plants whose *leaves* have reticulated or branched nerves, forming a sort of net-work; the *stems*, when cut across and examined, are found to consist of central pith, wood, and bark, and from the centre to the circumference there are fine lines, called medullary rays; they *increase with growth*, by the deposition of layers of wood beneath the bark, and there are found to be as many concentric circles of wood, in the trunk of a tree of this kind, as the plant is years old; the *flowers* usually have a quinary division; and the *embryo* of the seed has two or more cotyledons, opposite.

Endogens are plants whose *leaves* have parallel veins; the *stems*, when cut across, present no distinction of pith, wood, bark, and medullary rays, but consist of confused bundles of woody fibre; they *increase with growth*, by depositions in the interior of the stems; hence these increase but little in thickness, and there is no appearance of concentric circles of wood; the *flowers* usually have a ternary division; and the *embryo* of the seed has but one cotyledon, or if two, they are alternate.

Acrogens, or Cryptogamic Plants, have no *flowers*, properly so called; many of them are destitute of *leaves*, but if they have leaves, there are either no veins to them, or the veins are of the most simple kind, being either not branched, or if branched, divided by repeated

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Collecting & preserving.

[Taxidermy etc

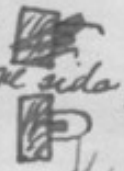
Report of Illinois Nat His Soc 1867.

Davies Pract. Naturalists Guide

Cheese cloth (plenty) for towing, butterfly nets &c Comrie]

Tin boxes in wooden cases are best for packing specimens.

Drying cases to take to pieces vide for size Hints to Trav. (Geo. Soc)



wooden frames with zinc (perfd) each opposite portion being ploughed thus & the (The staple one at each end passes through opposite side & tightened with a pin or a catch. ~~

Perforated zinc for drying algæ coll^n of algæ etc. ——— in Drury Lane has quantities & at a cheap price. a quantity of sheets of diff^t qualities could be purchased cut to size & at a low price — (Card flatness)

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Neuropterous Insects
Van Voorst
by R. McLachan, F.L.S.
London Van Voorst 1873

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INSTRUCTIONS FOR THE COLLECTION AND PRESERVATION OF NEUROPTEROUS INSECTS.

The best aid and incentive to the study of any group of natural objects is the possession of a well-ordered collection, and any hints tendering to further this acquisition cannot but be of service. Taking this for granted, I propose to give here general instructions to those entomologists—few though they be—who turn their attention to that heterogeneous assemblage of insects known as the Linnean order Neuroptera, believing also that some who have neglected this order for want of some general guide to the means of possessing the necessary collection, may be induced to turn their attention thereto if they learn something of the *modus operandi*. As the majority of these insects are aquatic in their earlier stages, the very excursions necessary for their collection cannot fail to be a source of enjoyment to all who can appreciate the beauties of natural scenery, for they must take the collector to the banks of rivers and lakes, reedy ponds and rushing waterfalls, localities upon the beauties of which the author of 'Rambles by Rivers' would have eloquently discoursed.

As the utility of all instructions depends upon their conciseness, I shall endeavour to concentrate these remarks as much as may be consistent with their usefulness, by laying down general hints, leaving the more minute particulars to be filled in by the accumulated experience of individual collectors; for, after all, experience is the only true guide,—*that* alone can help the entomologist to that correct appreciation of cause, effect, and probability, so essential to the success of the object he has in view. And though I especially address these notes to *British* entomologists, I shall embody therein more general instructions to collectors abroad, those who cannot find time for elaborate preparation of their specimens, and with whom the acquirement of large numbers of specimens and species is really of more consequence, both to themselves and to the entomologists who may benefit by their labours, than beauty of condition of a few examples. Specimens cannot be too perfect, or in too good condition; this I look upon as an axiom: yet it seems to me that the rage for

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'perfect' specimens, so strongly marked in many entomologists of the present day, savours more of the amateur than of the student; and I confess that, for my part, I would rather have 50 species perfect enough to admit of a correct appreciation of their structure and peculiarities, than 10 so perfect that not a defect exists. I throw out this last opinion not as recommending carelessness of preparation, but as discouraging the craving for cabinet objects instead of materials for study. The student-entomologist should try to believe that "half a loaf is better than no bread," and not despise a specimen because a joint or two of an antenna, or a leg, &c., be missing.

GENERAL OBSERVATIONS.

Before proceeding to consider the different families of Neuroptera in detail, it may be as well to give a few general hints that will apply to all.

Nets.—This subject may be dismissed in very few words. An ordinary butterfly ring-net is sufficient for almost every purpose; for colour I prefer white, and for material ordinary book-muslin, though something stronger is sometimes advisable for sweeping. The ring of the net should be of moderately large size to suit it to the capture of Dragon-flies by giving sufficient spread.

Pinning and Setting.—Almost all these insects should be pinned through the thorax between the anterior pair of wings, inclining the head of the pin slightly forward. As I take it to be almost useless to attempt to induce collectors of British insects to adopt other than *short* pins, I urge here only that the pin should be run through the body so far that at least one-third of an inch projects on the under side, and that the setting board be comparatively flat. By this means the legs, &c., which are most important members in the study of Neuroptera, and without which even the generic positions cannot in many cases be ascertained, are left free, and less liable to be broken off, and the wings touch the paper of the drawer or box in no part. I would earnestly beg all Neuropterists to eschew the plan adopted by many of our Lepidopterists, who so pin and set their insects, that when placed in the cabinet they look more like so many permanent rows of postage-stamps neatly gummed in an album, than collections of natural objects intended for purposes of study and hence liable to repeated removals, the legs, &c., being so hidden as to give an idea

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that these are absolutely of no consequence, and that everything depends upon the pretty colours or markings of the wings. Setting-boards with *square* grooves I hold to be infinitely preferable to those with the ordinary *rounded* grooves. My own British collection is set upon short pins, but if I had to re-commence to-morrow (which Heaven forbid!), I would carefully avoid these, use longer ones, and set the wings flat, after the method adopted by almost all except British entomologists. The advantages are infinite. The insects suffer little, if at all, from mites and other depredators; and, what is of paramount importance, the notes of the locality, date, &c., can be placed in neatly written labels upon the pin itself, and every specimen may also bear a name-label, a point of much weight in typical collections; furthermore, the insect is easier to examine under the lens. But some of our continental friends carry the use of *long* pins to an excess, beyond the bounds of reason or utility. A pin of about 1½ inch in length is quite sufficient, and it should be pushed through the insect for fully two-thirds of its length. It should be *not too fine* (a point upon which continental entomologists strongly err). Two sizes are enough for all ordinary purposes, and for my re-set foreign insects I use Nos. 2 or 3, and 16, manufactured by D. F. Tayler and Co. A strong pin renders the specimen much more durable, and I fancy the absurdly fine pins used on the continent have to some extent disgusted English entomologists with the high-setting there adopted: these can only be inserted in the cork by the use of the forceps *under* the insect, and even then we often see them bent into all sorts of zig-zags, to say nothing of the unavoidable jerking off of bodies, &c. For very minute insects it is always advisable to use short pins, such as Nos. 19 and 20, adopted by English Micro-Lepidopterists, and if the collection be otherwise set on long pins, then these short pins bearing the insects should each be stuck into a little oblong piece of white pith neatly cut with a very sharp thin knife (a razor will not do owing to its thick back), and this impaled on a long pin. The best kind of pith is that obtained from dead and dry stems of Jerusalem artichoke, which is of extreme whiteness, and does not change colour by age, the latter being an especial defect of elder-pith. In setting, the wings should be spread out with braces exactly as in butterflies and moths; but it is always desirable to leave a few of each species unset, so that on the pin they retain the natural position in repose.

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Setting-boards suitable for long pins are kept in stock by many dealers in entomological apparatus, or would readily be made to order; the groove should be very deep, leaving only enough cork to hold the pin firmly, so that the legs may suffer no injury. But I am always glad to receive these insects unset. When the collector occupies himself with other orders, and catches Neuroptera simply to oblige friends, he cannot be expected to waste time in preparing insects that are useless to him. The greater part relax very readily on ordinary damp sand, or in a zinc relaxing-box: Dragon-flies are especially tractable in this respect, and, when treating on them, I shall take occasion to point out, especially to foreign collectors, that these are even better if sent home not pinned.

Carding.—On this point I shall say little, except to discourage, to the utmost, the adoption of the system. I look upon its application to almost any order as a modern innovation, which I would fain hope is on the wane, even among those inveterate "carders," the Coleopterists. To apply it to Neuroptera, is to render them almost absolutely useless. Nearly everything here depends upon the neuration of the wings; and this can, in most cases, only be properly traced by holding the insect to the light, the intricate veining being usually more or less pale, or even transparent. Carding can only be tolerated by the Neuropterist when applied to the preservation of minute apterous forms, such as some Psocidæ.*

Preserving in Alcohol, &c.—As so much depends in many groups of Neuroptera upon the form of the genital organs and their secondary appendages, it is of much service if some specimens be placed in spirits of wine, or some analogous medium, so that these forms can be more reliably ascertained, and safer descriptions and drawings be made therefrom than can sometimes be had from dry specimens. But I confess to having a prejudice against collections consisting almost entirely of specimens in alcohol. The constant care necessary for their preservation is a great drawback, and can be only

* In Coleoptera, "carding" has many serious disadvantages. Important characters are present in the "cushions" of the under-side of the tarsi, in the insertion of the coxæ, and in the abdominal segments, to say nothing of the mouth-parts. Some argue that all these difficulties can be met by gumming certain individuals on the back. But suppose the specimen *ventre à soleil* be not specifically identical with those *ventre à terre!* and this is an accident likely to occur to the most expert Coleopterist. An esteemed colleague, to whom I have often argued my objections to the carding system, suggests that the specimens can easily be "floated off" in water, and examined on all points. What unnecessary trouble! what bother over gum-beclogged tarsi, &c.! I often see carded Carabi; and, if the practice be not on the wane, as I think it is, I expect to see a carded Goliath-beetle!—R. McL.

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exercised in large museums, and, even in these, I think experience will prove that pinned specimens will stand a much better chance of a long existence than will those in alcohol; and this must not be lost sight of when typical collections are concerned. There is no reason why a pinned collection should not last for at least a couple of centuries, and be then of use to the student, if ordinary care be taken; but I much fear that the myriads of glass tubes with alcohol, &c., necessary for a large typical collection, would, with their contents, stand little chance of an existence for half that period. Hence, I look upon this mode of preparation as more adapted to temporary purposes. If the necessary descriptions or figures be once made, much is done, for the natural form of the parts can, in most cases, be traced in the dry insect; whereas, details drawn up from dry insects in the first instance, are often difficult of application to the actual condition as exhibited in moist preparations. Mr. Eaton strongly recommends using pure glycerine and water, the former being added drop by drop to a tube partly filled with water till it is full, and with the addition of a small drop of acetic acid, the tube being finally corked. And here I would urge my chief objection to moist preparations. If cork only be used, the spirit or other substance will quickly evaporate, and the insects be destroyed; and if hermetically sealed, the specimens are comparatively useless, for sufficient examination can seldom be made through the glass tube. Carefully prepared microscopic slides of the whole insect, or of the particular part to be examined, in Canada-balsam or glycerine, seem to me more likely to serve the purpose intended.*

Boxing, Killing, &c.—Most small species, when caught, may be placed in ordinary pill-boxes till arriving home from a day's excursion; but if the weather be hot, many of them are liable to die, dry, and get broken in the course of a long day. This applies especially to water-frequenting groups, for these part with their moisture very readily and soon become dry (Botanists experience a similar thing in drying water-plants for the herbarium). Therefore, it is often desirable to kill the insects as soon as caught, and pin them in a zinc pocket-box with damped cork. A quantity of small glass tubes with corks is a useful adjunct to the other apparatus carried by the collector. For

* Foreign collectors often send home beetles and other hard-bodied insects in spirits. This plan should not be applied to Neuroptera, unless on the before-mentioned principle, that "half a loaf is better than no bread," *or for special purposes*. Those with hairy bodies or pubescent wings are much injured in spirits.—R. McL.

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killing, nothing is better than a "killing bottle" (such as is now supplied by any dealer), consisting of a short, wide-mouthed pomatum-bottle, into which is placed a small quantity of cyanide of potassium, this being covered with about an inch of plaster of Paris made into a thick paste, which soon hardens, through which the deadly cyanogen gas slowly passes. Such a prepared bottle will maintain its effect for several years, and the insects die almost instantaneously without becoming stiff. In the case of insects in small pill-boxes, it is advisable to place box and all into the bottle, having first made (for more rapid effect) a small incision with the point of a penknife in each lid. Those species that have no great amount of hairy clothing may be bottled from the net, remaining in the bottle until the time arrives for setting, but hairy species rub too much one against the other if this plan be adopted for them.

In bringing these preliminary remarks to a close, I would reiterate that *experientia docet* is the best motto for the collector. I have known men who have spent the greater part of a tolerably long life in going from friend to friend asking advice, dying before they could make up their mind which particular instructions to follow. I cannot imagine a more unhappy or useless existence. Any honest advice is worthy of consideration; it is for the individual originality of the recipient to apply or modify it to his best advantage.

The few remarks on breeding that may be hereafter made, will be of necessity second-hand, my own experience on this subject not being sufficient.

SPECIAL INSTRUCTIONS.

Dragon-flies (*Libellulidæ*).

I commence the special portion of these 'Instructions' by a consideration of the *Libellulidæ* (using the term in its broad sense), partly because they are the most familiar Neuropterous insects, and also because this division of the subject requires to be rather more detailed than will be necessary in most of those that follow; the sequence of the groups being a matter of little consequence.

The larger species (*Libellula*, *Æschna*, *Anax*, &c.) force themselves upon one's notice by their bold and fearless flight when engaged

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in 'hawking' in the bright sunshine. Some also (e.g. *Æschna grandis*) delight in the long twilight of a fine autumn evening; but it is useless to expect to see dragon-flies at large in dull weather; they may then be occasionally found at rest, and picked up with the fingers. As water-loving insects *par excellence*, the vicinity of that element is of course the most likely situation in which to seek them. But many carry on *their* collecting operations far from water, and broad heathy commons, or shady lanes (according to the species), are often enlivened by the presence of these tyrants of the insect-race. Boggy moors, treacherous to the footsteps of the too bold entomologist, and rocky mountain-sides, are peculiarly favourable localities. Never *chase* a large dragon-fly; such a proceeding is useless 'waste of tissue,' to say nothing of the chance of sinking to the middle in a bog, or coming violently to grief over herbage-hidden rocks and cavities. When one is seen frequenting a certain spot, wait till some tempting prey bring the pursuer to within reach, then, by a dexterous stroke of the net, secure it. Many species shew especial predilection for even a particular twig, and although they may make long and varied excursions, they will return again and again: so be not too precipitate, remembering that if one be struck but not captured, or sufficiently scared, it will go away at a pace defying pursuit, and not again put in an appearance. Mr. Wallace, in his 'Malay Archipelago,' relates that at one of the islands (Lombock) visited, and where large insects are used as food, the natives catch dragon-flies by means of limed twigs, the habit of haunting particular spots being no doubt taken advantage of. I have frequently, when out walking without a net, knocked down the large species with my stick, and specimens so caught often sustain little or no injury. The smaller slender-bodied species (*Agrion*, *Calopteryx*, &c.) can be captured with comparative ease, though even with them one must not rely upon obtaining a second stroke if the first miss its object. These frequent the sides of running brooks, reedy ponds (especially those formed by the 'backwaters' of rivers, which are often isolated in summer, though connected with the stream in the floods of winter), and weedy ditches. If there be a hedge-row in the vicinity, so much the better, as they will leave the margins of the pond or ditch for the sheltered side of the hedge, where they may be seen flying in swarms. Even the open expanse of a flowery meadow far from water, and the rides in woods, are often haunted

by myriads of Agrions. Scarcely anything more beautiful exists in nature than a stream over which are flying our native species of *Calopteryx;* but the sight of a forest rivulet frequented by some of the brilliant and metallic exotic species must be a treat never to be forgotten by the naturalist.

It must be borne in mind that dragon-flies are long-lived insects, and, in some cases, several days elapse after hatching before the colours are fully matured: thus the male of *Libellula depressa* only obtains its pulverulent blue colour by slow degrees; for some days it is yellow, like the female; in a collection, it is always desirable to have specimens thus comparatively immature. *Very recently developed* examples are detected by the limp consistency of all their parts, and especially by the wings, which, when the insect is feebly flying, look as if (to use the apt expression of another observer) they had been dipped in mucilage; for the sake of understanding a species in all its conditions, it is even advisable to retain some of these.

With regard to the best means of conveying the insects home when caught, I can scarcely do better than quote the words of Dr. Hagen in the 'Entom. Weekly Intelligencer,' vol. iv, p. 88. He says:—"In collecting the *Libellulæ*, I take a number of strips of "paper doubled in two, and place the wings of a caught specimen "between the folds, and with a pin at each side of the wings, fasten it "into my collecting box, without pinning the insect itself: thus, in a "small box, you may pack many in a small compass, taking care not "to put them within reach of each other's jaws." Or the insects may be killed or stupified by a sharp pinch, and then be temporarily pinned in the box through the side of the thorax, the wings being kept down by a simple paper brace pinned at each end. A more elaborate plan is that explained by M. Blisson in the 'Annales de la Soc. Ent. de France' for 1840, who recommended that the insect when caught be placed in a sort of paper shroud, covering almost the whole insect excepting the head. With the slender-bodied small species it is, I think, better to pin at once in the ordinary manner between the wings: but, in all cases, emphatically regard the instructions not to put them within reach of each other's jaws; even specimens thought to be dead may revive, and then, upon arriving home, the results of a day's labour present no better appearance than jagged wings and mutilated bodies. Though, apparently, so insensible to

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pain, and tenacious of life, they are, in reality, easily killed, and Dr. Hagen even asserts that they die rapidly by simply placing the box close to a window in the hot sunshine: this I have not tried.

I now come to the most important parts of the subject: firstly, the preservation of them in collections without breakage; secondly, the preservation of the colours. On these points much has been written; and I will endeavour to combine the advice of previous writers with my own experience. The body of a dry dragon-fly is extremely liable to dislocation at any segmental division, the compound consolidated thorax being in reality the only part that will remain entire with any degree of certainty. The head is attached very slightly, yet this will often move round, almost as if on a pivot, without becoming detached: however, if it come off, it can easily be re-attached by a strong solution of shellac in spirits of wine; and some may even prefer to voluntarily behead all their specimens, and unite again with this or some similar liquid cement. Taking the smaller species (*Agrionidæ*, &c.) first, I do not recommend, with them, any system of disembowelling, believing, from experience, that the preservation of the colours is not furthered thereby. Dr. Hagen ('Intelligencer,' vol. ii, p. 82, and vol. iv, p. 88), advises that a needle with thread be introduced into the under-side of the thorax, and brought out *before* the termination of the body (mark especially, *before* the termination, so as not to injure the appendages of the apex), the thread being drawn backwards and forwards to remove some portion of the viscera, and a clean thread then inserted and cut off at each end. Baron de Selys-Longchamps, whose experience is probably greater than that of any other living entomologist in these matters, prefers ('Revue des Odonates,' p. 378) to use no endeavours to extract the viscera in the slender species. In this I agree with him, and explain here the plan I adopt. Having provided myself with some stout horse-hairs, I cut them up into short lengths; one of these lengths is inserted in the under portion of the thorax of the insect, and is gently pushed down until it reaches the extremity of the abdomen, but it is not pushed *through*, and, by this means, the anal organs can suffer no injury; the thoracic end is then cut off, and the specimen is thus rendered incapable of breakage. I conceive horsehair, when it can be obtained, to be infinitely preferable to any other substance, if only on account of its elasticity. The larger species require a more elaborate treatment, and,

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as a rule, it is certainly desirable to eviscerate at least the abdominal portion of the body. To do this, take a fine-pointed pair of scissors, and cut an incision along the membranous longitudinal suture of the under surface; the inside can then be extracted with a pen-knife, and a little brush-pad of cotton wool may be used to wipe out the remaining moisture. Then fill in the interior with clean cotton wool, a small quantity will suffice; and it is better to err on the side of too little than of too much; for, in the latter case, the body assumes an unnaturally dropsical appearance when dry. I prefer *white* wool in all cases. Many elaborate plans of using differently coloured paper, made into little rolls, or coloured wools adapted to the natural colour of the body, have been proposed, and some have gone so far as to attempt to imitate the markings by designs painted on the inserted paper (!). All this I look upon as unnecessary and, to a considerable extent, more than useless, trouble. It is in vain to attempt to reproduce the natural tints by artificial means; if the eviscerating process be performed with sufficient care, some, at least, of the original beauty will remain; more than this cannot be obtained, and should not be expected. Species of medium size may be partially cleansed by means of a piece of dry grass-stem drawn backwards and forwards (after the manner before noticed when speaking of the *Agrionidæ*), and breakage prevented by a clean piece of the same stem (or some similar substance) inserted permanently: decidedly the best material is the straight wire-like vegetable substance so extensively used in making mud-brooms; this possesses almost the elasticity of horse-hair, and is stout enough for even the largest species.*

In the 'Intelligencer,' vol. ii, p. 82 (see also vol. iv, p. 87), Dr. Hagen very justly remarks that:—"If a species be sufficiently common "to allow of many specimens being taken, we are sure to find that some "of them keep their colours well without any preparation." This I can emphatically confirm: I have, *inter alia*, large British *Æschnæ* which now, after several years, have their colours and intricate markings almost as fresh as when first caught, and this without the slightest preparation. But he goes on to say:—"These are specimens which "had not long escaped from the pupa state, and had not yet commenced "their ravenous career; their empty intestinal canal containing no

* This material is known in commerce as 'Bass' or 'Piassaba.' Mr. Jackson, of the Kew Museum, informs me that it is the produce of two species of Brazilian plants—*Attalea funifera* and *Leopoldinia Piassaba*.—R. McL.

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"foul matter." The last part of this sentence is perfectly correct, for it is the decomposition of the partially-digested food (assisted in the ♀ also by the ova) that destroys the beauty of the specimens, and, at first, I accepted the explanation in all its details. Further consideration, however, induces me now to differ from him as to these specimens being recently developed. All dragon-flies take from two days to a fortnight (according to the species) to become fully mature; yet they eat in the meantime, and the individuals that do not change *are* usually fully mature. I look, therefore, to another explanation. Dr. Hagen hints that specimens taken very early in the morning are the most likely to retain their colours; this I consider not owing to the fact that they are recently developed, and have not fed at all, but that the food of the preceding day has been digested and passed away: and I should look to even more certain results in the case of specimens taken during the first incoming of fine weather after an uninterrupted series of gloomy and wet days.

I conclude the already too lengthy remarks in this chapter by a few hints to *foreign* collectors. If the specimens be pinned when caught, each should have a grass stem, or some analogous substance, run into the body as mentioned above, taking especial care that one end be *in the thorax;* otherwise it is impossible to send over a collection which shall arrive in good condition, and one large body becoming detached will play havoc with the others. But almost all can be sent in squares of paper folded into triangular envelopes, one in each: if the body then become broken, the pieces can be fitted together with certainty. They should not be placed in these envelopes *until dry*, that is, until after they have been for some time braced down as recommended for the field collecting box, otherwise the pressure alters the form, and decomposition sets in under very unfavourable conditions, so far as the colours are concerned.

Dry dragon-flies relax very easily, and need not remain upon the setting-board for anything like the time required for smaller and more delicate insects. When the bodies are broken, they can easily be reunited by using horsehair (or something stouter for large species), inserted into the dislocated portions, taking the precaution to smear the substance with the shellac cement, and the pin will also require some of this cement on the portion that will remain *in* the thorax, to keep it secure. Pins with the heads cut off, and wire, are not

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desirable mediums wherewith to connect broken fragments, as they become rusty, and eventually destroy the specimen. Baron De Selys even advises that the abdomens of all dry specimens should be voluntarily detached, and then re-connected. A solution of phenic (carbolic) acid in alcohol should be applied to each specimen to destroy mites or mould, and as a future preservative. The wool used for stuffing fresh specimens should also be saturated with some of this solution.

White-Ants (Termitidæ).

Excepting in the extreme south, Europe is happily free from these pests, and I have never yet seen any species alive. Their habits are, of course, gregarious; and Mr. Bates' 'Naturalist on the Amazons' gives a general idea that will apply to any part of the world where they occur. Each species is well known to have many separate forms (soldier, worker, &c.), and all these should be obtained from one 'termitarium.' Possibly the best plan is to send home all the forms in spirits; or, if the winged examples be pinned, they should certainly not be expanded, for the following reasons. At certain seasons these shed their wings voluntarily, and this is done by these organs becoming detached at a transverse suture close to the thorax; and specimens at all times are liable to become thus dislocated, and more especially when the wings are expanded. If anything *could* induce me to relax my opposition to 'carding,' it would be in the case of winged white ants, for I know not how to keep them intact. The gravid female, with her enormously distended abdomen, must be placed in spirits.

The small allied family *Embidæ* is rare, and the species are not numerous. It appears to be certain that the varied conditions existing in *Termes* are not found here, but of some species the larvæ only are yet known; these occur under stones in sandy districts. M. Lucas states that the winged (or perfect) form of an Algerian species was seen running up and down the stems of low herbage, without attempting to fly when taken. The wings are not deciduous, and may be expanded in the usual way.

Psocidæ.

These, for the most part minute, insects are to be met with on the trunks of trees, old palings, &c., as well as by beating the boughs over the net; and, for this latter operation, firs, larches, yews, and, in

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fact, all conifers, are particularly favourable. Where a species occurs it is usually abundant, for they are more or less gregarious: a few exotic species are of comparatively large size, but very few exceed half-an-inch in expanse of wings, and the majority are very much smaller. They are often imported with merchandize in ships; some small species (I speak here of the winged genera) naturally inhabit houses and warehouses. All run with extreme rapidity, and seldom use their wings: when captured, they should be placed in small pill-boxes, or (better still) in small glass tubes. Owing to their small size, only few will satisfactorily bear a long pin sufficiently strong, and for most it is necessary (if the long-pin system be adopted) to use the oblong pieces of pith, noticed in my general observations, for the purpose of mounting them. The wings should be expanded in the usual way on small setting-boards; but in the case of very small forms, the action of pinning will open the wings sufficiently to admit of the requisite examination. Very little is yet known of them, excepting European forms, though the exotic species are certainly *very* numerous, and are much needed: some are of extreme beauty, and sometimes even furnished with semi-metallic scales as in small moths. This is possibly the *most* neglected family of that neglected order *Neuroptera*, and the known species probably scarcely represent one hundredth part of those that exist:—*verbum sap.!*

Of the apterous species (*Atropos*, *Clothilla*, &c.) it may be truly said that most entomologists need instructions as to how to get permanently rid of, rather than how to procure, them. They are everywhere, and always making themselves obnoxious by destroying the peace of mind—and the collections—of the Naturalist. One species, at least, is known to inhabit ants' nests, and many more may yet be discovered as ant-guests. Any permanent mode of preserving them as specimens is difficult. They may be carded — unsatisfactory!; mounted on mica—also unsatisfactory!; or mounted as microscopic slides—perhaps the most satisfactory. Collectors should try to get rid of the notion (still fostered by some who ought to know better) that these little pests are only larval forms of winged insects. Two species (one *Atropos*, one *Clothilla*) are common in all houses, and with them, no doubt, the larvæ of minute winged species that frequent human habitations; but the structure of these latter would detect them. It may here be well to remark, that there is a suspicion, not

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yet sufficiently grounded, that some winged tree-frequenting species have apterous conditions allied to what is found in *Termes;* it is certain there are forms with imperfectly developed wings, and I think these are always females.

May-flies (Ephemeridæ).

Insects more attended to by the angler than by the entomologist, and upon which much poetry has been written on the taken-for-granted supposition that the romance of their few hours' existence is founded on fact. Possibly, however, some few live only a day or two as perfect insects; but these are exceptions. The neighbourhood of water, especially running water, is sure to produce multitudes of May-flies. The males of some large species *(Ephemera)* dance in swarms over the stream; whereas, the females are only to be found among the herbage, or taking short flights. The smaller species fly in calm weather more steadily and very slowly. Some are so abundant as to be used for manure, and even for feeding pigs (!), on Continental rivers; and we are even told of shrubs being bent down by the multitudes of an American species. Mr. Eaton has done good service by his recent Monograph of the family, but very little is yet known of extra-European forms. The sexes generally differ much in appearance, and, owing to the fact of the final moulting being performed after the winged condition has been assumed, it is thus necessary to have four distinct series of each species, as Dr. Hagen observed in the 'Entomologist's Annual' (1863, p. 6). When pinned, it is a matter of indifference as to whether they be 'set' or not; the caudal setæ are very difficult to retain entire, but this is best facilitated by pinning high, and not allowing these setæ to come in contact with the drawer or box when dry. The true forms cannot be properly retained in dry specimens, and Mr. Eaton (see p. 5) advises that all be preserved moist: altogether they are unsatisfactory insects from a collector's point of view, and none suffer so much from the attacks of the apterous *Psocidæ*.

Stone-flies (Perlidæ).

Always found in the vicinity of water, and, as a rule, running water, the more rapid the better. Mountain streams are especially favourable; and the larger species may be found among the herbage

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on the banks, or more readily under the large stones (sometimes partially in the water) that lie on the edges of the burns. The species of the genus *Pteronarcys* (which is almost peculiar to North America) frequent the spray of waterfalls, and are furnished in the perfect state with external respiratory filaments, showing that their habits are even then so aquatic as to necessitate the extraction of air from water. The large species fly but little, yet are difficult to capture, owing to their rapid sliding motion when alarmed; the smaller forms *(Leuctra, Nemoura,* &c.) fly in calm weather slowly, but moderately high, over the water. Some species *(Nemoura)* inhabit muddy ditches containing very little water, but the majority are emphatically torrent-loving insects. All may be pinned and set out in the usual way, care being taken not to break the caudal setæ of those larger forms that possess these organs; and it is also necessary to be careful in spreading out the folded and delicate anal portion of the hind-wings: in re-setting relaxed specimens, this portion of the wing is extremely liable to get torn. The whole family has no great amount of beauty to recommend it, but many of the forms are extremely curious, and comparatively little is yet known of them, the separation of the species being very difficult; and, indeed, it is almost imperative that for this purpose some of each should be placed in spirits or glycerine. They are no doubt most numerous in northern latitudes; but the streams of tropical mountains are certain to produce them in numbers. Few are known from the Southern Hemisphere, yet there are some curious forms in Australia and New Zealand.

With this family I conclude what is termed the Pseudo-Neuropterous division, viz., those which undergo an imperfect metamorphosis.

Planipennia.

In this division are grouped all the species with complete metamorphoses, excepting the *Trichoptera*, and as the groups are not so sharply differentiated as those previously treated upon, they will be severally considered in separate paragraphs. Several of the families are not represented in Britain. All insects of this division should be pinned and set in the ordinary way. The larger species may be pinned into the collecting box when caught; the smaller can be placed in pill-boxes or glass tubes, and many may be confined in one receptacle, for they seldom damage each other, and have no scales to rub off.

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Sialidæ.—The most familiar representative of this family is the abundant *Sialis lutaria* (well known to the angler), which swarms on palings, walls, trees, &c., near water in early summer, and may be picked up with the fingers; its flight is slow and steady, but sufficient examples can always be obtained without the use of a net. It is frequently mistaken for a caddis-fly. Only this genus exists in Europe; but there are other exotic genera, and some of the species of *Corydalis* (a genus peculiar to America) are among the largest insects known, some being nearly six inches in expanse of wings, and the males usually provided with enormously elongated mandibles, the use of which is not clearly evident,* as they are harmless insects of nocturnal habits. Another genus, *Chauliodes*, is found both in the old and new world; some of the species are very pretty, and many remarkable for the diversified structure of the antennæ of the males. All the genera are aquatic in their early stages.

Raphidiidæ (*Snake-flies*).—A small group, peculiar to temperate climates, remarkable for the greatly elongated prothorax. The larvæ live under the bark of trees, feeding upon other larvæ, &c. The perfect insects may be taken by beating the boughs over the net, and fir trees are the most favourable for this operation; they may also be occasionally found on the trunks. Their flight is probably nocturnal, for they seldom show any inclination to use their wings when captured in the day-time. Up to the present time they have only been found in Europe, Northern Asia, and Western North America.

We now come to a series of families or groups remarkable for the beautifully close network of their wings, which, however, gives them no powers of flight equal to that of the dragon-fly, and they are, for the most part, feeble insects easily captured.

Myrmeleonidæ (*Ant-lions*).—A very extensive family, tolerably well represented in Europe, but absent from Britain; furnished with *short* clubbed antennæ. The peculiar habit of the larvæ of many species, viz., that of making pit-falls in sand, wherein to entrap ants and other insects upon which they feed, is familiar to all entomologists. All appear to frequent sandy districts, and some are of very large size and great beauty. Most of them are nocturnal in their habits in the perfect

* A very interesting account of the metamorphoses and habits of *Corydalis* is to be found in the 'American Entomologist,' vol. i, pp. 61—62. It is there stated that one use of these enormous mandibles is to seize the female.—R. McL.

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state, and are seldom seen even in localities in which the myriads of pits in the sand formed by their larvæ prove them to be abundant. Their flight is slow and feeble, and they are frequently attracted by light. In preserving them, it is often advisable to run something into the body, as recommended for Dragon-flies, for, although they are not so liable to breakage as are those insects, yet their durability is rendered much more certain if the body be strengthened by artificial means: the point of dislocation most to be feared is between the abdomen and the meta-thorax. Some 300 species are already known, but many of them are difficult to determine, or even to describe, with any degree of satisfaction, and the generic differentiation of the various groups has yet to be undertaken, all done hitherto being only preliminary.

Ascalaphidæ.—Closely allied to the Ant-lions, but distinguished by their *long* clubbed antennæ, which are like those of butterflies; and, in fact, this peculiarity, combined with the gay colours of the restricted genus *Ascalaphus* (which is peculiar to the European fauna), so far deceived some of the earlier entomologists, that—overlooking all other characters—they described them as Papilios. They frequent dry and sandy districts, but the larvæ never make pit-falls. The species of *Ascalaphus* have a habit of 'dancing' in the air in the bright sunshine, and their powers of flight are greater than are those of any other *Planipennia*. Most of the less gaily coloured exotic genera are nocturnal or crepuscular, and one species has been noticed hawking after insects round the branches of trees in the evening, much after the manner of Dragon-flies, retiring into the crevices of the bark during the day. All of them rest with the wings closed longitudinally and roof-shaped in repose, with the exception of one American genus, in which they are extended horizontally. With the long slender-bodied species it is best to insert something in the body. Both these and *Myrmeleonidæ* may be sent home in paper envelopes, as noticed for Dragon-flies, though it is not here so advisable; but if this be done, it is especially desirable not to place them in the envelopes until fully dry.

Nemopteridæ.—One of the most extraordinary groups, the underwings being extremely long and narrow, whereas the fore-wings are short and broad. The species are not numerous, and next to nothing

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has yet been recorded concerning their habits: they are peculiar to the old world, and frequent hot and arid situations. The most handsome species are found in the South of Europe. Care must be taken not to injure the long tail-like hind-wings, which are sometimes so slender as to be reduced to mere long threads; but several of them have these wings oddly dilated immediately before the tips.

Mantispidæ.—Yet another group not found in Britain, and even feebly represented in Europe. Noticeable for the elongated prothorax (as in *Raphidia*, only that the legs are attached to the anterior instead of the posterior end), and for the remarkably constructed anterior legs, which have very long coxæ, and strongly dilated raptorial femora, the tibiæ and tarsi being much aborted. The exotic species are very numerous. The larva of the European *Mantispa styriaca* has the peculiar habit of living in the nests of spiders, feeding upon their eggs and young; and an allied genus, *Trichoscelia*, found in South America, infests the large papyratious arboreal nests of Hymenopterous insects. This clue may be of service to collectors, especially as most species seem to be rather abundant where they occur, frequenting herbage and undergrowth. Their preservation calls for no particular remark, unless it be to exercise care in dealing with the legs.

Nymphidæ.—A small (chiefly Australian) family, concerning the habits of which we have no information. The typical *Nymphes myrmeleonides* is a large handsome insect, much resembling an Ant-lion.

Osmylidæ.—Represented in Britain (and Europe) by two genera, *Osmylus* and *Sisyra*, both aquatic in their larva-states, and frequenting rather swiftly-flowing streams. The handsome *Osmylus* is seldom seen on the wing, but may be easily brushed or beaten out of trees overhanging streams. The small *Sisyræ* are often abundant among the herbage bordering streams, and the larva of the common species has been found in the interior of the fresh-water sponge, but no doubt is not confined to this situation, as the insect is often abundant where there is no sponge. The discovery of the habits of some of the exotic genera must decide the question as to whether they really belong to this family: among these may be noticed the curious Australian genus *Psychopsis*.

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Hemerobiidæ and *Chrysopidæ*. (Known as '*Aphis-lions*,' '*Golden-eyes*,' '*Lace-wings*,' and '*Stink-flies*').—Two families, which, in their larva-states, feed upon *Aphides*, often covering themselves with the empty skins of their prey. They may all be beaten out of trees, and are easily captured. Certain species affect particular kinds of trees. Fir-trees are always productive, both because they have species peculiar to them, and afford convenient shelter for others. The species of *Hemerobius* mostly sham death when in the net. The *Chrysopidæ* frequently come to gas-lamps: they are very numerous in species, and mostly of a delicate green colour, the eyes brilliantly golden or coppery when alive. Though amongst the most beautifully delicate of all insects, they are notorious for the power which some species possess of emitting an intolerably disgusting smell of ordure when handled, almost sufficient to cause the most enthusiastic entomologist to fling them away at once, and seek for means whereby to free himself from what may be likened to a concentrated essence of cesspools. Many of them, however, are perfectly inodorous. Some few (e. g., *Chrysopa vulgaris*) corrode the pins very rapidly, and become almost destroyed in the course of a few years. *C. vulgaris* hibernates, and, in winter, assumes a reddish colour. Their cocoons, like small white peas, may be found on the plants where the larvæ have been assisting the horticulturist, and it is a matter of no little astonishment to the uninitiated to observe so large an insect emerge from so tiny a cocoon. Re-set specimens should remain upon the setting boards for a considerable time, much longer than is requisite for the powerful dragon-flies; and care should be taken in relaxing not to allow the water to actually reach the wings, or these members become matted together, and are sure to get torn in endeavours to spread them out.

Coniopterygidæ.—Minute insects, wholly covered with a white, waxy, pulverulent secretion, and which may be beaten from trees, especially firs. Their treatment should be precisely similar to that adopted for winged *Psocidæ*. Some are so small that it is almost impossible to spread the wings, unless the manipulator has already had experience as a Micro-Lepidopterist.

Panorpidæ (*Scorpion-flies*, &c.).—Common amongst herbage, and easily captured on the wing, or swept up with the net. The males of *Panorpa* have the peculiar forcipate dilated terminal segment from

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which their vulgar name is derived. In setting, some of these males should have the three terminal segments forcibly extended until dry, as otherwise they are curved over the back, and not so easy to examine,—an important point, taken into consideration with the fact that the specific characters mostly lie in these segments. They are highly predacious, feeding upon other insects, and can inflict a momentarily painful wound in the fingers by means of their mandibulate rostrum. *Bittacus* (not represented in Britain) is extremely like a *Tipula*, only with four wings instead of two, and this disguise probably has a purpose, for, in the case of a recently discovered apterous species, it was found that semi-apterous *Tipulidæ* existed in the same locality; they may thus be likened to wolves in sheeps' clothing. The legs are of extraordinary length, and, in setting, must be arranged one by one with pins, otherwise they become entangled and easily break. *Boreus* is a genus of small and virtually apterous insects, found only in winter amongst moss, &c., and even sometimes on the surface of the snow. They mostly fall in the way of the Coleopterist when hunting for moss-frequenting beetles, and are no doubt often cast aside as *Acari*, or similar 'rubbish.' Though I cannot explain by what means they jump, it is nevertheless certain that they possess some amount of saltatory powers. The specific characters exist chiefly in the ventral segments of the males, a sufficient reason why they should not be 'carded;' simple pinning is sufficient, or, if time is no object, the legs may be neatly spread out with small pins.

The *Panorpidæ* are aberrant *Planipennia*, and by some are thought to form a passage to the next division.

Trichoptera ("*Caddis-flies*").

In no group of insects have I acquired so much practical knowledge of the habits and private lives, as in the *Trichoptera*. Although my attention has been gradually directed to the order *Neuroptera* as a whole, yet the Caddis-flies were my earliest favourites, and still constitute my pet division of the order. The days and hours spent in the pursuit of our native species have been—I can safely say—the happiest moments of my life, and I still look back with unalloyed gratification to the year 1859, when, as an enthusiastic pupil of Dr. Hagen, I commenced to collect and study them. Would that I had more companions in the field!

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Wherever there is fresh water, either standing or running (so long as it be not habitually dried up by the heat of summer, or poisoned by the refuse of mines and factories, or the sewage of large cities), there caddis-flies will be found. But the immediate vicinity of water is not absolutely necessary, for many of the more powerfully organised species evidently take long nocturnal flights, and are often dislodged during the day in localities very far from water. I remember once finding numbers of a species of *Limnophilus* in a sheltered hollow on the summit of a bare chalk-cliff, where there was no fresh-water for two or three miles. I have several times before had occasion to refer to fir-trees as particularly productive to the Neuropterist; to the collector of *Trichoptera* they are pre-eminently favourable. The best way is to beat the branches over the net, and the caddis-flies that tumble into it must be boxed or bottled speedily, for they are wonderfully nimble, and by their peculiar zig-zag motions, often escape; and this habit renders their pursuit when on the wing somewhat perplexing, for although they do not fly far when disturbed, they often baffle the collector, and are even difficult to detect when settled, though probably under one's very nose. Some species (e. g., *Colpotaulius*) may be "trodden out" from the herbage on the margins of ponds, and the longer the same spot is disturbed, the more abundant the insects become. Another good plan is to separate the reeds or flags with the hand, and examine closely near the roots or at the surface of the water, for this is the favourite diurnal hiding-place of many. The copings of bridges and walls should not be neglected. I have, on more than one occasion, found good species under the coping of the bridge over the Serpentine in Hyde Park. Some species of the beautiful long-horned *Leptoceridæ* fly briskly in the hot sunshine close to the water in calm weather; but, if an air of wind disturb the surface, or the sun become obscured for a moment by a passing cloud, they mount rapidly into the air and disappear. Some again (species of *Hydropsyche* for instance) dance in swarms over streams, especially towards dusk. Although (with only one or two exceptions) they are all aquatic in their earlier stages, yet their habits are as varied as are those of the terrestrial *Lepidoptera*. Many genera can only exist as larvæ in water that is always in a placid condition (such as that of ponds), whereas others require the element to be highly aërated (e. g., *Rhyacophila*) and constantly cold, and there are lovers of every inter-

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mediate state, so that a few miles walk along the banks of a small stream sufficiently varied in its character, will furnish a large number of species. Even the mechanical contrivances by which man alters the natural state of a stream for his own benefit are of use to the collector, for if the placid course of a slowly flowing stream be changed to a foaming waterfall by a weir or water-wheel, the congenial conditions are at once seized upon by species which otherwise might be sought in vain. In fact, it is probable that more species frequent running than standing water, and it is this that makes the torrents of alpine regions so particularly productive; the cold is no hindrance, they may be found up to the snow-limit, and delighting in the vicinity of a glacier. So marked is the necessity of certain aquatic conditions for the well-being of particular genera or species, that the water-system of a particular district or country can often be understood by an inspection of a collection of caddis-flies from it. Thus, I once examined a large collection of species from Holland, which told as plainly of a low-lying flat country without mountains or torrents as could the most elaborate map. A certain amount of shelter in the perfect state is absolutely necessary to *Trichoptera*, and for this reason streams flowing over barren rocks are not productive. The acme of success may be obtained when the stream is fringed with low overhanging bushes; the net should be placed as far under the bush as possible, and the latter beaten vigourously over it, taking care that the net itself do not come off its handle, or it may go sailing away down the stream at a rate anything but agreable to the astonished collector: such a *contretemps* has more than once happened to the writer. In moorland districts there are often streams which have cut their way through the peat, fringed with heather and other herbage; these are localities that should never be neglected. Light powerfully attracts some species, and unique or rare forms have more than once been found on gas lamps in the suburbs of London. It has also been recommended to hang a white sheet near water, the insects being attracted by it after dark, and settling on it. Tree trunks and walls near water should always be examined; on such positions the minute and excessively rapid species of *Hydroptilidæ* often absolutely swarm. But *experience*—that "hardest of all schools," as I have seen it termed—is the one thing to be gained and acted upon.

Trichoptera should be set exactly as are *Lepidoptera* (premising

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that the excessively low setting mentioned at the beginning of this paper be eschewed), but must remain upon the setting boards longer than is necessary for insects of the latter order. Relaxed and re-set specimens take an especially long time before it is certain that the wings will not ultimately fall back. Much care should be exercised in re-setting with regard to the management of the hind-wings, which are very troublesome and liable to get torn; occasionally a specimen will remain so long in the damping box that it falls to pieces, and yet these wings will not sufficiently relax the muscles at the point of attachment to the metathorax. If a specimen be quite intractable, then all one can do is to so far expand the wings by means of pins that an examination of the apex of the abdomen is possible.

No collection of *Trichoptera* can be considered complete without the cases manufactured by the larvæ of the various species. These are marvellous, alike from the beauty and variety of form exhibited in them, as from the great ingenuity displayed in their fabrication. The larvæ or pupæ should be extracted, and the cases may then be pinned, or gummed neatly on card. Cases made out of all sorts of fanciful materials may be obtained by forcing larvæ confined in aquaria to use such materials in default of being able to find anything else; but such cases should be looked upon in the light of curiosities only; there is always sufficient variety in natural conditions to satisfy the most fastidious collector.

CONCLUSION.

My purpose will be served, if the foregoing sketch of the ways and means best adapted to the acquirement of a collection of *Neuroptera* induces some of our young entomologists, who are tired of forming part of the crowd that can see no beauty in any insects other than *Lepidoptera*, to strike out a path for themselves, by bestowing a favourable glance upon my favourite order. It will be doubly served if they become not only *collectors* but *students* of that order. The field is enormous, and the land almost untilled: the settler in it may have (speaking metaphorically) to hew his own timber and build his own hut, but the result will be an abundant harvest.

Notes concerning the breeding of the various families from the egg, or larva, must be deferred to another opportunity.

39, Limes Grove, Lewisham, London, S.E.:
January, 1873.

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In gathering specimens of any kind, it is important to fix with the utmost precision the localities where found. This is especially desirable in reference to fishes and other aquatic animals, as they occupy a very intimate relation to the waters in which they live.

The smaller quadrupeds, of the size of a mouse, may be preserved entire in alcohol. Larger kinds should be skinned, and the skins put into alcohol, or coated on the inside with arsenic, and dried.

The skulls of the smaller kinds may be left in the skins; those of the larger should be removed, taking care to attach some common mark, by which they may be again brought together. Large animals, of or above the size of a wolf, may, for greater convenience, be skinned after the method pursued by butchers, by drawing the skin of the legs down to the toes, and there severing the joint. The skins need not be sewed up, as is directed for the smaller kinds, but rolled up into bales, after applying an abundance of arsenic and drying them. In the absence of arsenic, salt applied to the skin will answer as a preservative. Immersion in a strong brine of alum and salt will be found very efficacious. Powdered green or blue vitriol, sprinkled on the hair, will serve a good purpose in keeping off insects.

It is very important to procure the skeletons, and at all events the skulls, of all the species of mammals, in sufficient number to include all the variations of age and sex. These may be roughly prepared by cutting off the flesh, extracting the brain, and drying in the sun.

In passing through the breeding ground of species of birds whose nidification and eggs are not known, attention should be paid to securing abundant specimens of nests and eggs. When possible, the skin of the bird to which each set of eggs may belong should be secured, as well as the skins of birds generally.

A great obstacle in the way of making alcoholic collections while on a march, has been found in the escape of the spirits and the friction of the specimens, as well as in the mixing up of those from different localities. All these difficulties have been successfully obviated by means of the following arrangement: instead of using glass jars, so liable to break, or even wooden kegs, so difficult of stowage, a square copper can should be procured, having a large mouth with a cap fitting tightly over it, either by a screw, or otherwise. The can should be inclosed in a wooden box, or may be made to fit to a division of a pannier, to be slung across the back of a mule. Several small cans, in capacity of from a half to one-third of a cubic foot, or even less, will be better than one large one. Small

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§ I. GENERAL REMARKS.*

THE general principle to be observed in making collections of Natural History, especially in a country but little explored, is to gather all the species which may present themselves, subject to the convenience or practicability of transportation. The number of specimens to be secured will, of course, depend upon their size, and the variety of form or condition caused by the different features of age, sex, or season.

As the object of the Institution in making its collections is not merely to possess the different species, but also to determine their geographical distribution, it becomes important to have as full series as practicable from each locality. And in commencing such collections, the commonest and most abundant species should be secured first, as being most characteristic. It is a fact well known in the history of museums, that the species which from their abundance would be first expected, are the last to make their appearance. Thus, while the rarer mammals of the plains are tolerably well represented, the antelope, prairie-dog, the various species of wolves, the black-tail deer, and others, so numerous in perfectly accessible localities, have scarcely ever been seen in a preserved state.

The first specimen procured, however imperfect, should be preserved, at least until a better can be obtained.

Where a small part only of the specimens collected can be transported, such species should be selected as are least likely to be procured in other localities or on other occasions. Among these may be mentioned reptiles, fishes, soft insects, &c.; in short, all such as require alcohol for their preservation. Dried objects, as skins, can be procured with less difficulty, and are frequently collected by persons not specially interested in scientific pursuits.

* This chapter is intended especially for the guidance of travelling parties by land, and embraces many points referred to subsequently at greater length.

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will be none the less interesting. Different forms will be found in different localities. Thus the *Etheostomata*, or Darters, and the *Cotti*, live under stones, or among gravel, in shallow clear streams, lying flat on the ground. Others will be dislodged by stirring under roots or shelving banks along the water's edge. The *Melanura*, or mud fish (a few inches in length), exist *in* the mud of ditches, and are secured by stirring up this mud into a thin paste with the feet, and then drawing a net through. The sticklebacks and cyprinodonts live along the edges of fresh and salt water. The *Zygonectes* swim in pairs slowly along the surface of the water, the tip of the nose generally exposed. They generally have a broad black stripe on the side. By a careful attention to these hints, many localities supposed to be deficient in species of fishes, will be found to yield a large number.

The alcohol used on a march may be supplied with tartar emetic. This, besides adding to its preservative power, will remove any temptation to drink it, on the part of unscrupulous persons.

Nearly all insects, scarcely excepting the *Lepidoptera*, can be readily preserved in alcohol. Crabs and small shells may likewise be treated in the same manner.

It is not usually possible to collect minerals, fossils, and geological specimens in very great mass while travelling. The fossils selected should be as perfect as possible; and especial care should be paid to procuring the bones and teeth of vertebrate animals. Of minerals and rocks, specimens as large as a hickory-nut will, in many cases, be sufficient for identification.

Where collections cannot be made in any region, it will be very desirable to procure lists of all the known species, giving the names by which they are generally recognized, as well as the scientific name, when this is practicable. The common names of specimens procured should also be carefully recorded.

All facts relating to the habits and peculiarities of the various species of animals should be carefully recorded in the note book, especially those having relation to the peculiarities of the season of reproduction, &c. The accounts of hunters and others should also be collected, as much valuable information may thus be secured. The colors of the reptiles and fishes when alive should always be given, when practicable, or, still better, painted on a rough sketch of the object.

bags of mosquito netting, lino, crinoline, or other porous material, should be provided, made in shape like a pillow-case, and open at one end; these may be from six to fifteen inches long. When small fishes, reptiles, or other specimens are procured in any locality, they may be placed indiscriminately in one or more of these bags (the mouths of which are to be tied up like a sack), and then thrown into the alcohol. Previously, however, a label of parchment, leather, or stout paper should be placed inside the bag, containing the name of the locality or other mark, and written in ordinary ink. The label, if dry before being placed in the bag, will retain its writing unchanged for a long time. The locality, or its number, should also be coarsely marked with a red pencil on the outside of the bag. In this way, the specimens, besides being readily identified, are preserved from rubbing against each other, and consequent injury. Still farther to facilitate this object, an India-rubber gas-bag may be employed to great advantage, by introducing it into the vessel, and inflating until all vacant space is filled up by the bag, and the consequent displacement of the spirit. When additional specimens are to be added, a portion of the air may be let out, and the bag afterwards again inflated. Should this arrangement be found impracticable, a quantity of tow, cotton, or rags, kept over the specimens, will be found useful in preventing their friction against each other, or the sides of the vessel.

The larger snakes should be skinned, as indicated hereafter, and the skins thrown into alcohol. Much space will in this way be saved. Smaller specimens may be preserved entire, together with lizards, salamanders, and small frogs. All of these that can be caught should be secured and preserved. The head, the legs with the feet, the tail, in fact, the entire skin of turtles, may be preserved in alcohol; the soft parts then extracted from the shell, which is to be washed and dried.

Every stream, and indeed, when possible, many localities in each stream, should be explored for fishes, which are to be preserved as directed. For these, as well as the other alcoholic collections, the lino bags are very useful.

Great attention should be paid to procuring many specimens of the different kinds of small fishes, usually known as minnows, shiners, chubs, &c. Among these will always be found the greatest variety of species, some never ceeding an inch in length. These fish are generally neglected under the idea that they are merely the young of larger kinds; even if they should prove to be such, however, they

Skinning & Stuffing. Birds.

~~This being done,~~ Make an incision through the skin only, from the lower end of the breast bone to the anus. Should the intestines protrude in small specimens, they had better be extracted, great care being taken not to soil the feathers. Now proceed carefully to separate the skin on each side from the subjacent parts, until you reach the knee, and expose the thigh; when, taking the leg in one hand, push or thrust the knee up on the abdomen, and loosen the skin around it until you can place the scissors or knife underneath, and separate the joint with the accompanying muscles. Place a little cotton between the skin and body to prevent adhesion. Loosen the skin about the base of the tail, and cut through the vertebræ at the last joint, taking care not to sever the basis of the quills. Suspend the body by inserting the hook into the lower part of the back or rump, and invert the skin, loosening it carefully from the body. On reaching the wings, which had better be relaxed previously by stretching and pulling, loosen the skin from around the first bone, and cut through the middle of it, or, if the bird be small enough, separate it from the next at the elbow. Continue the inversion of the skin by drawing it over the neck, until the skull is exposed. Arrived at this point, detach the delicate membrane of the ear from its cavity in the skull, if possible, without cutting or tearing it; then, by means of the thumb-nails, loosen the adhesion of the skin to the other parts of the head, until you come to the very base of the mandibles, taking care to cut through the white nictitating membrane of the eye, when exposed, without lacerating the ball. Scoop out the eyes, and, by making one cut on each side of the head, through the small bone connecting the base of the lower jaw with the skull, another through the roof of the mouth at the base of the upper mandible, and between the jaws of the lower, and a fourth through the skull behind the orbits, and parallel to the roof of the mouth, you will have freed the skull from all the accompanying brain and muscle. Should anything still adhere, it may be removed separately. In making the first two cuts, care must be taken not to injure or sever the zygoma, a small bone extending from the base of the upper mandible to the base of the lower jaw-bone. Clean off every particle of muscle and fat from the head and neck, and, applying the preservative abundantly to the skull, inside and out, as well as to the skin, restore these parts to their natural position. In all the preceding operations, the skin should be handled as near the point of adhesion as possible, especial care being taken not to stretch it.

Finely powdered plaster of Paris, chalk, or whiting, may be used

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to great advantage by sprinkling on the exposed surface of the carcass, and inside of skin, to absorb the grease and blood.

The next operation is to connect the two wings inside of the skin by means of a string, which should be passed between the lower ends of the two bones forming the forearm, previously, however, cutting off the stump of the arm, if still adhering at the elbow. Tie the two ends of the strings so that the wings shall be kept at the same distance apart as when attached to the body. Skin the leg down to the scaly part, or tarsus, and remove all the muscle. Apply the arsenic to the bone and skin, and, wrapping cotton round the bone, pull it back to its place. Remove all the muscle and fat which may adhere to the base of the tail or the skin, and put on plenty of the preservative wherever this can be done. Lift up the wing, and remove the muscle from the forearm by making an incision along it, or, in many cases, the two joints may be exposed by carefully slipping down the skin towards the wrist-joint, the adhesion of the quills to the bone being loosened.

The bird is now to be restored to something like its natural shape by means of a filling of cotton or tow. Begin by opening the mouth and putting cotton into the orbits and upper part of the throat, until these parts have their natural shape. Next take tow or cotton, and after making a roll rather less in thickness than the original neck, put it into the skin, and push firmly into the base of the skull. By means of this, you can reduce or contract the neck if too much stretched. Fill the body with cotton, not quite to its original dimensions, and sew up the incision in the skin, commencing at the upper end, and passing the needle from the inside outwards; tie the legs and mandibles together, adjust the feathers, and, after preparing a cylinder of paper the size of the bird, push the skin into it so as to bind the wings closely to the sides. The cotton may be put in loosely, or a body the size of the original made by wrapping with threads. If the bird have long legs and neck, these had better be folded down over the body, and allowed to dry in that position. Economy of space is a great object in keeping skins, and such birds as herons, geese, swans, &c., occupy too much room when outstretched.

In some instances, as among the ducks, woodpeckers, &c., the head is so large that the skin of the neck cannot be drawn over it. In such cases, skin the neck down to the base of the skull, and cut it off there. Then draw the head out again, and, making an incision on

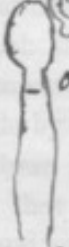
HOW TO PRESERVE MAMMALIAN SKINS.

BY C. A. WALKER.

WHEN an animal is ready for skinning, the mouth, nostrils, and shot-holes should be filled with cotton or tow. Place the animal upon its back, take the scalpel in the right hand, and with the left separate the hair to the right and left in a line from the front of the pubis quite down to the vent, so that the skin beneath can be plainly seen. Make a longitudinal incision along the course, directed in as straight a line as possible, taking care not to cut so deep as to expose the intestines. The skin should then be turned back on either side with the aid of the scalpel, working downward towards the back. When the thigh has been laid bare, sever it from the pelvis at its junction with the femur or thigh bone. Layers of cotton or tow should, from time to time, be placed between the skin and body, as it will prevent the hair from being soiled. This operation should be repeated with the other side. Next the intestinal canal should be cut off a little way above the anus, and the tail separated close to the body. The skin should then be loosened from the back and breast until the forelegs are visible. Sever these at the shoulder joint or the base of the humerus. Remove the skin from the neck, and the back part of the skull will appear. In skinning over the skull, care should be taken to sever the ears as close to it as possible; also not to injure the eyelids, or cut too close to the lips. The carcass should next be separated from the skull at the first vertebræ, or the junction of the skull and neck. The next operation is to remove the tongue, eyes, and all the muscles attached to the head. Through an opening in the occipital bone, carefully clean out the brain. Next the legs should be skinned quite down to the claws of the feet, removing all muscles, but leaving the ligaments and tendons of the knees. The hind legs should undergo the same operation. Lastly, skin the tail as far back as the first three joints of the vertebræ, and to this stump fix a stout cord, which should be fastened to a hook or other projecting object on the wall. A strong piece of wood is then prepared, flat, and sharpened upon both edges. This should be introduced between the skin and the vertebræ, and by working it around the latter, the attachments will be severed and the vertebræ within can be easily pulled from the enveloping skin. In skinning the tail of the beaver an incision should be made upon the under side, running lengthwise from the base to the tip. The skin should then be loosened, beginning upon either side of the incision, until the flesh is entirely free, when it can be removed, the arsenic added, the skin restored to position, and the incision sewed up.

The foregoing method is practised only upon the smaller quadrupeds; with the larger mammalia a different course is pursued. An incision is made from beneath the under jaw, in a straight line to the anus; transverse cuts are also made, running down the inside of both fore and hind legs. These being made upon the inner side will render the seams less conspicuous after the specimen has been mounted. To detach the hoofs, place them upon a stone and strike them repeatedly with a mallet; they will soon loosen and can be separated from the bone. After the operation of skinning has been completed, every part of the skin should be anointed thoroughly with arsenical soap. Turpentine applied to the nostrils and lips will prevent the approach of noxious insects. When the skin is too large for the application of the soap, it should be thoroughly saturated with a solution of "alum and water." The different bones left in the skin should all be thoroughly anointed with the preservative, and the eye-sockets and cavity of the brain filled with cotton or cut tow before replacing the skull in its natural position. If the animal be not too large the carcass should be preserved, as it will greatly aid the operator in his work of modelling a body. If immersed in alcohol, it can be kept any length of time.—*American Naturalist.*

In skinning serpents I always made an incision either longitudinal or vertical just below the jaw & when I had severed the vertebra tied a string to the severed end & let the head fall back thus (ventral side)



This can be done up to 6 or 7 feet. When longer as a rule the dorsal muscles are so strongly attached as to only be cut away with the scalpel. I once skinned a Python reticulatus 17'9" long & it took me the whole of a day although I had native assistance. The fat (for Embrocation) & the flesh for eating was eagerly sought for by Chinese

A. C.

A cut across the throat weakens the skin & it may part from the head a cut thus in a line with the head removes this danger.

Finely powdered green vitriol, or copperas sprinkled on either hair or feathers, will have an excellent effect in keeping out moths. Covering with tobacco leaves will also answer the same end.

In some instances, large skins may be preserved by being salted down in casks.

3. REPTILES.

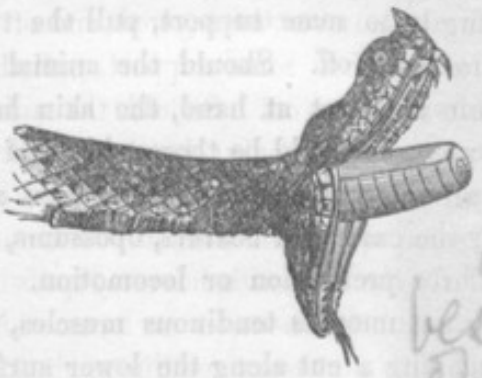
The larger *lizards*, such as those exceeding twelve or eighteen inches in length, may be skinned according to the principles above mentioned, although preservation in spirit, when possible, is preferable for all reptiles.

Large *frogs* and *salamanders* may likewise be skinned, although cases where this will be advisable are very rare.

Turtles and *large snakes* will require this operation.

To one accustomed to the skinning of birds, the skinning of frogs or other reptiles will present no difficulties.

The skinning of a snake is still easier. Open the mouth and separate the skull from the vertebral column, detaching all surrounding muscles adherent to the skin. Next, tie a string around the stump of the neck thus exposed (see figure), and, holding on by this, strip the



skin down to the extremity of the tail. The skin thus inverted should be restored to its proper state, and then put in spirit or stuffed, as convenient. Skins of reptiles may be stuffed with either sand or sawdust, by the use of which their shape is more easily restored.

Turtles and tortoises are more difficult to prepare in this way, although their skinning can be done quite rapidly. "The breastplate must be separated by a knife or saw from the back, and, when the viscera and fleshy parts have been removed, restored to its position. The skin of the head and neck must be turned inside out, as far as

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the outside, down the back of the skull, skin the head. Be careful not to make too long a cut, and to sew up the incision again.

The sex of the specimen may be ascertained after skinning, by making an incision in the side near the vertebræ, and exposing the inside surface of the "small of the back." The generative organs will be found tightly bound to this region (nearly opposite to the last ribs), and separating it from the intestines. The testicles of the male will be observed as two spheroidal or ellipsoidal whitish bodies, varying with the season and species, from the size of a pin's head to that of a hazel-nut. The ovaries of the female, consisting of a flattened mass of spheres, variable in size with the season, will be found in the same region.

For transportation, each skin of mammals as well as of birds should, when possible, be wrapped in paper.

2. MAMMALS.

The mode of preparing mammals is precisely the same as for birds, in all its general features. Care should be taken not to make too large an incision along the abdomen. The principal difficulty will be experienced in skinning the tail. To effect this, pass the slipknot of a piece of strong twine over the severed end of the tail, and, fastening the vertebræ firmly to some support, pull the twine towards the tip until the skin is forced off. Should the animal be large, and an abundance of preservative not at hand, the skin had better remain inverted. In all cases, it should be thoroughly and rapidly dried.

The tails of some mammalia cannot be skinned as directed above. This is particularly the case with beavers, opossums, and those species which use their tail for prehension or locomotion. Here the tail is usually supplied with numerous tendinous muscles, which require it to be skinned by making a cut along the lower surface or right side, nearly from one end to the other, and removing the bone and flesh. It should then be sewed up again, after a previous stuffing.

For the continued preservation of hair or fur of animals against the attacks of moths and other destructive insects, it will be necessary to soak the skins in a solution of corrosive sublimate in alcohol or whiskey, allowing them to remain from one day to several weeks, according to the size. After removal, the hair must be thoroughly washed or rinsed in clean water, to remove as much as possible of the sublimate; otherwise, exposure to light will bleach all the colors.

f. 320c

the head, and the vertebræ and flesh of the neck should be detached from the head, which, after being freed from the flesh, the brain, and the tongue, may be preserved with the skin of the neck. In skinning the legs and the tail, the skin must be turned inside out, and, the flesh having been removed from the bones, they are to be returned to their places by redrawing the skin over them, first winding a little cotton or tow around the bones to prevent the skin adhering to them when it dries."—RICHARD OWEN.

Another way of preparing these reptiles is as follows: Make two incisions, one from the anterior end of the breastplate to the symphysis of the lower jaw, and another from the posterior end of the breastplate to the vent or tip of the tail; skin off these regions and remove all fleshy parts and viscera without touching the breastplate itself. Apply preservative, stuff, and sew up again both incisions.

"When turtles, tortoises, crocodiles, or alligators, are too large to be preserved whole in liquor, some parts, as the head, the whole viscera stripped down from the neck to the vent, and the cloaca, should be put into spirit or solution."—R. OWEN.

4. FISHES.

As a general rule, fishes, when not too large, are best preserved entire in spirits.

Nevertheless, they may be usefully skinned and form collections, the value of which is not generally appreciated. In many cases, too, when spirit or solutions cannot be procured, a fish may be preserved which would otherwise be lost.

There are two modes of taking the skin of a fish: 1. The whole animal can be skinned and stuffed like a bird, mammal, or reptile. 2. One-half of the fish can be skinned, and nevertheless its natural form preserved.

Sharks, *skates*, *sturgeons*, *garpikes* or *garfishes*, *mudfishes*, and all those belonging to the natural orders of *Placoids* and *Ganoids*, should undergo the same process as given above for birds, mammals, and reptiles. An incision should be made along the right side, the left always remaining intact, or along the belly. The skin is next removed from the flesh, the fins cut at their bases under the skin, and the latter inverted until the base of the skull is exposed. The inner cavity of the head should be cleaned, an application of preservative made, and the whole, after being stuffed in the ordinary way, sewed up again. Fins may be expanded when wet, on a piece of stiff

A 320

paper, which will keep them sufficiently stretched for the purpose. A varnish may be passed over the whole body and fins, to preserve somewhat the color.

In the case of *Ctenoids*, perches, and allied genera; and *Cycloids*, trouts, suckers, and allied genera; one-half of the fish may be skinned and preserved. To effect this, lay the fish on a table with the left side up; the one it is intended to preserve. Spread out the fins by putting underneath each a piece of paper, to which it will adhere on drying. When the fins are dried, turn the fish over, cut with scissors or a knife all around the body, a little within the dorsal and ventral lines, from the upper and posterior part of the head, along the back to the tail, across the base of the caudal fin down, and thence along the belly to the lower part of the head again. The dorsal, caudal, and anal fins, cut below their articulations. This done, separate the whole of the body from the left side of the skin, commencing at the tail. When near the head, cut off the body with the right ventral and pectoral fins, and proceed by making a section of the head and removing nearly the half of it. Clean the inside, and pull out the left eye, leaving only the cornea and pupil. Cut a circular piece of black paper of the size of the orbit and place it close to the pupil. Apply the preservative, fill the head with cotton as well as the body. Turn over the skin and fix it on a board prepared for that purpose. P[illegible] tack it down at the base of the fins. Have several narrow bands of paper to place across the body in order to give it a natural form, and let it dry. The skins may be taken off the board or remain fixed to it, when sent to their destination, where they should be placed on suitable boards of proper size, for permanent preservation.

Such a collection of well-prepared fishes will be useful to the practical naturalist, and illustrate, in a more complete manner, to the public the diversified forms and characters of the class of fishes which specimens preserved in alcohol do not so readily show.

These skins may also be preserved in alcohol.

§ IV. PRESERVING IN LIQUIDS, AND BY OTHER MODES BESIDES SKINNING.

1. GENERAL REMARKS.

The best material for preserving animals of moderate size is alcohol. When spirits cannot be obtained, the following substitutes may be used:—

f. 321r 281

Arsenical soap (the best according to Messrs Davison & Hume)

~~the~~ Equal parts of finely pow^d ~~sugar~~ or sublimed arsenic & good white soap. Shred the soap add little water, apply heat & make a soft equal paste-work in the arsenic. ¼ part of Camphor diss^d in spirits or oil of turp: and add turpentine to the whole mixture till it acquires the consistence of dough. Never use Corr: Subl: or potash as it makes the skins brittle.

Wards liquor for large skins etc much more simple & thoroughly successful than arsenic. Cover the skin thoroughly with alum then fold up & put in a barrel & pour in liquor. Liquor 6 lbs alum 3 sea salt to 1 gallon of hot water. Use when cold. Soaking tubs with lids. Also saucepans (large square ones).

Small animals effectually killed with pipe juice or tobacco from bottom of pipe.

f 322.5

I. GOADBY'S SOLUTION.—A. *The aluminous fluid*, composed of rock salt, 4 ounces; alum, 2 ounces; corrosive sublimate, 4 grains; boiling water, 2 quarts. B. *The saline solution*, composed of rock-salt, 8 ounces; corrosive sublimate, 2 grains; boiling water, 1 quart. To be well stirred, strained, and cooled.

II. A strong brine, to be used as hereafter indicated for Goadby's Solution.

III. In extreme cases, dry salt may be used, and the specimens salted down like herring, &c.

The alcohol, when of the ordinary strength, may be diluted with one-fifth of water, unless it is necessary to crowd the specimens very much. The fourth proof whiskey of the distillery, or the high wines, constituting an alcohol of about 60 per cent., will be found best suited for collections made at permanent stations and for the museum. Lower proofs of rum or whiskey will also answer, but the specimen must not be crowded at all.

soaking pans.

To use Goadby's Solution, the animal should first be macerated for a few hours in fresh water, to which about half its volume of the concentrated solution may then be added. After soaking thus for some days, the specimens may be transferred to fresh concentrated solution. When the aluminous fluid is used to preserve vertebrate animals, these should not remain in it for more than a few days; after this, they are to be soaked in fresh water, and transferred to the saline solution. An immersion of some weeks in the aluminous fluid will cause a destruction of the bones. Specimens must be kept submerged in these fluids. The success of the operation will depend very much upon the use of a weak solution in the first instance, and a change to the saturated fluid by one or two intermediate steps.

The collector should have a small keg, jar, tin box, or other suitable vessel, partially filled with liquor, into which specimens may be thrown (alive if possible) as collected. The entrance of the spirit into the cavities of the body should be facilitated by opening the mouth, making a small incision in the abdomen a half or one inch long, or by injecting the liquor into the intestines through the anus, by means of a small syringe. After the animal has soaked for some weeks in this liquor, it should be transferred to fresh. Care should be taken not to crowd the specimens too much. When it is impossible to transfer specimens to fresh spirits from time to time, the strongest alcohol should be originally used.

To pack the specimens for transportation, procure a small keg,

f. 322 v

which has been properly swelled, by allowing water to stand in it for a day or two, and from this extract the head by knocking off the upper hoops. Great care must be taken to make such marks on the hoops and head, as will assist in their being replaced in precisely the same relative position to each other and the keg that they originally held. At the bottom of the keg place a layer of tow or rags, moistened in liquor, then one of specimens, then another of tow and another of specimens, and so on alternately until the keg is *entirely filled*, exclusive of the spirit. Replace the head, drive down the hoops, and fill completely with spirits by pouring through the bung-hole. Allow it to stand at least half an hour, and then, supplying the deficiency of the liquor, insert the bung and fasten it securely. An oyster-can or other tin vessel may be used to great advantage, in which case the aperture should be soldered up and the vessel inclosed in a box. A glass jar or bottle may also be employed, but there is always a risk of breaking and leaking. In the absence of tow, or rags, chopped straw, fine shavings, or dry grass may be substituted.

It will conduce greatly to the perfect preservation of the specimens, during transportation, if each one is wrapped up in cotton cloth, or even paper. A number of smaller specimens may be rolled successively in the same wrapper. In this way friction, and the consequent destruction of scales, fins, &c. will be prevented almost entirely. The travelling bags described on p. 6, will answer the same purpose.

Should the specimens to be packed vary in size, the largest should be placed at the bottom. If the disproportion be very great, the delicate objects at the top must be separated from those below, by means of some immovable partition, which, in the event of the vessel being inverted, will prevent crushing. The most imperative rule, however, in packing, is to have the vessel perfectly full, any vacancy exposing the whole to the risk of loss.

It is sometimes necessary to guard against the theft of the spirit employed, by individuals who will not be deterred from drinking it by the presence of reptiles, &c. This may be done by adding a small quantity of tartar emetic, ipecacuanha, quassia, or some other disagreeable substance. The addition of corrosive sublimate will add to the preservative power of the spirit.

2. VERTEBRATA.

Fishes under five or six inches in length need not have the abdominal incision. Specimens with the scales and fins perfect

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P. 32,3v

Hard bodied insects placed in spirit (Baines, Wells)

DIRECTIONS FOR COLLECTING INSECTS.

BY A. S. PACKARD, JUN., M.D.

INSECTS differ sexually in that the female generally appears to have one abdominal ring less (one ring disappearing during the semi-pupa state, when the ovipositor is formed), and in being larger, fuller, and duller-coloured than the males, while the latter often differ in sculpture and ornamentation. In collecting whenever the two sexes are found united, they should be pinned upon the same pin, the male being placed highest. When we take one sex alone, we may feel sure that the other is somewhere in the vicinity; perhaps while one is flying about so as to be easily captured, the other is hidden under some leaf, or resting on the trunk of some tree near by, which must be examined, and every bush in the vicinity vigorously beaten by the net. Many species rare in most places have a *metropolis* where they occur in great abundance. During seasons when his favourite are especially abundant the collector should lay up a store against years of scarcity.

At no time of the year need the entomologist rest from his labours. In the winter under the bark of trees and in moss he can find many species, or on trees, &c., detect their eggs, which he can mark for observation in the spring when they hatch out.

He need not relax his endeavours day or night. Mothing is night employment. Skunks and toads entomologize at night. Early in the morning, at sunrise, when the dew is still on the leaves, insects are sluggish and easily taken with the hand; so at dusk, when many species are found flying, and in

The various sorts of galls should be collected in spring and autumn and placed in vials or boxes, where they may be reared, and the rafters of outhouses, stone walls, &c., should be carefully searched for the nests of mud-wasps.

Collecting Apparatus.—First in importance is the *net*. This is made by attaching a ring of brass wire to a handle made to slide on a pole six feet long. The net may be a foot in diameter, and the bag itself made of thin gauze or muquito-netting (the finer, lighter, and more durable the better), and should be about twenty inches deep. It should be sewed to a narrow border of cloth placed around the wire. A light net like this can be rapidly turned upon the insect with one hand. The insect is captured by a dexterous twist, which also throws the bottom over the mouth of the net. The insect should be temporarily held between the thumb and forefinger of the hand at liberty, and then pinned through the thorax while in the net. The pin can be drawn through the meshes upon opening the net. The *beating-net* should be made much stouter, with a shallower cloth bag, and attached to a shorter stick. It is used for beating trees, bushes, and herbage for beetles and Hemiptera and various larvæ. Its thorough use we would recommend in the low vegetation on mountains and in meadows. The *water-net* may be either round or with the part farthest from the handle flattened. The ring should be made of brass, and the shallow net of

wild bees, *Osmia*, *Ceratina*, and the wood-wasps, *Crabro*, *Stigma*, &c., the habits of which, with those of their Chalcid and Ichneumon parasites, offer endless amusement and study.

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Wollaston (*Entomologists' Annual*, 1865) states that sandy districts, especially towards the coast, are at all times preferable to clayey ones; but the intermediates soils, such as the loamy soil of swamps and marshes, are more productive.

Near the sea, insects occur most abundantly beneath pebbles and other objects in grassy spots, or else at the roots of plants. In many places, especially in Alpine tracts, as we have found on the summit of Mount Washington and in Labrador, one has to lay down and look carefully among the short herbage and in the moss for Coleoptera.

The most advantageous places for collecting are gardens and farms, the borders of woods, and the banks of streams and ponds. The deep dense forests and open treeless tracts are less prolific in insect life. In winter and early spring the moss on the trunks of trees, when carefully shaken over a newspader or white cloth, reveals many beetles and Hymenoptera. In the late summer and autumn, toadstools and various fungi and rotten fruits attract many insects, and in early spring, when the sap is running, we have taken rare insects from the stumps of freshly cut hard-wood trees. Wollaston says, "Dead animals, partially dried bones, as well as the skins of moles and other vermin which are ordinarily hung up in fields, are magnificent traps for Coleoptera; and if any of these be placed around orchards and enclosures near at home, and be examined every morning various species of *Nitidulæ*, *Silphidæ*, and other insects of similar habits, are certain to be enticed and captured. Planks and chippings of wood may be likewise employed as successful agents in alluring a vast number of species which might otherwise escape our notice, and if these be laid down in grassy places, and carefully inverted every now and then with as little violence as possible, many insects will be found adhering beneath them, especially after dewy nights and in showery weather. Nor must we omit to urge the importance of examining the under sides of stones in the vicinity of ants' nests, in which position, during the spring and summer months, many of the rarest of our native Coleoptera may be occasionally procured." Excrementitious matter always contains many interesting forms in various stages of growth.

The trunks of fallen and decaying trees offer a rich harvest for many wood-boring larvæ, especially the Longicorn beetles, and weevils can be found in the spring, in all their stages. Numerous carnivorous Coleopterous and Dipterous larvæ dwell within them, and other larvæ which eat the dust made by the borers. The inside of pithy plants like the elder, raspberry, blackberry, and syringa, are inhabited by many of the wild bees, *Osmia*, *Ceratina*, and the wood-wasps, *Crabro*, *Stigma*, &c., the habits of which, with those of their Chalcid and Ichneumon parasites, offer endless amusement and study.

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Various sorts of *forceps* are indispensable for handling insects. Small, delicate, narrow-bladed forceps, with fine sharp points, in use by jewellers, and made either of steel or brass, are excellent for handling minute specimens. For larger ones long curved forceps are very convenient. For pinning insects into boxes the forceps should be stout, the blades blunt and curved at the end, so that the insect can be pinned without slanting the forceps much. The ends need to be broad and finely indented by lines, so as to firmly hold the pin. With a little practice the forceps soon take the place of the fingers. They will have to be made to order by a neat workman or surgical instrument maker. Some persons use the ordinary form of pliers with curved handles; but they should be long and slender. A spring set in to separate the handles when not grasped by the hand is a great convenience.

Various pill-boxes, vials, and bottles must always be taken, some containing alcohol or whisky. Many collectors use a wide-mouth bottle, containing a sponge saturated with ether, chloroform, or benzine, or bruised laurel-leaves, the latter being pounded with a hammer and then cut with scissors into small pieces, which give out exhalations of prussic acid strong enough to kill most small insects.

Besides these, the collector needs a small box lined with corn-pith or cork, and small enough to slip into the coat-pocket, or a larger box carried by a strap. Most moths and small flies can be pinned alive without being pinched (which injures their shape and rubs off the scales and hairs), and then killed by pouring a little benzine into the bottom of the box.—*A Guide to the Study of Insects, Salem, U.S.* 1868.

f. 324r

should be selected, and, if convenient, stitched, pinned, or wrapped in bits of muslin, &c., to preserve the scales. In general, fishes under twelve or fifteen inches in length should be chosen. The skins of larger ones may be put in liquor. It is important to collect even the smallest. The same principles apply to the other vertebrata.

The smallest and most delicate specimens may be placed in bottles or vials, and packed in the larger vessels with the other specimens.

3. INVERTEBRATA.

INSECTS, BUGS, &c.—The harder kinds may be put in liquor, as above, but the vessel or bottle should not be very large. Butterflies, wasps, flies, &c., may be pinned in boxes, or packed in layers with soft paper or cotton. Minute species should be carefully sought under stones, bark, dung, or flowers, or swept with a small net from grass or leaves. They may be put in quills, small cones of paper, or in glass vials. They can be readily killed by immersing the bottles, &c., in which they are collected, in hot water, or exposing them to the vapor of ether.

When possible, a number of oz. or 2 oz. vials, with very wide mouths, well stopped by corks, should be procured, in which to place the more delicate invertebrata, as small crustacea, worms, mollusca, &c.

It will frequently be found convenient to preserve or transport insects pinned down in boxes. The bottoms of these are best lined with cork or soft wood. The accompanying figures will explain, better than any description, the particular part of different kinds of insects through which the pin is to be thrust: beetles (Fig. 1) being pinned through the right wing-cover or elytra; all others through the middle of the thorax, as in Fig. 2.

The traveller will find it very convenient to carry about him a vial having a broad mouth, closed by a tight cork. In this should be contained a piece of camphor, or, still better, of sponge soaked in ether, to kill the insects collected. From this the specimens should be transferred to other bottles. They may, if not hairy, be killed by immersing directly in alcohol.

The camphor should always be fixed in the box containing insects, as it would break the feet and antennæ of the latter if in a loose and crystalline state. It may be kept in a piece of muslin or canvas, and then pinned at the bottom of the box.

Sea-urchins and starfishes may also be dried, after having been

F. 324v

previously immersed for a minute or two in boiling water, and packed up in cotton, or any soft material which may be at hand.

Fig. 1.

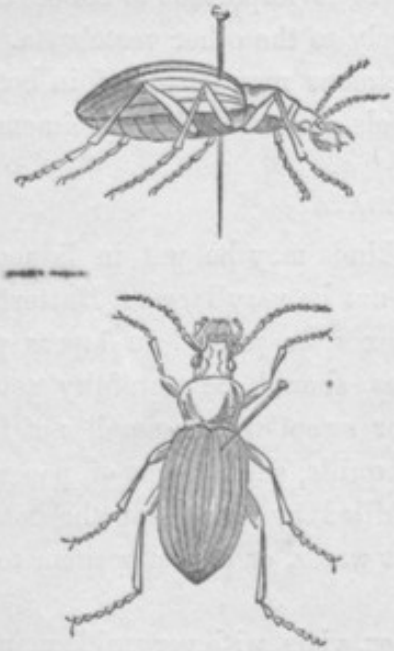
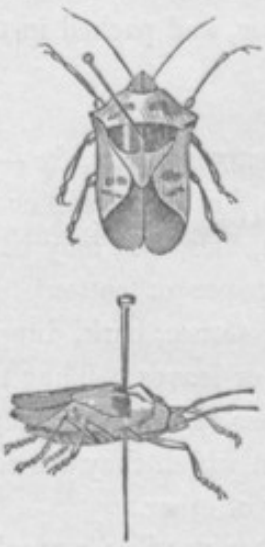


Fig. 2.



The hard parts of coral, and shells of mollusca may also be preserved in a dried state. The soft parts are removed by immersing the animals for a minute or two in hot water, and washing clean afterwards. The valves of bivalve shells should be brought together by a string.

Wingless insects, such as spiders, scorpions, centipedes or thousand-legs, earth-worms, hair-worms, and generally all worm-like animals found in the water, should be preserved in alcoholic liquor, and in small bottles or vials.

§ V. EMBRYOS.

Much of the future progress of zoology will depend upon the extent and variety of the collections which may be made of the embryos and fœtuses of animals. No opportunity should be omitted to procure these and preserve them in spirits. All stages of development are equally interesting, and complete series for the same species would be of the highest importance. Whenever any female mammal is killed, the uterus should be examined for embryos. When eggs of

f. 325

Spiders.

The plan is as follows: Make an incision along the ventral aspect of the abdomen nearly its whole length, or as long as will enable the pulpy contents to be easily removed; then pinch up the pulpy mass with a small forceps, carefully avoiding any dragging; then with a sharp-pointed scissors cut away the contents bit by bit until the whole is nearly removed, or until you can see the brilliant colour shining through what remains in the cavity —better leave a little too much than be too nice in clearing all away;—then with a blowpipe distend the empty abdomen: it will very soon become firm, and retain its original form; but until it is so the blowing must be frequently repeated. How long in our cold climate this may be required I can hardly say; but in the tropics, where the heat in the sun during the day is seldom under 120°, or even 140°, three or four times a day, for a couple of days, was quite sufficient to keep them permanently distended, as well as perfectly harden any of the contents which it was thought right to leave.

This was generally all that was required before placing them in their future abode; but sometimes I have coated the interior with a preservative which I have always employed for the bodies of beetles, moths, and even butterflies—for I empty; all and the result is, that all my cases of insects are as free from dust arising from the decay of animal matter as when originally put up. Sometimes in the larger-bodied Tarantulæ or moths I have stuffed them with cotton-wool wetted in the preservative; but generally this is not necessary. The frequent distention by blowing along with a heated atmosphere will be perfectly sufficient to prevent any future shrivelling.

I add the preservative, as it may be useful to others:—

Corrosive sublimate, ʒii.
Spirit of wine (a pound), ʒxvi.
Camphor ʒss. Mixed.

f. 326r

birds, reptiles, or fish are emptied of their young, these should be preserved. It will be sufficiently evident that great care is required to label the specimens, as in most cases it will be impossible to determine the species from the zoological characters.

§ VI. NESTS AND EGGS.

Nothing forms a more attractive feature in a museum, or is more acceptable to amateurs, than the nests and eggs of birds. These should be collected whenever they are met with, and in any amount procurable for each species, as they are always in demand for purposes of exchange. Hundreds of eggs of *any* species with their nests (or without, when not to be had) will be gladly received.

Nests require little preparation beyond packing so as to be secure from crumbling or injury. The eggs of each nest, when emptied, may be replaced in it and the remaining space filled with cotton.

Eggs, when fresh, and before the chick has formed, may be emptied by making a small pin-hole at each end, and blowing or sucking out the contents. Should hatching have already commenced, an aperture may be made in one side by carefully pricking with a fine needle round a small circle or ellipse, and thus cutting out a piece. The larger kinds should be well washed inside, and all allowed to dry before packing away. If the egg be too small for the name, a number should be marked with ink corresponding to a memorandum list. Little precaution is required in packing, beyond arranging in layers with cotton and having the box entirely filled.

The eggs of reptiles, provided with a calcareous shell, can be prepared in a similar way.

The eggs of fishes, salamanders, and frogs may be preserved in spirits, and kept in small vials or bottles. A label should never be omitted.

§ VII. SKELETONIZING.

Skulls of animals may be prepared by boiling in water for a few hours. A little potash or lye added, will facilitate the removal of the flesh.

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Skeletons may be roughly prepared by skinning the animal and removing all the viscera, together with as much of the flesh as possible. The bones should then be exposed to the sun or air until completely dried. Previously, however, the brain of large animals should be removed by separating the skull from the spine, and extracting the contents through the large hole in the back of the head. In case it becomes necessary to disjoint a skeleton, care should be taken to attach a common mark to all the pieces, especially when more than one individual is packed in the same box.

Skulls and skeletons may frequently be picked up, already cleaned by other animals or exposure to weather. By placing small animals near an ant's nest, or in water occupied by tadpoles, or small crustacea, very beautiful skeletons may often be obtained. The sea-beach sometimes affords rich treasures in the remains of porpoises, whales, large fishes, as sharks, and other aquatic species.

§ VIII. PLANTS.

The collector of plants requires but little apparatus; a few quires or reams of unsized paper, of folio size, will furnish all that will be needed. The specimens, as gathered, may be placed in a tin box, or, still better, in a portfolio of paper, until reaching home. About forty or fifty sheets of the paper should be put into the portfolio on setting out on an excursion. Put the specimens of each species in a separate sheet as fast as gathered from the plant, taking a fresh sheet for each additional species. On returning to camp, place these sheets (without changing or disturbing the plants) between the absorbent drying papers in the press, and draw the straps tight enough to produce the requisite pressure. The next day the driers may be changed, and those previously used laid in the sun to dry; this to be continued until the plants are perfectly dry. If paper and opportunities of transportation be limited, several specimens from the same locality may be combined in the same sheet after they are dry.

Place in each sheet a slip of paper having a number or name of locality written on it corresponding with a list kept in a memorandum book. Record the day of the month, locality, size, and character of the plant, color of flower, fruit, &c.

If the stem is too long, double it or cut it into lengths. Collect,

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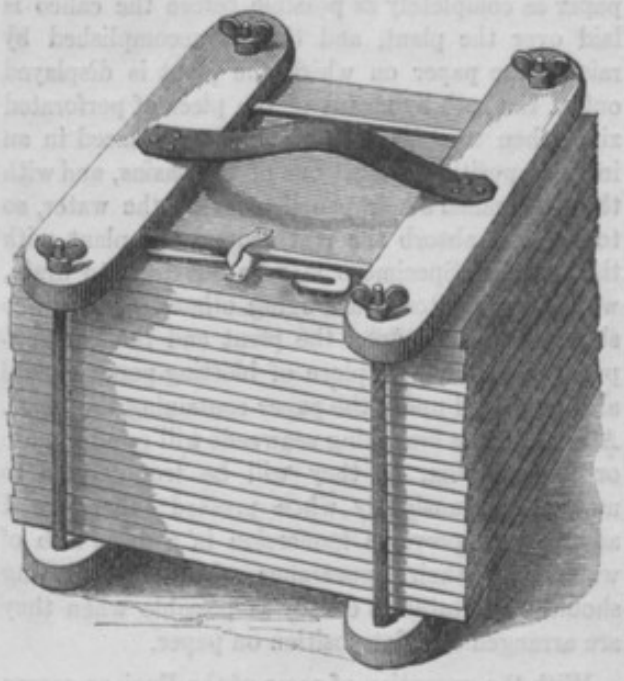
a proper seaweed-press, containing about a dozen smoothly-planed boards; it takes up very little space, and in travelling, the papers, calicoes, and blotters may be placed between the boards. The figure below represents the press which I have employed for years; and on it lies the iron clamp by means of which any requisite amount of pressure may be obtained by tightening the screws, which cap the iron rods con-



necting the cross-beams of wood enclosing the pressure-boards. Residents in and around London may examine this press on application at the office of this journal.

Space will not admit of any further description of the process of seaweed-mounting; but I hope that the few directions I have given will help beginners to dry any pretty plants they may meet with.

W. H. Grattann.

Enough for all!—A thousand million of men

collector should be provided with three different sizes of paper, varying from six to eight or ten inches square, and these should have each a piece of calico and four pieces of blotting-paper to correspond. Some people make use of fine muslin, but for all purposes I prefer very fine calico, and that which has been frequently washed is the best. Care should be taken that the water be drained off the paper as completely as possible before the calico is laid over the plant, and this is accomplished by raising the paper on which the plant is displayed out of the bath by means of the piece of perforated zinc; then transfer it to a thin board placed in an inclined position against one of the basins, and with the large camel's hair pencil *paint* off the water, so to say, and absorb the rest around the plant with the sponge. Specimens may be left thus to drain, while the operator is arranging others. The calico should be placed upon the plant and the blotting-paper laid over it; a piece of blotting-paper should also be placed under the paper containing the plant. Almost all the branching seaweeds will require more or less pruning, or they will be troublesome to mount, and unsightly when pressed; therefore I advise their previous immersion in a deep dish of water, and their appearance when thus floating should be imitated as closely as possible when they are arranged in a flat position on paper.

With the exception of some of the Fuci, or coarse rockweeds, I never place seaweeds in *fresh* water; but with the former a few hours' immersion in fresh water is an advantage, as it soaks some of the salt out of them, and renders them more pliable. As nearly every species of Fucus turns black in drying, and few of them adhere well to paper, I arrange my specimens in single layers between the folds of a clean dry towel, and keep them under moderate pressure for a few days; when they are dry, they may be put away loosely, or gummed upon sheets of paper.

can also be plunged for a minute in boiling water.

Motley placed succulent plants in sheets for a night or two: they then dried effectually when dried. Wright used a copper flat iron for succulents & portfolios instead of vasculum in collecting. In drying he placed each plant in double sheet of thin paper & never removed it till dry.

Bulbs inserted in trees to ascertain their temp: 1 ft also 3 ft below ground.

Kew plant sol: 1/4 lb carbolic acid

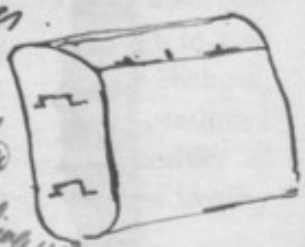
Size paper Oliver 16½ × 10
Bentham 16 × 10½ att. 1/4 " corr: subl:
not larger or smaller
or covers 17 × 12
papers 15 × 9. 1 gall methyl: sp:

Sundry knapsack with stiff Ends
Pill boxes & bottles. wrapping paper spatula
Note color hard tough, gelatinous, soft
spongy, odour milky changes when cut
spores in paper. col: outline
Cut in slices & dry
sew 4 to 6 sheets together of drying paper.

Herb:
Segil (Collector)
Exherb.

Soc.
Formation.

Wood, fruit & seed collections.
? Canvas covers for plants end & side wrap in
Tin boxes?
Large canvas haversack for plants
Vasculum filled in 5 minutes.
New vasc: opening at top
#2504 Tinned good for plants attacked by insects.
plant iron - like trowel sampling iron.



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if possible, half a dozen specimens of each kind. In the small specimens, collect the entire plant, so as to show the root.

In many instances, old newspapers will be found to answer a good purpose both in drying and in keeping plants, although the unprinted paper is best—the more porous and absorbent the better.

When not travelling, pressure may be most conveniently applied to plants by placing them between two boards, with a weight of about 50 lbs. laid on the top.

While on a march, the following directions for collecting plants, drawn up by Major Rich, are recommended :—

Have thick cartridge, or envelop-paper, folded in *quarto* form, and kept close and even by binding with strong cord; newspapers will answer, but are liable to chafe and wear out; a few are very convenient to mix in with the hard paper as dryers. This herbarium may be rolled up in the blanket while travelling, and placed on a pack-animal. The specimens collected along the road may be kept in the crown of the hat when without a collecting-box, and placed in paper at noon or at night. Great care should be taken to keep the papers dry and free from mould. When there is not time at noon to dry the papers in the sun, they should be dried at night by the fire, when, also, the dried specimens are placed at the bottom of the bundle, making room on top for the next day's collection. A tin collecting-box is very necessary; plants may be preserved for two or three days in one if kept damp and cool. It is also convenient in collecting *land-shells*, which is generally considered part of a botanist's duty. A collector should also always be provided with plenty of ready-made seed-papers, not only for preserving seeds, but mosses and minute plants. Many seeds and fruits cannot be put in the herbarium, particularly if of a succulent nature, causing mouldiness, and others form irregularities and inequalities in the papers, thus breaking specimens and causing small ones and seeds to drop out. Fruits of this kind should be numbered to correspond with the specimen, and kept in the saddle-bag, or some such place. It is necessary, in order to make good specimens, to avoid heavy pressure and keep the papers well dried, otherwise they get mouldy, turn black, or decay.

The seeds and fruits of plants should be procured whenever practicable, and slowly dried. These will often serve to reproduce a species, otherwise not transportable or capable of preservation.

On board ship, it is all-important to keep the collections from getting wet with salt water. The papers can generally be dried at the

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galley. The whole herbarium should be exposed to the sun as often as possible, and frequently examined, and the mould brushed off with a feather or camel-hair pencil.

In collecting algæ, corallines, or the branched, horny, or calcareous corals, care should be taken to bring away the entire specimen with its base or root. The coarser kinds may be dried in the air (but not exposed to too powerful a sun), turning them from time to time. These should not be washed in fresh water, if to be sent any distance. The more delicate species should be brought home in salt water, and washed carefully in fresh, then transferred to a shallow basin of clean fresh water, and floated out. A piece of white paper of proper size is then slipped underneath, and raised gently out of the water with the specimen on its upper surface. After finally adjusting the branches with a sharp point or brush, the different sheets of specimens are to be arranged between blotters of bibulous paper and cotton cloth, and subjected to gentle pressure. These blotters must be frequently changed till the specimens are dry.

§ IX. MINERALS AND FOSSILS.

The collections in mineralogy and palæontology are, amongst all, those which are most easily made; whilst, on the other hand, their weight, especially when on a march, will prevent their being gathered on an extensive scale.

All the preparation usually needed for preserving minerals and fossils consists in wrapping the specimens separately in paper, with a label inside for the locality, and packing so as to prevent rubbing. Crumbling fossils may be soaked to advantage in a solution of glue.

Fossils of all kinds should be collected. Minerals and samples of rocks are also desirable. The latter should be properly selected, and cut to five by three inches of surface and one to two inches thick.

The vertebrate fossils of North America are of the highest interest to naturalists. These are found in great abundance in those portions known as "Mauvaises Terres," or "Bad Lands," and occurring along the Missouri and its tributaries, White River, Milk River, Platte, Eau qui Court, &c. The banks and beds of these and other streams likewise contain rich treasures of fossil bones. Similar remains are to

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be looked for in all caves, peat bogs, alluvial soil, marl-pits, fissures in rocks, and other localities throughout North America.

The floor of any cavern, if dug up and carefully examined, will generally be found to contain teeth, bones, &c. These, however similar in appearance to recent or domesticated species, should be carefully preserved.

Specimens ought to be tightly packed up in boxes, taking care that each one is wrapped up separately, in order that the angles or crystalline surfaces should not be destroyed by transportation; their value depending upon their good condition. The same precautions will be required for corals. The interstices between the specimens, in the box or cask, may be occupied by sawdust, sand, shavings, hay, cotton, or other soft substance. It is absolutely essential that no cavity be left in the vessel or box.

§ X. MINUTE MICROSCOPIC ORGANISMS.

It is very desirable to procure specimens, from many localities, of the various forms of microscopic animals and plants, not only on account of their intrinsic interest, but for their relation to important general questions in physical and natural science. These will almost always be found to occur in the following localities:—

1. In all light-colored clays or earths, as found in peat bogs, meadows, soils, &c., particularly when these are remarkably light.

2. In the mud from the bottom of lakes and pools. A small handful of this mud or of the confervoid vegetation on the bottom, if dried *without squeezing*, will retain the Diatomaceæ and Desmidieæ.

3. In the mud (dried) from the bottom and along the margins of streams in any locality. The muds from brackish and from fresh waters will differ in their contents.

4. In soil from the banks of streams. The surface and subsoils should both be collected.

5. In the soundings brought up from the bottom of the sea or lakes. These should be collected from the greatest possible depths. If an armature be used to the lead, it should be of soap rather than fatty matter, as being more readily removed from the organisms. The mud which adheres to anchors, to rocks, &c., below *high*-water-mark, as well as below *low*-water, should also be carefully gathered.

F. 330v

6. In bunches of damp moss from rocks, roofs of houses, trees, about pumps, &c.

7. In the deposits in the gutters and spouting of roofs of houses.

8. In the dust which at sea collects upon the sails or deck of vessels. When not in sufficient quantity to be scraped off, enough may be obtained for examination by rubbing a piece of soft clean paper over the surface affected.

Specimens of all these substances should be gathered, and, when moist, dried *without squeezing*. The quantity may vary from a few grains to an ounce, depending on the mode of transportation to be adopted. *Every specimen, as collected, should have the date, locality, depth below the surface, collector, &c., marked immediately upon the envelop.*

It is also very important to collect filterings from river, brackish, and sea-waters. To do this, take a circular piece of fine chemical filtering-paper,* six inches or thereabouts in diameter (the patent blotting-paper will answer if the other cannot be procured), and weigh it carefully in a delicate balance. Pass a quantity of the water, varying with its turbidity, from a pint to a gill, through the paper, and allow this to dry. Mark the paper or its envelop with the original weight of the paper, the amount of water passed through, date, place, &c. It is desirable to have specimens thus prepared for every locality and for every month in the year. They may be sent, as well as light packages of dried muds, &c., by mail, and should be transmitted as speedily as possible.

When the water of lakes and ponds has been rendered turbid by minute green or brown specks, these should be gathered by filtration through paper or rag, which may then be dried, or, still better, have this matter scraped off into a small vial of alcohol.

* The Smithsonian Institution will furnish filtering-paper to those who may wish it.

with this solution 293

Skins stretch on frame, remove fat + rub over (powd alum ?
do fermerie 4 do myrabolans 8 muy? + del with water in a paste)
rub over with sandstone, wrap up for 24 hours in shade, again
rub with same, finally with grease. milk renders waterproof

Tallow preserves for ages and moths better than pepper.

American Indian method skins, cleaned + then rubbed with
animals brains after 24 h. are washed + should still damp
stretched or hung up + scraped over the edge of a plank
or with a scraper + dried over wood smoke.

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SUGGESTIONS

FOR FORMING

COLLECTIONS OF BIRDS' EGGS.

By ALFRED NEWTON, M.A.,

Fellow of Magdalene College, Cambridge, F.L.S., F.Z.S., etc.

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PREFACE.

A FEW months since, at the request of Professor Spencer F. Baird, Assistant-Secretary to the Smithsonian Institution of Washington, I wrote the following 'Suggestions' for circulation among its correspondents, and accordingly upwards of three thousand copies of them have been so distributed in the United States. I have thought that a republication of the pamphlet in England, with some slight alterations, would be a matter of convenience to British Oologists, many of whom, I believe, have felt the hitherto-existing want of a concise set of directions on the subject of egg-collecting, for transmission to their friends at home or abroad.

I have had the less hesitation in offering these 'Suggestions' to the Ornithological public, because I know that the principle of taking much greater care than is ordinarily done with respect to the proper identification and authentication of eggs, on which principle I have endeavoured most to to dwell, is that which was so thoroughly and so successfully maintained by my late friend Mr. John Wolley. To his example, indeed, I would chiefly attribute whatever merit might be found in these pages, though several hints which I cannot but consider valuable have been kindly supplied to me from other sources. I only trust that the subject has not suffered from its treatment at my hands, for I am fully convinced that the study of Natural History will be much benefited by an extended knowledge of Oology. But that it may be so benefited it is of the utmost importance that our knowledge of Oology should rest on a firm and truthful basis, and this end can only be attained by unremitting caution and scrupulousness on the part of egg-collectors.

Elveden, Thetford,
July 11, 1860.

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SUGGESTIONS, &c.

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§ I.

GENERAL REMARKS.

The collecting of bird's eggs for scientific purposes requires far more discrimination than the collecting of specimens in almost any other branch of Natural History. While the Botanist, and generally speaking the Zoologist, at home is satisfied as long as he receives the specimens in good condition, with labels attached giving a few concise particulars of when and where they were obtained, it should be always borne in mind that to the Oologist such facts, and even the specimens themselves, are of very slight value unless accompanied by a statement of other circumstances which will carry conviction that the species to which the eggs belong has been accurately identified, and the specimens subsequently carefully authenticated. Consequently precision in the identification of his specimens should be the principal object of an egg-collector, to attain which all others must give way. There are perhaps few districts in the world, and certainly no regions of any extent, whose faunas are so well known that the most rigid identification may be dispensed with. Next to identifying his specimens, the most important duty of an egg-collector is to authenticate them by marking them in some manner and on some regular system as will leave no doubt, as long as they exist, of their having been obtained by him, and of the degree of identification to which they were subjected. Neatness in the mode of emptying the shells of their contents and other similar matters are much to be commended; they render the specimens more fitted for the cabinet. But the main points to be attended to, as being those by which science can alone be benefited, are IDENTIFICATION and AUTHENTICATION.

§ II.

IDENTIFICATION.

The most satisfactory, and often the simplest, way of identifying the species to which a nest of eggs, when found, belongs, is to obtain

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one of the parents by shooting, snaring or trapping. But it sometimes, in practice, happens that this is found to be difficult from one cause or another, such as the wary instincts of the birds, or the necessities of his position compelling the traveller to lose no time, or the scarcity of the species making him unwilling to destroy the individuals. In any of these cases there is nothing to be done but to make as careful an examination as circumstances will admit of the precise situation of the nest, the materials of which it is composed (supposing that the collector cannot bring it away with him), and accurately to survey the surrounding locality, to observe by what species it is frequented; all the particulars of which examination and survey should be fully noted down at the earliest opportunity possible. Should, however, either or both the birds be killed, they should be skinned, or at least some characteristic part of each preserved,* and duly labelled to correspond with the inscriptions subsequently put on the eggs, and always with a reference to the collector's journal or note-book, wherein fuller details may be found.

The Oologist is especially warned not to be misled by the mere fact of seeing birds around or near the nests. Many of the Crow family (*Corvidæ*) are great eaters of eggs, and mistakes are known to have originated from birds of that kind being seen near nests of which they were certainly not the owners. Others, such as the Titmice (*Paridæ*), though not plunderers, obtain their food by incessantly seeking it, even in the very localities where many species build. It often happens, also, that two different birds have their nests situated very close to one another; and if they be allied species the collector may be easily deceived. Thus, it has come to the writer's knowledge that the Dunlin (*Tringa alpina*) and the Purple Sandpiper (*Tringa maritima*) have have had their nests only a few feet apart. At first a pair of the latter only were seen, which by their actions betrayed their uneasiness. A short search discovered a nest with four eggs. The observer was one of the best practical Oologists then living, and his eye at once saw that it was not the nest which he wanted; but a less experienced man would doubtless have immediately concluded that he had found the eggs of the rarer species. Indeed it may, generally speaking, be said of most birds that whenever they have nests of their own they are

* Birds may be preserved entire by simply pouring (through a small funnel) a few drops of pyroligneous acid down their throats, and saturating the feathers, especially about the vent, with the same fluid; after leaving them to dry for an hour or so, they may be wrapped in paper and packed. This fact was kindly communicated to me by Mr. John Hancock, and I have since made successful trial of the plan.

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also acquainted with those of their neighbours, which by their actions they will often betray to the collector who may be patiently watching them. Birds, again, will occasionally lay their eggs—accidentally, as it were—in the nests of other species, even when they are not, as the Old World Cuckoos (*Cuculus*, *Eudynamis* and *Oxylophus*) or the Cow Blackbird (*Molothrus pecoris*), of a parasitic nature; thus, eggs of the Eider Duck (*Somateria mollissima*) have been found in the nest of a Gull (*Larus*), and other similar cases are on record, in some of which, from the species being nearly allied, confusion might easily have arisen, though at the time no doubt may have occurred in the collector's mind.

It would be impossible in this paper to treat of the various methods which may be successfully employed to obtain the birds to whom a nest belongs, and, in fact, these methods can generally be only learned by experience. It is sufficient to indicate here the use of traps, snares, hingles or bird-lime, in cases where the individuals are too shy to admit of being shot by the gun or rifle. Much may often be gathered by the collector from the practice of the natives, especially if they be savages or half civilized. In like manner it would too much extend these suggestions to give a detailed account of the different ways in which the nests of birds are to be found. The experience of a single season is to most men worth a whole volume that might be written on the subject. Nevertheless, a few hints are given further on which might not occur to the beginner.

§ III.

AUTHENTICATION.

The most complete method of authenticating eggs is that of writing in ink on their shells,* not only the name of the species to which each belongs, but also, as far as the space will admit, as many particulars relating to the amount of identification to which the specimen was subjected, the locality where, date when, and name of the person

* A few possessors of egg-cabinets have a great aversion to specimens which have been written upon in the manner here recommended. With all deference to their example I cannot yield to what I am compelled to consider a prejudice, and a prejudice which may indirectly lead to very mischievous consequences. The neat and ingeniously-prepared tickets or labels which are used by many persons are not of themselves the slightest guarantee for the authenticity of the specimens to which they are affixed, as the process of removal and substitution is one of the easiest imaginable.

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by whom they were taken, adding always a reference to the journal or note-book of the collector, wherein fuller details may be given. It is advisable to do this on some regular system, and the following method is suggested as one that has already been found to work well in practice. The scientific names only to be used, except with a mark of doubt or within brackets, when the specimens have really been satisfactorily identified; and if the identification has been made by obtaining one or both of the parent birds a memorandum of the fact to be added, thus: "Both birds snared," "Bird shot," or in smaller space, "Bd. st." If the identification has been effected only by obtaining a good view of the birds the fact should be stated thus: "Bird well seen," Bird seen," or "Bd. sn.," as the case may be. For eggs not taken by the collector himself, but brought in by natives, or persons not having a scientific knowledge of Ornithology, the local name or the name applied by the finder should only be used, unless, indeed, it requires interpretation, when the scientific name may be added, but always within brackets, thus: "Tooglee-aiah (*Squatarola helvetica*)," the necessary particulars relating to the capture and identification being added. Eggs found by the collector and not identified by him, but the origin of which he has reason to think he knows, may be inscribed with the common English name of the species to which he refers them; or if it has no such appellation then the scientific name may be used, but in that case always with a note of interrogation (?) after it, or else the words "Not identified." If the collector prefers it, many of these particulars may be inscribed symbolically or in short hand, but never unless the system used has previously been agreed upon with persons at home, and it be known that they have a key to it. Each specimen should bear an inscription; those from the same nest may be inscribed identically; but different nests, especially of the same or nearly allied species, should never be so marked that confusion can possibly arise. It is desirable to mark temporarily with a pencil each egg as it is obtained; but the permanent inscription, which should always be in ink, should be deferred until after the egg has been emptied. The number terminating the inscription in all cases referring to the entry in the collector's note-book, wherein full details will be found, and the words or letters preceding the number serving to distinguish between different collectors, no two of whom ought to employ the same. The initial letter of the collector's name prefixed to the number will often be sufficient.

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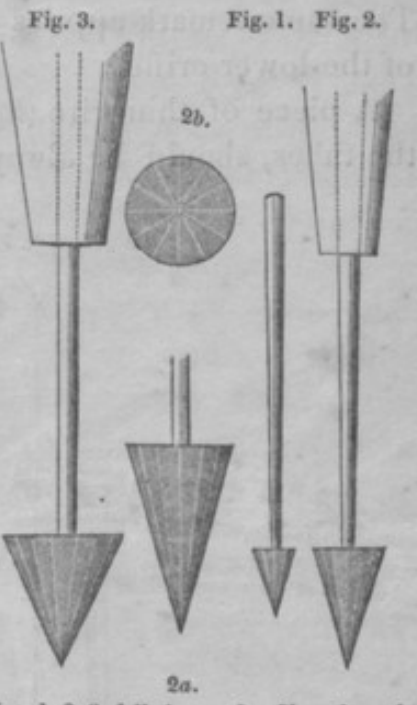
§ IV.

DESCRIPTION OF EGG-BLOWING IMPLEMENTS.

Figs. 1, 2 and 3 represent "drills" for making neat and circular holes in the shell. These drills should be made of the best steel that can be procured, and of different sizes. Fig. 1 is meant for the smallest eggs, even Humming Birds', up to those say of a Song Thrush (*Turdus musicus*). The grooves forming the drilling surface should be cut with a chisel. Fig. 2 will suit the generality of eggs, excepting those of very large birds and sea-fowl, which usually lay eggs with a strong but soft shell. The grooves may be cut either with a chisel or a file, but if with the latter greater care will be requisite in its use. Fig. 3 is intended for the largest eggs, and even some of the smaller ones which have a chalky shell, such as *Crotophaga*. The grooves are cut with a file. In the manufacture of all these drills the greatest care is necessary that the grooves should lie parallel to one another, and that their edges should be smooth. The smaller the drill the more acute should be the angle it forms at the point. The drills may be fitted with handles or not according to fancy. Those with handles are less likely than the others to cramp the fingers of the performer, an inconvenience which often causes breakages.



Figs. 1, 2, 3, full size. 2*a*, 2*b*, enlarged.

A separate sketch is given with the enlarged views (figs. 2*a*, 2*b*) of the end of a drill,* in order to show more plainly the manner in which the grooves should be cut.

Figs. 4 and 5 represent blowpipes for emptying eggs. They are best made of metal, and for this purpose nickel (or German silver) is preferable, as being less liable to rust. A collector should have two sizes, as a large pipe is not convenient for small eggs, and a small one causes loss of time in blowing large eggs. They should be

* The great object to be attained is the formation of a circular hole with smooth edges. Collectors not having such a drill as is here recommended will find a common nail or a three-cornered needle a useful substitute, but either must be used with extreme care. A rat-tailed file sharpened to a point at the end is also an effective instrument, as I am kindly informed by the Rev. S. C. Malan, who prefers it to the drill recommended in the text.

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be made as light as possible, or they may slip from the mouth and break the egg being operated on. The chief point to be attended to in their construction is that the lower orifice should be as large as the size of the pipe permits. It is of course necessary that they should be perfectly smooth outside, towards the lower end.*

Fig. 6 represents a tube for emptying small eggs by suction. The bulb is to receive the contents of the egg and prevent them from reaching the mouth of the operator and thus causing nausea. This instrument is best made of thin glass, as thereby it can be easily kept clean. The same remark applies to this as to the last with respect to the size of the lower orifice.

A piece of thin wire (fig. 7), long enough to pass entirely through the tubes, should be always kept at hand by the operator to remove

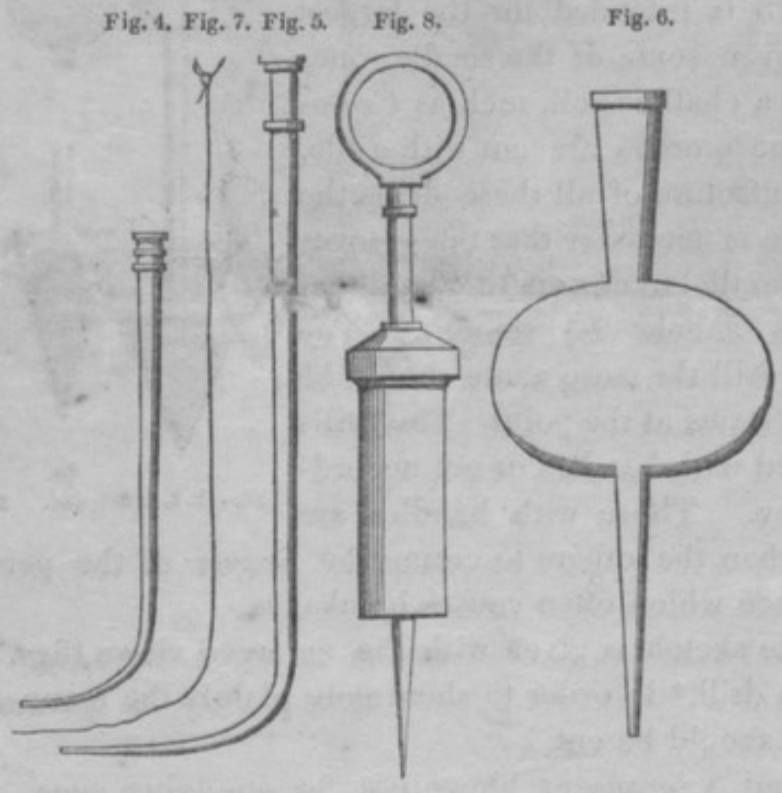

Fig. 4. Fig. 7. Fig. 5. Fig. 8. Fig. 6.

Half size. Full size.

obstructions which are likely to occur from small pieces of the embryo or half-dried yelk being accidentally drawn into the tubes or blow-pipes.

Fig. 8 represents a syringe, which will be found useful in rinsing out the inside of an egg. It may be made of any metal, though the

* In the absence of a blow-pipe, a reed, straw or grass stalk, will be found to be a tolerably efficient substitute.

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pewter ones are apt, from their weight, to be clumsy. Nickel is recommended, as for the common blowpipes. The lower orifice should be as large as possible. The ring at the top should be large enough for the insertion of the operator's right thumb — as it must be remembered that he has to work it with one hand.

Figs. 9 and 10 represent scissors of shapes likely to be found very useful; fig. 9. for cutting through the bones of the embryo before it is extracted, and fig. 10 for cutting off portions of it while it is being

Fig. 13. Fig. 12. Fig. 14.

The Embryos should be preserved -

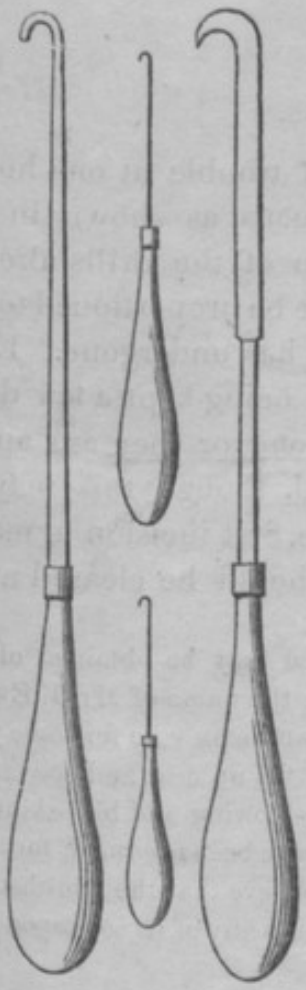

Fig. 11.
Full size.

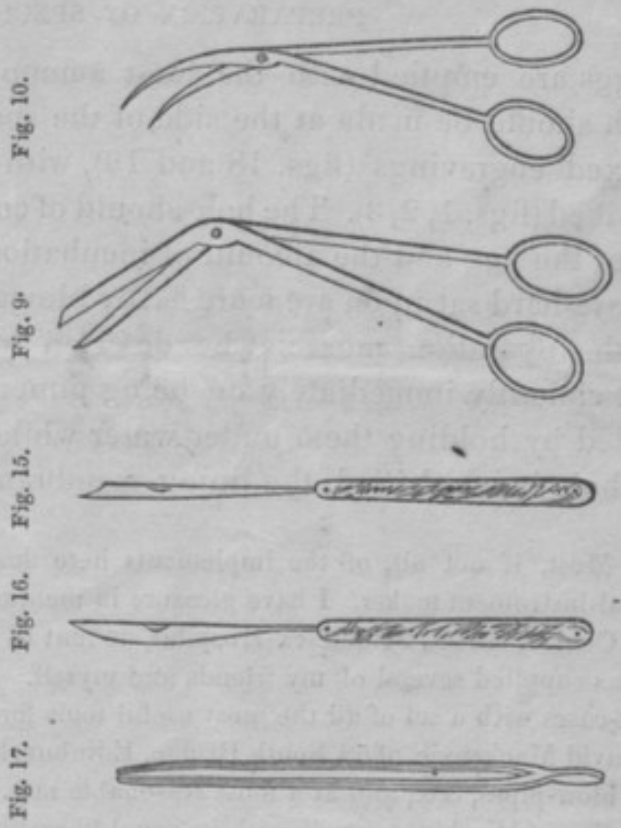

Fig. 10.
Fig. 9.
Fig. 15.
Fig. 16.
Fig. 17.

Half size.

extracted by one of the hooks represented in figs. 11, 12 and 13, which should vary in size from that of an ordinary pin to that of stout wire. The length of their straight portions should be rather more than the diameter of the egg they are used on.

Fig. 14 represents a knife with a curved blade, somewhat like a bill-hook, and may be useful in cutting up the embryo prior to extraction.

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Figs. 15 and 16 represent a penknife and scalpel with elongated blades or shafts, to admit of their being introduced into the egg to cut up the embryo. Fig. 15 is also, perhaps, the best instrument with which to remove the lining membrane from the hole. This is done by inserting the blade perpendicularly, and slightly scraping the edge of the hole as soon as it is drilled.

Fig. 17 represents a forceps for extracting the pieces of the embryo when cut up. The spring should not be too lively, as its resiliency may occasion breakage. The grasping surfaces should be roughened to prevent the pieces slipping.*

§ V.

PREPARATION OF SPECIMENS.

Eggs are emptied with the least amount of trouble at one hole,† which should be made at the side of the specimens, as shown in the annexed engravings (figs. 18 and 19), with one of the drills already described (figs. 1, 2, 3). The hole should of course be proportioned to the size of the egg and the amount of incubation it has undergone. Eggs that are hard sat upon are more easily blown by being kept a few days, but the operation must not be deferred too long or they are apt to burst violently immediately on being punctured, though this may be avoided by holding them under water while the first incision is made. The hole being drilled, the lining membrane should be cleared away

* Most, if not all, of the implements here described may be obtained of any surgical-instrument maker. I have pleasure in mentioning the name of Mr. J. Evrard, of 35, Charles Street, Middlesex Hospital, as that of the workman who for some years past has supplied several of my friends and myself. He fits up neat and convenient pocket-cases with a set of all the most useful tools for egg-blowing and bird-skinning. Mr. David Mackenzie, of 58, South Bridge, Edinburgh, I have been informed, furnishes drills, blow-pipes, &c., and at a most reasonable rate. I believe that the Smithsonian Institution of Washington will, with its usual liberality, equip any of its correspondents in America according to their requirements.

† Those who may still prefer to blow eggs by means of two holes are particularly requested not to make them at the ends of the eggs, nor at opposite sides, but on the same side (fig. 20). In this case the hole nearest the smaller end of the egg should be the smallest, and the contents blown out at the other. If the holes are made at the ends of the eggs it not only very much injures their appearance as cabinet specimens, but also prevents their exact dimensions from being ascertained accurately; and if they are made at opposite sides the extent of the "show surface" is thereby lessened.

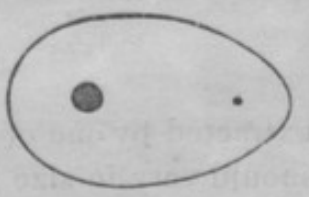

Fig. 20.

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from the orifice with a penknife (fig. 15), by which means not only is the removal of the contents, but also the subsequent cleansing of the specimen, facilitated. The small end of a blowpipe (figs. 4 and 5) should then be introduced, while the other extremity is applied to the mouth, and blown through, at first very gently. If the embryo is

Fig. 18.

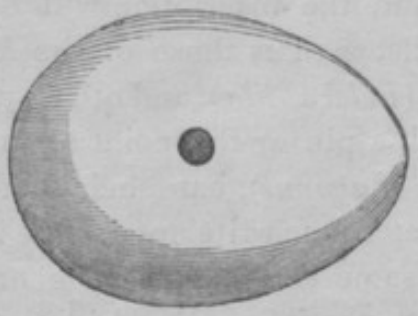

Fig. 19.

found to be moderately developed a stream of water should be introduced by means of a syringe (fig. 8), and the egg then gently shaken, after which the blowpipe may be again resorted to, until by the continued use of both instruments, aided by scissors (figs. 9 and 10), hooks (figs. 11, 12 and 13), knives (figs. 14, 15 and 16), and forceps (fig. 17), the contents are completely emptied. After this the egg should be filled with water from the syringe, gently shaken, and blown out, a process which is to be repeated until its interior is completely cleansed, when it should be laid upon a pad of blotting paper or fine cloth, with the hole downwards, its position on the pad or cloth being occasionally changed until it is perfectly dry. During this time it should be kept as much as possible from the light, especially from the sunshine, as the colours are then more liable to fade than at any subsequent time. In the case of very small eggs, when fresh the contents may be sucked out by means of a bulbed tube (fig. 6), and the interior afterwards rinsed out as before. It is always advisable, as far as possible, to avoid wetting the outside of the shell, as the action of water is apt to remove the "bloom," affect the colour, and in some cases alter the crystallization of the shell; consequently dirt stains or dung spots should never be removed. While emptying the contents it is as well to hold the egg over a basin of water to avoid breakage in case of its slipping from the fingers. Should the yelk of the egg be dried up, a small portion of carbonate of soda may be introduced (but with great care that it does not touch the outer surface of the shell, in which case the colour is likely to be affected), and then the egg filled with water

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from the syringe, and left to stand a few hours with the hole uppermost, after which the contents are found to be soluble, and are easily removed by the blowpipe, assisted by one of the hooks. It is almost unnecessary to add, except for the benefit of beginners, that the manipulation of the different instruments requires extreme caution, but a few trials will give the collector the practice necessary for success. Eggs should never be written on until the shells are perfectly dry, or the ink will be found to run, and the inscription will be rendered illegible. Eggs with chalky shells, such as those of the Anis (*Crotophaga*), Gannets and Cormorants (*Pelecanidæ*), and others may be conveniently marked by incising with a pin or the point of an egg-drill, so also those of the Ptarmigans (*Lagopus*), care being taken in this case to select the dark-coloured patches to write upon. The inscriptions should always be placed on the same side as the hole or holes, and confined within the smallest limits possible. For drilling the hole or holes the side presenting the least characteristic markings should be selected.

Eggs that are very hard sat upon, of whatever size they be, should be treated in the following manner, which is a method superior to any other known at present to the writer for preventing injury arising to them. The annexed engraving (fig. 21) shows a piece of paper, a number of which when gummed on to an egg, one over the other, and left to dry, strengthen the shell in such a manner that the instruments above described can be introduced through the aperture in the middle and worked to the best advantage, and thus a fully formed embryo may be cut up, and the pieces extracted through a very moderately sized hole; the number of thicknesses required depends of course greatly upon the size of the egg, the length of time it has been incubated, and the stoutness of the shell and the paper. Five or six is the least number that it is safe to use. Each piece should be left to dry before the next is gummed on. The slits in the margin cause them to set pretty smoothly, which will be found very desirable; the aperture in the middle of each may be cut out first, or the whole series of layers may be drilled through when the hole is made in the egg. For convenience sake the papers may be prepared already gummed, and moistened when put on (in the same way that adhesive postage labels are used). Doubtless patches of linen or cotton cloth would answer equally well. When the operation is over a slight application of water (especially if

Fig. 21.

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warm) through the syringe will loosen them so that they can be easily removed, and they can be separated from one another and dried to serve another time. The size represented in the sketch is that suitable for an egg of moderate dimension, such as that of a Common Fowl.

The most effectual way of adopting this method of emptying eggs is by using very many layers of thin paper and plenty of thick gum, but this is of course the most tedious. Nevertheless it is quite worth the trouble in the case of really rare specimens, and they will be none the worse for operating upon from the delay of a few days, caused by waiting for the gum to dry and harden. The naturalist to whom this method first occurred has found it answer remarkably well in every case that it has been used, from the egg of an Eagle to that of a Humming Bird, and among English Oologists it has been generally adopted.

The surest method of packing eggs so as to travel long distances and by rough modes of conveyance without receiving injury is to roll up each specimen separately in tow, flax, wool, or some similar material, so as to form a ball, and then to place these balls side by side in a good stout box, taking care that there be no room for them to shift their position. Those to whom this method may appear too troublesome are recommended first to put a layer of one of the substances just mentioned at the bottom of the box, then a layer of eggs, upon these another layer of packing material, and so on until the box is completely filled. The box should then be shaken, and if any rattling of the contents is heard additional packing material is required. More breakages occur by the use of boxes too large for the number of eggs than the contrary. As a general rule it may be stated that eggs if blown do not break against one another, but against the sides of thebox; if unblown, however, their weight renders it necessary to protect them from each other. On the other hand ,the surest method of packing eggs so that they may arrive at their journey's end broken is one which, though of course with the contrary intention, has often been recommended, *viz.*, to place them in a box, filling up the interstices between them with bran, sawdust, corn or sand. The effects of this method are in one respect diverse; if the eggs be unblown they will, after sufficient jolting, be found at the bottom, if blown at the top of the box, but in either case the result will be the same, and many be smashed. There is, perhaps, no greater annoyance to an Oologist than to receive from a correspondent a lot perhaps of valuable and carefully collected eggs broken through bad packing.

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§ VI.

CONCLUDING OBSERVATIONS.

The best allies of the collector are the residents in the country, whether aboriginal or settlers, and with them he should always endeavour to cultivate a close intimacy, which may be assisted by the offer of small rewards for the discovery of nests or eggs. He should, however, always insist upon any nests found being shown to him *in situ*, and the gratuities paid should be proportioned to his success in identifying the species to which they belong. He should steadily refuse any but the most trifling remuneration for nests or eggs taken and brought to him. As a rule the eggs of the different species of Plovers and Sandpipers (*Charadriadæ* and *Scolopacidæ*) are those most wanted by Oologists of all countries. These birds mostly breed in high northern latitudes, but they often choose elevated spots for nesting in more southern parallels. Their nests are nearly always difficult to find, even when the birds are discovered. Their habit is, if the ground be at all rough with herbage, to run off the nest for some distance before taking wing as the observer approaches; if the ground be bare they will try to escape observation by squatting closely until they are almost trodden upon. The best method of finding them, and indeed the nests of some other species, is for the collector to conceal himself near the place where he has reason to believe the eggs are, and to endeavour to watch the bird as she returns to her nest—using a telescope if necessary; but should this fail, after giving her time to settle herself upon it, to fire off a gun suddenly, or spring up and shout, when the bird, in her surprise, will often at once take wing from the nest, or at least without running many yards. To reach the nests of rock-building birds a man or boy can be lowered by a rope from the top, when it is accessible. The rope should always be tied under the arms of the person lowered, as substances, detached from above by the friction of the rope, may, by falling on him, stun him for a moment, and cause him to lose his hold. But in all places and at all times an egg-collector should recollect that IDENTIFICATION and AUTHENTICATION are his main objects, to attain which no trouble is too laborious, no care too great.

It does not come within the scope of this paper to offer any remarks on the arrangement or method of exhibiting eggs in cabinets. What has been attempted is simply a series of suggestions for collectors in the field. They are especially urged to aid the study of Oology by

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exercising greater zeal than many have hitherto been wont to do in seeking and recording precise information relative to the specimens they procure, and that at the very time and place when only it may be sought and recorded. It follows of necessity that such information should not be neglected by Oologists at home, but carefully entered and preserved in the catalogues of their collections, which all Oologists ought to keep. In many cases they may prefer forming these catalogues on their own plan; indeed for general collections of eggs they are obliged so to do; but to those who are content with a moderate series of the eggs of British birds only the useful 'Systematic Catalogue'* of the Rev. S. C. Malan will be found of very great convenience, though the plan recommended by that gentleman, of using tickets to distinguish the specimens instead of writing in ink on their shells, appears to the author, as has been stated above, to be liable to many grave objections. But with the simple substitution of inscriptions for tickets (which are so easily removable) Mr. Malan's method seems deserving of very great commendation, for it is the comparative indelibility of the former which gives them so great an advantage over the latter as permanent records of IDENTIFICATION and AUTHENTICATION.

* 'A Systematic Catalogue of the Eggs of British Birds,' arranged with a view to supersede the use of labels for eggs, by the Rev. S. C. Malan, M.A. London: John Van Voorst, 1, Paternoster Row. 1848. 8vo, pp. 170. Price 8*s.* 6*d.*

Printed by E. Newman, 9, Devonshire Street, Bishopsgate Street, London.

Number of small boxes to keep cod distinct

rake & 3-wide-pronged fork for shore raking

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DIRECTIONS

FOR

COLLECTING AND PRESERVING

SPECIMENS OF NATURAL HISTORY,

IN TROPICAL CLIMATES.

COMPILED BY SAMUEL STEVENS, NATURAL-HISTORY AGENT,
24, BLOOMSBURY STREET, BEDFORD SQUARE, LONDON.

INSECTS.—Insects may be found almost everywhere: look especially for all beetles under stones, under bark of decayed trees, in the inside of ditto, on felled ditto, on trunks of ditto (especially those that have the sap running from them), by beating the boughs into a net or sheet, smoking under and burning inside hollow trees, on long grass and herbage, on flowers, under rubbish (especially on the slopes of mountains, in marshy places), under sea-weed at the sea-side, and indeed they are to be found almost everywhere in warm climates, especially in and near woods and on the slopes of hills, and are generally most abundant in a light sandy soil and in the rainy seasons: they may be collected either by picking with the hands or by sweeping and brushing with a net, according to the situation collecting in: the larger ones may either be put separately into pill or other boxes, or else immersed at once into a bottle of clear spirit, when they almost immediately die; and may either remain in the spirit, and be sent in this way to England (if possible changing the spirit just before sending)) or else the same or following day taken out and soaked for about a quarter of an hour in warm water, and then laid on blotting paper a few hours to dry: after that, either pin and stick in tight in a well-made box, lined with cork or some soft wood, or else—if in a dry country—lay carefully in rows, in a box, on cotton wool: numbers may be packed this way in layers, and generally reach England in beautiful condition. The small beetles may also be collected and sent in the same way, and if immersed in spirit, put in a separate bottle from the large ones; or else when captured put into a phial with some blotting-paper, and killed when you reach home, by immersing it in hot or boiling water for a minute or two, or placing it in the heat of the sun for a short time: they can then either be pinned or else packed in cotton in rows and layers, as the others, and should not be despised on account of their small size, as they are frequently more valuable than the larger ones. Look especially in

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and near ants' nests, and under bark of trees where ants occur, or under stones, for a small beetle about this size and appearance: they are generally black and brown, and sometimes striped.

Butterflies and Moths (Lepidoptera) must be collected with great care, so that the beautiful scales on the wings are not rubbed off or injured, as they then become generally worthless: they may be bred from caterpillars found on various trees and plants (which is an excellent plan, as they are then very perfect), or else caught by the aid of a gauze net: a ring net, about a foot and a half in diameter and two feet deep, will do very well, attached to a stick three or four feet long. Woods and wild places are generally the best to find them in: it is necessary to pin them as you take them, which must be done with great care, so that the upper parts of the wings are not rubbed; therefore the collector must be provided with a good large box to stick them in. Some of the large and big-bodied moths will probably not die unless a little oxalic or nitric acid is applied to them, which may be done by dipping a long pin or needle into it and running it down the body of the insect, commencing under the mouth, two or three times: they can then either be pinned tight in boxes or else laid between dry cotton, the same as the beetles. Other sorts of insects may be caught and killed the same way, and sent over as before directed, between layers of cotton. No other insects but beetles should be put into spirits; and not these when the colours are beautiful, delicate, and of a chalky texture: the bottles before sending should be *full* of insects, or else filled up with cotton, so that they cannot shake about.

Great care must be taken with all insects that they do not get broken, especially the horns (antennæ) and legs of beetles, and the antennæ and wings of the butterflies and moths, for then their value is greatly diminished.

Beetles, butterflies and moths are the most saleable insects; still any remarkable forms and colours in the other orders should not be passed over. Beetles should always be pinned through the right elytrum, so that the pin may come out between the first and second pair of legs; but all other insects may be pierced vertically through the thorax.

Arachnida.—Spiders, Scorpions and Acari are best preserved in spirits, as well as the Myriapoda, including the Juli, Scolopendræ, and other individuals of the order; but they may be pierced through the thorax (the intestines being carefully removed and replaced by cotton), and pinned tight in boxes, as the insects.

Crustacea.—The marine species may be killed by being immersed in cold fresh water, and they should be left in it for several hours, to free them from the adhering salt, which, if not well washed out, renders them liable to attract moisture from the atmosphere and injures the specimens. When well washed, separate the upper shells, and remove as much of the fleshy parts as possible; then carefully dry and pack them. The smaller species may be pierced with pins, like insects, if the consequent bulk of the packages be not an objection. Entire Crustacea may be preserved in strong spirits or brine.

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Sponges and Corallines.—Search the line of sea-weed at high-water mark, and the more the latter are covered with small corals and other parasites the better. Never wash them in fresh water, but dry them as they are found. Never wash or squeeze sponges; the fuller they are of gelatinous or fleshy matter the better. Use unwashed small Fuci as packing, dried, but not to crispness: the boxes should be divided into two or three compartments. Corals should never be washed or bleached, but sent as they come from the sea.

Star-fish and Echini.—These may be either dried or bottled in the saline fluid. If large, plunge them for two or three minutes into boiling water before drying: if small, one minute will be enough. Annelides, Actinia, and other fleshy things, may be bottled with a saturated solution of bay salt, with two grains corrosive sublimate to each quart. Always keep up the strength of the saline solutions by the addition of salt as needed.

Land and Fresh-water Shells.—Land shells are found in many places, such as under stones, in clefts of rocks, on the sides of hills and mountains, under decayed wood and trees, on the trunks, roots and leaves of trees and bushes, in decayed vegetable matter, dried leaves and moss, on small plants; in fact, almost every situation produces them except open and cultivated places: where dead specimens are found, living ones cannot be far off. When collected, bring them home and put them in a pail, or some other large vessel, and pour a quantity of cold water over them; then cover up the vessel for two or three hours, which will cause the animals to come out a little (it is necessary to cover them up, or else they will crawl away): when they are a little out, draw off the water, and pour a quantity of boiling water on them, so as to cover them well: let them remain a few minutes to cool a little; then take out the animals with a large pin or needle, as you would a periwinkle: when they are all done, take a soft brush and wash off gently all the dirt and filth from them, and place them in another vessel of fresh water until all are clean; then shake out well the water that is in them, and place them out to dry, with their mouths downwards, but not in the sun: when dry, if they are small, pack them away in small boxes, writing on the cover the locality and situation in which found. Should the shells be rather large, then wrap each shell in a paper by itself, and pack them away in a larger box, with their localities, &c., with care; but never put by a box that is not quite full without adding sufficient cotton or other soft substance to fill it, for such tender subjects should not have play during their transit. In rivers, lakes, ponds and small streams, will be found many species of shells which—although not handsome—are very interesting, and many of them will prove valuable in England; none, therefore, should be left behind, as it may be a cause of regret hereafter. Some of the shells which will be found in the above-mentioned places are of the same form as the land shells; others are like our fresh-water mussel or cockle: they are mostly found in the mud, sometimes in deep water: dead ones are sure to be found on the banks of lakes and rivers; and if you cannot procure living ones, show the natives the dead specimens, and offer them money to get a quantity of living ones. The rivers and pieces of water abound with shells: be diligent in seeking them, and your labours will be

most amply repaid. Having collected the fresh-water shells, place them in a vessel, and pour a large quantity of boiling water on them: they do not require to be first put into cold water, as the land shells do: as soon as the water is a little cool, pour it off, take out the animals as before mentioned, wash the shells, &c., &c.; but as the bivalve or fresh-water mussel will open wide as soon as the animal is out, it must be tied close before being put out to dry, if not the hinge will break and make the shell valueless. Some of the fresh-water shells that are like the snails have a mouth-piece, or operculum, which must be taken care of: the mouth-pieces should be kept in separate packages, and packed with the species of shell to which they belong, as they are of great service in determining the species. Some of the land shells have also a mouth-piece, which should be packed in the same manner. When the bivalve shells are tied up and dry, wrap each of them in a piece of soft paper, pack them in small boxes, and remember localities, habitats, &c., &c.

Marine Shells.—The best time to collect shells on the sea-shore is at the new and full moon, for then the tides make greatest ebb: the collector should be on the spot two hours before low water, with an assistant to help in turning over the large stones, should there be any, under which will be found many species of Couries, Buccinums, Tritons, Mitres, Cones, and several species of bivalve shells, also many kinds adhering to the stones, which must be taken off with a knife in a careful manner: several species bore into the stone itself, which must be broken with hammers to get out the shells, or, if the stone be soft, cut it carefully with a hatchet, on doing which many more species will be found: care must be taken to avoid breaking the shells: be always provided with a light basket and a small box in it, in which put the smaller and more delicate specimens. The stones when turned over must be well inspected, as many will be found covered with marine matter, which makes them appear like the stone itself: collect all, and do not despise them on account of their unmeaning appearance, for amongst them may be new genera and other very rare shells. Many stones at the very lowest ebb will have most shells on them, therefore the collector must not mind getting a little wet. Amongst other sorts will be found Chitons, which must be taken off in the same manner as the limpet and other adhering univalves: care must be taken, when at home, to separate them from the other shells; put them into a pail of fresh water, and let them remain there from twelve to twenty-four hours, by which time the salt on the fleshy substance that surrounds them will be well soaked out; then cut out the animal, and wash the shells well, inside and out, from all filth, and throw them into another vessel of fresh water, where let them remain till the whole are cleaned; then place them on a narrow slip of board and bind them down tightly, put them in a shady place to dry, and in three or four days they will be fit to pack.

Amongst the rocks on the sea-shore, in the crevices and on them, will be found many species of Patellas, Chitons, Murices, &c. Make a careful survey of every rock and stone; they will amply repay the trouble. All sheltered coves or little bays are the best places in which to find shells: examine these places in preference to others, particularly those in more exposed situations. The first thing to observe when in a new locality is to go along the sands at high-water mark, for many good shells are thrown up by the sea, particularly light bivalves; any time of the tide will

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do. Never miss going after a gale of wind, for then many valuable deep-water shells will be found which are not seen at other times. In sheltered bays and places just at the very lowest water-mark, will be found, in the sand and mud, various species of bivalve shells, just beneath the surface, and generally in great abundance: do not neglect to collect all and every species, and in plenty.

In collecting shells, whether terrestrial or aquatic, the collector must always give the preference to live shells,—that is, such as are still inhabited by the living animal,—but if they cannot be obtained, dead shells are better than none, though, for the most part, they are worn and faded. The more delicate species must be packed in cotton or other soft substance, or, in default of such, a fine sawdust. Shells containing their animals, as well as the naked Mollusca, must be preserved in spirits or brine.

Dredging.—It is necessary to have a rope for the dredge from 2½ to 3 inches (60 fathoms long); a fine sieve, a bucket and a ladle; a boat with a small anchor and cable (not less than 30 fathoms), to moor her in the situation where you are going to dredge; a good stout canoe, to convey the dredge away from the boat as far as the rope will allow. The dredge to lie in the bow of the canoe, mouth upwards, handle inwards: when it is conveyed as far as the rope will allow, those in the canoe are to heave,—that is, turn the dredge over gently into the water, and let it be from five to six minutes, until it is fairly at the bottom; then haul it on board the boat: should any obstruction—such as a rock, &c.—prevent its being brought home, place the canoe under the rope and pull her along until the place of obstruction is arrived at; then bring up the dredge, either straight or by taking it a little way back, and let those in the boat haul dredge and canoe towards them until clear of the obstacle: the dredge is to be let down again, and hauled in as before. When the dredge is brought alongside the boat, lift it in, and take out all the mud and sand; half fill the sieve with this, and pour a bucket of water gently on it, the party holding the sieve to shake it gently until all the mud and fine sand has passed through: take out all the larger shells as soon as possible, to prevent their breaking the more delicate ones, and put them into your basket, and the smaller ones into boxes. Should there be many small shells in the sieve, which would take much time picking out, it would be best to throw the sand from the sieve into a basket, and take it home, where it can be inspected more minutely, after having dried it in the sun on paper. The nearer the collector gets to a reef of rocks in sheltered places, the better for shells, as they will lie there for protection; but be careful to throw the dredge clear of the rocks, as it will save a deal of trouble.

The dredge can be made 3 feet 6 inches long and 1 foot wide: the outer edge to be turned outwards about the angle of 30°, and beaten down rather fine: the lower part of the bar should not be less than half an inch thick, with holes punched in it from one end to the other, an inch and a half apart, to lash the bag to: the bag can be fashioned according to the dredge, and made of double bread-bags.

Mammalia.—The smaller animals of this class may either be skinned or inclosed entire (an incision being previously made in the under-side of the animal) in jars or

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barrels, which are to be filled up with some spirituous liquor, as gin, or, what is preferable when it can be procured, proof spirit diluted with half its bulk of water. If no spirit can be had, strong brine must be adopted. In respect to their retaining their natural colour, brine is even preferable to spirituous liquors for preserving the specimens. To skin the larger Mammalia, make an incision in a straight line along the belly, from the vent to the throat, and detach the skin carefully with the knife. The skull and the bones of the legs and feet are to be left; the brain, eyes and tongue must be extracted, and as little fat as possible be suffered to remain adhering to the inside of the skin, which is then to be dressed with arsenical soap, for the mode of making and applying which see note at end. If, however, some fat remain which cannot well be got rid of, strew it over with powdered tan, or the bark of oak, willow, &c., previously to applying the soap. The ears, lips and feet of large Mammalia should, when practicable, be well anointed with spirits of turpentine, which will assist their drying and tend to destroy insects: when dry, roll up the skin with the hair innermost, beginning with the head, and put a layer of dried grass or moss between the folds, to prevent its being injured by rubbing. The skin must be occasionally unrolled and examined, and, if practicable, exposed to a hot sun, and fresh spirits of turpentine added. If any symptoms of insects should appear, tobacco (the stronger the better) strewed in the package will be serviceable; and in countries where spices and aromatic drugs can be procured at a reasonable rate, these may be used to great advantage, and even supersede the necessity of applying the arsenical soap. When a very large animal has been killed, under circumstances which prevent the application of the arsenical soap, the skin should be stretched out on the branches of a tree, to give the air free access to every part of it, and, as soon as it is cold, well dressed on the inside with wood ashes. Entire skeletons (especially of the rarer animals) should be procured when possible. It is not necessary that they should be jointed or set up, but, having removed all the soft parts, boil the bones, and when well dried pack them with moss or grass, or the best packing-stuff at hand, so that they may travel securely. Take especial care that not a bone, tooth, or claw, be lost.

Birds.—With respect to birds, the collector should proportion his shot to their size, so as to injure the skin and feathers as little as possible. As soon as the bird falls, the blood should be carefully wiped up, and cotton placed within the beak to absorb any that might flow from the mouth, and thus prevent its staining the plumage. Birds should be skinned as soon as may be after they are killed, for, if suffered to remain till putrefaction has begun, the feathers fall off. The mode of skinning birds is very similar to that of skinning Mammalia, and equal care must be taken both to make the incisions as small as possible and in the least visible parts, and the feathers must be separated so as not to be injured by the knife in dividing the skin; the incision may be made from the vent to the breast: the head and legs must in all cases be carefully preserved, and the os coccygis left in the skin, otherwise the tail-feathers will be liable to drop out. In packing the skins, care must be taken that the plumage be not injured by contact with the harder parts, which for that purpose should be surrounded with cotton, tow, or the best soft packing material at hand, as dried leaves or grass. When more than one individual of the same species can be procured, it is desirable that a second specimen should be preserved in spirits, and the same remark

applies to the smaller Mammalia, and indeed to all the orders. The bird-skins must be dressed with the same materials as those of the Mammalia, but the arsenical soap —if used at all—must not be too liberally applied. As the plumage of birds varies extremely at different periods of their life, and even at different seasons of the year, it is of great importance to obtain both sexes, if possible, of all ages, from the chick just hatched to the adult in its maturest plumage, and also in their summer and winter liveries. Birds' eggs should also be anxiously sought for, and the species carefully identified: the best method of emptying them is to make a single hole near the middle of the shell, of about a quarter of an inch in diameter, into which a small tube is to be inserted, so as nearly to touch the opposite side of the shell, which, being held with the hole downwards, is easily emptied of its contents, by blowing pretty strongly through the tube: if no more convenient instrument be at hand, a straw will make a very serviceable blowpipe. Birds' nests should not be neglected; they possess a high degree of interest: the collector should therefore take accurate descriptions of the materials, form and size, of every kind of nest he finds, always being extremely cautious to ascertain the species to which each respectively belongs: he should also make careful drawings of every variety, and even collect such of the smaller nests as possess any peculiarity in point of material, structure, or mode of suspension.

Reptiles and Fish.—These are best preserved in spirits, each specimen being previously wrapped in a linen cloth; but when too large to be so treated, serpents and fish may be carefully skinned, with the least possible injury to the scales or any of the external organs, and with especial caution not to destroy the form of the skin, which may be preserved by stuffing it lightly with cotton or tow, or by filling it with sawdust, and the skins dried, with the head, feet and fins on. Instead of being skinned whole, fish may be divided into two nearly equal portions, by an incision passing longitudinally through the vertex of the head, the back and belly, but on one side of the dorsal, caudal, anal and ventral fins, so as to leave one half of the animal with the gills and all the organs of motion perfect. Their flesh may then be easily removed from this portion, and replaced by tow, which will preserve the form of the body. When well dried, this portion is to be carefully packed. On the whole, this method is preferable to all others; and fish thus preserved, when provided with proper artificial eyes and mounted on flat boards, afford excellent specimens. The upper and lower shells of the tortoise tribe should be separated by dividing the ligamentous or bony portion which unites them on each side, between the fore and hind legs; after which the fleshy parts may easily be removed,—the head, legs and integuments of the body being carefully preserved. As to the lizards and crocodiles, they may be skinned in the usual manner, care being taken not to injure the tails of the former, which are very brittle, or, when not too large, they may be preserved in spirits, which is still better.

The form and colour of the eyes in all the Vertebrata, of whatever class, should be carefully observed and noted down the moment they are taken.

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General Remarks.—Every specimen, dry or in spirit, should have a number attached to it, corresponding to one in the collector's note-book, in which he must enter his memoranda concerning it; as for instance,—

The country where found,
The season when,
Habits,
Habitat,
Local name.

The collector should be furnished with knives, scissors, scalpels, pliers, nets, a large assortment of pins of various sizes, needles, a hammer, small hatchet, packing-cases (large and small, including cork boxes for Lepidoptera and other insects, and a great number of pill-boxes in nests), cotton and paper, and also with a folding-net, hoop-net, water-net, forceps, digger, glass phials, &c., for collecting insects: he must also have a good supply of prussic acid and arsenical soap. The composition and mode of making the latter is as follows:—

Camphor	5 oz.
Arsenic, in powder	2 lbs.
White soap	2 lbs.
Salts of tartar, or, Subcarbonate of potash	12 oz.
Lime, in powder	4 oz.

Melt the soap completely with heat in a small quantity of water, and add the potash and lime; then remove it from the fire and stir in the arsenic; next add the camphor, previously rubbed to powder with a little spirit of wine, and mix the whole thoroughly: it should now have the consistence of paste. Preserve it in carefully-closed, glazed vessels, labelled "Poison."

To use it, mix the quantity required with cold water, to the consistence of tolerably clear soup, and apply it with a brush to the inside of the skins.

E. Newman, Printer, 9, Devonshire Street, Bishopsgate.

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COLLECTING AND PRESERVING.

No. V.—BUTTERFLIES AND MOTHS.

By Dr. Knaggs.

THE collector of Lepidoptera who aspires to success must read the book of nature as he runs. If he have not the wit to note and turn to account each little fact which may come under his observation, neither he nor science will be the better for his collecting. He should, whenever he makes a capture, *know the reason why*, or he will never make a successful hunter. He should be ever on the alert, his motto, *nunquam dormio*.

Some collect for profit, others for pastime; but the aim of our readers, I take it, is not only to acquire a collection of really good specimens, but also at the same time to improve their minds; and the best way of effecting this purpose is to hunt the perfect insect, not so much for itself as for the sake of the golden eggs, which, with proper care and attention, will in due course yield the most satisfactory results in the shape of bred specimens.

This being the case, and space being limited, it seems best to simply touch upon the preliminary stages of insect existence, pointing out as we go those methods of collecting and preserving which experience has shown to be the most successful.

There can be no doubt but that egg-hunting is a very profitable occupation, and far more remunerative than most people dream of, particularly as a means of acquiring the Sphinges, Bombyces, and Pseudo-bombyces. Eggs, speaking generally, are to be found on the plants to which the various species are attached; and a knowledge of the time during which the species remains in the egg state, as well as the appearance of the eggs as deposited in nature, should if possible be acquired previous to proceeding to hunt. The most practical way of ascertaining the food and time is to watch the parent insect in the act of depositing her ova; but when the plant has been thus discovered, the best way is to capture her, and induce her to lay at our home. When eggs are inconspicuous, of small dimensions, or artfully concealed, the use of a magnifying-glass is invaluable.

Eggs may be preserved by plunging them in boiling water or piercing them with a very fine needle, or they may have their contents squeezed out and be refilled by means of a fine blowpipe, with some coagulable tinted fluid; but the shells themselves, after the escape of the larvæ, form, when mounted, beautiful objects for the microscope.

The three most successful plans of obtaining caterpillars are searching, beating, and sweeping. The first requires good eyesight and a certain amount of preparatory knowledge; the others are a sort of happy-go-lucky way of collecting, useful enough and profitable in their way, but affording a very limited scope for the exercise of the wits. In searching for larvæ, the chief thing is to observe the indications of their presence. A mutilated leaf, a roughened bark, a tumid twig, a sickly plant, an unexpanded bud, an abortive flower, or a windfall fruit, should at once set us thinking as to the cause; or, again, the webs, the silken threads, the burrowings and trails, or the cast-off skins of larvæ, may first call our attention to their proximity. Of course, larvæ may be found on almost all plants, as well as in the bark, stems, or wood of many; but the collector should fortify himself with a knowledge of what each plant is likely to produce, and hunt accordingly; for though indiscriminate collecting may sometimes be successful, it does not tend to improve the intellectual powers.

Beating is the more applicable method of working trees and bushes. It is carried out by jarring the

larvæ from their positions by the aid of a stick or pole, in such a manner that they will fall into an inverted umbrella or net; or a sheet may be spread beneath for their reception. Sweeping with a strong net, passed from side to side with a mower-like movement, is better adapted for working low ground-herbage. The umbrella net, shown in fig. 75, is, perhaps, the best for this purpose. It is

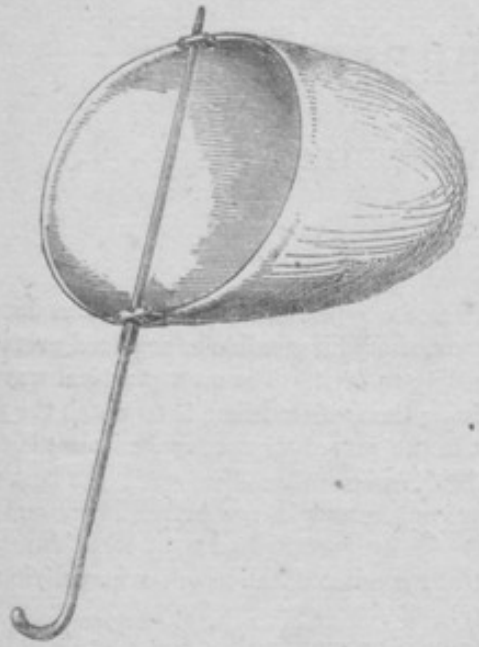

Fig. 75. Umbrella Net.

constructed by hinging two lengths of jack-spring on to two pieces of brass, and adapting them to the stick of the net, the upper piece of brass being fixed, the lower movable.

When captured, larvæ should be transferred to chip boxes, or else to finely and freely perforated tins, the latter better preserving the food. A very handy box for the purpose is formed by fitting a second lid on to the bottom of a chip box, and then cutting from the second lid and bottom a hole, as shown in fig. 76 (2); larvæ may then be inserted through the hole; but when the lid is shifted round, and the holes are not opposite, of course there will be no opening, as in fig. 76 (1), and the contents are secured from escape.

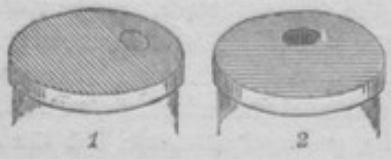

Fig. 76. Box for Larvæ.

Larva-preserving is carried out by first killing, and then squeezing and extracting the contents through the anal orifice by means of a crochet hook.

When this has been done, the skin is inflated, but not to such an extent as to distend the segments, and is kept thus inflated while it is being dried in a heated metal chamber. Afterwards, if the colours are observed to have faded, they may be cautiously restored by the application of paint. These objects, mounted on suitable artificial leaves, are then ready for the cabinet.

Chrysalis-collecting is conducted according to the situation of the object sought. Some are to be found in the chinks of bark or under loose bark, which may be detached by means of a powerful lever. Some are suspended from trees, bushes, copings, hanging head downwards, or girded by silken threads to low plants or walls; others are to be found in the stems or trunks of their food plants; many are concealed in cocoons of more or less perfect construction, others again among fallen leaves, but the majority are to be met with under the surface of the ground; in which case we shall have to dig for them by the aid of a trowel or broad chisel. The best situations for subterranean pupæ are open park-like fields, borders of streams, open spaces in fir woods, and they are usually situated within a foot or so of the tree trunks, at the depth of two or three inches, though sometimes considerably deeper. Of course both larvæ and pupæ of aquatic species will have to be sought for in their element, among the plants they frequent.

Chrysalis-preserving is a simple matter: the pupæ may be killed by plunging them into hot water or by baking; frequently, however, we find that the natural polish disappears with death, and this may be restored by varnishing. It is advisable that the cocoons also, where practicable, should be preserved, to give a notion of their appearance in nature.

Moths and butterflies may be sought for at rest or on the wing. They may be disturbed from their hiding-places or they may be attracted by various alluring baits.

At rest on stems of grasses and other plants butterflies may be taken on dull, sunless days; but it requires some experience to detect a butterfly with its wings raised up over its back: the little "Blues" may thus be freely boxed in their localities. Again, such butterflies as hybernate may be found in old sheds and outhouses, or under stacks.

Moths may be taken at rest on tree trunks, palings, and walls, or amongst foliage and ground-herbage. Some species are to be freely captured in this way after their evening flight is over. Of course, for evening work, a lantern to assist our vision will be indispensable.

On the wing, some butterflies are exceedingly active, others comparatively sluggish; some fly high, others low. In hunting them, the chief points to be remembered are not to alarm, but rather cautiously to stalk our game, and strike, when we have an opportunity, with precision. It is important also to avoid throwing a shadow over them.

and it is a good plan to get to windward of them—anything like flurry will be fatal to success.

Moths which fly by day may be chased in the same manner, but some may be observed disporting themselves round trees; these must be watched, and netted as they now and then descend. Others fly at a very low altitude, and are only brought into the field of vision by our assumption of the recumbent position. At night again, though we watch for anything stirring in the air, among the trees or the herbage, our tactics are somewhat modified; for if the insect be of whitish colour, we should so place ourselves that its form will stand boldly out against a mass of dark foliage, whereas, if it be dingy in hue, we must take the sky for our background.

Disturbing insects, and thus causing them to start forth, and so render themselves visible, is another method of collecting. This is carried out in various ways.

First, the occupants of high trees may be expelled by jarring the trunk with a heavily-loaded mallet, or by thwacking the trunk with a long hazel stick; but a sharp look-out must be kept, for some sham death, and fall plump down, while others make off as fast as they can. Other plans are to pelt the trees with stones, or pump on them with a powerful garden-engine, or beat them with a long pole; and of all trees the most profitable for this purpose is the yew; though firs, oaks, beeches, and other trees are not to be despised.

For beating bushes there is nothing better than a walking-stick, and for low herbage a long switch passed quickly from side to side with a tapping movement is best adapted. The tenants of tree trunks may be disturbed by brushing the surface with a leafy little bough, or, better still, by the use of a strong fan, with which a powerful blast may be driven, the net being held in such a position as to intercept such insects as are blown off.

Thatch-beating in the autumn is a very profitable employment, particularly in the matter of *Depressariæ*. Sweeping need only be mentioned here, for moths collected by the process are anything but perfect insects.

There are various methods of attracting moths and butterflies. The first is effected by confining a virgin female in a muslin cage, the frame of which may be very readily formed by bending three pieces of cane into circles, and fixing these together at right angles, as shown in fig. 77. When this baited cage is placed in a favourable position, and the weather is propitious for the flight of the males, the latter will, in some cases, congregate, and may be freely captured.

Fig. 77. Frame of Cage for Virgin Lepidoptera.

Then, the food-plant of the species is an attraction at which we stand the best chance of procuring impregnated females.

Various kinds of blooms possess alluring qualities for insects: of these, sallow and ivy are the greatest favourites with collectors. They should be worked after dusk by means of a lantern and net; but the combination of a lantern fixed to a long stick, with a shallow net beneath and a little in advance of it, as shown in the cut, is the apparatus best adapted for the purpose; the object of the net being to intercept any insects which may happen to fall under the stimulus of light. These attractions should be first well searched over and afterwards, a sheet (split if necessary) having been carefully spread below the bushes, a gentle shaking should be administered. Besides these blossoms, heather, ragwort, bugloss, catchfly, bramble, various grasses, and a vast number of other flowers, are wonderfully attractive. In working patches of bloom we should remain stationary and strike as the visitors arrive. Again, over-ripe fruit, the juicy buds of certain trees, sap exuding from wounds in trees, are all more or less attractive. The secretion of aphides, commonly called honey-dew, observable in hot seasons on the leaves of nettles and various other plants and trees, is also well worth attention, and is at times very productive of insects.

Fig. 78. Lantern and Net.

Sugaring is the next attraction, and a very important one it is. "Sugar" may be prepared by boiling up equal quantities of coarse "foots" sugar and treacle in a sufficient quantity of stale beer, a small quantity of rum being added previous to use, and also, if considered advisable, a flavouring of jargonelle pears, anise-seed, or ginger-grass. This mixture should be applied by means of a small paint-brush to the trunks of trees, to foliage, flowers, tufts of grass, or indeed to any object which may present a suitable surface; for in some localities we are put to shift to know where to spread our sweets. This operation should be performed just before dusk, and soon afterwards the baited spots should be visited and, by the aid of a lantern gently turned on them, examined, a net being held beneath the while. The best form of net for the purpose is formed by socketing two paragon wires into a Y-piece and connecting their diverging extremities

by a piece of catgut, as shown in fig. 79. The catgut, being flexible, will adapt itself (see the dotted line) to the surface of a tree trunk when pressed against it. With regard to insects captured at sugar, they are usually remarkably quiet,

Fig. 79. Net for Sugaring.

Fig. 80. Box with linen joints.

and may be boxed without difficulty, and, with a few exceptions, may be conveyed home in the boxes, care being taken to let each have a separate apartment. The boxes should be strengthened with strips of linen pasted round the joints, as shown in fig. 80, otherwise accidents may occur, particularly on wet evenings or on rough ground. The skittish individuals may be best captured by means of the sugaring-drum, of which a cut is given in fig. 81. This apparatus consists of a cylinder, one end of which is covered with gauze, the other provided with a circular valve, which works in a slit. For

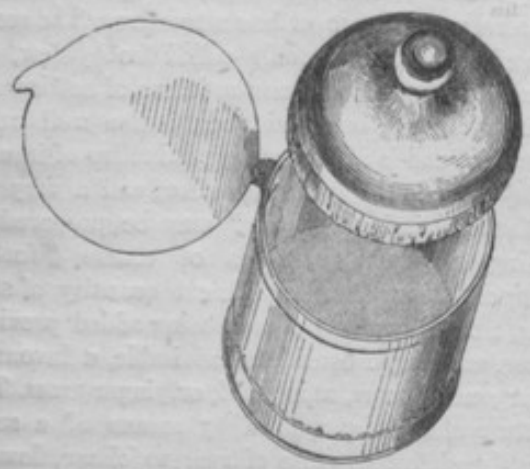

Fig. 81. Sugaring-drum.

use, the valve is opened and the cylinder placed over the insect, which naturally flies towards the gauze; then the valve is closed, the corked piston, shown at the lower part of the cut, placed against it, the valve re-opened, the piston pushed up to the gauze, the insect pinned through the gauze, and the piston withdrawn with the insect transfixed it to.

Light is another most profitable means of attracting. The simplest way is to place a powerful moderator lamp upon a table in front of an open window which faces a good locality, and then wait net in hand for our visitors, which usually make their appearance late in the evening, and continue to arrive until the small hours. Those who prefer

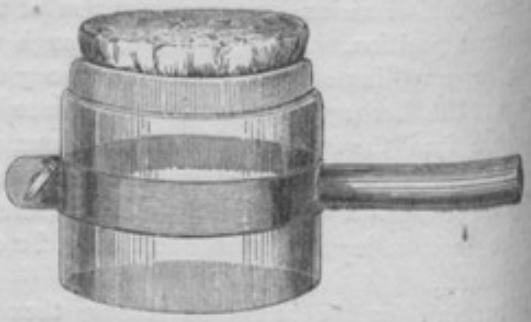

Fig. 82. Cyanide-bottle and Ferrule.

it can use the American moth-trap, which is self-acting, detaining such insects as may enter its portals, or those who can afford the space may fit up a room on the same principle. Street lamps are very profitable in certain localities, and amply reward the collector who perseveringly and minutely examines them. The apparatus depicted in fig. 82 is very useful for taking off such insects as may be on the glass of the lamp: it consists of a cyanide-bottle attached by a ferrule to the end of a sufficiently long stick. When placed over an insect, stupefaction is quickly produced. A net of the shape represented in fig. 83 is also very useful for getting at the various parts of the lamp.

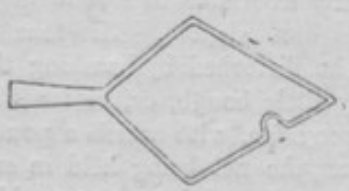

Fig. 83.

The best methods of stupefying and killing insects on the field is the cyanide-bottle, prepared by placing alternate layers of cyanide of potassium and blotting paper in the bottom of a wide-mouthed bottle, the mouth of which is accurately stopped with a cover, which is better for the purpose than a bung. The chloroform-bottle, which is generally made with a little nipple, through which the fluid flows slowly out, and covered with a screw-top, as in the cut, is also handy. The chloroform should be dropped over perforations in the box containing our patient, these perforations having been previously made by a few stabs of a pen-knife. After the fluid is dropped, our thumb should cover it, when the vapour will quickly enter,

Fig. 84. Chloroform-bottle.

he inmate speedily become insensible. Afterwards he *coup de grâce* may be given to the insect by ricking it under the thorax with the nib of a eel pen dipped in a saturated solution of oxalic cid. If we are smokers, a puff of tobacco may e blown into the box with like result. If we re destitute of any apparatus, and brimstone ucifers for the purpose of suffocating our captures nder an inverted tumbler cannot be obtained t some roadside inn, we must fall back on he barbarous practice of pinching the thoraces f such as cannot be carried home in boxes. At ome we shall find the laurel-jar and ammonia-ottle the most useful. The former is made by artially filling a large wide-mouthed bottle or jar ith cut and bruised dry leaves of young laurel: if ny dampness hang about them, we shall have the ortification of seeing our specimens become mil-ewed. The latter consists in adding a few lumps f carbonate of ammonia, or some drops of strong iquid ammonia, on a sponge, to the bottle in which ur captures, with each box lid slightly opened, have een placed. But it must be borne well in mind, rstly, that ammonia is injurious to colours of most reen insects; and secondly, that if the specimens e not well aired after having been thus killed, the ins with which they are transfixed will become rittle and break. Insects should be left in the mmonia for several hours, and are then in the ost delightful condition for setting out.

To pin an insect properly is a most important rocedure. The moth, if of moderate dimensions, ay be rested or held between the thumb and fore-nger of the left hand, while the corresponding

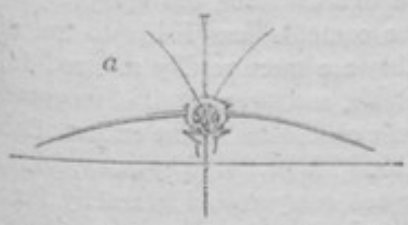

Fig. 85. Front View of properly pinned insect.

igits of the right hand operate by steadily pushing pin through the thorax, bringing it out between he hind pair of coxæ until sufficient of the pin is xposed beneath to steady the insect in the cabinet.

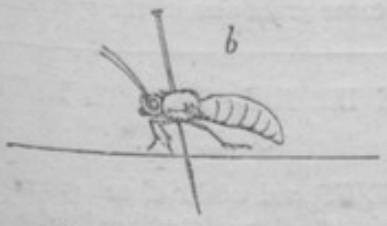

Fig. 86. Side View of ditto.

The direction of the pin should be perpendicular hen the insect is viewed from the front, as in fig. 85, *a*; but a lateral view should show the pin slightly slanting forwards, as in fig. 86, *b*. Pins made for the purpose in numerous sizes are sold by Mr. Cooke, of New Oxford Street. f 349c

Setting out moths and butterflies is an operation which, if skilfully performed, adds much to the beauty of the future specimens. The method of setting most popular is carried out by means of saddles and braces. These so-called saddles are pieces of cork rounded as in the sectional figure, a

Fig. 87. Cork Saddle for setting out insects.

groove being cut out for the reception of the bodies of the insects: they are generally strengthened by a strip of wood, upon which they are glued. Braces are wedge-shaped pieces of card or thick note-paper, the thick end strengthened, if necessary, with a disk of card fixed by shoemaker's paste, and pierced with a pin through it, as shown in fig. 88.

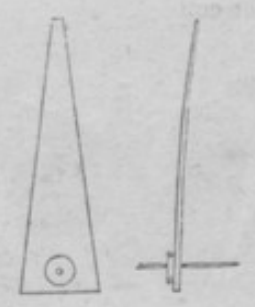

Fig. 88. Braces for setting out.

The mode of application of these appliances is beautifully shown in fig. 90.* But before these straps can be applied, the wings must first be got into position by means of the setting-needle and setting-bristle, which are thus manipulated; the setting-bristle, by the way, being formed by fixing a cat's whisker and a pin into a piece of cork, at the angle shown in fig. 89:—After the

Fig. 89. Pin, Bristle, &c., for setting out.

insect is straightly pinned upon the saddle, and the legs, antennæ, and, if necessary, the tongue, got into position, the left fore-wing is to be pushed or

* This figure and the following have been kindly lent by Messrs. Reeve & Co.

tilted into its place by means of the setting-needle, which is merely a darning-needle with a handle; and simultaneously it is to be held down by the bristle; then a small brace should be applied to the costa of the fore-wing. Next the hind-wing should in like manner be adjusted, and as many braces as are considered necessary to keep the wings in this place should be added. Lastly, the right side of the insect should be treated in a similar way.

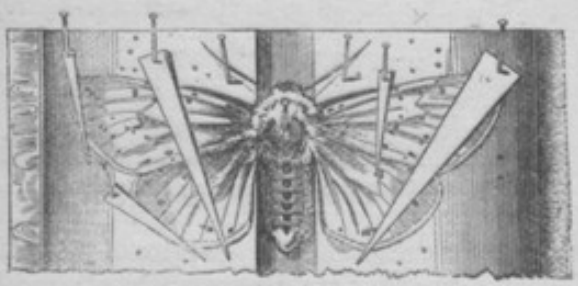

Fig. 90. Moth set out on cork saddle.

A very useful mode of setting, invaluable when we are destitute of saddles, is known as "four-strap" setting, and is well explained in fig. 91.

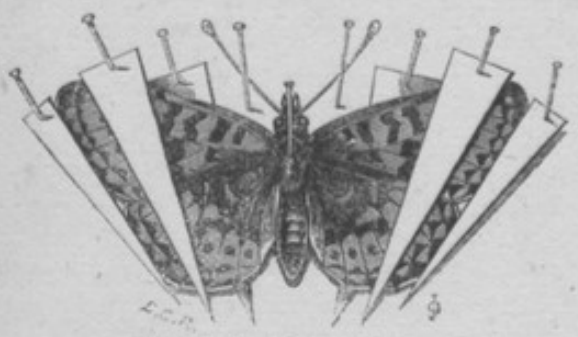

Fig. 91. Four-strap setting.

In this case the lower straps are first put into such a position, that when the insect is placed over them, the middle of each of the costæ will rest upon them; then the wings are got into position, and the second pair of straps are applied over the wings, the latter retaining their position through the elasticity of their costæ: two more straps are generally added to secure the outer borders of the wings, as shown in the drawing; but these, though advantageous, are not absolutely necessary. The saddles, with their contents, should be kept in a drying-house, which is a box adapted for their reception, and freely ventilated, until the specimens are thoroughly dry, when the latter may be cautiously removed, and transferred to the collection.

To preserve our collection from decay, considerable care and attention is necessary. In the first place no insect which is in the least degree suspected of being affected by mites, or mould, or grease, should upon any account be admitted to our collections. It is best to be on the safe side and submit every insect received from correspondents, whether mity or not, to quarantine, by which meant their detention for a few weeks in a b the atmosphere of which is impregnated with so vapour destructive to insect life; such as that benzole. Our own specimens we should kyan by touching the bodies of each with a camel's-h brush dipped in a solution of bichloride of merc of the strength six grains to the ounce of spirit wine,—no stronger.

As for mould, it is best destroyed by the ap cation of phænic or carbolic acid, mixed with th parts of ether or spirit. As preventives, specimens should be kyanized as above. Caution the use of laurel as a killing agent must be ex cised, and the collection must be kept in a room.

Grease may be removed by soaking the inse in pure rectified naphtha or benzole, even by b ing them in it if necessary. When the bodies o are greasy, they may be broken off, numbered, treated as above. After the grease is thorough softened, the insects should be covered up in p dered pipeclay or French chalk, which may be s sequently removed by means of a small sable bru As a precaution against grease, it is advisa remove the contents of the abdomina by slitting the latter beneath with a finely-pointed pair scissors before they are thorough-dry, and pack the cavities with cotton-wool. The males, especia of such species as have internal feeding lar should be thus treated.

Some prefer to keep their collections in w made store-boxes, which possess many advanta over the cabinet; for example, they may be k like books in a bookcase, the upright position r dering the contents less liable to the attacks mites; they are more readily referred to, and more portable, and they admit of our gradually e panding our collections to any extent. Cabinets, the other hand, are preferred by many, for the reas that they are compact and generally form a han some article of furniture; moreover, good cabin are made entirely of mahogany, which is the b wood for the purpose; deal, and other woods co taining resinous matter, having a decidedly j jurious effect on the specimens. As a preservati there is, after all, perhaps nothing better than ca phor; but it should be used sparingly, or its tende will be to cause greasiness of the specimens.

ART IN ITS RELATION TO NATURAL SCIENCE.

PAINTINGS, and works of art generally, ha not hitherto been introduced into Scienc Gossip, but, on reflection, it appears that fine arts would be advanced by the applicat of science to them. Anatomy, perspective,

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COLLECTING AND PRESERVING.

No. VI.—BEETLES.

By E. C. Rye.

THE general rules, so ably expounded by Dr. Knaggs in his recent article on *Lepidoptera* in this Magazine, as to constant alertness and making "the reason why" the starting-point of investigation, apply with equal force to the collector of *Coleoptera*, and need not be here recapitulated. But they do not, in the instance of the latter, require generally to be observed, except as to the perfect state of beetles; for, owing to the hidden earlier conditions of life of most of those insects, and to the long period during which these conditions exist, it is but seldom that the pursuit of rearing them, so universally and profitably adopted by the Lepidopterist, is found of much use to the collector of beetles. And this is very much to be regretted; because, in the majority of cases, if the latter succeed in rearing a beetle from its earliest stage, and keep proper notes of its appearance and habits, he will probably be adding to the general stock of knowledge, as the lives of comparatively few, even of the commonest species, are recorded from the beginning. It may be, also, in addition to the reasons above mentioned for the usual want of success attending the rearing of beetle larvæ, that the fact of bred specimens being frequently (from the artificial conditions attending their development, and from their not being allowed that length of time which, in a state of nature, they require after their final change before they are ready to take an active part in their last stage of life), not nearly so good as those taken at large, militates considerably against the more general use of this method of adding to a collection. In this respect, of course, the Lepidopterist is actuated by precisely opposite motives; as for him a bred specimen is immeasurably superior to one captured. And the fact of so few beetle larvæ being known at all, or, if known, only to the possessor of somewhat rare books, renders it very likely that a mere collector, finding a considerable expenditure of patience and trouble result in the rearing of a species of which he could at any time readily procure any number of specimens, may very probably abandon rearing for the future.

These observations, however, are not in the least intended to dissuade any one from breeding or endeavouring to breed beetles. On the contrary, it is obvious from them that it is precisely by attending to these earlier stages that the earnest student (novice or expert) has the most chance of distinguishing himself, on account of the more open field for discovery. And in the instance of many small, and especially gregarious, beetles, breeding from the larvæ is frequently very easy, if only the substances (fungus, rotten wood, roots, stems of plants, &c.) containing them be carefully left in precisely the same state as when found, and be exposed to the same atmospheric or other important conditions. In fact, to insure success and good specimens, it is best that in their early stages beetles should be "let alone severely."

It may be here observed, that we have been lately in this country indebted to the minute observations and great tact of some of our best students of *Micro-Lepidoptera* (in which branch of entomology we are second to none in Europe), for some most interesting additions to our knowledge of habits, and for long series of insects usually rare in collections.

Dismissing then the earlier stages of beetles, the following observations will apply only to the imago,

or "beetle proper." And here I would repeat how evident it is, that the knowledge of "the reason why" is especially indispensable to the beetle-collector, judging from the extreme rarity of the occurrence of any new or valuable insect in the stores of a mere random collector or a beginner. For him, no old hand detects an equivalent to *Daplidice* or *Lathonia* in his duplicate boxes: whereas, among Lepidopterists, "school-boy's luck" is proverbial. I can give no reason for this statement, founded on my own (by no means trifling) experience in the way of examining specimens. And in this idea I think I am corroborated by the very great rarity in old collections and records of many species now universally common; the directions in older manuals, as to looking under stones, on walls, paths, &c., pretty clearly showing that the majority of captures in the olden time were what are now irreverently designated as "flukes." Still, it is astonishing to what good account a sharp observer may turn these casual meetings, often to him resulting in the discovery of "the reason why" as to the particular species accidentally found, and to the correlative increase of his collection. And, apart from anything but individual captures, many good (and more bad) things will constantly occur to such a collector. One, for instance, who will startle his friends in the streets, by suddenly swooping with his hat after an atom flying in the sunshine, or who is not too proud to pick up another, racing on the hot pavement, during those days of early spring, when the insect myriads, revelling in warmth and light, after their long winter's durance, may be seen madly dashing about, even in towns: on such a day, for instance, as that whereon a certain well-known doctor among the beetles found that living carabideous gem *Anchomenus sexpunctatus*, far from its native *Sphagnum* and heath, wandering on the flagstones of the W.C. district.

But, before referring to special modes of hunting, it may be as well to mention the *instrumenta belli* required for the equipment of the Coleopterist in this country. These are but few, and of the simplest kind; indeed, in entomology, as in the gentle art of angling, it is often the most roughly accoutred that secures the best basket. The umbrella-net, figured at p. 122, used both for beating into and sweeping, cannot be dispensed with, and a beating-stick can be cut out of the nearest hedge. The net itself should be of fine "cheese-cloth," or some strong fabric that allows the passage of air, but not of beetles; otherwise, if of too close a fibre, it is apt to "bag" with the inclosed air, and reject its contents during the operation of sweeping. The net being of course used with the right hand, its left top edge especially bears the brunt of the attendant friction, and gets soon worn; it is consequently advisable to have an outer strip of stout "leather-cloth" sewn strongly over the rim there for some little distance, extending that protection also to the right top edge, though not for so long a space. The curved handle of the stick should be sawn off as soon as possible; it frequently catches in the pockets of the sweeper, causing a jerk to the net, and dispersal of its contents. For a similar reason, the feruled apex may be well removed. Some collectors keep the sharp cutting edge of the spring sides of the net uncovered, sewing the net itself to holes drilled at intervals on the lower side of the springs. It will be found handy if the bag of the net be cut to a point from the front towards the handle side: this causes the contents to gravitate to the bottom, as far as possible from the point where the rim meets the substance swept.

A common umbrella (easily slung by a stout string over the back when not in use) is an admirable (some think, superior) substitute for this net, as it can be held up higher by the ferule, and tall bushes and trees (of which the branches nearer the top are usually most productive) can be beaten into it with more certainty of their beetle-contents being caught. The steel frames will be found in the way when the beetles are being bottled; consequently, a good large gingham may be consecrated to collecting, and its inside (not the open ribs) covered all over up to the middle (leaving no aperture there if possible) with thin white calico, stitched *over* the frame.

Another good form of net for sweeping or dragging in long grass and herbage, is of the common fishing landing-net description, made of very stout wrought-iron or steel wire, either in a simple hoop, if a moderate size only be required, or with a single-stopped hinge to fold into two, or with three such hinges, folding into four, as may be desired. I have used one of these four-folding nets for years, and never found it fail. One end is hammered out flat and perforated, the other forming a male screw, bent at right angles with the body of the frame, passes through the hole, and fits into a female screw in a strong and long ferule, fixed in the usual way to the end of a stout oaken walking stick. As the power exerted in sweeping with such a net is great, and the action continuous, the simple screw is not enough, and a small screw-hole is drilled right through the ferule and the screw end of the net; a small thumb-screw, in shape like an old-fashioned clock key, going transverse through both, and effectually hindering later displacement. The framework of the net and the ferule are better made of the same metal, because, if made of two metals of different density the stronger soon wears away the weaker; and the stick must be inserted deeply into the ferule, and held on with *two* deep pins or small screws on opposite sides, one being insufficient to stand the strain. The net, of the same substance as the above mentioned, is made with a loose "hem" to slip on the frame before screwing it in the ferule

A leather-cloth edging all round is advisable, and the bag should be cut long enough to prevent the possibility of the contents jerking out. Another very good plan for securing the frame to the ferule is to have both ends of it soldered together into a deep square-sided plug, fitting into a corresponding hole in the ferule. The small cross-screw or pin is here also to be used, but the angles of the plug naturally keep a much tighter hold than the worm of a screw. Such a frame as this cannot, of course, be folded.

For water-beetles, a similar net to that last-mentioned is effective, but it should be stouter and with a flat front, for dredging closely against the sides and bottoms of ponds. The best substance for its bag is fine sampler canvass; and a very large stout bamboo cane is at once light and strong for its stick. To avoid friction, the bag may be affixed to small wire rings let into holes on the lower edge of the frame, or running on the frame itself.

A sieve is one of the most remunerative implements, and may be procured either simple or folding. It consists of a stout wire-framed circle, connected by a strong linen band, six inches deep, with the bottom of an ordinary wire sieve, the meshes of which are wide enough to allow any beetle to pass through. Leaves, grass, flood-refuse, ants' nests' materials, cut-grass, sea-weed, haystack and other *débris*, are roughly shaken in this over a sheet of brown paper, which should invariably form part of a Coleopterist's apparatus. A stout piece of double water-proof material may be substituted; and, in marsh-collecting, must be used as a kneeling-pad.

For ordinary bark-collecting, a strong ripping-chisel (of which the blade is well collared, so as not to slip) is as useful a tool as can be procured; but for *real* tree-working, no ordinary portable implement is thoroughly effective. Light steel hammers with a lever spike may delude the collector; but a woodman's axe, a saw, a pickaxe or crowbar, will often be found not too strong. For cutting tufts, &c., a strong garden pruning-knife is good, and an old fixed-handled dinner-knife (carried in a sheath) better.

For holding the results of the operation of these instruments, the collector needs but one or two collecting-bottles,—one rather small and circular, of as clear and strong glass (*not* cast) as can be got, with a wide mouth and flat bottom. Its neck should not slope, but be of even width, or the cork will often get out of itself. This cork should be a deep one, and be perforated longitudinally by a stout and large round quill, the bottom of which should be level with the bottom of the cork, the top projecting some inch and a half, with the upper orifice not cut off straight, but slightly sloped diagonally, so as more easily to scoop up beetles from the net or hand. It is closed with an *accurately-fitting*, soft, wooden plug, rather longer than the quill, reaching exactly to the bottom of it, but with its top projecting above the top of the quill, and broader than it, so as to be easily pulled out by the teeth when the hands are occupied. The bottle should be secured by stout twine to the buttonhole, enough play being left for it to reach the net in any ordinary position. I usually secure the external junction of quill and cork with red sealing-wax, and have more than once found the bright red catch my eye when I have lost my bottle. [N.B. This loss will always happen to every collector; generally after a peculiarly lucky day's work: so use the string-preventive.] The body of the bottle may usefully be half-covered with white paper gummed on. A few stout, plain glass tubes, papered in like way, and with plain corks, should be carried for special captures; and a cyanide-bottle, as mentioned at p. 124,* or one containing bruised and shredded young laurel-shoots, will be found useful for safely bringing home larger species, or such as would devour their fellow-captives. Put in these latter, beetles almost instantly die and become rigid, needing a stay of two days or so to become relaxed, in which condition they will then safely remain for a considerable period. In the first collecting-bottle a piece of muslin should be put, to give the contents foothold: these are brought home alive, and killed by bodily immersion in boiling water, after which they are placed on blotting-paper to drain off superfluous moisture.

Good things should always, when practicable, be set out at once, as the pubescence is apt to get matted if they are consigned for too long a period to the laurel- or cyanide-bottle; but such as remain unmounted can be put in a little muslin bag, and deposited in laurel until a more convenient opportunity. Beetles also, when taken in large numbers during an expedition into a productive locality, may be collected indiscriminately into a bottle containing sawdust (sifted to get rid both of large pieces and actual dust), and a small piece of cyanide of potassium. Each night, on reaching home, these will be found to be dead, and they can then be transferred to a larger bottle or air-tight tin can, partially filled with the same materials and a little carbolic acid to check undue moisture. Filled up with sawdust, this will travel in safety for any distance, and almost any time.

Species of moderate size, say up to that of an ordinary *Harpalus*, are in this country usually mounted on card. Much is to be said both for and against this practice; it enables the proportions and formation of limbs to be well appreciated, and it preserves the specimens securely; but there can be no doubt that it prevents an inspection of the

* "Killing-bottles," containing a layer of cyanide of potassium and gypsum, may be bought at most natural-history apparatus dealers, and are useful as relaxing depôts.

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under side, except at the trouble of extra manipulation in floating off and reversing, and that the gum used clogs the smaller portions of the insect that come in contact with it. Specimens larger than those mentioned should be pinned through the centre of the upper third of the right wing-case, and the limbs extended in position with pins on a setting-board, made of a flat strip of cork glued on deal. Both these and the mounted examples must be left to dry, for a week at least, in the open air; if the boards are fitted to a frame, let them be so placed that the specimens are bottom upwards. Specimens dry more rapidly in spring and summer than at any other time, and of course more readily in dry weather.

For mounting specimens, five or six small pieces of the finest and most transparent gum tragacanth, or "gum dragon," with the same number of pieces of clear gum arabic, are to be put in a wide-mouthed bottle with about a large wine-glassful of cold water. In a short time (twenty-four hours at most) the gum absorbs the fluid and swells; then add half as much more water, and stir the mixture, which, on being left for another twenty-four hours at most, will be ready for use. The gum should be dull white, of even texture, and not quite fluid. Never make a large quantity at one time, or be persuaded to put *anything* else into it. Card for mounting should be the whitest, smoothest, and best that can be procured. "Four-sheet Bristol board" for large specimens, and three-sheet for ordinary use, are about the proper degrees of thickness. Robersons, of Long Acre, artists' colourmen, have promised the writer to turn out cardboard of this kind with an extra milling, to insure a good surface. Upon strips of this card, pinned on a setting-board, the insects to be set out are mounted, one at a time, and not too close to each other, each on a separate "dab" of the gum, the limbs being duly set out with a fine pin or needle mounted in a paint-brush stick. A pin with the point very finely turned, so as to form a minute hook, is very useful; and for extremely minute work a "bead-needle" is valuable. The gum-brush should not be used in setting, but one or two very fine-pointed camel's-hair brushes may be found of advantage. Before mounting, reverse the specimen on the blotting-paper, and brush out its limbs as far as practicable with a damp flat brush. Very refractory individuals may require to be gummed on their backs; as soon as the gum is dry, their limbs can be more easily got into position, and they can then be gently damped off their temporary mount, and treated as above.

A small pair of brass microscope-forceps, ground or cut to a minute point, will often materially assist in getting refractory limbs into position. French white liquid glue (not made of shell-lac) is useful for fastening down larger specimens, as it is very strong and dries readily; and with a very small quantity of it rows of specimens can quickly a securely be roughly mounted, in the continental wa which is preferable in many cases to leaving t insects for a long time in laurel before setting the out. Such specimens can afterwards, if desired, relaxed by leaving them on damp sand, or in t cyanide- or laurel-bottle, and be then set in the w above indicated.

Care must be taken, in setting, not to put t specimen lop-sided on the card, or to distort segments unnaturally by pulling them out of po tion, &c., and not to allow gum to lodge anywh on the upper surface. It is easy, soon after a sp cimen is securely mounted, to remove with cle water and brush any superfluous gum. In prepar such insects as are liable to "run up" in dry (*e.g.* the *Staphylinidæ*), the abdomen should be d pulled out by a bead-needle inserted at its ape and, to prevent the contraction of the internal mu cles in drying, this part may be held with t liquid glue above mentioned. Usually, by putti these insects as soon as mounted into a box a keeping it closed for a few hours, while the fi drying takes place, the proper dimensions of t abdomen may be preserved, and thus the natur facies of the insect retained. The contents of t bodies of very large insects may well be remov either by the anal orifice, or by an incision on t lower side of the abdomen. The Oil-beetles (*Meli* alone require careful stuffing. This is best done separating the entire abdomen from the metathor beneath the elytra, and close to their point of ins tion: the body is then easily emptied and wash out, and may be filled with cut-up wool, whi packs closely: when gummed on again, the jun tion is not visible, and the entire insect preser its wonderfully obese appearance.

To save time, in mounting many specimens, it better to merely gum straight on the strip of c as many specimens as can be managed at a sitti The left side of each of these can then be slig damped with clear cold water, and its left limbs out: when all are thus done, the first one will nearly, if not quite, ready to have its right s treated in like manner; and so on to the end. V refractory specimens will sometimes require to even held down with little braces of card on p and to have each limb damped and set out b separate operation. The card of large specim will often curl upwards in drying, owing to amount of damp; to counteract this, the *lower* of the card may be washed with a wet brush, before gumming its surface.

Before putting insects away, when dry, the in vidual specimens should be cut off the strips of c by a straight cut on each side, one at right ang to the sides in front, and another behind, all cept the last) close to the tips of the limbs as out, so that the whole card forms a parallelogra

a very little practice will enable the operator to do this both certainly and quickly. No two individuals, save perhaps a male and female, of whose sexual relations there can be no doubt, or an example mounted on its back, to show its underside, along with a member of the same species, should be allowed to continue on one card; much less should *a row* of any species be left together. And each specimen should have sufficient card left *behind* it to allow of a glass of high power being passed between it everywhere and its pin. The pin should perforate the card in the middle of, and close to, its hinder margin; and the whole card be lifted three-fourths up the pin, to keep it from mites and dirt as much as possible. Proper entomological pins can be obtained of all sizes at the agents of Edelsten, 7, Silver Street, St. Martin's-le-Grand, also (with all other apparatus) of any natural-history agent or dealer in London; such as Mr. E. W. Janson, 28, Museum Street, or Cooke, New Oxford Street. "No. 8" pin is, perhaps, the most useful size. In removing many specimens, proper insect-forceps will be found handy: these can be obtained at the two last addresses, or of Buck, cutler, Tottenham Court Road.

Specimens will occasionally become discoloured with grease, usually from defective drying, though many water-beetles and internal feeders, and most autumn-caught specimens, are specially liable to this defect. Benzine is an effectual remedy for it, and for mites, and can be liberally applied with a brush. Carbolic or phœnic acid, dissolved in that fluid (or alone, see p. 126), is an effectual safeguard against mould from damp. To re-card a specimen that has become discoloured (whether from either of these causes, or from age), it is only necessary that it should be floated in cold water for a few minutes; the insect can then be dried, well saturated with benzine, and again mounted, looking as fresh as ever. But in re-carding specimens it is necessary to be very careful with such as were originally kept too long in laurel- or cyanide-bottle, as they are apt to become so rotten that a little damp will cause a "solution of continuity."

As to storing the specimens when quite dry, I can add nothing to the excellent observations of Dr. Knaggs at p. 126, the same remarks applying with equal force to *Coleoptera;* except, perhaps, that, even when the collector has (and is satisfied with) a cabinet, he is likely, in proportion to the *real* work done by him, to establish type-boxes of all the difficult groups.

For the examination of insects, readily manipulated by being pinned singly on a square flat thick piece of cork or bung, a pocket glass is, of course, necessary. In this case, the best instrument is the cheapest in the long run, whatever it cost; and one by a good maker, such as Ross, with modifications of four powers, will suffice for any ordinary work. For very small species, a Coddington, of the clearest definition and highest power attainable, is of immense help. But when the collector finds that he needs a compound microscope to separate species, it is the firm opinion of the present writer that that collector had better take to some other pursuit than studying *Coleoptera*. To any one, however, whose researches entail an examination of the minute cibarian and other organs of beetles, whether for purposes of classification or otherwise, the compound is absolutely necessary; though even then the lower powers are usually sufficient. For rough dissection, all that is needed are a very small oculist's lance-headed dissecting-knife and a stout and fine needle. With these, under a lens mounted on a little stage to allow the free use of both hands, much may be done. The writer, however, has seen and used a very pretty (and comparatively inexpensive) dissecting-stand, with various powers and much latitude of motion, by Ross.

After mentioning that, in sending mounted beetles by post to correspondents, it is far more practical to use a *strong* box, not too deep, to fasten the pins securely, with a layer of manufactured wool in the lid (glazed side towards the beetles, so as not to catch limbs), and to put more wool outside, and write the address and affix the stamp on a label attached, than it is to pack carelessly, write "with care" outside,* and then grumble at the Post-office because the insects are broken, I think I cannot, with use, say anything more upon beetles in their preserved condition; and I will therefore now give some hints as to their haunts when alive.

To exhaust the accidental-capture system above alluded to, mention must first be made of sand-pit collecting, a most profitable employment, especially in spring and early summer. A clean, straight-sided silver-sand pit is the best, and, if in or near a wood, its attractions will be at their highest. Beetles, flying of an evening and by night, dash against the pit sides and fall to the bottom; others merely crawl in for shelter, or tumble over the sides, and many seem attracted by the mere damp at the bottom or in the corners. Old collectors used to recommend a sheet spread out to attract insects; and there is no doubt that a certain number can be found by such means, just as they can be picked up floating on horse-troughs or on ponds. Artificial traps exist in the corridors of the Crystal Palace, some half-inclosed country railway stations, and such places; crawling up the windows of which many specimens are to be found. But these can only be considered as indications of what species occur in the district, as they are mere stragglers. Deliberately laying traps in sand-pits, on commons,

* It is, however, always as well to write "Insects," signifying contents that are "caviare to the million," and, therefore, not likely to be appropriated *en route*.

&c., will be found most productive: small dead animals, fir-branches, dead leaves, &c., can be examined time after time with profit in such situations.

After heavy floods, as during severe droughts, beetles may be found in great profusion; in the former case by sifting the refuse left by the water; in the latter by diligently examining the damp residuum of former ponds, and, if no damp be found, by even searching below the surface where it last occurred.

The wet hay, often decayed and mouldy, at the bottoms of stacks, which bad farmers have placed directly on the ground, will be found to teem with beetle-life; as will the margins of dung and vegetable-refuse heaps, wood-stacks, cut grass, &c.; and many good things may be taken by gently waving a light gauze net to and fro, just before sunset, close to such places, whither the instinct of nature impels the flight of myriads.

In winter, isolated tufts of grass in wet places, on the margins of streams, the crests of banks, &c., must be cut close to the ground, and gently torn in pieces over brown paper. Wherever many insects seem to be found, it will in most of these cases be found advisable to sift the fragments, and bring home the beetles and small stuff unexamined in a bag with a string at the neck to prevent their escape. Moss should be treated in this way, and the layers of black and rotting leaves found in woods, especially at their outskirts. Beech leaves usually produce many species, and the autumn and spring are the best times for hunting for them.

In winter, also, many species will be found hybernating in grass at the roots of trees, under bark, &c., in conditions not usual with them at other times.

In autumn, fungi, in woods especially, will be found most productive.

General sweeping, except during the winter, will always be more or less remunerative. No general rules can be laid down for this; in a good neighbourhood (on chalk or sand, or both joined) beetles will swarm almost anywhere in due season, and the most unlikely-looking spots will frequently be found the best in the end. In luxuriant herbage, among low shrubs, in the close-growing vegetation of hillsides, the sweeping-net may be plied with success; but the best way, with all *Phytophaga* at least, is to start with a fixed idea as to catching certain definite species, and then, at the right time, to hunt for such plants as these are known or supposed to frequent; and, such failing in the district, to try their allies. Of course, the collector will not fail to sweep flowers in woods and lanes, whereon, in the hot sunshine, many showy beetles bask. Many good things will be found by sweeping under fir-trees, especially towards evening, and even by night; in many places, especially marshes, nocturnal feeders may be secured by the vague use of this net. By ni also many species may be found at sugar pu trees for moths, and on ivy or sallow-blossom.

Beating is most productive in early summe especially in the second year's growth of youn cuttings in woods, and the Oak, Hazel, and Popla will generally yield many species to the tap of th stick. Good thick, and especially *old* hedges, mus also be always carefully thrashed into the net very many good things, otherwise not procurable will reward this toil. Another scheme for gettin rare species is to beat the tops of trees with long pole, placing beneath a sheet or ten covering.

Breaking away the extreme edges of bank throwing water on them, treading heavily on th margins, diligently examining grass and roots clos to the wat, reeds (especially if cut and on th ground in heaps), &c., will bring to light gre numbers of wet-looking beetles. Water-beetles, pu and simple, must be dragged and dredged fo especially round water-plants beneath the surface and along the sides of ponds, in eddies of runnin streams, in the moss on stones in them, and on th stones themselves, &c.

The *Coprophaga* will be found readily in th droppings of various *Mammalia*, and also in hol bored in the ground beneath, often to a great depth An easy and clean way to secure them is to throw droppings, ground and all, into water, the beetle coming to the surface.

As to wood-beetles, they must be sought fo under and in bark, in solid wood, in decaying branches, and such places; a rule to be remembered is that most of these occur at the *tops* of trees hence the paucity of so many species in collections Indeed, to properly hunt for the majority of them it is necessary to obtain *carte blanche* and a ladder if any success be hoped for. Felled trunks are, of course, easy to manipulate; and their freshly-cu stumps, exuding either resin or a peculiar an often sweet *mucor*, are very attractive to many beetles, as is freshly-cut sawdust, and, most esp cially, the (to us) fetid and acrid juice resulting from the attacks of the larva of the Goat-moth. Rotten fruit, &c., is also not to be passed by with out examination. Many small species occur in, can be reared from, the topmost twigs of trees blow down by the wind.

Dead animals, as before mentioned, must be ex amined, as must the vegetation and soil near them A keeper's tree in a wood will always produce something for the collector, who need only hold h net beneath the gibbeted *feræ* and bang their hid and bones with his beating-stick. During differen stages of decomposition and desiccation, beetles widely varied affinities will result from this metho of collecting.

Ants' nests would require a special notice, so p

BOX FOR CATCHING INSECTS.

HAVING often felt the want, in catching insects, more especially for the microscope, of a means for readily securing the insect upon the spot, by chloroforming it whilst quite fresh and uninjured, I have been led to devise, with a friend, a little box for this purpose, which has been found so convenient and efficient that a description will probably interest your readers.

A shallow transparent glass jar is fitted with a wood cover lined round the edge with cork to fit air-tight, similar to the ordinary glass pomatum-jars. In the centre of the cover a hole about ¼ inch diameter is made (*a*), and a small piece of fine-grained sponge about ¾ inch diameter is fixed over this hole inside the cover, by gluing it into a conical recess cut round the hole (*b*); the sponge being trimmed with scissors to a thin edge all round, and pressed down flat whilst the glue is drying, finishes with a close-fitting and neat edge all round: the natural surface of the sponge is left for the face. Directly an insect is caught in the box, a few drops of chloroform are put on the sponge through the hole in the cover, and a finger placed over to close the hole. The smaller insects are killed in two or three seconds in this way by three or four drops of chloroform, and the larger ones are so far stupefied that the box may be safely opened, and the insect killed by some chloroform dropped upon it, the state of the insect being readily observed through the transparent glass.

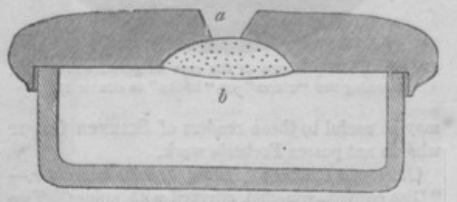

Fig. 201. Section of Collecting-Box.

The most convenient way of carrying the chloroform for the purpose is in one of the small bottles made with a pouring-lip at the edge of the neck, and fitted with a sound cork; this is carried conveniently ready for use in the waistcoat pocket, and lasts for a day's use. In catching insects, the transparent glass box gives the means of seeing at once whether the desired insect has been secured or missed; and, in the case of a winged insect settled upon a plant, the whole leaf or small shoot is enclosed at once in the box on catching the insect, and then by watching the movements of the insect the leaf or shoot can be readily and safely withdrawn by slackening the opposite side of the cover, when the insect is immediately chloroformed and removed to the store-box. By this means a succession of insects can be rapidly secured by the same catching-box, which is ready again each time for the same purpose very quickly, and with the smaller insects the chloroform vapour remaining in the box is then sufficient to stupefy them at once, or even to kill them. In catching insects with a net, the box is introduced into the net by the hand, confining the insect against the side of the net, and the cover of the box being slipped on outside the net, the insect is chloroformed at once through the cover, and then removed safely in the open box directly it is seen to be dead or sufficiently stupefied. A catching-box about two inches diameter and ¾ inch deep inside is found the most convenient for general purposes, as shown full size in the accompanying sketch, and a larger size three inches diameter is used for the larger insects, which is also useful for butterflies and moths bred from the pupa. This box is made with the sponge and hole in the centre of the glass bottom instead of being in the cover, and it has the advantage that the glass box can be dropped over an insect running upon the ground, and sufficient chloroform applied on the spot to stupefy the insect for safe removal, without the risk of soiling and injuring it that is incurred in picking the insect up in a box whilst running upon the ground. In this box the sponge could not be fixed by cement to the glass, on account of the dissolving action of the chloroform, and it is secured by six small holes being drilled through the glass round the centre hole (like the holes in the ends of lustre-drops), and fixing the sponge by a thread sewn all round its edge through the holes.

The smaller size of this box is readily made by cutting off the bottom of a glass bottle of the required size, grinding the edge smooth, and fitting on the cork-lined cover of a pomatum-jar; the bottom of the bottle being cut off by a thread dipped in spirits of wine being wrapped round the bottle and set on fire, and the bottle then dipped into cold water, taking care to keep the line of the thread level with the surface of the water.

W. P. MARSHALL.

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hardly ever alighting directly on a rock, but even after its longest flight splashing slap into the water, at the base of the stone selected as a resting-place, and then scrambling to the summit of this. In its motion in the water it more closely resembles the Jackass Penguin of Cape Horn (*Apt. chrysocoma*) than any other aquatic bird I have had an opportunity of studying. Like that bird (especially in the breeding season), the ouzels may be seen at times leaping right out of the water in their gambols.

"That the bird actually does possess the power of motion under water, the following notes on a wounded bird, made on the spot, abundantly prove:—

"'Nov. 29, 1850.—Bohernabreena. Wounded a water ouzel, which, as I observed them all to do, immediately made for shore. On my going to seize him, he darted into the water, running slap in; waded in after him; under water he looks quite glossy, but does not seem increased in bulk, the glossiness probably arising from the oiled state of the plumage, or else from its peculiar texture. When I first got up with the bird he was perfectly stationary at the bottom, not using any exertion to remain there (this remark applies to two other birds wounded later in the day, which also took to the water). The bird next got under a big stone, and when I poked him out on one side he ran to the other—after the lapse of a minute or so he put his head out of the water to breathe, always keeping the stone between him and me, and when I tried to catch him he would dodge under the water again, and come up on the other side.

"'Finding that I was still chasing him, he took to the stream, and went under water faster than I could follow him; he seemed to move now altogether by means of his feet, his wings hanging down behind his tail, though his motions were so quick it was difficult to be positive as to the latter part of this observation. At times he swam in mid-water, using his wings, crossing the current several times, and seeming but little incommoded by it.

form for the purpose is in one of the small bottles made with a pouring-lip at the edge of the neck, and fitted with a sound cork; this is carried conveniently ready for use in the waistcoat pocket, and lasts for a day's use. In catching insects, the transparent glass box gives the means of seeing at once whether the desired insect has been secured or missed; and, in the case of a winged insect settled upon a plant, the whole leaf or small shoot is enclosed at once in the box on catching the insect, and then by watching the movements of the insect the leaf or shoot can be readily and safely withdrawn by slackening the opposite side of the cover, when the insect is immediately chloroformed and removed to the store-box. By this means a succession of insects can be rapidly secured by the

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ON COLLECTING AND MOUNTING COLEOPTERA.

By E. C. RYE.

THE present space at my disposal being necessarily limited, I can only indicate the habits and haunts of our Coleopterous Fauna in a very superficial way; and, unfortunately, it is precisely in the case of this order of insects, both on account of its numerical extent (containing as it does upwards of 3,000 recorded species in the British Isles), and the very varied and mostly light-shunning proclivities of its members, that a considerable amount of specific knowledge on those points is required before the collector can expect to be at all successful. Moreover, it is of the greatest importance that the student should be enabled to detect his captures specifically at the time; which to do requires acute vision and a good memory—a combination not developed in all men. It is to these considerations that I attribute the paucity of rare or new species among the beetles that occur to beginners. Luckily, however, the field of observation is so large, the structural details of the species so varied, and (as yet) their preliminary stages so little known, that there is more than room for all.

Looking at the British Isles in a Coleopterous point of view, it may be remarked that Ireland is the least worked, and should, for various reasons (especially the set of the Gulf stream on its southern coasts), be most likely to produce novelties. The boundary counties of Wales are also promising and comparatively virgin hunting-grounds. In certain parts of Scotland (especially towards the west) an unexpected development of Alpine and Swedish forms occurs; and Scotland itself, as a whole, is much more productive, both of species (whether recorded or new) and individuals, than the dweller in the Midland Counties would expect. The neighbourhood of London, both on account of its geographical position and its command of varied soils, through the numerous railroads of which it is the centre, is perhaps the best of any district, judging from results, which, however, may be fallacious, the numerous captures of good things in its vicinity being possibly due to the number of resident entomologists. Anyhow, it is beyond doubt that beetles are to be found nearly everywhere; though it is also still more so that a chalky or sandy soil (or, still better, the point of junction of chalk and sand) is the most, and a clayey soil the least, productive. Nevertheless, fenny districts (wherever such now remain undrained) are exceedingly prolific in beetle life, the *Hydradephaga* being of course proportionately predominant.

As instructions for collecting, the method at once most exhaustive and most likely to be efficacious would be to go through our list of *Coleoptera*, pointing out localities for the different families or minor subdivisions of them; but want of space prevents me from adopting such a course, and I can only throw out general hints for the use of the beginner.

First, then, it may be remarked that the prevailing notion as to the abundance of insects, and therefore of beetles, in the hot summer months is scarcely a correct one. For the most part, beetles attain the last stage of their metamorphosis at the latter end of the autumn, passing the winter without leaving their hiding-places, and coming into outer light with the first warmth of spring. Many, also, which come to maturity during the earlier autumn hybernate in all kinds of nooks and corners, appearing also again in the ensuing spring. The

spring, early summer, and autumnal months are therefore the best for collecting; and the height of summer is not found productive, on account of the survivors of the preceding year having died off, and the prospective generation being either in the larval or pupal condition. Winter, however, will prove a good season for the energetic collector, who then will find in moss, at roots of tufts of grass, under bark, in cracks of trees or the soil, or even deep under the surface, abundance of torpid beetles, if he search in likely places. For this winter work all the implements required are a stout knife and a sheet of brown paper, on which latter moss, grass, or other insect-harbours are to be shaken. Moss is often so productive (whether from tree-trunks or growing on the ground) that it is worth while to take it home in a linen bag, the contents being examined at leisure; in this case it saves time and space if the moss be pulled to pieces at once over a coarse wire sieve (which, with canvas sides, and either simple or folding for the pocket, can be obtained at Mr. Brewer's, 55, Great Russell Street, opposite the British Museum, and is almost indispensable for small insects), the insect contents and small fragments only being then taken home. It stands to reason that isolated tufts of grass, and places where moss is not very abundant, will be found most productive; for, where there is an abundance of cover, insects are widely spread, and where there is but little, they congregate in numbers. Tufts should be cut just below the soil, and pulled to pieces over the paper. A common garden pruning or clasp knife is good, but an old sharp dinner knife (to be carried in a sheath) is still better. A yard or so of double india-rubber cloth makes an excellent kneeling pad for use in marshy places; and, if faced with white or grey, is good for shaking tufts on also.

For general purposes the spring and early summer will be found the best times in which to collect. The most careless observer can scarcely have failed to notice the myriads of beetles, of all kinds and sizes, that, waking from their long rest, gambol about in the air, and settle or run on the paths, even in our cities, when the first hot rays of the sun in April or May seem to arouse all nature to enjoyment of life. Then is the time for the novice to lay in his first stock of material; whether he travel to the coast, where the sand-hills teem with beetle life (those at Deal are the best, and easily and cheaply accessible), or seek the nearest wood, plantation, fields, or common. Scarcely any implements are required, the hand alone being almost sufficient; but a small and light gauze bag-net, such as is employed by butterfly hunters, will at this time be found very useful in entrapping the numerous winged Coleopterous atoms that cross and recross the path of the collector in rapid flight. Such a net, however, will be of little avail at other times, as there are none of our beetles sufficiently active on the wing to require its aid, save the *Cicindelidæ*, or Tiger-beetles, which run and fly alternately (like partridges) in the hot sunshine about sandy places; and none of these but *C. campestris*, abundant in most parts of the kingdom, are likely to be met with often. This light net can, perhaps, also be used with advantage by waving it about at sunset in the summer over heaps of cut grass, dead sticks, or manure, to which many small and rare species fly just before dusk. These despised heaps of garden and other refuse act as first-rate traps for beetles; and any collector living at the shortest distance from the metropolis (or even in it) will do well to keep a little heap of leaves, twigs, rotten wood, grass, and such odds and ends, in which he will constantly find many beetles. Wide-mouthed bottles sunk in the ground, and baited with a piece of dry meat or small bone, are often attractive; but the dry carcase of any small animal, whether nailed up or left on the ground, will be better still. Of course, if the collecter can in his rambles find a barn-door covered with feathered robbers, or a keeper's tree, its boughs laden with cats, weasels, &c., great will be his reward in *Necrophaga*, *Nitidulidæ*, *Necrobiæ*, *Brachelytra*, &c. These he will obtain by holding an umbrella or beating-net beneath, and administering the bastinado to them with a stick. This beating-net (which may also be used for sweeping) is absolutely necessary to the Coleopterist, and may therefore be described at once. It consists of a stout stick, to the ferule of which is attached on each side, by a strong hinge, a strip of flat steel or whalebone; these strips are united at their extremity near the handle of the stick, and fixed into a brass ring that plays up and down, and when pushed forward and caught by an umbrella spring half way down the stick, forms a stout circular frame. To this is appended a net of strong but fine canvas or coarse linen, the rim being well bound with leather cloth, to lessen the effect of friction. The whole, when folded up, resembles a large umbrella, being thrust into the usual glazed cover, and is very portable. Such a net is to be obtained at Cooke's, New Oxford Street, near Mudie's Library, and can be used for sweeping herbage, beating into, or any other operation of collecting. A smaller net, for sweeping only, will be found of great assistance: this can be made of stout iron wire, circular in shape, and either stiff or folding (and if so, in one or three places), to go into the pocket; and one end of it should be forged flat, with a hole drilled through it to admit the other end, which must be wormed, and screw into a long ferule fastened on a stick. In a short time, however, the screw will cease to bite firmly; so I find it best to drill a hole at once through the ferule and screw, inserting a moveable metal pin transversely, which prevents the net turning round, and probably all

the contents being lost. To this wire a net of similar stuff and binding to the sweeping net must be fitted, and can easily be made so as to slip on and off. A similar net, of stouter wire, larger dimensions, and wider-meshed canvas, and fastened to a much longer and stronger stick, can be made for water-beetles; and it will be found efficacious then to fasten the canvas to the frame with small wire rings.

The insects, when caught, must be conveyed home in a collecting bottle, of which it is best to be always provided with two; it is usual also to provide one's self with divers small strong glass test-tubes, fitted with corks, for special captures. The ordinary collecting bottle should be of strong clear glass, with a wide mouth, lipped (so that it can be attached by string to the coat), and flat-bottomed; it need not exceed three inches in length, and if covered with white paper on one side will be less likely to get broken,—the paper, moreover, affording a background for the easier examination of its contents when collecting. It must be provided with a stout cork, perforated by a wide quill, which should be level with the cork at its bottom, but must project about an inch and a half at the top, where it may advantageously be cut across diagonally, instead of straight. This quill can be fastened in with sealing-wax at its points of junction with the cork, leaving of course a free passage for the beetles captured. It is stopped up with a long wooden plug, fitting accurately, but easily, and with a knob at the top to allow of its being taken out with the teeth—the hands being often both occupied. The object of the quill is to avoid handling the beetles when captured, as they can be easily bottled through it; if, however, a specimen must be taken by hand, the best way is to touch it with a damp finger and put it on the back of the hand, then bottling it through the quill. A piece of fine muslin or crumpled blotting-paper should be kept in the bottle and tubes, to afford foot-hold, and prevent the contents rattling about. The other bottle above mentioned should be larger, and need have no quill through its cork; indeed, I find the common wooden screw top, fitting outside, is more secure than a cork. It must be about one-third full of young shoots of laurel, bruised and chopped up, which effectually quiet (and, if fresh, kill) almost any beetle. Into it all voracious insects must be put—*e.g.*, all the larger *Geodephaga*, *Hydradephaga*, and *Brachelytra*, the *Telephoridæ*, and many others, whom a sad experience of misplaced confidence, testified by the broken limbs or utter absence of smaller and more precious captures, will soon impress on the young collector's memory.

Having now mentioned the principal instruments required, I can continue my hints as to the haunts of *Coleoptera*; and I may here observe that at the time when insects fly much, in the spring and early summer, as above mentioned, sand-pits, especially if their sides be straightly cut, will be found most excellent traps for very many species, which, when dashing wildly about on the wing, knock against them and fall, stunned, but uninjured, to the bottom. Many species live constantly also in such places such as *Gronops*, some *Bledii*, *Dyschirii*, *Sibynes*, &c. Charlton, Shirley, Weybridge, Hampstead, and Reigate are all good sandy localities near London. At this time, also, beetles may often be seen crawling on wooden palings, especially if they are unpainted, and freshly put up. Sandy places formed by diversions of the currents of rivers, or on the sea-shore, harbour very many beetles, which even occur in places that for a portion of the day are covered by the tide. Some of these come to the surface at sunset, others during the blaze of mid-day, and very many will be found by shaking heaps of seaweed and other tidal refuse on paper, pulling up and shaking plants (especially disturbing the ground at their roots), and examining dead birds, fishes, &c. On chalky parts of the coast, stones should be carefully turned over (this applies also to inland chalky districts, such as Box Hill), as many good *Geodephaga*, *Brachelytra*, *Rhyncophora*, &c., are found in such places. Chalk pits also harbour some few good things, readily to be detected crawling at the bottoms of the sides, and under stones. Stones and logs of wood may always be turned over with possible advantage; and every pebble or boulder on high hills or mountain-tops should be rolled out of position, and the cavity beneath it, and moss (if any) round it, carefully examined.

Assemblages of beetles, of many species and in great numbers, will be often found in refuse at the edges of rivers after floods or unusually high tides, and also on bushes or palings after the prevalence of winds in particular quarters. These, however, are lucky accidents for the collector, and cannot be reckoned on or explained. By shaking and sifting (with the sieve) the damp stuff at the bottoms of haystacks, beetles of numerous species and genera (*Cryptophagus*, *Monotoma*, *Atomaria*, *Latridius*, *Heterothops*, *Haploglossa*, *Stilicus*, *Quedius*, &c.) will be found in abundance, and at all times of the year. Dead leaves, especially of the beech, that have dropped in hollows and remain undisturbed until the bottom layers are black and damp, must never be neglected; here the sieve is a *sine quâ non*. Very many good species haunt the sappy exudations of trees (those from oak, elm, and pine being very attractive), and most especially when these are caused or increased by the ravages of the caterpillar of the Goat-moth, the damp frass of which full-flavoured beast appears exceedingly to the taste of certain Coleopterous aristocrats, many of the best *Brachelytra* and *Nitidulidæ* being only obtainable in this way. It may, indeed, be shortly remarked that any diseased part of a tree or plant is almost

sure to be visited by beetles (which in many cases doubtless cause the complaint).

The dwellings of our social *Hymenoptera*—ants, bees, wasps, and hornets—are all especially inhabited by Coleopterous lodgers; indeed, collecting ants'-nest beetles is quite a study of itself. I may remark briefly that where a nest is in a tree, the bark, &c., should be carefully examined, and stones and pieces of wood laid as traps; in other situations the nests can be sifted, stones turned over, and the "runs" of the ants examined. Any attack upon the nests of the other and more warlike insects must be left to the collector's discretion (or valour); in the hornet's nest he may find the giant "Devil's-coach-horse" (*Quedius dilatatus*), which also occurs about *Cossus*-burrows, and should in the latter case be searched for by night, with a lantern.

Trees, standing or felled, and whether in a sound or rotten state, harbour a great many species. To extract beetles from solid wood is no easy task, and requires the most potent tools that can be obtained; a long and strong chisel, however, is handy in many cases. Perhaps the majority of the wood-infesting *Coleoptera* are found in the bark, which should therefore be always very carefully examined, and even broken into fragments where there is reason to suspect a beetle-tenant. *Under* dry or loose bark, also, very many species constantly occur, of flattened habit of body, and usually predaceous; but a considerable number live either on the surface of the solid wood, mining galleries beneath the bark, or drilling their circular holes deep into the trunk. Some also dwell in the topmost twigs, and in the dry stumps whence boughs have been cut or fallen. The best trees for wood-feeders and their parasites are oak, beech, and pine, ash and willow also sometimes being good. The collector must in no case despise old heaps of dead sticks or twigs, whether on the ground or remaining on trees, or thrust into gaps of hedges, since out of them many good things may be beaten; and he must especially look out for fungoid growths on trees, which often harbour a profusion of insects.

In spring and early summer, woods must be visited for beating purposes, the best trees being oak, hazel, and dwarf poplar, and young growth of the second year the most productive—large trees being seldom of much use. "Beating about the bush" is here the most direct way to success, and an umbrella held open beneath the young trees, which must be tapped with a stick, is a most efficient receptacle for the results, being preferred by many to the orthodox net above described. *Longicornes*, *Curculionidæ*, and *Eupoda* of varied forms will repay the collector's toil. I have observed that the best time for beating is just before a storm. Darenth Wood, near Dartford, is one of the best places for the metropolitan Coleopterist for this work. It is of course needless to say that such conspicuous species as frequent wild flowers must be looked after sharply at all times; many of them, however, must be "stalked" with care, as they are often wary in the extreme.

When the time for beating is over, sweeping (always good) may be said to commence; and I can give no better advice than to try all plants and places. Experience alone can here suggest a likely spot for work, and a knowledge of the habits of one species in a genus will often afford a clue whereby its congeners may be found. Grassy banks in sheltered places, water plants, wild plants in hedges, ragged and straggling roadside weeds,—all must be tried. Sweeping beneath trees and in damp meadows towards evening will be often found very remunerative.

"Book" knowledge is also here of great help, in order to search for particular plants, &c., which are known to be frequented by particular species; and many beetles not yet found with us may be discovered by a reference to continental works mentioning their haunts and seasons.

The edges of the banks of ponds and rivers will always be good hunting-grounds; they should be stamped upon or broken away, and any plants pulled up, so as to loosen the soil. Water dashed into the cracks will often bring to light numerous lurkers. The droppings of herbivorous animals must be carefully examined, especially in sandy places, and in the spring and autumn. If near water, they can be broken up and thrown in, when the beetles will appear on the surface. Marshes, heaps of old reeds, water-plants, &c., harbour myriads of beetles which also will be found by grubbing up roots and breaking away the edges of the ground near the water. Sugaring by night, as done by Lepidopterists will produce some nocturnal species, many of which also come to light, like moths.

In the autumn, the various species of fungus that so abundant must be carefully examined, and will be found to contain an enormous number of inhabitants, even the puff-ball having its peculiar denizens.

I have no space to do more than refer to the numerous water-beetles; these occur in running streams and rivers (usually at eddies, or near plants where the current is violent), in stagnant ponds and brackish streams, the banks and shores of all of which must be carefully examined for such as are of sub-aquatic habits. Stones in running streams beneath the water often harbour many species, and the net should be carefully drawn round the banks and bottom, and especially among and round water-plants.

Finally, I would recommend all who have the opportunity to endeavour to breed from the early stages: to do this they must keep the larvæ and pupæ as nearly as possible in their natural state. A piece of Wood with larvæ in it may be brought home easily

and plants containing larvæ or pupæ in the stems are not difficult to carry away.

To kill the captured insects it is only necessary to immerse them in boiling water for a very short time. They should not be left in it after their death-struggle, but taken out with a camels'-hair brush and placed on blotting-paper to dry. This does not destroy or damage their colour or markings in any way. A good way to get them out of the water rapidly, and without handling them too much, is to make a sort of strainer with a piece of muslin, which is put into the hot water, and into which the captives are then immersed. In this way all can be lifted out at once and placed on the blotting-paper. It is always as well to put the beetles out of the laurel bottle also into the hot water, lest any spark of life should remain. Those that are *killed* with laurel are so stiff that it will be found impossible to set them at once. They should be dried on blotting-paper (merely to drain off the water), and put, with all others which it is not convenient to mount at once, into a muslin bag, which is to go into another tightly corked laurel bottle, retained for relaxing purposes—the effect of a stay in the latter for a few days being that the insects can be most easily manipulated. They may, indeed, remain in it for months, or even over a year, but are in that case liable to go rotten and greasy.

The young and tender topmost shoots of the laurel are best: they should be bruised, stems and all, and cut up into little pieces. If damp when gathered, laurel and beetles will go mouldy.

To mount the specimens, all that is required is good cardboard of fine surface and moderate stoutness, some pins, a setting-needle (made by inserting the point half of a fine needle into a thin paint-brush stick), a fine brush for setting, a larger one (flat red sable is the best) for brushing out the legs, a piece of flat cork to pin the card on, and a bottle of gum-tragacanth. The latter can be obtained at any chemist's, and should be selected of as transparent a nature as possible. A few flakes of the size of the finger nail, with one or two nodules of clear gum-arabic, will make a good-sized bottle full, —the gum not melting, but absorbing water, and swelling into a milky mucilage, which should be of even quality, and so thick as not to flow readily. Only a little need be made at a time, and a drop or two of carbolic acid will prevent it from turning mouldy. Another brush should be specially retained for the gum-bottle, and a little clean water always at hand when specimens are to be mounted. The readiest way is to take a strip of card rather deeper than the insect to be set, pin it on the cork, and put some of the gum on the space the insect is to occupy: the specimen (which has been turned on its back in order that its legs and antennæ might be brushed out) is then put on the gum, and arranged with the setting-needle and fine brush, care being taken not to gum the upper surface. A pocket glass of moderately low power will usually be needed for the more exact performance of this operation. Perhaps the best direction for the limbs is as follows: the palpi straight forward; the antennæ sloped on each side straight, at an angle of about 45 degrees; the front legs forward, parallel with the antennæ, and the middle and hinder legs parallel to each other, and rather directed backwards; but the limbs should not be straggled out unnaturally, nor the different segments of the body unduly separated or distorted, the main object being to get the body strictly level and straight, and to display the limbs (and where practicable the mouth-organs), so that they can be readily examined with a higher power when necessary. Many specimens can be mounted side by side on the same strip of card, leaving a gap between each; or, if preferred, each specimen can be mounted on its separate card. All superfluous gum must be washed off the card (which it is sometimes desirable to damp on the lower side, to prevent curling), and when dry, which will be in a week or fortnight, according to the weather, the specimens can, if set in a row, be cut up separately and evenly the card being trimmed away close, and straight in front and at the sides, but leaving a moderate space behind, through which the pin is to be pierced. Insects of the same species will, of course, have their cards afterwards cut to exactly the same length. When a specimen is refractory, it should be left to dry on the gum, and in a quarter of an hour or so it can be easily treated by damping and pulling into position one leg, or all the limbs on one side, at a time. A small pair of forceps, such as are used with the microscope, is very useful for this purpose. Stubborn limbs can also be held down with small card braces on pins until the gum has dried. The *Brachelytra* require very careful setting, as their long, flexible, and uncovered abdomens run up in drying. To avoid this, it is best to insert the point of a fine needle into the extremity of the abdomen, and pull out all the segments to their utmost; this breaks away the "intercostal" muscles, if I may so pervert that adjective, and the abdomen can then be put back to its proper length without much fear of shortening. A very fine setting-needle for this purpose is obtained by putting a sealingwax handle to a "bead-needle." An extra application of gum to the tail is also useful here. Specimens of both sexes of each species will be, of course, mounted on their backs, to show the under side. Large beetles (the word *large* being construed according to individual fancy) must be pinned straightly through the right wing-case, near the shoulder, avoiding the articulation of the middle legs. Their limbs can be displayed with pins or card-braces on a cork setting-board. If beetles of large size be mounted on card, their bodies should be fastened to it with white liquid glue, obtainable at any oil-shop; their limbs

can be set out with the usual gum. All specimens should be put into a setting-frame, or pinned in an open box, and exposed to fresh air for a week or fortnight, though *Brachelytra* best avoid running up by being first left for a day or so in a closed box. Finally, benzine must be kept to clean specimens from grease, and carbolic acid to destroy mould.

PHANTOM LARVÆ.*

By Dr. Carrington.

EARLY in September, 1867, while netting for microscopic objects in a favourite pond of mine on the Ellesmere estate, near Eccles, I met with a number of larvæ which were new to me. At first I thought I had captured the rare *Cheirocephalus diaphanus*, but on closer inspection it was evident they were the larvæ of some dipterous insect (*Corethra plumicornis*), and until their true name was obtained, they were generally spoken of by us as the Phantom Larvæ.

My acquaintance with entomology is scant[y] tending only to dissections of some few gen[a]; it was impossible to watch these larvæ day[s] day, and gradually become acquainted with anomalous structure and strange habits, and wish others should share the pleasure. I accordingly made some drawings which at may claim the merit of accuracy, and shall endea[vour] as briefly as possible, to describe those anato[mical] details which appear to me of most interest.

The characteristics that would strike an obs[erver] viewing them for the first time with an ord[inary] lens are, first, their remarkable transparen[cy]. deed, they are so translucent, that unless you what to look for, it is difficult to make them o[ut] the water. Their specific gravity also coin[cides] with that of water, so that they are enabled to near the surface, or bottom of the vessel, out apparent effort. They differ from all with which I am acquainted by this habit maining suspended in mid-water; seldom se[ek] the surface for purposes of respiration, as i[n] case of other Diptera. I must not, however, you to form the impression that their habit[s] sluggish and inert. Far from this, their quiet[ness] that of the eagle, for, like that bird, they are w[atch]ful, and ready to pounce in a moment on any moving beneath them. Their spectral appea[rance] and the mysterious manner in which they vanis[h] reappear in unexpected places, will explain name we ventured to apply to them. One seemed at first especially "uncanny," the s[ide]way in which they make a half-turn, like the n[eedle] of a magnet; so that if we are examining head, we find the tail substituted in its place before we have time to make out the details—p[resto] the head as suddenly reappears! Our phantom I fear, not as innocent as phantoms should be. may rather compare them with vampires which the life-blood of unwary victims;—a glance a[t] cruel armature of the mouth will satisfy you o[f] fact. I do not allude to the formidable-looking [jaws] which articulate with the snout, and look like fangs of a viper; these are modified antennæ serve the animal to rake up the surface m[ud] search of prey. Foot-like antennæ are also fou[nd] some Entomostraca (*Candonia*), and in *Corey*

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* I was ignorant until after the completion of my paper that the subject had been preoccupied by such competent observers as Mr. E. Ray Lankester (*Popular Science Review*, 1868), and Prof. Rymer Jones (*Microscopical Journal*, Oct., 1867).

Prof. Jones contents himself with a brief but lucid summary of the chief points of interest in the development of the "glass" larva. More fortunate than myself, he has been enabled to describe the wonderful growth of the respiratory system which takes place during the transition to the pupa state. Some of my larvæ are still living after three months' confinement (Feb. 10, 1868), but I have watched in vain for their metamorphosis.

From some points of the professor's description I must dissent. Thus, referring to what I have called the antennæ (fig. 5, *a*), he writes: "In their disposition they remind us of the foot-jaws of the Branchiopod Crustaceans (such as *Cheirocephalus*), and in like manner are equally instruments of progression and weapons for the capture of prey. The anterior pair, articulated to the apex of the snout, are of great strength, and are moved by powerful muscles, distinctly seen through the transparent covering of the head. At their extremities they bear fan-like tufts of stiff setæ, that, when expanded, form powerful oars, the downward strokes of which, when energetically made, have a *marked effect in aiding the progress* of the animal through the water. More frequently, however, their movements are of a gentler character, and only serve to cause the influx of a *constant stream towards the mouth*."

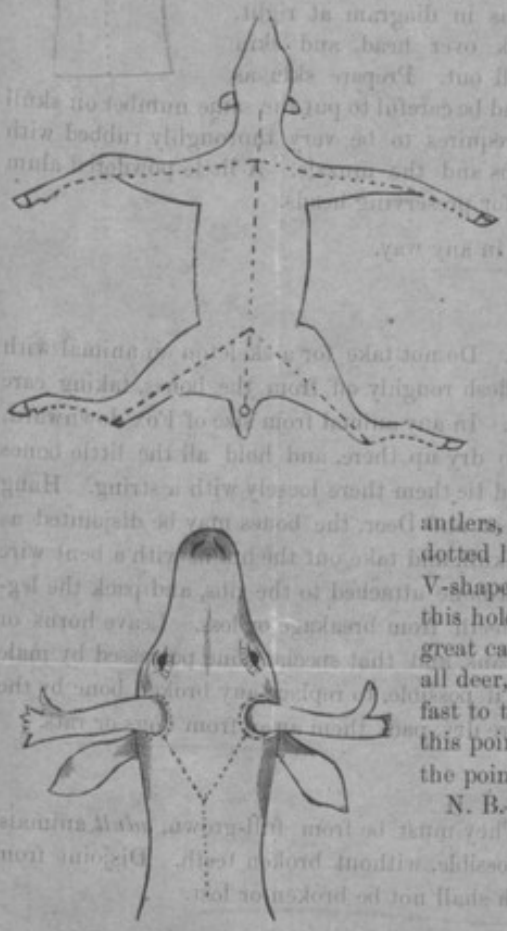
Again, he writes: "The second pair of appendages are composed of numerous narrow laminæ, much resembling in their arrangement the plates of whalebone in a whale's mouth; *and, indeed, they perform a very similar office*," for they "can be spread out like the walls of a tent, so as to enclose as in a net whatever small animals may be brought within their expanse by the intrait current above alluded to." Now it must be admitted the uses and homologies of the oral appendages are most puzzling, but I cannot but suppose, when the above words were written, the professor was trying to reason out the problem on the dead animal rather than the living one, or has mistaken the convulsed motions preceding death for normal acts. How can naturalists expect other than lying responses from creatures undergoing the torture of the compressorium, or sealed up alive in a glass cell? After repeated examinations, I have failed to trace any current, *constant or otherwise*, towards the mouth referrible to the antennæ; nor have I seen them used as oars [for] progression. The ordinary movements of the larva [appear] be due entirely to the anal fan. Each antenna bear[s] (not six, as in the drawing, *Mic. Journ.*, Vol. xv., Pl. [1]) slender setæ (not plumed, as in true swimming feet) [which] are used only in retaining the prey, or forcing it up [to the] lancets, or in raking up the surface mud. The second appendages, again (fig. 5, *b*), seem to me to be true [jaws], and I feel certain I have seen them so applied in pierc[ing] larger Entomostraca, which are then passed on [to the] powerful jaws.

In the same plate, the fourth appendage (*l. c.*, fig. [5]) which seems to me to be single and trowel-shaped, form[ing] upper lip, is figured with two blades.

f. 359r

Directions for Skinning Mammals [Beasts of all kinds,] and preparing their Skins for Stuffing for Museums:

A.—For Skinning a Deer or Antelope, or any animal with antlers or horns, so that skins may be stuffed:



Lay animal on its back, and make a cut along the belly and lower side of neck from the tail to the root of his tongue. Then make a cut at right angles to this, down each leg to the back of each knee. (The dotted lines in the diagram show the cuts which are to be made.) Continue the cut from the knee down the back of the leg to between the hoofs. Cut off the leg, leaving the two lower leg-bones attached to the hoofs, clean the flesh from these bones, after skinning the legs to the hoofs. Skin the tail, taking out the bone. Then skin the whole body, taking care not to cut holes in the skin, nor to leave tags and patches of meat attached to it. Skin up on neck to back of head, and disjoint head from neck. Place head flat on jaws with the antlers up, as in diagram. With a sharp-pointed knife cut skin free around the base of each antler. Then from back of each antler make a cut, bringing them both together in one about 8 inches back of antlers, and continue that one back about eight inches further. (The dotted lines in the diagram show these cuts.) By turning back this V-shaped flap to the antlers, the head may now be skinned out through this hole, separating the base of the ear close to the skull, and taking great care not to enlarge the eyes by cutting or stretching them. (In all deer, too, there is a place just in front of the eye where the skin is fast to the skull, care should be taken not to cut through the skin at this point.) Cut through the gristle of the nose a short distance from the point.

N. B.—Do not get blood on hair side of skin.

B.—For Skinning a Bear, Wolf, Lion, Wild-Cat, Seal, Female Deer, or any animal without horns or antlers:

Follow the same directions as before for cutting the skin. Carry the cut on legs to tip of paws, and cut the meat well out of paw. Skin the tail clear to its tip. Make no cut on top of neck. There being no bones to interfere, you can draw the skull out from below. Be very careful not to stretch the skins of small animals. Preserve the skulls of all animals. Do not break them or chop into them. Cut the flesh off pretty clean, and tie the skull loosely to the skin, or tie a number (on a bit of card board) to it and *the same* number on the skin.

C.—To prepare Skins after they are taken off from the animal.

First, cut off all the tags of flesh from the flesh side. Then wash off all blood or dirt from the hair. Spread the skin widely out on a floor or on clean grass, with the flesh side up. Cover this flesh side with Salt in abundance. (Three pints will do for a full-grown Deer or Bear; three quarts for an Elk or Moose.) Rub this salt very thoroughly into the skin in every part: do not let a single part escape the rubbing. The Head, Legs and Tail require especial care that there shall no folds of the skin escape the rubbing. Hang the skin to dry, over a stick or a line, with the skin side up. Before it gets quite stiff, sprinkle a little dry grass over the skin surface, fold inwards the head and legs, and roll up in a loose package. Keep in a dry place, and away from rats and mice. For all small skins, from size of a Beaver or Rabbit down to a Prairie Dog or a Rat, you must have a mixture of finely powdered Alum and Salt, about one-third alum and two-thirds salt. N. B.—Do not spread skins to dry in a hot sun, and do not hang skins up by the nose, nor stretch them in any way.

D.—For Preparing HEADS of Deer, Elk and other Animals to Mount on Shields.

Cut the skins about 10 inches long on the back of neck (10 inches back of the ears), and much longer on the throat side, as shown in diagram at left.

If the animal has horns or antlers, open skin along line of back of neck with V-shaped cut, as described in "A." If without horns (as a Bear, Wolf or female Deer), then open skin with a straight cut along top line of neck to back of skull, as in diagram at right. Then turn skin of neck back over head, and skin down to nose, taking the skull out. Prepare skin as directed in "C." Clean skull and be careful to put the same number on skull and skin. The skin of head requires to be very thoroughly rubbed with salt, particularly around the lips and the muzzle. A little powdered alum with the salt is very desirable for preserving heads.

N. B.—Do not chop the back of the skull or damage it in any way.

E.—For Preparing Rough Skeletons:

Only a full-grown, adult animal will do for its skeleton. Do not take for a skeleton an animal with a broken skull, or with many other bones broken. Cut the flesh roughly off from the bones, taking care not to hack the bones or to cut the cartilage of the breast-bone. In any animal from size of Fox downward, the bones should not be separated. Leave skin on paws to dry up there, and hold all the little bones together. Fold the legs, when cleaned, up against the body and tie them there loosely with a string. Hang skeleton in wind to dry. For larger skeletons, as of Wolf, Bear and Deer, the bones may be disjointed as much as is needful for convenience in packing. Disjoint the skull, and take out the brains with a bent wire or a stick, through the hole in its back end. Leave the breast-bone attached to the ribs, and pack the leg-bones in the chest cavity. Wrap cloth about jaws, to keep teeth from breakage or loss. Leave horns or antlers on skull, and claws or hoofs on feet. Save the knee-pans, and that special bone possessed by male of many animals. Be very careful not to lose any bone, and, if possible, to replace any broken bone by the same bone from another animal of *same size*. When bones are dry, pack them away from dogs or rats.

F.—Skulls.

Skulls of all animals are interesting and valuable. They must be from full-grown, *adult* animals, and be *entire*, without broken jaws or bullet holes and, if possible, without broken teeth. Disjoint from neck without cutting back of skull. Wrap jaws so that teeth shall not be broken or lost.

G.—Preserve Odd Bones.

The skull and the lower leg-bones are to be preseved with the skin to be used in stuffing it. Therefore, the *same* animal will not furnish *both* skin and skeleton. But after obtaining skin as directed in "A" and "B," you may still obtain from the carcass some valuable bones. These are, the last two Vertebræ of Neck (next to skull), Collar-bones, Shoulder-blades, Hip-bone, entire Tail, Thigh-bones, and Arms. Finally, when the skin of an animal (Bear, Beaver, Fisher, Otter, &c.), is taken off for commerce, the entire Legs may be saved without disjointing, cutting off only the flesh and leaving all ligaments.

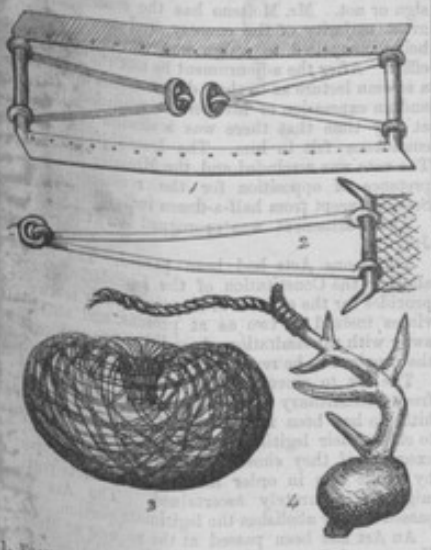
H.—Packing.

Keep all objects mentioned above *dry*, and away from rats and other vermin, in a *tight* box, with enough packing to prevent their rattling about.

For further particulars, or for the purchase or sale of Natural History specimens, address

HENRY A. WARD,
ROCHESTER, N. Y.
United States of America

ON COLLECTING LAND AND MARINE SHELLS IN FOREIGN COUNTRIES.



1. Framework of a Two-foot Wrought Iron Dredge; 2. Side View of Same; 3. Nautilus Trap; and 4. Grapnel, as used in Fiji.

Of all the various objects of natural history that present themselves to the traveller abroad, especially in warm climates, shells are the easiest to collect, and when collected are preserved with very little trouble. It is simply from a want of the knowledge *how* and *where* to look for them in a living and perfect condition that most persons neglect to collect them when travelling through, or residing in, distant countries. Every region and almost every island, however small, has its peculiar land shells; and the variety and exquisite beauty of many of the marine species that inhabit tropical and sub-tropical seas cannot fail to impress even the most casual observer. Good and rare shells will at all times command a considerable money value from collectors in this country, as well as in Europe and America; and persons visiting little-known portions of the globe, more particularly islands, might, if they knew how to collect shells in the right way, not only provide themselves with an interesting amusement for their leisure time, but find it also a lucrative pastime; to say nothing of the advantages science might reap from their researches. The late Mr. Hugh Cuming realized some thousands of pounds by collecting land shells in the Philippines; and there are still rich harvests awaiting the industrious collector in such prolific regions as Madagascar and New Guinea. It is now our purpose to furnish our readers abroad with such simple and practical hints as cannot fail to be of service to them if they desire to collect shells, either for their own amusement and instruction, or as a commercial speculation. With such an object in view, a walk through the forest, or a ramble along the sea-shore, becomes doubly interesting in countries where new species, and even new forms, are pretty certain to reward the search of the diligent collector.

Land shells may be looked for in a vast variety of places, such as under stones; in the clefts of rocks; on the sides of hills and mountains; underneath dead logs and decayed timber; on the trunks and leaves of trees; on wooden pailings; at the roots of plants and bushes; nestling in decayed vegetable matter, or amongst damp leaves and moss; on small shrubs; in fact, almost everywhere except in very open, and cultivated places, and in pastures fed off by sheep and cattle. The best time to find them moving about is in the early dewy morning, or late in the evening; and more particularly after a shower of rain. Look for them diligently in all the localities above-mentioned; when you find dead specimens, you will by searching, soon discover living ones. A wide-mouthed pickle bottle, with a cork or bung, is a good thing to put the specimens in, and can be carried in the pocket. The smaller and very fragile ones may be put into pillboxes. When brought home, the shells should be all carefully emptied into an earthern vessel, or bucket, and a quantity of cold water poured upon them, which will cause the animals to come out a little from their shells. They should be covered over to prevent their crawling away; and in two or three hours time the cold water should be poured off gently, and the vessel filled up with boiling water, so as to cover them entirely. This will kill the animals, which, after remaining a short time to cool, may then be removed with a large pin, just as you would extract a periwinkle. When all the animals are taken out, remove all the dirt from the shells with a soft brush, in clean tepid water, and then, after rinsing them well in cold water, lay them out to dry on a piece of board with their mouths downwards, but not in the sun. When dry, they may at once be packed, the smaller ones in pillboxes, or cigar boxes; and the larger and stronger ones, each wrapped separately in a piece of soft paper, taking care to write on a slip of paper, or on the boxes, the locality of each species. Should any of the boxes not be quite full, care must be taken to fill them up completely with cotton wool, moss, or soft dry grass, to prevent them from being shaken during transit.

Freshwater shells are to be found in rivers, lakes, ponds, and small streams, and should be treated with boiling water in the same way as land shells. They occur mostly on the mud in shallow water, and may be captured with a small landing net attached to a long handle. Other kinds are met with adhering to stones, or beneath them, in running streams.

It is of importance to preserve the *operculum* or "mouth-piece," with which many kinds of land and freshwater, as well as univalve marine shells are furnished. These should, after the animal is detached from them, be placed inside the mouths of the shells to which they belong, and secured with a plug of soft paper or cotton wool.

In many countries the natives will prove of great use in collecting shells. Show them a specimen, if only a dead one, of any desirable species, and on promise of payment for their services they will bring you living examples in quantity. In this way, by enlisting the services of the children in the Philippines, Mr. Cuming obtained large numbers of his finest land shells for a mere trifling consideration.

Marine shells are to be procured either upon sandy beaches at high water mark after a storm or strong breeze; at low water, on reefs, amongst rocks and under stones, or buried in, or creeping upon, the sand and mud; on sand-banks, in sheltered bays, that are only left bare for a short time at the lowest spring tides; or by dredging. The first thing to do on visiting a new locality is to go along the sands at high water mark, along the line of which many good shells, particularly light bivalves, will be found thrown up by the sea. Never miss searching in this way after a gale of wind, as then rare and valuable deep-water shells may be often secured.

The best period for collecting on the reefs at low water is at the new and full moon, for then the tides make the greatest ebb; therefore it is advisable to be on the spot about two hours before low water, taking a native or other assistant furnished with a crowbar to help in turning over all large stones, pieces of rock, and loose fragments of coral, beneath which many of the finest shells find shelter in a living state—such as cowries, mitres, cones, &c. Almost all the under surfaces of these rocks thus rolled over a vast variety of shells of all sizes will be found adhering. A very careful inspection is necessary as some kinds are covered, or partially so, with the mantle of the animal and are not at first readily distinguished. All these must be collected, however small, and such sorts as stones at the *very lowest ebb* will yield most shells, therefore the collector must not mind getting wet to the knees. Put on an old suit of clothes, or a pair of canvas trousers, and protect the feet with strong boots. In such spots as these, on some reefs, shells to the value of 20*l.* and upwards may be procured during a single tide. Search well the crevices of rocks in the sheltered nooks and bays, and examine the ledges overhung by seaweed. In tranquil bays, when the tide is at the very lowest, many good species of bivalve shells, of the genera *venus*, *tellina*, *cardium*, *mactra*, and *donax* may be found just beneath the surface of the sand and ooze, and in the finest living condition. Isolated sand-banks, which are only left dry for an hour or so at spring tides, afford a rich harvest to the conchologist. They should be approached by a boat as soon as they begin to be uncovered, so that all the available time may be taken advantage of for collecting. Some of these sandbanks in the tropical seas, especially where they are sheltered from all surf and wind, are literally covered with choice living shells. Sieves should be provided in the boat in which to gather the larger shells; while the smaller and more fragile sorts may be secured in a light basket, in which are a number of chip boxes for holding especial rarities. On getting home, the first thing is to remove the animals from the shells. This, in the case of all bivalve shells (such as pectens, scallops, and the like), and such univalve shells as do not possess an enamelled surface, may be done by pouring *boiling* water over them, or even by boiling them in a vessel over the fire for a short time. Care must be taken to remove all parts of the animal, and to preserve the operculum, where there is one. The bivalve shells will gape after the animal is taken out, and must have their valves tied closely with cotton or fibre till quite dry. Porcellanous shells, such as cowries, olives, and marginellas, which are in a living condition, must be placed closely in

TECHNOLOGICAL COLLECTION.

No.

(James Collins.)

Name

Nat. Ord.

Gen.

Sp.

Hab.

Use.

History

Remarks

Butchers skewers, hooks,
chopper cleaver &c.

Write out full list in columns 29
with reference to pages in this book
Write out ~~for~~ in one of

Natural History

+

General Scientific

Stores

&

Entomology

Pocket & store boxes & bottles
pins. ~~pocket~~, ether, cyan: pot:
sponges, chloroform, syringe

pigskin 2'6" by 8" wide
pocket for lin box ÷ 3 to
hold arsenic, camphor, soap
bich mercury.
Chloride zinc 1 to 20 for preserving

Nets & spare netting. scissor
net.
Forceps, Digger, Setting board
Bottles with cyan & sawdust.
Box. glass. [illegible] sponge let in
lop. small test tubes. bottle
having quill with wooden
plug. Scissor net.

Seaweeds & shells.

Handbasket lined with zinc.
Cheap calico for drying.

Towing Net

Iron Rake

Panniers for holding spirit,
stores, specimens &c
2 copper or tin vessels lobed
specimens in spirit.
muslin for bags for specimens.
JR bags or other material
to keep specimens from
washing about
Parchment, tin, lead &c for labels

K

£ 372 0

Fishing Lines & Hooks.
Nets for fish. (Seine)
Casting Net
Alcohol
Small W. M. bottles, packed
phials &c box.
Arsenic in Canisters.
Cotton or low. shapes.
Butcher's knife, scissors,
needles & thread.
Corrosive Subl:

Carbol: acid
Caspary's rake with rope
iron or tin ladle, spoon
chip boxes.
sol: isinglass for Fielens
Chisels &c
~~mosspapers Cubs in ears~~
Filtering shapes.

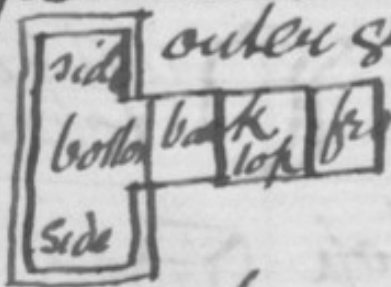
Zoology

Skinning Instruments
Arsenic &c

Drying boxes Zinc sides
to take to pieces – for
hanging up.

Strong hooks & cords.

specimen boxes in the flab.

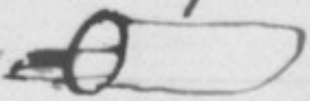


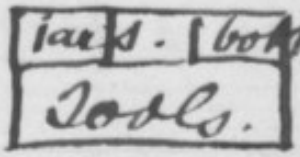
Mixture, 6 oz arsenic, 3 oz corr. alk
2 oz yellow soap, 1 oz Camphor
1½ pints H. mix & boil slowly
& pour into do. as bottles

III

f 373v

Dredge. hooks & grains.
fish hooks & lines.
fish cage

Plummet. log & line.
towing net. bunting 2 ft deep
fastened to hoop 14 in dia
3 cords 18" long at equal
distances 

Gosse Basket:- 

Highlep dredge thin cast iron
side & net ends with hooks
& chain

Dredging sieves. top 3
top coarse, 2 zinc sieves ¼
3 gauze fit into each other

Dredging hook.

Potash for rotting flesh

Botany.

Portfolio, Paper, Card, lattice
Moss bags. Field book with
straps let in.
Iron & spirit for drying plants

press with iron (long &
short going through the
ends (thumb screw or
wrench)

Ethnology.

Callipers for taking facial angles. with graduated arc. with shifting arm. both should fold up. or partly slip in.

Conchology. dredge of

2 cones

outer sheath

bottle

cloth.

Birds-egg implements

f. 382. 34

Geology & Mineral 1

Canvas bags diff[t] Sizes

Hammers, Crowbar, chisels