he added, did the highest honour to the individual who accomplished such laborious and hazardous journeys, and had made us familiar, through his artistic skill, with vast mountainous regions of the earth which had been trodden by few civilised men. He strongly commended this work to the favourable consideration of the Fellows.

ANNOUNCEMENTS.—The Chairman announced that, respecting the reported discovery of a large fresh-water lake in South Australia by Mr. Goyder, an account of which had been read at a previous meeting, Captain Freeling, the Surveyor-General, had just returned from the exploration of the so-called grassy, well-watered district, which he found to be almost entirely imaginary, and that the flood waters had disappeared. Lake Torrens was again a shoal salt lake, with immense borders of mud. After the most persevering efforts it was found impossible to launch the boat taken up by Captain Freeling. The country near the lake was also found to be of the most desolate character, exactly as our geographers Eyre, Sturt, and Frome had described it.

The papers read were:—

1. *The Exploration of Arid Countries.* By FRANCIS GALTON, Esq., M.A., Honorary Secretary.

THERE is no comparison between the difficulty of first exploring a desert land and that of travelling across it when its oases have been discovered. Besides the difficulties of a new road and the necessity of travelling during the heat of daylight, all first explorers labour under a peculiar and overwhelming difficulty in having the fear of a double journey perpetually before their eyes. They can never venture so far from camp as to preclude the possibility of being able to return to it without a fresh supply of water, and the extreme limit of their excursions, into the heart of the desert, is reduced to one-half of that which they (or other travellers after them) could have accomplished, if they had been assured of a watering place at the close of their journey. Again, as the *radius* of their excursions is only one-half of the length available, it follows that the *area* of their explorations may be only one-fourth as much, and, therefore, that their chance of finding an oasis, useful to others, is in that proportion less than what it would be if they became possessed of means of travelling farther. And, finally, even this limited field of exploration can only be attempted by persons who are able to endure great personal hardship, and who do not shrink from the certainty of exhausting their cattle, and the great risk of killing some of them, in each fruitless expedition. Exceptional cases doubtless occur; indeed, if it were not for these, the longer

caravan routes could never have been discovered, but, speaking generally, the difficulties of an explorer are such as I have described them to be, and any unknown fringe of desert which happens to contain no sure watering place within a circuit of a day and a half or a two days' journey will check the progress of travellers and settlers for many years.

It would therefore be a real advantage to persons who found themselves at the borders of unknown regions in arid countries, whether they were cattle owners straitened for fresh pasture land, or miners seeking for new fields of mineral wealth, as well as to leaders of expeditions who found themselves stopped by drought, if any satisfactory method could be devised by means of which the radius of exploratory trips might be largely increased, and the object of the present paper is to show that it is really feasible to devise such a scheme, and that by its aid the desert may be explored to distances fully as great as any cattle could be driven, and, lastly, that these distant explorations may readily be carried on without the sacrifice of a single meal.

I suppose an "*exploring*" party, as few in number as is consistent with efficiency, to be aided by a "*supporting*" party, who may be divided into two or more sections. The duty of this supporting party is to carry provisions, partly to be eaten on the way out, and partly to be "*cached*," or buried in the ground, in order to supply the wants of the homeward journey. After a certain distance from camp had been reached, and the loads of one "*section*" of the supporting party had become exhausted in furnishing meals and câches to the entire expedition, this section would separate from its companions and return home. A second "section" would subsequently act as the first had done, and afterwards a third, and even a fourth, according to their original number. Finally, the explorers would be left by themselves at some days' journey in advance of the farthest known watering place, with their own loads of provisions untouched, and with other provisions, stored in câches, fully sufficient for their return, and in every respect as capable of farther exploration as if it was from their own camp, and not from a spot in the heart of the desert, whence they were about to take their departure.

Doubtless the same general idea must often have occurred to other travellers besides myself; but whether it is because the details have been found puzzling and difficult to work out, or because the necessary vessels for carrying water were not to be met with when wanted, no traveller in arid countries has ever availed himself of the great power which this method of exploration affords.

Number of Rations that can be carried.—The following Table (1) affords, I believe, as fair an approximation as the nature of the case admits of, to the weight of rations consumed by men and cattle in an arid climate, and to the weights they are severally able to transport across a broken and a pathless country. It must be recollected that the weight carried is a diminishing one:—

TABLE 1.

	Full Rations.		Shorter Allowance.		Net Weight Transportable.	
	Water.*	Food.	Water.	Food.	On Wheels.	On Back.
	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
Horse or mule ..	45	20	30	20	250—350	130—180
Ox	60	20	40	20	250—350	110—150
Man	10	3	..	..	..	15—25

Table 2 is deduced from Table 1. It shows how many days' rations can be transported under various circumstances. H stands for one horse; M for one man: thus the first line signifies that a horse can transport on wheels $3\frac{1}{2}$ days' rations of food as well as of water for himself and one man; the joint weight of these rations being 273 lbs.:—

TABLE 2.

	Number of Day Rations.	Food and Water for Horse and Man.	Number of Day Rations.	Water for Horse, Food and Water for Man.	
		lbs.		lbs.	
Horse or Mule. On wheels	$3\frac{1}{2}$	H + m = 273	$5\frac{1}{2}$	H + m = 318	Full rations.
	$3\frac{1}{2}$	H + 2 m = 266	$5\frac{1}{2}$	H + m = 236	Short rations.
Horse or Mule. On back	$1\frac{1}{2}$	H + 2 m = 137	$3\frac{1}{2}$	H + = 157	Full rations.
	$1\frac{1}{2}$	H + 4 m = 141	$3\frac{1}{2}$	H + m = 144	Short rations.
Man, on back ..	$1\frac{1}{2}$	M . = 20	..	..	Full rations.

The general result is that a man can carry $1\frac{1}{2}$ day's rations, and that a horse can transport, according to circumstances, $1\frac{1}{2}$, $3\frac{1}{2}$, or $5\frac{1}{2}$ days' rations for himself, and for one man at least.

It is necessary to determine how many meals shall be allowed per day, in order that when a "section" of the supporting party turn back, they may do so after one of their regular meals; for it would be absurd to require that they should turn back at the end of some quaint fractional part of a day's journey after they had been supposed to have eaten a corresponding fraction of a day's

* A large bucket, full to the brim, holds 3 imperial gallons, or 30 lbs. weight of water. My full rations for a horse are two large buckets a day, each of them as nearly full of water as those given to horses usually are.

rations, and we must make our selection between a division of the day's rations into one, two, or three meals. In the steady equable travel which I have in view, I entertain no doubt that the best economy of strength and food, both in man and beast, is to be obtained by assigning them two journeys and two meals a day—a morning and an afternoon journey, and a noon and an evening meal. This, then, will be the arrangement I shall lay most stress upon.

Size of the "Sections."—The number of men that turn back would naturally bear in each case a constant ratio to the numbers that go on. If, for example, the exploring party consist of 10 men, and the detachment that last left them consisted of 10 men also, this same proportion would hold from first to last throughout the journey; that is to say, whenever a detachment broke off, the number of men that returned in it would exactly equal the number of those who continued to advance. Theoretically speaking, any proportion whatever might be adopted, but it so happens that the one I have taken as an example, half going back and half going on, is the one that is likely to be the most generally useful; for it is very simple and easy to be remembered, very generally applicable, and one of the most economical as regards work done and numbers employed. In this paper I shall give most space to its description, and simply indicate other cases which might be serviceable by drawing attention to the General Table, No. 4. To this I must again refer. At present, recurring to our *binary* system, if the exploring party consists of a number of men equal to e, the following Table (3) shows what must be the constitution and size of its supporting party, according to the number of "sections" intended to be employed in it:—

TABLE 3.—BINARY SYSTEM.

	At end of last Stage.	At end of last but one.	Of last but two.	Of last but three.	Of last but four.	&c.
Total number of Advance party ..	e	$2e$	$4e$	$8e$	$16e$	&c.
Exploring party	e	e	e	e	e	
Supporting party:—						
Latest detachment	..	e	e	e	e	
Last but one	..	..	$2e$	$2e$	$2e$	
Last but two	..	..	..	$4e$	$4e$	
Last but three	..	..	..	..	$8e$	
&c.	&c.					

Length of Stages and Loads carried.—The Table (4) (see page 64), so far as it extends, shows every case in which there can be an exact adjustment of loads, meals, and subdivisions of the party. It

Table 4.

General Table, showing the number of Day Rations that must be carried by each Individual under various conditions of—1st, *Numbers and Constitution of the Party*; 2ndly, *Number of Meals per Day*; 3rdly, *Length of each Stage*,—in order to ensure an exact adjustment between the Food taken and the Food wanted.

		Accurate.	Accurate.	Accurate.	Accurate.	Approximate.	Accurate.	Approximate.	Accurate.	Approximate.	Accurate.	Approximate.	Accurate.	Approximate.	Accurate.	Approximate.	Accurate.	Approximate.	&c.	
Number and constitution of the party.	Explorers	1	1	1	16	4	81	9	81	3	16	2	64	5	81	7	256	4	&c.	
	Last Section	1	2	3	8	2	27	3	54	2	24	3	48	4	108	9	64	1	,,	
	Last but one	2	9	12	12	3	36	4	90	3	60	7	84	7	252	21	80	1	,,	
	Last but two	4	18	48	18	4	48	5	155	6	150	19	147	12	588	49	100	2	,,	
	Last but three	8	54	192	27	7	64	7	250	9	375	48	..	21	1372	114	125	2	,,	
	&c. &c.	&c.																		
Ratio between	Those who go on	1	1	1	2		3		3		2		4		3		4		&c.	
	,, who go back	1	2	3	1		1		2		3		3		4		1		&c.	
	Length of each Stage.																			
Day Rations served out in 1 Meal.	1 day journey	3	2	$1\frac{2}{3}$	5		7		4		$2\frac{1}{3}$		$3\frac{2}{3}$		$2\frac{1}{3}$		9		&c.	No. of Day Rations carried by each individual.
	2 ,, ,,	7	5	$4\frac{1}{3}$	11		15		9		$5\frac{2}{3}$		$8\frac{1}{3}$		6		19		,,	
	3 ,, ,,	11	8	7	17		23		14		9		13		$9\frac{1}{2}$		29		,,	
	&c. &c.	&c.																		
Differences	1 ,, ,,	4	3	$2\frac{2}{3}$	6		8		5		$3\frac{1}{3}$		$4\frac{2}{3}$		$3\frac{1}{2}$		10		&c.	
Day Rations served out in 2 Meals.	$\frac{1}{2}$ day journey	$1\frac{1}{2}$	1	$\frac{5}{6}$	$2\frac{1}{2}$		$3\frac{1}{2}$		2		$1\frac{1}{6}$		$1\frac{5}{6}$		$1\frac{1}{4}$		$4\frac{1}{2}$		&c.	No. of Day Rations carried by each individual.
	1 ,, ,,	$3\frac{1}{2}$	$2\frac{1}{2}$	$2\frac{1}{3}$	$5\frac{1}{2}$		$7\frac{1}{2}$		$4\frac{1}{2}$		$2\frac{2}{3}$		$4\frac{1}{6}$		3		$9\frac{1}{2}$		,,	
	$1\frac{1}{2}$,, ,,	$5\frac{1}{2}$	4	$3\frac{2}{3}$	$8\frac{1}{2}$		$11\frac{1}{2}$		7		$4\frac{2}{3}$		$6\frac{2}{3}$		$4\frac{3}{4}$		$14\frac{1}{2}$		,,	
	2 ,, ,,	$7\frac{1}{2}$	$5\frac{1}{2}$	$4\frac{1}{6}$	$11\frac{1}{2}$		$15\frac{1}{2}$		$9\frac{1}{2}$		$6\frac{1}{6}$		$8\frac{5}{6}$		7		$19\frac{1}{2}$		,,	
	&c. &c.	&c.																		
Differences	$\frac{1}{2}$,, ,,	2	$1\frac{1}{2}$	$1\frac{1}{3}$	$3\frac{1}{2}$		4		$2\frac{1}{2}$		$1\frac{4}{6}$		$2\frac{2}{6}$		$1\frac{3}{4}$		5		&c.	
Day Rations served out in 3 Meals.	$\frac{1}{3}$ day journey	1	$\frac{2}{3}$	$\frac{5}{9}$	$1\frac{2}{3}$		$2\frac{1}{3}$		$1\frac{1}{3}$		$\frac{7}{9}$		$1\frac{2}{9}$		$\frac{5}{6}$		3		&c.	No. of Day Rations carried by each individual.
	$\frac{2}{3}$,, ,,	$2\frac{1}{3}$	$1\frac{2}{3}$	$1\frac{1}{9}$	$3\frac{2}{3}$		5		3		$1\frac{8}{9}$		$2\frac{7}{9}$		2		$6\frac{1}{3}$		,,	
	1 ,, ,,	$3\frac{2}{3}$	$2\frac{2}{3}$	$2\frac{2}{9}$	$5\frac{2}{3}$		$7\frac{2}{3}$		$4\frac{2}{3}$		3		$4\frac{5}{9}$		$3\frac{1}{6}$		$9\frac{2}{3}$		,,	
	$1\frac{1}{3}$,, ,,	5	$3\frac{2}{3}$	$3\frac{2}{9}$	$7\frac{2}{3}$		$10\frac{1}{3}$		$6\frac{1}{3}$		$4\frac{1}{9}$		$5\frac{8}{9}$		$4\frac{1}{6}$		13		,,	
	$1\frac{2}{3}$,, ,,	$6\frac{1}{3}$	$4\frac{2}{3}$	$4\frac{1}{9}$	$9\frac{2}{3}$		13		8		$5\frac{2}{9}$		$7\frac{4}{9}$		$5\frac{2}{6}$		$16\frac{1}{3}$		,,	
	&c. &c.	&c.																		
Differences	$\frac{1}{3}$,, ,,	$1\frac{1}{3}$	1	$\frac{8}{9}$	$2\frac{2}{3}$		$2\frac{2}{3}$		$1\frac{2}{3}$		$1\frac{1}{9}$		$1\frac{5}{9}$		$1\frac{1}{6}$		$3\frac{1}{3}$		&c.	

is drawn up under the several conditions of one, two, or three meals being issued per day, and the details of any particular set of cases can, at once, be deduced from it.

The "*differences*" supply ready means for continuing the columns, and, if it be desired to extend the table, or to work out any question relating to the subject of it, it is easy to do so by employing the following formulæ. Let a = the number of the exploring party; b = those of the section that turns back last; s = those of the section that turns back first; m = total number of individuals (horses or men, as the case may be) employed in the expedition; l = load of day rations carried by each of them; n = number of meals into which the day ration is divided; d = distance to which the explorers are to be forwarded; r = number of stages into which d is divided; g = length of each of them reckoned in day's journey. Then, we have—

(1.) $$\frac{a}{b} = \frac{ln - 2gn + 1.}{2gn.}$$

(2.) $$m = \frac{(a+b)^r}{a^{r-1}}$$

(3.) $$s = \frac{(a+b)^r}{(a+b)^{r-1}} - \frac{(a+b)^{r-1}}{(a+b)^{r-2}}$$

(4.) $$r = \frac{d}{g}$$

(5.) The additional distance that can be travelled by a, after the last section has turned back, $= \frac{ln+1}{2n}$; if this is not integral, the integer next less than it must be adopted.

In the equation (2), if $a = 1$, and if b is an integer, then m is necessarily an integer also; but if a be greater than 1, and if $\frac{a}{b}$ be a fraction reduced to its lowest denomination, m cannot be integral, unless both it and all the terms of the series $a, b, \ldots s$, be multiplied by a^{r-1}. This has been done in the headings of the fourth and subsequent columns of Table 4, and shows the cumbrous series of terms that become necessary when $\frac{a}{b}$ is other than a very simple fraction. An accurate adjustment of loads taken and of food wanted is not, however, essential, and I have therefore appended an approximative series of terms of more manageable size, and which would serve well enough, in actual practice, in cases where each man's rations were not kept separate from those of his colleagues.

Table 5: it shows the precise method according to which the

meals are dispensed in the three most useful cases of the "binary system," which are those contained in the first column of Table 4.

TABLE 5.—DISTRIBUTION OF MEALS.

Binary arrangement of Party and one Section only employed.

Distance in Day's Journey.	3 Meals, or 1½ Day Rations. CAMP.	7 Meals, or 3½ Day Rations. CAMP.	11 Meals, or 5½ Day Rations. CAMP.	
½	●●●	●●●●	●●●●	Loads of the respective Supporting parties.
1	● ●	● ● ●	●●●●	
1½	●	● ●	● ● ●	
2		● ●	● ●	Loads of the respective Exploring parties.
2½		● ●	● ●	
3		●	● ●	
3½			● ●	
4			● ●	
4½			●	

The importance of adhering strictly to the determinations of Table 4 is very great: thus, to take a case under the "binary system," it shows that if a supporting party starts carrying more than 1½ and less than 3½ days' rations per man, they can give no greater assistance than if they carried 1½ day's rations only. But, again, by looking over the Table, we find if the travellers adopted a system, such as is shown in the sixth column, that their powers of carrying 2 days' rations per head, would be utilised to the utmost, and so on in any other of the vast number of cases which might be proposed for solution. It must be recollected that a waste, which may be of little importance when the supporting party consists of one section only, becomes multiplied over and over again, and increased enormously, when many sections are employed. Again, though the Table shows the load which must be carried to meet the requirements of each case, it does not follow that we need adhere strictly to them, but, for instance, a load of 3 meals may be taken as a nominal 2⅔ths, or a load of 6 meals as a nominal 6½th, and the traveller feasted or fasted, as the case may be, in proportion.

Ratio between { those who go on / „ who go back }	1/1	1/2	1/3	2/1	3/1	3/2	2/3	4/3	3/4	4/1	&c.
1 meal	3 { 4 men. 2 days. 2 stages.	2 { 9 men. 2 days. 2 stages.					$2\frac{1}{3}$ { $\frac{12}{2}$=6 men. 2 days. 2 stages.		$2\frac{1}{2}$ { $\frac{37}{7}$=5 men. 2 days. 2 stages.		
2 meals		$2\frac{1}{2}$ { 9 men. 2 days. 2 stages.	$2\frac{1}{6}$ { 13 men. 2 days. 2 stages. *	$2\frac{1}{2}$ { $\frac{20}{4}$=5 men. 2 days. 6 stages.		2 { $\frac{23}{3}$=8 men. 2 days. 4 stages.	$2\frac{5}{8}$ { $\frac{12}{2}$=6 men. 2 days. 2 stages.		3 { $\frac{37}{7}$=5 men. 2 days. 2 stages.		
3 meals	$2\frac{1}{3}$ { 8 men. 2 days. 2 stages.	$2\frac{2}{3}$ { 9 men. 2 days. 2 stages. *	$2\frac{3}{9}$ { 16 men. 2 days. 2 stages. *		$2\frac{1}{3}$ { men. 2 days. 6 stages. *	3 { $\frac{14}{3}$=5 men. 2 days. 3 stages.	3 { $\frac{12}{2}$=6 men. 2 days. 2 stages. *	$2\frac{7}{9}$ { $\frac{28}{3}$=6 men. 2 days. 3 stages.	2 { $\frac{86}{7}$=12 men. 2 days. 3 stages.	1 { men. 2 days. 6 stages. *	

Extreme distance attainable.—I next give a Table which shows the extreme distance to which a reconnaissance may be effected in the three simple cases of the binary system, and the total number of men, including the exploring party, that would be required to work it. The explorers are supposed to carry provisions just as their supporters do. If one or more of them be exempted from porterage, the extreme distance that can be reached will be somewhat diminished :—

TABLE 9.

		No "repetition" employed.			First stage repeated.			First and second stages repeated.			
Number of days' rations conveyed by each member of the entire expedition		1½	3½	5½	1½	3½	5½	1½	3½	5½	
Number of additional days' journey required owing to the employment of "repetition"		0	0	0	1	2	3	4	8	12	
Organization and numbers of the entire expedition.	Organization.	Total number.									Extreme distance attainable.
	E	*e*	1	2	3	1½	3½	4½	2	4	5
	E + *e*	2*e*	1½	3½	4½	2	4	6	2½	5	7½
	E + *e* + 2*e*	4*e*	2	4	6	2½	5½	7½	3	6	9
	E+*e*+2*e*+4*e*	8*e*	2½	5½	7½	3	6	9	3½	7	10½
	&c.	&c.									

When men only are employed, *e* refers to their number; but when horses and men are employed together, *e* stands for the number of horses, each of which is supposed to be accompanied by one or two men, and carries provisions accordingly. (*See* Table 2.)

We may therefore conclude that it is easy to organise an expedition, on the binary method, which shall be able to reach and to return from points in the heart of the desert at the below-mentioned distances, without the sacrifice of a single meal, and without obtaining any other provisions than those carried by it from the camp whence the start was made :—

TABLE 10.

	In a grassy but waterless country.	In a perfectly barren country.
By caravans composed—		
of Horses in harness	From 7 to 9 days' journey.	From 4 to 6 days' journey.
of Pack horses	,, 4 to 6 ,,	,, 2 to 3 ,,
of Parties of men ..	,, 2 to 3 ,,	,, 2 to 3 ,,

I need not enlarge on the vast increase of field that the adoption of the above method would give to the excursions of an explorer.

A well-acclimated horse can barely be driven for four days without water in an arid country, two days out and two days home; he certainly would succumb before the close of the fifth day: and here we see that, by carrying no extraordinary weight, and by using no impracticable size of caravans, a distance of up to nine days' journey out and then back again, or 18 days in all, can be accomplished without any stint whatever as regards their commissariat.

It is not easy to specify the average distances that may be accomplished by horses working for their lives, upon short rations, but I think that the gain in using my plan may be moderately stated thus:—

A horse that carries no water may, at the risk of his life, accomplish 4 days' journey; viz.	2 out and 2 home.
A horse that carries 5½ day rations may, without stint, accomplish 6 days' journey; viz.	3 out and 3 home.
A horse that carries 5½ day rations may, at the risk of his life, accomplish 10 days' journey; viz. ..	5 out and 5 home.
A horse, backed by a supporting party, and that carries 5½ day rations, may, without stint, easily accomplish 18 days' journey; viz..	9 out and 9 home.
A horse, backed by a supporting party, and that carries 5½ day rations, may, at the risk of his life, accomplish 22 days' journey; viz..	11 out and 11 home.

It will make the disposition of the entire party perfectly intelligible if, in any case that may be fixed upon, a schedule of their intended proceedings be drawn out on a large sheet of paper, according to the form of Table 11. In it I have taken for an example those of a party aided by two sections organised after the binary system, each individual carrying 3½ day rations, and two meals being issued per day. The exploring party is represented by E, and I will suppose it to consist of three men; and, therefore, the two sections which are represented by A and B will consist respectively of six and of three men. The small figures, 6, 3, 3, refer to the number of meals consumed or câched by the parties to whose names they are attached and at the places where they are entered;* by the addition of these numbers together we obtain the results printed at the foot of the several columns. For distinctness sake I have been obliged to withhold all reference to the meals carried by the relief parties, whose proceedings are indicated by small letters, *a* and *b*, and who form an expedition entirely self-sustaining and independent of the main one.

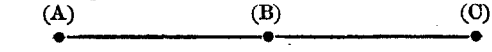
* It is not in the least necessary that a câche should be made at every place where a meal has to be consumed. It would be quite sufficient if a double or a treble one, as the case might be, were formed at each encampment from which a section turns back.

TABLE 11.

NO REPETITION.										FIRST STAGE REPEATED.									
	CAMP.	Encampment at end of ½ day's journey.	of 1 day's journey.	of 1½ "	of 2 "	of 2½ "	of 3 "	of 3½ "	of 4 "	CAMP.	Encampment at end of ½ day's journey.	of 1 day's journey.	of 1½ "	of 2 "	of 2½ "	of 3 "	of 3½ "	of 4 "	of 4½ "
Before starting	A B E									A B E									
Noon of 1st day		d. 2. 3. A B E									d. 2. 3. A B E								
Evening of 1st day			d. 2. 3. A B E									d. 2. 3. A B E							
Noon of 2nd day		d. A		2. 3. B E							d. 2. 3. A B E								
Evening of 2nd day	A				2. 3. B E					A B E									
Noon of 3rd day	A			3. B		3. E					d. 2. 3. A B E								
Evening of 3rd day	A		3. B				3. E.					d. 2. 3. A B E							
Noon of 4th day	A	3. B						3. E					d. 2. 3. A B E						
Evening of 4th day	A B								3. E					d. 2. 3. A B E					
Noon of 5th day		a b						3. E				d. A			2. 3. B E				
Evening of 5th day			a b			3. E						d. A				3. B E			
Noon of 6th day		a		b							d. A				2. B		2. E		
Evening of 6th day	A				3. b E					A				3. B				2. E	2. E
Noon of 7th day	A			3. b E							a		2. B						2. E
Evening of 7th day	A		3. b E																
Noon of 8th day	A	3. b E									3. a B								3. E
Evening of 8th day	A B E									A B								2. E	2. E
Noon of 9th day											a b						2. E		
Evening of 9th day												a b				3. E			
Noon of 10th day											a			b	2. E				
Evening of 10th day										A									
Noon of 11th day										A				3. b E					
Evening of 11th day										A		3. b B							
Noon of 12th day										A	3. b E								
Evening of 12th day										A B E									
		A's load. 42 ½-day rations, carried by 6 men = 3½-day rations per man.		B's load. 21 ½-day rations, carried by 3 men = 3½-day rations per man.		E's load. 21 ½-day rations, carried by 3 men = 3½-day rations per man.					A B E's load. 84 ½-day rations, carried by 12 men = 3½-day rations per man.		A's load. 42 ½-day rations, carried by 6 men = 3½-day rations per man.		B's load. 21 ½-day rations, carried by 3 men = 3½-day rations per man.		E's load 21 ½-day ra carried by 2 = 3½-day ra per man		

Relief Parties.—It is easy to learn from a Table, like the above, at what date the return sections of a supporting party may be re-dispatched with fresh provisions, in order to meet E on their return, and to act as a "relief" party in case of accident or distress, and also at what depôt they may expect to meet him. There is always a great facility in sending these relief parties, and they are able to

carry a large surplus store of water, as may be understood from the following considerations:—



All the sections that turn back at B, or short of B, have time to return to A, reprovision themselves there, start afresh, and meet the exploring party on its return to B: because, from B to A and back again to B is exactly equal, in days' journey, to the distance from B to C and back again to B. If the explorers returned prematurely, the meeting would take place between A and B.

When the individuals composing the relief party travelled on their first journey, they had not only to feed and to câche for themselves, but they had also to feed and câche for the exploring party, and perhaps for other sections also; but, when they travel as a relief party, the equivalent to these latter supplies remains on hand as a clear overplus, to be disposed of for purposes of relief. It somewhat complicates the question to attempt the method of *repetition* with relief parties; however, the first section can always be redispatched immediately after its return to camp, with a heavy load of provisions to câche at the end of the first stage, where it will meet the second section, and whence it will return with it to camp, and then, having reprovisioned themselves, they may start afresh as a relief party.

Conclusion.—It would take far too much space if I were to attempt to enter minutely into many particular cases, and it would be unnecessary if I did so, because no adventurer would ever attempt a more complicated experiment than that I am about to describe without having repeatedly practised his party at simpler ones, neither would he undertake the simplest one without having had sufficient rehearsal of it on a small scale to satisfy himself and his associates that they understood it perfectly.

The general rules to be adopted are to keep to steady day's work, neither more nor less; to mark the roads, and number the camps, so that there can be no possibility of mistake about either of them; and to make the cleverest câches they can. Very little delay need be apprehended from the straying of cattle, as they would soon learn to crowd to the camp, as to a water-tank, when they were thirsty.

For the purposes of câching and conveying water, and most kinds of food also, I know of no plan equal to that of employing one-gallon or half-gallon tins painted white, and packed securely with grass in strong hampers. 10 lbs. weight of water, or an imperial gallon, contains 277 cubic inches: and the canisters that appear to me most

convenient in size would be $4\frac{1}{2} \times 8$ inches at the base, and 8 inches high with an extra inch for the neck. 50 lbs. weight of water, in four whole canisters and two half ones, would pack side by side in a hamper measuring over all 11 inches $\times$ 10 inches $\times$ 2 feet 5 inches. Men would carry their loads in the way they were best accustomed to. One good plan is to drop the vessels into loose fitting bags, and to sling these at either end of a pole borne upon the shoulder. The mouth of these canisters should be like that of an ordinary tea-canister, closed with a cork, and the cork covered with a close fitting tin cap, to keep out ants and other small marauders. There can be no mistake about the number of these tins that would be required, as the Tables show the number of days' rations that must be carried for each individual of the party. The cost of a number of these vessels, sufficient to supply the wants of a large party for a long series of expeditions, would not exceed that of a single horse. If from any cause the rations appear inadequate, no danger or hardship need result to the party in consequence. It is always open to the leader of it to curtail his excursion, and to give to his cattle and men the water that was stored for their use during those stages which he now determines to stop short of. And, again, the safety of their return journey need not wholly depend upon that of the câches, since it has been shown how easy it is to dispatch relief parties for further security.

I sincerely trust that explorers in Australia may be induced to give a fair trial to my proposed method; and I would suggest to a person who wished to do so that he should make a few preparatory attempts on foot, after the following simple arrangement, with a description of which I will close this paper. Let the explorer adopt as his immediate object the investigation and survey of a line of country to the distance of one and a half day's journey into the heart of the desert. He need not carry any load of food, but let him select 7 natives as porters, and prepare the following outfit:—

21 half-gallon water tins, of the description mentioned above; viz. 4 $\times$ $4\frac{1}{2}$ inches at base, and 8 inches clear height, exclusive of the neck.

21 food tins; being simply square tin boxes with close-fitting lids, 4 $\times$ $4\frac{1}{2}$ inches at base and 3 inches high, a pile of three of them being of the same size as a water tin.

21 meals (of $\frac{1}{2}$ day rations each) of food; viz.: tea, sugar, flour, and salted meat; each ready to pack up in its separate food-tin.

14 light canvas bags; each capable of holding two water tins, or else one water tin and a pile of three food-tins. The bags to be adapted for slinging from a pole, and having long enough necks to admit of their being sewn up or otherwise well secured against tampering.

1 large spare bag; a very light one, capable of holding four sets of food and water tins.

7 strong light poles; six feet in length, to be carried on the shoulder, to each end of which a canvas bag is to be slung; the one bag containing

2 water tins, and the other 1 water tin and 3 food tins, or exactly three complete meals in all.

The expedition will consist as follows:—

The explorer E_1 carrying nothing, and his attendant E_2 carrying 3 meals and the spare bag .. .. or 3 meals in all.
Two natives B_1 and B_2 carrying 3 meals each .. .. or 6 meals in all.
Four natives A_1 A_2 A_3 A_4 carrying 3 meals each .. or 12 meals in all.

Let them start in the early morning and travel for half-a-day, say 4½ hours, without stopping; then let them encamp at Camp I., and take a meal out of the loads of the party A, the packages of B and of E being left untouched: there are 8 mouths to feed and 12 meals, leaving an overplus of 4 meals. In the afternoon the party A is sent back to camp with 8 empty sets of tins, and each of the parties B and E take 2 meals and câche them separately, and then proceed on their journey for another 4½ hours. At night, at Camp II., B's packs are opened, the 6 meals are taken out, and 4 of them are eaten by B and E, while the 2 remaining ones are given to E, who câches them. In the morning, B turns back and the party E pursues its journey (B opens its câche at Camp I. at midday, and, having eaten the 2 meals contained in it, stores the empty tins in the places left vacant in its bags by the two meals left behind with E, and starting in the afternoon, reaches the home party at night). The party E travels on for half-a-day to Camp III., and then its men eat two of their meals; the third is intended to be kept as a reserve in case of any emergency. In the afternoon they fall back upon Camp II., dig up their câche, eat the food contained in it, and place the empty tins in the spare bag. In the morning they start for Camp I., reach it at noon, dig up the câche, eat their meals, and carry off the empty tins as before, and reach the home party at night.

The next adventure, which I will not describe in detail, might be to leave the parties A, B, and E exactly as before, but to lade the explorer E_1 with three meals, and also to make a repeated journey of one long half-day's stage. In doing this, 16 extra sets of tins would be found necessary, and a distance of 2½ days' journey from camp would be finally reached.

The PRESIDENT directed the attention of the Fellows to the value of Mr. Galton's labours in elaborating such a scheme for the guidance of travellers in dry and arid countries, and mentioned his calculations as being analogous to those by which a quartermaster-general enabled troops to make effective marches.

DR. BARTH, F.R.G.S.—I think the plan proposed by Mr. Galton suitable to a country like Australia, where the danger of the câches being destroyed by barbarous tribes is not very great; but it is not applicable to such a country as Northern Africa, where a depôt cannot be deposited without running the risk of

being discovered by the tribes who constantly infest the roads, so that the supplies may be destroyed or removed. In traversing deserts like those of Northern Africa, I think a traveller must always rely upon the provisions he takes with him. I have travelled through the desert with two horses, and I was obliged to take corn for them for sixty days. Water is found at the different wells, at four, five, and six days' distance apart. Mr. Galton's calculation with reference to the quantity of water required by the horses is quite right, for I found, when water was not abundant, that a skinfull, from 40 to 50 lbs. weight, was sufficient for each horse. There was very little herbage, and I gave each animal about 10 lbs. weight of corn per day, and they went on very well with that supply.

MR. ATKINSON, F.R.G.S.—The mode in which I travelled over the steppes of Central Asia is very different from what Mr. Galton has described. In most parts of these regions (except in the Gobi) we can find water by digging into the sand, from 5 to 7 feet deep. The water is very brackish, still the horses will drink it, and tea can be made with it—it is not an agreeable beverage—necessity alone makes a man drink it. We had a mode of travelling much more rapid when crossing the arid plains than that suggested by Mr. Galton. To travel with wheeled carriages is absolutely impossible. We travelled on horseback, each individual of the party taking three horses and 3 or 4 lbs. of prosei, a species of millet, in a small bag slung to his saddle-bow. This and a glass of tea or water make a meal: in this way about 300 versts can be traversed in twenty-four hours. On our journey we frequently endured great privation from want of food, and in many instances we suffered from want of good water, as the tea made with water from the well was often exceedingly nauseous and unwholesome.

COUNT STRZELECKI, F.R.G.S.—I can bear testimony to the value of Mr. Galton's suggestions with regard to the deserts already ascertained. There are parts of North America, where the United States Government is now engaged in an expedition against the Mormons at Salt Lake, a district separated from civilisation by a belt of desert, similar to a desert in Africa, where relief parties pursuing the system suggested by Mr. Galton would be of the greatest possible value. There are deserts in South America that I have visited to which the system would be perfectly applicable; as also the two routes of desert in Australia, one in the northern and the other in the southern region—where it is well known that beyond a certain distance you cannot penetrate without taking supplies for both men and beasts. But in passing through a *terra incognita* to a given point on the chart—when you know nothing beyond the horizon you see—it is almost impossible to apply a system or devise means which may insure you against the want of water and provisions. To advance boldly with supplies calculated approximatively upon the time requisite to accomplish your section of exploration is all that you can do. During five years of my surveys in Australia, it was my lot on one occasion to travel through a country untrodden by white men. The party consisted of seven men and six pack-horses, carrying our supplies of flour, tea, and bacon, sufficient for five months, the maximum of time calculated as necessary for the accomplishment of the self-imposed task. Notwithstanding the unexpected ranges of mountains and rivers which we met on our way, and which retarded our progress, we were actually within 35 miles of our destination, when our journey was suddenly arrested, not by want of provision or water, but by a belt of impracticable brushwood, which forced us to abandon the pack-horses and collections, and cut our way through at a rate of 1½ mile a day the best we could. In such explorations there is no system which can extricate you, except common prudence, determination, and extremely vigorous constitutions. I believe that the expedition of the United States Government failed for want of a proper system of conveying the troops through the desert, which is not perhaps very

extensive; but still presenting such difficulties that without an organised system of provisioning troops as suggested by Mr. Galton, it is impossible for them to traverse it.

MR. PLINY MILES, of the United States.—I have travelled through some of the wild parts of North America, and I can confirm Dr. Barth with respect to the danger of the natives discovering and destroying the câches. A method found successful for preserving a câche has been adopted by some American travellers. At a convenient distance from, but not too near the real câche, they make a false one, put in a small quantity of provisions, and make numerous footmarks about it. The Indians come and find the place, and suppose that it is the only câche there. But it requires a great deal of art to deceive them. In some seasons of the year travellers get along better with a supply of parched Indian corn than to rely entirely on animal food. The corn is light and very nourishing. Buffalo meat, dried and salted with care, and placed in câches, will keep a long time. I quite agree with Count Strzelecki as to the cause of the failure of the United States expedition.

MR. GALTON, F.R.G.S.—I ought to explain that I consider my method especially applicable to untraversed tracts of open country, that resist the efforts of explorers on account of their aridity and extent, such as exist in many parts of Australia, and which it is the object of an advancing civilization to explore systematically. In countries that are half desert, where there are natives prowling freely about, my method would be of less service, even if the security of the câches were unquestionable. When expeditions were planned upon a large scale the câches and depôts might easily be guarded by encampments of small parties of men detached for the purpose.

The Second Paper read was:—

Narrative of a Journey in the Bushman and Namaqualand Districts of the Cape of Good Hope, with Map. By ROBERT MOFFAT, Esq., F.R.G.S., Government Surveyor. (1st Part.)

Communicated by the Right Hon. H. LABOUCHERE, F.R.G.S., H. M. Secretary of State for the Colonies.

[This paper will be printed in full in the Journal.]

THE PRESIDENT.—Our thanks are due to Mr. Moffat for his able memoir, and also to Mr. Labouchere of the Colonial Office for his kindness in communicating it. As the brother-in-law of Mr. Moffat, our valued friend Dr. Livingstone, is present, I will not occupy your time, but at once call upon him to explain what he knows of the region described. Before I do so, however, I must express my sincere gratification at the announcement made by the Chancellor of the Exchequer in the House of Commons, that Her Majesty's Government has decided to give due and becoming aid to Dr. Livingstone, so that he may pursue his researches in Africa, and overcome those difficulties which have hitherto prevented so many travellers from penetrating into the interior of Africa. I may also state that Government has written most explicit instructions to our minister in Portugal, to aid Dr. Livingstone by every means in his power, and to prefer a similar request to the Portuguese Government. I have only to express my hope that the Government will appoint two or three men of science to accompany Dr. Livingstone, and to assist him in developing the natural history and resources of the country, in accordance with wishes long entertained by ourselves, and in compliance with the request of the British Association for the Advancement of Science.

DR. LIVINGSTONE, F.R.G.S.—The first remark that I would make on Mr. Mof-