

Dear Odell

We're awfully sorry to have
left things in such a mess -
our Anna Coker rolled down the
slope at the last moment.

Be sure of getting back to IV
to morning in time to evacuate
before dark as I hope to

Shut the tent I must have ~~some~~
left a compass - for the Lord's sake
because it - we are without -

To leave on go at morning
for the 2 days - so we'll probably
go in 2 cylinders - but it's a heavy
load for climbing.

Perfect weather for the job

Yr. ever
G. Mallory

THE LAST MESSAGE

Sent from Camp VI. and received at
Camp V. about 3 p.m., June 7.

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THE PROBLEM OF MT. EVEREST.

BY LT.-COL. E. F. NORTON, D.S.O., M.C., R.A.

(Leader of the 1924 Everest Expedition.)

(Read before the Alpine Club December 15, 1924.)

THIS is intended to be a severely practical paper. I fear I must abandon any attempt to be picturesque, or even interesting except, I hope, to those who are genuinely interested in the problem of climbing Mt. Everest.

I propose only to touch on this year's attempt in so far as this is necessary in order to explain what follows: then to state the difficulties which confront us in organising a future attempt; lastly, to give you my ideas of how these difficulties may be met.

The 1924 Attempt.

The original plan was decided on in principle between Tinki and Shekar Dzongs, two weeks before we reached the Base Camp. We had been discussing it by correspondence and verbally since early in December.

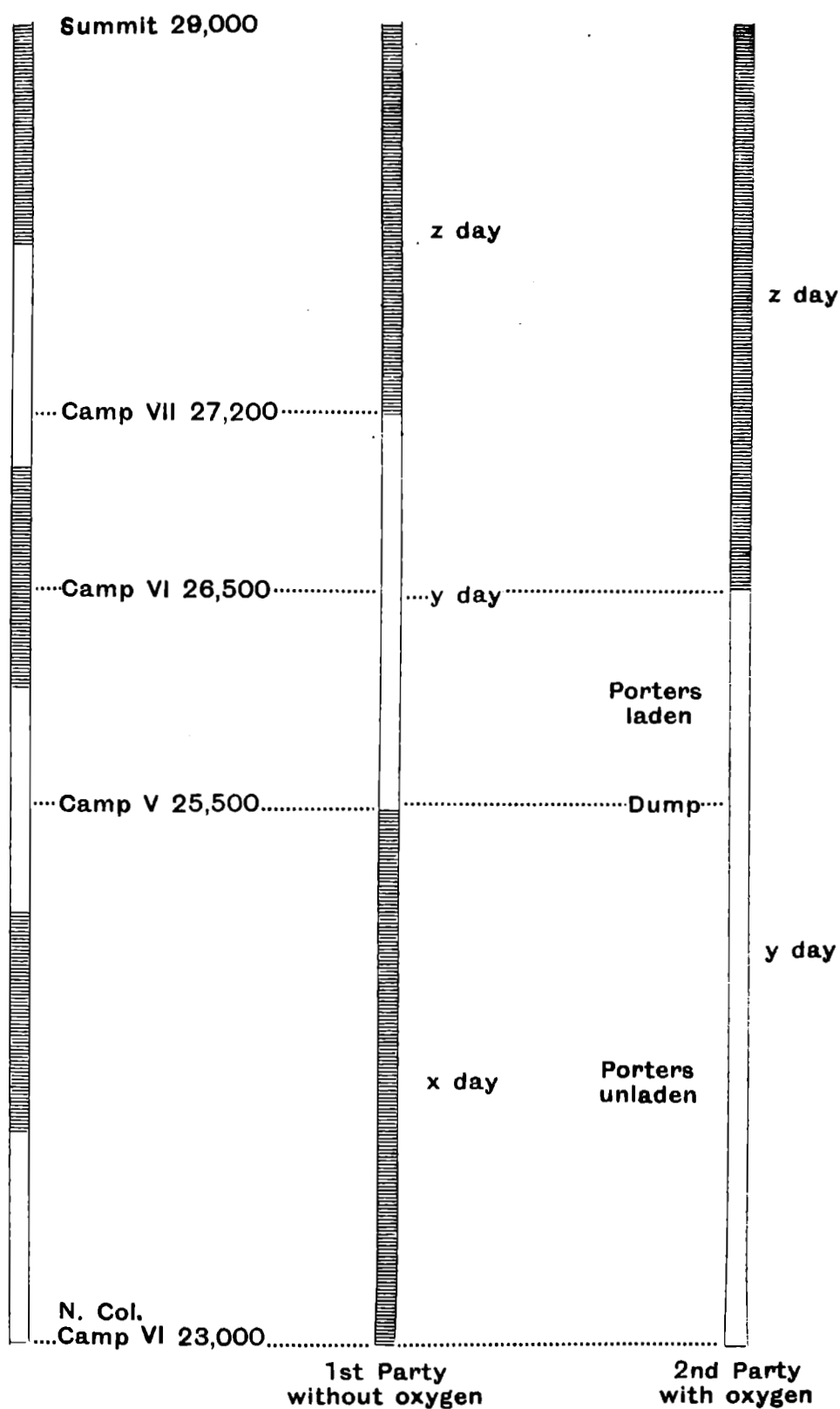
By the time we reached the Base Camp it was settled in detail, with the exact daily programme of porters' and climbers' moves typewritten out in the form of a table; you would scarcely believe the amount of detailed work which was required to arrive at this table.

To follow one's movements it is essential to know the positions of the various Camps.

TABLES OF TIMES AND DISTANCES.

Stage.	Approx. Distance.	Height Gained.	Up or Down.	No. of Times Recorded.	Average Time. hrs. mins.	Quickest Time. hrs. mins.	Average Climbing Rate. ft. per hr.	Remarks.
Base to I	16,800 3¾ miles	1000 ft.	UP	4	2 35	1 55	387	
I to I	17,800		DOWN	1	1 30		752	
I to II	17,800 3¼ miles	1450 ft.	UP	7	2 40	1 55	545	
II to II	19,250		DOWN	3	1 20	0 55	1190	
II to III	19,250 4 miles	1950 ft.	UP	2	3 10	2 20*	615	* Was certainly done in 2 hours but not recorded.
III to III	21,200		DOWN	1	1 45		1114	
III to IV	21,200 1½ mile	1500 ft.	UP	7	3 40	{ 2 40† 3 00‡ }	410	† With oxygen. ‡ Without oxygen.
IV to IV	22,700		DOWN	3	2 40	1 30	564	
IV to V	22,700 1⅓ mile	2600 ft.	UP	3	5 10	3 15	503	
V to V	25,300		DOWN	2	1 35	0 30	1646§	§ Glissading on snow.
V to VI	25,300 ½ mile	1500 ft.	UP	2	4 50	4 50	310	
VI to VI	26,800		DOWN	2	About 2 hrs.	About 1 hr.	750	
VI to	26,800 ¾ mile	1300 ft.	UP	1	6 20	—	205	
	28,100		DOWN	1	About 2½ hrs.	—	520	Very weak party.

ORIGINAL PLAN



The Base Camp, 16,800 ft., was half a mile below the snout of the main Rongbuk Glacier, and about 12 miles as the crow flies from the top of the mountain.

Camp I, 17,800 ft., was in the valley of the E. Rongbuk Glacier, a short mile above its junction with the main Rongbuk valley, and just below the snout of the E. Rongbuk Glacier, 2 to 3 hrs. from the Base.

Camp II, 19,250 ft., was 2 to 3 hrs. above Camp I on the left lateral moraine of the E. Rongbuk Glacier.

Camp III, 21,200 ft., was 2 to 3 hrs. above Camp II on the left lateral moraine of that branch of the E. Rongbuk Glacier that comes from the N. Col.

Camp IV, 23,000 ft., was 200 or 300 yards N. of the actual N. Col.

Camp V, 25,300 ft., was a little on the E. or sheltered side of the N. Arête.

Camp VI was actually sited at about 26,800 ft. on the N. Arête; in our original plan it was to have been at about 26,500 ft., with Camp VII at about 27,200.

The plan (see diagram on p. 3) was as follows :

(i) As soon as Camp III was established, and while it was still being stocked with stores for the higher Camps, a party of 2 climbers without oxygen was to work out the route to Camp IV.

(ii) Next, a party of 2 climbers, without oxygen, escorting some 12 porters, was to establish Camp IV.

(iii) Next, a party of 2 climbers, using oxygen as a trial trip, and escorting 15 porters, was to sleep at Camp IV, and then go on to Camp V, select a suitable position about 25,500 ft., and there build the necessary platforms, pitch tents, and establish a dump of oxygen and other stores—a big day's work.

(iv) Now came the 2 parties of 2 climbers each, which were to make the first assault on the summit.

The first pair, without oxygen, on what we will call x day (about May 15), was to take some 9 porters to Camp V with extra stores required for that Camp and for Camp VII, and sleep there with 4 of the porters, sending back the remaining 5 unescorted to Camp IV.

(v) The next, or y day, the second pair, carrying oxygen, but using it to the minimum extent, was to escort some 9 porters, unloaded, to the dump previously established near Camp V; this meant for the porters a climb of 2500 ft. unloaded; thence they were to carry the necessary loads,

including oxygen, another 1000 ft. to Camp VI, at about 26,500 ft., or as near that point as possible.

On this same day the non-oxygen party, who had slept at Camp V (25,500 ft.), was to climb some 1700 ft. with 4 porters, and establish Camp VII at about 27,200 ft.; all porters of both parties were to return unescorted to Camp IV the same evening.

Thus you will understand that on *y* night the non-oxygen party was to sleep at near 27,300 ft., and the oxygen party at 26,500 ft., both parties unencumbered by porters.

I should here explain that the number of porters required for carrying oxygen on the scale we then considered necessary forbade the oxygen party sleeping two nights above the N. Col.

(vi) On *z* day both parties were to go for the top; it was assumed that the oxygen party would travel the faster, and consequently the 2 parties might be expected to synchronise near the summit; the parties were to be independent, but it was evident that they would never be separated by much more than 800 ft., and would reduce this distance as time went on, and they would thus be in a position to afford mutual support if required. A supporting party of one sahib only (on account of the tentage available) and some porters was to climb this same day to Camp V, there to meet the returning climbers.

On the whole this plan was unanimously approved of: we considered its weak points to be:

(i) It was too complicated, and smacked of that most difficult operation in war—the concentration of troops from different points on the field of battle at the decisive moment; in war you never know what surprises the enemy has in store, and in this case the enemy was the weather.

(ii) It was never certain that porters could be induced to carry to over 27,000 ft., or that the climb of the oxygen party from 23,000 ft. to 26,500 ft. could be accomplished.

(iii) It called for some 40 per cent. of our total porter corps to carry to 25,500 ft. or higher.

(iv) And it was a big gamble to use 4 out of a possible total of 8 climbers on one day; it put too many eggs in one basket.

But from our subsequent experiences there is now but little doubt that, given the weather conditions of 1922, it could have been done.

It was hoped to complete this attempt by the end of the third week in May, and, if successful, to repeat it with necessary modifications, using the other 4 climbers at some subsequent date to be decided by monsoon prospects.

Most of you know what happened. We encountered unexpectedly bad weather ; temperatures as low as 24° below zero F. at Camp III, compared to a minimum temperature of 12° below zero at that Camp in 1922, a blizzard and repeated falls of snow ; as a result we had to retreat to the Base Camp on May 11, without even reaching the N. Col.

Advancing again on May 17 we were again forced to retire on May 25, having achieved no more than the establishment of Camp IV—with 4 tents, very little food, and no oxygen.

By now everyone, with the possible exception of Geoffrey Bruce, was showing signs of wear, and the *moral* of the porters was much shaken ; it was evident that we could at best only resume operations within a day or two of the date on which the monsoon broke in 1922.

It was therefore necessary to revise our original plan ; two factors definitely precluded our carrying it out : first, the fact that we could only count on some 15 diehards out of our 55 porters even to reach the N. Col. (we rightly assumed that any who did so would go higher) ; second, that the time available before the monsoon was quite uncertain, but might obviously be only a few days.

We held two lengthy conferences at Camp I., in which all but Hagar and Beetham took part. Attempts by parties of 3 were unanimously vetoed, and the only alternatives seriously discussed were :

(i) A modification of the original plan cutting down everything to the barest necessities, but retaining the principle of a simultaneous assault by 2 parties of 2.

(ii) A series of attempts without oxygen ; each attempt to consist of 2 climbers, sleeping 2 nights above the N. Col ; attempts to start on consecutive fine days.

After much discussion I summed up all the arguments, showing in detail the number of porters required to carry out each of the methods discussed ; the second was unanimously adopted as our revised plan.

I know there has been criticism of the use of parties of 2 ; as regards the general principle I have nothing to say.

As regards this particular case, however, I am perfectly satisfied that we adopted the only course which combined a

fair chance of success with what I regard as an essential safety precaution—the provision of an adequate supporting party on the N. Col. For we had now only 7 climbers and 15 porters.

An unexpectedly prolonged spell of fine weather brought, I think, 3 more porters up to the scratch. With these 18 porters we actually put 2 parties of 2 climbers into Camp at nearly 27,000, and in doing so we used up every single climber and porter (I remember that Somervell and I had to carry kit on our own backs that should have been carried for us, had we had one spare man). It would have been impossible to do this with parties of 3.

Again, the use of parties of 3 would have entailed sacrificing the strong supporting party of 2 climbers at Camp IV, on which I always insisted ; subsequent events demonstrated its importance. I may add that above the N. Col the mountain is an easy rock peak, with no ice or crevasses.

The principal reasons for the abandonment of oxygen were :

(i) At this stage we had not succeeded in transporting any oxygen cylinders even as far as the N. Col, and the shortage of available porters precluded the necessary organisation.

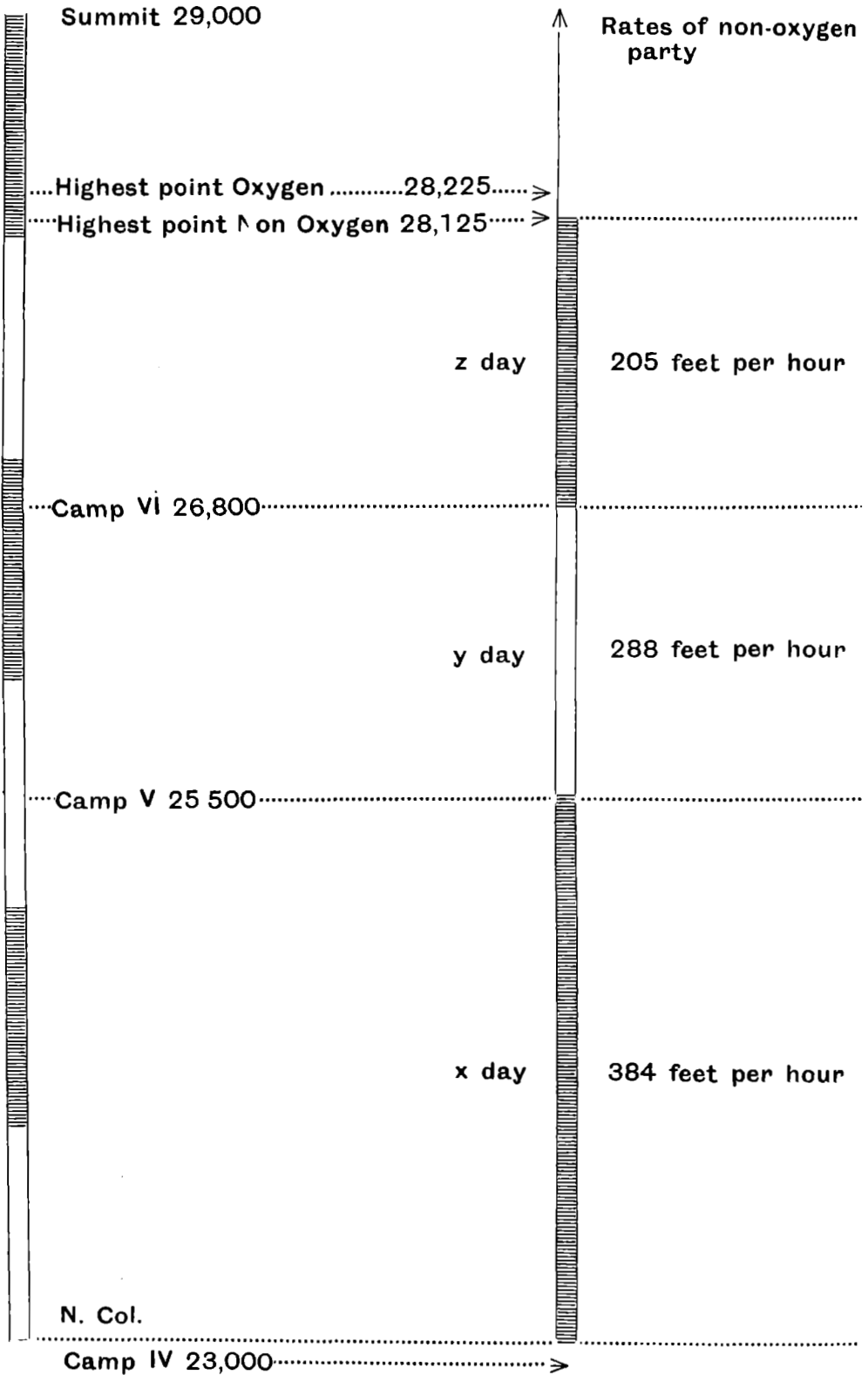
(ii) We had very little faith in the very imperfect apparatus at our disposal.

I will explain later why oxygen was, after all, used in the last attempt. I would ask those who are disposed to criticise our decision on these two points—the employment of parties of 2 and the abandonment of oxygen at this stage—to remember that the decision was arrived at after very full discussions ; a number of minor considerations contributed to it : I have given only the most cogent. At the time these considerations were sufficient to produce a unanimous decision by the men on the spot, and I think this fact is the best answer I can give to those who criticise our action.

The revised plan was put into operation ; the result is known to most of you.

The first pair, Mallory and Geoffrey Bruce, had to turn back from Camp V, as their porters would go no higher ; the wind had taken the heart out of them ; I would emphasise the point that the day on which this occurred was a normal fine day, and the wind was what one may encounter on any cloudless day on the mountain. The entry in my diary for this date—which I passed between Camps III and IV—is, ‘ weather still perfect.’ Yet if anyone could have got these men to go on it would have

ACTUAL ATTEMPTS



been Bruce, who talked their language fluently and had a great influence over them.

The second pair, Somervell and myself, were defeated principally by time and altitude. Starting from 26,800 ft. at 6.40 A.M., we turned back at about 28,100 ft. at 1 P.M. and, passing Camp V about dusk, we reached Camp IV at 9.30 P.M.

We had proved the possibility of getting a Camp to nearly 27,000 ft., and of sleeping well there, and we had got far enough to make a fair estimate of what physical difficulties are to be expected in the last 1000 ft. of the mountain.

While we were on the mountain Mallory had organised a third attempt with oxygen; the necessary porters were collected by making use of the majority of those who had accompanied him and Geoffrey Bruce to 25,300 ft., with the addition of the 3 more volunteers I have already mentioned.

You may ask why at this stage an oxygen attempt was possible after having been ruled out; the answer is that it was a very much modified form of what we had previously considered necessary. For it had now been proved that it was possible to climb to—and then to sleep quite comfortably at—nearly 27,000 ft. without oxygen, and Mallory decided to use very little if any up to that point. Camp IV was now established and stocked with all requisites except one more porter's load of food, so that all but one of the available porters could be used for carrying oxygen. The 3 more porters who had volunteered to go high just made it possible.

Mallory and Irvine reached Camp IV without a hitch, and thence sent a note to say that they hoped to reach the foot of the final pyramid (about 28,300 ft. odd) by 8 A.M. next day. They were last seen at 28,300 odd at 12.50 P.M., over 5 hours late.

I should add that, with the exception of Odell, we all thought that their loss was probably due to a slip; the theory that they were benighted and failed to find Camp VI is difficult to reconcile with the fact that no light was seen on the mountain after dark.

Difficulties.

Turning to the future, the difficulties which will confront another expedition may be summarised as :

- (i) The Weather.
- (ii) Physical Mountaineering Difficulties.
- (iii) Porter Organisation.
- (iv) The Physiological Problem and the Use of Oxygen.

(i) *The Weather*.—As regards the weather. I hope it may be assumed that the weather met with in May of this year was exceptional; the Darjeeling tea-planters said that for at least twenty years no such weather had been known at this season.

On the other hand, Odell has an interesting paper by a man in Calcutta who has compiled very convincing statistics to show that the weather in India runs in cycles of sixteen years, and that we are now at the bottom of a wave corresponding to a series of wet years; he claims that he foresaw that this year's expedition was foredoomed to failure, and he says that no new expedition should be undertaken until 1929.

But it must not be forgotten that the year 1924 would have been sufficiently favourable if we could have foreseen what was coming; Camp III could have been established and stocked, but not used for sleeping, and an advance to Camp IV and onwards only undertaken with the beginning of the spell of three weeks' fine weather which begun on May 26. This would have sufficed, though it would be preferable to have more margin; the point is, can we—or can we not—reckon on three clear weeks of fine warm weather before the monsoon? I believe that normally we can.

There is one more point about the weather: it must be recognised that during any spell of fine weather it is impossible to guarantee that within three days there may not be a snow-storm or a particularly severe wind on the mountain—in this respect the Himalayas do not differ from other mountains—and so a party starting from the N. Col gambles on three suitable days running. If it encounters bad weather it runs the risk not only of temporary failure but also that its members may have shot their bolt for the year; we are not all Odells to go repeatedly to 25,000 and 27,000 ft.

(ii) *Physical Difficulties*.—In all probability these exist only in two places—the slopes leading to the N. Col and the approach to the final pyramid a little above 28,000 ft.; with these two exceptions the route is all easy and safe, except perhaps after new snow.

The approach to the N. Col is simply a steep glacier, and the route evidently varies from year to year; unexpected difficulties may always confront a future expedition here.

The obvious route, the zigzag trough used throughout the 1922 attempts, was avoided this year on account of the dangers of avalanche, for it was here that the whole party was swept away during the last attempt of that year, and 7 porters were killed.

The alternative route adopted this year avoided the dangers of the trough, but entailed some very laborious climbing and carrying.

The final steep traverse before arriving on the shelf, where Camp IV has been pitched for two years, is unavoidable, and will always be a source of possible danger.

The approach to the final pyramid appears to be the only other place entailing any danger, except perhaps when new snow is lying. Here there are two possible routes; the first, which Mallory always favoured, and which he followed in his last climb, is by the crest of the N.E. Arête.

There was always the doubt that a feature in this route, which we called the second step, might cause considerable difficulty; it presents a vertical face to the S. and E., but seemed surmountable, though evidently steep, to the N. Mallory and Irvine were last seen on the top of the step, and so must have climbed it; but this is not quite sufficient to guarantee this route, as they may well have fallen from it on the descent.

From the point where they were last seen to a point some 300 ft. below the summit it is all steep, but almost certainly easier than the place they had just surmounted; the last 300 ft. is obviously easy.

The alternative route which I favoured, and which Somervell and I followed, is roughly parallel to the crest, but 500 to 1000 ft. below it on the N. face. This route becomes steep and rather dangerous, though nowhere difficult—if I may so differentiate—in, and just W. of, the big couloir, which cuts off the final pyramid from the great N.E. shoulder of the mountain. For a short distance, perhaps 200 ft., the going is very steep, and composed of overlying slabs approximating to the general slope of the mountain; there is always apt to be a sprinkling of snow here, which conceals the footholds and constitutes the principal danger of a slip, for, sheltered as it is from wind and sun, the snow is powdery (of the consistency of coarse salt) and nowhere supports the foot.

About 200 ft. above the point I reached, all of which is of the steep slabby rock I have described, you emerge on to the face of the final pyramid, and, as far as we could judge from the Base Camp, there should be no further difficulty up to the summit.

Thus by either route there is some steep climbing at about 28,200 ft., steeper than anything on rock below; this factor must not be forgotten in estimating times both in ascending

and descending, for over portions of it it may be necessary to move one at a time on a belayed rope.

(iii) *Porter Organisation*.—Our principle was that, in the early stages, parties of porters must always be escorted by climbers on the glacier between Camps I and II, and between Camps III and IV. When the route and the generally negligible crevasses between Camps II and III became well marked, and when the elaborate system of fixed ropes which we used below Camp IV was established, such escort could be dispensed with if necessary. On the N. Arête of the mountain, between Camps IV and VI, it has always been considered justifiable to send down returning porters without escort.

Above the N. Col the whole difficulty—a very real and vital one—will always be the lowered vitality at high altitudes and its effects on the *moral* of the porters ; it becomes necessary to stimulate their will-power to carry out what their physical powers are certainly capable of.

(iv) *The Physiological Problem and the Use of Oxygen*.—Is it possible to climb the last 1000 ft. without oxygen ?

After our experience at 27,000 ft. in 1922, we were somewhat disappointed at the bad progress we made this year near 28,000 ft. It was merely a question of pace : our going-power seemed steadily to diminish, there were no other symptoms ; one could sit down and smoke a pipe in comfort, and my pulse after sitting for some minutes was only some twenty above normal. The trouble was that one went so miserably slowly uphill ; downhill, on easy going, one could always go all right.

As regards pace at this height, we have no satisfactory figures to guide us, for though it is true that I only mounted something under 100 ft. and progressed horizontally about 200 yds. in my last hour, this hour included the only comparatively difficult going we met.

I was precluded from mounting by a series of buttresses, which forced me to traverse until I reached the big couloir : I had twice to retrace my steps and select a new route, and I was bothered by the powdery snow, and some trouble with my eyesight (the beginnings of snow-blindness, which attacked me the same evening).

I was alone, unroped, and had to be exceedingly careful. Finally, I was not in a fit condition to provide a test case, as I had lost too much condition throughout the month of May, and the same applied in a greater degree to Somervell—owing to his throat trouble.

I myself believe that an average rate of 200 to 250 ft. an

hour could be maintained for the last 1000 ft. of Mt. Everest by a fit party without oxygen.¹

Is the oxygen apparatus, in its present form—*viz.* compressed gas in steel cylinders entailing a weight of 20 to 30 lbs. on the climber's back—sufficiently beneficial to outweigh the time, labour, and organisation it involves? It is very hard to say; in its favour are :

(a) The experience of Finch and G. Bruce two years ago.

(b) A somewhat vague statement by porters that Mallory and Irvine were going well up to 27,000 ft. (though Mallory wrote to Odell that they had used very little oxygen up to this point).

(c) A record I have discovered in the Camp diaries of a quick climb from Camp III to IV by Mallory and Irvine in which they are stated to have used oxygen.

(d) The very optimistic note from Mallory, written from Camp VI, telling Noel to be on the look-out for them with his cinema at the foot of the final pyramid at 8 A.M. This surely must indicate that they had reason to anticipate great things from the oxygen next day.

¹ The following times are the quickest recorded for a party of two or more. Some exceptionally quick times by a single climber are omitted. With one exception all are without oxygen.

		UP.		DOWN.	
Stage.	Difference in Height.	Hours.	Feet per Hour.	Hours.	Feet per Hour.
III 21,200 to IV 22,700	1500 ft.	3 with O ₂ 2 $\frac{2}{3}$	500 564	1 $\frac{1}{2}$	1000
IV 22,700 to V 25,300	2600 ft.	6	433	1 $\frac{1}{4}$	2000 (glissading)
V 25,300 to VI 26,800	1500 ft.	4 $\frac{1}{2}$	333	1 $\frac{3}{4}$	857
VI 26,800 to 28,100	1300 ft.	6 $\frac{1}{3}$	205	about 2 $\frac{1}{2}$	about 520

Against it are :

(a) The experience of G. Bruce and Odell, who both obtained very little—if any—benefit from it up to 23,000 ft.

(b) The subsequent experience of Odell, who used it up to 27,000 ft. with similar results. He admits that he used it very economically, but states that when he turned on the full two litres it did him no more good.

(c) Mallory's and Irvine's actual appearance, at 12.50 P.M., at a point still below the foot of the final pyramid, indicating a rate of progress but little better than Somervell's and mine without oxygen.

Personally, I think that this unaccountable delay was, at least partly, due to some mechanical defect in the apparatus, which postponed their start while Irvine was putting it right, but I do not propose to touch on the mechanical question to-night: this must be the subject for discussion by experts.

There you have the data about the oxygen: it remains the unknown quantity—the x of Mt. Everest.

Other physiological problems are those of food and acclimatisation.

There is no doubt that it is exceedingly difficult to hit on the right form of food for high altitudes. It should be palatable, for men will not eat enough of anything which is not; it should be so easily digestible as not to handicap the climbers' going-power for the next three hours, during the process of digestion; yet it must be sufficiently sustaining to prevent a hollow feeling soon after it is eaten, to support life for several days of severe exertion, and to offer resistance against cold.

Of acclimatisation we have learnt a good deal this year, though we have, no doubt, much still to learn.

There appears to be a certain permanent acclimatisation which lasts over a period of at least two years, for there is small doubt that those of the party who had been there before adapted more readily than the new-comers.

The undoubted superiority of Mallory in pace and general going-power over all of us, in both 1922 and 1924, may have been partly due to his having a year's start over the rest.

I believe that everybody has a certain limit up to which he improves under favourable conditions, and that this limit varies from, say, 19,000 to 23,000 ft.

There is also no doubt that some men adapt faster than others, and that some of those who adapt slowly prove the

strongest in the long run : Somervell in 1922 and Odell in 1924 are good examples of this.

For some, three weeks' acclimatisation at each advance in altitude would be desirable—were it possible.

On the other hand, during five days at Camp III, in the third week in May this year, when the weather conditions were very bad, the whole party deteriorated so rapidly that it became imperative to retreat ; the general ill-effects of hardship, cold, and lack of sleep far outweighed the question of acclimatisation.

The difficulty will always be to strike a balance between these conflicting considerations.

Solution.

I will now give you, as briefly as I can, my own suggestions as to how the difficulties I have described may be dealt with.

(i) *The Weather.*—The Meteorological Department at Simla should be approached for any data as to :

(a) The probability of a cycle of unfavourable years in the near future ; for the reasons I have already given I do not consider this so important as :

(b) Whether a spell of fine hot weather immediately preceeding the monsoon is normally to be expected.

If the answer to this latter question were in the affirmative, it would be a great help to the leader of a future expedition in making up his mind when to ' drop the flag.'

With the same object in view, another possibility is the provision of a wireless receiving set to accompany the expedition, who would thus be enabled to receive messages as to the progress of the monsoon. This year we made arrangements for such telegrams to be sent us both from Simla and Colombo, but they inevitably arrived too late : the first useful message we received met us at the Base Camp just as we had finished for the year.

Armed with this knowledge, the leader of a future expedition should be able to avoid the exhausting process of unnecessarily fighting severe weather conditions.

(ii) *Physical Difficulties.*—I would not advocate any attempt to find an alternative route to the N. Col. The approach from the W. *via* the main Rongbuk Glacier may well be as liable to avalanche as the present route ; it is more exposed to

the danger of falling stones, it entails a climb of nearly 1000 ft. more, and both it and the Camps below would be exposed to the full force of the W. wind.

Our experience of two years tends to show that the 1922 route, what I have called the trough, may probably be used with safety until the advent of the true monsoon and the soft S.E. wind, for even after a new fall of snow the hot sun and cold nights, which are characteristic of the pre-monsoon North-westerly weather, soon render it safe. An alternative route on the same side, like the one used this year, should, if possible, be worked out to provide a bolt-hole if necessary.

The final traverse should never be tackled from below immediately after a fresh fall of snow ; if it becomes necessary to descend by it, a judicious use of ropes, fixed and otherwise, one man only moving at a time, should make it reasonably safe.

As regards the route to be followed for the last 1000 ft., I think that the experienced climbers who will lead future attempts must form their own conclusions from their reconnaissance of the ground and the data of this year's experiences.

For myself I still incline to the lower route.

(iii) *Porter Organisation*.—There is only one way of overcoming the difficulty I have mentioned—that of inducing porters to go to somewhere near their physical limit on their highest day—and this is for a large proportion of the climbers to acquire such influence over the porters that the latter will follow them.

To do this the first essential is that they must learn at least something of their language. I have learnt something of four Oriental languages, and I speak from experience when I say that, given the necessary determination and goodwill, much can be done between leaving England and arriving at Rongbuk ; but I would go further, and insist that, with the aid of the London School of Oriental Languages, of retired officers of Gurkha regiments, or some such means, members of a future expedition should, before sailing from England, acquire a foundation on which to build rapidly when once they get among the hill folk.

In addition, every climber should know every porter by name—here again I speak with certainty when I say that it is perfectly easy to know fifty or sixty men by name in a week or two ; and more, not only must he know the men, the men must know and trust him.

Without these fundamentals the small amount of leadership

required is impossible ; surely I do not ask too much when the success or failure of the whole expedition may—nay, must—depend on this one link in the chain.

(iv) *The Physiological Problem and Oxygen.*—As regards the use of oxygen, the balance of probability is now that men can reach the top without ; but it is by no means certain. I do not think it would be justifiable to send an expedition unequipped in this respect.

It must be for the experts—using Odell's invaluable experience—to rectify as far as possible the faults of this year's apparatus. I believe there is little—if any—hope of materially lightening it.

I would suggest that a future expedition would do well to confine themselves to using it only above 27,000 ft., for the acclimatisation acquired in climbing to that height without oxygen is the surest safeguard against serious effects of a breakdown of the apparatus high up.

I would deprecate any attempt to influence beforehand the decision of the leader of an expedition as to the extent to which oxygen is to be used ; supply the best apparatus that can be made, and leave the party a free hand whether—or when—it is to be used.

Without oxygen the surmounting of the last 900 ft. resolves itself into a question of 'time and space.'

With or without, I now consider it essential to sleep two nights—and only two—above 23,000 ft. ; to sleep three nights above this height would entail impossibly big intermediate Camps.

I am quite satisfied that Camps V and VI can be pitched 250 and 500 ft. higher, respectively ; we have always aimed at putting Camp VI just under the N.E. shoulder, at about 27,200 ft., but if a suitable site can be found nearer the summit at this level it would be much better.

This would leave 1800 ft. for the last day against, say, 1300 covered by the non-oxygen party this year. This party started at 6.40 A.M., having been delayed an hour by an accident to a thermos flask. They turned back at 1 P.M. and reached Camp IV at 9.30 P.M.

I should say here that an early start in the Alpine sense seems impossible on Mt. Everest ; I can only suppose that this is due to the lowered vitality of the early hours. But assume a start at 5.30 A.M. and a return to Camp V only ; we save at least 3 hours in which to cover the remaining 500 ft.—up and down. This runs it very fine indeed, but I am taking

the rate of progress of this year's party, and I think the pace ascending—but particularly descending—should be considerably faster with a fitter party.

The position of Camp VI will be the deciding factor. The nearer it is to the summit the greater the chance of success—obviously—but also the greater the risk that a party, with the tempting goal so close, will postpone their return until too late to reach safety. Leaders of future climbing parties should keep a clear sense of their responsibility in this respect.

As regards the food question, I can only suggest that some keen biologist might be asked to tackle the matter scientifically—it is worth all possible investigation—but I am not hopeful of improving very much on what we had this year.

Finally, as regards acclimatisation and the conservation of energy, I would take a leaf from Longstaff's book and say, *if conditions are bad*: 'Go as often as possible to 20,000 ft.—even to 23,000 ft.—but do not stay there.'

Sleep no higher than you can sleep well, than the highest point where you can to some extent enjoy your food, but spend as long as possible at this height.

In any case, I would not advocate going higher than 23,000 ft., until it is necessary, for above that point most people lose more in general condition than they gain in red corpuscles.

It must be the aim of a future expedition to make Camp III almost as comfortable as the Base Camp was this year; it is an impossible ideal, but we can get very much nearer it than we ever have before.

I have alluded to what Longstaff said about acclimatisation; I should like to pay a tribute to his remarkable insight into the whole problem under discussion. In many other respects his prognostications, made years before the 1921 Expedition first reconnoitred the mountain, have been proved accurate: the height of the snow-line on the Northern side of the range, the height of the Base Camp, the organisation and positions of intermediate Camps, the composition of the climbing party and the best type of porter, the minimum rate of progress necessary to ensure success—in all these matters he has been a true prophet, and I hope that a future expedition will not fail to benefit by the advice and help which he is always willing to give.

In conclusion, I must again apologise for a dull paper; my only excuse for inflicting it on you is that it contains a certain

amount of solid matter which I can find no better opportunity to publish.

In the ensuing discussion, Dr. T. G. Longstaff remarked :

This year's success is almost incredible under the adverse weather conditions which were met with. Colonel Norton has generously referred to what I said in this place a long time ago ('A.J.' xxiii. 256² and xxiv. 193³). I still think it is quite possible for some exceptional men, such as we had this year, to climb to the top of Mt. Everest without an accessory supply of oxygen. The great difficulty is establishing the high camps. If we can get hold of climbers who can carry their own camps up the mountain for three days—their tents, sleeping-bags, primus stove, fuel for snow-melting, food, and spare clothing—well and good. I don't look on this as possible on Everest. I've tried it myself up to 23,000 ft. When we tried Nanda Devi, of course, we broke down; climbed up it for three days and then had to chuck it. I think we must have porters if the climbers are to have any chance at all. These porters cannot sleep really high, because they can only carry just enough for the climbers. The porters must get back to Camp IV to sleep. Therefore you cannot count on a last Camp higher than about 27,000 ft. I can best explain the case by quoting, if I may rely on your forbearance, the problem I faced when I wanted to explore beyond the Karakoram in 1909. I was limited to horse transport and there was no horse-feed in the country I wanted to get into. I found I could cut down my ponies to 15 for one month. I then found that I required about four times that number to carry the fodder for my ponies and to carry the fodder to feed the

² 'He personally thought that if an easy way up existed, it would be possible for some exceptionally strong climber to reach 29,000 ft., but if the route were hard he doubted that height being reached.' (1906.)

³ 'On Everest he would be surprised to find the snow lower than 20,000 ft. The Tibetan side would, he thought, prove easy of access. It was just a question if there was a technically easy route up the north side. There was none up the south or the west. A camp should be placed on stones—not on snow—at about 20,000 ft.; the Base Camp should be an easy day below where existence was tolerable; the working party should establish the 20,000 ft. camp, and also another 4,000 ft. higher. The party for the actual event, say four in number, could go up there fresh and make a dash for the summit, which perhaps two might reach.' (1908.)

ponies that were carrying the fodder, and so *ad infinitum* to a recurring decimal! We had to drop it. Norton's paper has been severely technical: exactly what this audience wanted; but part of the story of this year's doings has never been told in full—through a perhaps too reticent modesty. When Norton and Somervell and Mallory started up the N. Col to rescue those coolies they were already quite played out. The severe weather and labour at Camps III and IV had done them in. Their only chance was to get back quickly to the Base Camp to recover form. Instead, they had this infernally trying and excessively dangerous job of rescuing those men. That is what upset their apple-cart more than anything else. I know Strutt thought with me, when he heard that tale, that it was all up for this season. If only Somervell could have gone straight down, his throat would probably have recovered. It's what they'd already gone through that made their pace so slow at their last shot. What they did under such conditions quite convinces me that if circumstances had been really favourable they would have got to the top. In justice to those who favour oxygen, I must protest that Norton's double-vision had nothing whatever to do with his subsequent snow-blindness: it was a symptom of derangement of the higher brain-centres due to want of oxygen. But I hold that this was not due to absolute altitude so much as to the utter exhaustion produced by weeks of long-continued over-exertion, just as a runner faints at the post. The mystery of Mallory and Irvine is extraordinarily difficult. Unless they had been going fast—that is, at an Alpine rate—it's hard to believe that Odell could have seen them at all at that distance. Crawling men would have been invisible. Odell reports them moving actively, smartly, and at such a time and place as indicated that there is no reason why they should not have reached the summit. It looks as if Irvine had actually got the apparatus to work and that they were benefiting by oxygen. But really we have no proof that they were using oxygen at all. Undoubtedly the effects of altitude are less felt on a ridge than on a face; but whatever had delayed them for four hours, it could not have been slow pace. What happened afterwards no one knows; if it was a slip, which is fatally easy on the descent—we shall never know. But none who knew them can doubt that they would do their utmost to attain success, avoiding what risks they could and facing those they must.

I have been asked to add a note concerning the time available for the last day's climb. We are warned to beware of lying,

damned lying, and statistics. But if you know all the circumstances and conditions you can learn a lot by the comparison of 'times.' Such sums are simplest if we do them backwards. We assume the three essentials—fine weather; good mountain conditions; the climbers not already overstrained. Assume Camp VI at 27,000 ft. and Camp V at 25,000, where a supporting party is ready to meet the returning climbers at 7 P.M. (and being them down to IV if the luck holds). In 1922 Mallory, Somervell, and Norton, after their great climb, descended from 27,000 to 25,000 ft. at 1333 ft. per hour. In 1924 Norton and Somervell, both completely 'bust,' descended from 28,000 to 23,000 ft. at 700 ft. per hour, while Odell alone descended from 26,000 to 23,000 ft. at 1380 ft. per hour. It is reasonable to assume that from 28,000 to 25,500 ft. they can descend at 1000 ft. per hour. They should therefore be back by 4.30 P.M. Allowing a whole extra hour for an expected difficult passage, they should leave the summit at 2.30 P.M. If they can start at 6 A.M. they have $8\frac{1}{2}$ hrs. for the final 2000 ft. They must average 250 ft. an hour. It is to me utterly incredible that anyone whose pace is reduced below this—*merely by the effects of high altitude*—can possibly last the course in any circumstances, and I shall be very much surprised if a successful party does not make better time.

Mr. N. E. Odell remarked :

I should like to say how much I have appreciated hearing Colonel Norton's paper, and admired his able exposition and summing up of the problem for the benefit of a future expedition. There can be no one better fitted to do this than our capable and extremely sympathetic leader of this year.

It is unnecessary for me here to discuss in detail the question regarding the use and efficacy of oxygen on the mountain. I was in charge of it this year, and I have already stated my views in the official report presented at the Albert Hall Meeting. I will only remind you that the apparatus we had was much too heavy, and those of us who used it were unanimous in questioning very much whether there were any real advantages to be gained from it commensurable with the weight (about 30 lbs.) of apparatus carried. In any case we consider that acclimatisation to as high an altitude as possible is most desirable on many considerations, and that only for the final 'sprint,' so to speak, from the highest Camp need oxygen, or should it, be used. I think it will not be necessary for a future party to take more

than the lightest apparatus possible, with a less quantity of gas, to be used, if found beneficial, on this final portion of the climb to the summit; or, on the other hand, to be available merely as an emergency measure. To take it in large quantities on the lower parts of the mountain, apart altogether from the important question of increased transport necessitated, prevents proper acclimatisation, and thereby renders the user more liable to collapse in the event of the apparatus failing.

PHYSIOLOGICAL DIFFICULTIES IN THE ASCENT OF MOUNT EVEREST.

BY MAJOR R. W. G. HINGSTON, I.M.S.
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THE primary object of the Mount Everest Expedition was to reach the highest summit on the Earth. Everything else was subordinate to this. Elaborate scientific investigations were impossible, and anything involving complicated apparatus was altogether out of the question. We had to content ourselves with simple experiments and with the records of the experiences of individual climbers. These, nevertheless, may be worth discussion. They will give us some idea of the physiological difficulties involved in an ascent to so great a height.

Alterations in Breathing.—The most obvious of these is the difficulty in breathing. Owing to the gradual nature of our ascent this shortness of respiration was scarcely noticeable below 10,000 feet. It was definitely apparent above 14,000 feet, and above 19,000 feet the slightest exertion made breathing laboured and severe. When the body was at rest, even at extreme altitudes, the rate of breathing was apparently normal and as comfortable as at sea-level. But the very slightest exertion, such as the tying of a bootlace, the opening of a ration-box, the getting into a sleeping-bag, was associated with marked respiratory distress. The difficulties of the ascent were thus enormously increased. The breathing was quicker rather than deeper, but it was necessary to stop at frequent intervals and take a series of long, deep breaths. This very quickly brought relief and made one ready for a further advance. Norton