The painful subject of accidents has again cropped up, and this year it appears to have been in Tyrol and the Dolomites especially that most lives have been so sadly sacrificed. The Marmolata, Winkler Thurm, Santner Spitze, Croda Rossa, Kleine Zinne, and one each of the Sella and Adamello peaks claimed victims, besides others of which I have not been able to get particulars. On the Winkler Thurm two lives were lost, as already named, and there have also been unverified 'Daily Mail' reports of tourists murdered at a 'Gasthaus' near Botzen. Fortunately no British climber met with any disaster. Various explanations might be given, such as longer training, more experience, good ropes, greater care, and less rashness; also perhaps judicious choice of suitable guides for difficult peaks, or equally judicious choice of suitable peaks for guideless expeditions; above all absence of solitary climbing. I think, however, to these reasons one more should be added, namely, the relative scarcity of our compatriots in these parts. If they do not go they cannot come to grief, for here as elsewhere—

> On Dolomite faces, in perilous places,
> More safety we all of us find—
> True sportsmen and shoddy—in absence of body
> Than even in presence of mind.

On Snow Avalanches.

By Dr. H. HOEK.

THE most terrible foe the winter tourist, and especially the ski-runner, has to shun in the Alps or other steep mountains is the avalanche. But when you know your enemy he loses half his terror. I have seen something of this White Hydra of the Mountains, an account of which may interest the reader.

Avalanches are the rule, not the exception, throughout the Alps in winter. They are, indeed, the rule on *all* steep slopes, whether these are above or below the snow-line. The elevation and the neighbourhood of glaciers do not influence these phenomena. The widespread belief that avalanches are influenced by elevation or glaciers could only arise in the mind of such as visit the Alps in summer exclusively, and because few have seen the very highest Alps in winter, for but rarely do avalanches reach down to the bottoms of the principal valleys.

A big, typical avalanche is not such a simple affair as one

Digitized by Google

might suppose; it is, in fact, a complicated phenomenon. Nearly every avalanche has its starting-point (starting-line, as the case may be), its gathering funnel, its track and place of arrest, where it is heaped up for the most part in the form of a cone.

Such, at least, is the regular course not only of those avalanches in the highest regions, that bring down the white powdery snow from the edges and the ridges to the cirques and glaciers, as well as of those that tear their course through the sides of the woods, bringing death and destruction to everything in their way. They are of such common occurrence that there are known stretches in the higher Alps where the starting districts of several avalanches almost or literally touch each other.

The motion of the avalanche is a flowing one. Avalanches take place more or less periodically, but for all that they are real snow streams. The solid masses and conglobated snow lumps naturally hinder each other in this movement. The lower ones get into rotation; the upper are hurled upwards, and often, if only the snow be dry enough, travel forwards in the air.

The course, direction and speed of the flowing avalanche are determined by the shape of its bed; in certain conditions it rushes over the cliffs like a waterfall. The larger the moving mass grows and the smaller its single components are, the more does the analogy of a river force itself upon us. Many avalanches never develop this character; they abort before attaining full dimensions.

For instance, when on the slopes of a steep valley the equilibrium of the snow is disturbed, and the whole of it slides down and covers up the road for hundreds of yards; then, destructive as that is, it is not the full-fledged avalanche, it it is only one arrested in formation. The difference between an avalanche and a snow-slip ('snow shield' or 'snow board,' which would be the literal translation of the expressive German words) is only a gradual one. Small, harmless snow-slips are, with few exceptions, only avalanches that were stopped at an early stage of their course.

Have you ever noticed how the snow slides off the sloping roof of a house? Flake upon flake had settled; thicker and thicker the layer had grown. Suddenly there comes a gust of wind; it blows off a patch of the light, loose material. The snow purls from above into the gap; more follows; finally the mass gets into movement, powdery snow whirls up, and the whole falls like a heavy veil over the eaves.

Digitized by Google

On the other hand, the snowfall may gradually turn into rain. Then the whole white layer becomes saturated. It gets heavier and heavier with water; at last the fluid reaches down to the mossy tiles. The weight increases further, and begins to carry the mass on its slippery floor, and, to the street arabs' joy, it crashes down upon the silk hats of incautious pedestrians.

Now imagine the analogous process on a vaster scale and on a mountain slope, and you have types of the two principal forms of avalanches—'the powdery avalanche' and the 'solid avalanche' (*Staub-Lawine* and *Grund-Lawine*). Of course there are transitional phases. The sharp division is merely a convenient one, like every other division of natural phenomena.

On a steep slope lies snow several yards deep. This is subject to the laws of masses resting on inclined planes. The chief determining factors are weight, height, internal friction, and inclination of slope. It may happen that the equilibrium is just maintained; then it needs but the slightest disturbance, sometimes the mere acoustic vibration, to start the movement. How much more must, then, the continual cutting of a ski track disturb the equilibrium?

Slowly some particles begin to move; they start others; the movement grows swifter. The consequence is a current of air directed towards the valley, a current that itself again moves snow and whirls it up. Finally the whole slope is alive; a destructive whirlwind, laden with enormous quantities of the finest snow, 'the powdery avalanche' roars down, destroying everything in its way. At the foot of the slope most of the snow settles down in a loose, smooth, symmetrical cone, in which the foot sinks deeply. The snow-laden wind rushes onward against the opposite side of the valley. The strongest blast is often some distance above the avalanche; it spares the woods on its own side and uproots those on the opposite slopes. Dry snow is the first condition of this kind of avalanche: the steeper the mountain, the smoother the substratum, the easier it is started.

The most liable sites are smooth grassy slopes with the blades bent down, or glassy snow on which fresh powdery snow has fallen without being congealed. There must of course be innumerable transitions between the gigantic destructive avalanche and the small harmless snow-slips that only hide the cliffs for a moment like a thin fluttering veil.

Powdery avalanches are most typical in winter. After a heavy snowfall in cold weather they are a great and always threatening danger for the ski runner, all the more so as they

Digitized by Google

are quite incalculable, and not bound to certain tracks like the 'solid avalanche' of the spring.

Quite different in its nature is the last-named, 'the solid avalanche.' The season is advanced, and 'Föhn' has settled in, with warm, thawing days. Rain or snow water from the surface has saturated the whole layer, it has reached the soil and loosed the icy band between the snow and its substratum; but the ground has not yet deeply thawed, and under the snow you encounter only a slippery, muddy, soapy slush. As though on a prepared slide, the snow is awaiting the moment when the slightest imaginable cause starts the first movement. A small quantity begins to glide—a piece of a corniche has broken down, and is first rolled up to a ball; it is shoved like a wedge into the lower situated mass, the snowball being the apex. The apex advances; the sides of the wedge grow and attain gigantic dimensions.

Soon the wedge is lost in the general rush, the whole slope is alive. From above the gliding masses push and press; they set the lower-lying snow going also; it starts with an undulating movement, and the wave advances downhill with ever-increasing speed.

It rushes down, a roaring river, a thundering waterfall of solid snow, an all-destroying stream. The characters of solid avalanche * are a pronounced flowing movement; the absence of whirling, and in its place conglomerating snow, which often in the moment of arrest immediately turns into a mass like a well-pressed snowball, hard as plaster of Paris. Especially when the avalanche cannot spread out, when it is banked up and the succeeding masses press against those at rest, the result is a hard compact mass, which imprisons its victim in an iron grasp. A creaking noise, like that of a heavy waggon on hard snow, is often heard—'Die Lawine schreit,' as the Swiss say.

The surface of such an avalanche is lumpy and uneven, often with gaps between the pieces, and is difficult to cross.

If the avalanche, still moving, reaches gentler slopes, one may occasionally observe that the front is turned over whilst the rear is still gliding. The edges and the bottom move much more slowly, because of the greater friction, and sometimes become stationary. The result is that the avalanche

* I cannot sufficiently emphasise the fact that a 'balling' avalanche never occurs—no such thing as a house-high giant's football, such as one may read of in the May number of *Pearson's Magazine* 1906, and elsewhere.

Digitized by Google

slides in a trough formed by itself. And a further result of this is that the avalanche at final rest has a streaky appearance.

This kind of avalanche is most typical in spring. The weight of the wet snow, and the river-like movement are responsible for its course, which generally follows the tracks of the torrents.

Between the two kinds of avalanche stands, in respect of structure and nature of movement, 'the powdery-solid avalanche.' The name speaks for itself (*Staub-Grund-Lawine* of German authors).

By far the most avalanches travel during the day. Especially on bright days in March, April and May, when the heat of the sun makes the snow melt, the 'day avalanche' is the rule; and naturally slopes with south aspects are most dangerous. Whoever has visited the Alps in spring will remember how the avalanches begin to thunder a couple of hours before noon. From every mountain one hears the low rumble; between one and three o'clock the uproar is at its height, and dies slowly away towards the evening.

One is accordingly sometimes obliged to remain in the high-lying huts, avoiding descent during the day, and to wait till the cold of the night has frozen the snow again. With a pronounced thaw and warm rain, such precautions of course would be useless, for then the avalanches travel during the night as well as during the day. But, the quantity of snow in the mountains not being unlimited, the sportsman who is surprised by bad weather can sometimes wait till most of the avalanches have descended, and return to the valley in safety.

The usual rule is, in fine weather, do not traverse suspicious slopes—if you can by any means avoid it—except before ten or after five o'clock.

Besides the two types of avalanches already described there is a third, the so-called 'snow-slip' or 'snow shield' (the *Schnee-Brett* of German authors). One might call it a kind of superficial avalanche, for almost without exception a higher layer of snow slides down on the smooth surface of a lower one.

The chief characteristics of a snow shield are the clean cut, with the mass broken off some two yards deep and even more, the breaking of the whole shield into clods, the absence of conglobating snow, and the tendency to start at temperatures below freezing point.

Especially liable to the danger of snow shields are slopes

Digitized by Google

on the mountain sides protected from the wind. When snow has fallen under heavy wind, a great quantity of fine snow is heaped up at such spots in 'the shadow of the wind.' At all events this snow is of different consistency from its substratum; generally it is more compact because finer. It seems as if such masses got lifted a little locally, and no longer lay wholly on the lower snow, thus developing a state of tension. Therefore it is not necessary for the snow first to be saturated by rain or snow water, and then to be frozen again. At falling temperatures freezing water expands, as is well known, and it seems as if the closely packed snow surface *in toto* expands more than the substratum, from which tension must naturally result. It may happen also that locally the lower layer sets, and in this manner a cavity is produced. The effect, of course, is the same. When a layer in such tension is disturbed it breaks off in a sharp line and is splintered into floes, which glide down, and in doing so often break into small clods, but, if the movement be slow enough, remain whole.

The original starting-place is generally small, but the mass, once alive, may lead to the breaking down of more snow on the sides. Thus I have noticed a successive lateral breaking away of layers. Of course, it happens often enough that such snow-shields start regular avalanches.

The exact reason for these snow-slips is not yet fully understood, but at any rate big snow shields are among the most serious dangers for the ski runner, the more so as they are so treacherous and apt to deceive even the most experienced. On an apparently safe and hard slope you imagine yourself quite secure. Suddenly big cracks arise; with a dull crash, a moment later, huge angular blocks begin to slide down in a vast swarm.

Snow shields are doubly dangerous, owing to the rapidity with which they break down.

As already stated, the rupture of a snow layer in tension sometimes seems to be the cause of a snow shield. On the high plateaux in Sweden I have noticed the same cracking, the same splits, and often the collapse of a large mass of snow like a flat-formed shield within a radius of about fifty yards. This occurs there even on level ground on which large quantities of the finest powdery snow have been deposited and after a long spell of severe cold (10° to 20° C.).

My practical advice to ski runners is accordingly as follows: the moment the ominous crack of the snow shield is heard, or splits in the snow are noticed on a slope of more

Digitized by Google

than 23°, return at once! After strong gales every slope protected from the wind is more or less suspicious, even when it has not snowed for days. It is especially the drift snow on its new resting-place that originates snow shields.

The only protection for the ski runner against avalanches is caution and the avoidance of suspicious places. If a certain slope looks dangerous, on no account attempt it. Often you may circumvent such a slope; you may follow ridges and edges, and traverse it high up under the protection of rocks. Sometimes it is quite safe to go *up the face* of a slope, while the *crossing* of it would be fatal; sometimes you may walk in it, whereas the continual cutting of the ski would disturb the equilibrium.

'The why, when, and wherefore' of all those possibilities cannot be taught by precept; it is matter of experience, of personal instruction, instinct, feeling.

To sum up, neglect no precaution, never use the rope, let the members of a party be well spaced on all slopes where an avalanche is in question.

Only when crossing small gullies, and with a sure foothold for the holder of the rope, should you rope as a protection against an avalanche. And, finally, follow this rule: the snow is safe on all slopes of less than 23°, safe also on steeper slopes if it appears of the same consistency throughout, is not deeper than a yard or so, and the slope has a rough surface (bushes, stones, and so on). In all other conditions the possibility of an avalanche exists.

But should you, in spite of all precautions, be caught by an avalanche, do your utmost to keep on the surface of the flowing snow stream, so as not to be overwhelmed by it. In rare cases one may escape by lying flat on the back, freeing the limbs as they again and again are imprisoned by the snow, so, as it were, swimming on the avalanche. But this is out of the question with the long ski blades on the feet. Your first thought must be to get rid of them. Cut the binding with your knife and let the blade go. The above, of course, only applies to the solid avalanche and the snow-slip. In the whirlwind of the powdery avalanche one is helpless.

APPENDIX.

1881. *T. Coaz:* Die Lawinen in den Schweizeralpen. Bern.
1885. *A. Heim:* Handbuch der Gletscherkunde. (Chapter I., 'Lawinen.') Stuttgart.
1899. *F. W. Sprecher:* Grundlawinenstudien, 'Jahrbuch S.A.C.' 1899, p. 268 *et seq.*

Digitized by Google

1891. *V. Pollack :* Ueber die Lawinen Oesterreichs und der Schweiz und deren Verbauung. 'Zeit- und Wochenschrift des Oesterreich. Ingen.- und Architekten-Verb.,' 1901.
1902. *F. W. Sprecher:* Grundlawinenstudien, 'Jahrbuch S.A.C.' 1902, p. 219 *et seq.*
1903. *A. v. Radio-Radiis :* Die Lawinengefahr für den Skiläufer, 'Oester. Alp.- Ztg. 1903,' p. 336.
1903. *W. Paulcke:* Alpentouren und Lawinengefahr, 'Deutsch. Wintersport,' 1903–4, p. 18 *et seq.*
1904. *M. Madlener :* Ueber Schneelawinengefahr, 'Deut. Alp.-Ztg.' 1903–4, p. 164 *et seq.*
1904. *H. Wödl :* Die Lawinengefahr bei winterlichen Hochtouren, 'Oester. Alp.-Ztg.' 1904, p. 73 *et seq.*
1905. *E. Zsigmondy :* Die Gefahren der Alpen (the chapter dealing with avalanches in the fourth edition). Innsbruck.
1905. *E. C. Richardson :* Ski-Running. Second edition. London. (See the chapter 'Ski-Mountaineering,' by W. R. Rickmers, p. 98 *et seq.*)
1905. *H. v. Ficker :* Winterschnee und Lawinenbildung. 'Oester. Alp.-Ztg.' 1905, pp. 13–20.
1906. *C. Ray :* Avalanches, the Terror of the Alps, 'Pearson's Mag.' May Number, 1906.

The Conquest of Ruwenzori.

By DOUGLAS W. FRESHFIELD.

ON January 12 our member H.R.H. the Duke of the Abruzzi read before the Royal Geographical Society, in the presence of its Patron and Vice-Patron, his Majesty the King and H.R.H. the Prince of Wales, an account of his recent explorations and ascents in the Ruwenzori range. The Duke's narrative has been printed in full in the February number of the 'Geographical Journal.' With the leave of the Duke and the Council of the Society the illustrations and map that accompany it are here reproduced. I propose to take the opportunity to join with them a few notes on the results of this most successful expedition.

I shall imitate the Duke of the Abruzzi in avoiding any lengthy discussion as to the identification of Ruwenzori with Ptolemy's Mountains of the Moon. It is enough for me that its snows feed two of the Nile lakes. But I may point out the sort of rumours which two hundred years and more ago were recorded in Arab chronicles. For it is highly probable that stories of the same kind reached the Greek geographer

Digitized by Google