Cambridge Himalayan

Snow Algae Expedition

1980

EXPEDITION REPORT

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Abstract

The primary object of the expedition was to study the nature and distribution of snow algae in the Ladakh Himalayas, and to monitor their environment. Snow samples were taken in the Leh region generally and more intensively from the Nimaling valley. Snow algae were found only in cryaconite holes, and not on the snow surface as had been expected. Nevertheless, distinct patches of pink snow were seen on the Zoji-la pass, so it may be that snow algae can be found in the region, possibly earlier in the year. Samples also contained rotifers, pollen and mineral debris. Environmental conditions were monitored on a daily and hourly basis, temperature records revealing greater variability in air, snow and water temperatures respectively, the algae appearing to favour the warmer and more stable environment.

Collections of lichens, mosses and pressed flowers were made for the British Antartic Survey, Cambridge, and the Institute of Terrestrial Ecology, Edinburgh. Bumblebees were sent to the British Museum and other research workers, and a report concerning their ecology prepared. A geological study was made of the Markha valley.

All the projects were successful, though the snow algae were much less widespread than initially expected.

ROUTE MAP

Introduction

The expedition took place between the 24th June and the 12th September, 1980. The members were:

Debbie Freeman, 21, Geographer - Leader

Paul McWhinney, 21, Medic

Simon Garth, 20, Engineer

Rachel Heath, 19, Geologist

Paul Williams, 20, Natural Scientist

Ladakh

The location chosen for our investigations was in the Nimaling Plain at the head of the Markha Valley about 50 km south of the town of Leh. Leh itself is a town of about 10,000 inhabitants, and provides the administrative centre for the surrounding region. Since the early 1970s, Leh has been open to foreigners, and this has led to a very rapid increase in the tourist trade, which is currently running at about 10,000 per year. The town cannot cope with these numbers, and unfortunately the traditional calm market town life-style is changing towards a much more aggressive tourist-based attitude. A prime cause of this appears to be the bi-weekly flights from Srinagar bringing tourists who still expect western standards of living at roughly western prices, and are not prepared to adapt to the local conditions. This change is bringing some degree of prosperity to the area, but, inevitably, also causes a good deal of resentment amongst the local people.

Location

The outlying villages in the Markha valley still retain many of their ancient traditions, largely due to their isolation. It takes 8 days to trek the length of the valley, starting at a height of 11,000 feet, and finishing at just under 17,000 feet. The population density is extremely low (the 1971 census gave 267 people living in the Markha valley) and these are organised as small villages situated on poor land, but close to fertile ground. Most of the villages are to be found below 13,000 feet, though there are several summer houses above this height.

Villages

The villages consist of a few houses generally clustered around a religious shrine or monastery. The houses are of simple construction, consisting of a ground floor made from stone, and a second storey made from mud bricks. The roofs are wooden poles stretching between the walls and covered with mud and straw. If possible, one wall is replaced by a natural cliff, as this provides both stability and shelter. Houses will either have pens for animals

outside, or a room on the ground floor where animals may be kept. The focal point of the house, the kitchen, is almost always on the second floor, and is kept meticulously clean with the family's selection of pots and pans lining the walls in the form of decoration. In the centre of the room is a mud stove, some form of table, and in the richer households, a rough woven carpet.

Climate

The climate of Ladakh is extremely varied, and does not always live up to the textbook predictions. Almost everywhere you look, a figure of 3" - 4" is quoted for the annual rainfall in Leh. We were unable to confirm or refute this statement at first hand, but talking to the local people in Leh gave us the impression that approximately this much rain had fallen during the summer months, which meant that no account has been taken of the main precipitation when the snows come in the winter. This is not an indication of the inherent inaccuracy of the textbooks, but rather is caused by a seemingly fundamental change in the local climate towards a wetter summer. The overall climate in the Markha region falls into three distinct periods. The following relates to the region around the town of Markha (about 12,000 feet) and applies generally with the compensation of about 1° C per 300 feet of altitude.

Summer: May-October. The air temperature is about 20° C at midday, but is seemingly much hotter, due to the high levels of incident sunlight. Night-time temperatures in the region of 15° C. Dry, frequently still air and little cloud covering.

Autumn: November-March. Permanent hard-packed snow on the ground.

Winter: Daytime temperature around freezing, though quite bearable due to the high levels of sunlight. Night-time temperatures are some of the coldest in the world, with recorded temperatures of below 40° C in the mountains.

Spring: March-April. The months in which all the snow melts. Daytime and night-time temperatures increasing towards their summer values.

Agriculture

The problems of agriculture in Ladakh are immense, but with the primitive tools at their disposal, the local people manage remarkably well to provide enough food for themselves. Indeed, while obesity is unheard of, so is starvation, though the balance of the diet may leave something to be desired, particularly with respect to some vitamins and minerals. There is currently a nutrition programme being run by the 'Save the Children' charity, to try to relieve this problem. The main crop is barley, which is grown universally up to an altitude of about 13,000 feet. At lower altitudes additional crops such as wheat and vegetables are grown. The crop cycle is very efficient, as it has to be fitted into the six summer months. Each village has its own, often very complex irrigation system, which is fed from the Markha Chu (river) which in turn is fed from the glaciers at the head of the valley. The fields are ploughed and sown by the men, and weeded and irrigated by the women, and finally reaped by men, women and children alike. No artificial fertiliser is used, but any dung (including human) is collected and ploughed into the ground at sowing. As a result, the overall yield is about 200 kg of barley per acre. Above 13,000 feet, the land is used exclusively as pasture for numerous animals. Each household may have some horses, mules and donkeys for load carrying (particularly firewood, which is a valuable commodity), goats and sheep for food and wool, and a few yak or dzo (cross between yak and cattle) who are beasts of burden. In addition, a household would have at least one dog, whose function is to guard the goats and sheep, particularly from wolves. Each day the sheep and goats are driven up to the fertile pastures, returning at dusk to their pens at the village. Overall the Ladakhis have an extremely well-organised agricultural regime, managing to produce sufficient in the summer months to give ample food for them and their animals throughout the harsh winter, and without over-farming the locality.

People

The basic structure of the population centres round the family unit. Polyandry is practised (though is declining) whilst younger sons either work

or go and live in the monasteries. The main job of the men is to look after the land, and to perform the more arduous tasks. The women do lighter work in the fields (weeding etc) and look after the home. They also produce most of the chang (beer), tsampa (ground roasted barley) and dairy produce, as well as spinning wool. The wool is taken from sheep, goats and yak. Depending on the animal used, the wool is either made into clothing or woven into long strips about a foot wide, which are then made into such things as carpets and saddle cloths. It was difficult to judge the ages of the people, but we had several reports of people aged 70 or more, so it would seem that if they survived to adulthood, there was a good chance that they would continue to a respectable age, though the harsh winter does take its toll, especially on the children. In general, the society we found was more stable than any other we had ever seen. Such social evils as theft and murder are almost unknown, and everyone works together for the survival of the family unit. This sort of attitude is characteristic of the people throughout Ladakh, and is carefully interwoven with their devout Buddhist faith. No doubt the increase in tourist traffic will bring the west to Ladakh, but let's hope not in such a way as to destroy the essence of their civilisation.

Bibliography

Asboe, W. (1947) 'Farmers and Farming in Ladakh (Tibetan Kashmir)'. Journal of the Royal Central Asian Society XXXIV, 186-192.

Lamb, A. (1966) 'Crisis in Kashmir". (London)

University of Southampton Ladakh Expedition 1976 report.

Diary

Landing in Delhi caused us a greater shock than we could have imagined; we stepped into the airport bus hoping that we would get away from the heat of the engine as quickly as possible, only to find that the temperature and humidity were not related to the aeroplane at all. It was 25 °C in the dead of night. What the next day would bring we didn't dare imagine. After passing through customs, we were greeted by what seemed like hundreds of rather underfed Indians; we were the centre of attraction for some minutes, which was hardly surprising, since we were wearing our warmest of jumpers, thick socks and heavy walking boots. After discussions and attempts to use the public telephone, we decided to try to find a room in the YMCA tourist hostel. At this time we knew nothing of taxi fares, so we gestured to one of the nearest drivers, of which there were dozens, to drive us there. It cost a sum of 40 Rs plus two pieces of chocolate; later we found that the average price from the airport to the city was a quarter of that, a lesson well learned.

The YMCA provided comforts which we didn't expect to find for 90 Rs a night, but nevertheless we decided to leave the city as soon as possible. Thus the following day was spent in attempting to buy tickets to travel to Srinagar, a task which involved a great deal of patience and energy in the scorching sun, with temperatures up to 39 °C.

Buying rail tickets in India involves having a reservation in your hand ready for the ticket you are about to purchase. In Delhi this was made as difficult and as tiring as possible by placing the reservation office on one side of the city, and the railway station on the other. When travelling from one to the other, we changed traveller's cheques at a bank, which we decided to do as rarely as possible in future, after waiting to be served for over an hour. Our tempers were understandably frayed, and a mango shake in the city's air conditioned market was welcome to everyone.

Before the expedition had set out from England we had arranged to meet Paul Williams, the remaining member of a collapsed Bhutan expedition. He was

to study bees there, but was denied permission to enter the region for political reasons. Still wanting to continue his studies, Paul joined our expedition to Ladakh, and was to fly to Delhi on the 30th, where we were to meet him at the airport. Our decision to leave thus meant that we had to inform him of our change in plans. Two telegrams were sent to England, and messages left in the YMCA. As it turned out we needn't have bothered, as neither arrived!

The road from the city centre to the railway station was lined with tents and Indians selling everything from lychees to haircuts. At the railway station, after much queueing (something we were quite accustomed to by this time) Debbie managed to buy tickets for a second-class sleeper to Jammu, which would take 24 hours, and costing a surprising fare of only 35 Rs each (£1 = 18.27 Rs).

The mundane tasks for the day over, we returned to the YMCA, and were able to spend the afternoon meandering down the market streets at leisure. We came to realise that carting a rather heavy pressure cooker from England was perhaps not the best of ideas, since they were on sale in the markets for the equivalent of £7.50.

The next day was spent working towards catching the train at 6.05 pm. We arrived at the station about 2 hours early, which was just as well, because finding our allocated berths was much more arduous than we had expected. One's name is actually posted onto the side of the carriage; however, the writing tends to be rather illegible and the trains are incredibly long, meaning that with hordes of people crowding the platforms, you have little chance of finding the correct carriage. The 'berths' were no more than wide planks of wood about 5½ feet long, in tiers of 2 or 3, but anywhere to lie at this time of day was greatly appreciated. Commuters eager to try their English halted our chances of an early night, but we found most of them to be pleasant and helpful, so we didn't mind at all. Our 'meagre' supper consisted of Nestles' milk, bananas, peanut butter and bread - an Indian family close by considered our eating habits rather strange, and taking pity, shared their rice and mangoes with us.

Sun rose at 5.30 am, and by 8.30 the foothills of the Himalayas could be

seen. We arrived in Jammu and within an hour we were packing our luggage onto the roof of a bus bound for Srinagar.

In Srinagar "everyone stays in houseboats" or rather the local Kashmiris expect foreigners to want to stay in houseboats. Hence we were pestered on the bus by one such owner, who insisted that his accommodation was the cheapest, and if we didn't go to the tourist office, he would pay for the taxi to get to the boat, etc. We were all very tired from the journey and didn't really mind being cheated, as long as it meant we would have a reasonably good night's sleep - and anyway the Kashmiri hadn't seen the amount of luggage he would have to transport, which we had on the roof of the bus! We were paddled to the houseboat in a shikara, a small wooden boat available for hire at extortionate prices (3Rs at night) to people wishing to return from the shore.

The following day was spent with Rahim (the Kashmiri) who showed us places of necessity, such as the bank which happened to be closed, and the tourist office which was crammed with queues to the information desk. Rahim suggested that we went to his 'uncle's' carpet shop; it must be said here that all Indians seem to have uncles or cousins who own shops that one really must visit. The Kashmir carpets were absolutely beautiful, and were 'very cheap' in price, 'very cheap' being anything from £200 to £1,000.

The afternoon saw us exploring Srinagar for alternative accommodation. What was expected to be a 3-hour jaunt turned out to be a rather tiring 10-hour slog, as our tourist map was a smaller scale than we realised, and as a result, we were all extremely tired and hungry; chapatties and dahl at a cheap restaurant were most welcome. The next day our visit to the tourist office was more than productive; we met Paul Williams, who had flown from Delhi, and had been talking to some of the locals who had apparently seen us around.

Having found Paul, we set about the serious business of buying food in Srinagar, to transport to Leh. Judging the amount of food we were likely to eat in five weeks was a difficult business; 12kg of rice seemed rather a large quantity at the time. The task was made easier by trying to stick to Indian-style nutrition. This was by far the cheapest way, and products were very easy

'The highest road in the world'

Srinagar to Leh.

Camp at the head of the Markha valley

to find. However, our desire for biscuits led us to buying tins of 'Krackjack krackers', good value, but a decision we were to regret when we were in the mountains. Packing the food and general luggage consumed most of our time the following day. A lot of the food was packed into a tea chest; that, as well as 10 rucksacks and 2 x 15 litre bottles of kerosine made our load extremely heavy.

The 5th of July saw us manoeuvring the load onto a very small shikara at 5.30 am, with the assurance from Rahim's brother that nothing would fall into the water - we accepted this with some uncertainty, but arrived at the shore safely, to be greeted by dozens of the local males taking their daily bath in the lake. A taxi journey to the bus station was rather expensive, but the fact that we arrived there in one piece made us soon forget about the price.

The 'B' class bus arrived at 8.00 am, however, before loading, the luggage had to be weighed, and excess baggage paid for - a total of 116 Rs. Manhandling the gear to the roof frayed tempers and was rather energy-consuming, but after much sweat, we settled into a rather rough-looking bus for the two-day journey ahead of us.

The 'Jammu and Kashmir Public Carriers' have to be travelled on to be believed, not that the seat room is excessively small, but one is destined to be arch enemies or intimate friends with one's neighbour after such a journey. The road for most of the time was incredibly steep, and was cut into the valley-side, meaning that at any one point we rarely exceeded 20 mph. The scenery compensated for this, though being one foot away from a 2,000 foot drop on a very tight hairpin on several occasions made us more than a little agitated.

The climate towards Leh was appreciated after the sheer hell of Delhi, the air actually felt cold at times! The overnight stop was at Kargil, where dozens of children leapt aboard the bus as soon as we stopped, quickly describing their very cheap hotels where we might stay the night. Prices ranged from 4 Rs to 10 Rs a night; we opted for a 5Rs place which apparently had a shower. We later found out that this was merely a tap 3 feet above the ground, and wasn't working.

The bus left in the morning at 5.30 am; the scenery was again spectacular, though the roads, much to our relief, were not as tortuous as on the previous day. At dinner time we decided to try one of the doubtful-looking eating places on the side of the road. Everything was curried, of course, but the meal was very filling, and much appreciated. When we had finished, a small boy took our plates away to the nearest puddle, and washed them! We decided that perhaps our decision to eat here was a mistake after all.

Paul Williams attracted a crowd of intrigued locals when he appeared with his bee net, and began hunting around in the vegetation.

Leh didn't look as we expected it to from the road - a dusty haze in the distance, with army camps and numerous petrol stations leading up to it. After examining the Fodor's guide, we decided that we should make for the Dak bungalow as soon as we arrived. However, when we stopped, we were again confronted by locals advertising their accommodation. We managed to work our way through the crowd, and after much struggle we found the tourist office, only to hear that the Dak bungalow was full. The assistant tourist officer, a young man called Hussein Khan, suggested that we should stay at his house while we were in Leh. This we did, and after tasting the delights of Ladakhi tea, we ate in a Tibetan restaurant in the town. We were given a room on the roof of the house, the whole of one side of which was windowed, looking towards the mountains in the South. The sun in the mornings here was extremely bright, and by 8 am most days the heat was almost unbearable. Up to the present we had eaten really well, and decided that perhaps we ought to begin on our five week supply. We divided everything into daily rations, with breakfasts consisting of porridge or cornflakes, dinners of krackjack biscuits and jam, or on day 3 of each week processed cheese, and teas of dried Batchelors' food (brought from England) and rice, with or without lentils. The five sacks which resulted from this seemed to contain a fair quantity, and we wondered whether we would actually need it all, but we were reassured by Paul and Simon that there wasn't too much.

Hussein introduced us to Deen Khan, his brother, who was involved with the Save the Children Fund, and knew various horsemen from the surrounding valleys

who would take us into the mountains. His English was excellent, and thus he acted as an interpreter for us and the horsemen. We arranged to catch a local bus to Kharu, some way along the Indus Valley east of Leh, and then take about 3 days' walking to get to the Nimaling plain at the head of the Markha valley, which is used as summer pasture for the inhabitants of the latter. The last day in Leh was spent exploring the place. The effect of altitude was quite noticeable, and we found that we tired very easily. We climbed up to the monastery which overlooked the town from a huge granite outcrop. The trek up was very tiring in flimsy leather sandals, but the reward of the view of Leh made the effort worthwhile. The houses in Leh resemble boxes, and are packed closely together, with gullies running between them. Beyond those, further up the valley, the land is irrigated from the river, and barley forms the major crop.

We arrived at Kharu on the 10th July at 10.30 am, wondering whether the place actually deserved a name; admittedly there was a passport checkpoint manned by the army, but the rest of the 'village' consisted of only two shops/houses and one toilet - a wooden hut on stilts about 200 yards away from the shops towards the Indus!

The midday heat was virtually unbearable, and we did our best to keep out of it by staying in a room we were loaned for the night. The area around Kharu was totally barren, with a boulder-strewn valley floor stretching for miles until it reached the scree slopes of the mountains. At about 3 pm the horsemen arrived with two donkeys, three mules and a horse. The horse was to be kept for riding, as up until now, Paul Williams hadn't been in a fit state to walk far. We arranged a time to set out the next day by way of watch-pointing gestures. 5 am saw us getting up and packing everything and by 7 am the animals were loaded, and we were walking behind them in a southerly direction. The pace at first was easy to manage, but within half an hour we found we were lagging behind the horses. Paul McWhinney actually found the energy to collect some algae along the valley, and seemed to suffer no shortage of breath. We realised that state was primarily due to the altitude rather than lack of fitness, but this helped none, especially when the mountains began to look

blurred, and we occasionally found it difficult to talk in sentences. The rain came down heavily that afternoon; Paul McWhinney and Rachel were out of sight of the horses, and took refuge in a cave on the valleyside, along with 3 Ladakhis who were travelling from Markha to Gya. Simon greeted them half an hour later with kagoules, and they steadily made it to the camping place for the night. On the second night we camped at the base of the 17,500 foot pass to the Nimaling plain. We reached the top in three hours, after a very arduous climb; the view from the pass would have been excellent if the cloud hadn't obscured the mountains. We arrived in the Nimaling plain and pitched our tents, collapsing into our sleeping bags thankful that we didn't have to get up early the next morning. The horsemen were paid and went.

The next few days were spent exploring the area for snow algae, rock outcrops and lichens. Paul Williams was busily catching bees, actually finding two previously unrecorded species. Our food fantasies were by this time becoming unbearable to listen to, and even the coffee cake we cooked in the pressure cooker didn't really satisfy our desires.

On the 18th of July, Sir Robert Foulkes, who worked with Deen Khan, arrived at the camp, and arranged with one of the local horsemen to take us further up the valley towards the glacier, since our snow algae findings had not been particularly impressive and we were too far from the snow line to take any regular samples.

In the mornings at the first camp we were frequently greeted by the Ladakhi children from a nearby village, who would sit and stare intently into our tents, spinning wool with their hands onto a spindle. The children actually helped Debbie with her flower collection, and managed to point out many species from drawings in a book. The effect of altitude was still noticeable to us all, and our walks usually took twice as long as expected. The scale of the mountains and valleys was incredible; we would often see a place to visit for various studying purposes, thinking that it might take us about an hour, only to find that we had been walking for 2½ hours and didn't seem to be any closer to our destination.

On the 24th of July the head man of the Markha Valley, called Largil, arrived with horses and donkeys to transport our gear to the glacier. Largil and his helper Tesha were really jolly, and, although their English was limited to no more than ten words and our Ladakhi was non-existant, we managed to convey our needs adequately.

Paul Williams had not by this time recovered from an illness, and so it was decided that he should be taken back to Leh; Largil and Tesha took him after transporting the rest of us to the head of the valley.

The nights were distinctly colder; we had moved about 1,000 feet upwards, and very often had to break the ice in the water container before making tea and porridge in the mornings. The following few days were spent pursuing our own fields of study; Debbie was busily taking photographs and samples of lichens and flowers, Paul and Simon were gathering numerous samples of snow from the glaciers and surrounding snow at the head of the valley, and Rachel was making geological observations and collecting rock samples. We could never really become accustomed to the diurnal temperature range; some mornings began with the sun scorching our skin, but even so, as soon as the sun disappeared behind a cloud it became bitterly cold. On the third afternoon here it began to hail, with hailstones that didn't only irritate but actually hurt when they hit you. Debbie and Rachel decided that the inclement weather was a good enough reason to start cooking something more filling than usual for tea, and managed to make cheese and onion flan and custard tart in the pressure cooker!

We found that because of our activities during the day we were usually in bed before 9 pm, and that if we had anything less than 11 hours sleep we were quite tired the next day. On the 27th of July we awoke to find the ground covered with snow, about an inch deep. The change in weather from the previous day was quite remarkable, and ruined our intentions of visiting the main glacier that day. We did manage to head up the valley the next day, armed with crampons and ice axes, and although we set off in bitterly cold weather by lunchtime the sun was scorching. The glacier looked relatively smooth from the new snow, making us extra careful in the search for crevasses. We climbed down the

snout after collecting some snow samples, not arriving at the tents until 3 pm.

Our limited variety of food rapidly led some of the more miserable hours to degenerate into food fantasies; these were rather elaborate at first, but by the time we were to walk back down the valley we were just longing for good wholesome food of any kind.

Paul had been searching for snow algae for some days now, eventually finding some in cryaconite holes on the glacier. Although we had expected to find them at the edge of the glacier in the melting snow we were rather relieved at their appearance. Thus Simon and Paul spent the next two days arranging a rpoe up the 150 foot glacier snout, to enable us to record hourly temperatures over a period of 48 hours.

Meanwhile Debbie and Rachel were busily collecting lichens and flowers, and extensively searching for rock exposures. They saw one fairly large dyke in the distance which they thought would be worth examining, and so one freezing morning ventured up the valley side and along the ridge. They remembered at this stage that distances in the mountains are extremely deceptive, and after 4 hours' hard walking the the dyke didn't seem to be getting any closer. They eventually arrived after 5 hours' hard walking, to find that the dyke was over 200 feet high.

Saturday 2nd August saw us all setting off to a tributary glacier at 6.30 am to monitor temperatures. Debbie and Rachel took the first set of readings over a period of twelve hours, then were relieved by Paul and Simon at 7 pm. We found that climbing the glacier was extremely tiring and at first rather frightening, and that crossing the melt water channel to actually get to the glacier was equally as arduous, especially at midday, when the flow increased dramatically and the water turned a condemning rust colour. Paul and Simon spent that night and the following day at the glacier, and Rachel and Debbie took over at 7 pm. By 7 am the next morning they were very tired and hungry, but felt content in that they had lasted the night without any major catastrophes (at 2 am Debbie dropped the torch batteries, and so they relied on candles for

guidance back to the shelter!).

Needless to say the following day began fairly late, with Paul and Simon taking a daily temperature reading at 10.15 am.

Our last few days at the head of the valley were spent organising food and luggage for our trek back, as well as taking the daily temperature reading. Largil and Tesha arrived at our camp on 10 August, with two horses and four donkeys. It was a pleasure to realise that after such a long time we were eventually starting for home, but all the same it was difficult to see the mountains slowly disappearing without a feeling of sadness.

We camped that night at our original campsite, and we were introduced to the staple diet of the Ladakhi people: Tsampa, roasted barley flour, which is often mixed with a most delightfully refreshing drink - chang, a sort of weak beer, which is also made from barley.

As we moved down the Markha valley the climate became more tolerable, and we even managed to sleep without wearing thermal underwear. The scenery was nothing short of beautiful. The trekking route ran through the bottom of the valley, and was enclosed on either side by barley fields and very large rock outcrops. We discovered on reaching Markha that food supplies were rapidly diminishing, and we only had enough for four more nights. Using hands we conveyed our problem to Largil, only to discover that we had five days to go. As a result, our food consumption was reduced, leaving us with a permanent hunger pain. Thus most of our days walking were spent fantasising about food. It was in the middle of such when we came across an expedition group from Oundle School: a group of twenty young men had come to climb Kang-y-sey, a 21,000 foot peak to the south of the Nimaling plain. We were greeted by them with the knowledge that bread had been freshly made. We ate three loaves, much to the amazement of the Oundle people, who admitted that we did look somewhat lean.

Two days later we were back in Leh. This was probably more of a culture shock than arriving in India in the first place, but we soon got over that, as we sat in the local tea shop, satisfying our craving for food.

Snow Algae Report

Algal Collections

1) Limited collections were made in the Leh region, and more extensive ones in the Nimaling Valley.

2) A number of snow samples were collected from the Nimaling Valley, most of which were contaminated with pollen. Snow samples were 10 ml of packed snow, and were either a) unpreserved, b) preserved with iodine, or c) preserved with formalin.

3) Samples were taken from cryaconite holes, including scrapings of the sediment from the bottom. They contained a number of rotifers, as well as algae (especially Chlamydomonas nivalis).

While crossing the Zoji La we saw a number of reddish snow patches from the coach, but whether these were algae or rock dust remains open to conjecture, and on our return six weeks later, when we had been hoping to sample them, most of the snow fields had melted completely.

Snow samples were examined back at camp, using a Vickers field microscope which proved to be invaluable. For examination, the specimens were gently thawed out and left to stand for 12-24 hours. The sediment was always examined, and occasionally the supernatant, which was always negative.

Appropriate samples were then retained.

Many of the snow samples had traces of plant material in them, which in some instances must have been blown for considerable distances. This would aid the growth of algae.

On the 12th July at 11.30 am, two samples of reddish snow were taken from the Kongmaru La. These were heavily contaminated with mineral debris, but also contained a few seven-pointed bodies with well-demarcated green centres. (Fig 1).

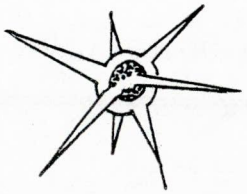


Figure 1.

On our return for closer inspection, this patch had thawed completely.

Thereafter a large series of snow samples were collected from around 20,000 feet, but these proved to be disappointing. Many gave the remarkable pH of 5.5 with 'Whatman' narrow range litmus paper. Many of the samples contained pollen, most likely to be of the Pinus species. (See Fig 2)

Figure 2.

The source of this pollen remains obscure.

Finally we turned our attention to the numerous cryaconite holes on the glacier systems at the head of the Nimaling Valley, and had more success in finding algae, though the study of cryaconite holes had not been one of our original objectives. The holes varied widely in size, and were mostly situated in rotten snow resting on ice. They were quite heavily sedimented. From our temperature measurements, it appears that they offer a more stable environment than the surrounding snowfield, but on the other hand, a number of the holes were observed to dry out during our study of them. Despite a number of snowfalls (some of them heavy), the holes always melted completely during the day. The largest holes were 36 cm in diameter and 18 cm deep, containing 12.5 cm of water and 2.5 mm - 7 mm of silt. The commonest holes measured 3 cm - 6 cm in diameter, and 13 cm deep, with 6.5 cm of water, and a little sediment. The smallest holes were about 2 cm in diameter. The depth of the holes was remarkably constant in all sizes. They were most frequent near the glacier snouts, where there was much surface water flowing through the snow. In general, the holes were away from the main streams, and sediment from these had considerably lower populations of algae etc. than sediment from the holes. This would appear to be the first report of snow algae or cryaconite holes in this region.

The sediment was principally composed of rock dust, but contained large numbers of motile algae and at least two species of rotifer.

Temperature Monitoring

This was done using thermistors and an AVO DAZ11 meter. The air temperature was taken under a sun shield, in an attempt to cut out direct heating.

The three snow surface thermistors were left in place and the air thermistor was used for the water measurements. If a film of ice was present, a small hole was punched in it.

Hourly temperature recordings were made over two days, and a daily temperature was taken for a further five. Three representative holes were selected, and as the results from these were similar, the mean was taken to produce graphs 1 and 2.

Over any one day, it is clear that there is almost as much variablility in the water temperature as in the snow temperature (2° to $2\frac{1}{2}^{\circ}$ C). The water in the hole averaged $3/4^{\circ}$ C, warmer than the surrounding snow.

Over the week, the hole temperature varied only by $\frac{1}{2}^{\circ}$ C, compared with $1\frac{1}{2}^{\circ}$ C variation in the snow temperature. This relative stability would need a longer study to confirm the significance of this.

It is interesting, however, to note that the holes are distinctly warmer than their surrounding environment.

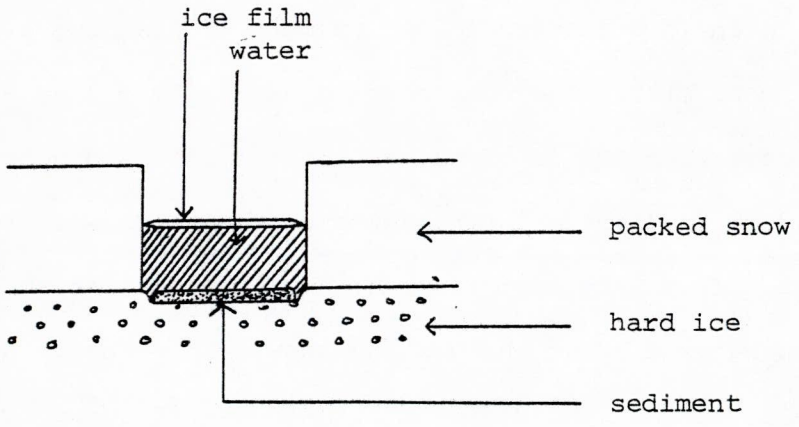
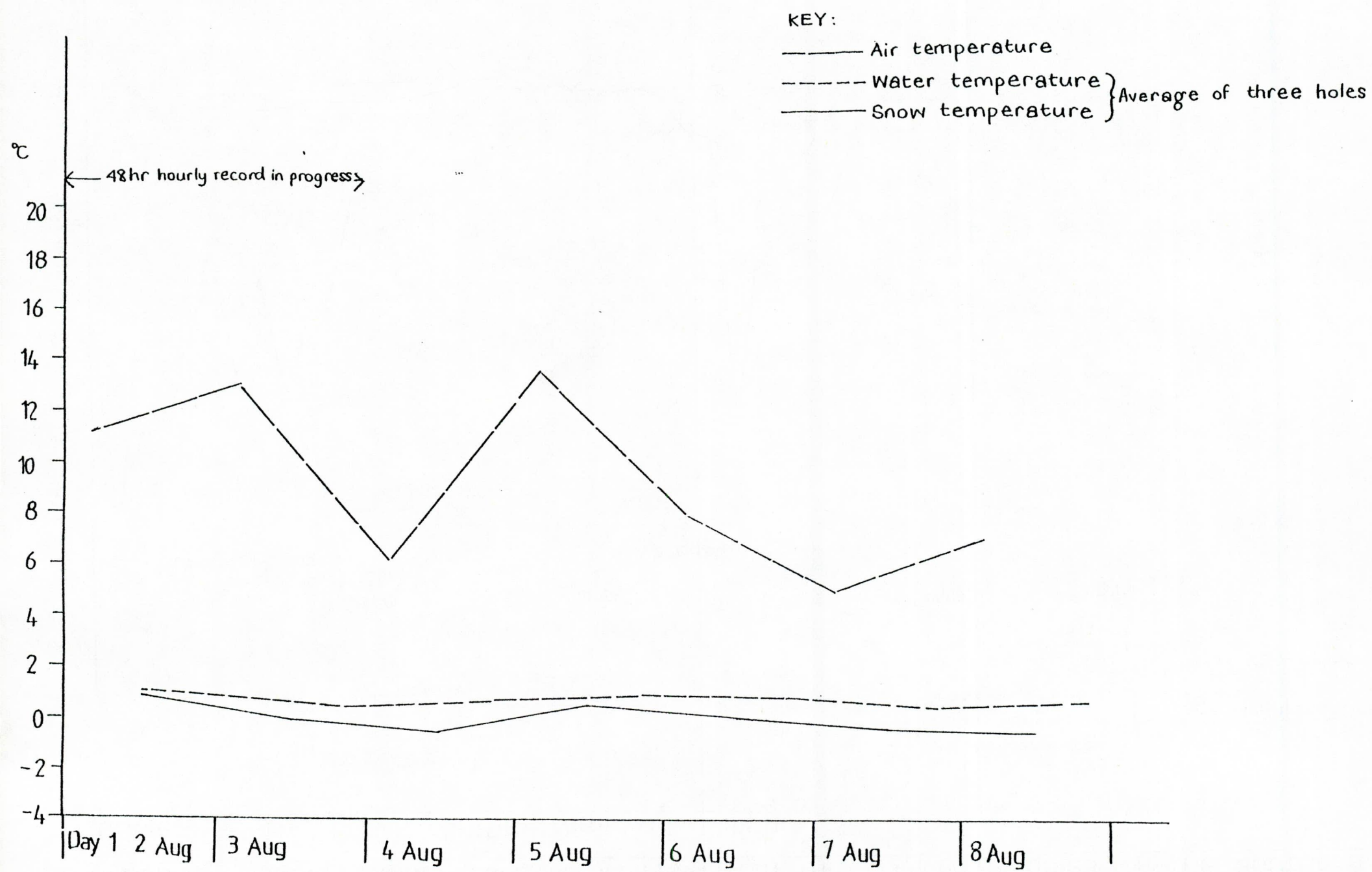
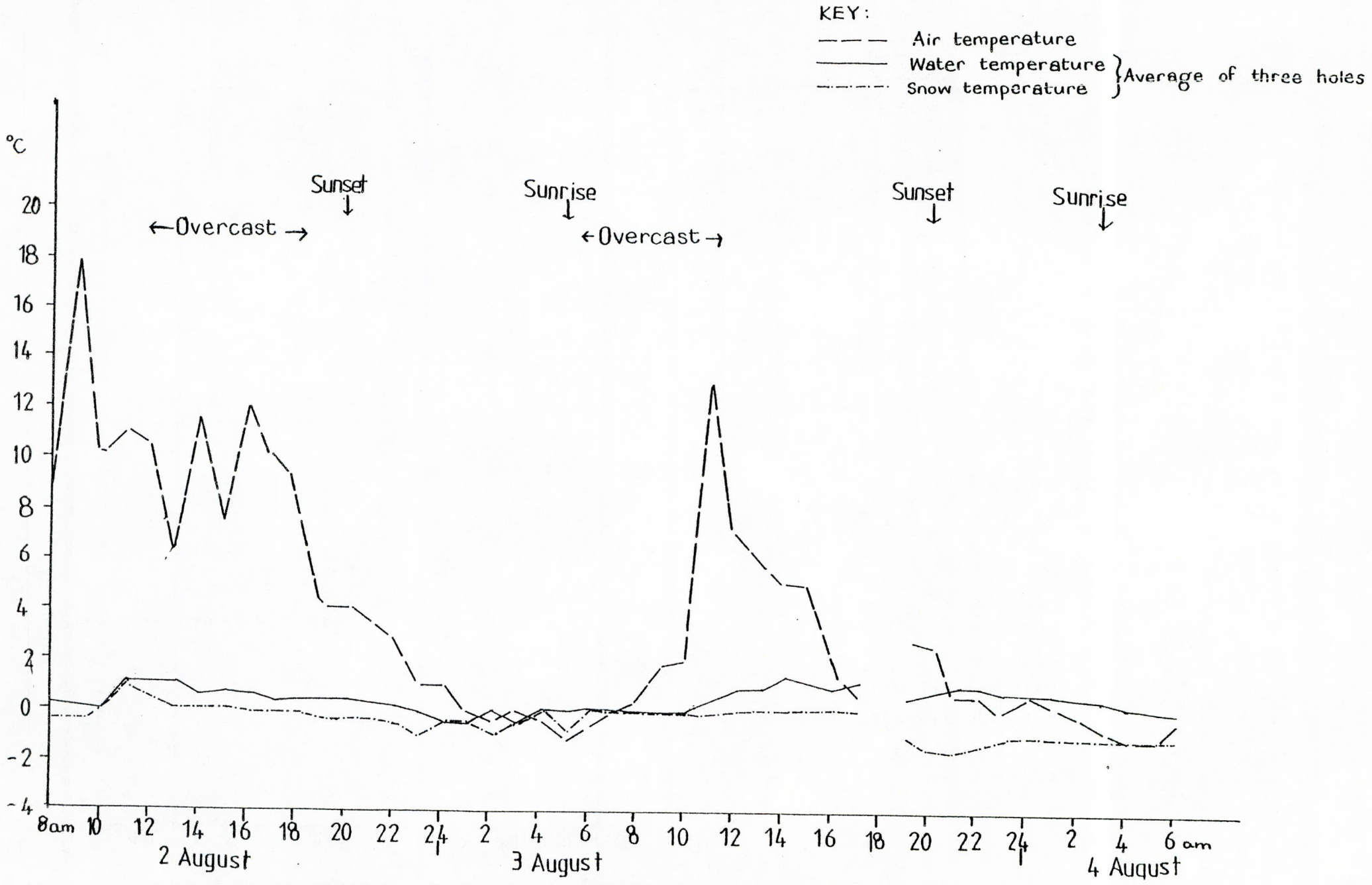


Figure 3.
Cross section of a cryaconite hole.

Graph 1: Daily temperature recordings from three cryaconite holes on the southern glacier at the head of the Nimaling Valley.



Graph 2: Hourly temperature recordings from the cryaconite holes on the southern glacier at the head of the Nimaling Valley.



Botanical Report

Species of vascular plants, bryophytes and lichens were collected in the region above 15,000 foot in the Nimaling Plain. These included:

i) C85 vascular plants, 69 of which have been identified to Genus or further.

ii) C40 lichens, the majority of which were crustose, attached to large granite boulders and shale fragments in the lower part of the valley, giving way to thallose and fruticose forms found in the loose soil of the terminal moraine close to the glacier snout.

iii) Three mosses found in the more moist areas of the valley floor.

The lichen species will be deposited with the British Antarctic Survey, Cambridge, and the mosses with the Bryophyte Project Group of the Institute of Terrestrial Ecology, Edinburgh.

A preliminary list of vascular plant species is included. These were very kindly identified by Mr C. A. Chadwell. Identifications not yet verified are indicated in parenthesis.

Preliminary Species List

ADIANTACEAE	
Cystopteris fragilis (L.) Bernh	Brittle Bladder Fern
RANUNCULACEAE	
Ranunculus puchellus C.A. May	Buttercup
Thalictrum alpinum L.	Alpine Meadow Rue
BRASSICACEAE (CRUCIFERAE)	
Draba oreades Hk.f.	Whitlow grass
Draba sp.	
Draba sp.	
(Draba sp.)	
CARYOPHYLLACEAE	
Silene gonosperma (Rupr.) Bocquet	Campion
Stellaria palustris Retz	Stitchwort
Arenaria musciformis wall.	Sandwort
BIEBERSTEINACEAE	
Biebersteinia emodi Jaub. & Spach.	
FABACEAE (LEGUMINOSAE)	
Astragalus sp.	Vetch
Astragalus sp.	
Astragalus sp.	
Oxytropis microphylla D.C.	Oxytropis
Oxytropis tartarica Camb. ex Bunge	
Oxytropis sp.	
Caragana versicolor wall.	Dwarf Tibetan Furze
ROSACEAE	
Potentilla bifurca L.	Cinquefoil

Potentilla multifida L.	
Potentilla (sericea L.)	
Sibbaldia tetrandra Hook. F.	Sibbaldia
CRASSULACEAE	
Rhodiola rosea L.	Stonecrop
Rhodiola (Crassipes Wall. ex Hook. f. & Thorns)	
SAXIFRAGACEAE	
Saxifraga sibrica L.	Siberian Saxifrage
APIACEAE (UMBRELLIFERAE)	
(Pleurospermum sp.)	Pleurospermum
POLYGONACEAE	
Polygonum aviculare L.	Bistort
Polygonum tortuosum D. Don	
Polygonum viviparum L.	Alpine Bistort
Rheum webbianum Royle	Rhubarb
URTICACEAE	
Urtica hyperborea Jacq.	Nettle
PRIMULACEAE	
Primula rosea Royle	Primula
GENTIANACEAE	
Gentiana carinata Griseb.	Gentian
Gentiana sp. (algida)	
Gentiana sp. (humilis Steven ex Bunge)	
SCROPHULARIACEAE	
Pedicularis cheilanthifolia Schrenk.	Lousewort
Pedicularis rhizanthoides Schrenk	
Pedicularis sp.	

LAMIACEAE (LABIATAE)	
Elsholtzia eriostachya Benth.	
Dracocephalum heterophyllum Benth.	Dragonhead
ASTERACEAE (COMPOSITAE)	
(Gnaphalium sp.)	Cudweed
Aster heterochaeta C.B. Clarke	Aster
Leontopodium nanum (Hook. f. & Thorns.) Hend.	Edelweiss
Tanacetum fruiticulosum Ledeb.	Tansy
Tanacetum sp.	
Saussurea sorocephala Hook. f. & Thorns.	Saussurea
Hieracium sp.	Hawkweed
Taraxacum sp. (cf officinale)	Dandelion
Waldheimia glabra (Decne) Regel.	
Waldheimia tomentosa Decne.	
(Cremanthodium sp.)	
LILIACEAE	
Lloydia serotina Roxb.	Snowdon lily
JUNCACEAE	
Juncus triglumis L.	Three-flowered rush
CYPERACEAE	
Carex nivaus Both.	Sedge
Carex moorcroftii Falc.	
Carex stenophylla Wahlenb	
Carex sp.	
POACEAE	
Festuca koelzii	Fescue
Festuca sp. (nitidula Stapf.)	
Festuca sp. (tibetica)	

Poa sp. (koelzii Bor.) Meadow grass

Elymus conge-aristatus (Nevski) Tzvelev

Trisetum spicatum (L.) Richt.

(Trisetum sp.)

(Bothriochloa sp.)

Christolea crassifolia

Bibliography

Blatter, E. (1928) 'Beautiful flowers of Kashmir'. Vols. 1 & 2, London.

Clapham, A.R. et al. (1962) 'Flora of the British Isles'. C.U.P.

Coventry, B.O. (1923-30) 'Wild flowers of Kashmir'. Series 1-111, London.

Fitter, R.A. (1973) 'The wild flowers of Britain and N. Europe'. Collins.

Grey-Wilson, C. (1979) 'The alpine flowers of Britain and Europe'. Collins.

Heywood, V.H. et al. (1978) 'Flowering plants of the world'. O.U.P.

Hooker, J.D. (1872-97) 'Flora of British India'. 7 Vols, London.

Hubbard, C.E. (1976) 'Grasses'. Penguin.

Hyde, H.A. et al. (1969) 'Welsh ferns, clubmosses, quillworts and horsetails'. National Museum of Wales.

Jermy, A.C. & Tutin, T.G. 'British sedges'. B.S.B.I.

Kachroo, P., Dhar, U. et al. (1977) 'Flora of Ladakh'. Delhi.

Schweinfurth, U. 'Die horizontal und verticale verbreitung der vegetation in Himalaya'.

Stewart, R.R. (1916) 'Flora of Ladakh'. Bull. Torr. Bot. Club, 43: 571-590 & 625-650.

Unpublished lists of species collected in Kashmir

Christopher A. Chadwell (1980)

Roy Lancaster (1978)

Aleg Polunin (1980)

N. Robson (1971)

Cambridge Himalayan Snow Algae Expedition 1980

80/8.

Acle

MOUNT EVEREST FOUNDATION

ST JOHN'S COLLEGE
CAMBRIDGE.
CB2 1TP
30 SEPTEMBER 1982

Dear Brigadier Baker Wyatt,

Enclosed is a copy of the report of my 1980 expedition. I am sorry for the delay in publication which was due to circumstances beyond our control.

Many thanks for your support of the expedition.

Yours faithfully,

Simon Carth

SCJ CARTH

Silene gonosperma

Paul Williams and Malaise trap

Geology Report

Introduction

The Indus tectonic belt is a remnant of the oceanic crust between Asia and the Indian subcontinent. Today it is seen to be composed of two major structural units: i) The Dras Volcanics and the Sumdo sedimentary zone,

ii) The Indus sedimentary zone.

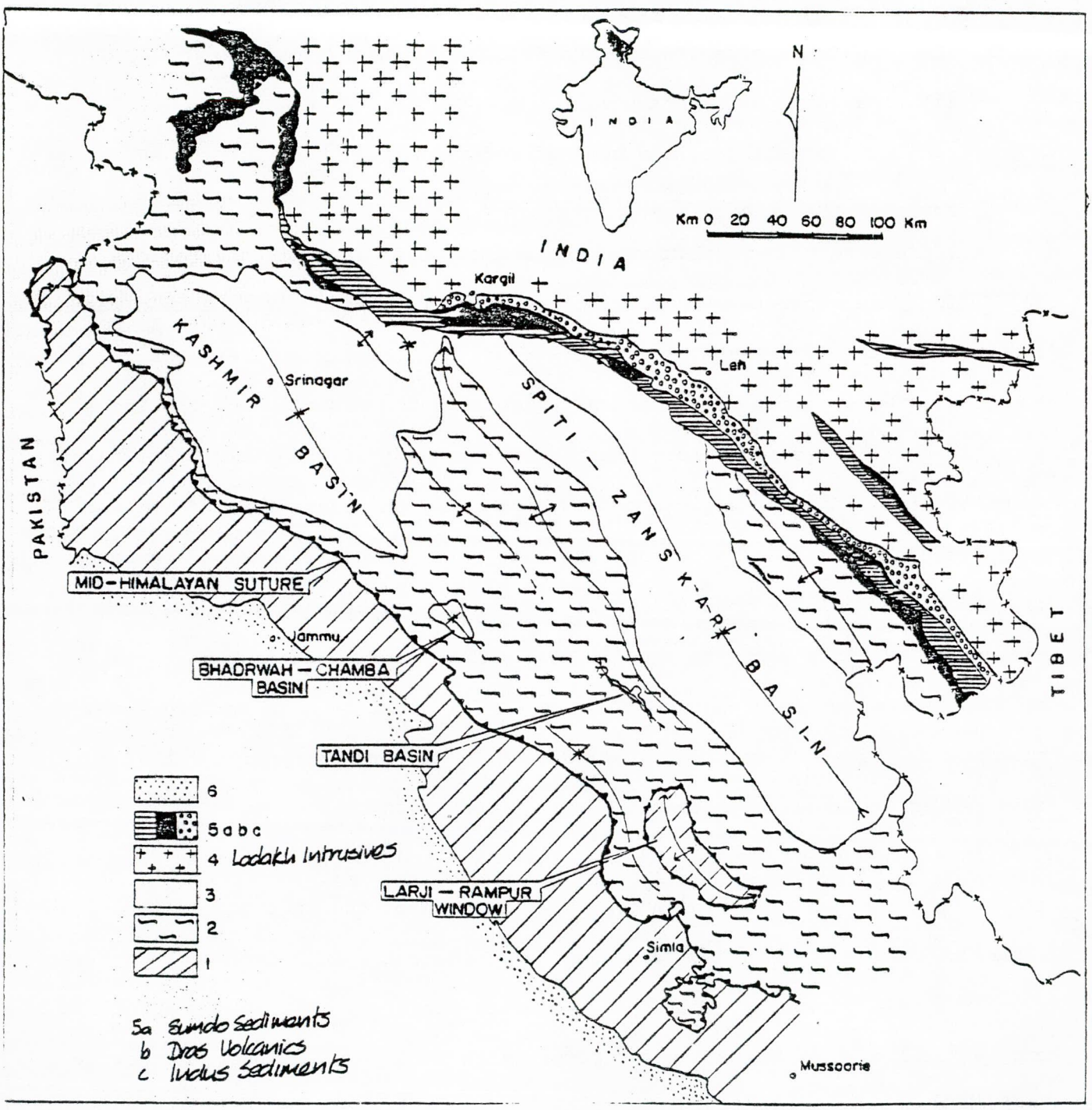
A great deal of thrusting of the beds of rocks took place during the evolution of the belt with both zones being folded and faulted.

The presence of two evolutionarily distinct units suggests the regions of deposition were separate. In fact, there were two basins within a main basin running parallel with the southern border of the Ladakh intrusives (Basal complex). There seem to be numerous thoughts on the evolution of the Indus tectonic belt; Gansser's theory that it is a remnant of the oceanic crust between Asia and India is widely accepted, but then, opinions differ. Gansser introduced the suture line concept and many agree with the idea of a subducting plate. Others believe that subduction did not occur here at all, and some geological evidence seems to support this, for example the fact that the metamorphis M here is of a rather low grade for it to be a subduction zone, and the general framework of the region suggests a history of tension rather than compression, which is representative of a subduction zone.

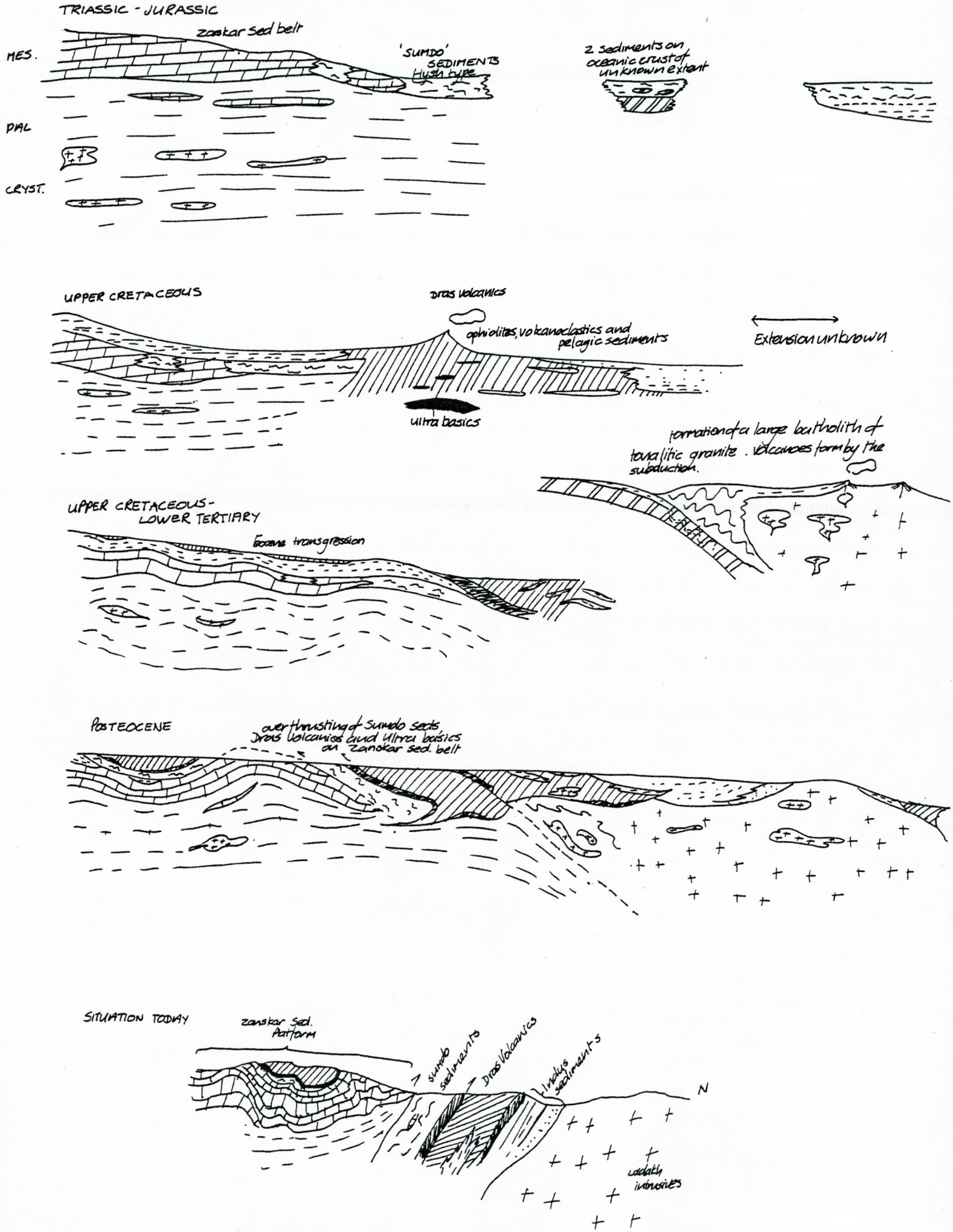
Thus a new theory was devised by Shikantia and Bargaud (1974). They said that subduction had occurred before the formation of the Indus tectonic belt; after the break-up of the Gondwana super-continent the Indian plate subducted along the Asian trench (parallel to the Asian plate). The collision produced a great deal of over-thrusting and compression; the zone, however, cannot be seen because of the over-thrusted rocks. Tension then built up in the south of the zone, and produced two parallel graben type basins; in both basins there followed a rapid subsidence, giving a huge sediment supply as well as volcanic activity in the Sumado Basin.

In the late Tertiary times, there was a total marine regression in the

Geological sketch map of Northern Kashmir



The Evolution of the Indus Tectonic Belt (Berthelsen, 1976)

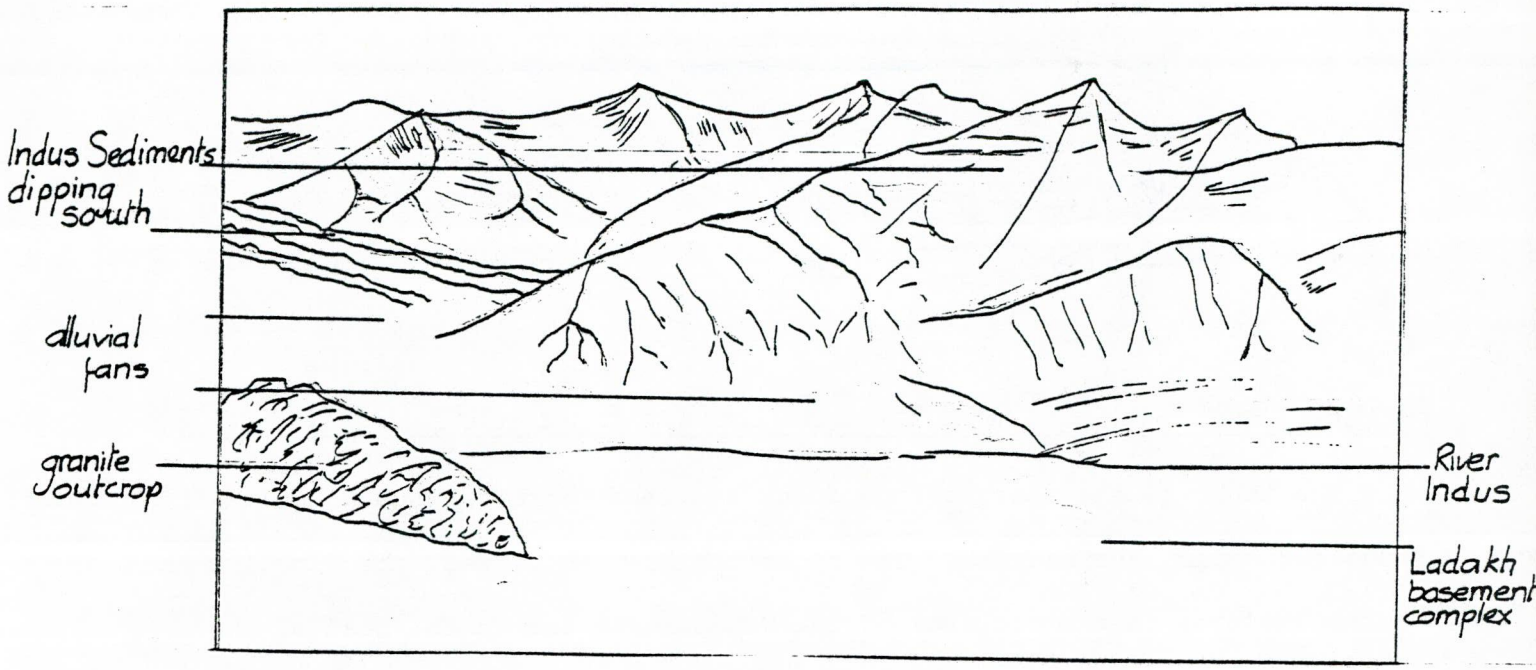


Sumdo region with a subsequent uplift; the Indus Basin then received a large amount of sediment from the area of Ladakh Granite to the north, which had also been uplifted. The shaping of the rocks into their present state was achieved primarily by glaciation with much of the area being covered with an ice sheet in the Pleistocene.

Leh is situated on the 'Basal Granite Complex' which borders the northern rim of the Indus tectonic belt, and as such the Indus sediments rest on this. The actual age of the granite is uncertain, although many writers favour between the Eocene and Cretaceous; there is also some uncertainty as to the number of plutonic events leading to the formation of the Ladakh Intrustives; some authors, for example Shah, believe there were two events; there may however have been only one, but evidence either for or against this is lacking.

On examining the granite at Leh, it was seen to be extremely variable in composition and texture; in some areas appearing gabbroic, with much biotite and hornblende present of grain size average 5 mm, to other areas, where the rock almost completely lacked mafic minerals, and posessed large white feldspar phenocrysts up to 30 cm in length. It is the variation of rock type that led to the discussion of the number of plutonic events.

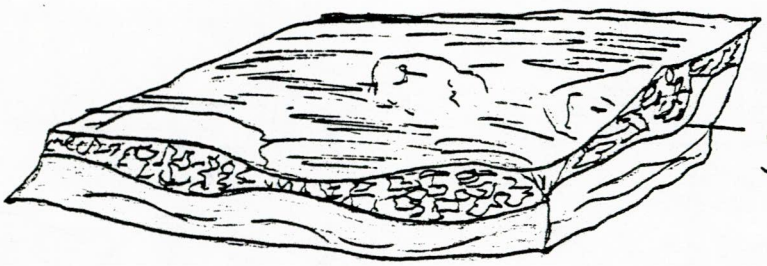
Looking southwards from Leh, the junction betwen the granite and the 'Northern Indus Molasse' (Gansser), ie the Indus sediments, can be easily defined by the sudden change in topography. The actual unconformity, however, is obscured at this location, and thus cannot be examined in detail.



Looking south from Leh towards the Indus sediments

In the Shang valley, which trends south-west from the Indus valley, the rocks are fairly well-exposed. Travelling along this valley, the first rock encountered is the Basal Conglomerate, which is massive. The clasts varied in size from 1 cm to 50 cm in diameter, and are primarily igneous in origin, varying from granite to basic volcanic. The matrix is pink, consisting primarily of quartz and feldspar (orthoclase) fragments, giving a gritty texture. On the whole, the rock is poorly sorted. The other sediments are seen to consist of massive granule stone beds varying in colour from green to purple and alternating with siltstone and shale beds.

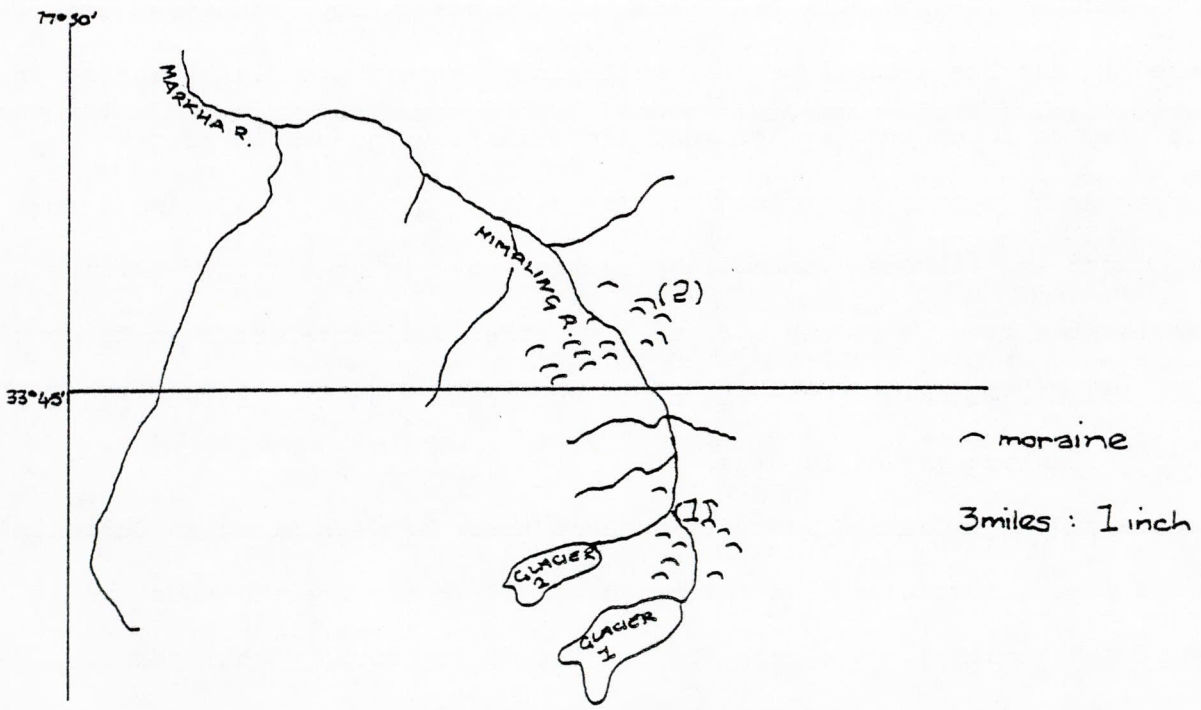
The age of the Indus Sediments is thought to be between Albanian-Cenomian and Miocene; the evidence is from gastropods found in the coarse sandstone at the base of the sequence. The presence of flute casts found in the purple sandstone suggests that the environment of deposition was shallow marine; obviously this would have changed to almost continental as uplift during the Eocene proceeded. Indeed, the sediments belonging to the Indus formation were deposited on the eroded granite surface of the Ladakh Basement complex, as well as in the basin to the south.



Flute casts in Purple Sandstone (Indus sediments)

The rocks to the south of the Indus sediments form a group known as the Sumdo formation (Shrikantia). The rocks can be seen between the Nimaling and Kichan valleys; in the vicinity of the Gongmaru La and at the head of the Nimaling valley. This area forms the head of the Markha valley, and is about 25 km due south of Leh.

The Nimaling valley trands NW/SE, turning south towards the head. Two glaciers terminate the valley in the south, and below them is much moraine.



Sketch map showing location of outcrops

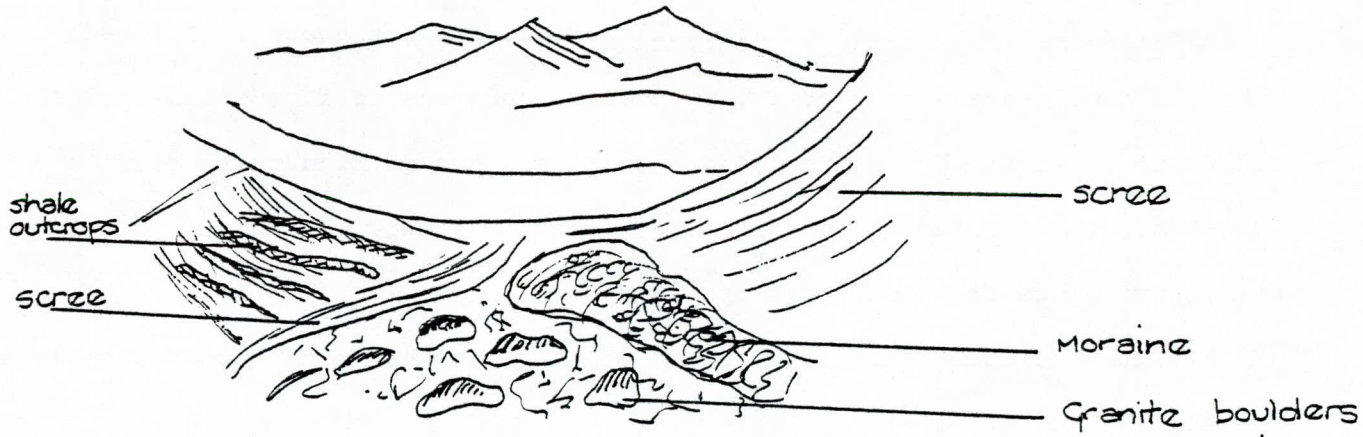
Gully trending is ESE on the ENE side of the valley (1) cut into shale. The shale outcrop extends for about half a mile north in the main valley before becoming obscured by scree or snow. The beds are generally very thin - up to

5 mm, and have been heavily flexured where the sides of the gully are particularly steep (about 75°). The flexuring is probably due to oversaturation and frost heaving, facilitated by the bedding (glide) planes. Thus, large amounts of scree have been formed, resulting in the actual angle of dip being difficult to measure. Lenses of quartz between the beds have caused additional warping; these range in size from 1 cm x 3 cm to 10 cm x 100 cm.

Further north (down the valley) it is possible to measure the angle of dip although there is a lack of uniformity, with a variation from 40° to 55° NE strike 310°.

Another shale outcrop on the NW side of the valley was examined; the dip here is relatively constant (55 - 60° ENE, strike 140°). The outcrop here in fact is walled by a huge mound of moraine, and probably protects the face from extreme temperature fluctuations. Any flexuring which is present here is primarily due to the presence of quartz lenses.

The shale was deposited in a very deep basin during Eocene times, although the depth fluctuated in accordance with the volcanic activity occurring upon the formation of the Indus tectonic belt.



Looking North: down the Nimaling Valley

Further north, ie downdip, the sides of the valley were covered with boulder clay and the only rock outcrops were above this. A section was examined between the Nimaling and Kichan valleys at about 17,500 feet. These rocks form the southern part of the Sumdo formation as defined by Shrikantia. Gansser recognised similar rocks at Hemis (see map) as the southern boundary of the 'Ladakh Molasse'. The 'Hemis Congomerates' have a southern dip - the rocks of the

Nimaling and upper Kichan valleys have a positive northern dip.

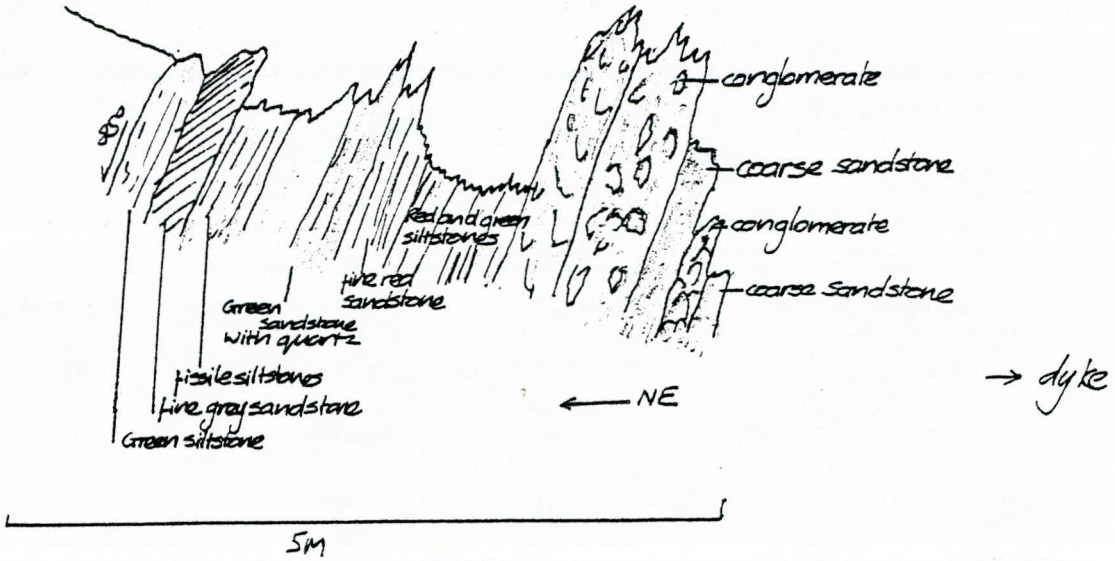
Both Shrikantia and Gansser recognise that there are three major units contained in the Indus tectonic belt, bounded by the Ladakh granite to the north and the Spiti-Zanskar basin to the south; although with regard to geological sketch maps there seems little agreement on the exact position of boundaries.

Rock outcrop between the Nimaling and Kichan valleys (2)

The southern edge of the section is bordered by a huge dyke (post-Eocene). The dyke, 200 foot high, trends WNW cutting across the Kichan valley, and passing into the Nimaling. Although being composed of a highly competent rock - basalt - the dyke is heavily frost-shattered, with the resut that much of the scree in the vicinity consists of basalt. The weathering has been facilitated by numerous calcite veins, about 15 mm wide, running parallel and at right angles to the edge of the dyke. The actual boundary between the base of the section and the dyke is totally obscured by scree, but can be seen as a flame of weakness by the presence of a longitudinal gouge.

The basalt bed of the section examined is a massive conglomerate with clasts of jasper, silica and volcanic material up to 10 cm in diameter. The beds above the conglomerate vary from very coarse sandstone to fine siltstone, the sandstones often show graded bedding and the siltstones tend to be fissile and cankerous. The surface colour varies from red to green, but this is due to weathering, since fresh surfaces appear grey.

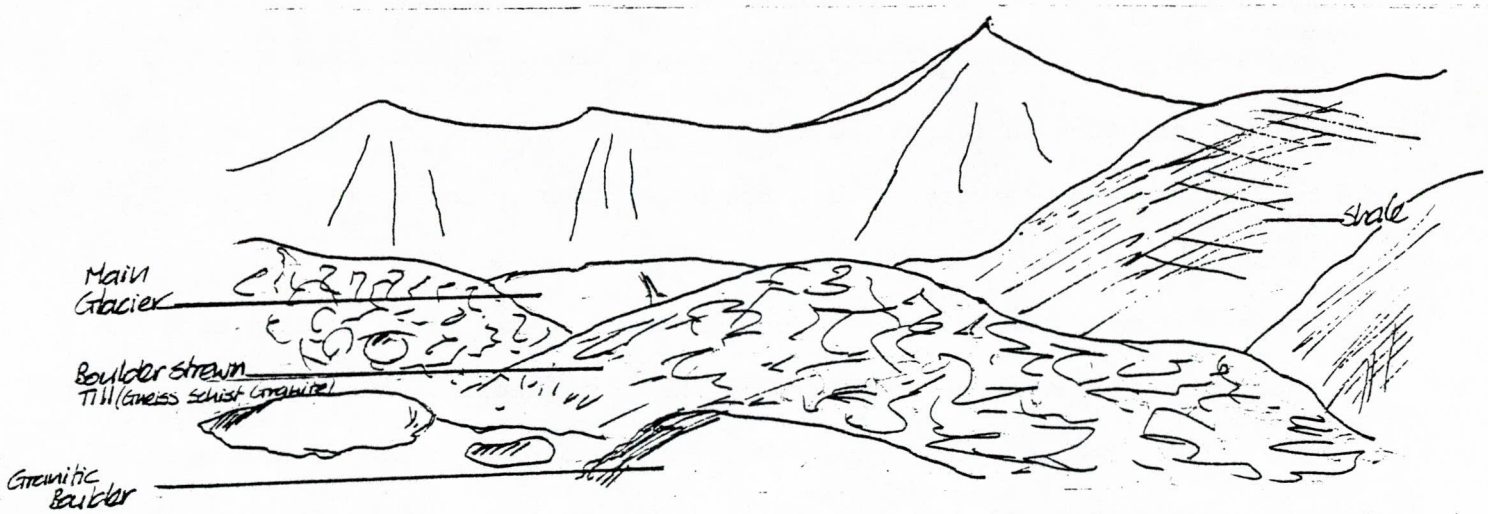
As with the Indus basin, the depth of the Sumdo basin of deposition varied from shallow to very deep.



Rock series

Superficial Deposits

At the head of the Nimaling valley, above the '17,500 foot contours' are large amounts of granitic boulders; they are sub-angular and large in size, from 25 cm x 25 cm up to 3 m x 5 m. The junction which is present between shale scree and the granite boulders is possibly the mark of a glacier end, that is, a minor glacier extending down the valley side from the north east.



Looking S.E. from gully in the E. towards the valley head

The boulders in gullies extending from the main valley sides are invariably composed of granite. On the main valley floor, however, boulders of many rock types can be seen; gneiss and schists as well as microgranite are present. Thus the rocks found in the bottom of the Nimaling valley were deposited by the main glacier. This was fed by smaller glaciers, each having

a different source of rock material. As a result, the boulders found in subsiduary valleys and gullies have a consistent rock type, whereas the rocks in the main valley are extremely variable.

The Mid-Nimaling Valley

Here are distinct signs of glaciation, that is, it is 'U'-shaped, with boulder clay obscuring rock outcrops below 16,000 feet. Above this, the peaks have suffered from being weathered by frost action, producing large amounts of scree between free faces. Travelling NW downstream towards the Markha river, the amount of boulder clay increases dramatically with many isolated hillocks resembling drumlins. They are, however, not 'typical' in shape, although they are elongate in the general direction of the valley. The size of these glacially deposited mounds is between 5 m and 200 m long, and 3 m and 50 m high. The boulders contained within the clay are subangular to subrounded, although mainly they are subrounded. This, however, is not representative of typical debris, and evidence of subsequent weathering, ie after-glacier retreat, can be seen by exploitation and the large amounts of lichen present. The boulders range in size from 2 cm to 3 m, and perhaps 90% of them are leucocratic coarsely-grained, holocrystalline to porphyritic igneous rocks, containing white alkali feldspar and quartz. Some of these granite rocks show a grading into a very coarsely crystalline rock, with individual minerals within the matrix ranging from 2 mm to 6 mm in size, and phenocrysts of a green feldspar up to 13 cm long, and 3 cm wide, showing simple twinning.

South-eastwards the valley extends for about 8 - 10 miles, and retains the 'U'-shape throughout. Here it is evident that the glacier has effectively eroded and deposited more than once. This can be seen by the vast mounds of moraine (greater than 100 m high), extending laterally along the valleyside. For this to have occurred, probably an advanced glacier, retreating, will have deposited large amounts of debris with the mounds being terminal and lateral moraine. On the second glacier advancement, the moraine was carved into a 'U'-shape, leaving the mounds on either side.

Towards the glacier snout, the amount of moraine in the valley decreases

markedly; also outcrops of shale begin to appear on the valley sides. The melt-out till becomes shaley and loosely packed, forming the outwash plain of glacier number one. Glacier number three, on the south side of the valley, has an outwash plain extending for about 3/4 mile, with large amounts of fine sediment, as well as discoid pebbles of shale being present. Boulders in the outwash plains are primarily of granite, and range in size from 2 cm x 3 cm to 3 m x 5 m.

The terminal moraine just beyond the glacier snout consists of huge mounds (up to 50 m high). Between the mounds are deposits of very small mica flakes along with schist and shale fragments, and probably represent flow till deposits - the mica probably was left after the breaking down of the rocks.

References

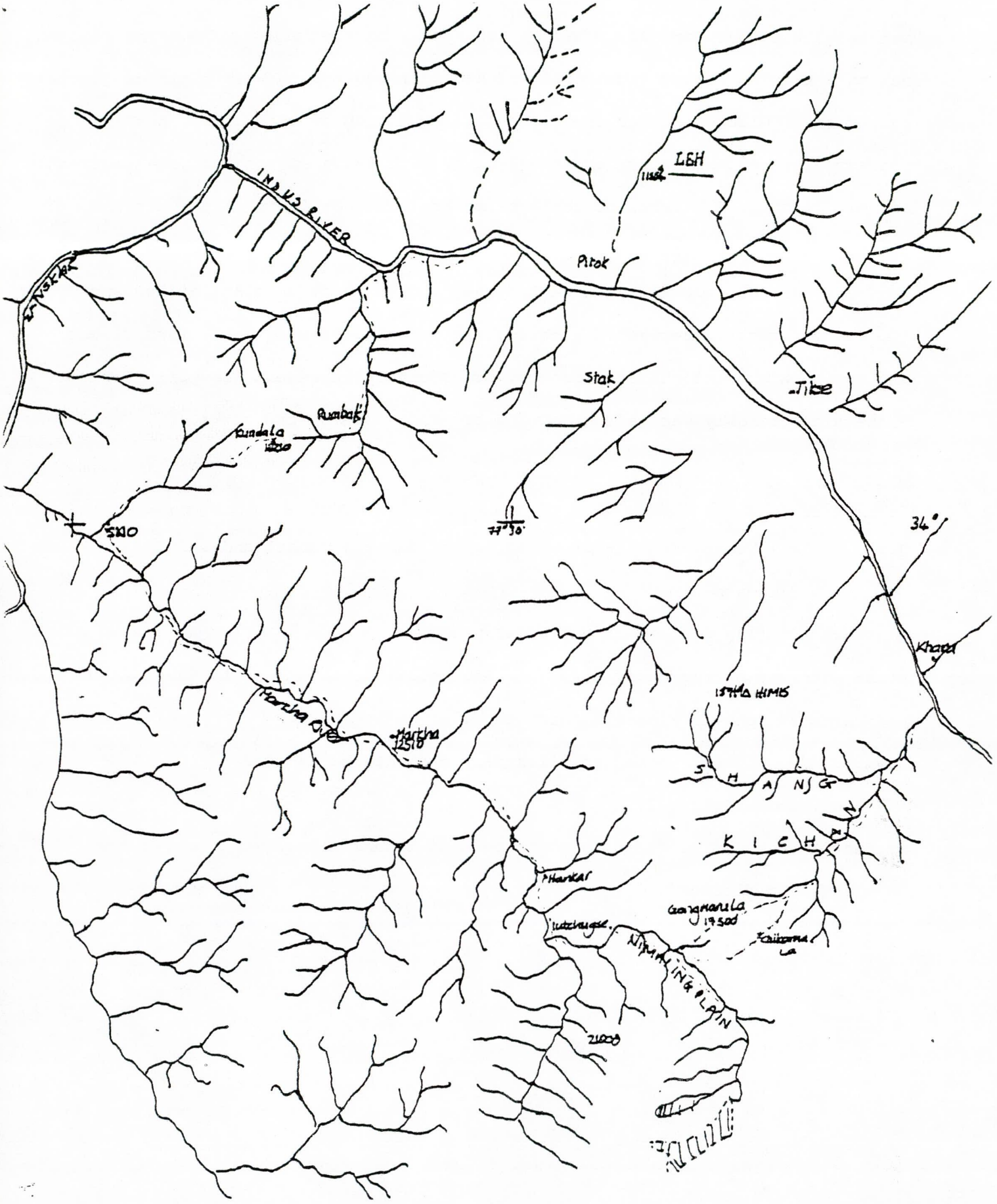
Gupta, V.J. & Kumar, S. (1975) 'Geology of Ladakh, Lahaul and Spiti'. Geol. Rundschau.

Gansser, A. 'The geology of the Himalayas'.

Frank, Gansser & Tromscarff (1977) 'Geological observations in the Ladakh area'. Schweiz Mineral. petrograph.

Tewari, A.P. (1964) 'The Upper Tertiary deposits of Ladakh'. Int. Geol. Cong. 22.

Srikantia, S.V. 'The Indus Tectonic belt of Ladakh Himalaya: its geology and significance'.



Location Map showing the position of The Nimaling, the Kichan Valley, the Shang Valley and the Markha Valley in relation to Leh.

Bumblebee Report

This project was incorporated into the expedition about three weeks before departure, following the cancellation of the 'Cambridge Expedition to Bhutan' for political reasons. Little was known concerning the taxonomy and ecology of the bees and wasps of the whole Himalayan region; information on the bumblebees of Ladakh is based on a very small collection made in 1925. The aim of the project was to make a complete reference collection, as well as field notes and a photographic record for ecological studies.

The first three and a half weeks were spent with the rest of the expedition in Srinagar, Leh and Nimaling. By that time, persistant gastroenteritis persuaded Paul to return to Leh to seek medical advice. For the following five weeks he continued alone, travelling from Leh to Srinagar and on to Gulmarg, Pahalgam and Delhi. During his stay at Leh, he was fortunate to meet Sir Robert Foulkes of the 'Leh Nutrition Project', and was driven around on his rounds. Generally the accommodation chosen was the cheapest available, although as a result the expedition numbers were boosted by various bed bugs and mosquitos. A guide was hired for the five days at Gulmarg; a grand old character who had been the first official guide in 1940. His knowledge of the forest and the meadows above proved invaluable in finding many species in so short a time and, perhaps more fundamentally, he negotiated a much cheaper rate at the guest house. While staying in Srinagar, Paul also paid a visit to the University of Kashmir, which was very enlightening.

In the nine weeks in India, the following collections were made: 580 bumblebees; approximately 250 solitary bees and wasps for the British Museum (Natural History) in return for loan of collecting equipment; 176 social wasps, for a number of research workers in Britain and the USA; 38 hoverflies for Mr F. Gilbert, currently undertaking Ph.D research in this group at the Department of Applied Biology, Cambridge University. The material for the Bumblebee Project is to be processed as Natural Sciences Tripos part 2 Applied Biology practical work, for a final report in the summer of 1981. Some observations

have already been presented for discussion; as an exhibit on the altitudinal distribution of social wasps for the Hymenopterists' Workshop at the Royal Entomological Society; and as a seminar on Kashmir bumblebees at the Department of Applied Biology.

Two of the areas studied would appear to represent novel situations on which the work is to be concentrated:

i) A diverse community of bumblebee species was found on Nimaling Plain, all foraging from the one species of flower. This is not consistant with the current ideas of niche separation and competition for food developed for European species.

ii) Also, in the arid Indus Valley, (for example at Leh) communities of plants are almost confined to areas irrigated by man. Lucerne was introduced to such areas about a century ago, as a winter forage crop for animals, and is largely dependant on bumblebees for pollination. This is an example of man having extended the range of several bumblebee species into an artificial, mutually beneficial system.

Finances

Income:	£	Expenditure:	£
Mark Pryor Fund (Trinity)	400.00	International travel + insurance	379.65
Carl Pantin Fund (Trinity)	100.00		
M.E. Mosely Fund (C.U.)	100.00	Medical + food supplies bought in U.K.	11.56
Worts Travelling Scholars Fund (C.U.)	90.00	Camping equipment + clothing	208.53
Official personal contribution	200.00	Project equipment	196.63
		Camera	200.00
Additional personal contribution + sale of some equipment	148.35	Film + processing	74.90
	£1168.35	Travel, accommodation + food in India	283.00
			£1354.27
TOTAL INCOME:	£1168.35	TOTAL EXPENDITURE:	£1354.27

It is hoped that the balance sought (£185.92) will be made up by employment in the summer of 1981.

Acknowledgements

I would like to thank all those who have helped the project to succeed. Special thanks are due to the Trinity College and Cambridge University Funds, whose most generous financial support made the project possible, and to the British Museum (Natural History) for the loan of the equipment.

Summary

Snow algae were collected from cryaconite holes in the Nimaling valley, and their environment monitored. A Geological Survey of the Markha valley was completed. The moss and lichen collections were sent to the Institute of Terrestrial Ecology in Edinburgh and the British Antarctic Survey respectively, and bees, wasps and hoverflies to the British Museum (Natural History) and research workers in Britain and the USA.

Accounts

Sponsorship was given by the following:	£
Mount Everest Foundation	300.00
W. A. Cadbury Trust	200.00
Texas Instruments Ltd.	200.00
Royal Geographical Society	150.00
Sponsored walk	120.00
Gilchrist Education Fund	100.00
Godman Fund (British Museum)	100.00
Aston University	100.00
St John's College	80.00
Newnham College	70.00
WORTS Travelling Scholars Fund	70.00
Gonville and Caius College	60.00
Mrs E Salter	25.00
Burtons	20.00
Hilary Belcher	10.00
W. Heffer & Son	5.00
Personal Contributions (4 x £250)	1000.00
TOTAL:	£2610.00

Expenditure:	
Flights	1184.00
Insurance	208.50
Film	180.50
Administration	250.00
Food	100.00
Horses	100.00
Travel in India	30.00
General costs in India	70.00
Equipment	573.00
CUETC Levy	14.00
	£2610.00

Food

The variety of food available in Leh is surprisingly good, considering its isolation - certainly there were few things which could be bought in Srinagar and not in Leh. What is more, due to a special tax in Srinagar, there is little difference in food prices between there and Leh. These factors combined with the sheer effort of transporting large quantities of food, make it advisable to buy all but the most specialist food in Leh. The fresh fruit and vegetable selections there are particularly wide. Very little is available in the remote valleys, however, and it is unfair to expect anything from the meagre provisions of the local people; it is best to aim for complete self-sufficiency outside the towns.

The best policy appears to be to tend away from a Western diet, and more towards an Indian diet. Western food is very expensive, even by English standards, whereas with a little imagination, some superb dishes may be made for a minimum of cost.

In the mountains, the basic diet was as follows:

Breakfast: Bowl porridge/cornflakes and sugar with milk.

Lunch: 7-10 small biscuits with jam/honey.

Supper: Portion of Batchelors' dried meal plus 2 oz rice or lentils, onions, pudding with custard.

Frequent cups of tea/coffee.

Tins of cheese and butter, peanut butter, lentils and dried peas, brown and white chappati flour (chappatis were eaten with lunch if near the camp), cooking oil, sweet biscuits, horlicks, cocoa and 'Rise and Shine' drinks were also taken. Milk powder was available in useful plastic bottle-shaped containers. Experiments were made with local plants such as the wild rhubarb, which had rather disasterous effects, possibly because we ate too much, and a type of freshwater algae, which was 'interesting'. A bag of fresh lemons was taken, but was eaten by a yak quite early in the expedition! A vitamin C supplement would have been useful.

The Batchelors' food provided protein, and was supplemented by TVP, which, surprisingly, was on sale under the name "Nutri-Nuggets". Much more use could have been made of the local herbs and spices, but was not, due largely to inexperience. If pressure cookers are used, then it is possible to steam bread, which is an excellent supplement to the diet. Dried egg is well worth taking, as it makes it possible to cook cakes, though we managed without. The pressure cookers can be extremely versatile.

This diet was adequate if little exercise was done, but insufficient for active work for the males in the party. Paul and Simon are thought to have lost between 3 and 4 stone between them during the 5 weeks they were on this diet. In general, porridge was more popular than cornflakes, and certainly better value for money. The lunches were the main failing of the diet, and should in future be increased to approximately the same calorific value as the supper.

Equipment

Below is a resume of some of the equipment used on the expedition.

Tents

We had three tents, a Vango Mk 3, a Robert Saunders Mountain Tent, and a Robert Saunders GC2+. As people have come to expect from Force 10s, the Vango performed superbly throughout. The mountain tent was quite satisfactory, except when it snowed, as the centre of the tent was then pulled onto the inner tent. Later models have longer poles, which solve this problem. The GC2+ was used as a gear tent, and as a light tent for spending odd nights away from camp. This worked remarkably well, and was only showing slight signs of deterioration at the end of the expedition.

Sleeping bags

We all used Mountain Equipment Redline sleeping bags. These were superb, and worked well with no additional clothing down to about -5 ^{o}C. They are cut rather large, which is good, as it makes them useable up to around 10 ^{o}C, but leaves room for additional clothing, probably making them useful to -25 ^{o}C or less.

Duvet Jackets

Two duvets were taken, a Mountain Equipment Annapura, and a Slaters' 20 Below. Both performed as well as, if not better than expected, and although not essential, certainly made life very much more comfortable.

Thermal Underwear

The thermal underwear used was made by North Cape Ltd, and was worn by all members of the expedition. Considering their weight and size, they performed superbly, and were certainly worthwhile.

Gaiters

We all decided to try the (then) new Berghaus Yeti Gaiters. Unfortunately we found them very disappointing, as they failed to live up to their advertising promises. The two problems were that they would pull off the boot at the slightest opportunity (even under crampon straps), and that the rubber rand was worn out within 3 weeks. This was due to a combination of bad design and

bad fitting, but ought to be remedied by a new moulded rubber rand which is fitted to the present gaiters.

Cookers

We took two Optimus III stoves, which performed very well, even at altitude, and are well-suited to this kind of expedition. Their only real disadvantage is the large price tag, especially since ordinary primus style stoves may be bought in India for around £5 each. Due to the quality of the paraffin, it is essential to filter all fuel before it is put into the stoves.

Pressure Cookers

One was taken, and another was bought in India at a cost of £10. It is difficult to see how we would have managed without them at altitude, and they are definitely worth the expense.

Watches

We were loaned watches by Texas Instruments Ltd, for use throughout the expedition. These worked very well under arduous conditions, and did not exhibit the rather annoying habit of freezing in the cold, as is found with many liquid crystal display watches.

Multimeter

We borrowed an AVO digital multimeter, which worked faultlessly, even at very low temperatures.

Medical Report

General Perspective

Introduction

The expedition can be divided into three main parts as far as medical problems are concerned. The first part, covering arrival in Delhi and travel to the hills, involved the usual risks of life in a third world country. The second part involved our ascent to altitude and our stay there. The final stage, the return home via Calcutta, could be expected to be similar to the first, though it did contain a few surprises.

The Approach

As described later, Iodine was used to counter the water-borne threat. This was popular compared to chlorine-based systems, and apparently effective.

Fruit and all other edibles were treated with a caution which was probably excessive at first, but with time, eating habits became quite relaxed. Peelable fruit was peeled, and most of it washed. In mountainous areas, these precautions did not really seem necessary. The standards of hygiene in some of the more primitive-looking roadside shops and eating places probably compares very favourably with that in more prestigious establishments.

There was probably a tendency to over-react with 'stoppers' to quite mild cases of diarrhoea (as we had been primed since early childhood on the horrors of eating in India). In at least one instance (RH) this led to a need for laxative (Senokot). In part the situation was forced by a fear of "the runs" while on the long coach journeys which are common in the Kashmir region.

The fifth member of the party (PW) started relatively thin, and just as the party was leaving for the mountains, he developed diarrhoea. Initially this was treated with Imodium and Electrosol. Later Ampicillin, Flagyl and glucose were used. The condition failed to respond to this treatment, and Tetracycline therapy was declined while arrangements were made for evacuation to Leh. Evacuation was by horse, and took three days. About 14 days after the initial symptoms, some chest pain was felt around the right shoulder. This spread over the following day, and was transiently worsened by coughing

and deep inspiration. The horses for the patient arrived the following day. A Belgian trekking party gave some Intetrix and Reasec (see medicine list). A course of Intetrix was started at once. 19 days after symptoms were first observed, the patient received medical attention in Leh. A diagnosis of Gastric Enteritis was made, and a course of Streptomycin with Chloramphenicol was prescribed, the course of Intetrix being interrupted. Shortly after the symptoms improved.

In Leh we had a brief encounter with bed-bugs, which were dealt with using DDT dust and aerosol agent.

At altitude

As the party made its way to the first camp, the normal features of altitude illness - loss of energy, dizziness, nausea and headaches - were felt. By modern standards, the rate of ascent was quite fast (4500 feet in three days) though loads were not being carried. One individual (DF) was particularly aware of peripheral oedema. She was premenstrual at the time. On the first night in the Nimaling, she started to show classic signs of HAPO (dry cough, tightness of chest, extreme breathlessness and anxiety). However, frank oedema was not present at any time, and no therapy was used, other than reassurance. The symptoms may have been in part psychological, as the individual had just read an account of HAPO, (AMS appears to have a large psycological component). There is no proven association between menstruation and HAPO, though there is a link with peripheral oedema.

Disturbed sleep was common, especially at the latter site, but sleeping tablets were avoided, due to the protracted nature of our stay. Generally, the members slept for 10-12 hours. Sore throats occurred in some members (DF, RH) and they also noticed some swelling of the neck lymph glands, particularly after exertion. As a contrast, constipation was the rule rather than the diarrhoea of earlier. This was never severe, and probably a consequence of the low-roughage diet. Accompanying altitude there is an increase in ultraviolet light levels. Our glacier cream, snow goggles and lip salves seemed to be effective, though the lip salves were rather under-used. This resulted

in one or two cases of badly chapped and split lips.

This leads to one of the less widely noted complications of altitude, that of slow healing. In two individuals (PM, SG) there was a marked increase in healing time. Vitamin C supplements seemed to have little effect on the situation. PM and SG showed a weight loss of 13/4 and 11/4 stone respectively, whilst DF and RH only showed small weight changes. The poor healing may have been related to weight loss, indicating poor nutritional status, or systemic illness. It is also possible that these were signs of high altitude deterioration (weight losses of the order of one stone are fairly typical of a prolonged stay at high altitude). The tips of the thumbs and fingers seemed quite prone to splits which followed the fingerprint lines. There was also some separation of the nail from the bed (PM) though this was probably associated with problems of pulling on gaiters. Both these problems were painful and very slow to heal.

The Return

From the clean mountains we returned to the evils of civilisation, and all developed a curious set of symptoms, which included a general apathy, vomiting (SG, DF), loss of appetite, tender stomachs, constipation or diarrhoea. Abdominal disturbances (with air) seemed to come and go, (esp. PM). Abdominal cramps were common (esp. PM). The symptoms had different latent periods, and deviations were generally ascribed to over-eating and carelessness, aggravated by a rough two-day lorry journey. Some Codeine phosphate was used, and much Senokot and Panadol.

Mosquitos were found in greater numbers than on the outward journey. They were especially noticeable in Srinagar and Jammu. As commonly noted, some individuals (SG, RH) were more susceptible to bites than others. This resulted in the rapid demise of the Flypel. We tried some of the local preparations, which seemed to be quite effective.

Immediately on our return to England, PM suffered an explosive diarrhoea, which was initially diagnosed as a Campylobacter infection. Later Tropical Sprue was suggested. Finally a second stool culture produced Shigella flexeneri.

The diarrhoea (dysentry) first showed on the evening of our return to England, and by the next day was severe. On the second night, fever with rigor was present, and there was fever and lassitude. Imodium was taken for a short period on the first day, and a high fluid and electrolyte intake assured. By the third day, there was a reduced frequency of stools. On the sixth day the patient was feeling much better. On the 10th day, a course of Erythromycin was initiated. The initial plate (day 5) only showed a Campylobacter infection, and the Shigella showed on day 15. Finally clear plates were produced 6/7 weeks after the onset, following a course of Ampicillin.

General Problems

Early on, one member (SG) showed signs of tenosynovitis on his ankle, but this disappeared after a couple of days' rest. RH had symptoms of a recurrent strain in an upper thigh muscle. This appeared to come and go at random, and occasionally caused much discomfort. Finalgon appeared, if anything, to accentuate the pain.

Sun

At lower levels no problems were encountered, although in Leh it became quite easy to get sunburn. As we moved higher, lips and noses suffered principally, the former probably being accentuated by panting due to altitude. The high (red) Savory and Moore glacier cream was the principal barrier used, with some supplement from tanning creams, especially at lower altitudes. 12 100g tubes were taken, and found to be more than adequate. We used polarising snow goggles, bought from Magic Mountain, which were surprisingly comfortable and effective, and at a very reasonable price. As portable spares, Robert Lawrie Ltd sell some very cheap plastic items, which fold flat. These were untried, but seem to be ideal for emergencies. For lips, all members were supplied with UVstat lipsticks, but for various reasons, including the unpleasant taste, these were little used. Also used was Labisan from Robert Lawrie Ltd, which suffered similarly. It did seem more effective at encouraging splits to heal, and if used regularly, was very effective. Surprisingly the tube did not rupture, though when cold, the contents did thicken noticeably, but this

was never a problem.

Water

Millbank filter bags were taken, but not used. Possibly there was one incident of diarrhoea due to glacial flour, but this was uncertain. While we were in 'civilisation' we either sterilised our water, drank tea or 'reputable' bottled drinks (some local drinks are rather suspect). National ice-cream chains (such as "Kwality") may be considered as safe, though locally produced goods should be treated with caution.

To sterilise water, we relied on the iodine system. A quantity of iodine is placed in a 1 oz bottle, and shaken with water for about 30 seconds. This water is then decanted into 1 litre of water, taking care not to drop the iodine crystals in. The water must be allowed to stand for 20 minutes. 10 grams of iodine is claimed to be sufficient for 500 litres. This technique is not suitable for individuals with iodine sensitivity/allergy, and if used for extended periods (many months?) may cause goitre. The treated water was felt to be more palatable than that sterilised with chlorine tablets. Additionally, iodine is effective against amoebic cysts, and is not subject to inactivation by organic detritus.

Insects and animals

While in Leh on our return home, one of our hosts was just starting a course of rabies injections, after being bitten by a mad dog. With large numbers of dogs to be found in some parts of India, this should be borne in mind, and due caution exercised. On our outward journey, we saw little in the way of mosquitos, but on the return they were more in evidence in Srinagar and Jammu. This resulted in the rapid demise of the expedition's tube of Flypel, though in the larger towns similar local products were available. The worst bites were treated with Dermogesic, which proved effective. As described elsewhere, bedbugs were a rather more serious problem, one that is better avoided rather than cured with powder.

General

While at altitude, it is essential to ensure adequate water intake. This

probably helps reduce the incidence and severity of Acute Mountain Sickness. Potassium depletion has been suggested as a mechanism for AMS, and potassium supplements were tried (Sandez K). This was inconclusive, but may have been useful. All but one of the party were vaccinated against T.B., a precaution which is worthwhile if untreated milk products are to be eaten. Weekly anti-malarial pills were taken between two weeks before departure and six weeks after the return. For most areas, Maloprim is the current favourite anti-malarial drug. Everyone had injections of cholera/TB vaccine, at two weeks and six weeks before departure. Some authorities suggest that it may be more effective to have the two initial injections six months beforehand, and a booster immediately before departure. From the attitude of the Indian immigration authorities, it would appear that a valid cholera vaccination certificate is required for India, despite advice to the contrary.

Passive vaccination with gamma globulin against hepatitis met with a rather hostile response from some quarters; however, the bulk of evidence still points to definite advantages in vaccination. Polio boosters were taken as a precaution.

Medicines used

Diarrhoea:

Codeine phosphate

Diocalm

Immodium

Lomotil

Constipation:

Senokot

Fluid replacement:

Electrosol tablets

Antibiotics:

Ampicillin

Metronidazole

Analgesics:

Panadol

Cuts:

Savlon cream

Savlon liquid

Sore throats:

Tyrozets lozenges

Muscle strain:

Finalgen

Bed bugs:

DDT powder

Aerosol insecticides

Dermogesic for bites

Sunburn:

Various popular skin lotions

UV Stat, Labisan } for lips

Calamine lotion

Miscellaneous dressings, crepe bandages and zinc oxide plaster.

General Comments

1) Horses are expensive (we paid £1.50 per horse per day) - allow plenty of money.

2) Pressure cookers are very worthwhile, and cheap in India if you don't want to exceed the 20 kg weight allowance on most flights. A version of the primus stoves (around £5.00) and paraffin lamps (£0.75) can be obtained in Srinagar and Delhi.

3) Small 'stuff-sacks' are useful for carrying food such as sugar, flour and rice. Large quantities of plastic bags are useful; they cannot be obtained easily in Leh.

4) Indian matches are notoriously bad, and caused us much anguish. Cigarette lighters and British (preferably waterproof) matches can be invaluable.

5) Film is extremely expensive in India, and it is best to take an adequate supply.

6) Avoid bureaucracy wherever possible. Don't look for it (trekking permits for restricted areas are very difficult to obtain).

7) Maps under 1:250,000 are not allowed in India, and good maps virtually impossible to obtain. We used the 1927 preliminary US Army Survey, which were adequate, but heights were wrong by as much as 500 feet, and several place names were incorrect or transposed.

8) The cheapest transport (2nd or 3rd class rail, B class buses) is OK, but look after your gear.

9) Trains need to be booked at the reservations office, which for the 2nd class in Delhi is at the opposite end of town to the station. The trains may be fully booked for two or three days ahead. Arrive at least one hour before supposed departure to find your seat. You are allocated a seat number, which relates to a seat during the day, and a wooden plank 'bed' at night.

10) Mail may be sent to the Post Office in Leh, where it is kept in pigeon holes. Look under your christian name as well as surname.

Acknowledgements

We would like to thank all those who helped make the expedition possible. In particular our patrons, Professors G.E. Fogg and H.W.R. Wade, Dr Hilary Belcher for her encouragement and advice, Deen Khan for his help in India, and Sir Robert Fowlkes, whose assistance in obtaining horses was invaluable. In Britain, Mr C.A. Chadwell kindly identified the plant specimens.

The list of financial sponsors is given in the Accounts, and we are most grateful to all those who gave money.

In addition, the following companies helped with equipment:
Robert Saunders Ltd, AVO Ltd, Clog Ltd, Troll Ltd, Texas Instruments Ltd.