THE ASSAM EARTHQUAKE OF 1950

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IN JANUARY 1950 my wife and I left the Tocklai Tea Research Station in Upper Assam by road, on a journey up the Lohit valley. For the last two years Tocklai had been our base for plant hunting expeditions south of the Brahmaputra, including Manipur and the Mishmi hills. The last named is, for the botanist, perhaps the most fascinating, because the least explored, region in the whole of India; and the prospect of eight or ten months botanizing in the very heart of the mountains behind the Mishmi hills was alluring.

It is not my purpose to describe in detail either the wonderful vegetation, or the fascinating glacial history of this region. But in order to make the short term—and probable long term—effects of the great earthquake of 15 August 1950 intelligible, it will be necessary to give a brief description of the upper Lohit valley.

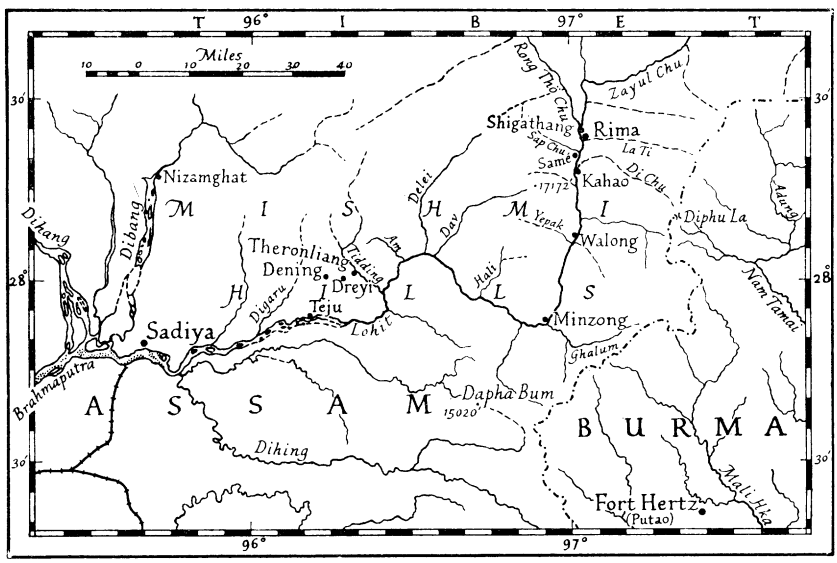
Between the point where the Lohit leaves the hills, and Rima (a distance of about 125 miles), eight major tributaries are crossed, the three largest being the Tidding, the Delei, and the Dav—all rising in the northern Mishmi Hills. As these hills are comparatively high (many of the peaks exceed 15,000 feet), and lie close to the plains, they catch the full force of the summer monsoon, converging on to them through the funnel-shaped Assam valley. The result is a rainfall heavy everywhere, and in some places (Denning, for example) exceeding 200 inches. Nor is that all. Their position, wedged between the escarpment of the Tibet plateau to the north-west and the Yunnan plateau to the east—both these areas, be it noted, dry in winter—draws all the moisture of the north-east monsoon on to themselves, so that the snowfall is also severe. The result is a heavy snow melt in the spring which, when combined with heavy spring and summer rain, causes tremendous erosion, particularly at the higher levels, before the vegetation has started into growth.

On the left bank only five large tributaries enter the Lohit, three of which rise on the Dapha Bum range close to the Burma frontier. At Minzong the Ghalum river joins in from the south-east. Seen from the west, its valley has all the appearance of being the main valley, whose direction it continues—as, indeed, it may formerly have been, when the present main valley to the north was blocked by ice. Evidence pointing to the same conclusion is found in a north–south alignment of high peaks immediately west of the Minzong bend, with Dapha Bum (15,020 feet) south of the river, and an unnamed peak of 17,172 feet about 25 miles to the north. The eastern flank of this range was heavily glaciated and fed the Lohit glacier, while from its western flank flowed the lower Lohit. The joining up of the glacier stream with the Ghalum at Minzong came later.

All the larger north bank tributaries are spanned by wire rope suspension bridges, and though the cables of the Delei bridge had sagged badly, the bridge was quite safe. Even before reaching the Delei, the road engineers

had had to ascend to some height before they could find a good alignment for the path; and as we pushed deeper into the hills, these abrupt ascents of the great buttresses, which shore up the peaks, became more frequent. In places the track was hewn out of the living rock, and being too narrow for a laden mule—it is, I suppose, thirty-five years since a mule caravan passed this way—one needed a steady head round the corners, though there was perhaps no real danger.

As far up as the Hali river, half-way to Minzong, for 2000 feet above the river the mountains are clothed with dense Indo-Malaysian broad-leafed evergreen forest, poorer in species than the Assam foothills but constituting a similar vegetation type. Only on the level terraces and gentler slopes has the forest been cleared and replaced by cultivation and secondary growth,



especially of tall grass. Before the corner is reached at Minzong, pine trees are mixed with typical Indo-Malaysian species right down to the river, sometimes forming thin patches of forest by themselves. By the time one is round the corner and marching north, the change from broad-leafed sub-tropical rain forest to warm temperate pine forest is complete. The change of vegetation takes place in less than 10 miles, and from this point onwards the lower stratum of the forest is inflammable.

Above its knee-bend the Lohit narrows, flowing for some miles in a deep gorge between high, bare cliffs; but before Walong is reached the valley widens again, the cliffs on the west side (whence flow several fair-sized tributaries) receding and becoming less steep. Well preserved terraces are numerous, besides enormous accumulations of boulders and gravel. As we travel north, the climate becomes steadily more arid, a fact quickly reflected in the vegetation. At Rima the valley widens out into a basin some 3 or 4 miles in length by 1 mile in width; the river too widens, and there is actually an

island covered with pine trees out in the stream. A scimitar-shaped bay in the hills on the east bank is occupied by a succession of terraces superimposed on one another, the uppermost being at the very foot of the steep outer range; and a cluster of three or four villages situated on the lowest terrace, in the midst of irrigated rice fields, make up Rima in the broad sense; one of them also carries that name. Its altitude is 5000 feet.

Between the rice fields and the second escarpment is a pond or swamp, where several pairs of Brahminy duck feed in the spring. Parts of three main terraces are well preserved, that on which Rima stands (about 100 feet above the river) being the most important. Only a corner of the second, some 300 feet above Rima, remains; being waterless, it is uncultivated, and uninhabited. The third, the highest and largest, is irrigated directly from the outer range of hills by several streams, and here is grown the bulk of the rice crop. The village of Tooning stands at the top of the gentle slope, 1000 feet above the Lohit.

A torrent—the La Ti—rising on the Burma frontier, separates Rima from the village of La Ti to the south; and 600 or 700 yards north of the La Ti torrent is the official village of Shigathang, where a small timber monastery stands on a square platform of flat stones; but Shigathang was burnt down during the New Year celebrations in February before we got there—all except the monastery—and the crowd of small officials who annually descend upon Rima during the brisk winter trading season were quartered in Rima village.

Half a mile north of Shigathang is the confluence of its two branches, the Rong Thö Chu flowing from the north-west, the Zayul Chu from the north-east. The latter is generally regarded as the main source of the Lohit—an honour to which it has no undisputed claim. Rice fields are plentiful for 20 or 30 miles up the former river, but there is no more rice cultivation up the almost uninhabited Zayul Chu.

Within 10 miles of the confluence, in every direction, the mountains reach 15,000 feet or higher, the average slope of the flanking ranges being 60°, though the cliffs immediately above the river are often vertical (or nearly so) for several hundred feet, and in places for much more. Between Shigathang and the confluence a rope bridge spans the Lohit.

The Rima basin, where not cultivated, supports thin pine forest, with bracken as undergrowth; or thorn scrub. In sheltered ravines, such as the La Ti, a thicker growth, including a much greater variety of species, is the rule, a large Pyracantha (*P. angustifolia*) being particularly abundant. In the stony fields, scattered trees of Rhus and willow are prominent; and in March the terrace is white with pear blossom. The pine forest extends to 7000 feet or higher; above that is solid temperate forest, with a mixture of conifers and broad-leafed trees.

When we reached Rima in the first week of April, the forest fires, which in one place or another had been burning since the previous November, were finished. These fires, started deliberately for the purpose of improving the grazing of a few cattle, or accidentally by careless campers—or even playfully by children—needlessly devastate considerable areas, though the upper valley is so sparsely populated that, apart from the permanent rice fields, only a

fraction of the cleared area is under cultivation in any year. This suggests that the population is diminishing, and derelict rice terraces at various places between Walong and Rima point to the same conclusion.

The annual fires not only check the growth of pine forest, but entirely prevent the growth of broad-leafed forest, except in the gullies. Pines appear to be the only seedling trees which can withstand the grass fires, but even they perish when the whole forest is ablaze. It is certain that a few broad-leafed trees, including *Quercus glauca*, would be well established if it were not for these fires. On one occasion I noticed a forest fire at nearly 8000 feet altitude.

Between April and July, the snow melts fast on the hills; but most of the rain is stopped by the outer hills, and the gorge is distinctly arid. Even so, the torrent beds are full, and the Lohit, whose source lies partly in glaciers on the Tibetan escarpment, is in high flood throughout June and July. The heavy winter snowfall is, of course, not immediately reflected in the Lohit, which reaches its lowest in January.

Such, then, is the background against which we must view the great earthquake, and assess its immediate and probable future effects.

The earthquake struck without warning an hour after dark on the night of 15 August 1950; that is, at about 8 p.m. local time. There were no preliminary tremors—unless a slight, an almost imperceptible jolt immediately preceding the main shock can be called that.

We reckoned that the main shock lasted five or six minutes. It was certainly of long duration and extreme violence, the motion being vertical, as though the crust of the earth were caving in, but found difficulty in getting through the hole. The illusion of everything falling down an immeasurable shaft was, of course, heightened by rocks pouring down the mountain sides all round us with a fearful clatter.

We lay on the ground outside our tent, which was pitched on a low sandhill just outside Rima village; the vibration was so rapid as to suggest the roll of kettledrums. Dark as it was, we could see the ridges silhouetted against the paler sky, with their fuzzy outline of dancing trees. The noise was terrific, petrifying, and long continued as whole hillsides, studded with pine trees, slid into the valley. These external clatterings quickly drowned the internal rumblings deep within the crust. But the strangest noises of all came at the end of the shock, when five or six consecutive explosions, all exactly alike, following each other at intervals of several seconds, were touched off. These muffled booms—they sounded like Ack-Ack shells bursting high in the sky—seemed to come from the north-west; that is to say, from right over the spot where seismologists have placed the epicentre of the earthquake, a few miles up the Rong Thö Chu. They were heard on the plain of Assam 150 miles distant, and in Myitkyina (north Burma) 200 miles away.

During the following three weeks while we remained in Rima—that is, until September 7—I was able to examine some of the local effects. Superficially these consisted mainly of landslides, which continued for months so unstable had the slopes become. The exposed flanks of the gorges which slit the ranges on both sides of the Lohit were frequently scraped clean in the first shock, and continued to pour down avalanches of rock at almost regular intervals. The dazzling whiteness of the scars was due to the nature of the

granite and gneiss of which these mountains are composed. Nevertheless, I was rather surprised how quickly the mountains had succumbed to the main shock, and to the many aftershocks and tremors which followed for weeks, each preceded by a noise like distant thunder. No doubt this was due to a combination of causes—the steepness of the slopes, the burning of the pine forest, the leaching of the granite, and to climatic weathering in a region where the range of temperature, though not excessive, is considerable.

Many of the lower ranges, not only within the Rima basin itself but up and down the gorge, undoubtedly consist of loose boulders, sand and gravel, or are covered with a blanket of such material. The numerous gravel terraces prove that the Rima basin was formerly filled with gravel to a height of at least 1000 feet above the present river level. Other loose accumulations are certainly moraines, while still others are alluvial fans washed out of the ravines.

In the alpine valleys, too, there is always an excess of weathered material, and much of this was shot into the torrent beds. What happened to the Rima and Tooning terraces was typical of all; their scarped edges crumbled and slipped; long, narrow fissures opened; in places the ground sagged and caved in, though I saw no deep cavities. The high river cliffs, of course, gave way in many places, and wherever a footpath ran parallel with the river, it was cracked down the middle, often for long distances, though the crack was never wide enough to put a foot in. Small fountains of fine silver sand—almost silt—were thrown up like worm-casts. Ploughed fields were often badly churned up; but the fact that the rice fields were deprived of water was only indirectly due to the earthquake, the main irrigation channel having been blocked by a rock fall close to where it led off from the La Ti torrent, a mile from Rima. It was cleared within a few days.

Going about the Rima basin from the river bed to the slopes above Tooning on the topmost terrace, and from the La Ti torrent to beyond the confluence, I was alternately amazed at how little the country as a whole had changed, and astonished at the havoc wrought at particular spots. The Tibetan villages suffered comparatively little, though at Shigathang the earthquake completed the work of destruction (which the fire had begun) by throwing the monastery off its plinth on to its side. In Rima every log house was unroofed, which was hardly surprising, since the roofs were of shingles kept in place by stones! Only pent houses, built on to the log houses, where pigs and cattle slept at night, were completely destroyed, killing many of the inmates.

Southwards, the precipice path opposite the village of Samé, which had always seemed to me dangerous—though we had actually taken ponies down as far as the Di Chu torrent—had been swept away, though men could still get by. But south of Kahao it was impassable; hence the only route to Walong was the main path on the right bank, and this, of course, depended on the rope bridge. The rope bridge, however, had been an early casualty, and abortive attempts to get a line across, first at the recognized crossing place, and later a mile or two downstream, left us marooned in Rima. It was three weeks before the river fell sufficiently to allow communication with the right bank to be restored, and this at the old crossing place.

Theoretically there is a wide choice of mountain trails leading out of Rima,

besides the path to India. By crossing the Diphu La, we could reach northern Burma, and eventually Hkamti Long—a journey I had made several times. As aircraft can land at Fort Hertz (Putao), this seemed an attractive route. Or there was the track up the Zayul Chu, whence one could go north, deeper into Tibet, or diverge to Szechuan, or to Yunnan. Finally, there was the path up the Rong Thö Chu, with a choice of reaching either the Dihang or the Tsangpo valley; though this route, like the one to India, depended in the first instance on the restoration of the rope bridge.

Any of these escape routes involved a long and formidable journey, but if the Lohit valley proved impassable, we would have to consider them. In the event, the Lohit valley route, though very difficult, proved possible, whereas the others were not. To great physical difficulties, which might perhaps have been overcome, were added still greater political obstacles which could not. Only the Burma route was safe from Communists, but we heard later that the path down the Nam Tamai river had been ruptured by the earthquake, so that even in the unlikely event of our being able to reach the Diphu La, we should still have been faced by a difficult problem. However, freedom to move about south-east Asia was rapidly being restricted by political, even more than by crustal, upheavals.

Perhaps the two tracks most completely destroyed were those up the La Ti torrent, and up the right bank of the Rong Thö Chu, though the Zayul Chu road (which twice must cross the river by timber cantilever bridges, both reported destroyed) could hardly have been much better. Before the earthquake we had followed the La Ti into its gorge for a short distance, finding ourselves on a narrow path which traversed an exceedingly steep grassy face, where a few tortured pines grew widely scattered. Later, from the opposite bank of the Lohit, we were able to look right into this gorge and see not only that the slope had been flayed dead white, but also that it was swept at regular intervals by tremendous rock avalanches. We heard, without surprise, that a Mishmi village perched on a spur had been buried without trace.

Every avalanche raised clouds of white dust, and as hundreds of them happened every day, the air was always thick with dust. On fine days a strong up-valley wind set in about noon, and by three o'clock a vast white cloud, through which the sun peered like a reddish copper disc, overhung the basin. This dust settled very slowly, yet everywhere the vegetation was thickly coated with it.

Conditions were now ripe for giving birth to heavy floods. But the gorges were quite deep enough to carry them, at the cost of their own beauty. It was not till they reached the plains that floods would become destructive of human life. For example, it would have required a very outsize flood to threaten Rima, which stood 100 feet above the Lohit and lay 600 or 800 yards back from it. Yet one could not altogether discount the possibility of its happening. If either branch of the river became seriously blocked higher up, an immense volume of water might be suddenly discharged when the dam eventually gave way. We might perhaps ignore the possibility of the Lohit itself being blocked *below* Rima, though in fact this did actually happen. However, it happened a good many miles below Minzong, and the Rima basin did not fill up.

It was otherwise with the tributary torrents. These all have their sources in wide glaciated alpine valleys, and become progressively narrower as they descend, finally reaching the main valley through a slit-like gorge in the cliffs. One day we heard a tremendous roaring noise from the direction of the river, and caught sight of a great wave, crested with foam like a bore, sweeping suddenly down from the direction of the Rong Thö Chu. Tree trunks were riding the flood, being tossed about like match sticks. The flood passed in a few minutes.

A more alarming example occurred while we were at Walong in October, when the Yepak, about a mile away, suddenly burst through a dam which had held for thirty-six hours. From where we stood we could not see what was happening, but the noise was ominous, rising to a roar as the flood reached its height, and sinking gradually away. Probably every torrent was blocked sooner or later at least once, for on our way out we crossed several which had had their interiors ripped right out. A peculiarity of these sluiced downstream beds was the iron grey mud which was heavily plastered over the rocks and banks, and its putrid smell. It suggested oil.

So far as I could judge, bird life was not seriously affected, except perhaps remotely; but it was curious that the Rima hens ceased to lay eggs after August 15, till we left on September 7. At dawn on the morning after the earthquake a bird was singing sweetly; but the arid Lohit gorge is a corridor for birds migrating from plains to hills and *vice versa*, rather than a residential area. Another curious effect: the village pye-dogs, which usually barked at night—and half the night—for the mere fun of barking as it seemed, were silent just before, during and long after the earthquake. With aquatic life it was another matter. The Lohit and its tributaries ran so thick with mud that the astonished fish found their world turning solid, and were liquidated accordingly. It was, of course, difficult to extract them from the waves, but we acquired one or two, and excellent eating they were. It seems highly probable that every living thing, plant or animal, must have perished slowly or suddenly, stifled by the mud which for months clogged the waters. (At Dibrugarh, Assam, an analysis of the Brahmaputra water gave 17 per cent. of solid matter!) The day before the earthquake the La Ti was a lovely blue-green, and crystal clear. From the sixteenth onwards it ran thick soup.

But it was, of course, the vegetation that suffered most, and most obviously. The number of pines which were hurled into the river from the lower slopes was prodigious; they came racing down on the crest of the Lohit flood in endless procession, a few helping to form log jams on the island while most passed on. Whole hillsides covered with forest peeled off like wet paper from a wall and slid into the ravines in a wild confusion of rocks and timber. Many trees, hit by flying boulders, snapped off short; but some showed small rocks embedded like bullets in their trunks.

It was not uncommon to see shrubs apparently unharmed on a gravel bank dying where they stood, as though of shock. They were undoubtedly shrivelling from lack of water; but whether some underground source had been switched off, or the gravel had been so badly shaken that the finest rootlets had parted company from the main root system, I could not tell. They could hardly have died as a result of dust clogging their foliage, for all vegetation

suffered in the same way, and had it been lethal, plants must have perished wholesale. The first rain—and some showers did fall even in Rima—washed off most of the dust, and though the film was renewed, there were periods of relief. On the whole the summer in Rima is a rainless season, with high temperature and humidity, a dead time for the vegetation. That dust caused a certain number of casualties seems likely. We ourselves were continually breathing dust, and our skins were powdered with it.

The water shortage was acute. Hitherto we had drawn our supply from the La Ti irrigation channel; but no river water was any longer drinkable. I found a small spring which had worked its way to the surface at the base of a terrace cliff; but when after a few days that ran dry, we had to draw water from holes dug in the still wet paddy fields, or from the marsh where ponies grazed.

On September 1, a patrol of the Assam Rifles from Walong, who had been up the Di Chu gorge at the time of the earthquake and had camped at the hot springs,[1] arrived in our camp. They had found it impossible to return to Walong down the left bank of the Lohit, so had, like ourselves, come to Rima. They were almost out of rations, which we luckily were able to supply, but only at the cost of curtailing our own survival time in Rima since the local people could spare us no more rice. It became imperative to get rice from Walong, or to return there ourselves. We continued to urge the headman of Tooning to put up a new rope bridge without delay, and now at last something was done.

Meanwhile rumours circulated freely, some from words shouted across the Lohit, eked out by signs, some started by new arrivals. How these came to Rima nobody seemed to know, though it was said that men had come down the Zayul Chu. However that may be, there were stories of villages wiped out, of fighting between Chinese and Tibetans, and of shattered paths and hold-ups. We even heard that the Assistant Political Officer for the Mishmi Hills, who had come up to Walong by reason of the Chinese advance into Tibet, had been killed. But until communication had been established with the left bank, from that side we could be certain of nothing.

However, we were greatly cheered when on September 5 word was brought that the local people, assisted by the Samé villagers, had at last got a line across the river, the level of which had dropped. By the sixth, two rope bridges were in position, one a two-way Mishmi cane rope, the other a Tibetan rope of twisted bamboo sloping to the right bank.

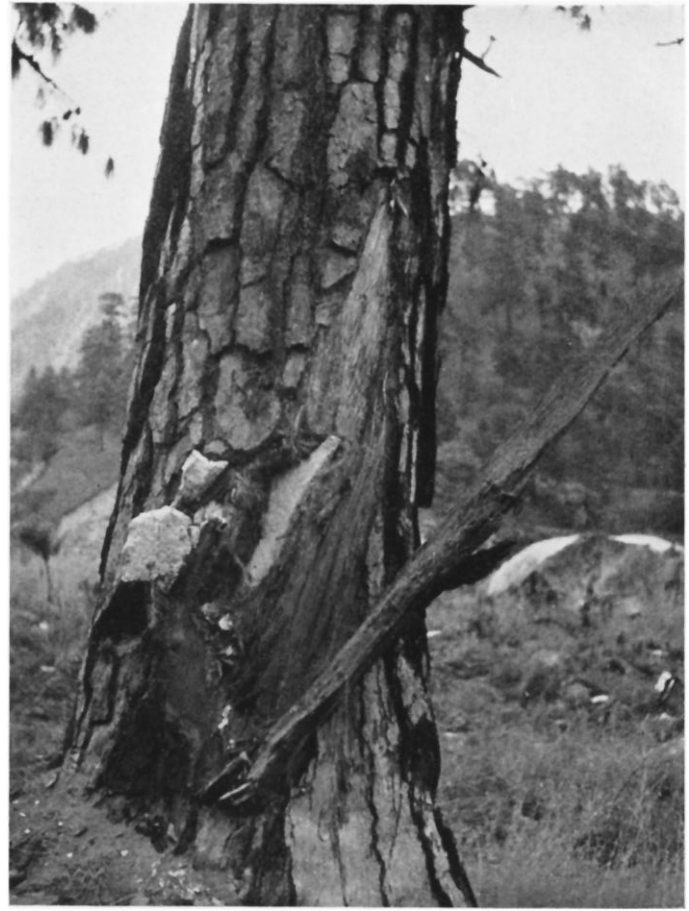
On the morning of the seventh we all set out for Walong, crossed the Lohit safely, and reaching Samé in the afternoon found a rescue and bridging party of the Assam Rifles, who were on their way to our assistance. They had brought rice, some medicine for my wife, and a note from the Assistant Political Officer—who had had a sufficiently narrow escape from death to justify the obituary notice—urging us to stay where we were, owing to the perils of the journey and especially of falling rocks. He himself and all his party had had a bad time, their camp with all equipment being buried beneath an avalanche of rock which had killed three of the porters and injured several

[1] The patrol went on as far as the Diphu La, the pass which leads down into Burma, *after* the earthquake, thus upholding the finest traditions of this force.

Hill split in half by the earthquake

Mishmi porters crossing flooded streams

A burst chorten at Rima



Rocks after earthquake embedded in a tree

people. The majority had escaped with the clothes they stood up in and had with great difficulty made their way back to Walong.

We debated whether to follow the Political Officer's advice or go on. As it was now three weeks since the earthquake, it did not seem likely that the danger would be appreciably less in any foreseeable time; and having started in good company, we decided to go through with it. The track was just as likely to deteriorate as to get better, I thought. Moreover, my wife was still rather upset; if she could do the trek to Walong she could have a proper rest and better food, under the eye of a competent and kindly Bengali medical officer whom we already knew.

Next morning the whole party, now swollen to sixty, set out for Walong and quickly crossed the Sap Chu. This torrent had ceased to run for two days immediately following the earthquake, and the ensuing flood had wiped out every vestige of the forest belt which had lined its banks, leaving in its place a residue of stinking grey mud into which our feet sank. The valley had been stripped and sterilized as though by a tidal wave.

The sights we saw during the next three days filled us with amazement. Along one stretch of the Lohit, pine trees were standing in the river with the water half-way up their trunks; and more remarkable still, a long whaleback of sand was visible above the swift, deep waters; this was at the foot of cliffs hundreds of feet high, down which rocks thundered at frequent intervals. Looking across the river we saw the small terrace above the Di Chu, on which our camp had stood five days before the earthquake, strewn with enormous boulders.

Right on the Assam frontier the men pointed out to us the site of the Political Officer's camp, now buried under hundreds of tons of rock; the regular camp site, with its permanent huts, half a mile on, had disappeared over the cliff. No wonder rumour had reported him killed!

We had to make an early start each day, and get as far as possible before the wind rose. It was noticeable that shortly after midday avalanches—which needed no more than a breath to set them off—became more frequent. By afternoon the air, which had become cleaner during the night, was again fogged with dust. On the third night from Samé, after a particularly awkward but short traverse high above the river, we camped near the Walong hot spring; and next day, after almost a mile of clambering over rocks and splintered tree trunks, we marched into Walong at 7 a.m., to be warmly welcomed by the Political Officer.

We now settled down to rest and await events. So far as that was concerned, I was prepared to wait two or three months; first because my wife was suffering from a mild form of shock brought on by all she had been through, and secondly in the hope of reaching the alpine region and collecting seeds. This latter was, however, a somewhat forlorn hope, since if the main path was so badly disrupted, it seemed unlikely that the tenuous hunters' trails which led into the high mountains would be less so. Another good reason for sitting tight in Walong was the fact that the rainy season would not end in the lower valley for another six weeks, and until it did, it would be safer not to proceed.

Walong itself, both the barracks on the middle terrace and the village on

the upper terrace, had escaped with only minor damage, though several slips on both sides of the river continued to pour down endless cascades of rock. What was more fortunate, the excellent water supply was intact; and with plenty of rice and vegetables from the Assam Rifles garden—which the O.C. generously allowed us to share—we lived better than we had done for several months. Luckily for everybody, the wireless was working and kept us in touch with India. From that, and from the Political Officer, a gallant and cheerful young Lushai, we at last heard the truth about the earthquake, which satisfied us that it was a big one. Naturally our relatives at home had been anxious at receiving no news of us for several weeks; but now H.E. the Governor of Assam kindly cabled them that we had reached Walong uninjured.

The weather was fine, with blue sky over the river, and hot, until the tearing midday wind rose and blew till sunset. I now set about finding a track into the mountains which would "go," but without success. At the third attempt I ascended, not without difficulty, up a steep pine-clad slope to a plateau at over 7000 feet altitude. This track had then continued up the ridge, and by the usual cliff traverse, into the upper Yepak valley; but the cliff had slipped badly and there was no possibility of crossing it, nor was there any water on the plateau.

It was not till October that the Walong men, who go into the hills to shoot goral (a variety of Himalayan goat like a small antelope), pointed out a track by which we could reach, if not the alps, at least the temperate forest. I engaged four Tibetan porters, and we set out on the morning of the ninth. In the first 1000 feet there were some difficult and even dangerous spots, but when these had been surmounted the going was reasonably good, and we finally camped on the edge of the forest beside the stream from which Walong received its water supply. From here it proved not too troublesome to reach a main ridge; but though I twice attained an altitude of over 10,000 feet, and silver fir forest, I never quite reached the tree line.

I remarked that south-facing slopes had suffered most in the earthquake. Across the Lohit the high ridges which climb eastwards to the Burma frontier were heavily scarred, both on their southern and western flanks. I concluded that north and east-facing slopes were better protected by their richer garment of forest than were the more exposed southern and western slopes. The cliffs directly facing the Lohit valley wind, however, were as badly scraped as any, and this was due not only to wind and exposure, but also in part to forest fires. There was very little dust on the foliage above 10,000 feet.

On August 15, when the Political Officer's party had been camped on the frontier, his escort, unable to move so fast, was still one march below Walong. On the sixteenth, after a desperate attempt to go on, they had been compelled to give up all idea of reaching Walong, and somehow managed to get back down the shattered valley. Eventually they had reached the plains, proving that the journey was at least possible, though it took them a long time. Perhaps it was as well they had *not* succeeded in reaching Walong, as pressure on the food supply might have been severe.

Shortly after the Political Officer's escort had retired, a party of volunteers from Walong, led by the indomitable Post Commander Jemadar Bir Bahadur

Gurung, and including the brave little Naga compounder, had done the four marches to Changwinti and back. The object of this sally was to obtain a supply of medicines, the Walong stock having been almost completely destroyed. That the party returned safely was a tribute not only to their courage, but also to their skill.

The Political Officer's party was the first to leave Walong, on October 2. We followed on the sixteenth, with a dozen porters for the four of us, carrying all our botanical collections, food for the journey, one small tent, and a minimum of equipment. We knew from reports which had come back that we were in for a tough time.

The first four days to Changwinti included two peculiarly unpleasant cliff traverses high up on the face, where the track had disappeared with the sloughing of the surface rock. Added to the possibility of losing one's balance on the 60°-slope was the perpetual threat of bombardment from above; in fact, getting out of the broken mountains was a far worse ordeal than the earthquake itself had been. It so happened that the earthquake occurred when all snow except permanent snow had melted, and this fact affected the result very considerably. So far as the upper Lohit is concerned, it was perhaps the season of maximum damage. The torrents were low (though by no means at their lowest) and it was difficult for them to keep their channels open in the face of the stuff poured into them. Even a small slip could block them for a day or two, while a head of water was forming behind the dam. Secondly, the slopes were well drenched with water, so that even though the rainy season was nearly over, the heavy surface was in a condition to slip easily. Thirdly, the strong summer wind blowing up the gorge and raising the dust, had some effect on the stability of slopes, making the passage of the valley highly vulnerable.

On the credit side was the fact that the vegetation cover had reached its zenith and was still in active growth; and this would help to hold together the soil. But once a slope gave way, this factor, of course, no longer operated; rocks and trees came down together in one solid piece before breaking asunder in chaos.

What then would have happened had the earthquake occurred in mid-winter? The surface layers would have been drier, and therefore lighter, and at alpine levels, frozen. Hence there might have been less tendency to slip, and that despite the dying down of the vegetation. On the other hand, the danger of snow avalanches would be greatly increased, especially towards the end of winter, when the snow would be more compacted. But as these avalanches take place anyway in the early spring, large snow beds accumulating in the gorges as low as 10,000 or even 9000 feet, this would make very little difference. Even if the earthquake did pitch large amounts of snow suddenly into the main valleys, its quick melting would be a great help in keeping the channels open; with the Lohit at winter level, there would be plenty of room for more water.

We stuck as closely as possible to the original track, considerable sections of which were undamaged. Only when crossing the great screes, some of which were 600 yards or more across, was it necessary to work out a new route. When we reached the broad-leafed jungle below Changwinti I

confidently expected to find fewer slips; surely the thick forest growth would prevent them?

However I had, it appeared, overlooked several important facts. In the first place, the rains in the lower half of the valley were not nearly over when the earthquake smote the hills. September and October are both wet months. Secondly, the outer ranges consist not of granite and gneiss, but largely of shales and schists, which give rise to a heavy greasy soil. Thirdly, I now recollected that vegetation, while it binds soil together, is not less active in disintegrating the rocks. Whatever the reasons, the mountain sides, heavy with water and a great weight of forest, had slipped badly here too. If less numerous than in the dry gorge, the slips were equally extensive, and even more hazardous to cross. One mountain at the base of which we passed, was literally split in twain.

Below Minzong we quickly ran into heavy rain, so that all temporary bridges were once more swept away; on the other hand, we were lucky to find nearly all the permanent suspension bridges—and notably those across the Dav and the Delei—intact, though the footway of the Am river bridge was canted at an angle of more than 30°, owing to the sagging of one of the cables.

My wife had a fall, and though she hardly more than grazed her skin, it turned septic. This accident, and more heavy rain down the valley, held us up for a week. Nevertheless, we reached the Tidding river on November 2, and found men putting finishing touches to the third temporary cane suspension bridge.

Approaching the outer range of hills, I expected to find fewer signs of the earthquake. As we reached the Tidding valley, therefore, it came as something of a shock to observe the colossal damage inflicted—far worse than anything we had seen previously. The steep hills which flank the gateway to the plains seemed to have been turned inside out. Not far above the Tidding confluence there used to be a big rock basin in the Lohit, where the river suddenly widened, then poured through a narrow gap; it was a magnificent fishing pool. Some days after the earthquake, the Lohit itself got blocked at this very point; we saw many trees still partly submerged along the banks. I believe that was the only time the Lohit failed to keep its channel open.

The most terrific sight of all, however, was the Tidding valley. The river, it appeared, had been blocked some distance above Theronliang for at least forty-eight hours—not on the night of the earthquake, but some days later. The result was dynamic. A wall of water 60 feet high had rushed at headlong speed past Theronliang, carrying the rest house and everything else with it. It had roared over the suspension bridge—we could not recognize the place where it had stood—and ripped out the rich lining of jungle on both banks, as though it had been turned on a lathe. The valley was now twice its former width, but it contained nothing but stones piled in vast mounds, with a muddy torrent rushing through the wilderness. It was a graveyard.

We crossed the Tidding a couple of miles below Theronliang, and walked up the right (west) bank, sometimes in the bed, sometimes high above it. Everywhere the mountains were silver as lepers with shining white scars, a country of death. No vestige of bridge, bungalow, sheds, or terrace remained;

only stones and stones. One would never have suspected that this valley had ever been inhabited.

We spent the night of November 2 at a relief camp which had been established on a small plateau several hundred feet above the Tidding, and next morning returned to the site of Theronliang. Curiously enough, the bridle path from here to the Saddle, nearly 4000 feet above, weathered the storm fairly well, and we reached the top, with few diversions, towards evening. Once again a thick mist prevented any view of the Tidding, and henceforth our only view was westwards across the plain. The Lohit had obviously widened out.

Descending the western slope, still in dense forest, we reached the headland on which Dreyi stands, at a height of 5000 feet, to find the rest house in ruins; we slept in another bungalow which was severely damaged but habitable in the circumstances. Below Dreyi, however, the mountain face had slipped badly, and we plunged straight down to a stream bed whence we reached the Sadiya-Teju motor road, 6 miles above Teju, in another three hours. Denning had been virtually wiped out and abandoned. After a day's rest at Teju we travelled by motor lorry to the Digaru river, which was shallow enough to wade, and a friend from Sadiya who had driven out to meet us, took us the last 30 miles.

It was surprising to see the outer ranges to the north dazzling white instead of jungle green. The Sadiya plain appeared to be ringed about with snow to the foot of the hills. There had been marked changes in the rivers too. The Dibang valley had suffered rather more than the Lohit, the river had been blocked, and in the short 30 miles between Nizamghat (where it debouched on to the plain) and Sadiya, it had changed its course, breaching the Nizamghat road and threatening to wipe out Sadiya.

So much sand had been poured into the Lohit that its bed had been raised several feet, causing extensive flooding. Miles of jungle on the left bank had been drowned, and when the river fell in November, a thick deposit of mud was laid down, where formerly there had been sand. A party of men had actually waded across the Lohit above Sadiya—perhaps on the very day it had been blocked at Nara.

But though the ground had swayed about in Sadiya, and considerable damage had been done in many places, all the serious damage on the plains had been caused by flood, but after the earthquake. Nor has Assam seen the end of it yet, for serious floods are likely to recur with the melting of the snows each spring, or the heavy rains, for some years. Any of the four big rivers which debouch into the head of the Assam valley—that is to say, the Subansiri, Dihang, Dibang, and Lohit—may give trouble at any time; but perhaps the most serious threat comes from the two last named, which might easily switch their waters to the south, just east of the railway, following more or less the alignment of the Assam Trunk Road.

No better opportunity for studying plant succession in this area, at all altitudes from 3000 to 12,000 feet, could be hoped for. Slope after slope was completely sterilized, and though many of them will be unstable during late spring and early summer—perhaps for years—and subject to devastating bombardment, the climate is such as to encourage plant life from the start. The battle between vegetation and earth movement is on. Abundant

windborne seeds of many species will reach the barren slopes from the surrounding forests; but the fact remains they must fall on stony ground, and on shifting sands at that. Unfortunately the opportunity to observe what is taking place is being missed, partly from lack of trained ecologists, partly for lack of funds, and partly owing to the remoteness of the region.

However, a large part of the devastated area will one day be reclothed though it is certain that the scars of the great earthquake will be clearly visible a century hence, and possibly long after that. Some of these will be cliff faces, some will be gullies, but many will be mere mounds of boulders.

One may surmise that the wounds will heal from the edge inwards, as is the way of wounds; plant life will creep slowly out from the living formation tissue, consolidating the ground as it advances. Amongst the earliest populations are likely to be many *Compositae* and grasses. Mosses and ferns, so abundant in the forested ravines, will be little in evidence because of lack of water and shade. There are plenty of local plants with wind-borne seeds belonging to numerous families. Pines will certainly be amongst the first trees to appear up to 7000 or 8000 feet; and, indeed, it was chiefly pine-clad—that is, exposed—slopes that slipped. Rhododendrons also have wind-borne seeds, and may predominate, with birch, poplar and willow, at altitudes of over 8000 feet, but only where moisture and shade are available.

In the Indo-Malaysian forests nearer the plain, regeneration is likely to be more rapid, and more complete. It is impossible to prophesy what the succession is likely to be, though one might hazard that alder will figure amongst the first trees. But it must be remembered that in the arid Lohit gorge, open pine forest is the dominant vegetation type between 3500 and 7500 feet, and that the sheer cliffs are almost bare in any case. The earthquake has made more such barren ground.

In February 1951, when Dakotas were dropping supplies to the outposts scattered round the head of the Assam valley, my wife and I on two occasions went as passengers to Walong. We had a fabulous view of the shattered ranges, which lost nothing in dramatic appeal when seen from the air. All the way up the gorge we flew about 3000 feet above the river, the mountains towering up on either side of us; from here the buttresses up which we had climbed, and the nerve-racking traverses, looked utterly impossible. What did seem surprising was, not that some of the side valleys had been blocked, but that any should have escaped being filled in like a grave. It will be a pity if the entire region has not been photographed from the air.

The area over which considerable or great damage was done extends from Rima north-westwards across the eastern Himalayas to the Tsangpo, above the gorge where Tsela Dzong was destroyed, and south-eastwards to northern Burma where the bridle path up the Nam Tamai was badly damaged. The principal rivers in the shaken area—any or all of which may be involved in floods—include: in Assam, the Subansiri, Dihang, Dibang and Lohit; in Burma, the Nam Tamai and the Adung. How far eastwards in the direction of the Salween river the disruption extended is unknown. But there seems no doubt that the earthquake, centred on the neighbourhood of Rima, affected more or less permanently a block of highly mountainous country which to west and south alone covers some 50,000 square miles, and to north and east probably no less.