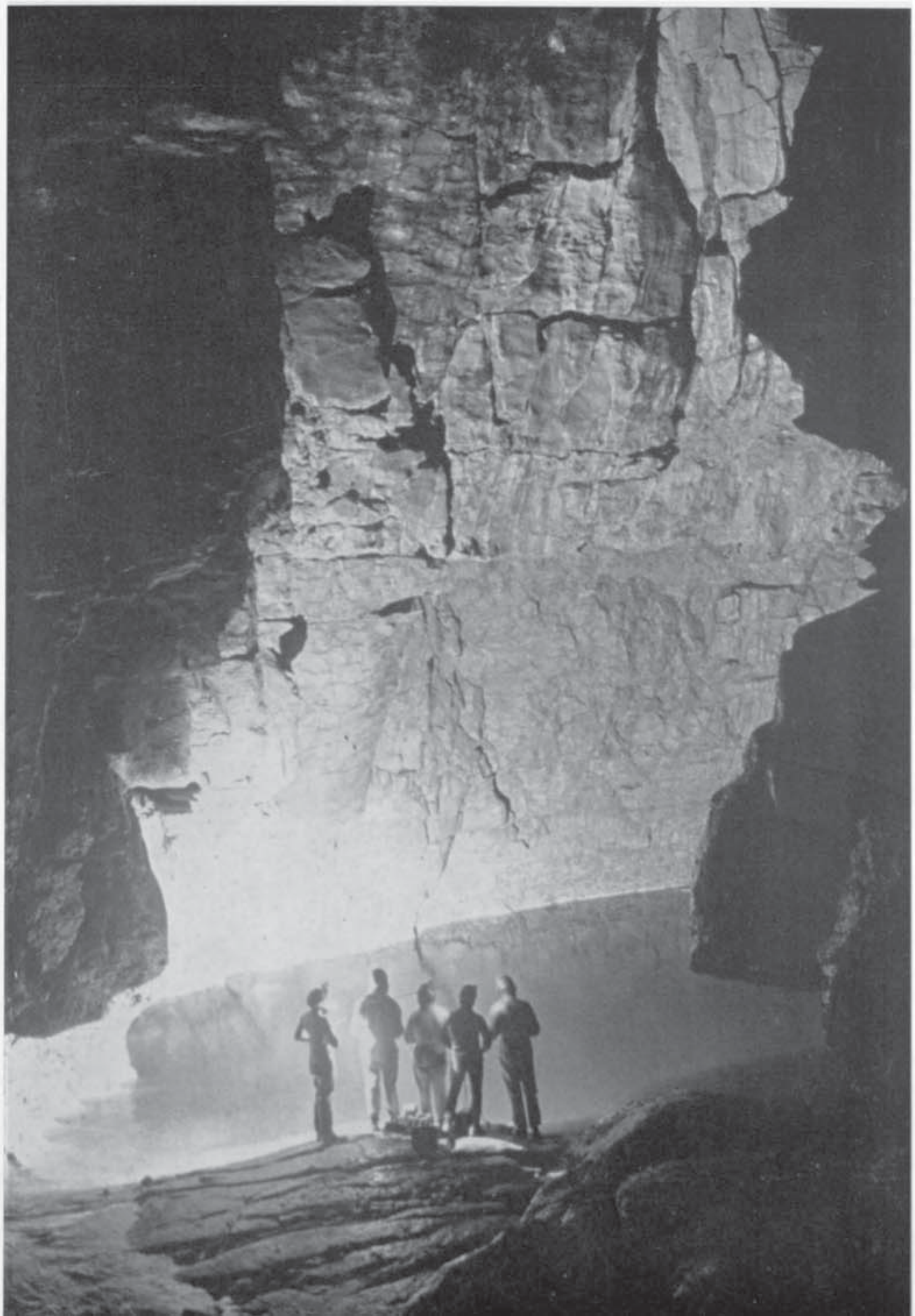
BCRA TRANSACTIONS

BRITISH CAVE RESEARCH ASSOCIATION

Volume 3 Combined Numbers 3 & 4 December 1976



The British New Guinea Speleological Expedition of 1975

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A very short summary of the principal conclusions should accompany every contribution.

References to other published work should be cited in the text thus . . . (Bloggs, 1999, p.66) . . . and the full reference with date, publishers, journal, volume number and page numbers, given in alphabetical order of authors at the end, thus . . .
Bloggs, W., 1999. The speleogenesis of Bloggs Hole. Bulletin X Caving Assoc. Vol. 9, pp. 9-99.

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THE BRITISH NEW GUINEA SPELEOLOGICAL EXPEDITION, 1975.

compiled by D. Brook

Contents *Page No.*

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FOREWORD

This comprehensive report produced by the members of the British Speleological expedition to New Guinea 1975 records the varied facts and preliminary conclusions gleaned from 5 months fieldwork centered on Telefomin amongst the high altitude karst of the West Sepik District of Papua New Guinea.

The venture was the most ambitious speleological expedition ever launched and received encouraging support from individuals, organisations and firms at an economically difficult time. Fortunately dogged effort was repaid by tremendous success. Reconnaissance groups visited 1,000 square miles (2,500 sq. km) of limestone terrain varying in altitude from 2,000 to 13000 ft. (600 to 4000m.) between the Star Mountains and the Strickland Gorge. Areas containing caves of world class depth potential were located and a multitude of caves were explored, some deep and others of vast dimensions. Surveying eventually confirmed that in Selminum Tem they had stumbled upon the longest and most impressive cave system in the Southern Hemisphere.

Underground human occupation sites and unusual cave art were recorded and more investigation of Selminum Tem and attendant systems revealed a wealth of evidence relating to the complex evolution of the Finim Tel plateau since it was elevated above sea level. The conclusions were reinforced by a parallel study of the diverse and well adapted cave fauna whose surface relatives no longer inhabit the plateau — a phenomenon not known before within the tropics.

ACKNOWLEDGMENTS

The expedition extends its thanks to H.R.H., the Duchess of Kent and Eric Shipton for their patronage; the Sports Council, Mount Everest Foundation, Ghar Parau Foundation, and WEXAS for grants; the RGS and BCRA for their approval; the University of Leeds for assistance; Papua New Guinea government departments for cooperation, and all the individuals and organisations whose generosity assured the success of the venture.

EXPEDITION MEMBERS

D. Brook — Leader
A.J. Eavis — Deputy Leader
H.M. Beck — New Guinea liaison
P. Beron — Biologist
*F. Binney — Soundman
*R. Blackham — New Guinea liaison
J. Buchan — Doctor
P. Chapman — Biologist
S.G. Crabtree — Geologist/Treasurer
J. Donovan — Speleologist
P.S. Everett — Linguist
*J. Farnworth — Speleologist
M. Farnworth — Equipment Officer
A. Goulbourne — Equipment Officer
P. Gray — Speleologist
S. Perou — Cameraman
N. Plumley — Assistant Cameraman
C. Pugsley — Food Officer
*J. Sheldon — Communications
A.S. White — Photographic
K.A. Wilde — New Guinea liaison/Ethnics
*R.G. Willis — Speleologist
D.W. Yeandle — Speleologist
C. Yonge — Food Officer

* part time

For their participation in the expedition Stephen Crabtree received a Churchill Fellowship and Dr. Petar Beron a U.N.E.S.C.O. grant.

DIARY OF EVENTS

by D. Brook and H.M. Beck

Why go to New Guinea? To some it was not the place to choose as the frontier in speleology in 1975. The idea was described as a "dubious venture" and an "heroic rather than reasoned attempt to locate major cave systems". Others thought that Britain's economic state would lead to the failure of any ambitious expedition and thus cast a shadow over future attempts to organise another. Such arguments certainly had some validity but if heeded by the adventurous, man would have yet to set foot on Everest, or the Moon, or in Selminum Tem!

The large island of New Guinea began to capture the imagination of cavers by the description in 1963 of mighty river sinks in the remote Star Mountains (Brongersma, 1963). Previous exploration accounts of the central mountains vividly described the difficult limestone barriers, bristling with pinnacles and riddled by great pits, but the Dutch expedition confirmed the existence of large open caves which were potentially thousands of feet deep. In 1965 Frank Salt tried to organise a British scientific expedition to the eastern Star Mountains and Telefomin area but it fell through for political reasons. Australian cavers took up the challenge and launched their own Star Mountain explorations, but, although they traversed many miles of high limestone country, all caves found were short and choked, and surprisingly they were not equipped to descend shafts more than 20m deep (Hallyer, 1965 and Shepherd, 1968)! Their dissappointing results led to the notion that, like the high Himalaya, the limestone mountains of New Guinea had been uplifted too recently and rapidly for accessible cave systems to have formed.

Cave exploration has been proceeding in the more accessible regions of Papua New Guinea for many years and has recently been well documented in the pages of Nuigini Caver, edited by Mike Bourke on behalf of the Papua New Guinea Cave Exploration Group. Of necessity work has been carried out by individuals or small groups, but sizeable systems have been surveyed; the longest up to 1975 being Irapui in the Chimbu area (1,600m). Also in the Chimbu area during 1972 the exploration of Bibima Cave was pursued to a depth of 494m, thus giving Papua New Guinea the deepest system in the Southern Hemisphere. (Wilde, 1972).

The first really determined caving expedition was mounted in 1973 by cavers experienced in deep vertical holes from Australia and New Zealand. Wilde and Watson carried out a reconnaissance to a remote plateau above the Strickland River in the Muller Range. An incredible river sink was reached and numerous promising holes reported so the full party of 26 moved into the area for 3 weeks intensive exploration. They found the conditions appalling (Holl, 1973), but explored many shafts, the deepest being 314m, and a few caves. The large river sink proved impossible to explore in the time available but although major systems had proved elusive it was felt that a return in 1976 would be more rewarding (James, 1974).

THE BRITISH EXPEDITION

Wherever there are caves to be found, British cavers will appear sooner or later. Their enterprise is well known world wide and considering the amateur status of speleology in Britain, its global impact is remarkable. After the Pierre St. Martin explorations of 1969-73 the suggestion of a long trip to New Guinea was made. Further research confirmed that the island contained some of the thickest pure limestone in the world, ranging from near sea level to the highest summits at 4,000m plus. Very high rainfall suggested that large cave systems could have formed in spite of rapid uplift. Members of the 1972 Venezuela and Ghar Parau expeditions were also seriously considering a similar venture, so in the Spring of 1974 a meeting was held at Ingleton at which people could discuss the prospects and appoint officers to set the ball rolling. Shortly afterwards a group of five left overland for India and thence to Australia to seek their fortunes and organise in Australia for the proposed expedition. Only Dave Yeandle, however, was to eventually join the team when the financial crunch came in 1975. Howard Beck, and later Roy Blackham, went out to work at Mount Hagen in the highlands of Papua New Guinea, and hence cooperate with Kevan Wilde who was our only experienced New Guinea caver. Between them they did a fine job; most problems arose from lack of communication when some of the British team dropped out of the venture. As a bonus they visited caves in the Chimbu region including a trip to the bottom of Bibima; they also carried out the first investigation of the huge Iaro River Cave (Beck, 1975).

Back home an encouraging grant was made by the WEXAS and Eric Shipton agreed to be a patron. Geological and topographical maps were tracked down by Andy Eavis and a talk with Martin White (Petroleum Geologist) decided us on the Telefomin/Hindenburg region (Fig. 1) since it had some of the thickest limestone in New Guinea at high altitudes and a dramatic report had been given of an aerial reconnaissance (Robb, 1973). Air photos were studied to outline the promising areas so that our New Guinea team could plan a ground reconnaissance.

Now came an unexpected bonus, for the National Caving Association had been negotiating with the Sports Council who had agreed to make a contribution towards the travel expenses of an expedition which would advance the standing of British caving. They were rather startled when presented with **New Guinea 75** but true to their word made a most welcome grant. Our thanks are due to Dick Glover who put our case and others in the N.C.A. who negotiated with the Sports Council. Here is a case when the N.C.A. proved its rele-

FIG. 1

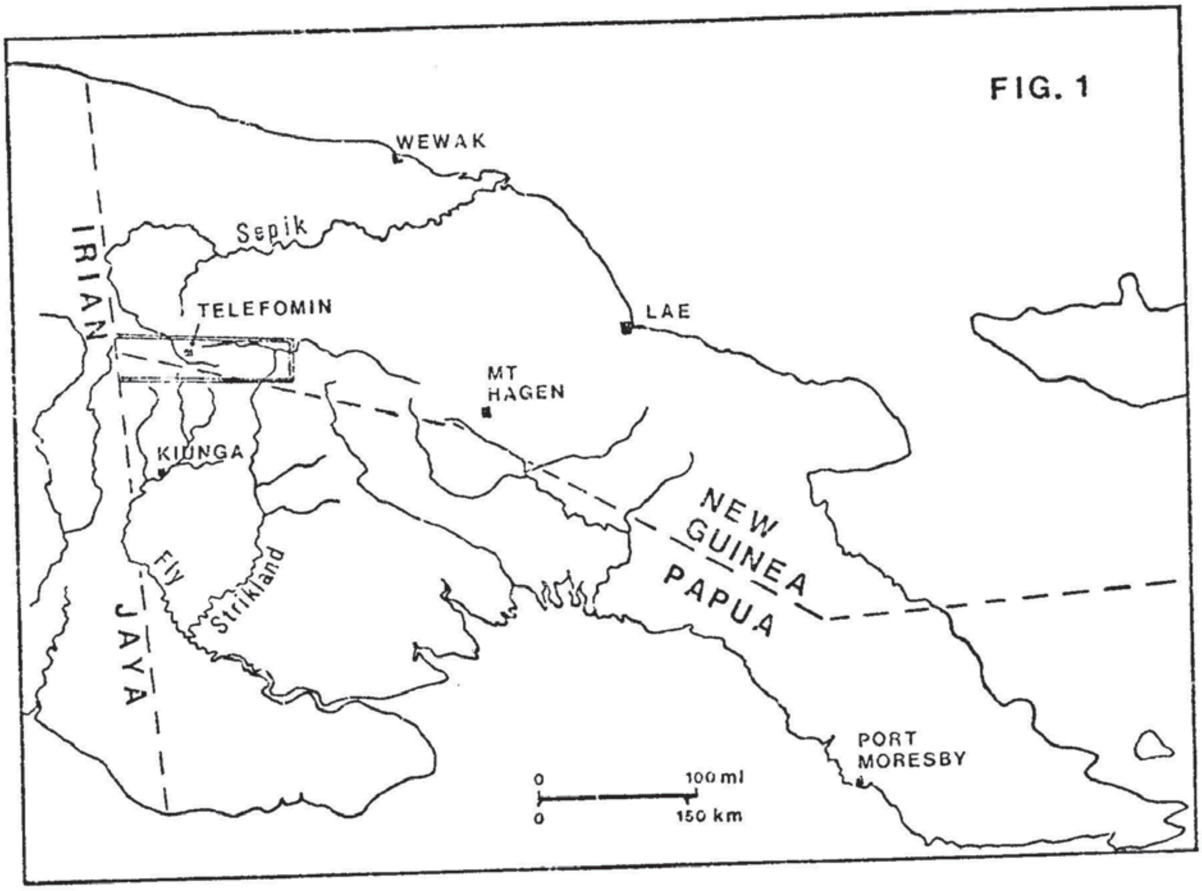
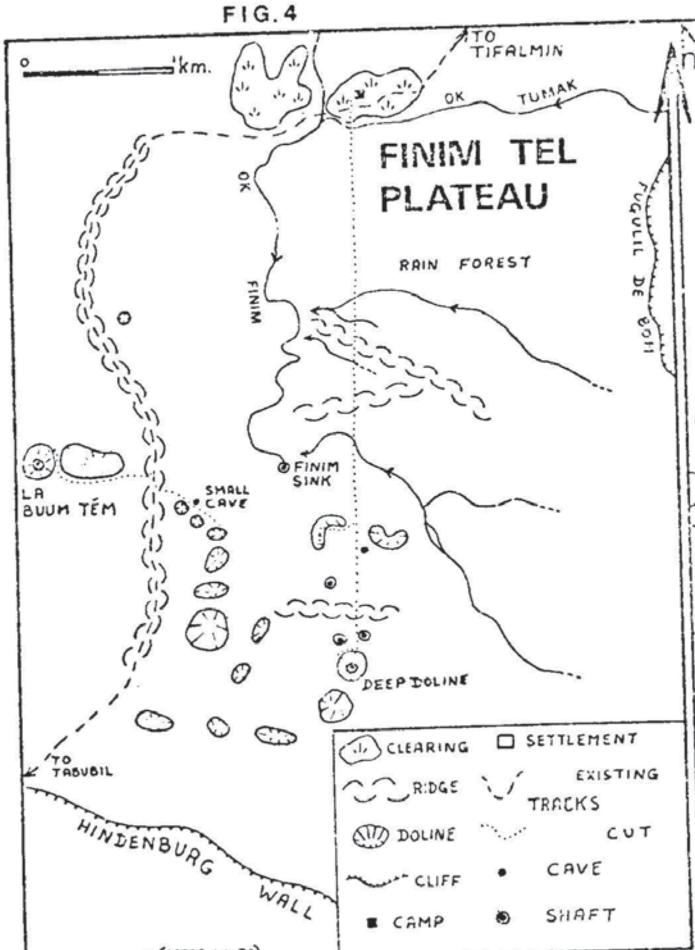


FIG. 4



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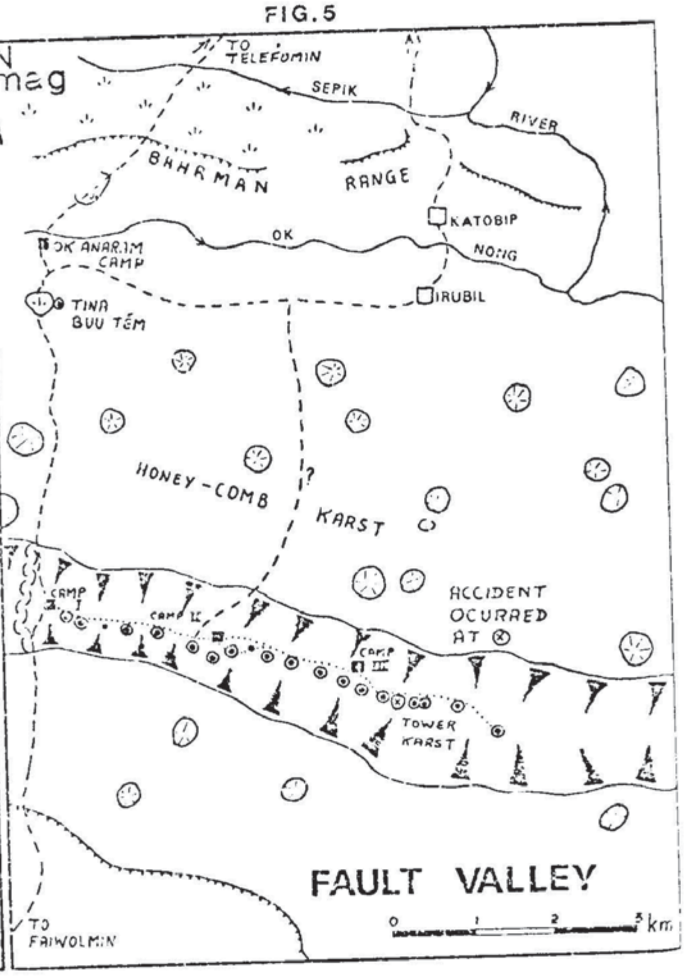


vance to the advance of caving.

Whilst applying for further support it was apparent that our aims and national status did not qualify for most trust funds and the Royal Society no longer supports expeditions – future Charles Darwins must look elsewhere for help! Our objectives seemed commendable to the Royal Geographical Society, however, who gave us their approval, and the Mount Everest Foundation donated an above average grant. The Duchess of Kent also agreed to be our royal patron. Now we had more support we approached firms and suppliers and on the whole received enthusiastic help in spite of the economic gloom (see Food and Equipment reports). Two awards were made to individuals on the team. Stephen Crabtree obtained a Winston Churchill Memorial Trust Fellowship to support his work as geologist and Dr. Petar Beron (biologist) received a grant from U.N.E.S.C.O.

Early in 1975 it became obvious that we were short of keen workers to organise the food – some people had contributed nothing since the meeting a year earlier! The financial crunch also came, for rough arithmetic indicated that a personal contribution of £600 each would be needed to field an expedition of 25 for five months. Several people dropped out due to lack of financial foresight or job commitments but their replacements were always qualified both as keen cavers and capable of specific jobs in the team. We were particularly lucky in our choice of Jon Buchan as doctor, for although limited in previous caving experience he proved a driving force in the expedition. There is no doubt that the ultimate success of **New Guinea 75** was due to the versatility and compatability of the team, and most people produced unexpected reserves of determination when the going got rough.

From the work load in Britain it was obvious that the proposed May departure for the main group would have to be postponed. The New Guinea contingent, however, had already laid on the reconnaissance from their own contributions and some money from Britain. Howard and Kevan had given their notices but Roy decided to keep working and join the main expedition later.

THE RECONNAISSANCE – H.M. Beck

The original plan was to carry out an aerial 'recce' followed by two patrols on the ground, but the pieces of reality didn't quite fit the jigsaw of probability without a little force. Kevan Wilde and Howard Beck left Mt. Hagen on the 4th April by light aircraft after spending several days buying supplies. En route west to Telefomin incredible unexplored limestone pinnacles were seen around Mt. Kaijende and the stupendous Strickland Gorge took the breath away.

In Telefomin supplies and equipment were unloaded and we took to the air again with two government patrol officers (Kiaps) to fly around the area. We proceeded south from the station, across an extensive honeycomb karst region, then west along the Hindenburg Wall as far as Tere Falls. (Fig. 2). The aircraft was too fast for useful observations and bad cloud buildup forced us to return without covering as much ground as intended. The 'wall' was very impressive but has suffered from exaggeration (Robb, 1973).

After sorting out matters in Telefomin we left for the Tifalmin valley to the west. A short patrol of one week duration was first made onto Mt. Aiyang (10,500ft. – 3,150m) at the head of the valley, and the summit reached after three days cutting. Here occurred the first of several accidents, when one of the carriers received a nasty gash on the ankle from a slip with an axe. Nothing was turned up in the way of promising caves.

Next the Bahrman Mountains south east of Aiyang were crossed to the Finim Tel plateau (Fig. 4). Things were different here. Within a week a track was cut south to two large shafts and a rising and sinking river (presumed to be the Finim) were found. More caves and another big shaft near the track to Bultem confirmed the speleological potential of the plateau, so construction was started on two large huts to accommodate the main team. Kevan had an attack of recurrent malaria and a return was made to Telefomin to recuperate.

The Assistant District Commissioner had offered a free chopper ride over some big sinks on Mt. Wamtakin but it was delayed and we headed south for the lush Nong valley bound for a high fault-controlled valley midway between Bolivip and Feramin (Fig 5). A really awe-inspiring shaft was seen adjacent to the track on the second day out. The locals called it Tina Bu Tem and it was populated by a large flying fox colony.

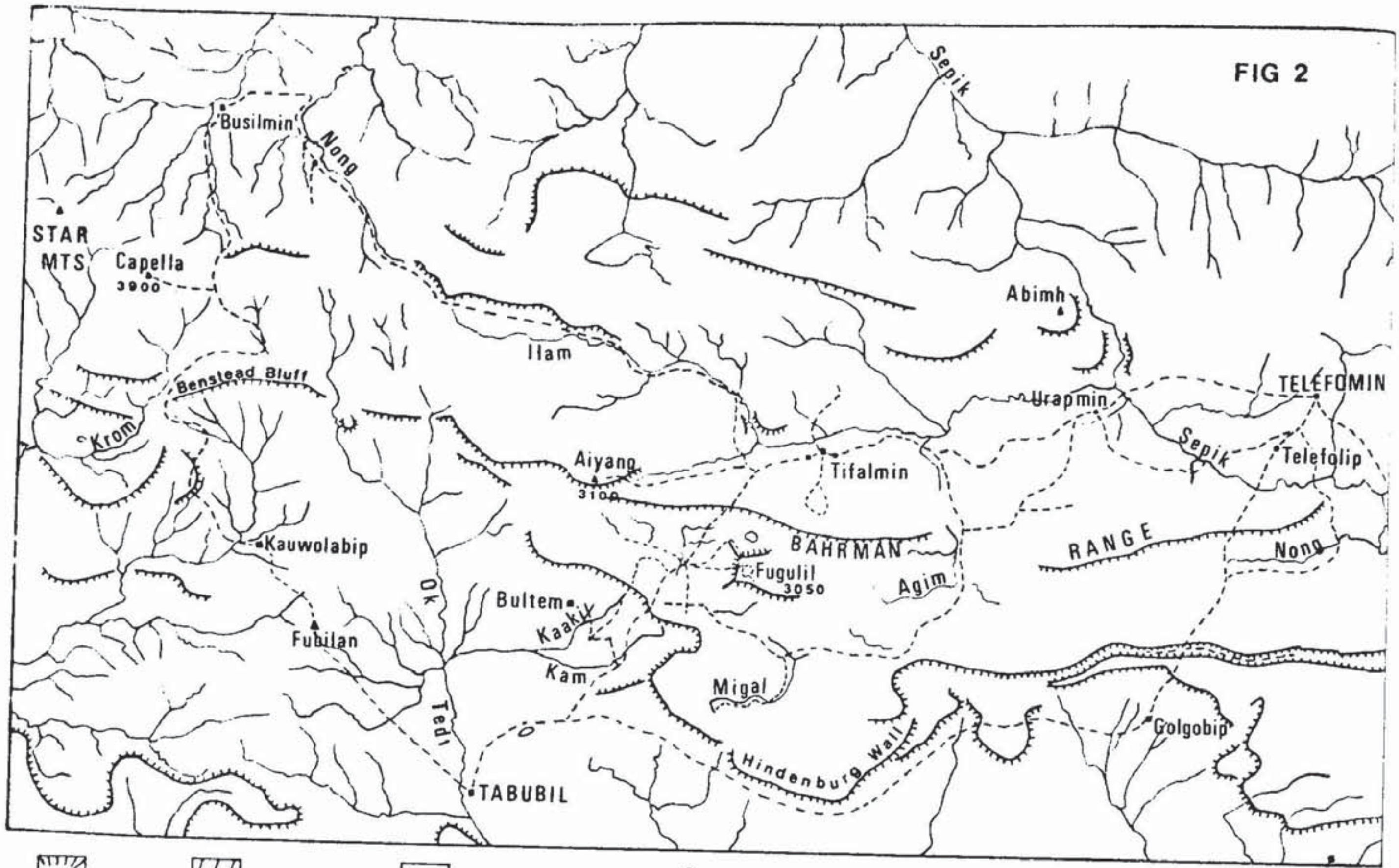
The first morning in the fault-controlled valley was far from pleasant. It was cold, wet and the jungle dense. Drizzly cloud permeated the stunted trees and this weather was to continue for a week. Cutting up the valley from a camp at Mogandabip, 26 shafts, sinks and caves were noted for future exploration but conditions were appalling – tower karst, dripping moss forest and daily downpours.

On the 12th May this patrol ended abruptly when Howard severely gashed his knee with his machette whilst jungle bashing. A three day trek over two mountain ranges to Telefomin for medical attention put him out of the field until the arrival of the main team in July.

Following a chopper reconnaissance over Mt. Wamtakin, Kevan went on to complete the last patrol of the series. From Tifalmin he went south to the sink of the Ok Agim and the impressive entrance of Agim Tem. Continuing south the track was left in search of the Ruun sink which looked promising. Cutting east from Agim Tem led to confusing and waterless country, and the 'Big Holes' marked on the geological map were elusive so a path was taken to Urapmin.

So ended a two month epic. Both of us had suffered at various times from tropical ulcers, swollen lymph glands, enteritis and fungal infections of the feet.

Fig. 2. Sketch map of expedition routes.



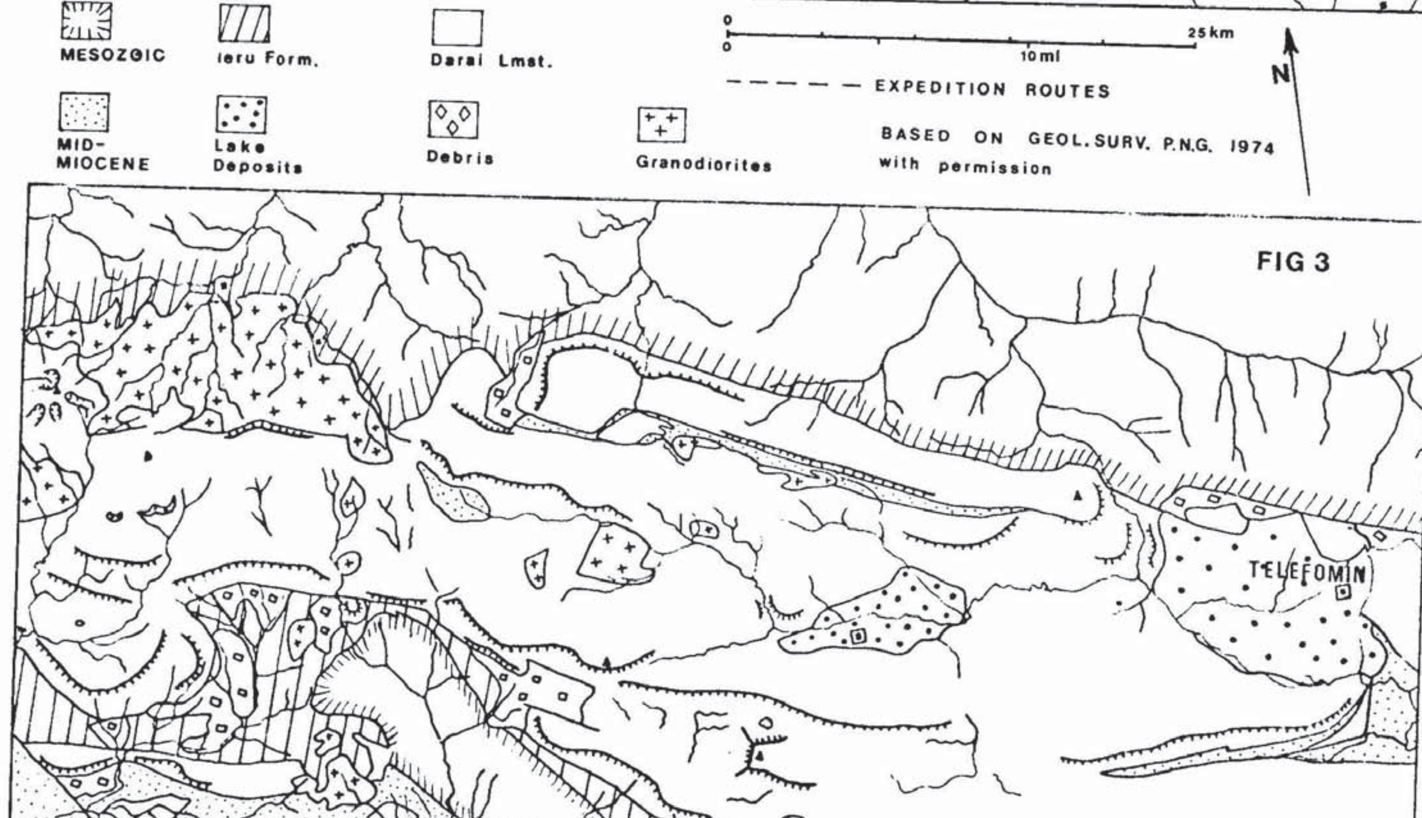


Fig. 3. Geological map of the expedition area.

THE BRITISH EXODUS – D. Brook

Back in the British camp the pot was coming to the boil. Thousands of letters were despatched and gradually 14 tons of food and equipment were stockpiled. Leeds University lent a suite of rooms with convenient loading space and these were to be the hub of the expedition until the departure in July. Without this facility a most difficult task would have been well nigh impossible and our special thanks go to the Registrar, Mr. J. Macgregor. Equipment was being tested and deliveries arriving up to the last minute and repacking the food took two weeks of continuous work. Crates were donated by Yorkshire firms and Derek Crossland allowed free use of his Land Rover for fetching and carrying. Eventually all was loaded and despatched to Tilbury docks one memorable day in April. London docks waived their charges and when the freight returned through Liverpool a similar much appreciated gesture was made. Another consignment of late deliveries were taken to Rotterdam by Chris Pugsley and Mike Farnworth, (who was to travel on the S.S. Willowbank with the freight) boarded ship at the same port.

In spite of the fund raising (especially in Ingleton) we were still short of money for internal transport in New Guinea, so Dave Brook as leader approached his friendly Yorkshire Bank manager who gained approval for a loan to be transferred out to New Guinea as required. With the last home hurdle cleared a greatly overloaded contingent reached Heathrow, with a lot of help from their friends, and flew out on July 16th. Throughout our travels airport staff and aircrews ignored our excess baggage and seemed to regard us as an entertaining diversion.

A stop-over in Hong Kong was a trip to paradise for those in search of new cameras but our Bulgarian biologist, Dr. Petar Beron, was impounded since he had no entry permit. On our early morning arrival at Port Moresby Kevan was there to meet us and as we wilted in the heat he and Bill Saunders organised accommodation for those in need. From now on we were to meet and make a host of friends in Papua New Guinea. There was still much to organise before we could get to Telefomin and launch the expedition in earnest. While most enjoyed a welcome short break a few finalised the DC3 charter with Air Nugini and contacted the Institute of Papua New Guinea Studies. They had negotiated our entry visas as a recognised expedition and also arranged for two Geography students to join the team in late November. We also learned that the geological survey would be operating near our area and agreed on mutual help. A visit to the Agriculture Department confirmed that our departure to Mount Hagen would have to be delayed because food at the docks in Lae had to be inspected. Our fault for not checking the regulations! As soon as the first load of equipment was released and on its way up the Highland Highway to Mount Hagen we were aboard a DC3 on our way to join it. Quite a stir was caused at Hagen when we burst a tyre on landing and closed the airport for 24 hours. Here we met Mike again after eight weeks at sea and he, Andy and Steve Crabtree stayed there to supervise the DC3 charter into Telefomin. The main group took off once more on the breath-taking forward flight. Cloud cover increased to 100% as the plane flew westward on visual navigation. Suddenly we dived through a hole in the cotton wool, banked steeply in a narrow valley and there dead ahead was the airstrip at Telefomin. After two years work we had made it!

IN THE FIELD – D. Brook

At Telefomin our welcome in Papua New Guinea reached its peak with friendly help and hospitality from both the administration and local people. A house had been provided, giving us a more comfortable base than we expected. It was a little crowded with over twenty people under its roof but most of the food and equipment now coming in was put into an empty government store. We were allowed to turn another store into a Heath Robinson darkroom and left it as such on our departure for resident photographic enthusiasts. While all the frieght was slow in coming in we explored some well known caves only half a mile from the airstrip; one wet and the other dry. Phil Chapman and Petar Beron collected fauna in the caves and were amazed to find marine relics – a most encouraging start to the biological programme. A few days later a further cave was entered but torrential rain and a flood pulse almost led to a premature end to P.B.'s expedition. The incident highlighted the catastrophic flooding of some of the caves we would be working in, but similar close shaves were rare due to a mixture of luck and common sense.

Kevan, Mike and Jack Sheldon with some Eliptamin carriers set off by the north track to Urapmin, Tifalmin and on to the Finim Tel plateau. The plan was for the majority of the team to make the three day walk to the plateau and so get fit and versed in bushmanship before splitting up into small groups. An airdrop was to be arranged and our cameraman Sid Perou was to film it. So far things had not gone too well for him as most of the film stock had been delayed in transit and he was committed to sending regular reports to television news back home. Sid set off in hot pursuit accompanied by Frank Binney, the American soundman who had worked with him in Canada on the Castleguard film. At first the narrow slippery tracks, deep mud and log bridges proved a great trial for those unused to the country. Towards the end of the expedition some would be covering 25 miles a day with full packs, but at this early stage 15 miles seemed a long haul and to make matters worse most were carrying 50 or 60 lbs which was a suicidal load for novices. In small groups we arrived at Tifalmin where a staging camp was established around the "haus kiap" used by government patrols and travellers. For various reasons the airdrop fell through and created a crisis up at Finim Tel where the advance party were facing starvation. The 'new' airstrip at Tifalmin was banned to most aircraft but mission planes are allowed to use it and they ferried in food when they could. Local carriers then took the supplies up over the Bahrman Mountains, a 4,000 ft. (1,200m) rise, to Finim Tel, and at last the search for caves could begin in earnest.

The native people of Tifalmin readily told of caves in the neighbourhood. Some were burial sites noted in the reconnaissance but Ok Kemimaal was a roomy old system with an interesting fauna. Hunters took a couple of us high up to the Bahrman Mountains to several shafts, one of which was 300 ft (90m) deep.

Up on the plateau a bush camp was established close to Girtoil at the end of the due south track cut on the reconnaissance. The two enormous pits, visible on the aerial photos were descended for 500ft (150m) but ended in chokes of boulders. Other shafts in the vicinity were also investigated but only one led to a cave of any significance. Back towards the Finim Tel clearing, the reconnaissance party had located a river rising and sinking at the base of a giant doline (Ok Kumun Tem). A fascinating maze of passages was now explored above the sink but they rejoined and ended all too soon in a high rift and narrow sump. The track from Finim Tel to Gertoil cut across the drainage on the shale beneath Mount Fugulil. The two streams nearest Ok Kumun Tem led into short caves with shafts nearby, but all ended in sumps.

Along the local trade route passing through Finim Tel to the village below the Hindenburg Wall a short track had been forced to the impressive open pit of Le Buum Tem. Flying foxes lived here and were hunted by the natives but the hole was choked at a depth of 400ft (120m). A bivouac was set up close to the pit and a track cut southeast towards another giant doline. In the course of cutting some small shafts were stumbled on but the route was a nightmare of tower karst and stinging plants. At the far side of the giant (Bilel dabom) doline was a rock shelter and an old hunting track was intersected leading to the Girtoil area.

Finim Tel was dominated by the great plinth of Fugulil Dabom – a block of limestone towering 2500ft (750m) above the plateau. The depth potential to the base of the Hindenburg Wall was about 5,000ft (1,500m) but the block appeared to be resting on beds of shale. However, the top was riddled with dolines and presented a considerable challenge so after a three day struggle a way was forced up the north-west ridge. It was a hopeless route for a supply line to keep men working up there so a remarkable alternative was pioneered up the South West buttress to a knife edge ridge and hence the summit. Kevan, Mike, Jack and Dick Willis spent an arduous week on top cutting through a frustrating mat of springy vegetation cloaking tower karst. Caves were found but they were small and the only deep shaft was blocked by a dislodged boulder. Consolation was provided by breathtaking sunsets and infinite cloudscapes.

Meanwhile down below things were looking up! One of our carriers was a Wokkamin, in whose hunting areas we were operating. He told of a large cave in which his people used to hunt flying foxes, so Jon invited two of his convalescing patients, Steve and Allan Goulbourne to take a stroll to the cave. Their guide led them to the huge Selminum doline not far from Le Buum Tem. Until now monster dolines have not led to large caves in Papua New Guinea but the golden rule was about to be debased with the discovery of Selminum Tem. The flying fox cave was high on a ledge in a 400ft (120m) cliff, and it was impressively large but ended all too soon in a choke. At the base of the cliff a wide opening beckoned with a cool raging draught and the trio scrambled down a boulder slope into an enormous tunnel which they followed in awe for half a mile before turning back and dashing to Finim Tel to convey the good news.

Next day the remarkably cured Steve and Allan returned with a team to continue exploration and bivouac at the cave. The large trunk passage continued for a mile to a canyon cutting across the route. This was descended on a rope and Tony White, Steve and Dave Yeandle scrambled upstream over colossal boulder piles in a vast cavern until a great shaft of daylight announced an exit. Having no idea where they were the explorers had to retrace their steps through the cave. Andy, Allan and John Donovan went downstream and found a dark chamber ending in a mud-choked tube. They also began exploring a ridiculous maze of tunnels beneath the trunk route and gave up at a seven ways junction! It was clear that a careful survey was needed to save wasted effort. Up until now very little survey had been done and much effort was being wasted for lack of foresight. From now on all discoveries were to be surveyed at once, preferably during exploration.

Jon Buchan had not considered himself experienced enough to take part in the big push in Selminum Tem so he joined Dave Brook in the hunt for the elusive sink of the Finim River. From the south track a stream was followed to the main river and cutting downstream led to the desired goal. There was no cave taking the water but under a cliff behind jammed logs was an opening and exploration for the day ended at a deep pool. The duo were joined next day by Chris and Chas Yonge when over 3,000ft of cave was eventually surveyed and the first of the remarkable Finim cave crabs was collected.

Parties were recalled from Fugulil and Girtoil to join in the exploration and survey of Selminum Tem. The idyllic bivouac at the ledge and entrance of the upper cave became rather crowded and thus long trips became the norm. Whilst surveying a considerable extension was made to the first major inlet, which ended in a calcite encrusted area. Following the same stream along the trunk route a lower labyrinth series was entered where more streams entered only to fall into a deep syphon at the lowest point of this Sump Series. In the far reaches more huge tunnels with unusual calcite formations were traversed to further entrances; the most distant and diminutive being christened the Tradesman's.

Strange man-made pits had been noted in the upper cave and the biologists were having a field day in the system. Unexpectedly a varied and well adapted cave fauna was found in the upper and lower caves and most were similar in form to European and North American species. They now had no surface relatives on the plateau and it seemed likely that drastic climatic changes were the explanation. More unexpected discoveries were to come from this remarkable cave system. Paul and Mike descended an obscure pit in the floor of a high oxbow on the trunk route and a small series of tunnels were being recorded when vertebrae and ribs were seen sticking out of the rock. Such a find was a chance in a million (or more) so photographs were taken, Jon made a "post mortem" report on the exposed bones and notification was sent to the Geological Survey of Papua New Guinea.

The next day (August 27th) was memorable for all but one of the team. The survey reached the first of the far entrances (The Backdoor) but at almost the same time a mile into the cave Steve set about crushing innocent rocks by diving 20ft onto them from a boulder. He took the full impact with his head but his helmet saved the day. His companion, Jack, positioned him more comfortably and went to get help. He met Pete Gray, Tony and Chas and while Tony sprinted to the Backdoor to get Jon and the rest of the survey team, Pete and Chas did what they could for the patient. Pete had only just arrived from operating communications in Telefomin and must have felt that he was fated to never reach the sharp end of the expedition. Meanwhile news reached the main entrance and Kevan instructed our newly appointed Wokkamin carrier Ayangim to fetch the stretcher from Finim Tel. This he did in the incredible time of 1½ hours and it was speedily taken underground. Jon was pleased with the first aid already given and supervised the transfer of the victim to the stretcher and the seven hour exhausting carry out. The midnight exit coincided strangely with the start of Jack's birthday but celebrations were limited to an immediate hourly rota set up to monitor Steve's condition. While Steve was slowly recovering the carriers constructed a helipad at the top of the doline; just in case he deteriorated and had to be evacuated to hospital. In the event it was not needed and Steve made it to Tifalmin under his own steam.

Sid had been filming at Girtoil and was dismayed to have missed the action, but we convinced him that a replay (without another incident) would satisfy even a most discerning public. The huge trunk route was crying out for still photography and before the team split up for other projects an ambitious trip was organised to capture some impressive shots (see photographic report). During one of the frequent lulls on such trips, some of the pebbles in the eroded sediments of Copernicus Cavern were found to be igneous rock with prominent hornblende crystals. Such pebbles were subsequently recognised throughout most of Selminum Tem, but no outcrop of the rock was to be found south of the Bahrman ridge and their original source aroused much speculation.

The photographic trip also led indirectly to the finding of the engraving of a bird 700ft (200m) from the cavern entrance. Chas and Chris assisted Kevan to plot the position and configuration of this and other engravings. A hearth was found on a high ledge closeby but no footprints could be seen either on the ledge or near the engravings, neither did the local people know anything of their origin – quite a mystery!

Exploration proceeded steadily and one extension was found in a unique way. A glaringly obvious roof passage was begging to be entered so Yaiyok our chief carrier cheerfully went ¾ mile into the cave and built a ladder from saplings and vines until it reached the opening. To his delight it led to a new series ending in pitches to a deep syphon. Also the upper and lower caves were finally connected after some excavation and airy climbing. Thus was solved the thorny problem of what to call the lower cave; since the locally named Selminum Tem was now part of the same system.

At this stage we had surveyed some 9 miles (14km) in the giant cave and knew we were getting near the southern hemisphere length record of Exit Cave in Tasmania, but people needed a change from caving day after day (some had been down ten days without a break) and a switch was made to locating the surface position of the far entrance. While cutting north several shafts were found, the deepest being 300ft (90m) and choked, but on cutting back towards Selminum Tem three caves were stumbled on. All led off from the same doline, hence the name Trinity, and the central cave was the most extensive being a huge fossil tunnel similar to Selmimum Tem.

The far entrances were proving elusive, so for a 'do or die' epic, bush knives were taken through the cave and a track started from the Backdoor due south. Darkness fell with no sign of familiar ground and the track ran into a mass of fallen trees. A decision was made to swing east and, just as a night out seemed inevitable, a track was intersected and almost missed in the gloom. It was our path to Trinity and so the grand circuit had been completed.

Everyone pulled back to Finim Tel as most were going back to Telefomin to join in the celebrations of Papua New Guinea's Independence from Australian administration on September 16th. Meanwhile, John Donovan and Ayangim had been retracing an old patrol track west from Finim Tel and found the sink of the Kaakil River. Together with Allan, John explored a labyrinth of passages and numerous entrances and exits before they traced the main river into a magnificent cave plunging into a deep chasm. The canyon below had deep pools and superb sporting climbs and traverses. It ended in a syphon the size of a swimming bath and was surveyed just before the departure for Telefomin. The Wokkamins told us that they called the great canyon Ok Tem i.e. River Cave.

Earlier two groups had set off on separate patrols looking further afield for caves. The first to leave trekked an erratic course beneath the great escarpment of Mount Fugulil to short caves at the sink of the Kam River before pressing on to the clearing of Bobor Tel. Andy had had the misfortune to fall off a log, which promptly fell on him! He laid up in the clearing while Paul and Ayangim followed the Migal River to its sink and beyond for several miles without finding major caves. They then rejoined Andy and continued via the Ok Agim and Urapmin to Telefomin.

The second patrol had the Ok Agim as their main objective. Kevan, Chris and Chas took on carriers at Mongabip, the most easterly village of the Tifalmin group. The cave had been located during the reconnaissance and takes the Ok Agim in flood. An enormous passage swept down via a series of pitches, interspersed with deep pools to a most uncompromising sump at a depth of 550ft (167m).

THE INDEPENDENCE PERIOD

All but three caretakers went back to Telefomin for Independence. Native people had walked up to 100 miles and brought all their finery with them. Telefomin had never seen anything remotely resembling the spectacle which was quite spontanecus and very impressive; a most memorable experience for everyone.

Jack Sheldon had to quit the expedition at this point since his leave from the Army was coming to an end. We were all loathe to see him go as he was a most dependable part of the team. Frank Binney had dropped a bombshell by announcing that he felt his and Sid's ideas for the film were incompatible and he wanted to pull out of it. From now on he ceased to take an active part in the search for caves and eventually left for the coast. Sid was left without any assistance but Noel Plumley had helped when Frank was out of action. He and Pam Henson had originally come along at their own expense and Noel had stayed on to help out and got on well with everyone. He was just the man to assist Sid and was promptly initiated as a full member. Petar Beron also left to increase the scope of the biological programme. He got lifts to attend an ecological conference at the Wau Institute where he gave a paper on the expedition finds to date. After collecting in the Chimbu caves he made a remarkable tour of New Britain and New Ireland to investigate their cave fauna so a comparison could be made with the high altitude cave populations being studied by Phil up at Finim Tel. (Beron, 1976).

Steve was advised by Jon to avoid strenuous and exposed situations for several months. He decided not to return home but to take over the demanding task of communications and organisation in Telefomin, on which the smooth running of the expedition depended.

FINIM TEL AGAIN

As Independence raged below, the three caretakers at Finim Tel were turning up more caves. Dave Yeandle and Phil carried a log into Selminum Tem and used it to get into Lumberjack Oxbow and the aptly named Piranha Passage. Not to be outdone Dave Brook stumbled across the Bitip River Cave north of the Kaakil and got into a spectacular roof level above the Ok Tem canyon. An enticing continuation was visible at the far side of the chasm and the logmen used their newly acquired expertise to span the gulf and survey more of the system. On plotting the various surveys on the air photos it was obvious that Ok Tem and the far entrances of Selminum Tem were not far apart and next day the surface link was easily forged by Dave Yeandle. The caves were extremely close indeed!

Because of delays Sid was short of vital sequences for the film, so to keep the epic as near the truth as was feasible, most of the expedition (variously disgruntled) strolled the 50 miles back to Finim Tel after Independence. Sid got his first sequences and most people shot off as soon as possible to get on with more exciting patrols. With so many people back at Finim Tel, food had to be got in quickly, and to this end an airdrop had been arranged from Telefomin. Finding a pilot to take it on proved difficult but Peter Booth took up the challenge with 'Kiap' Mark and Tony as dropmasters. The sacks and drums had to be dropped 600ft. (180m) because of wind conditions but all hit the clearing and it made a superb film sequence. Three days later we received the second part of the drop, but the plane now skimmed the trees because of low cloud and most of the sacks landed in the bush – some are still there!

Kevan, Howard and Pete were the first to be released from filming and left to record cave art and burial sites in the Tifalmin valley. The filming moved up Fugulil and Andy started a theodolite triangulation of all relevant points visible from the peak. During the lull Jon and Mike started a trek towards the region south of Selminum. In a hidden valley they found the Milky Way Cave and explored ancient passages encrusted with formation to a window exit in the high cliff above Selminum Tem. From the cave Dave B and Tikiok cut on to meet a prospecting track running from Selminum as far as another enormous doline with no caves. The cutting was continued south until, just as evening threatened, the world came to an abrupt end and a sea of cloud stretched out to infinity over the plain of Papua. The Hindenburg Wall at last!

The looming film epic at Ok Tem could be delayed no longer so all the team knuckled under and set to work. As the day wore on and a night of the same threatened, concentration slackened, so that two potentially serious accidents occurred before the trip was sensibly cut short. One man slipped and stopped right on the edge of the 100ft (30m) deep canyon and Mike hit an underwater flake receiving a deep gash in his knee. He walked back to camp and Jon stitched him up. After a day's break another long trip finished the job, and a few stills were grabbed between rushes. The weather promptly deteriorated and Ok Tem was impassable for the next month so we had to make do with what we had.

After final filming sessions at De Buum Tem and a memorable sunset at the Hindenburg Wall, Sid and Noel left for Tifalmin to pursue the next major discoveries being made in the Nong Valley.

MOBILE PATROLS – D. Brook

1. Urapmin

In early October Dick Willis and John Donovan spent eleven days out from Telefomin investigating dolines about 2000ft (600m) above the sacred springs at Urapmin. With two Telefolip and two Urapmin carriers they took a hunting track used by Kevan on the reconnaissance and set up camp east of Turil Dabom. Kevan had had trouble fixing his position in this area as the maps were in error but he considered that a line of huge dolines lay somewhere to the east.

Dick and John prospected east and all dolines were choked but after three days cutting two shafts were found; one 200ft (60m) deep. At last a knoll with a clear view permitted a position fix, confirming that they were about 2km. north of the huge dolines. As food was running out the patrol had to end however.

2. Wamtakin and Oksapmin

After advice from Keith Winchcombe the A.D.C., Chas, Chris and Arimniok set out to investigate sinks seen high on Mount Wamtakin. In Feramin they hired local carriers as guides and were led up the Um river over a ridge to the north and down to the choked sink of the Ok Dafar. The high ground north of the latter was known as Wam Tigiin to the Feramins and so it was here they had brought the mad white men – but no way was it Wamtakin! Making the best of the disaster the party explored another sink (Diatem) before Andy and Tikiok caught them up and wanted to know why they were ten miles off course. Another flood sink (Atum Tem) was investigated while trying to force a back route towards Wamtakin, but after glimpsing their quarry they were forced to retreat to the Sepik River and rejoin the trade route to Tekin. Andy and Tikiok pressed on with large loads while the rest went back to Telefomin for more supplies.

The Feramins showed Andy two shafts; one of which seemed very deep (Owillfore Tem) but with no rope the exploration had to be left until the return. They struggled onwards to the east col of Wamtakin (the real one this time) and camped amongst the regrowth bush dotted with dead trees. Tikiok now assumed his track cutting machine role, and six sinks had been reached by the time Chas and Chris returned with a line of carriers. Rope was now available to get down the shafts but great depth proved elusive. Fungi Tem was 466ft (140m) deep to a mud choked cavern and Ariyorba Tem ended at a depth of 400ft (120m) in a sump – both disappointing as the risings were several thousand feet below.

As food grew short again Andy and the carriers went back to explore the two undescended Feramin holes. One was only 100ft (30m) deep but Owillfore Tem started with 200ft (60m) and 300ft (90m) pitches. At a depth of 700ft (210m) a small passage suddenly intersected a huge underground pit but there was no rope left.

Meanwhile Chris and Chas headed down the Tekin River to Sembati (Tekin Mission) and took the road up and over the ridge into the remarkable Oksapmin polje where a river resurged and sank into a foaming vortex, presumably to reappear in the Strickland Gorge 3500ft (1000m) below. Having no money left for carriers the duo chose to walk back an adventurous route via resurgences below the continuation of the Hindenburg Wall. At Bimin village they left the last habitation they were to see until Feramin, and pressed on beneath beetling cliffs. Most of the rivers came down waterfalls although they may resurge higher up. It was a very tired pair that reached Telefomin after eighteen days continuous walking.

3. The Startrek

One of the expedition's original targets was a visit to the Star Mountains on the West Irian border, since they had the highest limestone in Papua New Guinea at 13,000ft (4000m) altitude. Once in Telefomin, however, it was obvious that to investigate the Stars in any detail was far beyond the resources of our expedition. After Wamtakin, Andy was all set to move to the Fault Controlled Valley but the camp there was full to capacity. He and Mike made a snap decision to attempt a reconnaissance of the Stars by travelling with dehydrated food and only taking two carriers. Most other people were eventually persuaded to agree to the ambitious venture and on November 1st Andy, Mike, Arimniok and Tigiok staggered off carrying 300lb between them. The carriers were so keen to go that they had volunteered to eat textured vegetable protein instead of part of their meat and fish ration.

From Tifalmin the route veered north up the west bank of the Ilam and then over the limestone divide below Lake Louise. The first plan was to cut towards the Stars via large sinks visible on the air photos but repulsive terrain, heavy rain and the proximity of a geological camp led to a change of route which (in retrospect) meant more miles for less reward. The long and spectacular detour followed the Nong river (not the cavernous one south of Telefomin, of course!) to the geological camp where a welcome awaited. No extra topographical information about the limestone to the south was obtained however, as no geological work was going on there. Steps were retraced, and passing the never used airstrip at Busilmin, the path was taken to the south up into the Star Mountains. As height was gained, the ghostly burnt moss forest suddenly gave way to the grassy vistas of the Dokfuma plateau, providing the first extensive view in eight days walking! Camp was established at 10,500ft (3,150m) at a place known as Tamanakavip and numerous choked pots, dolines and poljes showing striking temperature inversion controlled flora were investigated. Next day the ascent of Mount Capella (13,000ft (4000m)) was one of the high spots of the expedition.

More grassy walking passed a 200ft (60m) shaft before the Krom River was joined and then left. Back in the forest a little used track (cutting needed) led down below the Benstead Bluff to the hamlet of Kauwolabip at the base of the towering Benkwim Bluff. Passing on, the path rose and fell like a switchback to Mount Fubilan, a mountain of copper ore – one of the largest deposits in the world. Camping on the summit was a rich experience indeed, and in the morning a helicopter miraculously whipped the small group off to the civilisation of the Ok Tedi Development Co. base at Tabulil. Andy swapped yarns with fellow mining engineers before our party set off on the last leg of their journey. Beyond Lake Wangbin rivers were crossed below the Hindenburg Wall and the huge cliffs skirted to Migalabip and hence Golgobip, where the track rose over the wall to our Fault Controlled Valley base camp at Mogondobip and so to Telefomin. The 200 mile circumnavigation was over.

EXPLORATIONS IN THE NONG VALLEY – H.M. Beck

The weekend following the Independence celebrations on September 16th, 1975 a large party returned to Finem Tel for an action replay of Sid Perou Productions, in order to catch up on some lost filming time.

Back at the main base in Telefomin a week later, preparations were well in hand for the move to the Nong and up to the fault-controlled valley midway between Feramin and Bolivip. This remote area looked very promising on the reconnaissance. A small party were to explore caves in the Nong River valley en route, whilst supplies were being portered up the mountain to the advance base at Mogondabip, a native shelter on the trade track south to Olsobip.

Allan Goulbourne formed himself into an advance party on the 1st October and set off for the Nong with a couple of carriers. Loads of supplies were to follow every two days. Exciting reports were soon streaming back on the radio of huge resurgences, river caves and underground lakes. Expedition members listened each evening for the next gripping instalment crackling through the static.

A week later Howard and Pete joined Allan, slogging over the Victor Emanuel Range after the dubious Sepik crossing on a vine suspension bridge. From the Mip Tigiin pass it was downhill from the open hot grassland into the cool of the Nong bush. Half a mile (800m) down river from the Ok Anaram camp, Allan had explored **Karibu Tem** to a high waterfall chamber but missed the way on and was almost entombed in the cave by light failure. The three returned to continue exploration but the cave was mysteriously sumped near the entrance. Allan almost dived it in frustration but instead led the party to the next doline which intersected the cave. A horrifying spectacle presented itself. A great river rose beneath boulders, to hold back the Ok Anaram and tear into the continuation where Allan had followed the diminutive stream previously. Further work would have to wait for the flood to subside.

That evening about fifteen Faiwolmin hunters, their wives and children accompanying burst upon the camp demanding immediate employment. After radio consultation they all left the next morning to discuss work with Kevan in Telefomin.

Near the huge Nong resurgence, a cave .**Ok Miben Tem** had been located which emitted a powerful breeze. This was now followed until a river could be heard in the distance. Passing some beautiful gours a fine sandy floored gallery continued; the rumbling becoming louder with every step! Hearts started pounding. Suddenly around a sweeping bend there it was; a foaming torrent roared towards them and sank into a sumped rift. Upstream a frightening traverse reached the edge of a lake stretching into the distance. Back in camp radio requests were made for a dinghy and lifejackets.

Kevan arrived with the goods and the team donned wetsuits and lifejackets for the big push. Dragging a fully inflated rubber boat the intrepid cavers sweated their way through Ok Miben Tem. But something was wrong – the cave was quiet. The lake had gone and a steep long slope led to the river and a sump. Although Allan didn't recognise it in the high water conditions, this was the waterfall chamber in Karibu Tem. Because of the fierce current they couldn't make progress above the fall. That afternoon Ok Unaa Tem was visited. The feature had been heard during the reconnaissance but due to Howard's injury, was not visited. It carried such a large river as to be impassable.

TINA BU TEM

South of the Ok Anaram camp in the Un Tem Tigiin clearing was the spectacular pit of Tina Bu Tem, which promised exciting exploration. Peering cautiously over the lip the bottom could not be seen for mist! Not surprisingly, the name translated literally meant 'A Hole to look at but Not to go Down: 200m of rope was put down amid a gathering audience of maybe thirty sceptical Faiwolmins. Pete led down, passing out of dense bush into a mind-bending abseil. As he reached the half-way mark those on the surface heard a loud roar getting louder by the second. The cause became apparent as hundreds of flying foxes emerged. All descended; Howard last, weighed down with food, underground photography gear and a shotgun. Control with a rack with only three bars proved interesting. Sadly the pit choke at 910ft (275m).

Apart from a near-severed rope, Allan being hit by a rock dislodged by Pete and a titanium rack being dropped back down, the ascent ran quite smoothly.

Afterwards Alan and Kevan left for Mogondabip to start setting up base there. Pete and Howard returned to Ok Anaram to survey and continue exploration in the river caves whilst organising carriers and loads to the fault controlled valley.

A further length of passage was added to Ok Miben Tem and surveying showed a total of 3,000ft (900m) of passages. The system was photographed and the surface survey started before continuing up to Mogondabip leaving oddments to be cleared up on the return to Telefomin.

THE FAULT-CONTROLLED VALLEY

From the advance base at Mogondabip, surface survey and exploration of shafts already noted in the Fault Controlled valley began. In the first 1½m (2km) all the pots quickly choked so a further bivouac (Camp 1) was pitched at Anawoltuman. A short distance to the east Howard located a promising hole and Sid and Noel (who had caught up on the action) wanted to film it as it was explored. This almost led to disaster. During filming operations at the second pitch a mass of rock was dislodged onto Pete Gray, who was putting in a bolt down below. The potential victim cheated death by swinging out over a 150ft (45m) drop and jamming his fist in a crack as the avalanche of boulders and sound gear whizzed past. Pete had miraculously survived but the sound equipment suffered severe distortion from its 200ft (60m) fall. Next day Allan retrieved the shattered remains and reported the inevitable choke.

Spirits were understandably low but Jim Farnworth and Roy Blackham had flown into Telefomin and came up to give fresh impetus to the team. As cutting progressed Camp 2 was set up and more blind shafts descended. At last a deep pot, Langlang Tem, was found but it contained loose rock. Kevan and John Donovan reached a depth of 700ft (200m) where a tight passage continued. During the ascent a flood pulse caused a rock fall and Kevan was struck on the legs. He managed to prussik 270ft (80m) to an awkward traverse where he siezed up. A rapid and smooth rescue followed but two near serious incidents in the valley did not help morale. Jon Buchan later forced the tight passage to another pitch but loose rock, lack of more small men and a new deep hole meant that Langlang Tem was not forced to a conclusion.

The new hole (Terbil Tem) was a real horror. Short pitches all needing bolt belays and technical rigging. People became exhausted but eventually after 20 verticals the hole became too tight at a depth of 1,200ft (360m). Fresh talent now made a timely arrival in the shape of Chas and Chris. An offshoot in Terbil Tem merely rejoined lower down, so after a 17 hour filming and derigging trip the system was abandoned for fresh conquests.

Time was running out but another hole had been turned up so Camp 3 was established before half the team left to film the Nong Caves. Allan, Chas, John and Jim battled on with Camp III Hole and amazingly the weather was good for the first time in a month. A series of impressive drops dwindled to an exhausting meander and further pitches into a large chamber. A muddy tube and superb pit ended where the water sank into rock slabs at a depth of 1,100ft (330m). 21 pitches had been negotiated in a 14 hour trip and next day the system was surveyed by Chas and John. As a last straw the carriers left whilst all were underground (obviously they did not like the area or the low temperature) and it was a ladened party that reached Telefomin. So ended the most stoical episode of the expedition.

LAST DAYS AT FINIM TEL

When the filming was over only Tony, Dave Yeandle, Paul, Dave Brook and (later) Phil were left to carry on exploration, survey and scientific work. The radio soon packed up but it seemed of little consequence as food stocks were sufficient. In splendid isolation, life settled into a stimulating routine of worthwhile work and experiments in cooking. Lone wanderings became common but did not seem foolhardy, only necessary. The weather deteriorated and some caves became impossible, although tramping on the surface was no more unpleasant — rain is more refreshing than sweat!

Prospecting near Ok Tem led to the excavating of the entrance to the Aurora series which popped out in the roof of the river canyon. The passages were only 120ft (36m) from the Tradesmen's Entrance to Selminum Tem but although there was a hydrological connection no humanly passable link was found. Photographic records were made of Finim Tel the Bitip and Kaakil Caves. A week long camp was held at Selminum Doline and we took Ayangim and Dainok underground. Although both were Wokkamins they had no particular fear of the cave. Masses of photographs were taken to provide as wide a record of the cave as our small team allowed. Further passages were explored and the survey total at last crept past the magic 17km of Exit Cave (Tasmania), the longest in the Southern Hemisphere.

Moving back to Finim Tel cutting continued west, and Paul found shafts and a new cave (Yaromdeng) associated with the Feram River. The system was quite close to the Keyhole entrance to Selminum Tem, where ferreting by Dave Brook revealed yet more offshoots and a rabbit warren of passages. Phil, meanwhile, was avidly collecting cave bugs and developing some exciting ideas. Sadly the end of the expedition was looming but a message was delivered to the effect that the Geological Survey of Papua New Guinea was sending Rod Wells of Flinders University to look at the fossil bones in Selminum Tem. By coincidence our two Geography students from the University at Porty Moresby had arrived at Finim Tel as Rod was dropped by helicopter and next day Phil and Tony accompanied our guests to Selminum Tem. The students (Harry and Tamilong) helped by bug collecting, and were alarmed as water levels rose due to a flash flood. The same event caused Rod some consternation as the Bonewells filled up, but Tony kept cool and all survived. The scattered bone samples were recovered next day and the receding water left the evidence Phil had predicted from his ideas about the cave fauna.

ABOVE AND BELOW THE WALL

On the air photo a "cave" had been surmised in a gully a couple of hundred feet down the Hindenberg Wall, so a hair raising time was spent wielding a bush knife whilst abseiling above a 2000ft (600m) drop. The cave did not exist - only a recent rockfall, but the great resurgence far below was an obvious target for further investigation.

During the post Independence filming John Donovan had a quick trip down the trade route to Bultem to locate the water outlets below the wall. He reached a garden area by the Kam River but could not pin down the point at which it emerged in the thick bush. The next attempt was made by Paul, Tony and Petar Beron, sensibly guided by Ayangim, whose home village was Bahumgabip in the shadow of the wall.

He took them up the Ok Kaakil and the huge emerging river promised entensive caves but it rose from a blind pool. Openings were seen higher up the wall and one was a flying fox hunting site, now abandoned and the vine ladders fallen away. An attempt to re-enter it was rebuffed in spite of a gallant effort by Ayangim, so they returned to Finim Tel.

The gauntlet was picked up again when Tony, Dave Yeandle and Phil went back in November and bivouaced close to the resurgence. Phil attempted to reach a cave above the outfall by using a log against the face and bolting above it but the tool broke on the third bolt. Using local expertise a 100ft (30m) high scaffold was built up to the flying fox cave. It was disappointingly short but the villagers got the flying foxes they wanted as their part of the spoils. All was not what it seemed however, for at the eleventh hour a climb was discovered up to a complex of large tunnels and enticing pits with the roar of the river below. Photos were taken by Tony and Dave Yeandle and a survey made of the accessible reaches. They left the cave just before a flood pulse inundated it. Due to the bad weather on the plateau the rising was behaving most unpredictably and any further exploration under such conditions was very dubious. The problem resolved itself however, since our time in the field was drawing to a close, and Rod Wells was due in Tabubil and needed a guide to Finim Tel.

THE HOLE IN THE WALL

From Bahumgabip several openings were noted in the gulleys and faces of the Hindenberg Wall but the largest by far was situated half way up a particularly blank section of cliff. It so excited the imagination that when Tony got a lift in the helicopter carrying Rod Wells to Finim Tel, he persuaded the pilot to fly as near the feature as turbulence allowed. It was a huge cave alright, and at the limit of visibility it ended in – blackness! Overhangs would rule out a practical descent and entry from above, and below all routes are decidedly vertical. Here is an enticing target for a future expedition.

AFTERMATH

People returned from the Fault Controlled Valley, Star Mountains and Finim Tel to Telefomin and its homely atmosphere. The A.D.C. threw a party for the whole area as a farewell for those leaving for various reasons. We sorted and packed for the journey home and officially the expedition ended on November 28th, when the majority flew out to Mount Hagen, thanks to a remarkable air-coup by Steve. Because of the demand for flights in December, Fred Parker, who had extended our tickets, had booked us out on widely spaced flights. Some of us were not due to leave until January and so had time to see more of New Guinea.

A group stayed in Telefomin to supervise the freight on flights to Wewak. Paul Everett then left to walk about 300 miles to Mount Hagen and learn more of the people and languages. As he progressed the natives were so concerned for his safety, that prayers were said to ensure his survival day by day. He made it, of course, thanks to T.V.P. (see Food Report).

Chas, Chris, Tony and Noel flew to Yapsi and took on a guide (Stephen) who was to navigate two rafts down the August River. The water was low and the rapids promised to be interesting. One raft was soon wrecked and Chris was rescued from the other just before it was swallowed up by its "last rapids". They lashed two dugouts together to form a catamaran and continued through less frequent rapids to the junction with Sepik. The sun was merciless and thankfully they disembarked at Green River and walked to the station.

Noel now set off alone to walk the famous Kokoda trail whilst Chris, Tony and Chas joined the P.N.G.C.E.G.Christmas Meet at Kevan's invitation (Bourke 1976) and a most enjoyable and worthwhile time was had (Yonge, 1976). Darua Muru was followed to a depth of 187m where a pitch halted progress (Bourke 1976). A small streamway Angunga, was explored to its junction with a large main drain carrying the Kiowa River but complete exploration awaits the dry season. (Wilde and White, 1976).

* * * * * *

So ended a most satisfying expedition. For no more than the cost of living in Britain we had visited exotic remote areas, recorded a wealth of subterranean systems and brought back evidence for new ideas in many scientific fields.

But more than this – WE ENJOYED IT!

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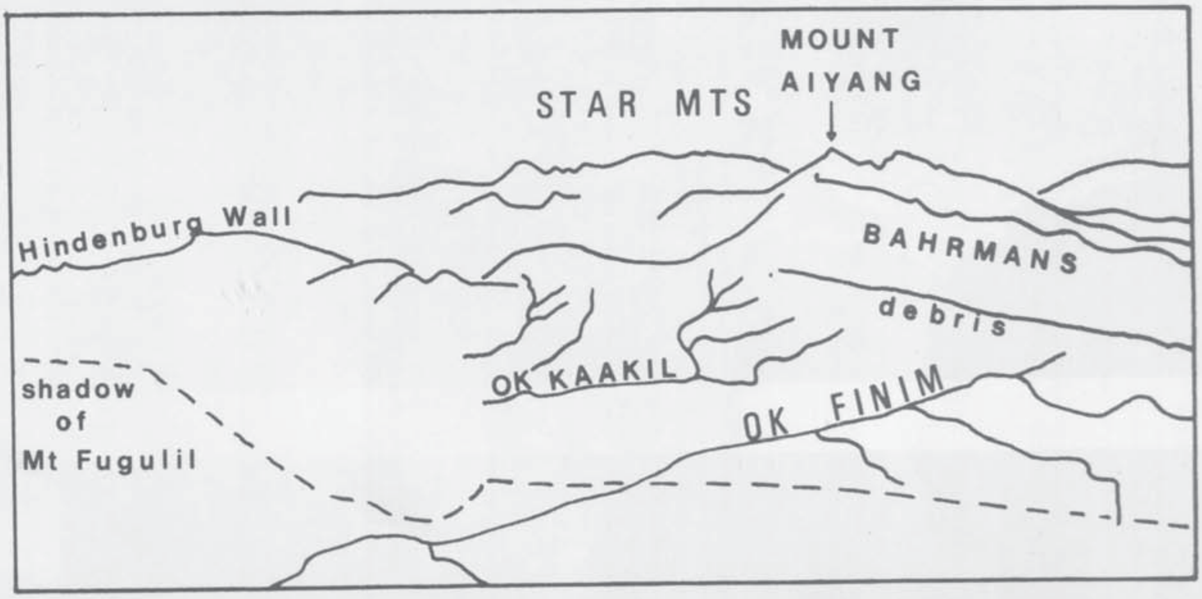
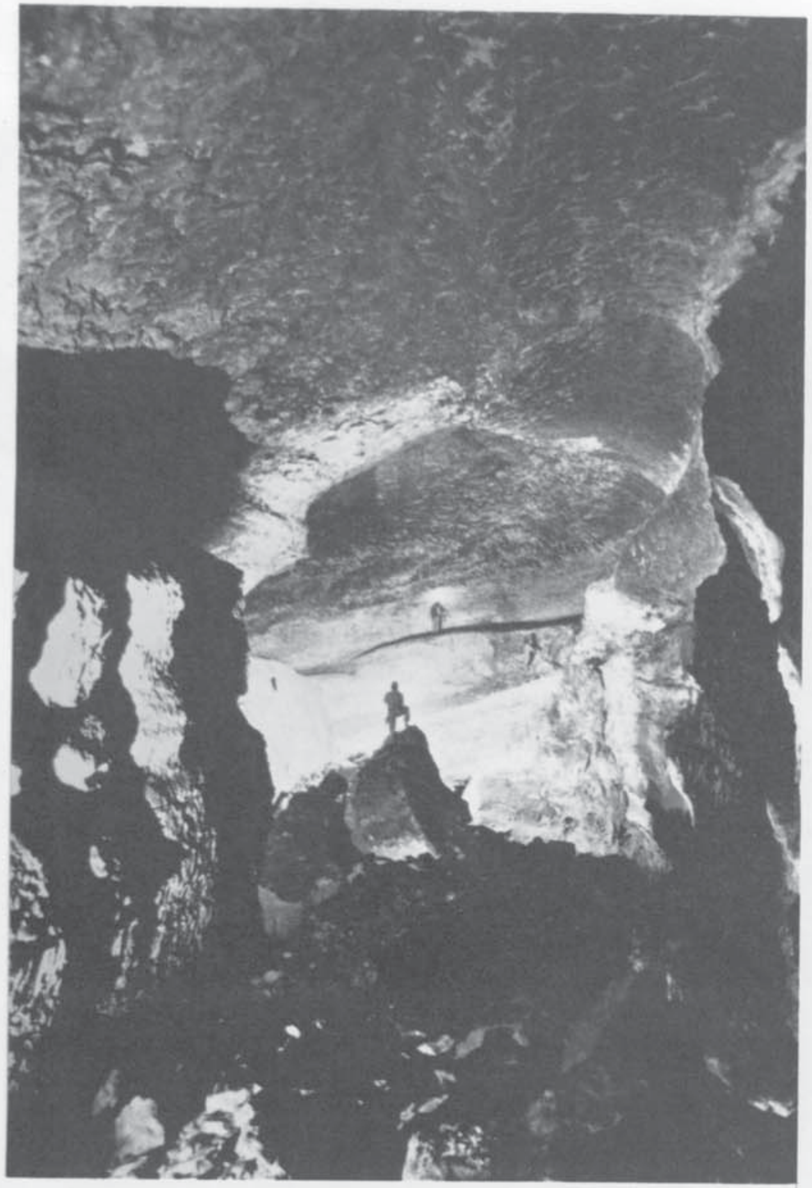
Plate 1

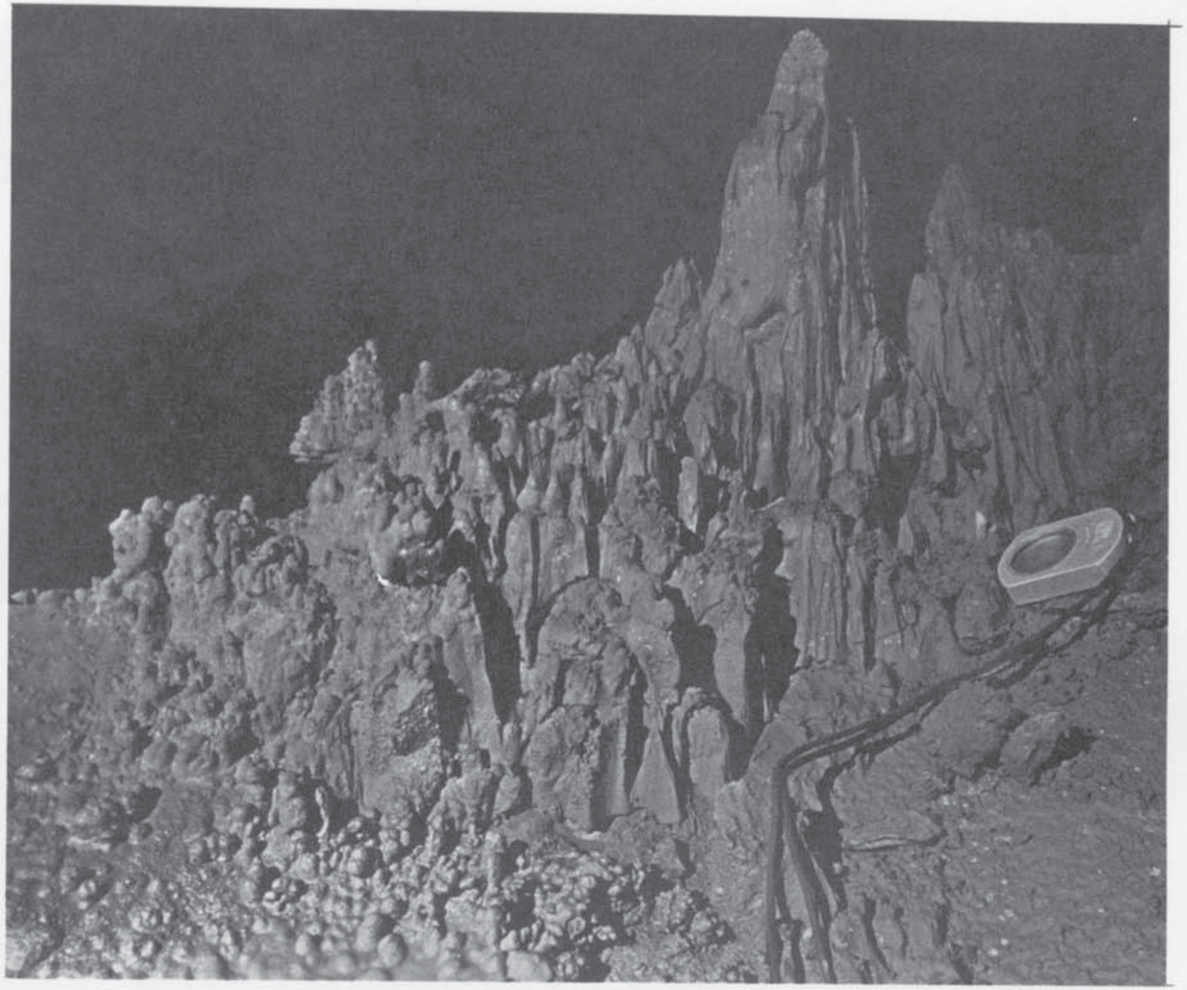
1. Panorama of Finim Tel (photo A.J.Eavis).



2. Upper entrance to Selminum Tem (photo D.Brook).



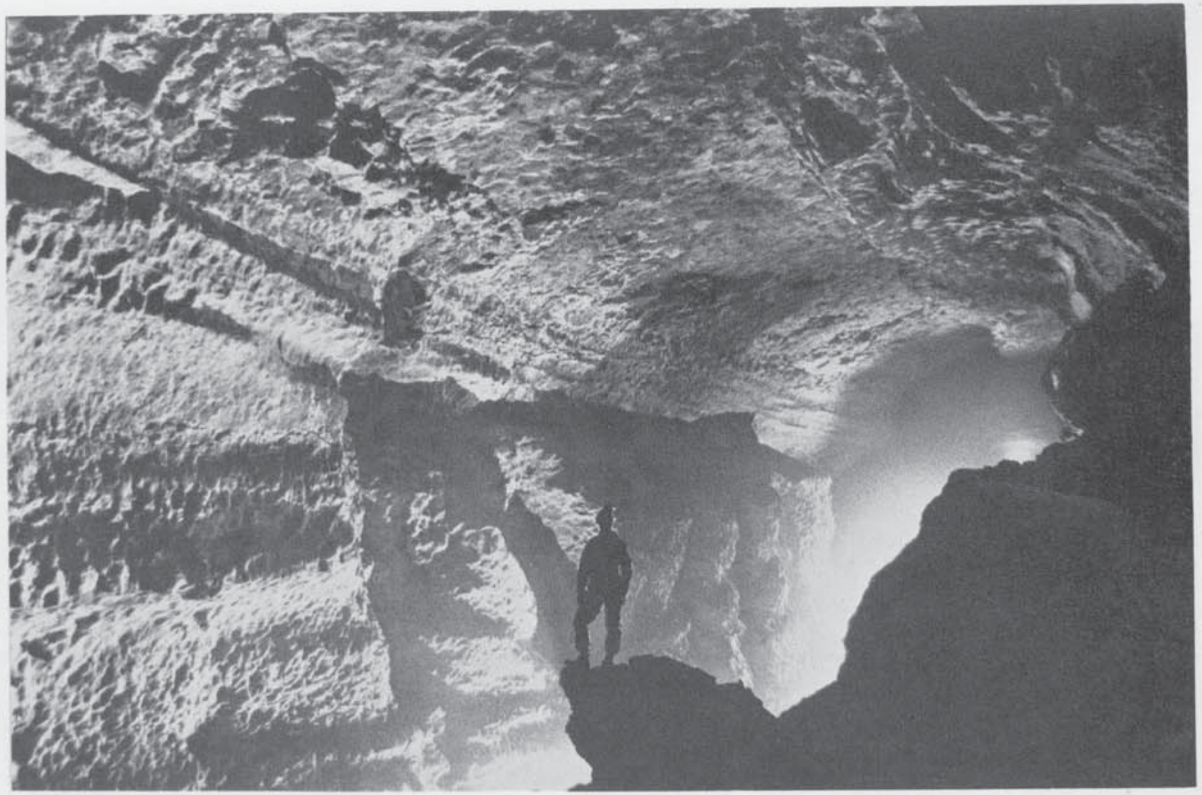
1. Warp Drive in Selminum Tem. Charcoal was found on the ledge with the furthest figure. (photo D. Brook).



2. Mud pillars in Selminum Tem (photo D. Brook).

Plate 4.

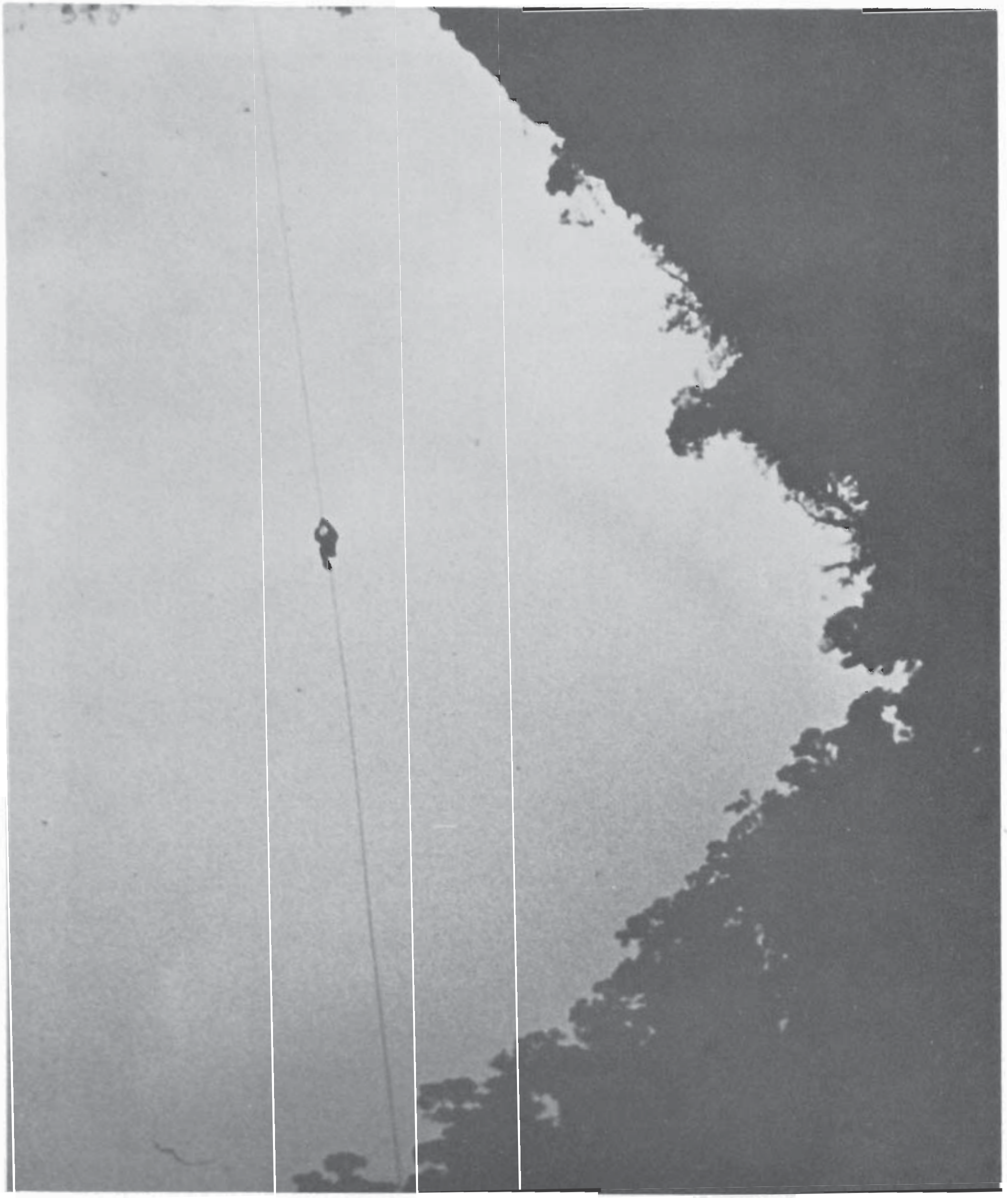
1. The first log bridge in Ok Tem (photo A.S.White)



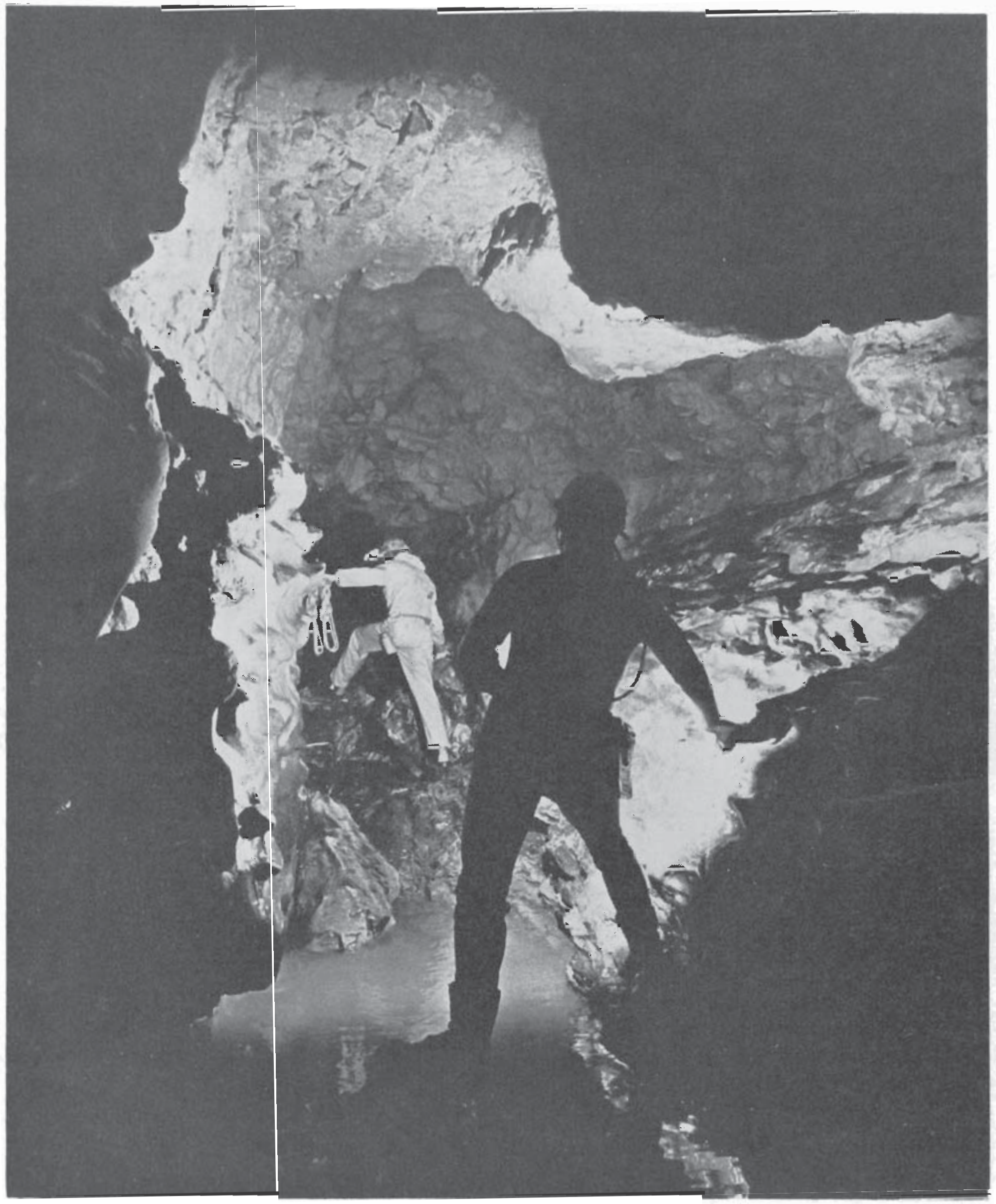
2. Warp Drive in Selminum Tem (photo D.Brook).

Plate 3.

Plate 2.



1. S.R.T. in The Sting (photo A.J. Eavis).



2. Flood phreas in muddy limestones in Finim Tem (photo A.S. White).

II

CAVES AND KARST

THE REGIONAL SETTING

S. Crabtree and A.J. Eavis

INTRODUCTION

The expedition visited an area which is in remote and difficult terrain, presenting special problems for both the academic and economic geologist. The major difficulty is often correlation of strata over wide distances with small outcrops. In less harsh terrain a rock group is established on a well exposed sequence. The equivalent in Papua New Guinea rain forests may be a few scattered outcrops in a stream. There is, therefore, a demand for an accurate dating of rocks which identifies their stratigraphic position, allowing elucidation of unconformities and structures.

The annual rainfall is high with 10,000mm recorded near the Ok Tedi mining camp in a single year. The lowest rainfall occurs in the intermontane valleys, such as at Telefomin. During the May to October period wet southeast winds deposit rain on the southern slopes which are consistently clouded over, while the central and northern part of the main range is relatively clear of cloud. For the rest of the year the situation is entirely reversed but with less rainfall and cloud cover. Maximum temperatures vary from 37^{0}C on the plains to 25^{0}C on the highland peaks, and a minimum of 20^{0}C to 0^{0}C. The very high rainfall coupled with fairly high temperature produces the ingredients for the fast erosion speeds that undoubtedly exist.

The predominantly E-W mountain ranges and rapid uplift have imposed a trellis drainage pattern and deep gorges. Telefomin is sited on old lake deposits, which are now being dissected by the Sepik headwaters as the gorge below the junction with the Ilam is deepened on the river's course to the northern plains of New Guinea. North east of Telefomin the Om River flows east for 40 miles (65km) before joining the Lagaip. The combined waters form the Strickland River running south through a great gorge cut across the grain of the central mountains to meet the Fly River drainage in Papua. There is little surface runoff from the limestone, but springs at the base of the Hindenburg Wall (the most prominent scarp in the region) flow south into the Fly River catchment, as does the Ok Tedi which collects water from the southern slopes of the Star Mountains. (Figs. 2 and 6).

Rainforest is the most prevalent vegetation but extensive 'kunai' grassland occurs near villages and on some hillsides; probably as a result of slash and burn agriculture. Above 6,000 ft (2000m) the trees progressively become more stunted and at around 8,000ft (2500m) the moss forest begins. The high peaks above 10,000ft (3000m) are crowned by tall wiry scrub, but the summits of the Star Mountains (13,000ft[4000m]) are bare rock or grass.

This account deals briefly with the wider aspects of stratigraphy and structure, both of which have been extremely important in cave development, and a resumé of research in the area. For further details about the geology three publications are to be recommended:-

1. Australian Petroleum Co. 1961 – *An Authoritive and Enlightening Summary of Western Papuan Geology.*
2. Jenkins 1974 – *The work of an oil geologist, largely a summary of B.P.'s later work in the 1970s. This covers the stratigraphy structural relationship and tectonism.*
3. Blucher Range Map Explanatory Notes 1974. *This is the "memoir" for the 1: 250,000 map. A high standard of mapping is accompanied by a short but well-referenced document on the Sepik Headwaters and surrounding areas.*

HISTORY OF RESEARCH

A good bibliography of the area is supplied in the Blucher Range Explanatory Notes and the A.P.C. 1961. Geological investigations have been carried out by three major groups.

(a) Oil Companies

Between 1937 and 1955, Australian Petroleum Company Pty. Ltd. worked extensively in the Western Central Highlands. This was continued by B.P. Development (Australia) Pty. Ltd. in the 1960s and early 1970s. The search for economic hydrocarbon deposits has been unsuccessful so far, but good detailed maps were produced, elucidating much of the stratigraphy and structure. (A.P.C. 1961. Findlay 1974, Jenkins 1974).

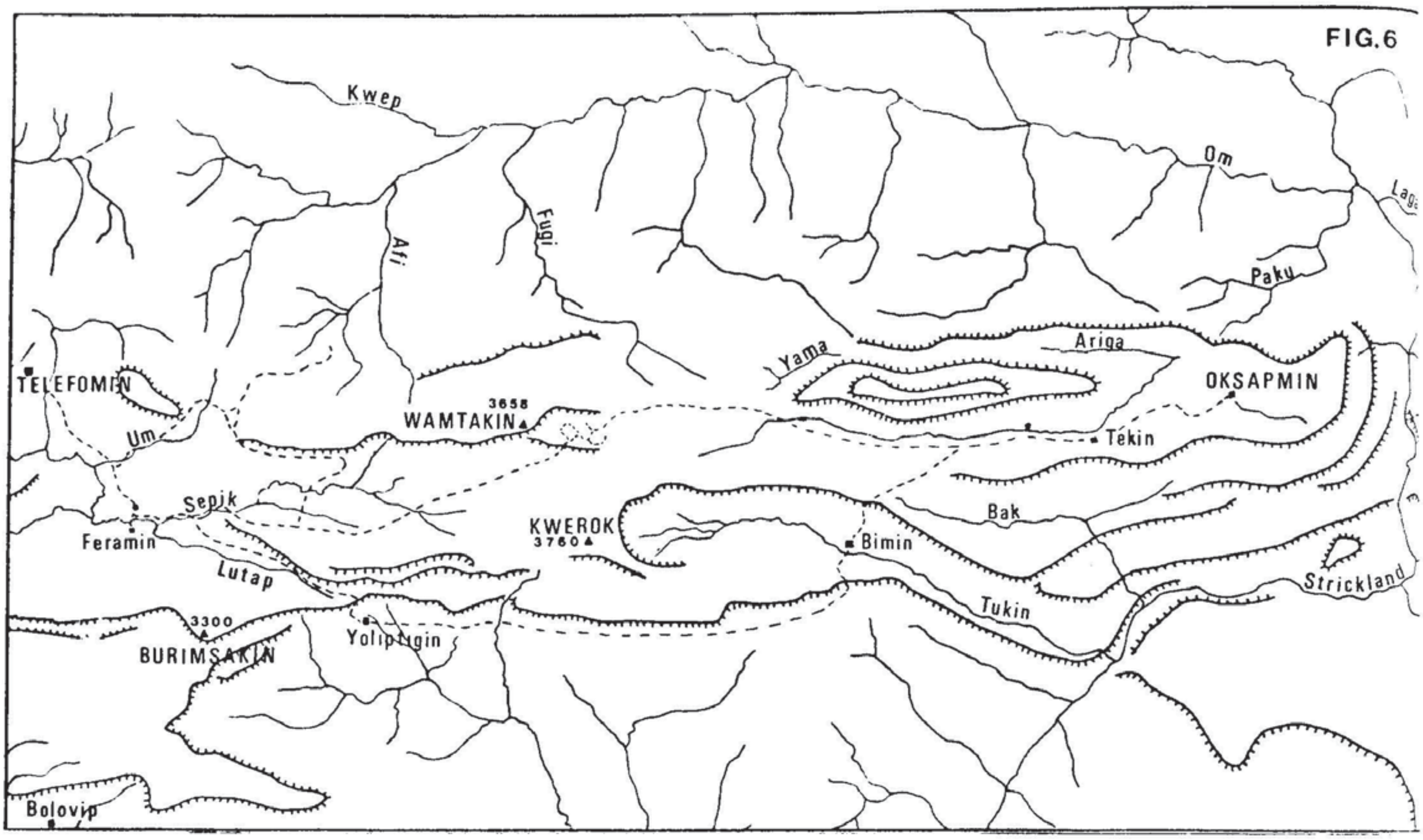
(b) Mining Companies

Geological exploration of the Mount Fubilan (Ok Tedi) copper deposits together with later investigations of the Tifalmin and Star Mountains (Nong River) deposits was carried out by Kennecott Explorations. This has now been taken over by the Papua New Guinea Government, who are working in the Star Mountains (Nong River). Carpenteria Explorations (part-owned by Mount Isa Mines) have also been mapping extensive copper deposits to the north of Telefomin on the Freida River. (Bamford 1972).

(c) Geological Survey

The work of the Geological Survey in the area was initiated by the Bureau of Mineral Resources (Canberra) in 1968. Subsequent extensive mapping took place in 1970, 1972 and 1975, mainly dropped by helicopter for day traverses. Using a compilation of B.P. Development and Kennecott maps, a sheet and ex-

Fig. 6. Routes in the Wamtakin - Oksapmin area.



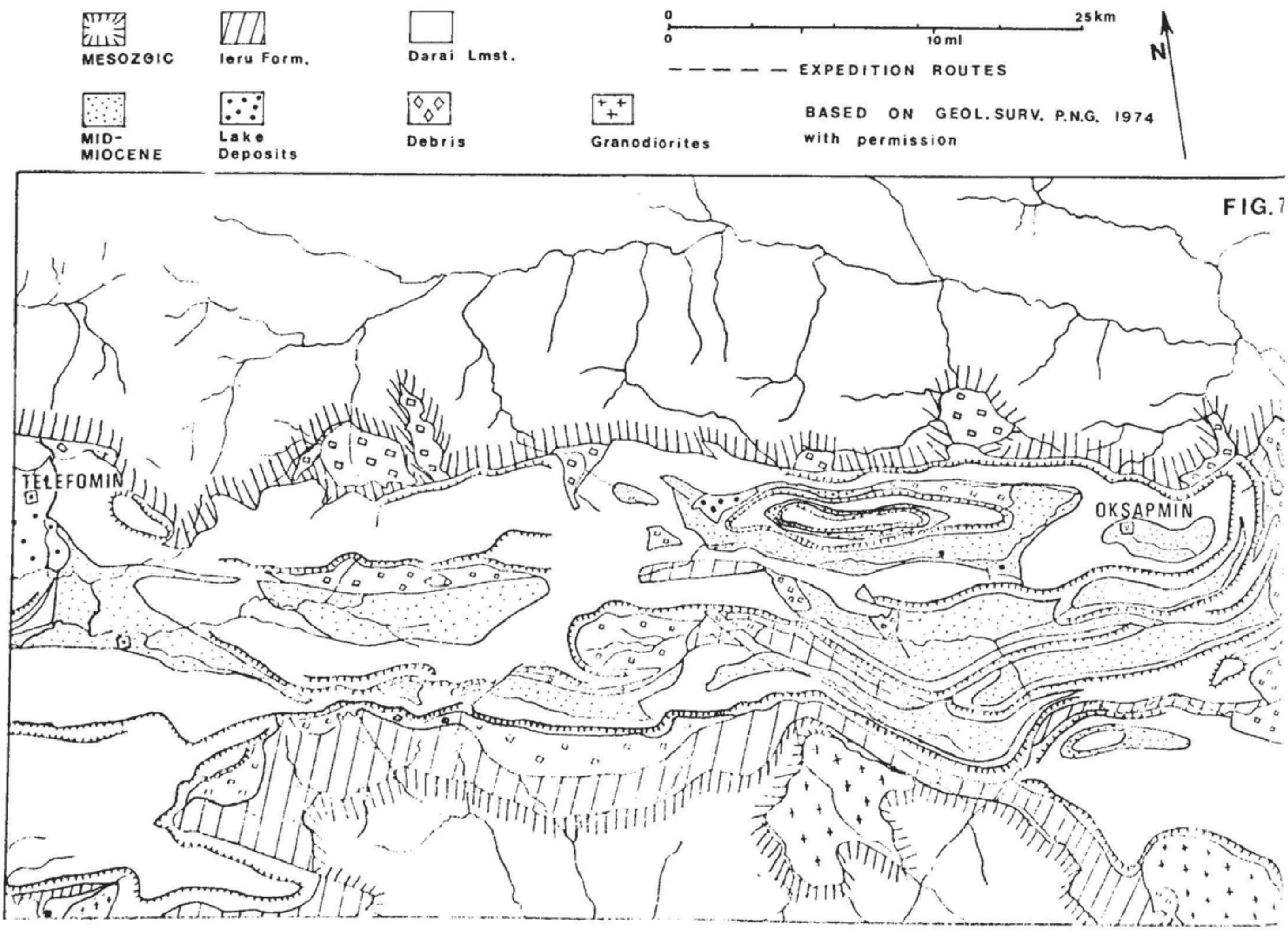


Fig. 7. Geological map of the Wamtakin - Oksapmin area.

planatory notes were finally published in 1975 at a scale 1:50,000. The Geological Survey Papua New Guinea publication provides a valuable guide to the area.

GEOLOGICAL SETTING (Figs. 3 and 7)

Papua New Guinea lies at a critical site on the Circum-Pacific Orogenic Belt. This is manifest as an active orogenic region (regular earthquakes and volcanic activity), where the subduction of several (oceanic) Pacific sub-plates is taking place beneath the (Continental) Australian plate. (Xavier 1968; Johnson and Molnar 1971; Smith 1965).

The sedimentation and structure of the island have been controlled by several tectonic cycles. These consist essentially of uplift/deformation/volcanism, followed by denudation and subsequent sedimentation. Of particular interest to cave scientists in the Highlands is the uplift history, each uplift providing new regions for cave development.

STRATIGRAPHY

The ages of the rocks within the Expedition area range from Upper Permian granite to Quatenary glacial and alluvial sediments. The stratigraphy can be traced both west into Irian Jaya (Barr et al 1960) and into the Central Highlands. The nomenclature has been defined by the Geological Survey Papua New Guinea in the Explanatory Notes.

(a) Strickland Granite (Upper Permian)

A granite outcrop in the Strickland Gorge to the south of Oksapmin. This is thought to underlie the Muller Anticline and is probably a part of the Australian plate. Progressively older granites outcrop southwards across Papua New Guinea. The oldest has been found in the Torres Straits (Upper Carboniferous).

(b) Kuabegin Group (Jurassic).

The group consists of low grade metamorphic rocks, conglomerates, sandstones and fine quartzites. These beds occur in the Eliptamin and Om Valley to the north of Telefomin and to the south in the core of the Muller Anticline.

It is presumed that the source of the sediments is to the south although no detailed analysis seems to have been carried out. Common fossils found in this group are ammonites, bivalves and belemnites. The metamorphic rocks, phyllites, slates and schists occur at the base of Kuabegin Group in the Om Beds. These beds have been highly deformed.

(c) Feing Group (Cretaceous)

This group represents shallow water deposits of glauconitic sandstones, quartzose sandstone with occasional limestone beds. The rocks of this group are often found as cave sediments.

The relationship between this group and the Kuabegin group is complicated by thrusting. Much of the group is fossiliferous and contains bivalves, belemnites and ammonites. Ammonites provide extremely useful stratigraphical indicators.

(d) Darai Limestone Group (Eocene-Miocene)

The Darai limestone includes a wide selection of rock types but in the Sepik Headwaters this is extremely thick limestone. The limestone (Eocene-mid Miocene) is a cliff-forming unit which has the thickness of 1,000 to 1,300m in the Barhman Mountains.

The limestone is massive and thickly bedded with a sandy glauconitic base which passes into a mixture of foramiferal biomicrites and pelsparites. The group is essentially an algal foramiferal biomicrite. (Blucher Range 1975).

In the expedition area strata conformably overlying the limestone were usually pale grey to blue marine mudstones with sandstone interbeds. To the extreme west of the area this merges into the **Iwoer Formation** which occasionally contains lignite and some plant remains. In the extreme eastern headwaters of the Sepik these sandstones thicken to produce ridges with many shale/sandstone landslides. There is a remote possibility of porphyry sills in this horizon as seen in the Lake Kopiago area, further to the east.

(e) Late Quateranary Deposits

The only other sedimentary deposits of particular relevance to the Expedition were the recent deposits. Below the various limestone cliffs were screes, often very extensive as at Golgobip below the Hindenburg Wall. These talus slopes often have a controlling influence on cave development. Some areas below the cliffs were surprisingly free from these deposits, probably due to rapid erosion and structural movements. Extensive lake deposits exist in the area around Telefomin and the Ilam Valley around Tifalmin. Evidence in several places suggests thicknesses of several hundred metres; the result of the damming of the Sepik Gorge north of Telefomin when the Pliocene-pleistocene thrusting around Mount Abimh occurred. In the Star Mountains fairly widespread glacial deposits were observed: these consisted of moranic debris to the north and south of Capella and glacial outwash sediments on the Dokfuma plateau.

STRUCTURE

The Sepik Headwaters lie on a sedimentary and structural arc, which extends from Irian Jaya/Star Mountains region into the Papua Gulf in the south. This has been termed the Papuan Fold Belt. Extensive work has been carried out by B.P. Development geologists, notably Jenkins 1974 and Findlay 1974. The geological structure is extremely complicated but fairly well known.

Essentially a decollment has taken place between the Mesozoic soft (incompetent) rocks and the (competent) Miocene limestones. At a similar time folding events and uplift took place at the end of the Miocene or early Pliocene and includes the whole cycle to tectonism.

The major effect of these events on the Darai limestones had been to produce low angle thrusts and low amplitude folds. The Mesozoic rocks suffered intense deformation, with isoclinal and overturned folds. Many of the folds have an axial planar cleavage which may be associated with subsequent metamorphism. Unfortunately no major fold structures have been determined.

The Darai limestones of the Sepik Headwaters illustrate "stacking" of thrust sheets on each other. Sometimes these have Mesozoic sandstone bases; the most spectacular being near the Tekin Mission. On the edge of this major thrust complex on the highland above the eastern Sepik Headwaters two thrusts were observed underground. The streams Fungi and Ariyorba were followed over contorted siltstones of the Ieru formation underlying the limestone. Soon after the limestone was reached the streams went underground in potholes lined with slickensides and exhibiting other evidence of low angle faulting.

It is believed that the Muller Anticline to the south may have formed a barrier onto which the limestone sheets have stacked. This indicates a slightly earlier age for the Muller Anticline, preceding the decollment.

A large number of caves explored, particularly the deep pothole systems, were extensively fault controlled. The exceptions were the caves of the Finim Tel area, which seem to be in a particularly undisturbed block of limestone with bedding playing a more important controlling role.

The absence of limestone on much of the crest of the Muller Anticline could be accounted for in two ways or in a combination of the two. The opening of the joints due to the upwarping is the first way which allowed incredibly rapid rates of erosion that has removed the 1,000 or so metres of limestone. This erosion would be both surface and subterraenean, with water gaining admission down the deep joints. The alternative is a gravity slide of the limestone down each limb of the anticline, the limestone moving on the incompetent underlying shale. After either mechanism of initiation scarp recession would follow with the scree being removed rapidly.

VULCANISM

In the area there is a sequence of porphyry deposits. In many places resistant boulders of Porphyritic Microgranodiorite were observed with distinctive elongated prismatic crystals of black or dark green hornblende: often these boulders formed part of cave sediments. The crystal size varied greatly from locality to locality and often flow patterns could be seen. Several examples of bedrock microgranodiorite were observed; notable ones were in the bed of the upper Ilam, several localities in the Star Mountains, Mount Fubilan and the boulders in the Migal river at Bobor Tel below the south escarpment of Fugilil.

Some of the intrusives have a quartz monzonite phase which are often the sites of the copper mineralization. The porphyritic stock at Fubilan is a complex with several phases; the copper mineralization is estimated to be 200 to 300 million tonnes of 0.9% copper with traces of gold, silver and molybdenum. The Nong river deposits in the Star Mountains are rather different with the highest grade mineralization in the shear zone between the intrusion and the limestone or quartzite country rock.

It has been suggested recently that the various intrusives in the Tifalmin, Ilam, Star region have been channelled by a large batholith. A recent airborne magnetometer survey early in 1976 might well shed some light on this when the results are available.

The intrusive events are linked to the tectonic cycle and may be responsible for important uplifts. The main Star Mountain intrusives have been dated at 2 to 5 million years with another major phase at 1.2 million years, the same age as the Fubilan stock.

CONCLUSION

This brief summary covers the wide aspects of the geology of the Expedition area. Unfortunately more detailed analysis of the geology was not possible. Of particular interest is the sedimentology of the clastic rocks and the environment of the Darai limestone. The suggested deep water environment of the limestone around Telefomin is subject to question. The present position and origin of the limestone sheets around the Sepik Headwater presents some interesting "space problems" as does the structure to the north of Telefomin.

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OKSAPMIN AND TEKIN POLJES (Fig. 6)

The great structural bowls of Tekin and Oksapmin are unique features which were only briefly inspected because of their distance from Telefomin. The Tekin river occupies a blind valley 30km (19 miles) long and sinks close to the point of engulfment of the Ariga river which drains the northern branch of the depression. Only in extreme flood do the two rivers advance and coalesce before sinking but no caves were found at the various sinks of the Tekin river. They were presumed to rise once more in the Oksapmin polje but Paul Everett considers that the size of the river at Oksapmin is not large enough to account for the Tekin and Ariga sinks, at least one of which probably flows eastwards to a tributary of the Om river. Some of the water may feed the Oksapmin river, either from the final point of engulfment or from upstream sinks flowing along the strike.

Oksapmin lies in a great polje, 8km (5 miles) long, of classical form, where a large river rises and sinks, yet this river does not appear to back up and flood the polje, suggesting that either there is a massive cave system with little entrance blockage, or that the catchment area of the Oksapmin river is relatively small and not greatly affected by floods. The river must resurge beyond the lip of the polje in the Strickland Gorge but the precise depth potential is not known because the gorge is cut through a succession of four overthrust sheets of limestone.

The main track from Oksapmin to Kopiago enters another blind valley at Gowantiamin and two more beyond. None has an extensive drainage area and they all must resurge in the Strickland Gorge. Sparse trees and grasslands give easier walking and simplify observations in a region which merits detailed attention.

THE EASTERN WAMTAKIN PLATEAU AND UPPER SEPIK – A.J. Eavis

To the north-west of Tekin lies a 3,700 metre mountain marked on the maps as Wamtakin. To the east of this is a large area of over 3000m in altitude. Bordered to the northeast by a dip slope going steeply down to the Om / Strickland and to the west by a limestone escarpment dropping to the headwater of the Sepik, the structure of the area is a series of thrusts. At least three repetitions have been recognised. The dip and thrusts both suggest subterranean drainage to the northeast and unvisited resurgences are visible on the aerial photographs, giving a depth potential of up to 1500m.

The vegetation varied from very dense privet-type scrub on the exposed ridges to dense moss forest in the protected small valleys. Between these there was an extensive area of thin regrowth with evidence of a pre-existing forest. Some small stands of pine dotted the area and in general it was fairly hospitable although windy and predictably cold. A multitude of dolines with temperature inversions extended east to west across the northern part of the plateau, which contained many active sinks but nothing penetrable. It was interesting to note that the draughting dolines in this area did not contain anomalous vegetation: perhaps the movement of air prevented the cold air build up. Towards the centre of this inversion area a stream was followed down: the bed changed from shale to limestone, then after a couple of hundred yards it sank in a fault feature **Fungi Tem.** (Fig. 8).

A dry valley led westwards from Fungi Tem and was intersected about 2 km to the west by following another river down an ancient kiap track past an equally ancient army camp. Once again the water ran off the shale, then followed the splendid dry valley that soon became a limestone gorge. The water disappeared in boulders and the overflow led towards Fungi Tem: this came to an impressive rock shelter after a couple of hundred yards. Sloping gnarled stalagmites suggested earth movements but on reflection they were more likely the result of phototropic activity. After another couple of hundred yards the clean washed trench terminated in a classic pothole entrance, **Ariyorba Tem.**

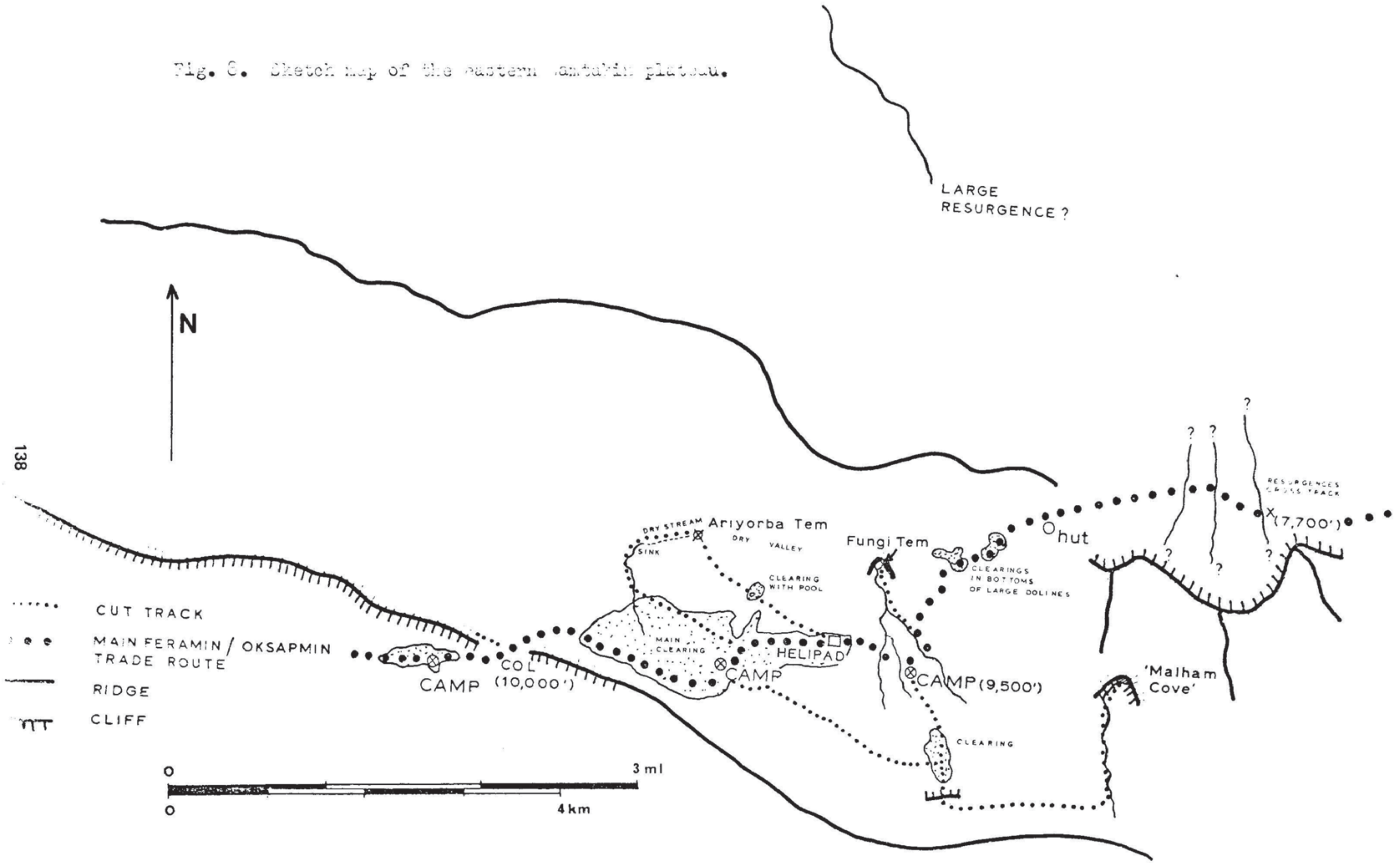
Two more dolines approximately midway between Ariyorba and Fungi were looked at, but the bottomless pits seen on aerial photographs were puddles about fifteen feet across and six inches deep. In one of these dolines a sizeable stream sank in an impenetrable fissure with a howling draught; but there was no vegetation anomaly.

A major feature on the photographs to the east of the main project area was investigated after cutting a route for 5 Kms. An impressive amphitheatre over 60m high had nothing but a large muddy sump pool and much evidence of the stream backing up at its base.

From this plateau westward the main kiap route followed the edge of a sandstone ridge often teetering along the edge of a steep escarpment of a hundred metres or so. There were many landslides along this edge often resulting in parts of the track being precariously rerouted. Just west of the Sepik's crossing a stream flowed west in a subsidiary valley off the impervious rocks and sank in a superb entrance, **Owillfore Tem.**

The track then followed this outcrop westwards towards Feramin and many dolines and shafts were

Fig. 8. Sketch map of the eastern Kamtukin plateau.



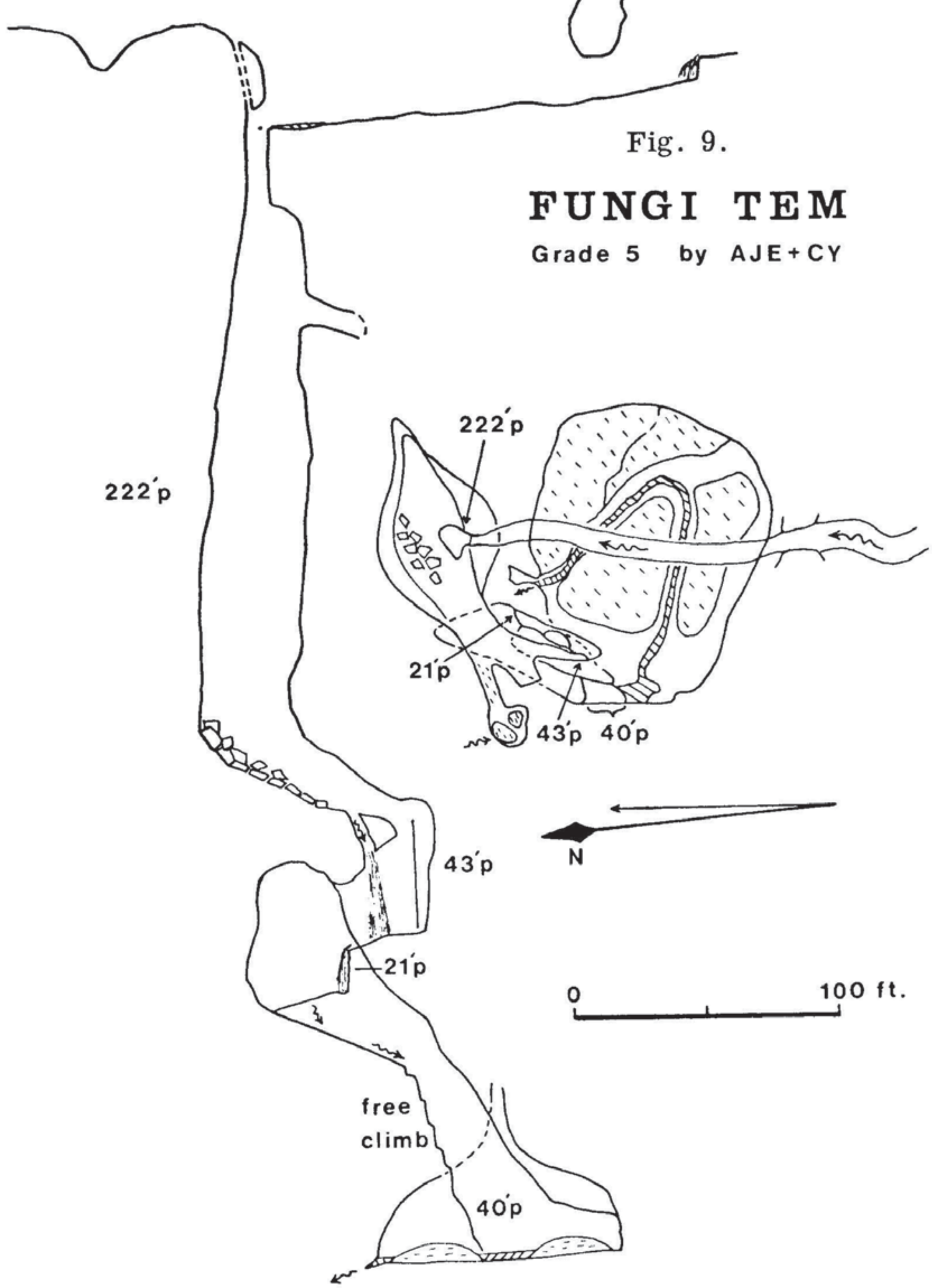


Fig. 9.

FUNGI TEM

Grade 5 by AJE+CY

passed. One of the largest shafts was **Romboom Tem**, over 30m deep.

Fungi Tem (Fig. 9)

Heading north down the Fungi River from the main Feramin-Oksapmin kiaps track a couple of deep pools were waded or avoided with difficulty and then a magnificent arch was reached. Just through this the river disappeared down a similarly magnificent shaft with a second shaft coming into the roof. In dry weather the water sinks upstream and comes into the shaft 20 feet down. The 222 feet (67m) pitch was free-hanging after about 20 feet of rope protection problems and was very wet since the water spreads out and lands over a large floor area. The chamber was about 50 to 100 feet with a large sloping passage of cascades and climbs. A small passage on the left gave a dry 43 feet pitch which corkscrewed down a fourth wet pitch of 22 feet to a clean washed steeply descending passage. A few sporting wet climbs led to the top of a moist 40 feet pitch which dropped into a hemispherical chamber exactly 100 feet (30m) in diameter. The water disappeared down a tiny crack under the left wall and banks of silt covered the floor. At a depth of 466 feet (141m) there was no way on. Down to the bottom chamber the cave showed much faulting and through the hemispherical chamber there was evidence of a low angle fault or thrust.

Airyorba Tem (Fig. 10)

A drop of ten feet (3m) at the end of the clean washed trench beyond the sink of the Ariyorba River gave way to a short passage, then a pile of vegetation and boulders on the right led to a second entrance. A pleasant clean washed 150 feet (45m) of passage in very light coloured limestone gave access to a lofty section with the third entrance coming in at the top of this. Immediately after a couple of small climbs led to a 60 feet (18m) pitch with a log jam belay. This landed in a small pool with another couple of 50 feet (15m) pitches, both with log belays. The second of these once again landed in a small pool. A sloping passage now twisted round descending steeply. A small trickle came in from the left and to the right the cave finished in a miserable sump at a depth of 400 feet (120m).

These two impressive potholes are in an area of large potential. The faulting in evidence in both caves is very probably the reason why the caves do not get any closer to attaining the potential depth. Active faults may be a barrier to deep cave development.

Owillfore Tem (Fig. 11)

Almost one Km west along the Feramin to Oksapmin kiap track from the upper Sepik crossing, a track cut directly downhill led to a small stream running east to west. This was followed until the water disappeared down a shaft about 100 feet by 50 feet with spray billowing out. Above was a small dry cave visited occasionally by the local people.

A tree belay on the east side gave a dry free-hanging descent to a boulder strewn floor at 150 feet. The main water disappeared in the boulders but a trickle led off down a couple of cascades to a 200 feet (66m) pitch, the last 20 feet being in a groove with an annoying amount of water. Another couple of cascades finished in a boulder strewn ledge with a 50 feet drop to a clean washed floor. A small hole with flood debris and other evidence of water back up led to another 40 feet pitch which landed at the start of a small west running rift passage. After about 150 feet instead of the expected sump a large void appeared. It was a ledge on the side of a sizeable chamber or passage. A waterfall could be picked out opposite and a stone dropped free for three seconds. No more rope was available, so a 700 feet (200m+) pothole was left and never re-visited.

Romboom Tem

Close to the kiap track about 1½ Km further west from Owillfore Tem was a 100 feet shaft Romboom Tem. In an area of many shafts but with little depth potential, it was not descended.

THE FERAMIN REGION – C. Yonge

The Sepik River Cave

The Lutap valley beyond Feramin is wide and U sectioned but deposits do not suggest a glacial origin. The shape appears to be due to the outcrop of impervious beds in the valley floor surrounded by walls of limestone. The Sepik has a larger drainage area than the Lutap but the upper Sepik valley hangs above the confluence of the two rivers. A steep V section trench cut in the Darai Limestone ascends from the confluence to the Sepik River Cave, where a short underground course marks the knick point of the upper Sepik. Beyond the cave the valley is wide and flat-floored due to the outcrop of less resistant beds once more. (Fig. 7)

Wam Tigiin

At the head of the Um River north of Fermin is a col at 8,100ft (2470m) asl to the Ok Dafar drainage. The latter soon disappears into a choked sink and backs up extensively in wet conditions. Further north the Ok Etmim curves round the limestone bluff of Mem Dabom and enters **Diatem.** Beneath an awesome dripping overhang a triangular-section walking passage leads to cascades and a sump. A bypass via high level rifts enters a chamber where the water falls from a log jam in the roof which is holding up the sump, a good example of a perched phreas created by damming due to recent sediments. The water enters a lower passage and a crawl ends at a second sump with no bypass. The cave floods totally. (Fig. 13).

A hunting track from the Ok Dafar passes the **Ateem Sink.** A large pool overflows under a limestone

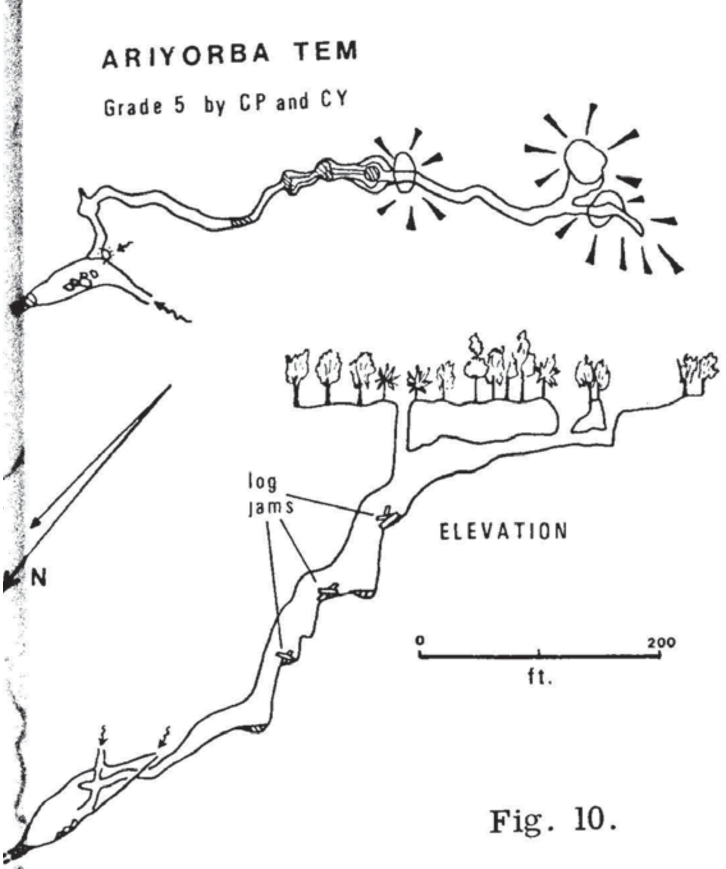


Fig. 10.

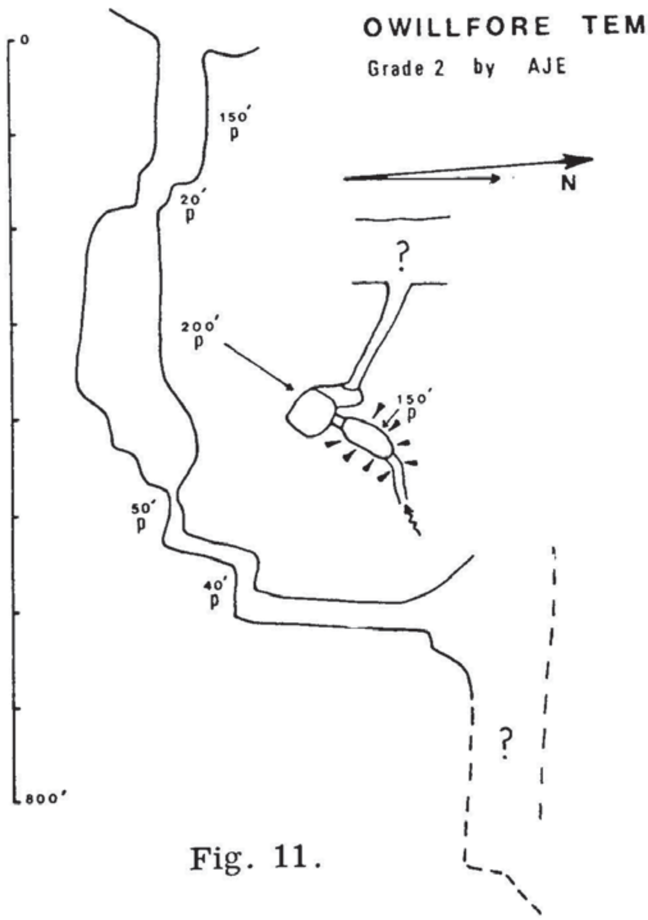


Fig. 11.

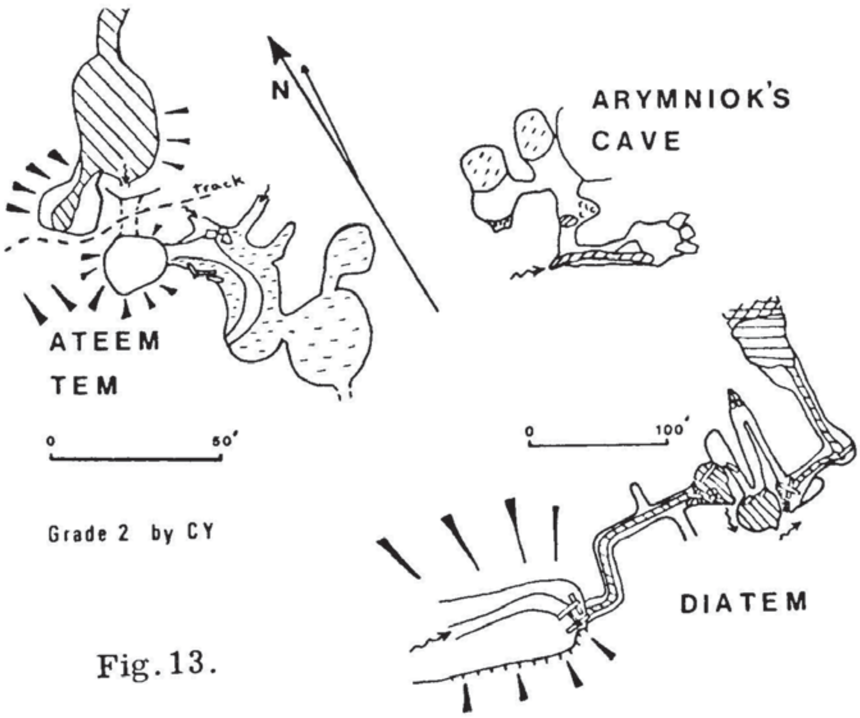


Fig. 13.

Fig. 12.

SKETCH MAP OF THE FERAMIN AREA

bridge and into a short cave, ominously full of grey silt and splattered with swift droppings. In dry conditions the water filters away amongst pebbles. Nearby Arymniok found another cave 150ft (45m) long but it also ended in a choke. (Fig. 13)

All the caves investigated in the Wam Tigiin region were disappointing and the depth potential is limited.

TELEFOMIN AND ENVIRONS – D. Brook

(a) The lake deposits

A maximum of 1000ft (300m) of alluvial beds have been exposed beneath Telefomin by the down-cutting of the Sepik and its tributaries. The highest clay beds form a ridge on which the school stands and flanking its summit is a well marked boulder bed. Some one hundred feet (30m) lower in the succession, on the road to the Sol River, slumped beds of clay, pebbles and anaerobic mud with roots are exposed, and at the road's termination above the Sol River trench a fresh cutting has revealed the sequence at a lower level. Here oxidised clay passes into unweathered grey clay overlying cobbles. Beneath the cobbles is a layer of roots and tree stumps resting on further clay and pebble beds. Local people consider that the preserved stumps 8ft (2.5m) below ground level, bear stone axe marks and officers from the government station have sent a sample to the University of Papua New Guinea for study and possible dating.

The base of the exposed succession is seen along the Sepik near Urapmin. It is composed of boulders and pebbles deposited during a much more active phase than the sluggish conditions indicated by the mud and root beds at Telefomin.

Since the great mass of alluvial sediments was laid down, it has been tilted slightly to the east (i.e. up-stream) by the same forces as formed the deepening lake by thrusting up the Mount Abimh barrier across the river basin. The Sepik has also shifted course, leaving its old valley plugged with alluvial beds opposite Urapmin, and cutting a great gorge 1000ft (300m) deep through the flank of Mt. Abimh. Thus as the tilting movements slackened, the lake was drained and the present rejuvenation of the Telefromin basin began.

The alluvial deposits are loosely assigned a Pliocene/Pleistocene age (Geological Survey of Papua New Guinea 1974) and a small core taken during the Star Mountains Botanical Expedition (1974) should provide some useful information on the age and depositional environment of the upper layers, although evidence from the caves indicates that the very top beds have been stripped over part of the basin.

(b) The Telefomin Caves (Fig. 14)

In the hills north of Telefomin are two groups of caves located in the blocks of limestone on either side of the Sol River. The higher and more distant group lie to the east of the Sol at 6500ft altitude. The resurgence, **Belzam Tem**, is an opening above a 15m waterfall but the cave at the sink, **Inum Tem**, is more accessible. A large chamber slopes down to the streamway where a series of falls are separated by deep plunge pools as far as exploration progressed. Pale pink leeches were noted on the walls and seemed to respond to the body heat of passing humans.

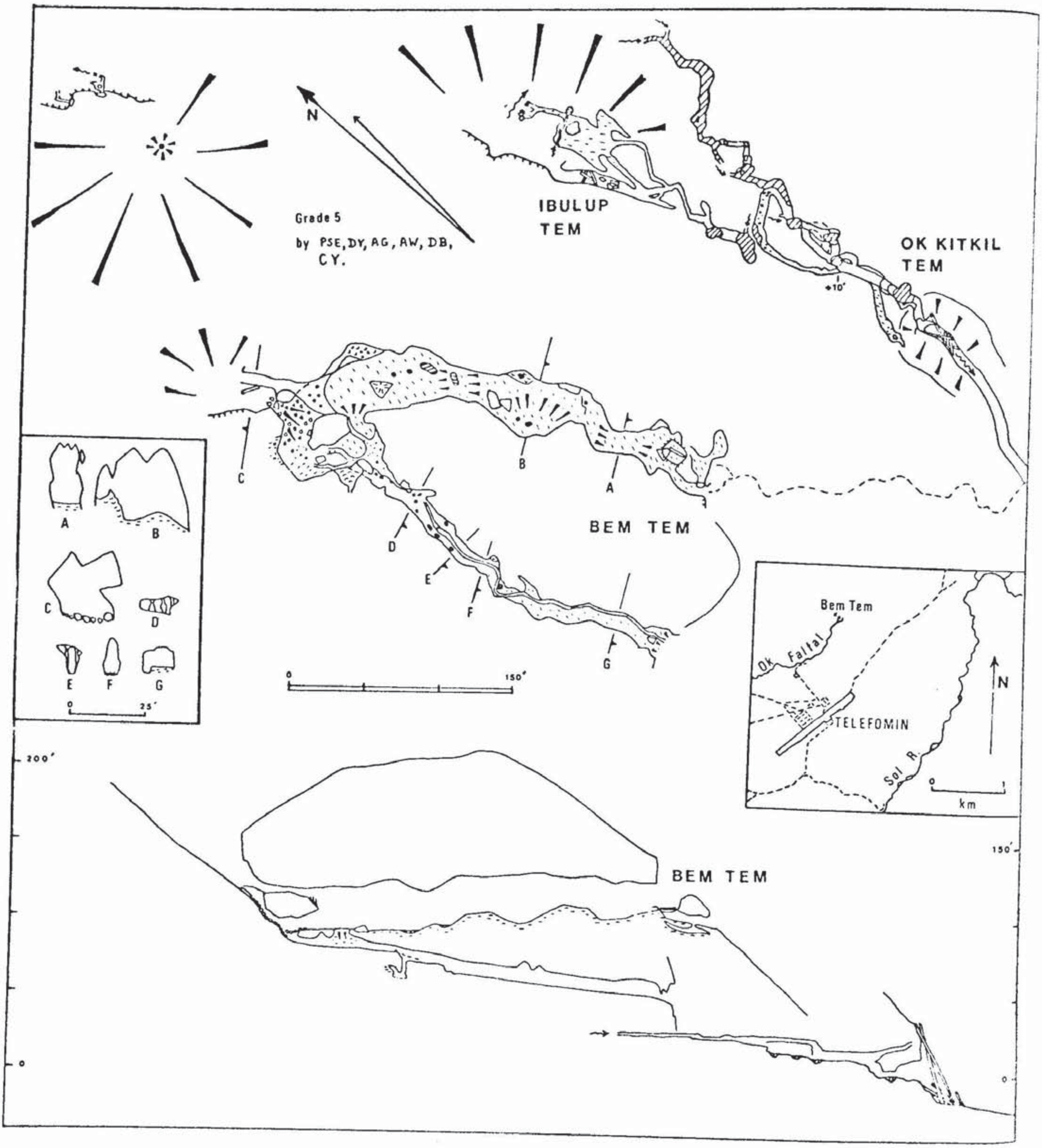
Only half a mile north of Telefomin is the Bem Tem group of caves (Fig. 14). **Bem Tem** (Worm Cave) itself is the largest cave and well known to the local people, being referred to as the Great Cave by the 1965 Star Mountains Expedition. A double level entrance, 150ft (45m) up the steep hillside above the Ok Falfal swamp, leads to an uneven floored tall tunnel, well decorated by large stalagmites. From a low final cavern a steep slope ascends to the north exit and part-way up the slope a passage opens out on to a fine decorated balcony above the main chamber of the cave. Two passages near the north entrance unite in an arched tunnel with a small floor trench and shingle deposits overlain by stalagmite. A hole in the floor leads to a choked chamber but shows that the deposits have completely filled lower level passages in the cave. The arched tunnel continues to emerge in daylight at an opening (Hidden Exit) in a precipitous slope smothered by dense bush. The cave has a bat colony and their droppings cover the floor of the main passage with slippery brown guano. Drip pools in the mud and guano have colonies of remarkable relict marine polycheate worms (see Biological Report) which seem to prefer the slightly acid water (pH.6.5, Temp. 16.7^{0}C, Total Hardness $CaCO_3$ 123 ppm. Aggressiveness to $CaCo_3$ 7 ppm).

Ok Kitkil Tem which is 112ft (34m) lower, discharges a powerful stream. The entrance, above a cascade, is obscured by a log jam where a Tirfor winch was used to shift large trunks. Within the portal a deep pool is crossed to a series of cascades and a passage back on the left leading to another exist above the water outfall. Upstream is a complex of high level oxbows, one with a low airspace duck, but beyond a further duck the streamway degenerates into a wet struggle to a point where the decreasing airspace is studded with stalactites. The water temperature in the system was a comfortable 17^{0}C, i.e. very similar to the mud temperatures recorded in Bem Tem.

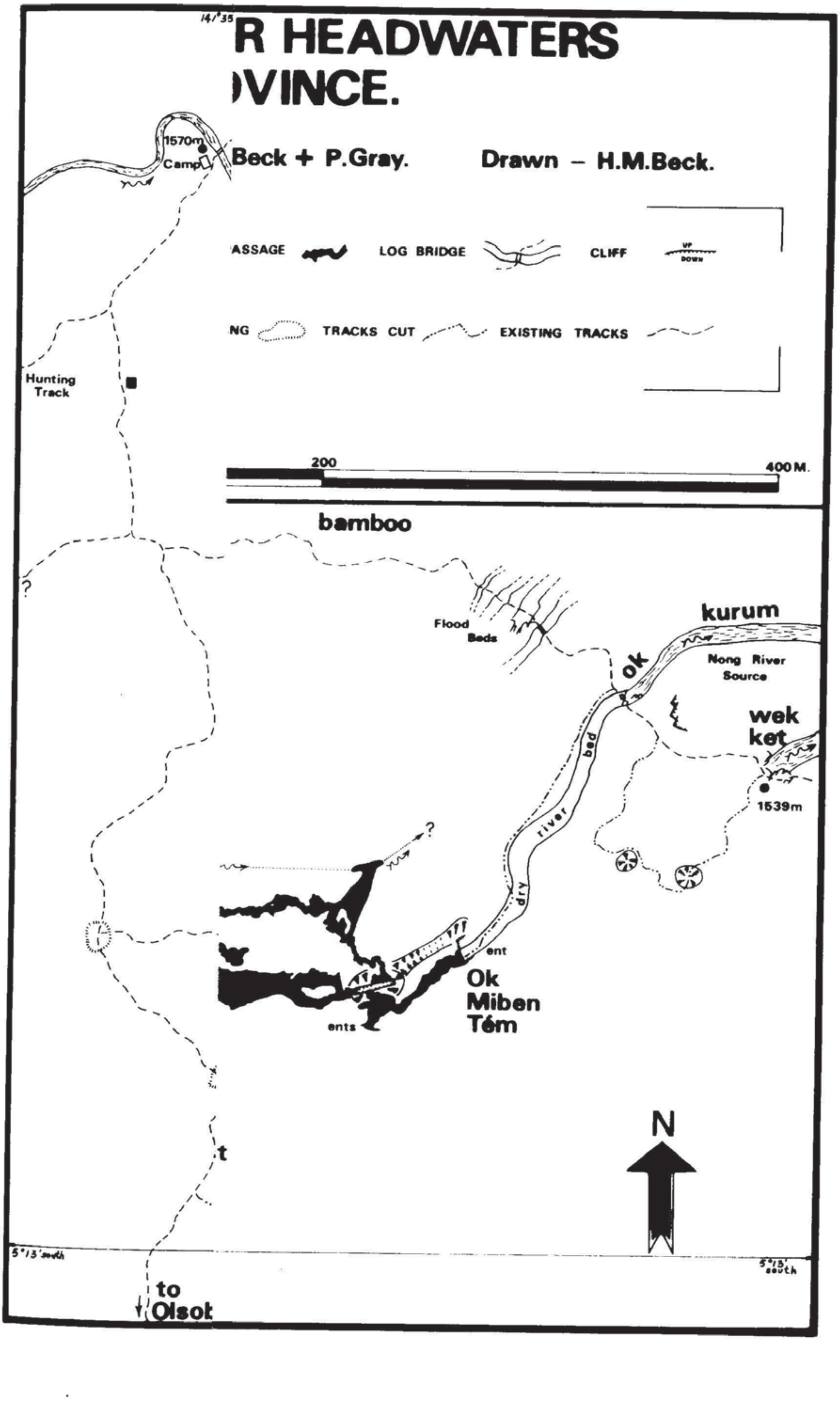
North of Ok Kitkil Tem Andrew Eavis found **Ibulup Tem** (Bat Cave) in a large doline. A route past logs intersects a series of passages running north and south. To the north it opens into a wide cavern with a large bat colony in an aven and a large stream can be heard at boulder chokes terminating the series. To the south a single walk-in passage ends in a sump, which is very close to the duck in the high level oxbows of Ok Kitkil Tem. Late on the day the cave was surveyed. Petar Beron almost met his end when the place flooded after torrential rain, with the sound and speed of an express train.

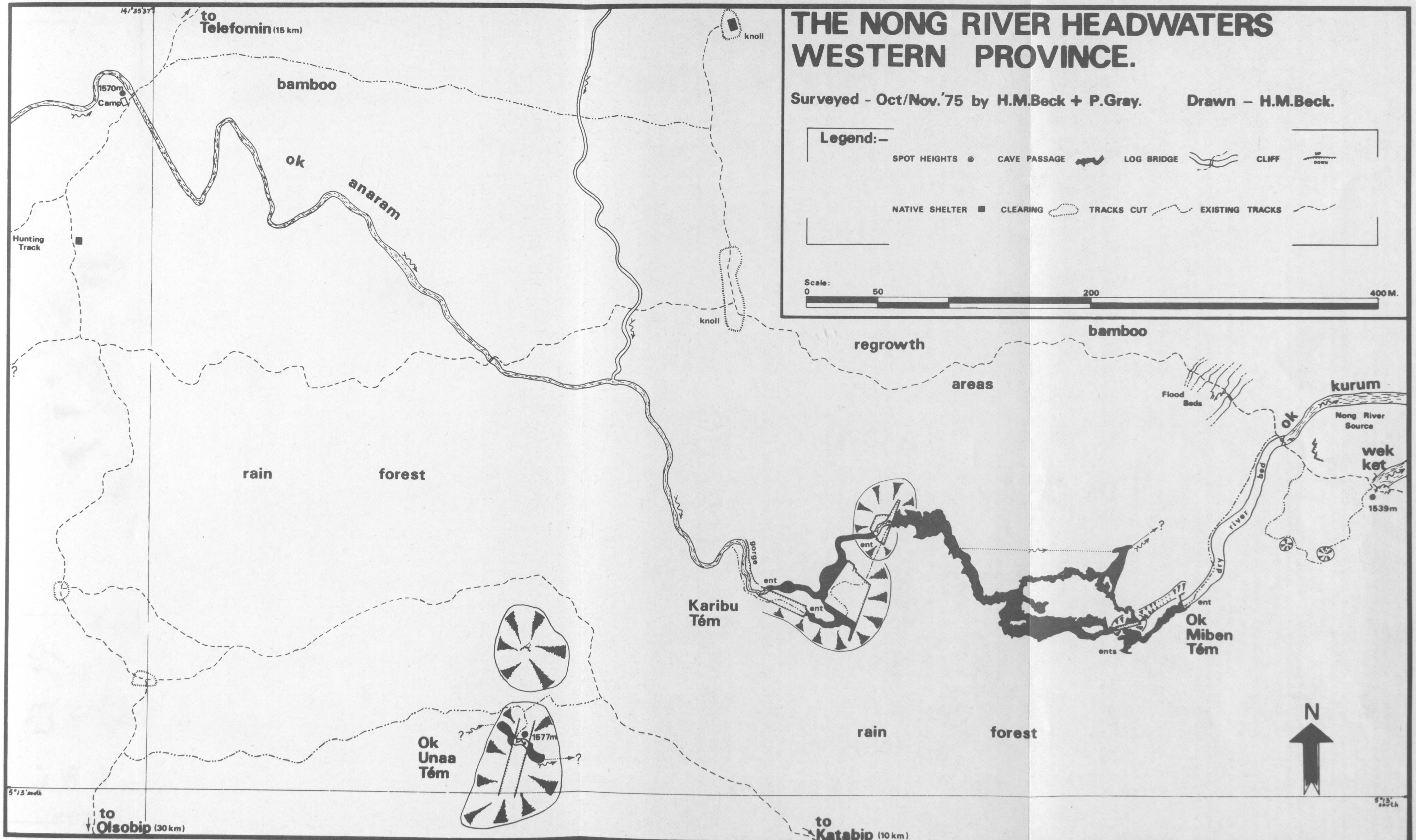
The Bem Tem group of caves are in a limited outcrop of Miocene limestone faulted against the Jurassic rocks to the north. More small caves were found by progressing northwards and Pete Gray and Phil Chapman

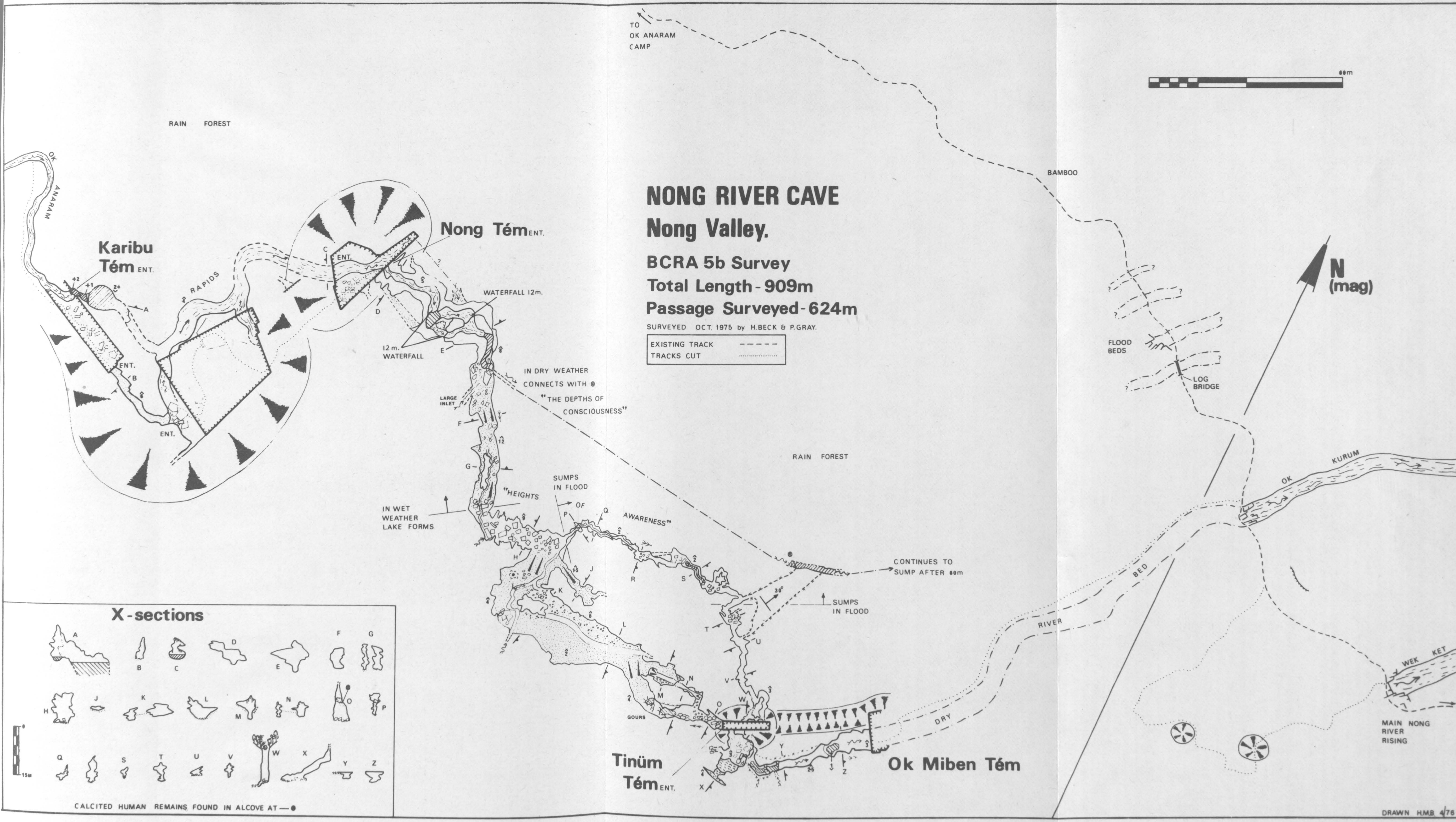
Fig. 14.



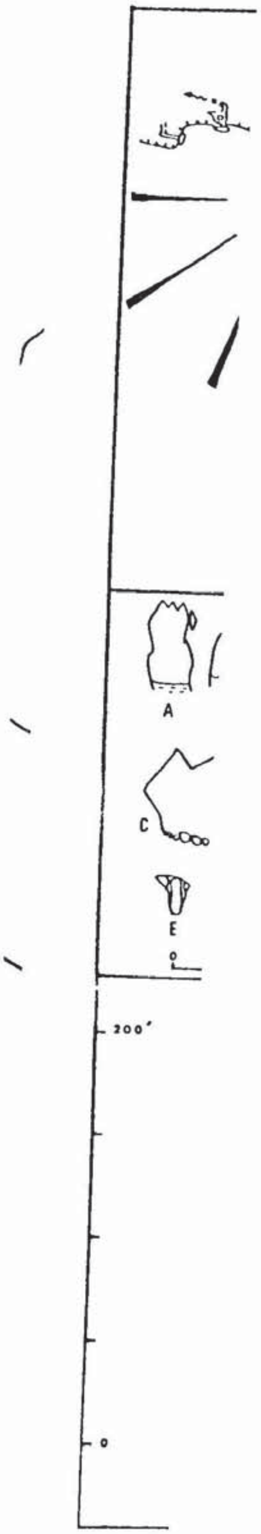
N
Grade 5
by PSE, DY, AG, AW, DB, CY.
IBULUP
TEM
OK KITKIL
TEM
+10'
BEM TEM
A
B
C
D
E
F
G
0
25'
150'
Bem Tem
Ok Faltal
TELEFOMIN
Sol R.
km
200'
150'
BEM TEM
0


141°35
R HEADWATERS
)VINCE.
Beck + P.Gray.
Drawn – H.M.Beck.
ASSAGE
LOG BRIDGE
CLIFF
UP
DOWN
NG
TRACKS CUT
EXISTING TRACKS
200
400 M.
1570m
Camp
Hunting Track
bamboo
?
Flood Beds
kurum
ok
Nong River Source
wek ket
1539m
dry river bed
?
ent
Ok Miben Tém
ents
N
t
5°13' south
5°13' south
to Olsot


THE NONG RIVER HEADWATERS
WESTERN PROVINCE.
Surveyed - Oct/Nov.'75 by H.M.Beck + P.Gray.
Drawn - H.M.Beck.
Legend:–
SPOT HEIGHTS
CAVE PASSAGE
LOG BRIDGE
CLIFF
UP
DOWN
NATIVE SHELTER
CLEARING
TRACKS CUT
EXISTING TRACKS
Scale:
0
50
200
400 M.
14°35'37"
to
Telefomin (15 km)
knoll
1570m
Camp
bamboo
ok
anaram
Hunting
Track
knoll
regrowth
bamboo
areas
Flood
Beds
kurum
ok
Nong River
Source
wek
ket
1539m
dry
river
bed
rain
forest
gorge
ent
ent
ent
Karibu
Tém
ent
ents
Ok
Miben
Tém
?
?
?
1577m
Ok
Unaa
Tém
rain
forest
N
5°13' south
to
Olsobip (30 km)
to
Katabip (10 km)



NONG RIVER CAVE
Nong Valley.
BCRA 5b Survey
Total Length - 909m
Passage Surveyed - 624m
SURVEYED OCT. 1975 by H.BECK & P.GRAY.
EXISTING TRACK
TRACKS CUT
TO OK ANARAM CAMP
RAIN FOREST
BAMBOO
OK ANARAM
Karibu Tém ENT.
RAPIDS
Nong Tém ENT.
WATERFALL 12m.
12m. WATERFALL
LARGE INLET
IN DRY WEATHER CONNECTS WITH
"THE DEPTHS OF CONSCIOUSNESS"
"HEIGHTS OF AWARENESS"
SUMPS IN FLOOD
IN WET WEATHER LAKE FORMS
CONTINUES TO SUMP AFTER 60m
GOURS
Tinüm Tém ENT.
Ok Miben Tém
DRY RIVER BED
OK KURUM
FLOOD BEDS
LOG BRIDGE
N (mag)
WEK KET
MAIN NONG RIVER RISING
X-sections
CALCITED HUMAN REMAINS FOUND IN ALCOVE AT —
DRAWN H.M.B. 4/76


A
C
E
200'
0

followed the dolines to a point 1500ft (450m) above the Kitkil resurgence, and descended a shaft which became too narrow. Apart from their great biological importance the caves have also preserved something of the erosional history of the area.

Four stages in successive base level lowering are apparent from Bem Tem main passage, Hidden Exit Passage, Ibulup Tem, and the present Ok Kitkil Tem streamway. The first three are deserted phreatic passages but the last is an immature vadose passage which had not had time to adjust to the last change in base level. Bem Tem main passage is well developed and represents a long quiet standstill 150ft (45m) higher than the top of the lake deposits at Telefomin. The Hidden Exit became active after a fall in base level of some 70ft (20m) and more rapid stream flow deposited pebble beds, which may have some correlation with the boulder bed on the school ridge at Telefomin. At this stage the polycheate worms must have become adapted to life in drip pools. Bem Tem became abandoned completely as the next fall as phreas led to the initiation of the Ibulup series but the new system could not expand to the dimensions of Bem Tem before further lowering of base level occurred. Since that time the stream has not been capable of cutting down quickly enough to adjust to falling erosion levels in the basin, hence the resurgence now hangs above the stripped terraces at Telefomin.

THE NONG CAVES

Compiled from notes by H. Beck and A. Goulbourne

Apart from two small caves (Nuk Tem and Mafak Tem) west of the track of Olsobip, all sites of speleological interest in the Nong valley visited by the expedition were east of the camp at the Ok Anaram. Allan Goulbourne began lone investigations in September and followed the Ok Anaram until it cascaded into **Karibu Tém.** Below the fall, wading and swimming leads to a great amphitheatre open to the sky, and on the right a dry oxbow links back to the gorge at the sink. A further short section of rapids emerges once again in daylight at **Nong Tém** where the river roars along a high rift at right angles and sinks into a log jam. Straight ahead above the level of the river bed an inviting tunnel is decorated with tooth-like stalactites and dark walls soak up the caver's light. Inside the water is rejoined as it crashes into a dark waterfall cavern where an exposed climb descends 90ft (27m) to a point where the stream enters an immature passage – the Depths of Consciousness.

Here the original explorer halted where the torrent almost filled the passage, but he was almost too late, for he had great difficulty in finding his airy route out of the noisy cavern and eventually in desperation an alternative exit was excavated through flood debris. The remainder of the system was subsequently explored when Howard, Pete and Kevan joined Allan in the Nong area.

In low water conditions a dry passage ascends from the waterfall cavern to a boulder strewn chamber and the Heights of Awareness series veers off to the left. The latter consists of smaller passages and forms a long oxbow. It is linked by a down-dip bedding plane to the aqueous levels of the Depths of Consciousness, which end in a sump. The main sandy cavern continues to rise and enlarge before a gour floored tunnel emerges at the **Tinum Tém** entrance, above which calcited human bones were found. The fossil tunnel continues to the old resurgence of **Ok Miben Tém.** (Fig. 15).

During frequent floods the scene is transformed. The waters of the Ok Anaram entering Karibu Tem are slow to rise but a huge inlet invades the amphitheatre and ponds back the Ok Anaram to create a sump. The Depths of Consciousness fill to the roof and the waterfall cavern backs up to form a lake which fills large sections of the Heights of Awareness. The flood observed, resulted from 3 inches of rain in one day in the Telefomin region. Until Howard Beck and Pete Gray surveyed the cave in low water conditions it was not realised that Ok Miben Tem and Karibu Tem were in fact one system.

In the bush to the south west of Karibu Tem the Nong explorers were shown the great slot of **Ok Unna Tém** where a raging river shot from one impassable passage into another. (Fig. 16). They were informed that on rare occasions the Ok Unaa dried up but it was not possible to force entry during the period September to November 1975. The source of the river was not discovered but the trunks washed through the cave point to an open entrance upstream.

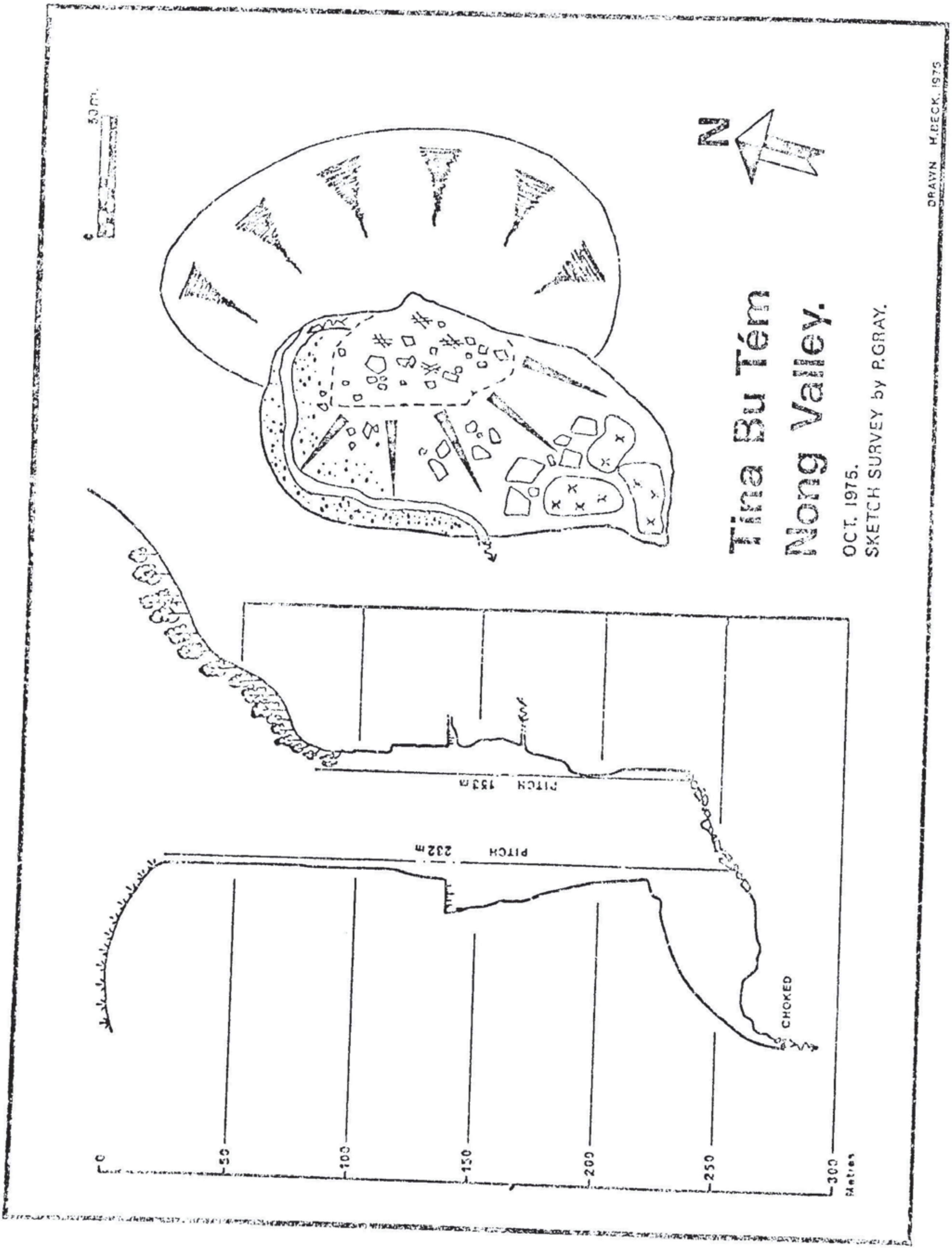
The dry river bed below Ok Miben Tem becomes active at the sizeable Ok Kurum resurgence. To the north west are the four stream beds of a braided flood outlet, but a more significant feature is the enormous **Wek Ket** rising which spurts out of an unusual dome. In flood it was observed to discharge about 800 cusecs (55 cumecs) at a conservative estimate.

No dye testing was carried out but a consideration of the size of underground streams and their trends indicate that the Karibu Tem water feeds first the Ok Kurum resurgence and perhaps contributes to Wek Ket. In flood, overflow water from Ok Unaa Tem invades the system at the amphitheatre, but the normal course of the Ok Unaa is directly to Wek Ket, which is also the likely outlet for sinks in the fault controlled valley. The latter are 3,500ft (1050m) higher and are up dip (which is 30^0 north east in this region).

Most of the passages in the Nong caves are strike orientated deserted phreatic passages and show modification by the frequent floods which inundate them. The rapids between Karibu Tem, however, are developed down dip. The waterfall cavern is the normal weather nick point of the system but the recently formed outlets are not yet mature enough to take the river during a rise in stage, thus periodic flooding of the Heights of Awareness occurs. A recent lowering of base level has occurred from a major standstill period corresponding with the trunk passage horizon some 100ft. (30m) higher than the present base level.

To reach the present resurgences all the underground streams in the Nong region must flow against

Fig. 17.



Tina Bu Tém
Nong Valley.
OCT. 1975.
SKETCH SURVEY by P.GRAY.
DRAWN H.BECK. 1975
N
0
30 m
PITCH 153 m
PITCH 232 m
CHOKED
0
50
100
150
200
250
300
metres

the dip to some extent and pass up through the beds, since the Miocene limestone dips beneath the overlying Lai siltstones in the valley bottom. The imperious strata influence the siting of the resurgences but a double thrust in the vicinity (Geol. Survey Papua New Guinea 1974) complicates matters and the true relationship of hydrology to structure deserves more detailed study.

Tina Bu Tem (Fig. 17)

This great pit is located in the Un Tem Tigiin clearing ¾ mile (1¼ Km) south of the Nong camp at an altitude of 6,300ft. (1885m). It had repulsed all attempts by local hunters to reach its large flying fox colony and their experiences gave it a name — 'A hole to look at but not to go down'. Its mouth is asymmetrical and offers two alternative abseils; both freehanging and extremely impressive. The first explorers chose the shorter hang of 502ft. (153m) and had trouble with rope abrasion at a bulge 340ft. (100m) down. Inlets spurted into the shaft at a prominent bedding level and astonishingly the only usable ledge was infested with crabs (see Biological Section). The great cavern at the base of the pit descended to a choke at a total depth of 910ft. (275m) i.e. close to the level of the Wek Ket resurgence at 5000ft. (1500m) asl. The north south orientation of the shaft is on a master joint and may be close to the route taken by the water from the fault-controlled valley.

Two flying foxes (out of many hundreds) were shot and presented to our Faiwolmin friends as thanks for their permission to explore a hole they regarded with awe. In spite of the descent the Faiwolmins are sensibly not going to change the name.

THE FAULT CONTROLLED VALLEY

Compiled from notes by K. Wilde, P. Gray, A Goulbourne and J. Buchan

Continuing up the track towards Olsobip from the Uun Tem Tigiin clearing, the rock shelter of Borem Imal is passed. This may be the one used by Champion's party on the first trek across New Guinea from the Fly to the Sepik. The path eventually crosses the high ridge of Tigam Tigiin at 8,000ft (2500m) a.s.l. and drops 800ft (250m) into the fault valley where the expedition established a base by the native shelter at Mogondabip. Several shafts were investigated close to the main track which continued to the Hindenburg Wall but all were less than 70ft (21m) deep. A new track was also cut westward along the fault valley but only one shaft was found and hence the project was abandoned.

The nineteen holes already noted in the eastern section of the valley were systematically checked by the small team but all were choked. More pots were found as the track was extended and two months' work was needed to explore the thirty six holes along the 6Km of valley traversed to the expedition. All are described in the accompanying list and plans (Figs. 18 & 19) and the most significant pots are detailed below.

Tum Dabom Tem

Named because of its loose walls, the explorers received 'stones on the head' but none caused permanent damage. A 110ft (33m) pitch lands on a steep rubble slope succeeded by a climb down to a choke. A narrow window is too tight but opens out into a high rift beyond: on our visit this was occupied by a swift's nest.

No. 10 Shaft. Two free-climable pitches and a final 67ft (20m) shaft end in a choke where a small stream sinks.

Anawol Tem. The scene of Pete Gray's near demise. An impressive shaft with a suicidal bottleneck partway down. For convenience and safety the pot was split into pitches of 107ft (32m) and 147ft (44m) but it ends abruptly in a choke.

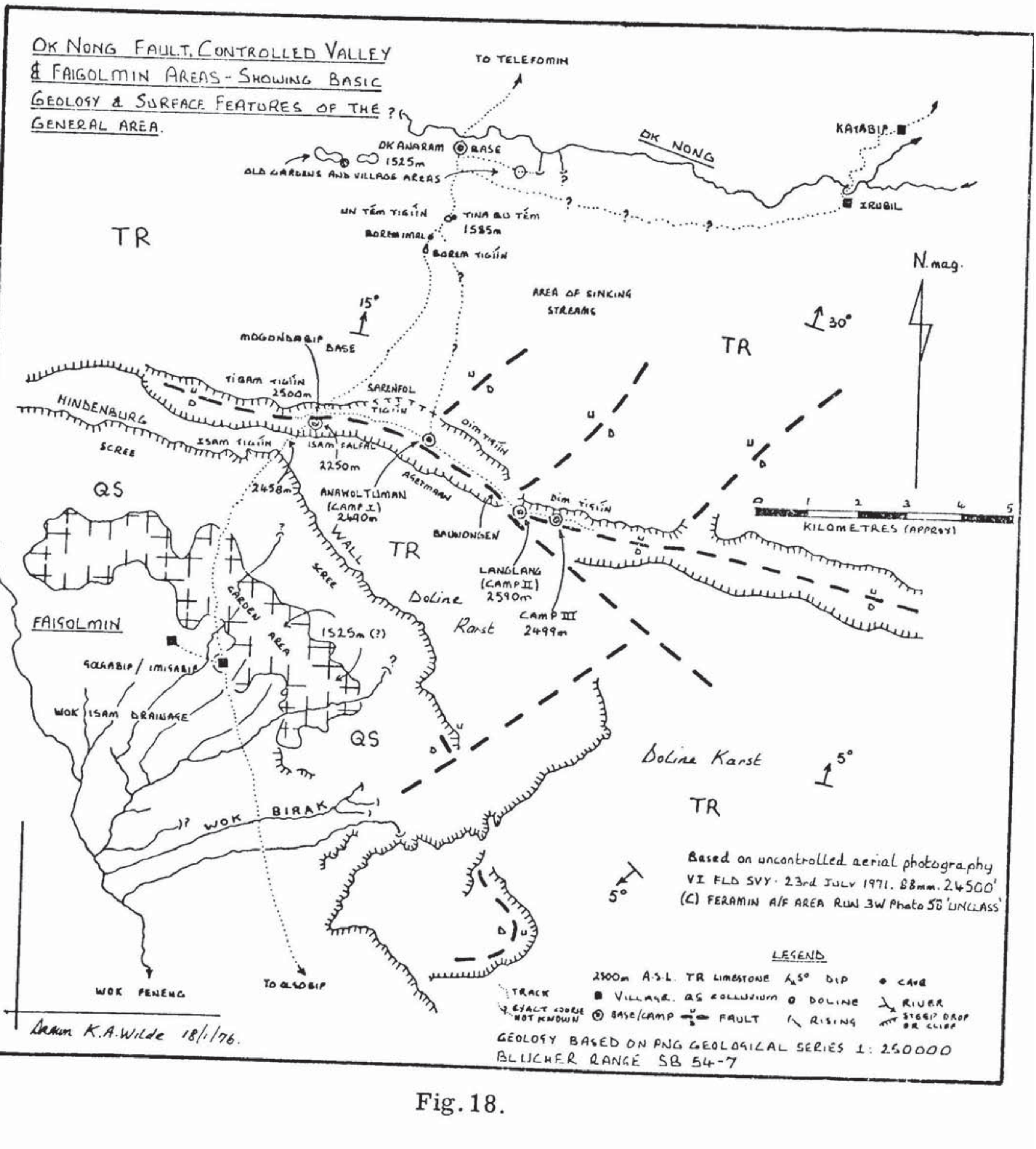
Ketan Tem. A pot which did not live up to its promise. it began in fine style with a double entrance opening taking a reasonable stream. Pitches of 73ft (22m) and 110ft (33m) enter a large chamber but a very tight squeeze prevented further exploration of the streamway.

Langlang Tem (Fig. 20) Spirits were running low before the exploration of this deep pot but the initial exploration and filming team was reinforced by the timely arrival of John Donovan, Jim Farnworth and Roy Blackham.

The entrance consisted of a couple of short pitches passing a rock bridge and a difficult traverse to a drop on to a ledge which was a natural trap for falling rocks. Above it were piles of loose rock and wet conditions caused a boulder fall down the succeeding 165ft (50m) pitch resulting in Kevan's accident. Beyond the large shaft was a second long pitch split at a sentry box. At its base a series of short pitches and cascades descended steadily along a single fracture and finally degenerated into a tight crawl. Jon Buchan forced the narrow section and emerged above a drop estimated at 50ft (15m) but in view of the lack of more small men and the dangerous nature of the large shaft the pot was abandoned in favour of Terbil Tem.

Shaft No. 28. A 100ft (30m) well developed shaft is a fusion of three avens, two of which breach the surface. The large chamber below had only one outlet which was choked by silt on boulders. The bedding appeared to be vertical but the effect could be a result of close joints or faults.

Terbil Tem (Fig. 21). A group of three 45ft (13m) pitches unite on a boulder slope where the first explorers (Howard Beck and Pete Gray) built a log bridge over a large upright block. The boulder slope continued to a small hole and the start of a clean stream passage. Two small climbs led to a 50ft (17m) wet pitch but this was subsequently rigged dry via a traverse and a freehang to avoid the water and rope abrasion. The system now split into two routes. The water took a 33ft (10m) pitch to a pool and immediate 50ft (17m) drop



OK NONG FAULT, CONTROLLED VALLEY & FAIGOLMIN AREAS - SHOWING BASIC GEOLOGY & SURFACE FEATURES OF THE GENERAL AREA.
TO TELEFOMIN
OK NONG
KATABIP
IRUBIL
OK ANARAM BASE
1525m
OLD GARDENS AND VILLAGE AREAS
UN TÉM TIGÍIN
TINA BU TÉM
1585m
BOREM IMAL
BOREM TIGÍIN
TR
N. mag.
AREA OF SINKING STREAMS
15°
30°
MOGONDABIP BASE
TIGAM TIGÍIN
2500m
SARENFOL TIGÍIN
HINDENBURG
SCREE
ISAM TIGÍIN
ISAM FALFAL
2250m
DIM TIGÍIN
AGETMAN
2458m
ANAWOLTUMAN (CAMP I) 2490m
BAUWONGEN
LANGLANG (CAMP II) 2590m
CAMP III 2499m
KILOMETRES (APPROX)
0 1 2 3 4 5
QS
WALL
SCREE
GARDEN AREA
Doline Karst
FAIGOLMIN
1525m (?)
SOGABIP / IMIGABIP
WOK ISAM DRAINAGE
WOK BIRAK
Doline Karst
5°
Based on uncontrolled aerial photography
VI FLD SVY · 23rd JULY 1971. 88mm. 24500'
(C) FERAMIN A/F AREA RUN 3W Photo 56 'UNCLASS'
WOK PENENG
TO OLSOBIP
LEGEND
2500m A.S.L.
TR LIMESTONE
5° DIP
CAVE
TRACK
EXACT COURSE NOT KNOWN
VILLAGE
QS COLLUVIUM
DOLINE
RIVER
BASE/CAMP
FAULT
RISING
STEEP DROP OR CLIFF
GEOLOGY BASED ON PNG GEOLOGICAL SERIES 1: 250000
BLUCHER RANGE SB 54-7
Drawn K.A. Wilde 18/1/76.

Fig. 18.

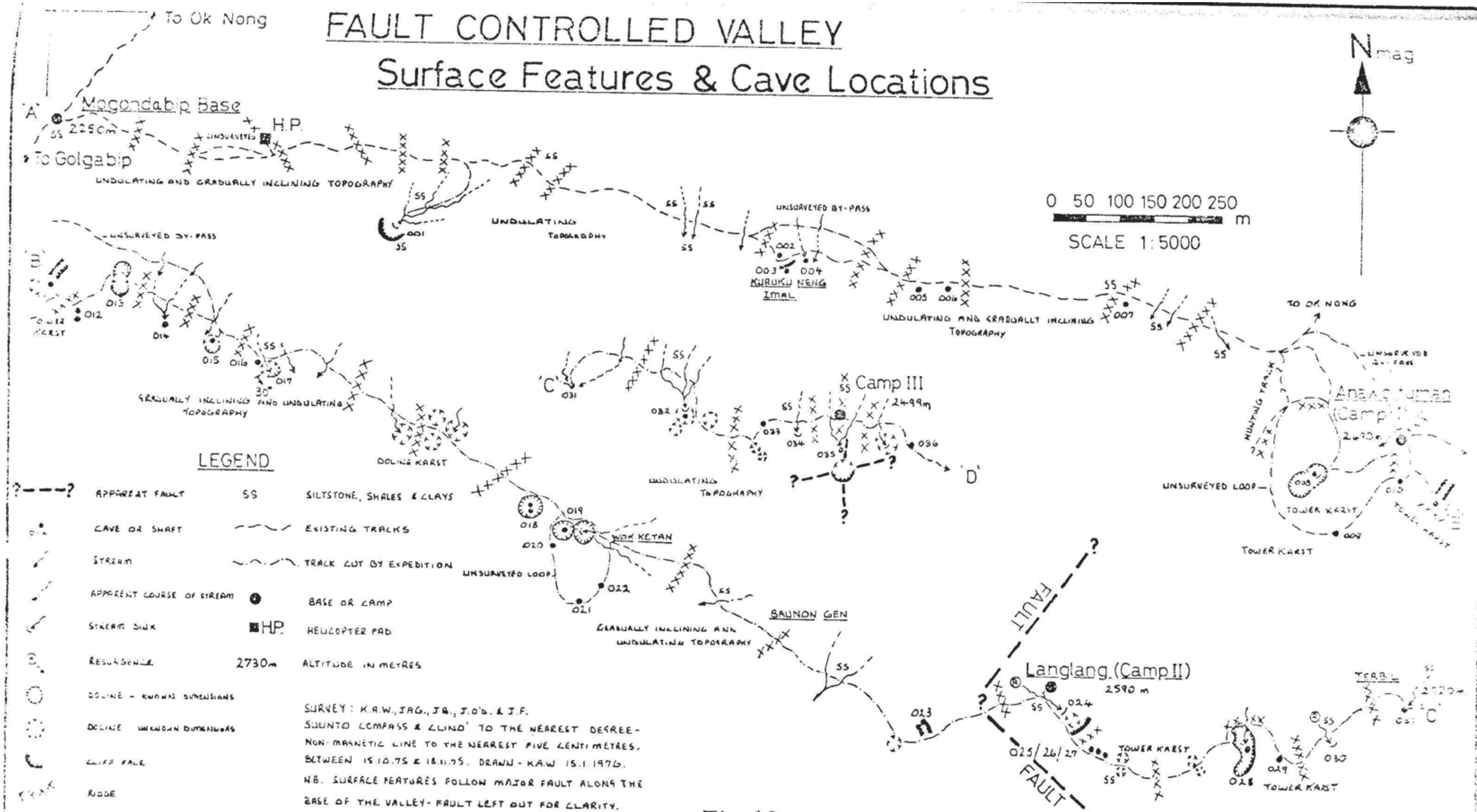
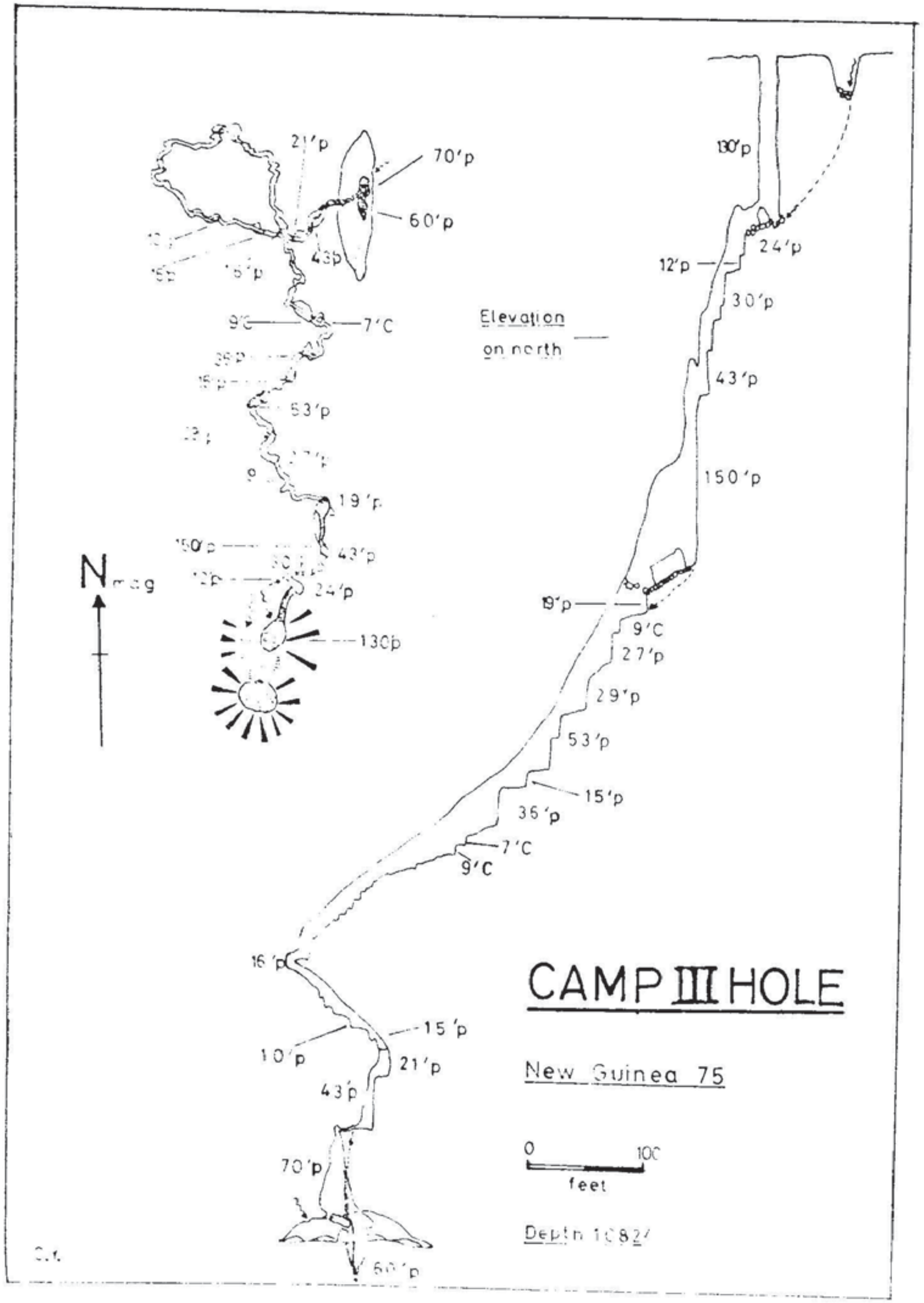


Fig. 19.

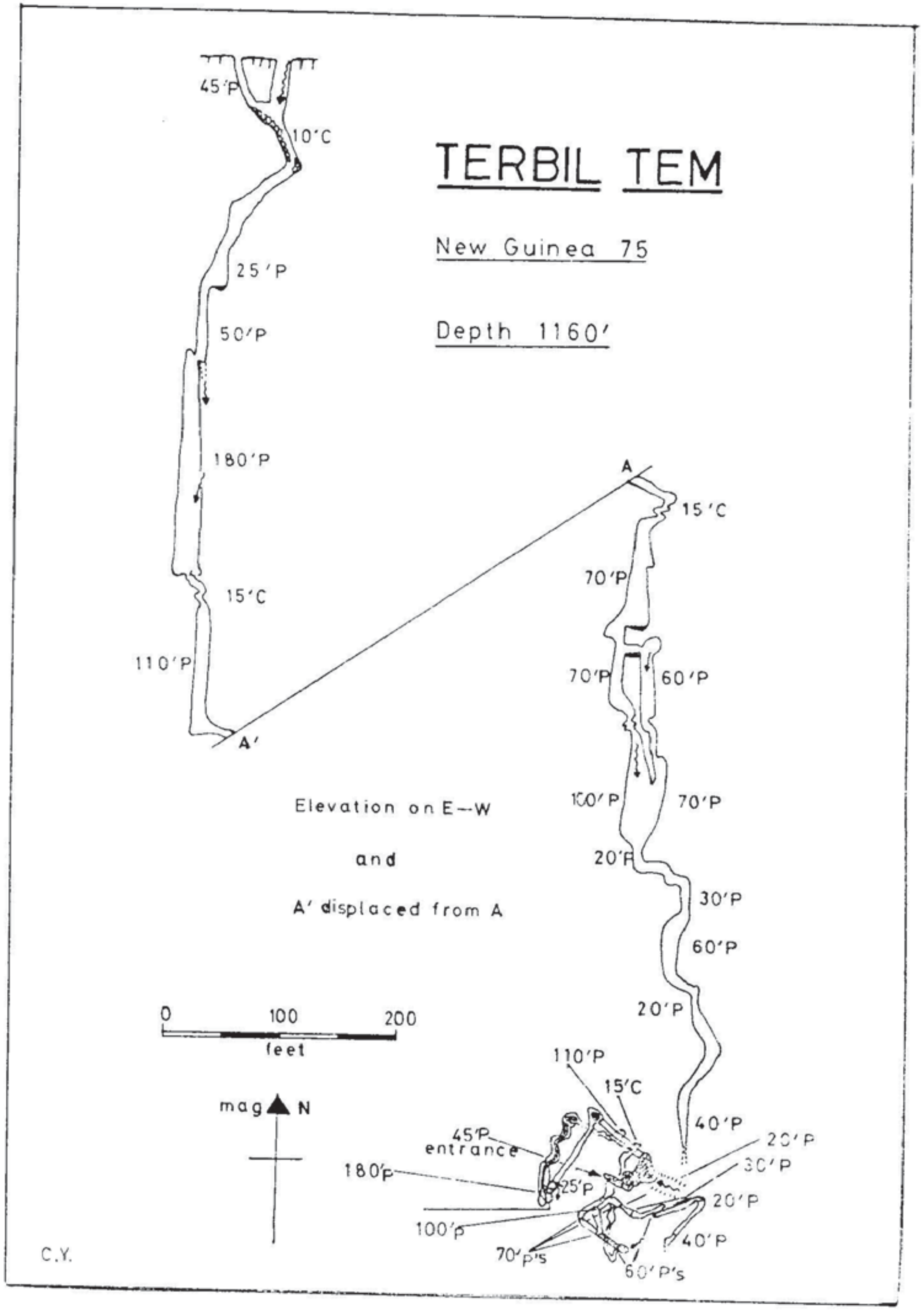
Cave No.	Description (Brief)
001	Two choked stream sinks
002	12m deep shaft — choked
003	**Kuruku Neng Imal**, rock shelter with small chamber and 8m pitch — choked
004	Choked stream sink
005	Choked shaft
006	Choked shaft
007	Choked stream sink
008	**Tum Dabom Tem**, double doline, 1st with 50m deep shaft — choked
009	Rift shaft, estimated 15m pitch — not descended
010	Shaft, amongst tower karst, 33m deep — choked — with stream inlet sinking in silt
011	**Anawol Tem**, shaft approximately 76m deep — choked
012	Two shafts, less than 33m deep — both choked
013	Tight shaft, 40m deep
014	Restricted and tight shaft, 40m deep
015	Choked stream sink
016	45m shaft — choked
017	Choked boulder sink
018	Two tight shafts, 1st 3m deep, 2nd 14m deep
019	**Ketan Tem**, shaft with sinking stream, double entrance, 40m deep, largish chamber, stream can be seen through tight squeeze.
020	Shaft, 18m deep — choked
021	15m deep shaft — choked
022	15m deep shaft — choked
023	Small cave, in rift
024	Boulder choked stream sink
025	**Langlang Tem**, approximately 200m deep (Fig. 20)
026	Small, tight shaft, may connect with 025
027	Small tight, deep (?) shaft, may connect with 025 and 026
028	30m deep shaft, inlet sinks in silt
029	33m (plus ?) shaft — not fully descended.
030	Stream sink — choked
031	**Terbil Tem**, approximately 360m deep (see Fig. 21)
032	Stream sink in gravel and rocks, plus 12m shaft
033	Shaft taking water, depth unknown (?)
034	Choked stream sink, in gravel
035	**Camp III Hole**, 330m deep cave (see Fig. 22)
036	Fissure taking water, 15m deep (?)

Fig. 22.

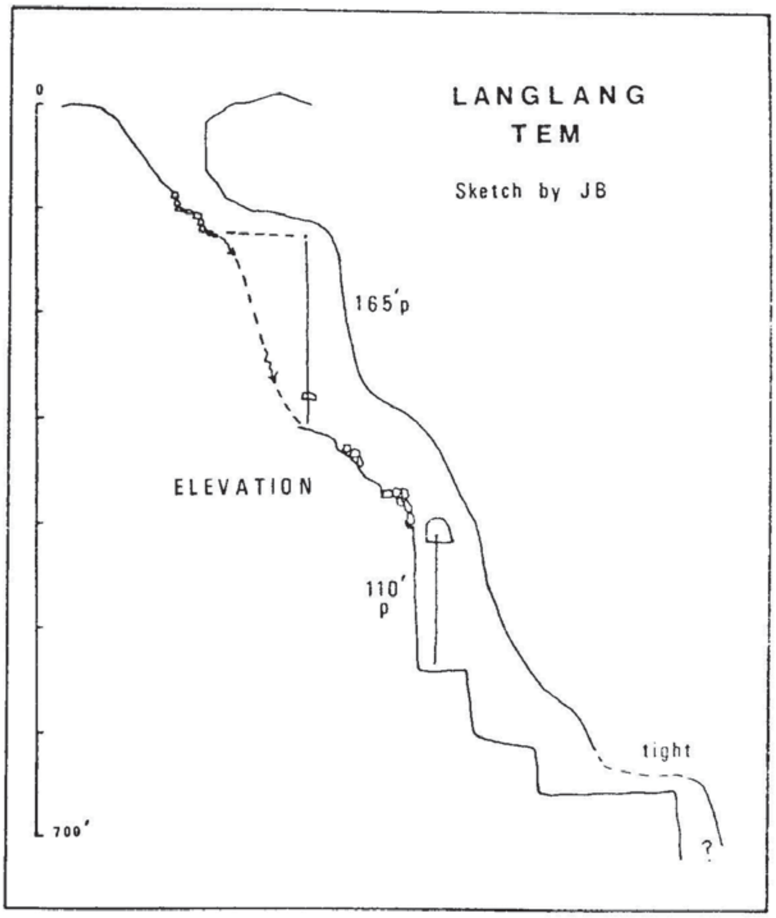


CAMP III HOLE
New Guinea 75
Depth 1082'
Elevation on north
N mag
0 100
feet
130'p
24'p
12'p
30'p
43'p
150'p
19'p
9'C
27'p
29'p
53'p
15'p
36'p
7'C
9'C
16'p
15'p
10'p
21'p
43'p
70'p
60'p
21'p
70'p
60'p
43p
7'C
53'p
19'p
43'p
24'p
130p
C.Y.

Fig. 21.



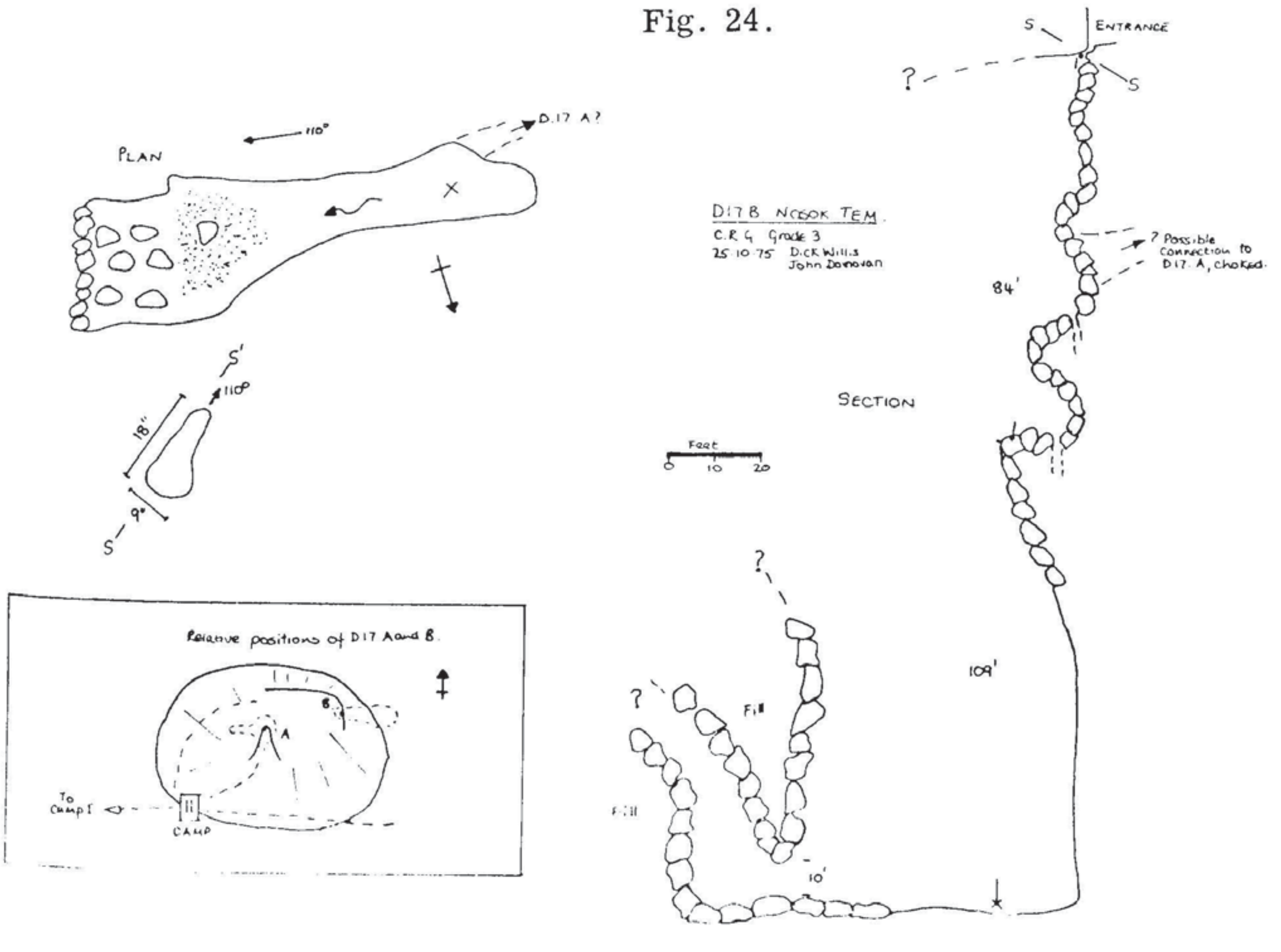
TERBIL TEM
New Guinea 75
Depth 1160'
Elevation on E--W
and
A' displaced from A
45'P
10'C
25'P
50'P
180'P
15'C
110'P
A
A'
15'C
70'P
70'P
60'P
100'P
70'P
20'P
30'P
60'P
20'P
40'P
0 100 200
feet
mag N
110'P
15'C
45'P entrance
180'P
25'P
100'P
70'P's
60'P's
20'P
30'P
20'P
40'P
C.Y.



LANGLANG
TEM
Sketch by JB
0
165'p
ELEVATION
110'
p
tight
700'
?

Fig. 20.

Fig. 24.



S
ENTRANCE
?
S
110°
D.17 A?
PLAN
S'
110°
18'
9'
S
D17B NGBOK TEM.
C.R.G Grade 3
25.10.75 Dick Willis
John Donovan
? Possible
connection to
D17. A, choked.
84'
SECTION
Feet
0 10 20
Relative positions of D17 A and B.
B
A
To
Camp I
CAMP
?
?
Fill
Fill
109'
10'

into a spray lashed chamber, but the outlet soon became impossible.

Due to illnes in camp Pete Gray carried on a lone exploration on several trips. He explored the dry route and rigged a 180ft (54m) shaft from a bolt traverse. The pot cut through several beds, one of which appeared to be marbled, and rejoined the stream in a narrow passage. A climb was succeeded by drops of 110ft (33m) and 70ft (20m) linked by a short passage.

Roy and Allan now joined the "lone bolting machine". An incongruous phreatic tube with some stalictite decoration was noted partway down the next pit but below a scramble over a pile of flakes soon led to another drop. Jon and Allan returned to the fray and below the next 110ft (33m) fall a series of small pitches ended disappointingly in a 4 inch (10cm) crack in chalky limestone at a depth of 1160ft (354m).

The phreatic tube remained as a hope for still greater depths so the new arrivals (Chas and Chris) plummeted down and pendulumed into it. A 60ft (18m) shaft quickly materialised but the outlet for the tiny stream was an equally tiny rift and awkward acrobatics were needed at the top of the next short drop into a chamber. A pile of flakes cunningly concealed the next vertical of 70ft (20m) but it merely rejoined the known system, so the pair retreated, surveying as they went.

Camp III Hole. (Fig.22). Of all the pots explored in the fault controlled valley this was the only one which had significant lateral development. It was the last major system to be found on the expedition. Allan and Chas began the investigation of the 130ft (39m) entrance pit and Noel and Kevan continued down a meander and a series of small pitches to a larger shaft.

Most people now began to pull out of the valley but John Donovan, Chas, Jim and Allan stayed on to explore the pot as far as possible. A dry hang via a traverse was attempted for the next yawning pit but 30ft (9m) down the stream struck a ledge and lashed the air with spray. At 90ft (27m) a sabre-like flake jutted out into the expanding shaft but luckily the rope hung clear of it. At the base of the 150ft (45m) pitch was a cavern with rifts above full of leaning chockstones and similar blocks on the floor gave a scramble down into the continuing streamway. A long series of small pitches in a tightening passage (Fig. 22) led to a low gradient meandering section, which was very tortuous. At this point the skeleton of an unhappy frog was encountered. A scalloped rift continued with rockmills, falsefloors and protruding flakes. More short pitches followed all with natural belays until a chamber with a floor of knobbly chert halted progress. A hole at the far end provided the way on and the water vanished down a slot. A muddy, small tube was the uninspiring way forward to a pitch and thread belay in the roof. This shaft was the most magnificent in the valley. A circular hole in a second chert sheet was the top of a perfect cone-shaped pot of 70ft (21m) and a further 60ft (18m) pitch entered a shattered chamber where the stream sank into a flake-choked pit. Partway up the last pitch a hole in boulders led to a domed chamber with banks of black silt. The pot was finished at a depth of 1082ft (330m).

The end of the expedition forced a halt to exploration of the valley at this point. From Mogondabip the valley bottom rises steadily (Fig. 19) but beyond Langlang it descends to a basin before rising to a cirque under the summit of Burimsakin at 10,000ft. (3050m). The latter feature is a promising site for deep pots but is best approached from Feramin.

Hydrology

The logistics of water testing in the fault controlled valley are considerable in view of the small streams sinking into the pots. According to our guides, Bimansep and Baraseng, the 'tumbuna' (ancestors) believed that all the creeks between Mogondabip and Anawoltuman joined underground to feed the Wok Isam (Fig. 18) and a large resurgence was located below Isam Tigiin. Drainage around Baunongen and Langlang was said to form the headwaters of the Wok Birak and join up with the Wok Feneng. Geological considerations however, suggest that all drainage north of the fault along the valley could drain to Wek Ket in the Nong valley.

THE URAPMIN REGION -- R. Willis and D. Brook

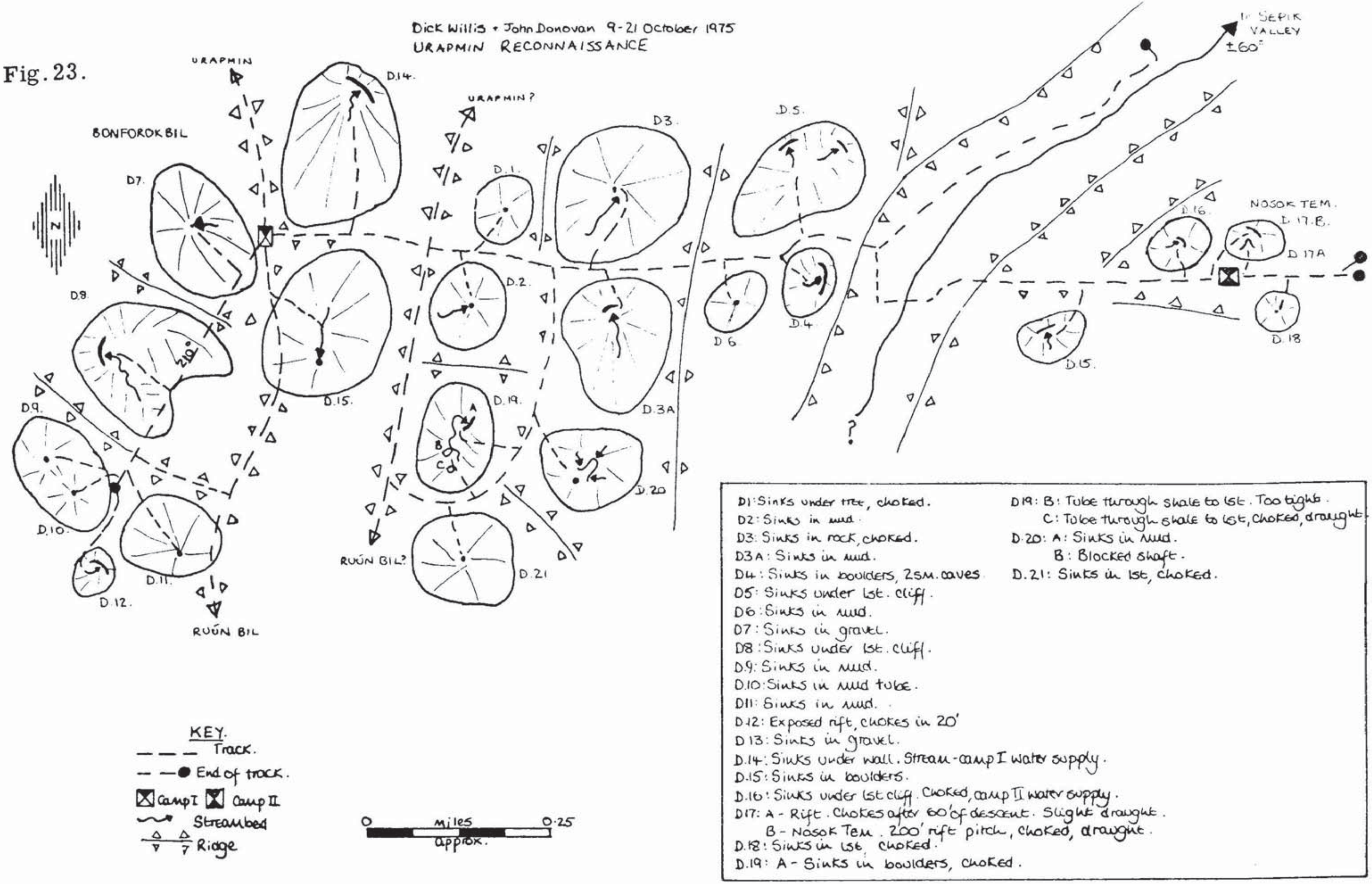
Beyond the Sepik bridge the south path to Urapmin crosses the powerful white-water stream (Ok Waal) from the **Ogalbil** resurgence. There is no possible cave at the outlets but they are close to the top of the terraces which are eroded remnants of the lake deposits. Hence the resurgence was being formed before the cutting of the Sepik Gorge and has not yet adjusted its level to the present incision of the river. In view of its age a search for abandoned caves in the vicinity of the resurgence may be rewarding. The water responds more slowly to rainfall than the Sepik and always runs clear, but the single total hardness measurement made was abnormally low (64ppm $CaCo_3$). Possible explanations are:-

1. fast drainage in conduits
2. the emergence of a dilute flood pulse or
3. the sparse tree cover above the system leading to low CO_2 content in the percolation water. A more detailed study is clearly warranted.

Below Urapmin the even larger **Winbil** resurgence bursts out and can be heard from a considerable distance. A feature in the same vicinity is called **Wintem** although the people told us it was not a cave. The resurgence features in the Afek legend and is considered 'tambu' by the local people, so we respected their beliefs and left it strictly alone.

In the high ranges south of Urapmin are a group of huge dolines situated about 2,500ft. (760m) above the Winbil resurgence and are so prominent in air photos that they are marked on the geological map. At the end of the reconnaissance, Kevan Wilde and his guides attempted to reach these dolines from the Ok Agim

Fig. 23.



Dick Willis + John Donovan 9-21 October 1975
URAPMIN RECONNAISSANCE
URAPMIN
URAPMIN?
BONFOROKBIL
N
To SEPIK VALLEY
±60°
NOSOK TEM.
D.1.
D.2.
D3.
D.3A
D.4
D.5.
D.6.
D7.
D8.
D.9.
D.10.
D.11.
D.12.
D.14.
D.15.
D.15.
D.16.
D.17.B.
D.17A
D.18
D.19.
D.20
D.21
A
B
C
210°
?
RUÚN BIL?
RUÚN BIL
KEY.
Track.
End of track.
Camp I
Camp II
Streambed
Ridge
0
miles
0.25
approx.
D1: Sinks under tree, choked.
D2: Sinks in mud.
D3: Sinks in rock, choked.
D3A: Sinks in mud.
D4: Sinks in boulders, 2 sm. caves.
D5: Sinks under lst. cliff.
D6: Sinks in mud.
D7: Sinks in gravel.
D8: Sinks under lst. cliff.
D.9: Sinks in mud.
D.10: Sinks in mud tube.
D11: Sinks in mud.
D.12: Exposed rift, chokes in 20'
D13: Sinks in gravel.
D.14: Sinks under wall. Stream - camp I water supply.
D.15: Sinks in boulders.
D.16: Sinks under lst cliff. Choked, camp II water supply.
D17: A - Rift. Chokes after 60' of descent. Slight draught.
B - Nosok Tem. 200' rift pitch, choked, draught.
D.18: Sinks in lst. choked.
D.19: A - Sinks in boulders, choked.
D19: B: Tube through shale to lst. Too tight.
C: Tube through shale to lst, choked, draught.
D.20: A: Sinks in mud.
B: Blocked shaft.
D.21: Sinks in lst, choked.

(see Agim section). He found the map to be in error but could only fix his position after days of cutting and had to abandon the search as supplies became low. In the light of Kevan's findings, John Donovan and Dick Willis returned to Urapmin in October and took on local carriers to continue the investigation of the area. They retraced the steps of the previous patrol up a hunting track and set up camp at a shelter west of the hill Tan de Bom. Here Kevan had left a note to the effect that the 'big holes' should lie to the east – so track cutting commenced. The advance camp was pushed forward and many large dolines investigated. (Fig. 23) Some took water in wet periods and small pots showed a shale/limestone boundary dipping to the north. On the fourth day the two deepest shafts were discovered in doline D17. D17a was a rift which choked at a depth of 60ft. (18m) but more significant was D17b - **Nosok Tem** a small draughting hole at the base of a cliff opened out into a series of steps caused by boulders wedged in a rift. These ended abruptly in a free hanging 110ft. (33m) pitch and the passage below quickly choked at a total depth of 200ft (61m) (Fig. 24).

One hour's cutting beyond Nosok Tem the party emerged on a clear knoll overlooking the Sepik Valley and at last they could fix their position. They estimated the huge dolines to lie 1½ – 2 Km to the south but once again lack of supplies forced a retreat.

In view of the difficulties of navigating in this most confusing area, a local hunter who knows the region well would greatly speed up a future exploration effort.

THE AGIM REGION

Compiled from notes by C. Yonge and K. Wilde

West of the prominent ridge crowned by the Tan Dabom peak the Ok Agim rises on the shales beneath the eastern flank of the Fugilil massif and seeps away on meeting the limestone. A flood channel continues to the impressive mouth of **Agim Tem** which was visited by Kevan Wilde's party in May, 1975. Considering the northerly dip of the limestone, local opinion, and the relative volumes of water, the sink is presumed to resurge at the head of the similarly named Ok Agim which is the only large feeder into the Ilam from the south (Figs. 2 and 25). The outlet is some 2000ft. (600m) lower than the sink and the two are linked by a dry valley utilised by the track up from Mongabip. Thus a major system was anticipated and in early September, Kevan, Chas Yonge and Chris Pugsley returned with four porters from Mongabip to pursue the exploration.

The hole provides a refuge for a large flying fox colony and figures in local legend (see Anthropological Section) but the people of Mongabip were happy about our investigation so long as the giant bats were not driven away. The site of the reconnaissance camp was used ten minutes away from the cave. It was obvious that in wet periods the river advanced progressively along the dry pebbly river bed, overwhelming many small sinks in the flood channel but it rarely reached the slippery rockchutes at the mouth of Agim Tem as shown by vegetation and guano deposits. The latter made the steeply descending floor of the entrance most treacherous. Using a rope on the slope and first 50ft (15m) vertical, a fine chamber was entered but the air was thick with flies and heavy with the stench of guano. Pink leeches waved at the intruders from nearby rocks and it was with relief (and a rope!) that they descended a further 30ft (9m) to a pool and a smaller decorated chamber which was refreshingly clean. Through a portal between thickly proportioned stalagmite bosses was a 20ft (6m) pitch into a still, green and very deep pool succeeded at once by another pitch. To save a swim a bridge was lashed up from a couple of imported logs and the next obstacle proved to be a 90ft (27m) vertical down the wall of a huge rectangular cavern 200ft (60m) long, 80ft (24m) wide and 150ft (45m) at its highest point. The vast passage plunged on downward as a two stage drop of 80ft (24m) on to a circular floor of sand and pebbles. In wetter conditions water appears to pond up here and flow over a bungalow-sized boulder containing a deep cleft where a sling for aid allowed the next level to be reached. Another deep but larger lake could be seen at the foot of the next 30ft (9m) pitch so Chas stoically removed his clothes and reverse jumared agonisingly into the cold water before a bracing swim took him to a large boulder decorated by a magnificent poached egg formation. He limped around over rocks but after 250ft (75m) the roof plunged into a debris-strewn sump at a depth of 548ft. (167m). (Fig. 26).

Throughout the cave the roof is determined relentlessly by the 30°.dip to the north, and the system is merely a series of vadose steps cut back from the roof bedding. The sump is an unexpected perched phreas although elsewhere on the expedition similar phenomena have been ascribed to a rapid, recent uplift. The sump in Agim Tem could however be merely due to structural control and further exploration of the area is needed before any conclusions can be drawn. A major cave system undoubtedly exists in the vicinity and Agim Tem is only an overflow system for the present active streamway as yet unentered.

Because of the Independence celebrations in Telefomin on September 16th, the party quit the area without investigating other holes noted by Kevan's patrol in May. They are noted here for future explorers. (Fig. 25).

East of Agim Tem a track was cut along a ridge towards Tan Dabom and two sizeable shafts were seen, but many deep dolines were passed and not investigated. The great empty quarter south of the Agim was entered in the early stages of the search for the "big holes" above Urapmin. A track was started from the abrupt bend in the Agim headwaters and crossed a ridge to the east and into the headwaters of the Ok Ruun. It was now realised that the map was in error and the large dolines were **not** due east of the bend on the Agim. However only 2 Km away the Ok Ruun disappeared on the air photo and two days of cutting reached the sink where a large stream fell into a double shaft in creamy limestone as soon as the river left the shale and siltstone. The cave (**Ruun Tem**) still awaits exploration and its potential and resurgence are not known.

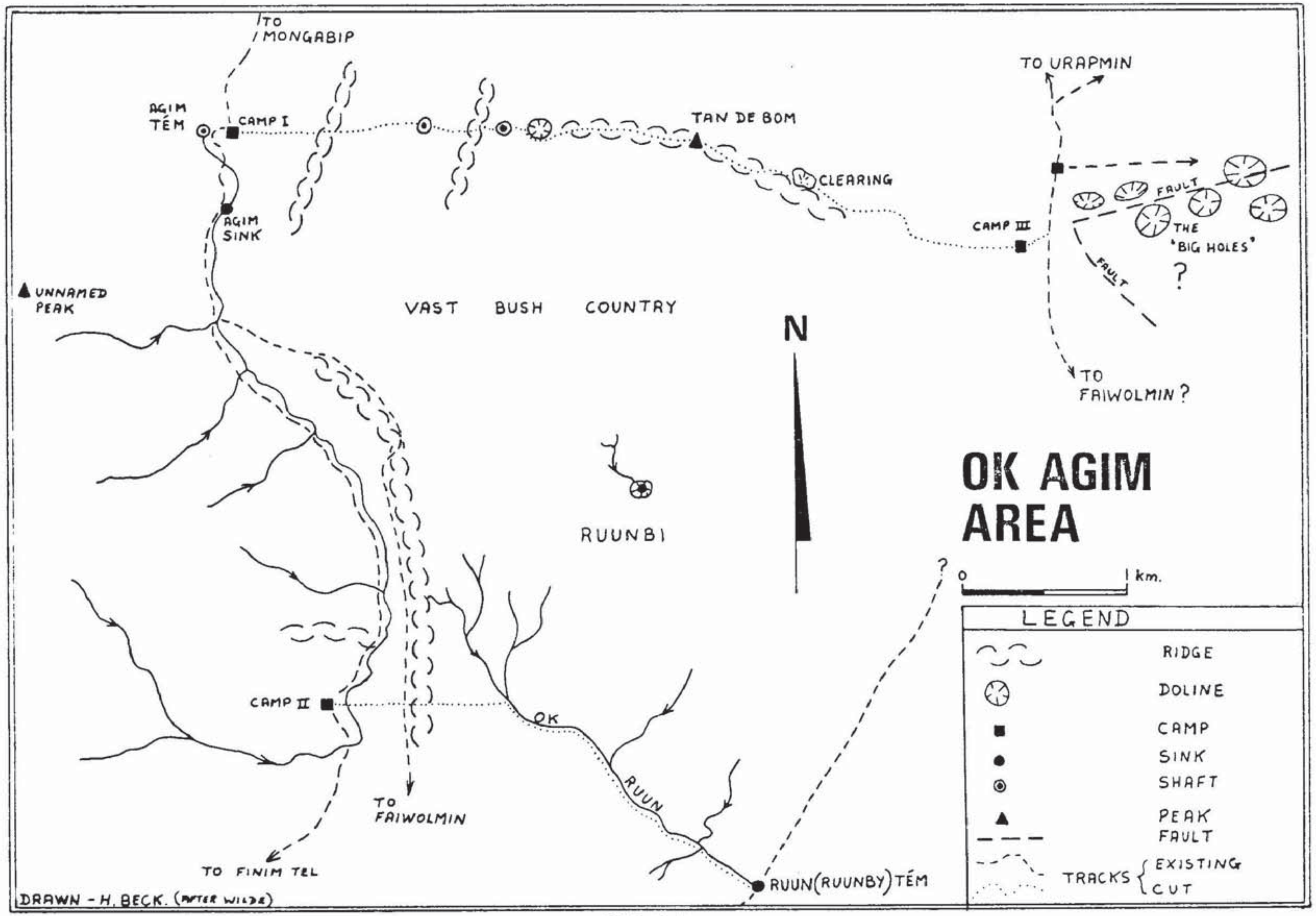

OK AGIM AREA
TO MONGABIP
AGIM TÉM
CAMP I
TAN DE BOM
CLEARING
TO URAPMIN
FAULT
CAMP III
THE 'BIG HOLES'
?
AGIM SINK
UNNAMED PEAK
VAST BUSH COUNTRY
N
TO FAIWOLMIN ?
RUUNBI
0
1 km.
?
LEGEND
RIDGE
DOLINE
CAMP
SINK
SHAFT
PEAK
FAULT
TRACKS
EXISTING
CUT
CAMP II
OK
RUUN
TO FAIWOLMIN
TO FINIM TEL
RUUN(RUUNBY)TÉM
DRAWN - H. BECK. (AFTER WILDE)

FIG.25

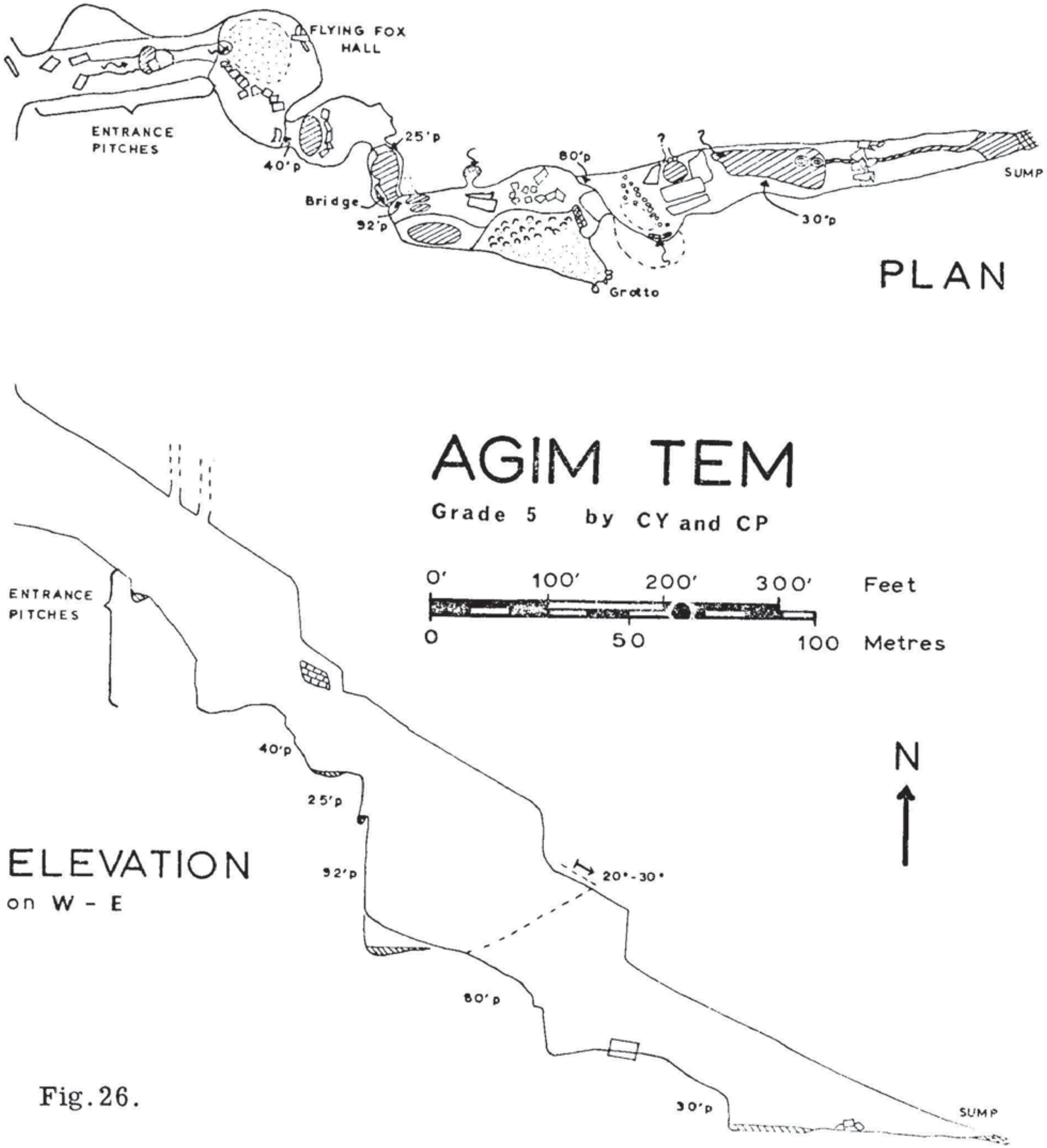

FLYING FOX HALL
ENTRANCE PITCHES
40'p
25'p
80'p
Bridge
92'p
30'p
SUMP
Grotto
PLAN
AGIM TEM
Grade 5 by CY and CP
0' 100' 200' 300' Feet
0 50 100 Metres
N
ENTRANCE PITCHES
40'p
25'p
92'p
20°-30°
80'p
30'p
SUMP
ELEVATION
on W - E

Fig. 26.

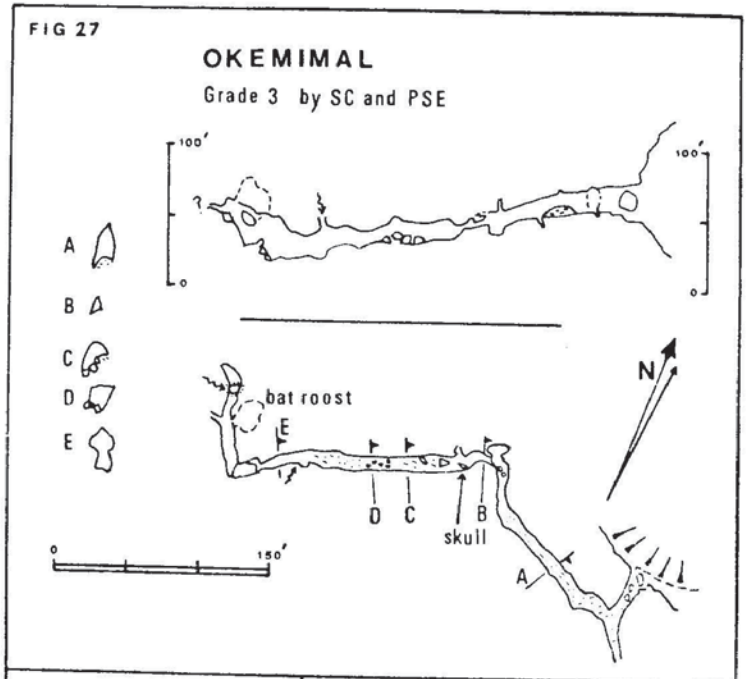


FIG 27
OKEMIMAL
Grade 3 by SC and PSE
100'
100'
0
0
A
B
C
D
E
bat roost
E
D C
skull
B
A
N
0 150'

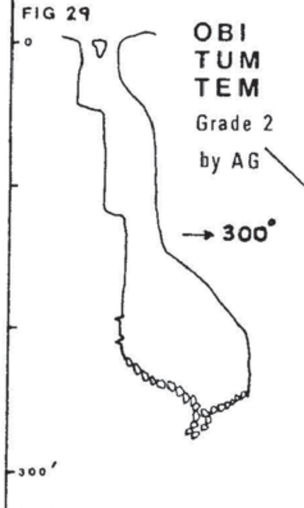


FIG 29
OBI
TUM
TEM
Grade 2
by AG
0
→ 300°
300'

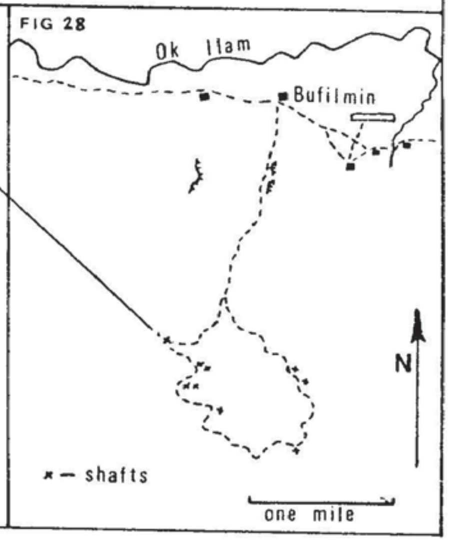


FIG 28
Ok Ilam
Bufilmin
N
× — shafts
one mile

THE TIFALMIN VALLEY – D. Brook and S. Crabtree

The lake deposits

About 600ft (180m) of a sequence of alluvial clays, cobbles and plant beds is exposed in the Ilam valley. The Tifalmin villages are sited on a plateau at the top of the succession and the Ilam has cut a trench into the sediments which display three prominent terraces. The most complete section is seen at the massive landslip across the Ilam from Mongabip. Cracked cobbles are common in the upper beds and could be indicative of severe frosts in the Pleistocene.

The type and thickness of the deposit is similar to that in the Telefomin basin but at Tifalmin the topmost beds are 600ft (180m) lower in altitude, thus suggesting less uplift of the Tifalmin valley floor than that which has occurred at Telefomin. The northern side of the Tifalmin valley has been uplifted considerably to create the upper Ilam Gorge and leave the tributary Aiyang Creek hanging at the top of the alluvial beds.

The Caves

Many rock shelters and burial caves were shown to the expedition (see Anthropology Section) but the only large cave visited was **Ok Kemimaal (Okemimal Tem).** The roomy entrance is 2000ft (600m) above the alluvial plateau north of the Ok Ilam and the cave is a deserted phreatic conduit (Figs. 27 and 28). It is developed along two major joint directions and gradually closes down above a series of climbs. A calcited human skull was found beneath boulders 300ft (90m) from daylight and a large bat roost occupied a high level cavern at the end of the cave although few bats were in evidence on our first visit. The fauna collected (see Biological Report) suggest the system is contemporary with Selminum Tem. Several percolation streams enter the tunnel via small vadose inlets but the main phreatic development must predate uplift, and deepening of the Tifalmin valley.

Another cave **Kabim Tem** was shown to Petar Beron and Phil Chapman during their biological investigations. It discharged a stream depositing tufa cascades and the entrance was an imposing arch, inside it dwindled quickly to a choked sump. A third cave is known to the villagers of Mongondabip but time did not allow a visit.

A few shafts were investigated on the south side of the valley above Tifalmin. A stupendous dip slope rises 5000ft (1500m) to the summit of the Bahrman Mountains and five pots were descended over a 1000ft (300m) altitude range (Fig. 28). All were choked but two 100ft (30m) pits await exploration. The most significant shaft was **Obi Tum Tem** which drops in three steps to a total depth of 280ft (84m). It is orientated by a fracture along the strike and the pitches lead to a steep and unstable boulder slope. A complex amongst the boulders at the lowest point of the floor did not provide a way onward (Fig. 29).

THE STAR MOUNTAINS – A.J. Eavis

The Star Mountains straddle the international border between Irian Jaya and Papua New Guinea, with the old border between Papua and New Guinea passing through the centre of the eastern part of the range. Their west-northwest to east-southeast axis is approximately 40 miles (64 Km) long with 30 miles (50 Km) of it in Indonesian Irian Jaya. The range is only about 10 miles (18 Km) wide and varies in height from little more than 1,000 feet (300m) ASL to nearly 13,000 feet (4,000m) ASL. Main peaks in Papua New Guinea are Capella at 12,500 feet (3,800m) and Scorpio at 12,250 feet. (3730m). In Irian Jaya Mount Juliana is 15,400 feet (4,700m) with a permanent ice cap.

The area had been visited by Europeans on two previous occasions, the first being the Australian Star Mountain Expedition in 1965 (Sheppard 1965) and the second a botanical expedition from the Department of Forests, Lae together with Australian scientists just before our expedition in 1975.

The rainfall of the main mountain range is unknown, the closest meteorological station being at Tabubil with others at Telefomin and Green River to the north. It must however be in excess of 200 inches a year and could be twice this figure, since the range gets both the northeast and southeast monsoons. There is some evidence to suggest a lower rainfall on the highest peaks but this is not certain. It is known from this expedition and previous ones that night frosts regularly occur over 10,000 feet (3000m) but there is no real evidence for active frost weathering below about 12,000 feet. (3650m). During early November when this expedition was in the area typical weather was clear very early morning, then cloud until afternoon and then rain until after dark.

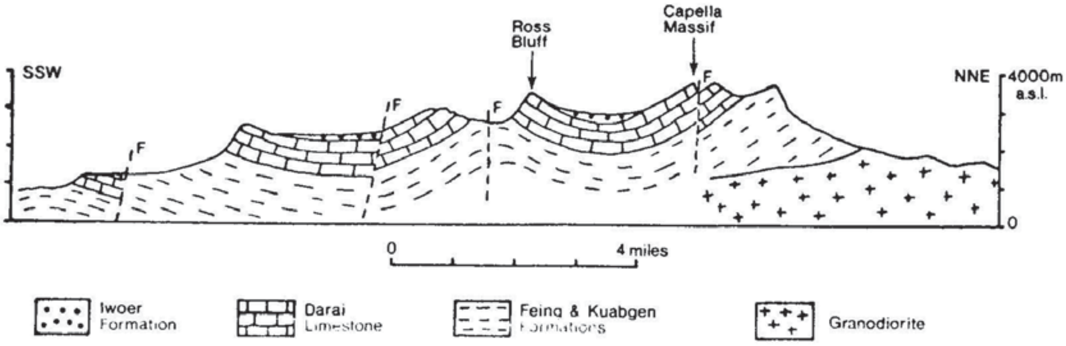
The foothills are vegetated with lower mountain forest, typically southern beech with an undergrowth including Pandanus and bamboo. At about 8,000 feet, (2500m) but very variable with position, moss forest started and gradually developed from a thin coating to dense moss over stunted, gnarled trees with thick moss on the ground. On the northern approach to the Star Mountains one area like this had undergone a recent fire that made an extremely depressing scene. Above the moss forest dense scrubby heathlands of a privet type bush developed with grasslands and stands of conifers. This was the altitude of temperature inversions, where enclosed depressions tended to trap heavy cold air and produce huge areas of grasslands and occasional tree ferns. Above this on the summits was Alpine vegetation with a lot of bare rock outcrops.

By far the most important rock type in the Star Mountains is the Darai limestone: this is 3 to 4,000 feet thick with a top rich in fossil algae. It overlies the Mesozoic Keing and Kuabgen groups of siltstones and sandstone or dark calcareous shales. The Mesozoic rocks outcrop to the north and south of the range and also to the west of the Berero Pass (not shown on the geological map). The limestone is overlain conformally by the Iwoer formation of black calcareous mudstones and sandstones: these were only seen to the extreme east in the headwaters of the Ilam.

The range is formed on an anticline (a staggered continuation of the Muller anticline) with both sides of the anticline turned up to form a north and south syncline. Some faulting has taken place along the anticlinal axis and a joint pattern has developed normal to it at about N45^0 E (mag). The upturned limb of the anticline to the south has an abrupt termination of the limestone which forms the Benstead/Benkwin Bluff "limestone barrier". There is some evidence that these 3 to 4,000 feet (1,000m) walls were fault initiated then scarp recession has left them in their present position. To the north the upturned limb of the anticline terminates against strongly folded Mesozoic, contact metamorphosed and andsitic flow rocks. North of this is a large granodioritic batholith clearly discernible on aerial photographs. Several other granodioritic outcrops occur and in the region of the Berero Pass basic igneous dykes infilling joints were observed.

The supposed tectonic history is of the plutonic intrusion acting as a rigid mass allowing the centre block to uplift intact with longitudinal fault system to each side. The uplift must have occurred in stages probably over the last 5 or so million years and been accompanied by further igneous intrusions. The intrusions have been dated as Pliocene and very between 2 to 5 million years. (Geol. Survey P.N.G. 1974).

Fig. 30 Modified from Shepherd (1965)



The foothills were characterised by huge landslides; one to the south near Kauwobip can be measured on the aerial photographs as 1600 x 500m. To the north above Busilmin another huge landslide in the distorted Mesozoic shales had blocked the Ban River. There is very vigorous erosion under the prevailing climatic conditions in areas where shales, marls, siltstones, sandstones, etc. occur. The modification of the foothills is taking place due to the removal of pleistocene deposits which were laid down during the intense physical weathering that must have occurred under glacial and periglacial conditions in the mountains. Below Busilmin there was evidence for an ancient lake bed that could well have been formed under similar conditions to the one at Telefomin/Tifalmin. Several boulders were observed in the area over 10m in diameter, though they appeared to have been transported by water. Rivers on the granodioritic batholith south of Busilman were meandering on a close – textural sub –dendritic pattern with straight sections joint controlled. These patterns made the intrusions clearly evident on aerial photographs.

In the Stars themselves the tectonics clearly controlled the valleys since they were either parallel to the axis of the anticline or along faults. The high permeability of the limestone probably makes them very resistant to fluvial action since all the water goes underground and virtually no flowing water was seen on limestone. The less permeable rocks, however, are susceptible to intense fluvial erosion.

In the Star Mountains there is much evidence for a fairly recent glaciation; this includes modified karst features, clearly defined moraines and many other glacial or periglacial type deposits. The most clearly defined moraines are at about 10,500 feet (3,200m) indicating a fairly small ice field, but did previous glaciations exist? Verstappen (1964) gave evidence of only one and further said that the mountains had not been uplifted to Alpine heights before the glaciation. Sheppard (1965) supported this view and offers no evidence for previous glacial action. Recent dating of igneous rocks however, suggests that the uplift might well be older than expected and hence previous glaciation could have taken place. Ice fields would have been extensive and down to lower than normal altitudes owing to the very high precipitation in the areas. A similar situation exists in New Zealand where almost tropical vegetation exists within feet of glacial ice. Moraines would be large due to the probable high susceptibility of the limestone to frost action, but subsequent erosion may have destroyed much of the evidence.

Along the southern foothills below the Benstead Bluff and in fact further east below the Hindenburg Wall, travetine was being deposited to give a perched river situation. Doline karst was much in evidence at the lower altitudes. The topography of the Stars was complicated by much of the limestone of the Dokfuma plateau being covered by a relatively thin layer of impermeable rocks, so both exposed and covered karst existed.

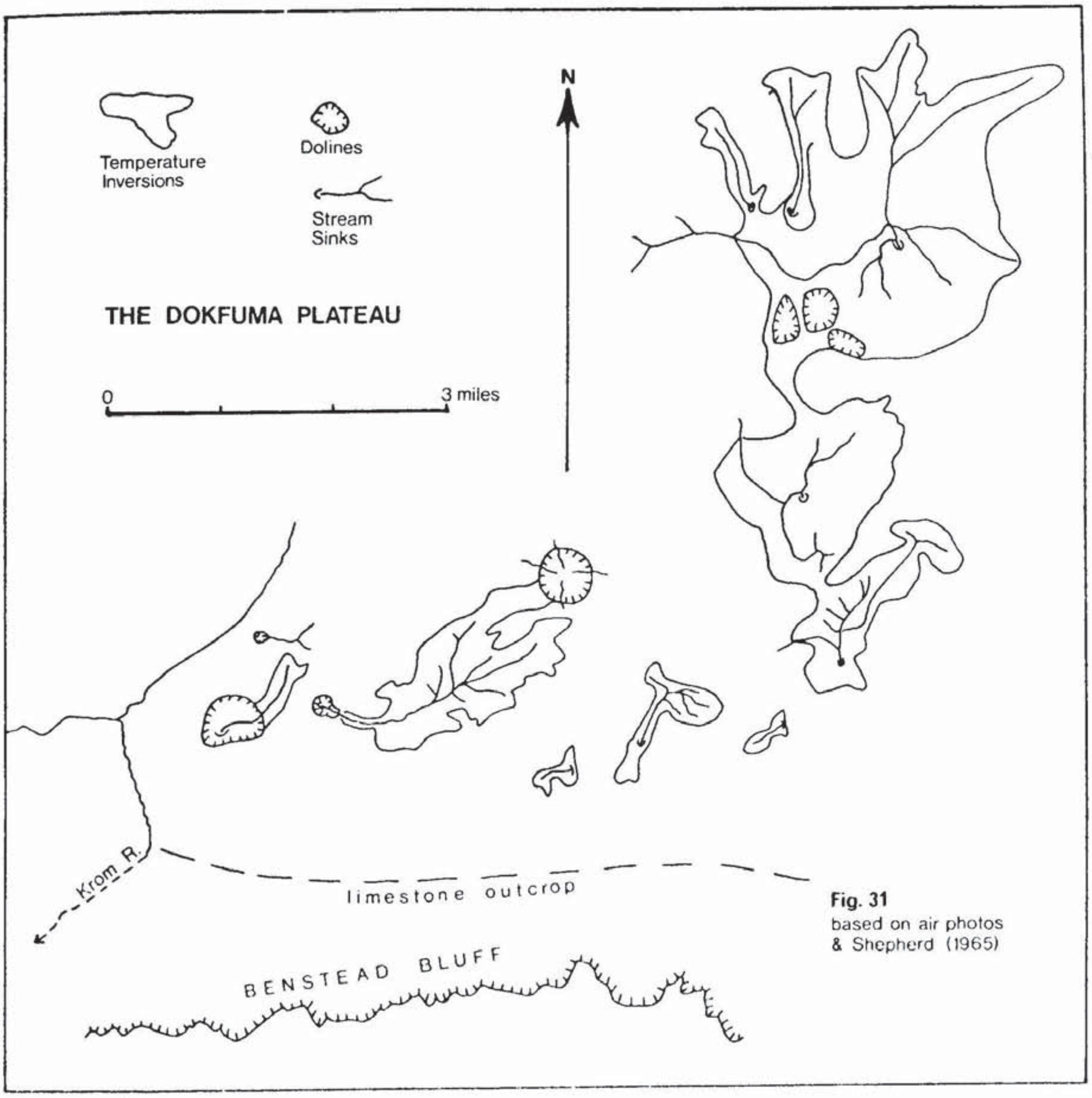


Fig. 31
based on air photos & Shepherd (1965)

Above the Benstead Bluff on the north facing dip slope uncovered doline karst was much in evidence at 10 to 11,000 feet (3000-3300m). This must be a prime speleological target since the whole of the thickness of the Darai limestone is exposed in the Bluff. The same is of course true of the unvisited Benkwin Bluff which had visible cave entrances part way up the 4,000 ft. (1300m) cliffs. Much of the Dokfuma plateau is covered Doline karst, some of the dolines being particularly impressive.

Dolines 1 and 3 are both about half a mile in width and over 300 feet (90m) deep, and both take consierable amounts of water but are both choked. Number 2 is smaller in diameter and only about 250 feet (75m) deep with an unenterable subterranean inlet for the stream that sinks in the bottom. Massive limestone is only visible low down in the feature and sandstones and shales form the upper walls. To the east and northeast of the plateau, dolines of varying sizes occur, grassy basins, a small polje and an area of pyramid and doline karst join to form a complex over 3 miles (5 Km) long. This area is in one of the largest temperature inversions in Papua New Guinea, and when visited by the expedition was thought to be a grassland paradise after the months of dense bush walking.

A feature called sink 6 by Sheppard (1965) consists of two depressions with swampy alluvial floors connecting together by a neck of alluvium. The water sinks in fissures in sediment or small turgid pools.

The polje to the north has a grassy alluvial floor a half a mile square entirely surrounded by steep sided hills which rise to 800 feet (270m) above. Four valleys unite in the polje and all water drains subterraneously through the limestone that composes the lower parts of the feature. Streams of two north west tributary valleys do not reach the main part of the polje but run into sinks in the valley floors. The most northerly of these sinks in the foot of a cliff with a tiny passage, significant draught and gurgling noise below. Much effort was put into engineering an entrance but it was in vain. To the north east a stream entered the polje via a waterfall, then joined another stream resurging from boulders and flowed across a grassy area to sink in a pool at the foot of a limestone cliff showing evidence of faulting. Around the perimeter of the polje floor where the alluvum meets the limestone, many small shafts and swallets were investigated; although one went to a depth of 50 feet and the others were well developed with stalactites and flowstone, no significant caves were entered. Some interesting troglobites were found however in these the highest caves of the expedition. It looks as though much of the polje floor becomes inundated during periods of heavy rain: blockage of the subterranean outlets by driftwood, etc. was much in evidence which will aggravate the situation. This polje doline sink system of the eastern Dokfuma must have been initiated by either subterranean collapse or more likely surface rivers downcutting through the overlying impermeables until the permeable limestone was reached.

In the east Dokfuma plateau at about 10,000 feet (3,000m) bowl shaped dolines, with grass covered pyramid shaped hills in brown crystalline limestone bounded the Capella ridge. Above 11,000 feet (3700m) on the ridge bare limestone was much in evidence with grikes, solution pipes and other open joints modified by the N45^{0}E main joint direction. This lapies karst must have been modified by glacial or periglacial action and on the highest parts there was much evidence of frost shattering. The pinnacles of limestone were hard crystalline and had extremely sharp karren making barefoot walking very painful.

Most of the plateau had been affected by a relatively recent fire that seemed to have spread up from the northern slopes and has removed most of the scrub vegetation over large areas. Aerial photographs taken now would look very different to the existing ones due to the increase in the rock exposures.

The caves that must exist to drain an area with such a high rainfall and no surface run off are illusive. Faulting and glacial action are obviously detrimental to finding enterable caves, but it was felt by the small team in the area that deep caves could be found in the Star Mountains. If, as Sheppard, suggests, the subterranean waters drain east along the anticlinal axis, then some of these caves will be very long as well. It may be that looking in areas of the Stars where the limestone has been exposed longest might prove rewarding as many of the caves formed since the cover was removed must be juvenile. An obvious place to look is behind and along the top of the Benstead and Benkwin Bluffs where aerial photographs show deep dolines.

THE CAVES OF FINIM TEL – D. Brook

Below the southern scarp of the Bahrman Mountains the trade route between Tifalmin and Bultem crosses an extensive shale outcrop where the Finim River rises. Beyond the Finim Tel clearing the river sinks into the top beds of the Miocene limestone which then rises steadily to an abrupt cut off at the Hindenburg Wall. The Kam, Kaakil, Bitip and Feram rivers also sink similarly at the base of the great saucer, 30 sq. miles (80 sq.km) in extent, behind the Hindenburg Wall (Fig. 32). Dominating the scene are the twin 10,000ft (3,000m) peaks of Aiyang and Fugulil. Aiyang is the highest point of the Bahrman escarpment due to a further repeating of the Miocene limestone by a thrust. It was climbed during the reconnaissance but nothing of speleological interest was found.

a) Fugulil Dabom

This massive block of limestone appears to be a detached section of the Bahrman thrust sheet. Its large summit area and shallow synclinal structure provide the limited drainage concentration which is absent on Mount Aiyang. Air photographs showed many dolines on Fugulil's summit so the attempt was made to site an advance camp on the peak, The first route chosen was up the Tumak valley, passing close to the resurgence and up the north west ridge of the mountain (Fig.33). Above the frustrating bamboo zone on the shale, the ridge was tough going as it undulated violently, and, although the summit was gained, the route was impractical for carriers to supply a camp. The second alternative was the improbable west buttress which towers over Finim Tel. It was steep but short and ropes were fixed on exposed verticals. Above 8500ft (2650m) altitude the moss forest began to give way to a 6ft (2m) tall, dense, springy scrub. This was to make progress on the summit plateau a nightmare because it clothed tower karst. Dolines were found in plenty and some had the weird tree ferns characteristic of temperature inversions, but all the caves were small and choked, though sometimes well decorated. On the fourth day of searching a 100ft (30m) shaft was found but jammed boulders prevented a descent. One other cave 150ft (45m) long was explored in doline F4 and further work may uncover larger cave systems but the previously unrecorded thick shales beneath Fugulil are a barrier to very deep cave development.

South of Fugulil

Our first investigation of the region was during the Eavis/Everett patrol in September. From the Girtoil camp they took a track north east and then south to a hut (Warumtamau) on the Warum River. Their guide (Ayangim) led them further south to the **Kam River Cave**; a tunnel 20ft (6m) high and wide cut through a ridge for 200ft (60m) to an exit. The river sank into logs amongst boulders in the tunnel floor but the active passage seemed small.

Further east the Migal River enters the clearing of Bobor Tel. On its east bank is an outcrop or boulder bed of "granodiorite" and it eventually sinks under a small limestone cliff with short blind caves nearby. In wetter weather it advances along a flood channel and inundates many small sinks. After several kilometres of southerly course it swings west into a dry limestone gorge with rock steps at the normal limit of flooding. The overgrown channel continues and receives many small streams from the north. At the native shelter of Migaltamau the new Migal turns south once more to enter a large polje where it and several other streams sink into mud.

Paul Everett and Phil Chapman returned to the Kam region in November to visit the postulated sink of the Warum River. New tracks were cut to give a shorter approach but the sink was choked by sand.

All the creeks to the north and east of Girtoil take underground courses through two thin limestone beds above the massive Miocene limestone. Caves in these beds were found to be choked or small but one 600ft (18m) long was located by a waterfall on the Warum River. It was presumably formed by the river but is now deserted and dry. It provided a convenient bivouac site and is an hour's walk downstream of the Warumtamau hut.

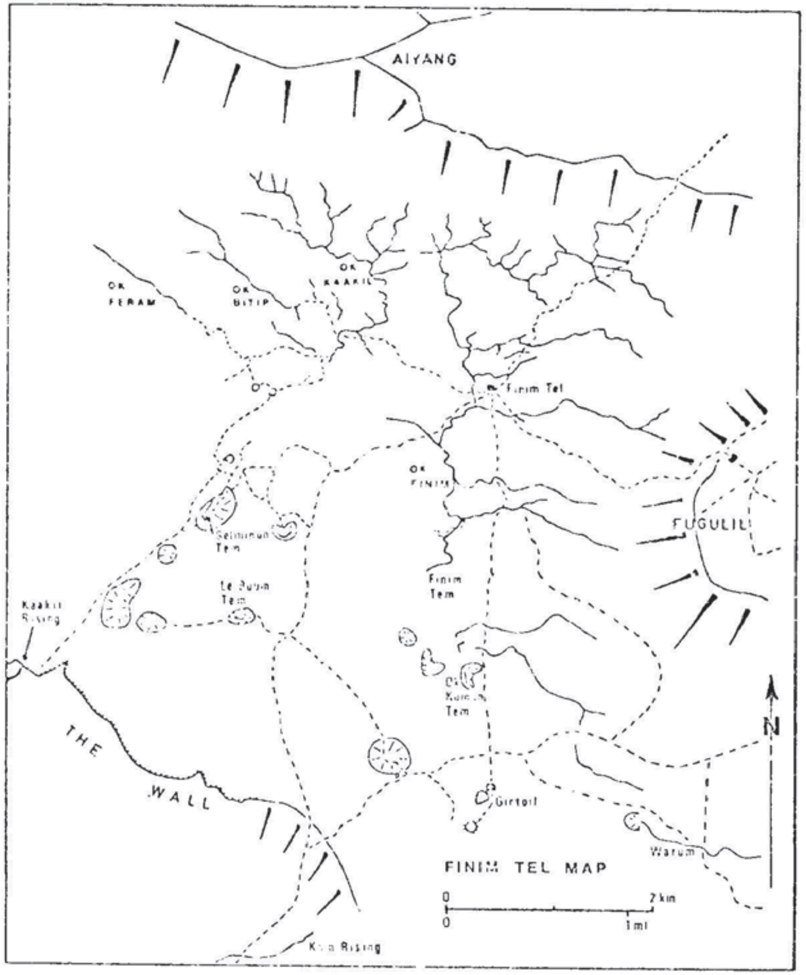
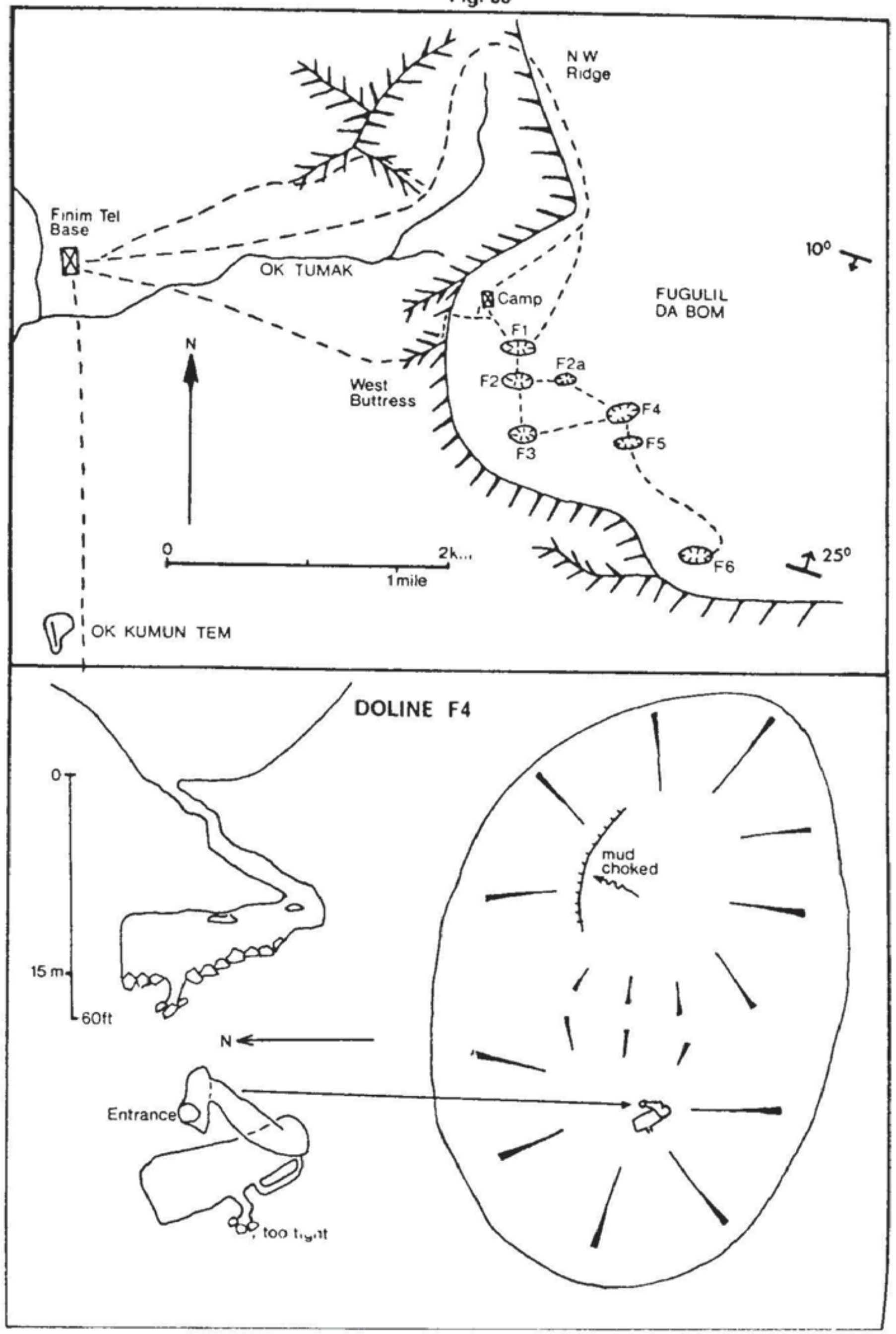

AIYANG
OK FERAM
OK BITIP
OK KAAKIL
Finim Tel
OK FINIM
FUGULIL
Finim Tem
Kaakil Rising
THE WALL
Girtoil
Warum
N
FINIM TEL MAP
0
2 km
0
1 mi

Fig. 32.

Fig. 33


Finim Tel Base
OK TUMAK
NW Ridge
Camp
F1
F2
F2a
F3
F4
F5
F6
FUGULIL DA BOM
West Buttress
10°
25°
N
0
2k...
1 mile
OK KUMUN TEM
DOLINE F4
0
15 m
60ft
mud choked
N
Entrance

GIRTOIL REGION – A.J. Eavis

When Kevan and Howard cut the track to the large pair of dolines, the first of which they affectionately called "Girtoil", they stumbled across a 240 feet (72m) shaft about 70 metres north of the doline. Later on a promontory above this shaft, a camp was established to enable the descent of the two dolines and the exploration of the area to be made.

At the same time as Girtoil, the most northerly of the two dolines, was descended, a track was cut to the more southerly one: this was later named "The Sting" due to the abundance of stinging trees growing in the bottom. Both dolines had faults going through them and the Sting had a considerable draught issuing from boulders in the bottom.

Almost on the track between the camp and Girtoil itself was a 50 feet (15m) pothole called "Cassowary Pot" because of the skeleton in the bottom.

Several other shafts were looked at in the area and a couple over 500 feet (15m) deep, but no substantial horizontal development was found.

Girtoil (Fig. 35) is the most northerly of the pair of dolines shown clearly on the aerial photographs (Run 15) in the southeast corner of the Finim Tel plateau, and almost a mile from the Hindenburg Wall. The descent down a gulley in the north-west rim of the hole was just touching the side for its 250 feet. (75m) At the bottom a spectacular surprise awaited: the rope went straight down the centre of an elliptical shaft for a further free-hanging 120 feet (36m). A pendulum was necessary to get off at the top of this and explore the doline floor. The latter was covered with lush, rich vegetation including several varietes of stinging trees and plants. The largest trees were about 30 feet (10m) in height. All the sides were nearly vertical with bare limestone exposed on all but the northern wall. A fault cut the feature on the line approximately 330 degrees with what appeared to be a small throw. In the central bottom of the doline were vegetation covered boulders of considerable size. The secondary shaft was about 12 feet (4m) in diameter at the top and soon belled out to about 30 feet (10m) diameter. After 120 feet (36m) a landing was made on the top of a pile of boulders that led down to a draughting choke. An aven went up behind the entrance shaft to an indeterminable height.

The Sting (Fig. 36)

About 300 yards south southwest of Girtoil was an impressive feature with an almost circular entrance over 200 feet (60m) in diameter and all the walls overhanging except for the north-west side. A 400 feet pitch (120m) just touching the wall started in thick vegetation and then passed bare limestone for most of its length. The bottom was over 250 feet (75m) wide and 350 feet (105m) long with sizeable stinging trees and other lush vegetation in the non-shaded centre. The east and south sides were dry and vegetation free due to the massive overhangs above. A pile of boulders 100 feet (30m) high was below the main southern overhang and in the trough behind it against the wall draughting gaps in boulders were tantilizingly too small. A large cave must exist somewhere below. A fault made a straight diagonal line on the northern vertical wall and the same fault controlled the eastern overhang. A small stream sank in the centre in a small pool after spraying down 450 feet (135m) from the lip edge. An impressive hole but no way on.

The "240 feet" Pot

Just north of Girtoil the cut track crossed a circular entrance about 10 feet in diameter. After a few feet a rope belayed at the eastern edge hung free, then touched the wall for the last 80 feet. In the bottom was a boulder floor with no way on at a depth of 240 feet (72m).

Cassowary Pot

In an obvious depression on the western side of the track between the 240 feet pot and Girtoil is a 50 feet (15m) shaft about 15 feet (4.5m) in diameter. About half way down the shaft elongates and finishes in a boulder floor rift with bones of a cassowary scattered about.

Other Holes

Many other holes were looked at in this vicinity: a couple were over 50 feet (15m) deep but small and with no horizontal development. It was an area of big trees and fairly thin undergrowth, but the karst terrain prevented easy travel, since limestone pinnacles and deep open joints were numerous in a region riddled with dolines.

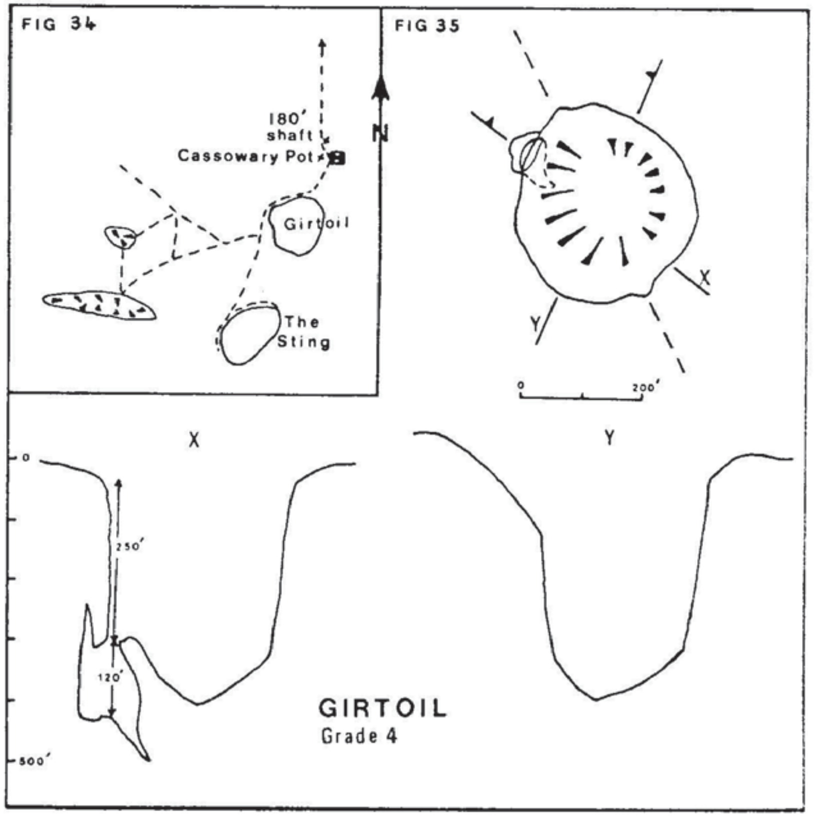


FIG 34
180' shaft
Cassowary Pot
N
Girtoil
The Sting
FIG 35
X
Y
0
200'
X
Y
0
250'
120'
500'
GIRTOIL
Grade 4

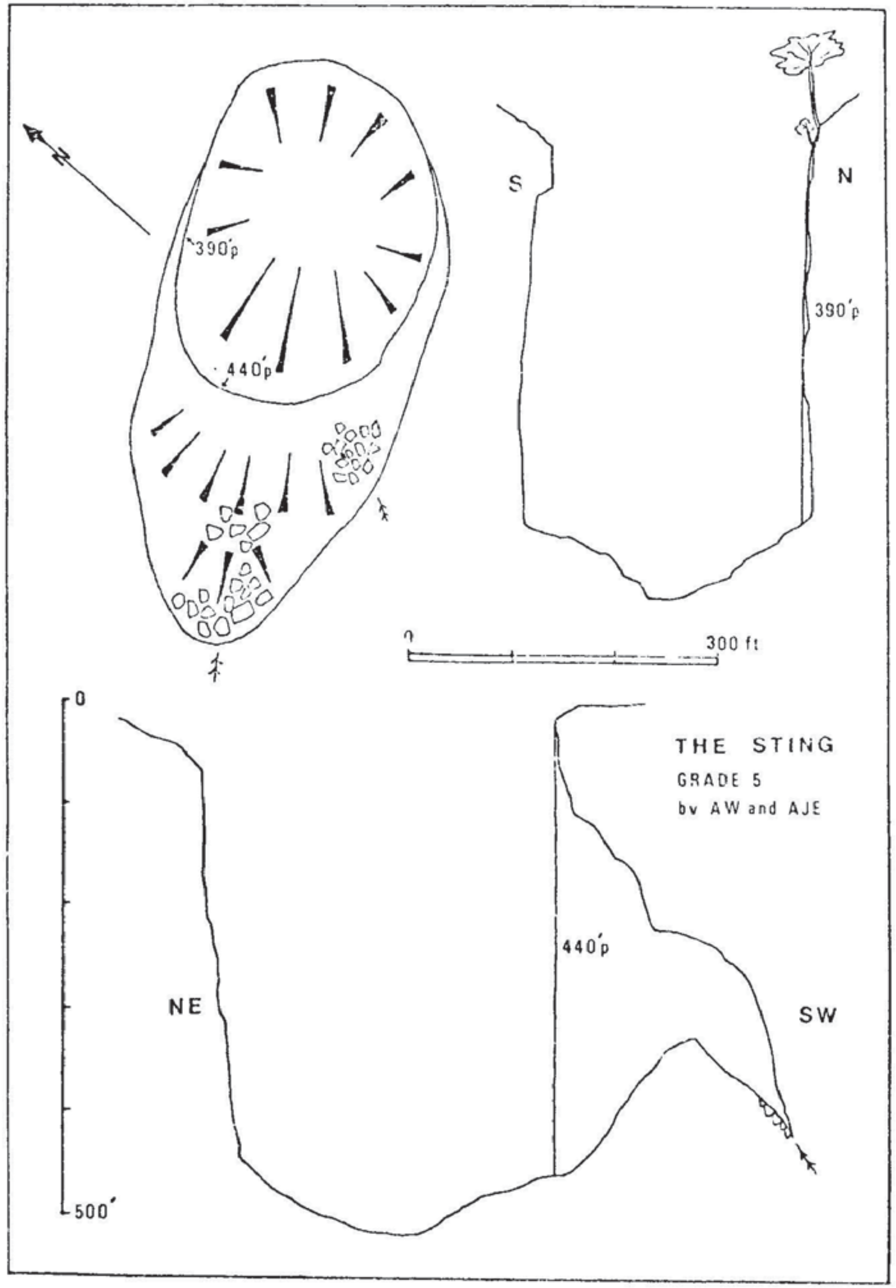

N
390'p
440'p
S
N
390'p
0
300 ft
0
500'
THE STING
GRADE 5
by AW and AJE
NE
440'p
SW

Fig. 36.

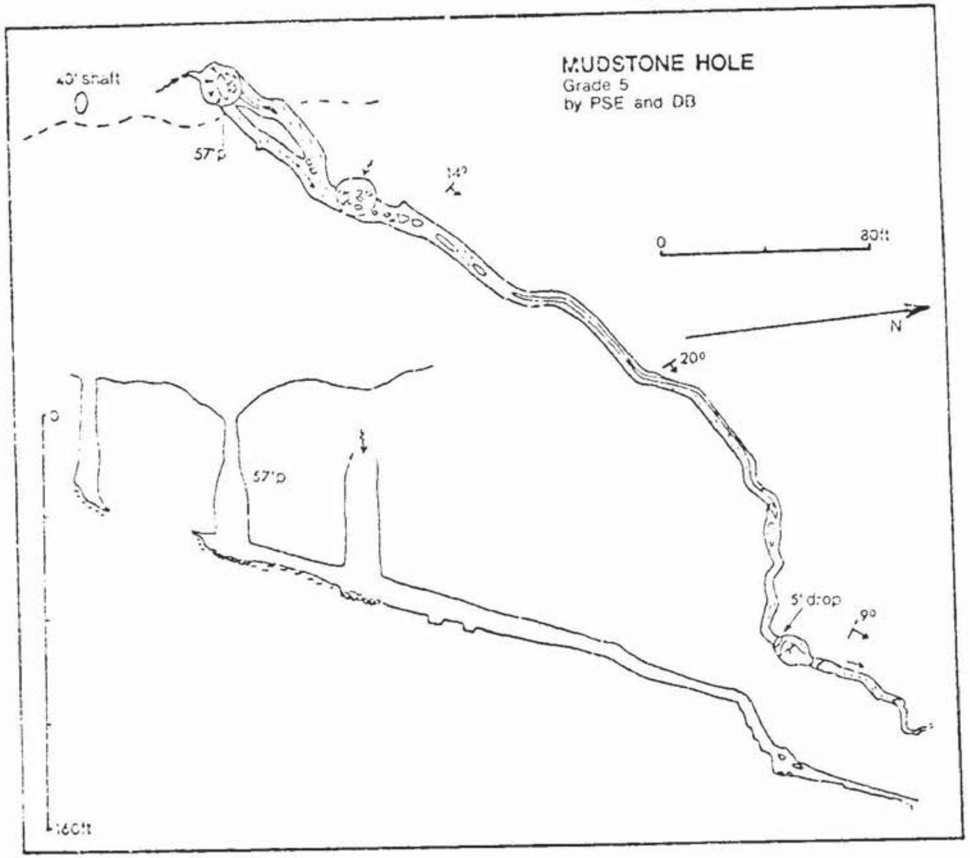

MUDSTONE HOLE
Grade 5
by PSE and DB
40' shaft
57' p
14°
0
80ft
N
20°
57' p
5' drop
9°
0
160ft

Fig. 37.

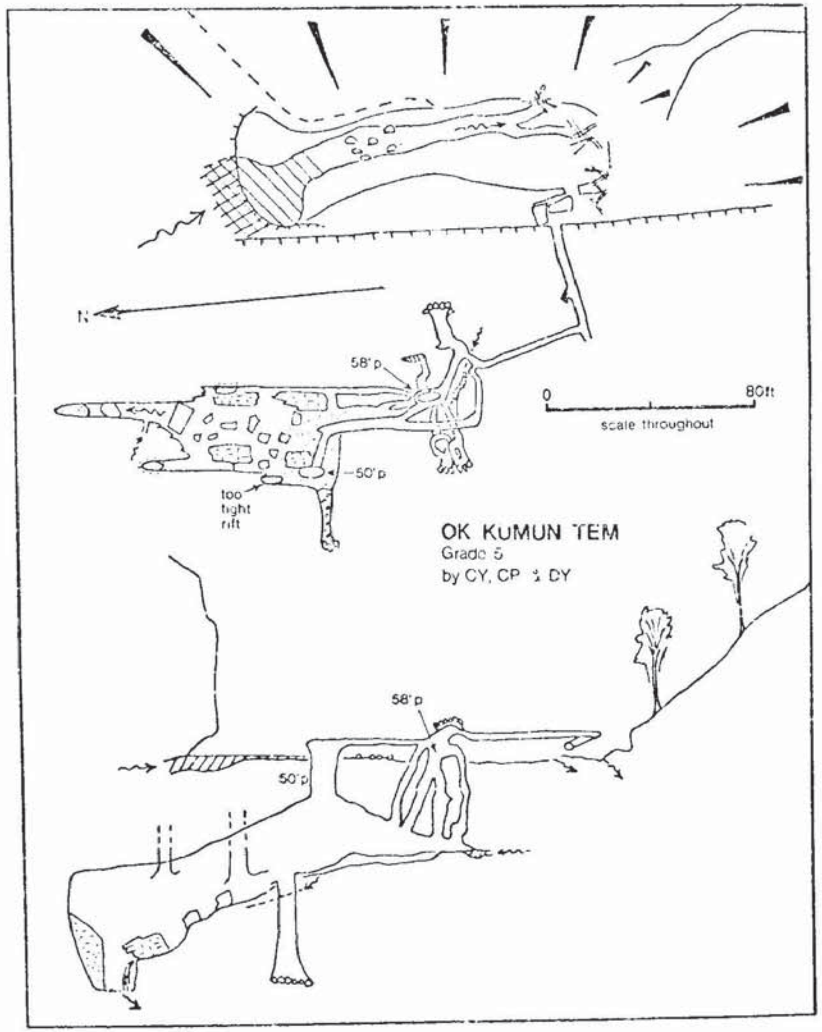

N
58' p
0
80ft
scale throughout
50' p
too
tight
rift
OK KUMUN TEM
Grade 5
by CY, CP & DY
58' p
50' p

Fig. 38.

Fig. 39.

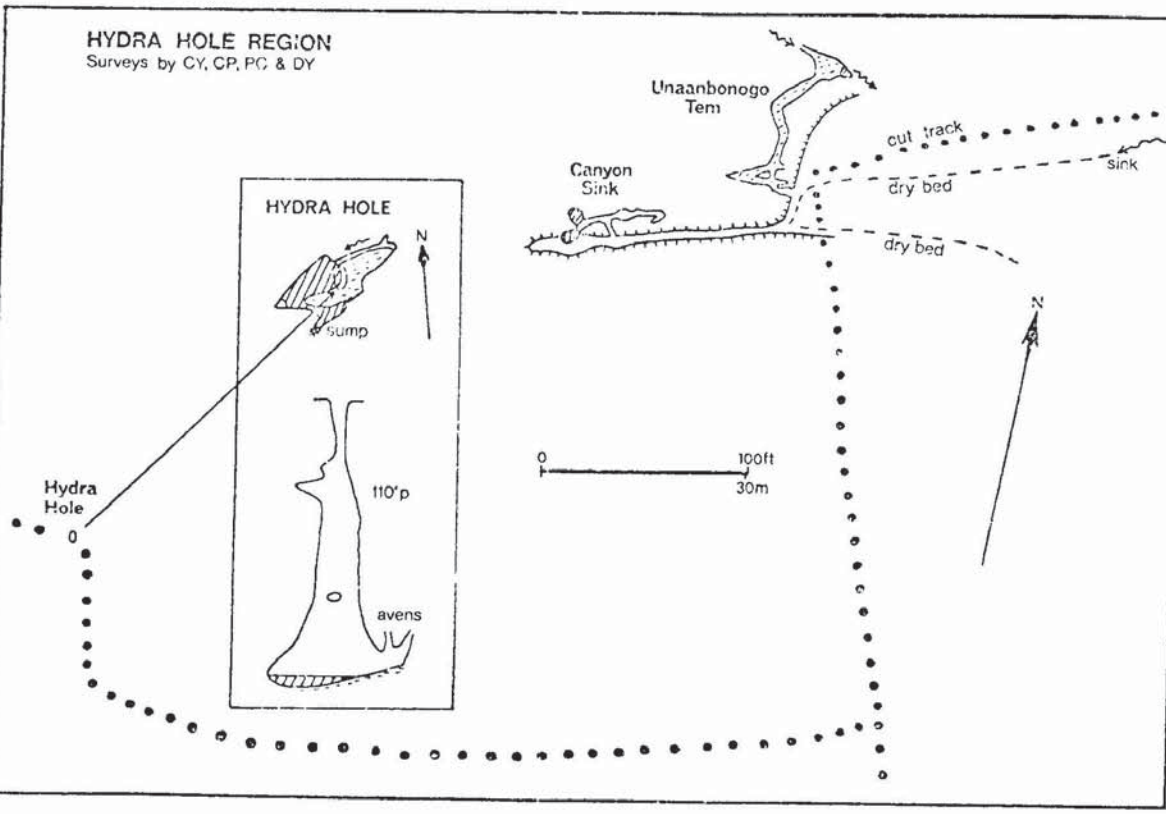
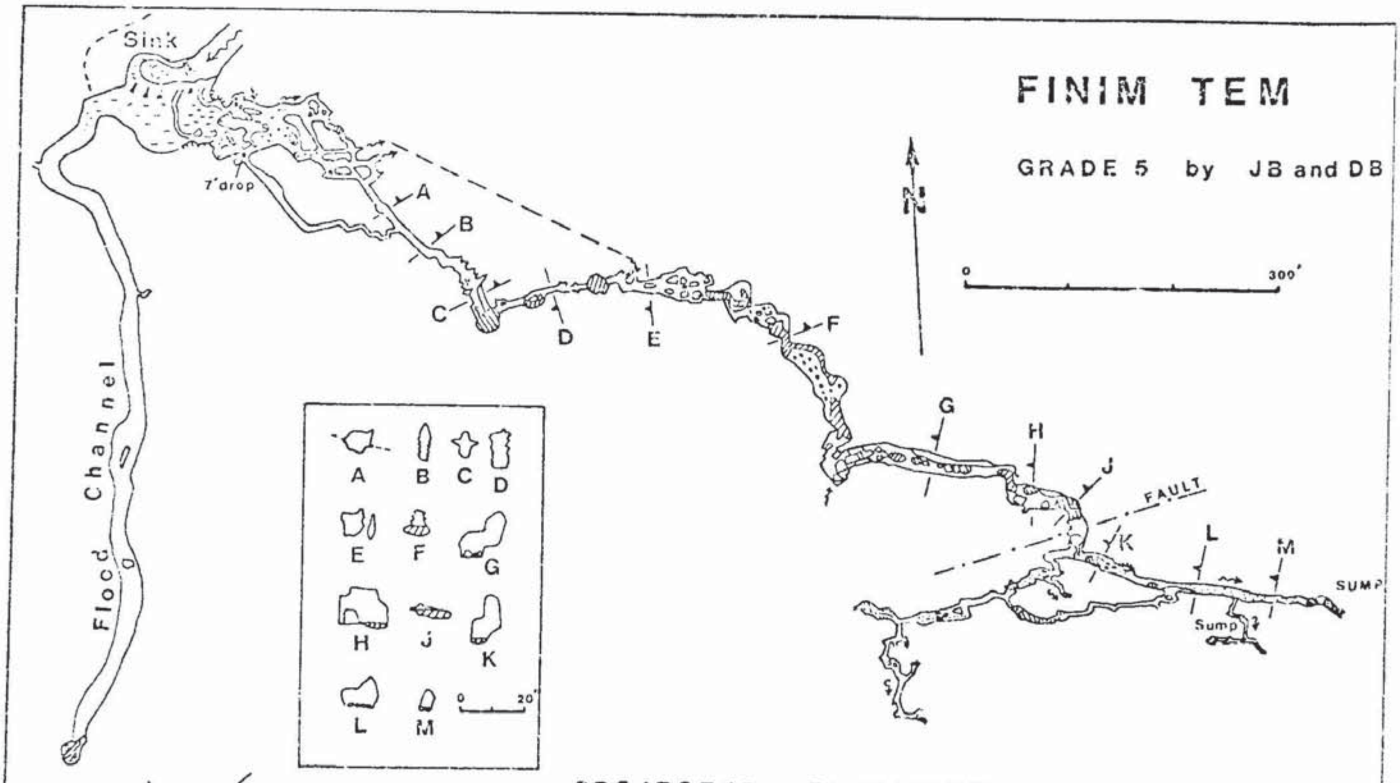

HYDRA HOLE REGION
Surveys by CY, CP, PC & DY
Unaanbonogo Tem
Canyon Sink
cut track
dry bed
sink
dry bed
HYDRA HOLE
N
sump
110'p
avens
Hydra Hole
0
0
100ft
30m
N

Fig. 40.


FINIM TEM
GRADE 5 by JB and DB
Sink
7' drop
A
B
C
D
E
F
G
H
J
FAULT
K
L
M
SUMP
Sump
N
0
300'
Flood Channel
A B C D
E F G
H J K
L M
0 20'
PROJECTED ELEVATION
0
100'

THE FINIM REGION – D. Brook

Mudstone Hole (Fig. 37)

An obvious shaft by the track between Girtoil and Ok Kumum Tem. The 57ft (17m) pitch intersects a bedding passage. Up-dip it is blocked by mud and is trending towards a nearby 40ft (12m) shaft. Down dip it provides stooping going to an aven chamber under a doline floored by logs. An oxbow runs back to the entrance shaft and gastropod shells and small mammal bones were noted. From the aven chamber the passage continues with false floors as a rift develops and the way narrows. A crawl ends at a drop into a round chamber with a bridge and mudstone cobbles on ledges. The way onward soon dwindles until it becomes impassable although the trickle of water can be heard splashing into a pool a short distance ahead.

The cave is formed in one bed of muddy limestone and is trending towards Ok Kumum Tem. Even in wet weather it only carries a small stream but obviously has taken much more water in the past.

Ok Kumun Tem (Fig. 38)

This huge doline, 250ft (75m) deep was a prize target during the reconnaissance. At its base a large river resurges from a sump and sinks into mud and boulders beneath an enormous linear cliff which continues to a choked flood sink. The river was assumed to be the Finim and a tubular entrance was noted behind a large slipped block near the sink. A log jam just inside was cleared by Andy Eavis and Dave Yeandle who entered a maze of phreatic passages in which the roar of the river could be heard. Pitches halted progress so they returned later with Mike Farnworth and a rope confident that a large river passage lay below. All that was discovered, however, was a shattered cavern and a sump. Passages at intermediate levels ended in boulder chokes where the roar of water was deafening. On a later trip the system was surveyed and some roof avens tied into pitches above. A last pitch remained to be investigated on a final visit but it also dropped into the shattered cavern. The water levels were lower, however, and the main stream was found to emerge from a crack and fall into a sump. A climable route was also found back up into the entrance series.

In very wet weather Ok Kumun Tem floods totally and the doline backs up 60ft (19m). Dye was put into the Finim River in moderate flood but no traces were seen at Ok Kumun Tem so it is presumed that the water is supplied by the two creeks to the north.

The creek immediately to the north was followed down to a muddy sink. Continuing west another valley was encountered where the next creek north resurged after sinking into a thin limestone bed. Beneath a small cliff Petar Beron found a small cave **Unaanbonogo Tem** (Peep Hole Cave). A crawl led to mud-floored joint passages with some formations. A wider T junction was encountered but an inlet vanished into a sump.

Downstream the dry creek bed developed into a narrow gorge 20ft (6m) deep leading to a cave and a boulder filled 30ft (9m) shaft bridged by fallen trees. **Canyon Sink** was short but roomy. It ended in a deep sump pool to the west and a mud choke to the east. Beyond it the dry valley continues with dolines but no open caves. **Hydra Hole**, was on the south flank of the valley, where a most unlikely 110ft (33m) shaft drops into a muddy cavern with a deep sump at the same level as that in Canyon Sink. To the southwest is an undescended 70ft (20m) shaft and a short cave remnant found by Phil Chapman (Fig. 39).

Finim Tem (Fig. 40)

Because of its presumed connection with Ok Kumun Tem, the Finim sink was not high on the list of priorities. It was finally reached after many false starts, by following the second creek south of Finim Tel on the track to Girtoil until it met the Finim. The latter was then pursued until it sank into logs and mud. A dry valley continued, trending slightly uphill, and ended in a wide choked pot.

Opposite the sink, a wide opening led to a dry bedding cave strewn with logs. A few were extracted by Jon Buchan and Dave Brook and an 8ft (2.5m) drop revealed to a lower series of passages. In a maze of oxbows a small stream has migrated downdip and vanished into very immature passages. The obvious route soon enlarges into a fine single channel to a climb into a pool. A muddy passage to the west is an oxbow connecting back almost to the entrance.

From the pool a joint passage enters a wider section created by blockfall and continues to the most entertaining obstacle in the cave – an overhanging drop into deep water. At the end of the joint the stream, lost earlier in the cave, rejoins the main channel from an impassable passage. A chaotic boxwork of joint passages follows and the cave lowers to a crawl and low airspace pool which briefly halted exploration. Ahead is a further blockfall in a large descending canyon and two more deep pools. The last is a near sump and beyond it the West Inlet is the largest side passage in the cave. The trunk route soon ends in a sump, which was still descending after a dive of 7ft (2m). Back on the left a tube ascends 15ft (4.5m) to a perched sump pool which was bailed and led to a complex of passages choked by flood debris.

The West Inlet ascends quickly and a flat-out oxbow rejoins the main passage downstream. The deserted inlet continues to a mud choke but in the roof is a series of abandoned outlets which subdivide into small crawls.

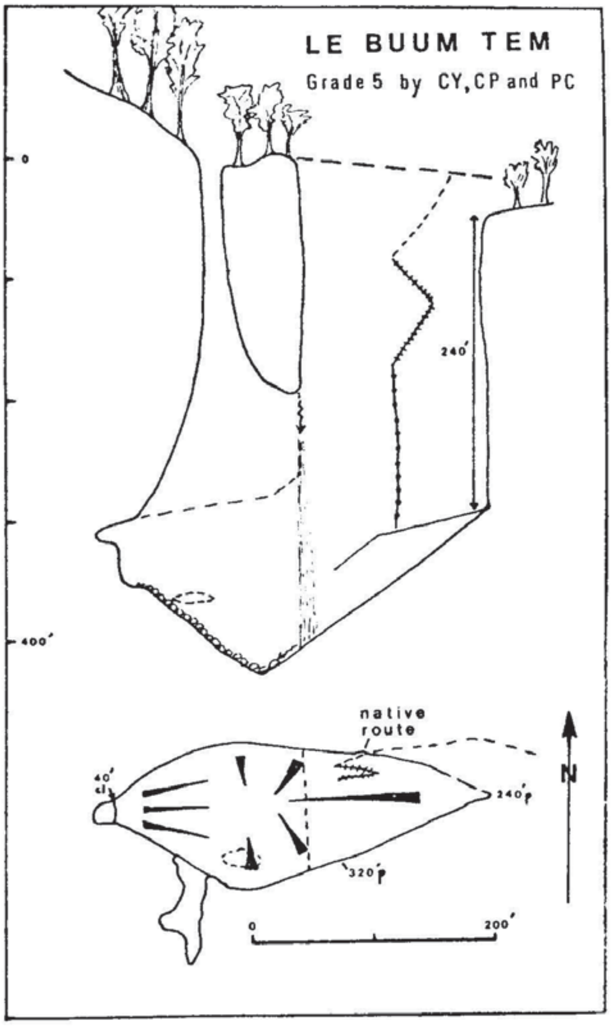
West of the Finim

The track from Finim Tel towards Tabulil and Bultem crosses the Finim and rises up a steep shale ridge to a shelter. The path follows the ridge and descends to a shale bridge between two valley systems which are linked by **Track Cave**. A stream sinks into a low entrance in the north west valley but there is a larger opening nearby which was the original sink. It soon joins the streamway in a 6ft (2m) high passage lowering to a crawl emerging at the resurgence. Total length 200 ft (60m).

Le Buum Tem (Fig. 41)

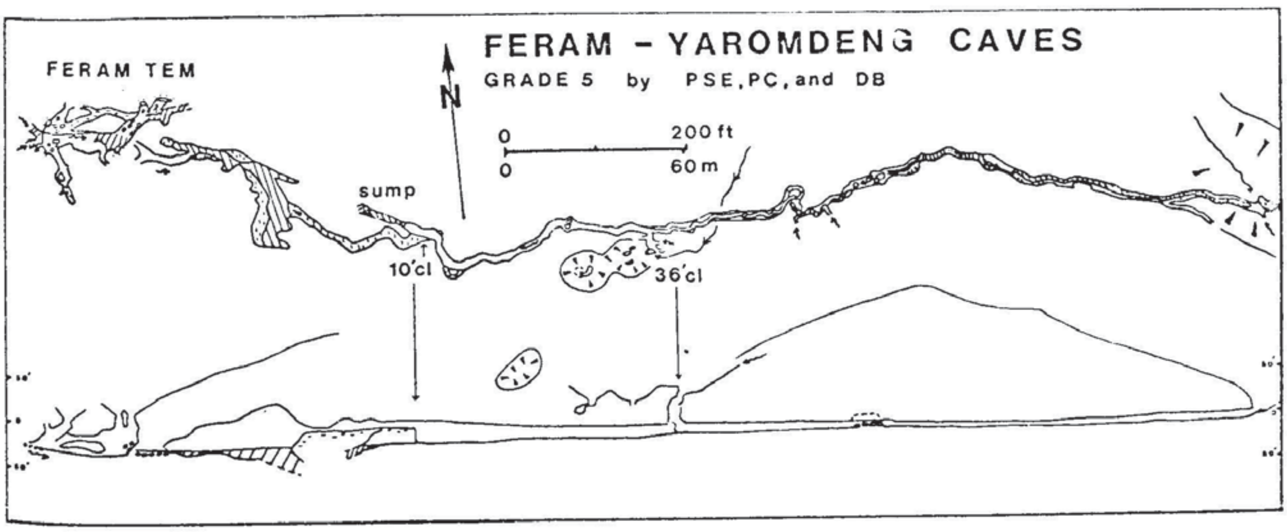
An old hunting track branches off the Tabulil "road" towards this great pit where the Tifalmin and Wokkamin used to hunt flying fox. The track was reopened on the reconnaissance and a bivouac established in the next doline during the main expedition. Our chief Tifalmin carrier (Tailok) demonstrated how the great pit could be descended on vines but we preferred to trust our ropes and rig the shortest pitch of 240ft (72m) to the floor of a great cavern. The small stream sank into rubble and a side passage soon closed down. An exposed climb only led to a small alcove and an aven in the cavern roof provided a magnificent alternative entrance pitch.

Fig. 41.



LE BUUM TEM
Grade 5 by CY, CP and PC
0
240'
400'
native route
40' cl
240'p
320'p
N
0
200'

Fig. 42.



FERAM - YAROMDENG CAVES
GRADE 5 by PSE, PC, and DB
FERAM TEM
N
0
200 ft
0
60 m
sump
10'cl
36'cl

A track had been started from Le Buum Tem towards Girtoil on a 130^0 bearing. It passed through a chaotic region of tower karst and dolines where Howard Beck discovered a short cave.

Another hole associated with rapidly developing karst was explored by Mike Farnworth and Jon Buchan by the path to Selminum. **Tower Pot** was a 70ft (21m) shaft in a shale-sided doline but it showed the presence of rapid fissure enlargement in massive limestone – the first stage of tower karst. To the north of Tower Pot prospecting in a sea of dolines unearthed the unusual **Shale Cave.** An extensive shallow depression shelved down to a cliff in massive shale and an opening into a short roomy cave. It was formed by collapse of the shale, and limestone only outcrops in the floor at the lowest point where a fissure is choked by shale debris.

The Bitip Caves (See Selminum Tem Survey)

A chaotic area was apparent on the air photos north of the Kaakil River and subsequent exploration revealed a large river sink and a complex of caves. The Bitip River vanishes into boulders but high in the ridge above is a fossil tunnel the **Upper Bitip Cave.** A steep slope descends to a chamber and a pot in the floor plunges into a choked lower cavern. The main tunnel divides but one branch soon terminates in boulder chokes close to the hillside. A further branch passage to the south is sealed by calcite and has a slippery pot of 30ft (9m) into a mud-floored rift. The high level tunnel penetrates the ridge to emerge above the tower karst in which the **Lower Bitip Caves** are concealed. The latter have many entrances but upstream all unite in a superb river passage ending in a boulder choke which can be forced until daylight at the Bitip sink is seen. Downstream the river roars through small passages into a white water sump. A maze of tubes becomes active in flood and ends in a boulder choke with a verbal connection with Archway Cave. The highest tube maintains a constant level between entrances as far as **Archway Cave** where the only way forward is a complex descent into a mass of passages which defy description. Boulder chokes prevent progress at each end of the cave. One connects with the Bitip Caves and the other is trending south beneath a high ridge of tower karst towards a remarkable valley. The latter has a steep headwall, is floored by loose boulders and short caves are present where the blocks meet the undercut retaining cliffs. It is a collapsed cave and downstream it quickly resumes the features of a normal valley cut in shale but with small caves in its limestone floor. Most of these caves are immature and mud choked but one is a short crawl to a waterlogged streamway with sumps in both directions. The channel only carries water in extreme floods and ends abruptly at one of the entries to the Kaakil Labyrinth.

The Kaakil Caves

In dry weather the Kaakil river promptly sinks as soon as it leaves the shale. Behind a log jam, the river roars down cascades in the **Main Sink** and enters a sump. A dry tube to the north becomes small and a larger passage to the south leads via a chamber to twin static sump pools.

In wetter weather the river advances and invades the river bed entrances to the **Kaakil Labyrinth.** In extreme conditions the labyrinth is flooded completely since it is developed 10 to 20ft (3 - 6m) below the flood channel of the Kaakil and the passages are limited in vertical range. Their complexity is illustrated by the survey (see Selminum Tem survey). The valley from Archway Cave enters the northern end of the Labyrinth and a wide, low passage soon meets the underground river cascading from a sump where the Main Sink water re-appears. Downstream the water normally seeps away into immature passages and a dry cavern is encountered with potholes going up to the surface. A long oxbow branches westward from the daylight cavern and has two fine examples of phreatic lifts. It also has an extension via a mud cavern to another pothole entrance near a small stream sink and a very tight crawl intersects a sumped streamway.

The main passage from the first daylight cavern passes through a pool (which quickly sumps in high water) to a T junction. Right leads to several exits into the flood channel but left opens up into a main conduit passing under two pots in the flood channel and a further junction with an old route from the largest flood sink. The tube continues south beneath more pots in the bush but eventually it splits into several levels and is choked by boulders in a faulted area. A dig emerged in a doline on the crest of an anticline.

Union Cave

At the end of the Kaakil flood channel a double decker entrance rejoins the river in Union Cave. The water resurges from a deep sump but the largest inlet passage only carries a small stream. It is a large tube which ends in a series of upper chambers and boulder chokes close to the Kaakil Labyrinth. The river flows in a canyon cut below the tube and passes under a daylight pit before a section of unroofed trench leads to the waterfall into Ok Tem.

Ok Tem (Ok Kaakil Tem Uneibo)

The waterfall was rigged as a strenuous rope pitch but future visitors are advised to use a 20ft (6m) ladder. Deep pools and scrambles over huge logs lead onward into a great canyon passage which continues with more pools and cascades. The last cascade is the largest and is best overcome by using an eyehole and a dry climb. The streamway is now a tortuous route through boulders and it is simpler to take the high road into a massive steep cavern. Scrambling down great blocks leads to a rock beach at the edge of an enormous sump pool.

Upper Ok Tem

South of Ok Tem entrance is a long narrow doline and a large cave mouth was found at its northern end. Above a boulder screen is a shaft to the surface and a series of squeezes into a wide low cavern. This remnant passage chokes but is trending towards a high level cave in the cliff above Union Cave (**Upper Union Cave**).

In the entrance chamber a side passage pops out on a shelf above the great trench of Ok Tem. A roof passage was visible across the gulf so a couple of logs were slung across and the airy bridge used to explore a mass of tube oxbows in the roof of the Ok Tem streamway but all of them eventually rejoin above the river passage. Further downstream inviting passages had been noted high in the roof and scaling and bolting were contemplated but during a flood a party dug in a doline with an enticing roar. They soon exposed a short shaft into a series of fossil tubes which were a continuation of those mentioned above. The **Aurora Tem** rejoined the roof of the Ok Tem canyon at two points and had been invaded by a small stream which gathers in the nearby passages of Selminum Tem. Prospecting in the dolines south of Ok Tem led to the descent of several shafts up to 100ft (30m) deep. All were blind however apart from one well decorated passage 100ft. (30m) long with a choked hole in the floor giving a total depth of 80ft. (24m).

The Feram Region

To the west of the Kaakil Caves and almost directly beneath Mount Aiyang, a large river was observed to sink on the air photos. Towards the end of the expedition Paul Everett was the driving force in exploring this region. Investigations began at the Keyhole entrance of Selminum Tem and nearby two impressive but choked open pots were found. Each was 50ft (15m) deep and a smaller pot dwindled to a tiny streamway at a similar depth. At the edge of the shale a stream sink (**Numeia's Folly**) was entered for 150ft. (45m) but it ended in a choke. A similar sink further west entered a walking size streamway which continued westward. It was named **Yaromdeng Tem** after the area. The cave had two short inlets and passed through a boulder chamber before a short branch led to a double aven. Here a damp and airy rope climb emerged on the surface at another sink which was the original route of exploration. The main streamway continues to the west and eventually sumps at shallow depth but a high level dry passage provides a bypass and shelves into a wide and gloomy canal. A swimming expedition revealed a massive lake chamber with no obvious outlet apart from a 17ft (5m) deep flooded rift (Fig. 42).

The elusive **Feram river sink** was finally located west of Yaromdeng. 300ft (90m) of low wide passage became very low and wet but open pits were found on the surface with the river rumbling enticingly below. The shortest of these were laddered and led to another section of the river passage. An oxbow and dry side passage were explored and many daylight shafts were noted. Downstream was a canal which must link with the Yaromdeng lake chamber in dry weather (Fig. 42).

Selminum Tem

Of necessity the following description is only a general guide to this most complex system. When the party of invalids were guided to the giant Selminum Doline, the cave they were shown was 80ft (24m) above the base of the depression on a ledge beneath a beetling cliff. This **Upper Cave** has a most impressive and superbly sited entrance and fire hearths point to its use as a hunting shelter. Inside the wide cavern has peculiar man-made pits (see Anthropological Section) and suddently decreases in size as it turns northeast. Two short crawls are succeeded by a mud chamber with masses of cave pearls in an upper passage, and a boulder chamber which was the original limit of exploration. A short dig by Tony White and Dave Brook gave a squeeze into a great black cavern with several offshoots. One of these was very well decorated and a series of interesting climbs dropped into a passage and 40ft (12m) pitch into the Great Rift of Lower Selminum Tem.

The invalids had noticed a wide low entrance at the base of a 400ft. (120m) cliff in the doline. It draughted strongly and inside a chaotic boulder slope swept down into a series of enormous chambers. From the second such chamber the Great Rift was later followed over mounds of slippery flowstone to the aven linking with the Upper Cave. The main route continued through a mud-floored wide tunnel until yet another great chamber was entered and an active inlet appeared.

Subsequently the tributary (Dee Inlet) was traced by Howard Beck up a series of rock ramps until it divided and ended in boulder chokes. When the passage was surveyed however, upper caverns were found and the chokes passed. All routes united in a high rift and muddy section which must sump in wet weather. The water, lost at the beginning of the inlet, was rejoined in a remarkable flat-floored streamway and eventually emerged from two roof inlets. A mass of dry side passages all led to another active aven with a 60ft (18m) pitch to a choked floor. Beyond the inlets, the tunnel was floored by soft stalagmite and reared up a fine cascade to a high aven with a passage visible 50ft. (15m) above. Poling and bolting attempts were frustrated by soft flowstone. Back in the oxbow region a flat out crawl was followed to a point where it was blocked by a boulder. A little hammer work allowed progress to the Hidden Inlet. Downstream was body-sized but upstream a succession of sporting climbs led to a well watered corkscrew where discretion forced a halt. This stream is also encountered in the Siren Squeezes – a small series of nasty crawls at the beginning of Dee Inlet.

The Dee Inlet stream crosses the main Selminum Tem passage to enter a bouldery lower series. The invalids named this cavern Warp Drive and tramped off over great ridges and mountains of sediment. After a quarter of a mile (400m) they realised that the "chamber" was, in fact, a passage when it expanded into the vastness of Copernicus Cavern. Here a slot under the wall and a climb bristling with chert, enters the Sump Series – a maze of tubes and streams. All the water unites in a 40ft (12m) pit into a flooded shaft.

Over the next sediment mountain beyond Copernicus is Kepler Cavern with a wealth of splendid mud towers. A sandy hole drops into Crater Series where a stream is encountered between sumps and a large aven communicates with the trunk passage above. Under boulders against the wall an unexpected crawl links with the Sump Series. From Kepler the massive trunk tube ascends past pebble capped sediment pillars to the Tycho Cavern where a confusion of passages radiate. One involves a traverse to a pit which drops 70ft (21m) into the Spacewalk. The latter is best entered via a steep boulder pile and is another massive tube which emerges 40ft. (12m) up the wall of Copernicus. In its floor is a pit and deep stream trench which both link with the Sump Series. An opening in the roof of the Spacewalk was reached by building a ladder. A series of tubes suddenly plummeted steeply into a deep static sump. The high road out of Tycho is Tranquility Oxbow and a narrow shaft in its floor is the Bonewells where a 70ft (21m) pitch intersects a system of tubes. A fossil sea-cow skeleton was found embedded in the limestone and the series sometimes floods – as the party collecting bone samples discovered. Downstream is a boulder choke which is close to the Spacewalk.

Most obvious of the Tycho exits is Moondust Oxbow (or the Moonwalk) – a low level alternative to Tranquility. At the lowest point is a slide into Rille Series where a small stream drops down a 35ft (11m) pitch. A fossil passage leads to the Sump Series via a rope climb while a small active crawl emerges in the deep floor trench of the Spacewalk. A dry roof tube also connects with the latter. The water falls into the flooded shaft of the Sump Series.

At the Moondust/Tranquility junction a scramble over blocks gains a wide ledge above a spectacular canyon – Hadley Rille. The great trench may be followed down into Rille Series, but it is best to keep to the ledge for 500ft. (150m) to an easy climb down. Opposite this point an opening was reached by pushing a log across from the ledge and prussiking up into Lumberjack Oxbow. The latter had some large gypsum crystals and re-emerged high above Tranquility. A low opening off the oxbow had a strong draught and a little digging produced a sandy crawl to Piranha Passage which was a flat-out struggle over fretted rock for 700ft (210m) to a drop and steep slope ending in a choke 40ft (12m) pot.

At the end of Hadley Rille is a fine grotto and the cave now becomes well decorated. From another grotto in Newton Cavern a side passage proved to be the first of eight entrances to several kilometres of maze passages – the Great Nebula.

By keeping right after the Newton grotto a pitch is encountered up a rather obscure passage. It drops in steps for 110ft (33m) to a muddy bedding plane. Crawls through boulders leads to the bottom of two separate shafts in Crab Cavern which is next to Newton in the trunk route, and was the scene of the accident. Through the muddy bedding plane is an oxbowed trench passage (Parallel Time Continuum) which ends at a high aven. A succession of climbs pop out in the floor of a gothic passage with startling black and white walls. It trends downhill through pools of liquid mud to a pitch and slope to a sump pool. Above the pitch is a most complex system of climbs and crawls which drop into a continuation of the sump and an active inlet which was forced for 50ft (15m).

The Great Nebula Series is also entered from a boulder slope above one of the floor shafts in Crab Cavern, where a short link meets Castor Street – a keyhole section down dip passage. It passes a window into the second floorshaft and ends after 700ft (210m) in a sump. Side passages near the sump choke with mud but a climb on the right wall enters a series of crawls (The Cord) which are the connection to the North East Complex and Six Ways Junction.

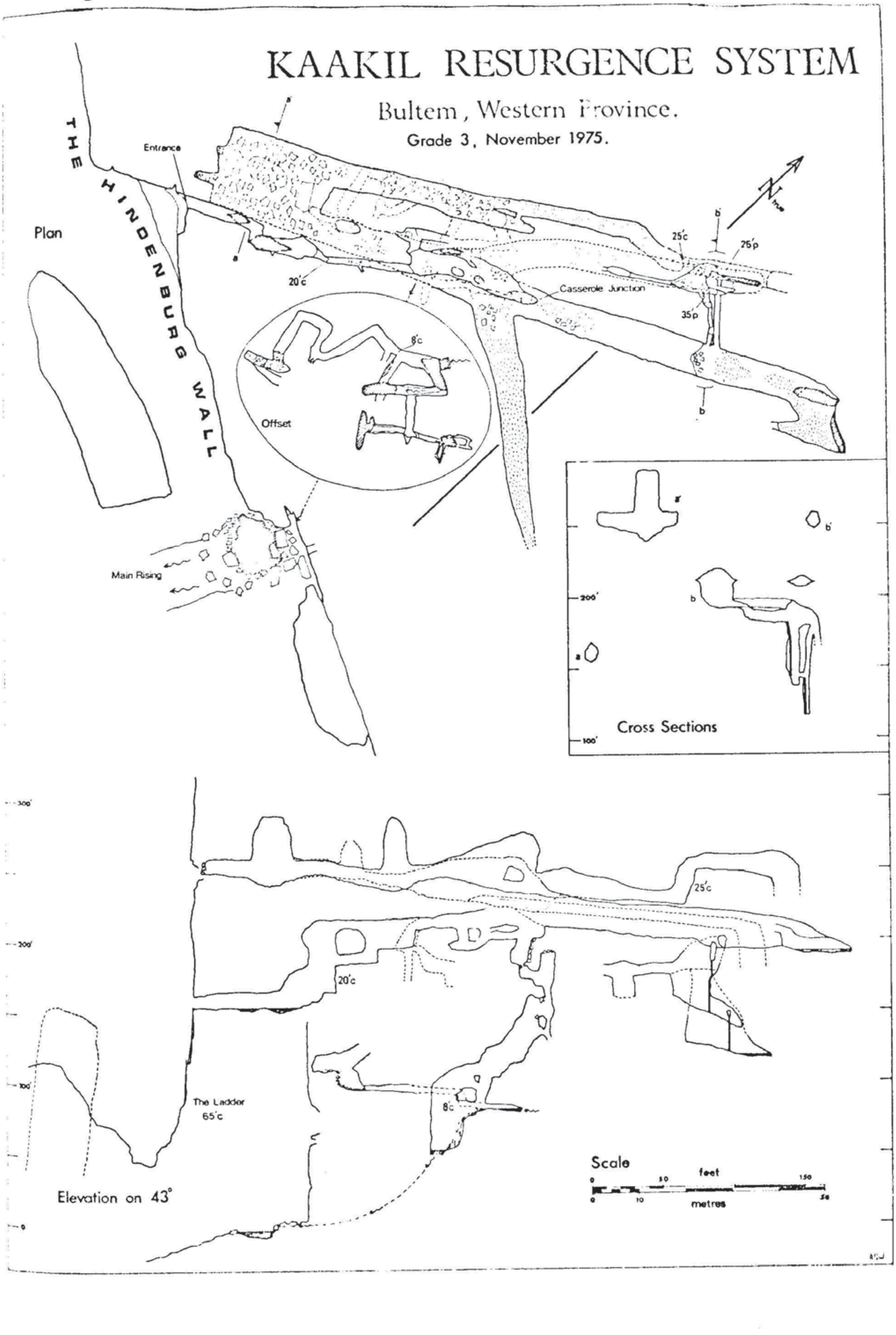
At Crab Cavern the trunk passage splits into two levels. Above the Balcony the high route has a pot in the floor which joins the Cord in the Great Nebula. The lower route is well decorated and takes a trench cut into beds of silt and pebbles. Below two 20ft (6m) pitches the way downwards is choked but an obvious wide passage meets a boulder slope in Orion Cavern where the Balcony route is rejoined. A hole in the boulder slope is a pitch into the massive tube of Cornucopia which may be reached without tackle via the North East Complex near the Cord. The tube gradually lowers and blocks with mud after 400ft (120m). At the lowest point of Orion is a small stream sink and close to it a 20ft (6m) climb down provides the easiest bypass (The French Connection) to the Canyon Pitch in the main route. The climb leads to Six Ways Junction where two passages join the streamway from Coprates Canyon.

The obvious way forward from Orion is up a steep slope and under a bridge to a division of large passages. Left is White Way, so called because the floor silt is almost pure gypsum. The large tunnel chokes beyond a group of chasms in the floor unite in a passage to a 20ft (6m) pitch. Below, the way forward meets a wide junction with a tube which chokes with mud after 450ft. (135m) but a small stream passage on the right ends in a large sump pool. At the wide junction a maze of passages and tubes enter a large chamber (White Hope) where a roomy upper passage can be seen across blind pits in its floor.

Keeping right at Orion a magnificent passage ends dramatically at the edge of a great gash in the floor. The Canyon Pitch of 25ft (7.5m) overcomes the obstacle and to the north is a remarkable standing block perched above a precipitous boulder slope down into Monolith Cavern. The exit is a large tube which gradually fills to the roof with mud. East from the Canyon Pitch is a fossil vadose trench of staggering dimensions (Coprates Canyon).

A small stream runs in an undercut and may be followed down to an 8ft (2.5m) waterfall coated with a slippery black manganese deposit. Here a dry muddy crawl up to the left terminates in a sloping pitch of 140ft (42m) to a mud choked passage and draughting dig. On downstream beyond nodular chert beds two passages on the left meet Six Ways Junction and the water swirls impressively down Intergalactic Laxative; a 110ft (33m) wet pitch to a sump pool. 70ft (21m) upstream of the pitch a window gives access to another large dip tube (Pollux Street) which also connects with Six Ways Junction. From Pollux Street a 15ft (5m) high passage degenerates into a crawl which ascends to an unexpected window into the Monolith tube beneath Six Ways

Fig. 43.


KAAKIL RESURGENCE SYSTEM
Bultem, Western Province.
Grade 3, November 1975.
THE HINDENBURG WALL
Entrance
Plan
20'c
25'c
25'p
35p
Casserole Junction
8'c
Offset
Main Rising
Cross Sections
200'
100'
300'
The Ladder
65'c
Elevation on 43°
Scale
feet
metres

Junction a tight rift drops into the Frogmarch, a 5ft (1.5m) high passage into another complex linking with Intergalactic Laxative at several levels and also with Cornucopia. Only the main passages are mentioned above to prevent utter confusion for the reader.

Upstream of the Canyon Pitch the immense passage provides sobering caving. The stream has undercut the walls over a width of 200ft (60m) and piles of boulders obstruct Coprates Canyon creating several routes. The Southern Cross Series joins a section of the streamway as a large phreatic tube discharging a trickle of water (Stoat Inlet) which enters from seepages. Through boulders a clean crawl becomes too low and a 20ft (6m) climb up leads to a mud-floored passage beneath a high aven.

The great canyon continues in similar fashion but it is now possible to explore oxbows at roof level. The trench ends at the Stargate, where a vast boulder slope ascends to another monolith. Flat-roofed caverns lead northwards over breakdown past a forest of stalagmites (The White Dwarves) and there are several short offshoots from the silt-floored tunnel until daylight is reached at the wide but low Backdoor entrance.

Above the Stargate holes under either wall lead to lower systems of passages. Those to the east are short but to the west one enters a group of boulder chambers and the wide, aptly named, Mud River Passage. Beyond a chaotic inlet from a sump the deserted floor trench may be followed for 400ft (120m) to a noisy inlet from a wall crack and a group of choked sinks. A crawl continues to link with Astradome Passage at floor level. The latter is more obviously approached via a large hole in the west wall just before the White Dwarves. It is a large tunnel which becomes very impressive as it passes under a roof dome (The Astradome). Most offshoots are short but beyond the Astradome is a choked sink and above it is the hidden entrance to Middle Series, where the main high level crawl eventually choked with stalagmite but it is intersected by a series of inlets and outlets. Most inlets terminate in high or tight avens and the outlets dip steeply to sumps or immature passages. One 60ft (18m) pitch leads to a mud choke which was dug to enter a small streamway leading to a sump. A tight crawl opens into a maze of crawls and avens at several levels.

Astradome Passage continues northwards and lowers until a roof inlet splashes into a large pool (Aquarius). The water flows away to sink in a great cavern and ahead a slope rises to the Keyhole Entrance: the largest in the system. On a ledge in Keyhole Cavern is a window into a fine tunnel and a boulder slope up into a chamber with a unique calcite bucket formation. Down on the right a low arch opens into a tubular passage which splits into two and rises to chokes close to the Backdoor entrance.

From the calcite bucket the main boulder strewn tunnel passes through a faulted zone and has many offshoots, daylight shafts and low level oxbows before it lowers over soft calcite and reaches daylight at the Tradesman's Entrance in the end of a long doline. The **Aurora Tem** entrance is in the middle of the doline and beneath the far cliff a short cave is an underground link with the Upper Ok Tem doline.

A track was cut north from Selminum in search of the far entrances and several shafts were noted. Most were only 50ft (15m) deep but an exception was the **Rubbish Chute.** The largest of twin entrances was descended to a loose ledge at 80ft (24m). Numerous small ledges demanded gardening and the landing at 280ft (84m) was at the side of a massive collapse block 50ft (15m) high. All passages quickly choked.

Due north of Selminum Tem the three caves of **Trinity** were found in a deep doline. The **West Cave** funnels down to a 20ft (6m) pitch and a passage which lowers to a mud choke. The **East Cave** has a most unusual entrance in an alcove. A high level window slot was reached with a log and a 20ft (6m) pitch laddered into a high but blind chamber. The **South Cave** is the major system and consists of a string of large caverns which are the remnants of a massive tunnel. Beyond a dip tube the way on is choked and a low level sink passage becomes too low.

The South Cave was thought to be part of the Upper Selminum Tem passage and a search between the two unearthed **Collapse Cave** where a small deep doline revealed a remnant of the passage in the shape of a large chamber.

Whilst filming the cliff in Selminum Doline, another entrance was seen high up and further north. It proved to be one of the entrances to the **Milky Way Cave.** An attempt to reach it from above was pipped at the post by Jon Buchan and Mike Farnworth who found a draughting dig in a long doline behind the sharp ridge at the top of the Selminum cliff. A hole was opened into a series of tunnels floored by mushy calcite – hence the name. In one chamber with two levels, a ramp descended to a pitch choked by boulders. Two entrances emerged dramatically high above the Selminum Doline and a third one was another link with the shallow long doline to the west.

A further fragment of the Milky Way passage system may be the short but similar **Bushmash Cave** found on the southern rim of the Selminum Doline. Further south another massive doline is obvious on the air photographs but actual inspection showed it to be a fusion of many small dolines. The only holes found were in the most northerly of these. Two blind shafts were explored and a fissure cave was pursued to a depth of 40ft (12m). It became too tight but draughted strongly. More imposing was a deep shaft up on the edge of the doline. **Fafalok Tem** (Swift Hole) is a 150ft (45m) shaft with a short passage and swifts' nests on the ground, not on the wall as is usual.

Below the Hindenburg Wall

The only cave explored was the **Kaakil Resurgence System** (Fig. 43). A hole 60ft (18m) above the impassable resurgence was not reached, but led by Ayangim, our carriers built a very exposed ladder up to a nearby cave where flying foxes were hunted. A short gothic passage led to an aven and a short but tricky climb emerged in a complex region with many holes in the floor. Over boulders was a massive passage at Casserole Junction – so called because of the shape of the tunnel. Due to rope shortage the river was only gained via one of the many inviting holes. It spurted out of an immature sump and crashed 20ft (6m) into another, but the volume was not enough to account for all the water at the rising. From Casserole Junction the large down dip passage chokes with mud but on the left is a side passage to a blind pot and another shaft to the river. Up dip is a flat roofed collapse chamber (close to the cliff) and a scramble over boulders into another down dip passage to climbs and another pitch to the river. To add to the confusion yet another large passage from Casserole Junction also ended in another shaft to the river. All these pitches are in the same area and will bypass the sump already discovered.

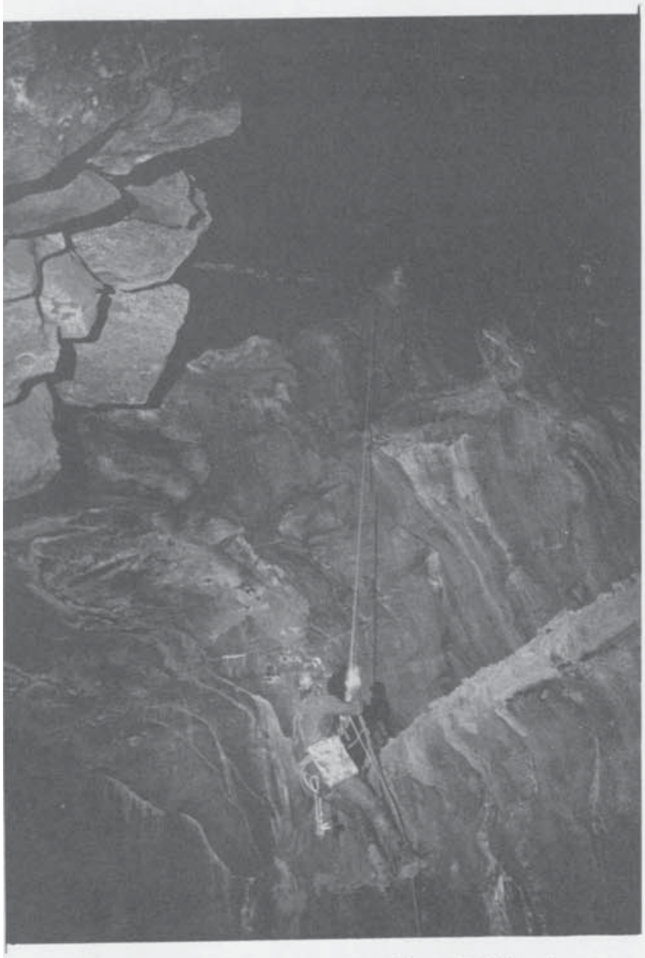
Plate 5.

Copernicus Cavern in Selminum Tem.
(photo A.S.White).

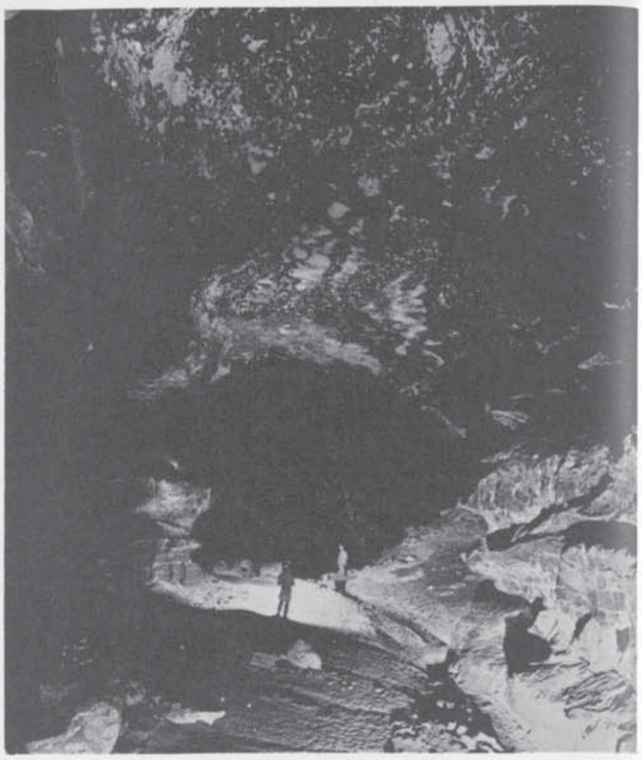
Plate 6.

1. The top of the Kepler Dip tube in Selminum Tem. (photo A.J. Eavis).

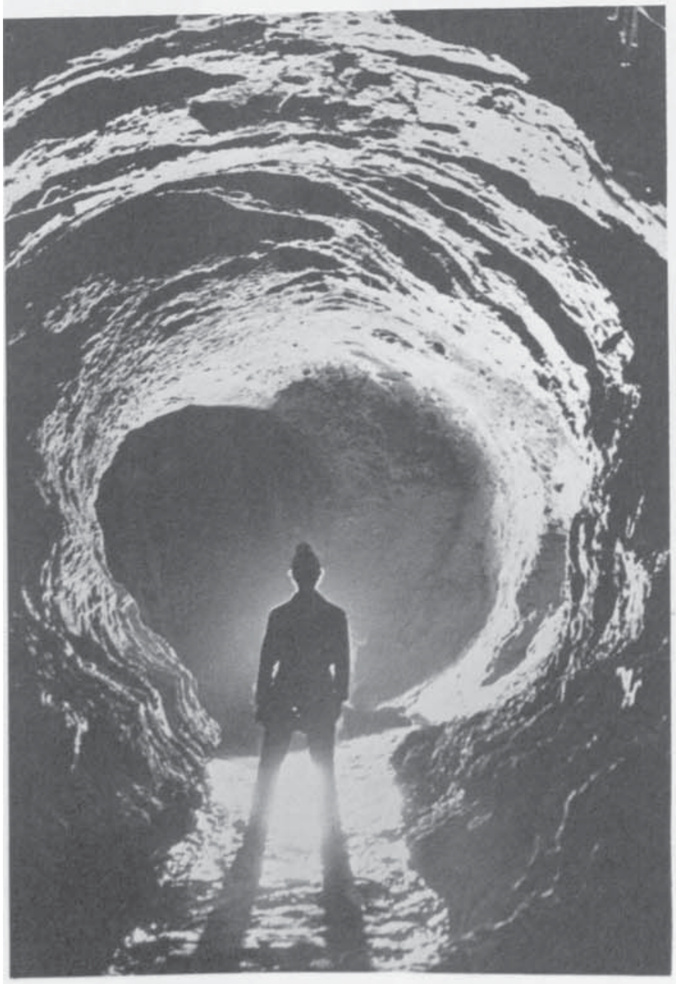
2. Hadley Rille, a fossil vadose canyon in Selminum Tem (photo A.J. Eavis).



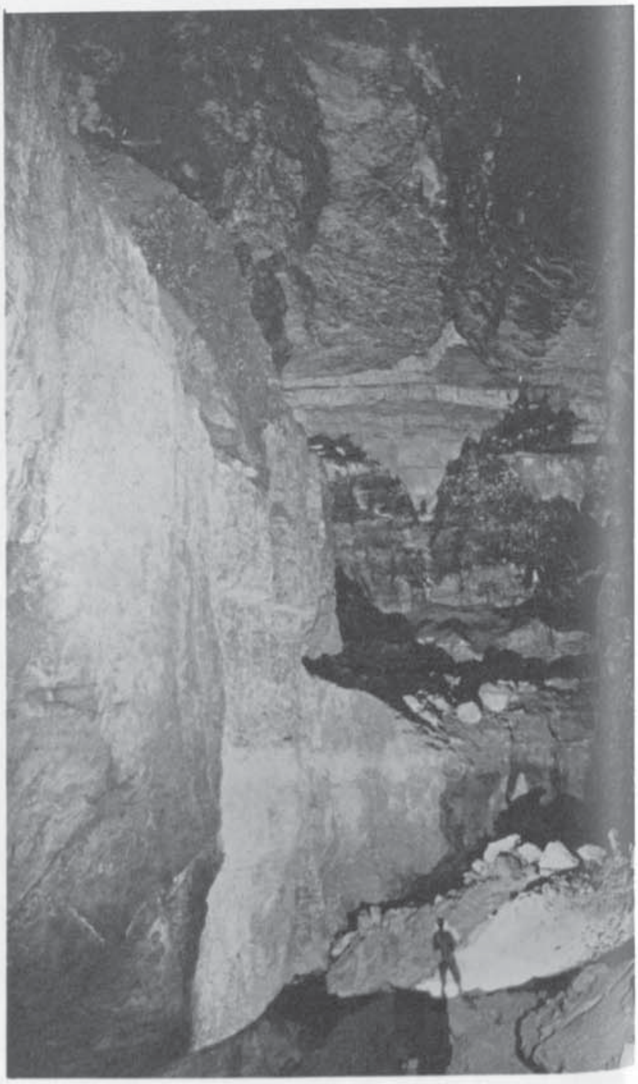
1. Prussiking up Hadley Rille to Lumberjack Oxbow (D. Brook).



2. The old phreatic conduit between Coprates Canyon and Orion (A. Eavis).

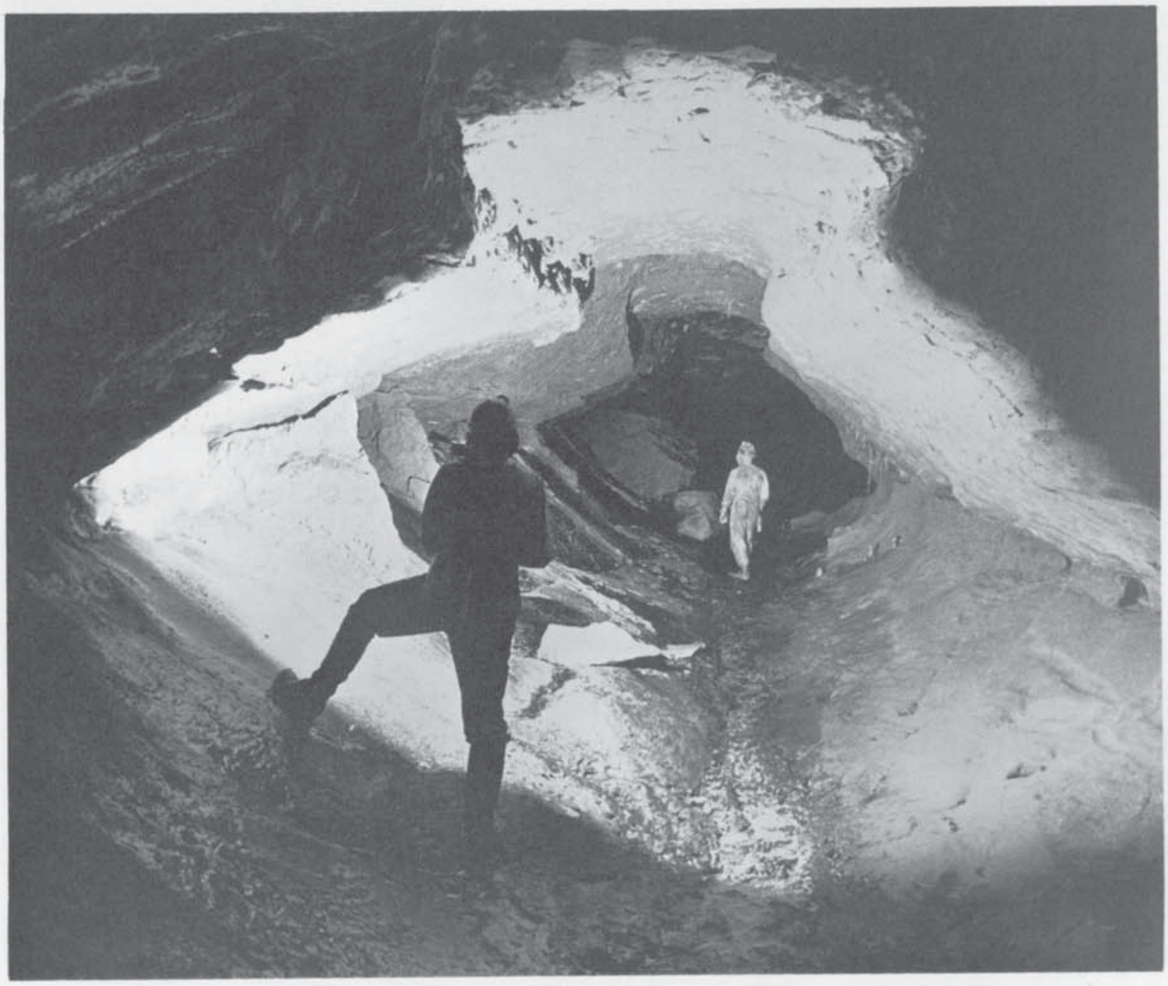


3. A tube in the Great Nebula Series. (photo C. Pugsley).

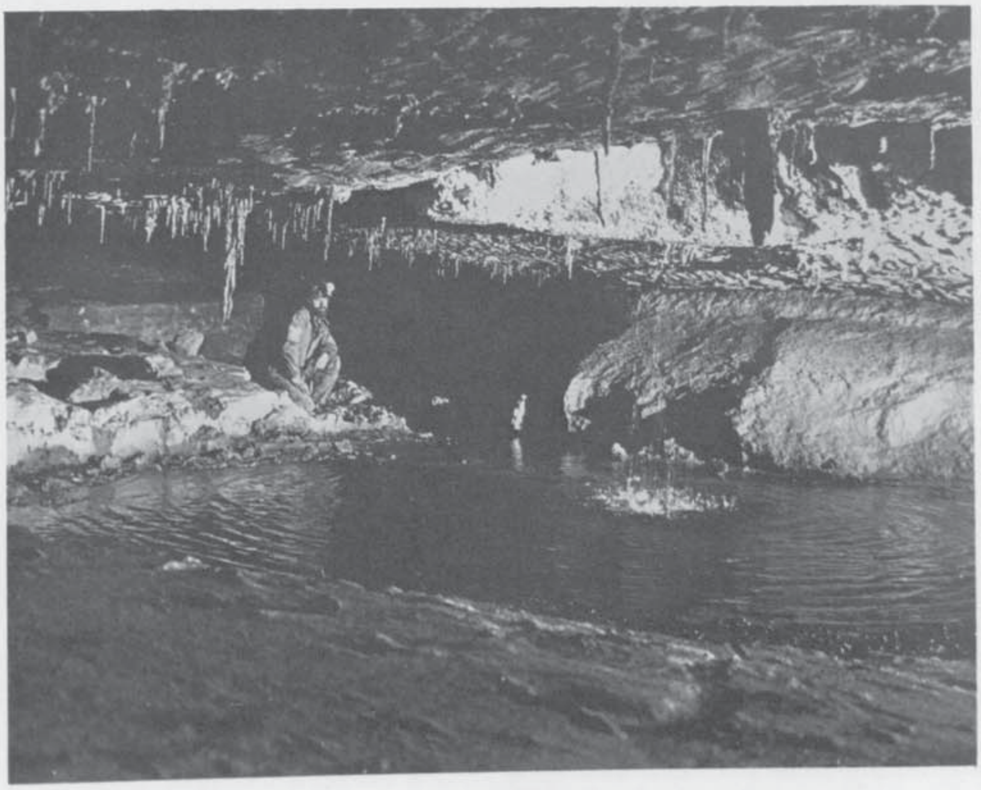


4. Coprates Canyon - a massive fossil vadose trench in the floor of the phreatic trunk route (D. Brook).

Plate 8.



1. Southern Cross Series - a low level phreatic tube in Coprates Canyon (photo D. Brook).



2. Aquarius - a percolation inlet (photo D. Brook).

Plate 9.

1. Undulating bedding near the White Dwarves (photo D. Brook).

2. Sediment pillars capped by granodiorite pebbles in the Kepler Dip tube. (photo D. Brook).

1. Bird engraving in Selminum Tem (photo D. Brook).

2. A prehistoric pit in Upper Selminum Tem (photo D. Brook).

III
SPECIAL STUDIES

(a) THE KARST AND CAVE DEVELOPMENT OF FINIM TEL – D. BROOK

Structure

The composition and structure of the region between the Hindenburg Wall and Tifalmin is more complex than is shown on the current geological map (Geological Survey of Papua New Guinea 1974) which only records Darai Limestone. Thick shales outcrop beneath the Bahrman Mountains and Mount Fugulil. They separate the Finim Tel/Hindenburg and Bahrman/Fugulil slabs of Darai Limestone. Thin limestones occur near the base of the shales thus suggesting that this part of the succession is the overlaying Pnyang Formation. Large scale thrusting has occurred to cause repetition of the Darai Limestone and hence the upper part of the shales and siltstones may be of the Ieru Foundation which underlines the Miocene Limestone.

Stratigraphically, the Darai Limestone is not uniform and shows marked lateral variation. On the Bahrman escarpment calcite mudstone beds are prominent in outcrop and also in the slumped debris below the scarp. These mudstones are absent from the Finim Tel limestone which seems rather uniform in the stark cliffs of the Hindenburg Wall and collapse dolines. In the caves however strong bedding planes and great lithological variation are apparent.

Near the Finim sink, the top of the succession is thinly bedded but becomes more massive with depth. The limestones are muddy with Ca CO_3 content as low as 60%. At the Kaakil and Bitip sinks however sparry coral-bearing beds and conglomerates occur above and below a thin argillaceous mudstone. Some 45m below the top of the limestone in Ok Tem is a remarkable bed of 2cm diameter stick-like fossils possibly silicified worm burrows, overlain by cherty limestone with occasional rib fragments (syrenian?). In the Bonewells of Selminum Tem, 200m (660ft) below the top of the succession, a fossil skeleton was found embedded in fossiliferous limestone. The silicified vertebrae and ribs were of an animal 2.5m (8ft) long and has been provisionally identified by Dr. Rod Wells of Flinders University as a syrenian (sea cow). Since these are shallow sea and swamp browsers, deep water deposition of the limestone is most unlikely (Jenkins 1974). Close to the Bonewells horizon there is a 5m (17ft) bed of 50% chert and branching 'stick' fossils in the sump series of Selminum Tem.

The regional dip is generally northward and varies between 6° and 20° (Fig. 44). Close to the shale/limestone boundary, however, the angle eases and small folds occur. These are well seen near the White Dwarves. A fault and anticline separate Union Cave and the Kaakil Labyrinth and a similar anticline was mapped in the Upper Bitip Cave. These structures may show the original limit of the overthrust Bahrman limestone, which has since been eroded back.

Climate and Karst Forms

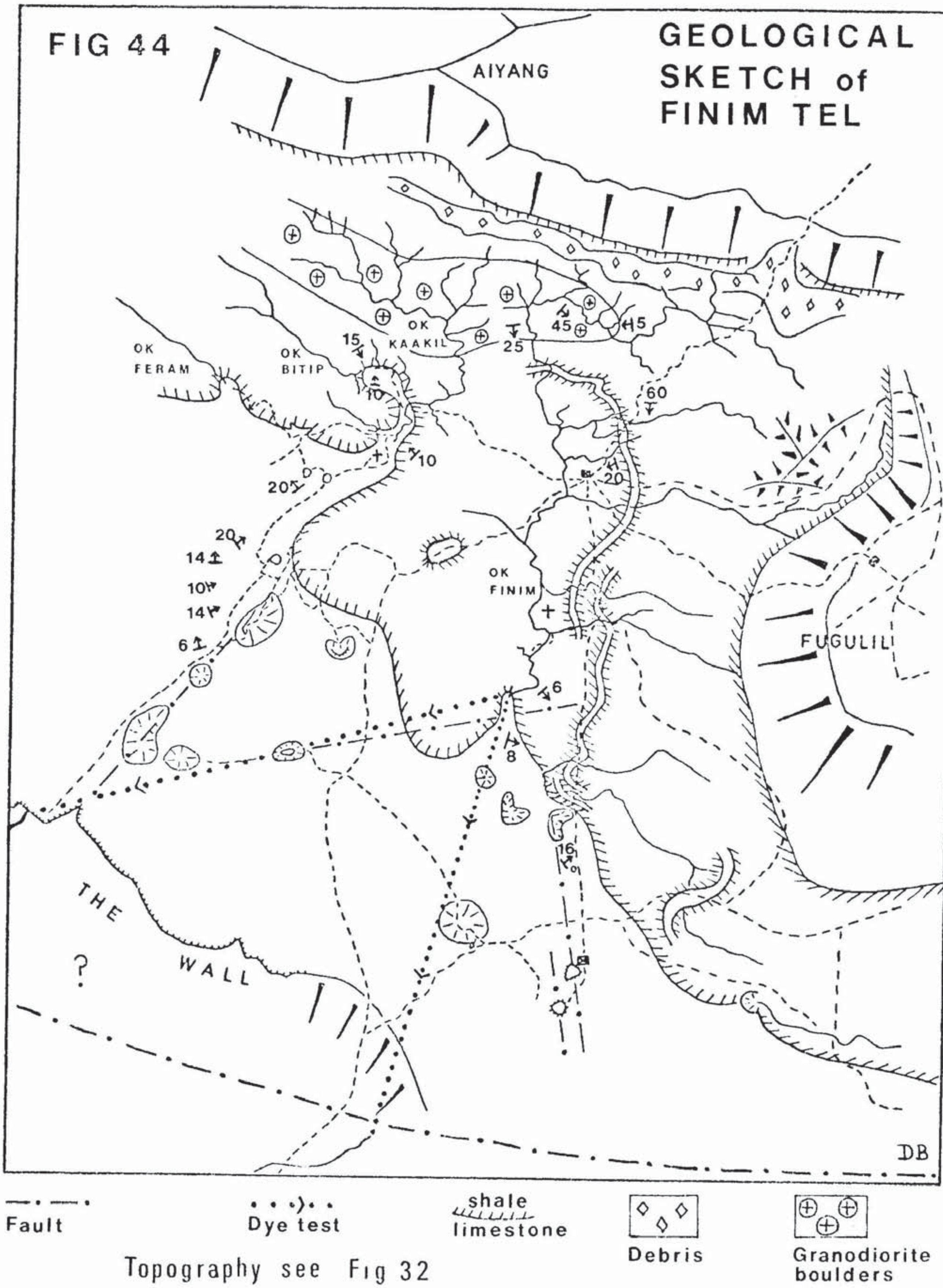
The Hindenburg Wall acts as a barrier against the South east monsoon, and the Bahrman range as a similar barrier to the North west monsoon. Hence the Finim Tel saucer is drier than many places at similar altitude. Rainfall throughout the expedition area tended to be in the form of tropical downpours as is well illustrated by the precipitation histogram recorded at Telefomin (Fig. 45) in 1975.

The large scarps of the region tend to create their own thermals and cause violent storms locally but a remarkable phenomenon is caused by the saucer behind the Hindenburg Wall. At night it fills with cold air to create a sea of mist. As the sun rises, it warms the atmosphere below the wall and an interface mist forms as cold air pours from above. At sunset heat is cut off and the interface mist sinks as the air above the wall cools again (Observations by Jon Buchan).

The effect also occurs in the Selminum Doline itself and the cold air is not dispelled until midday at which time the draught in the Lower Cave reverses. The reversing draught has formed slit shaped drip pits near the northern entrances.

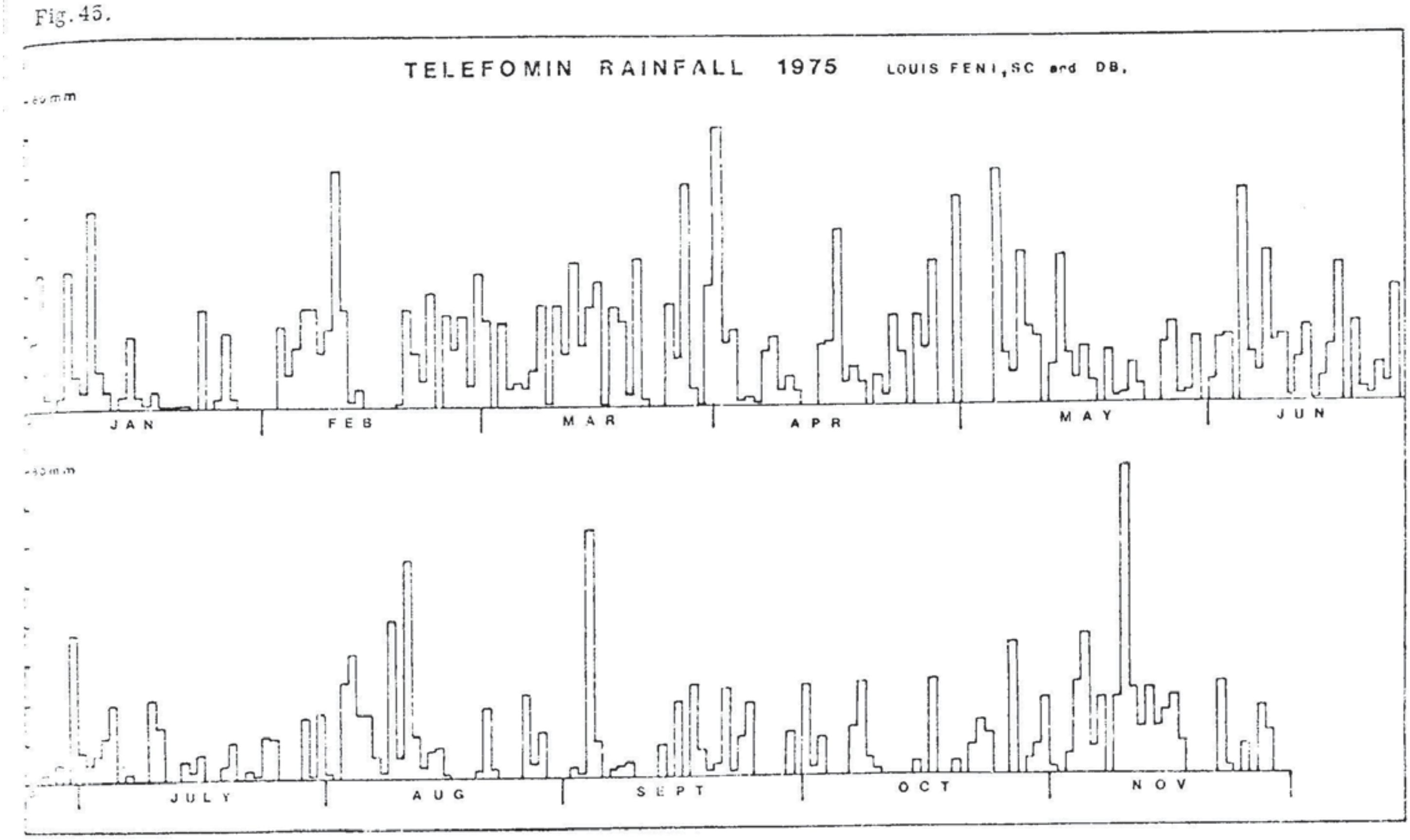
Over a long period, however, the rainfall on the Finim Tel saucer will not be too unevenly distributed and if the limestone were homogeneous a fairly even distribution of dolines would be expected. This is true in one respect. Dolines cover the total limestone surface but the large ones are concentrated on faults and strong joint lines. Many of the largest are collapse dolines wth prominent cliffs and their siting is thought to reflect the presence of caverns and the transmissions of earthquake shocks along faults and joint planes.

The predominant karstform is tower karst which displays various stages. These occupy belts between the shale edge and the abrupt cut off of the limestone at the Hindenburg Wall, and range from dolines in shale to massive classic tower karst. The sequence of development begins as the shale retreats. Dolines form in the thinning shale, some by collapse into cavities but most by slumping of shale into enlarging joints. Limestone is eventually exposed at their base and deep clefts appear. The familiar close spaced towers are formed as the shale is stripped completely but as solution continues so the spacing increases and the opening of bedding planes undermines the towers. Collapse results (more quickly in steeply dipping beds) and the first generation towers are reduced to boulders. These are further reduced to debris by solution and second generation towers emerge from the rubble to start another cycle. Debris accumulation and the non-synchronous nature of later cycles reduce the height of towers above the general plateau surface (Fig. 46). The best developed tower karst is in a zone from Selminum Tem to Le Buum Tem and Girtoil.



Topography see Fig 32

Fig. 45.


TELEFOMIN RAINFALL 1975
LOUIS FENI, SC and DB.
JAN
FEB
MAR
APR
MAY
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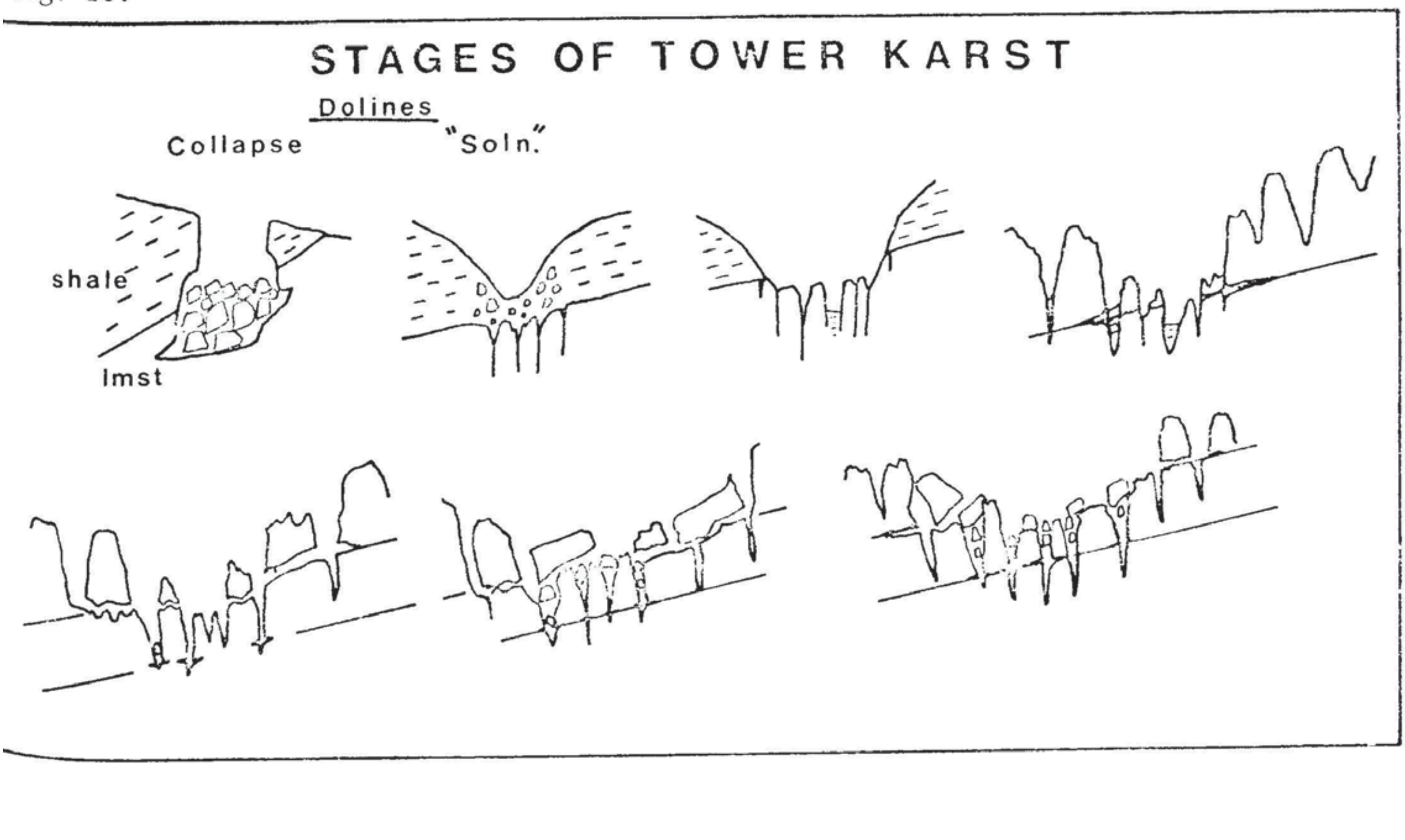
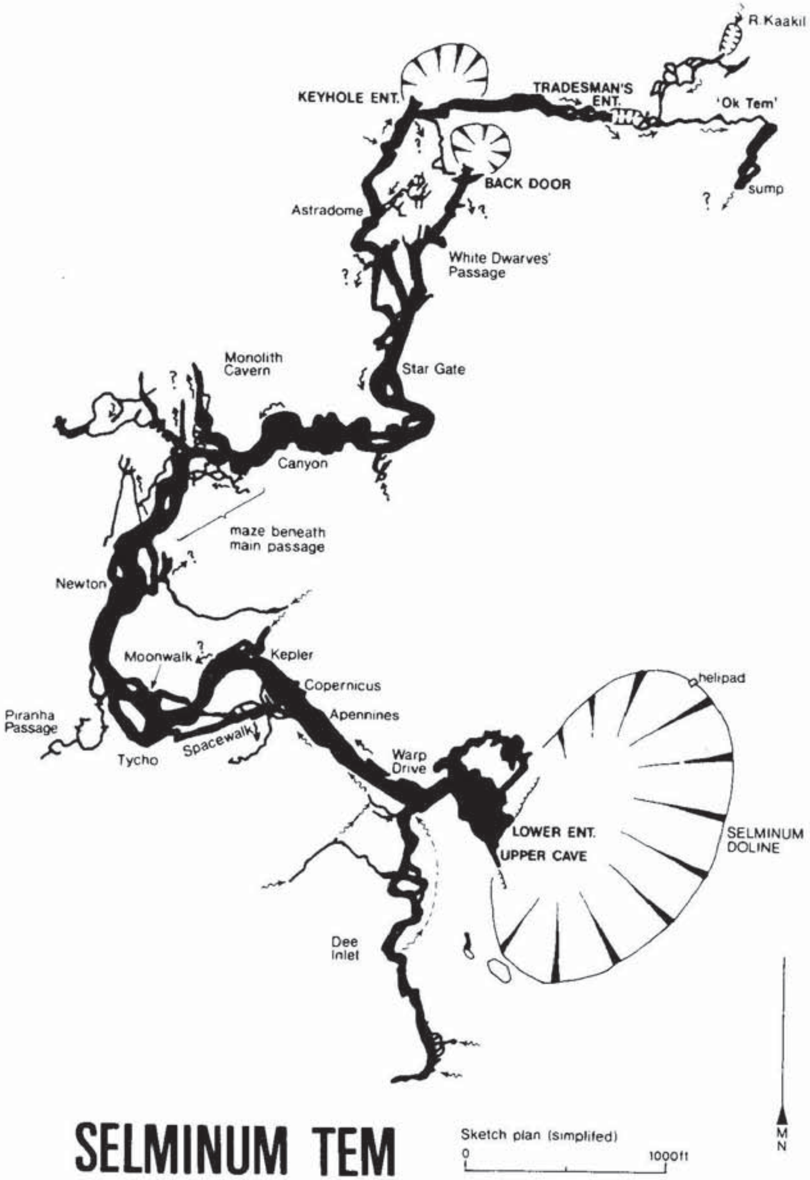
JULY
AUG
SEPT
OCT
NOV

Fig. 46.

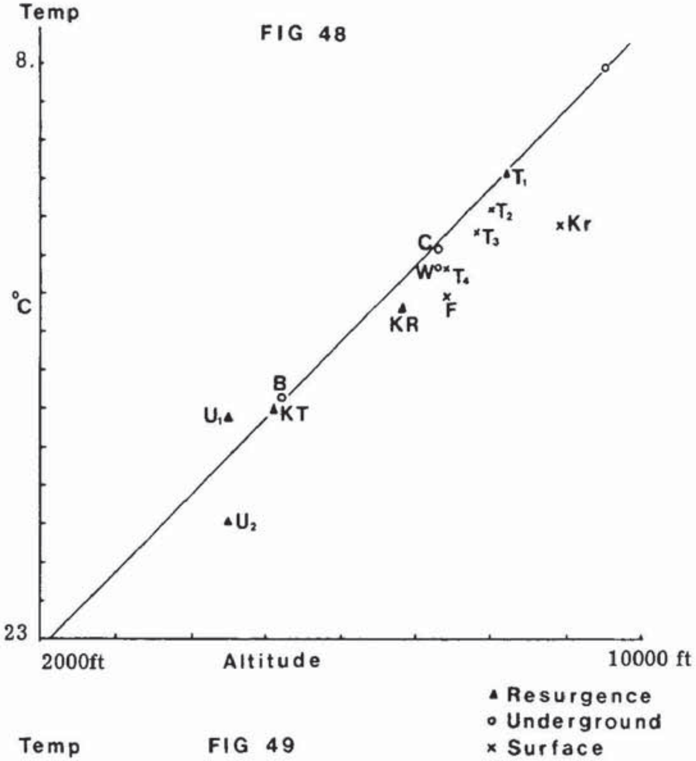

STAGES OF TOWER KARST
Dolines
Collapse
"Soln."
shale
lmst

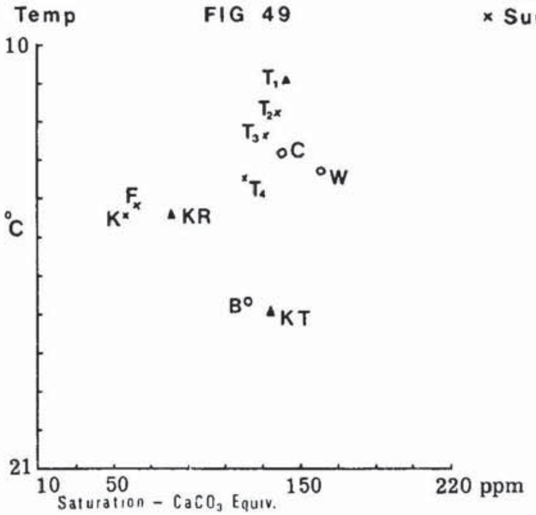


SELMINUM TEM

PERCOLATION STREAMS

Fig. 47.





Hydrology and Water Chemistry

One large scale dye test was performed. During the stormy period at the end of the expedition 9kg of Fluorescein was put into the Finim Sink in high stage conditions. No trace of it was seen at Ok Kumun after 2 or 20 hours. Two floods occurred in the next four days, but no trace of dye was seen below the Hindenburg Wall. Detectors had been placed in the Kam, Bilel, Seman and Kaakil resurgence rivers however. The Kam detector was faintly positive and both the Kaakil detectors were very faintly positive. No contamination had taken place since both the Bilel and Seman detectors were negative. Therefore at high stage the Finim feeds the Kam rising but with some overflow to the Kaakil, which is not a surprising result in view of the strong E-W fracture passing through Le Bum Tem from the Finim sink region to the Kaakil rising. From a consideration of water volume, known cave trends and geological structure the local naming of the rivers is probably correct i.e. the Kam, Warum and sinks of the Finim region feed the Kam rising, and the Kaakil, Bitip and Feram sinks flow to the Kaakil Resurgence (Fig.47) The Seman and Bilel springs deposit tufa and they must be derived from underground pickup. Dye from the Bitip was not detected at Union Cave after 3 days in wet weather.

All the streams in Selminum Tem are derived from percolation sources. They are gross underfits for the passages they utilise apart from infrequent immature stream channels. The Coprates Canyon carries most of the drainage in the northern part of the system but elsewhere the drainage is very unpredictable and at first glance, irrational. This is due to scattered inputs trying to take a vadose path in a deserted phreas. Their courses are soon terminated by perched sumps and some hydrological links were proved by dye tests (Fig. 47).

Studies of the temperature and response to rainfall of these percolation inlets showed that most were well integrated drainage channels having a fast response to rainfall even at a depth of 150m from the surface. Other channels which only carry small volumes of water, are not part of the rapid transmission networks and they showed little or no variation during the study period of three months. These sluggish percolation routes are more common in passages at shallow depth (such as the Tradesman's Entrance, Upper Bitip and Milky Way Caves) but these have a greater variation with rainfall than those at depth, and deposit soft 'moonmilk' calcite. Inlet temperatures in the northern parts of Selminum Tem were always higher (13.3 - 13.4°C) than those of the southern inlets which had penetrated more limestone and tended to approach the rock temperature of about 12.8°C.

A limited number of water samples were collected for analysis. Calcium hardness was determined by the method of Patton and Reeder (1956) and total hardness by standard methods. The contribution of aluminium, iron and manganese ions was measured by masking with cyanide and hydroxylamine or a large volume of triethanolamine (Welcher 1958). Stenner's method (1969) was used for direct measurement of aggressivity to calcium carbonate. Three titrations were performed for each estimation and blanks run with deionised water. Most of the samples were stored for up to two weeks before being transported and assayed in Telefomin. Samples collected from the Bem Tem caves near Telefomin were, however, used as controls. Two series of samples were taken. One was analysed at once and the other after three months storage in their field containers (glass and polythene screw cap bottles) at about 23°C in a dark cupboard. The calcium and total hardness samples in polythene bottles showed no change. Aggressivity values rose slightly even though they were stored in hard glass bottles (but see later).

The results obtained, together with three quoted by Shepherd (1965) are given in the table of water analyses and call for some preliminary comments.

WATER ANALYSES

			$CaC0_3$ ppm						
Alt.feet	*Code*	*Sample*	*Fe Al Mn etc.*	*Ca*	*Mg*	*Equilibrium $CaCo_3$*	*24 hr. Aggression*	*pH*	*Temperature °C*
5100	KT	Ok Kitkil	0	125	13	132	-6		17
5200	B	Bem Tem Drip	2	105	16	140	16	6.5	16.7
4500	U_1	Urapmin*	-	157	7	-	-	7.5	17.2
4400	U_2	Urapmin*	-	156	34	-	-	8.2	20
8900	Kr	Krom Sink*	-	24	0.3	-	-	7.4	12.2
7500	K	Kaakil	5	19	10	57	23	-	14.2
7400	F	Finim	4	21	15	62	22	-	14.1
6800	KR	Kaakil Resurgence	5	42.5	14	80	18.5	-	14.4
7300	W	Warp Drive	0	97	43	160	20	6.8	13.3
7300	C	Copernicus	20	123	9	140	-12	7.8	12.8
8200	T_1	Tumak Rising	15	102	35	142	-10	-	10.9
8000	T_2	Tumak	10	98	35	138	-5	-	11.8
7800	T_3	Tumak	10	94	32	131	-5	-	12.4
7400	T_4	Tumak (Finim Tel)	8	82	33	120	-3	-	13.5

*After Shepherd (1965)

a) Warp Drive. Collected from a splash pool beneath a showerbath which responds very quickly to rainfall. Its magnesium to calcium ratio is high and so is its aggressivity. Although all the surfaces wetted by the shower are coated with manganese deposit its constituent metals were not detected in solution. They must be already in particulate form or tightly bound into complexes.

b) Copernicus. An inlet which does not respond to rainfall and is depositing gour pools. The magnesium/calcium ratio is low and its aggressivity negative. The concentration of trace metals is high and they may be causing the yellow discolouration of the calcite being deposited.

c) Kaakil and Finim Sinks. Overall solute load is low, although not as low as recorded by Shepherd for the Krom Sink in the Star Mountains. Trace metals form a high proportion of the total and aggessivity is high.

d) Kaakil Resurgence. This sample was taken between floods and the high temperature suggests that the water had been transmitted very rapidly. Trace metals have the same concentration as at the sink but calcium hardness has more than doubled. Nevertheless the water is just as aggressive as when it entered the limestone.

e) Tumak. The sample near the resurgence is similar in composition to that from Copernicus apart from its higher magnesium content which seems typical of more rapidly transmitted waters. The Tumak responds to rainfall but with a time lag of 10 hours or so. By comparison the Kaakil can flood only one hour after rain and the pulse is transmitted to the Kaakil Resurgence in a further hour in extreme cases.

The change in composition of the Tumak waters as they descend to join the Finim is interesting. Trace metal concentration falls and so does calcium hardness although magnesium remains constant.

A plot of altitude against temperature of water samples illustrates a definite correlation (Fig. 48). Waters which have reached the rock temperature fall close to a line such that:-

$$\text{Temp}\ {}^{\circ}\text{C} = 27 - \frac{\text{altitude (ft)}}{500} = 27 - \frac{\text{altitude (m)}}{150}$$

over the range 4,500 – 10,000ft. (1350–3050m)

Rapid water movement causes deviations from this plot either by rapid percolation of cold high altitude waters or warmer daytime surface water.

If, however, the amount of solute in the various waters **at equilibrium** is plotted against temperature there is no correlation (Fig. 49). Only by considering very limited areas such as the Tumak can any trends be seen. As the Tumak's temperature rises so its equilibrium solute content falls and within the Finim Tel caves the effect seems more intense but with a wide scatter.

Bem Tem and Latent Aggression

The Bem Tem drip pools (home of the polycheate worms) were sampled and found to be similar in composition to Copernicus. Trace metals were low and aggressivity high. Phosphates and organic acids from the guano probably account for the low pH of 6.5. The Ok Kitkil resurgence had no detectable trace metals and was negative in aggressivity although not depositing calcite (Table 1).

These samples were used as the three month storage controls and although the calcium and total hardness values showed no change the aggressivity figures showed an increase of 3 and 8 ppm $CaCo_3$. The analyses in Table 1 were made 6 hours after being collected in hard glass bottles and by repeating the double sampling procedure and assaying after 6 and 30 hours it was found that much of the extra aggressivity is picked up during this time. The test was repeated with tap water from our roof tank (i.e. rain) and no aggressivity changes were found so it must be attributed to a factor in the cave waters. Volumes of samples brought from Finim Tel were not sufficient for a rigorous investigation of the effect but it was found to contribute 10 ppm $CaCo_3$ to the aggression of the Kaakil Resurgence and resealing and occasional aeration by agitation added another 8 ppm after 24 hours. The phenomenon deserved further study under controlled conditions, preferably by on the spot assays and storage at cave temperatures and in total darkness.

Cave Development

a) Cave Types

The four major sinking rivers of Finim Tel enter caves of very different character. The Feram and Finim Caves are relatively simple and shallow. Both end in sumps but the Finim Tem has a branching series of downstream passages typical of flood phreas c.f. Mossdale Caverns and Goyden Pot. The Bitip water also sumps in immature passages but abandoned tunnels form two distinct levels; the higher Upper Bitip Cave being 25m (70ft) above the present river sink and having no obvious continuation. It is an erosional remnant. The lower tube enters Archway Cave and is associated with the collapsed dry valley beyond it. The Kaakil River enters the most complex sink region and often floods the Kaakil Labyrinth when the immature lower passages cannot cope with the water. The extensive Labyrinth and Union Cave are a good example of horizontal phreatic development in dipping and sometimes contorted beds. The deep vadose trench of Ok Tem has left an upper series of tubes which correspond to the Labyrinth development. Surface lowering is now dissecting the Labyrinth and the river may be unroofed unless the retreat of the trench allows it to assume lower levels.

Upper Union Cave and Upper Ok Tem are fragments of an old phreatic tube whose remnant passage sections link dolines as far as the Tradesman's Entrance to Selminum Tem. It then unites with passages at a similar level from the Keyhole Entrance. The Backdoor is at a higher level and may represent an older sink. Below the Stargate is a huge vadose canyon cut into the floor of the 30m wide phreatic tube. The canyon terminates at Monolith Cavern where it plunges into a down dip phreatic tube.

The old tube above the canyon turns off to Orion and begins to undulate (see Selminum Tem survey). The high points are bypassed by large low level oxbows and at still lower levels are mazes of tubes where the percolation inlets fall into deep sumps. These are at lower elevations than those in the river caves at the back of the plateau but they are still 100m (330ft) above the Kaakil Resurgence.

In the Selminum Doline the Upper Cave represents a fragment of another great tube 50m higher than the trunk route of the Lower Caves. The upper tube is glimpsed again at Collapse Cave and another large section is the South Cave of Trinity. Even more significant are the old tubes of the Milky Way Cave at the top of the Selminum Doline and 100m (330ft) above the level of the river sinks.

b) Outline of Speleogenesis

The plans of the Finim Tel caves (Fig. 47 and Selminum Tem survey) indicate that the abandoned tunnels were once the main drains for earlier river sinks at the back of the plateau. Even the highest fragments of the Milky Way and Bitip caves mirror the course of later, more complete passage systems, hence the jointing was much as now when the older caves formed. Apart from the vadose passages of the present river caves, Coprates Canyon, Hadley Rille and some minor trenches, all the conduits in the area formed under phreatic conditions, domed or even circular cross sections being the norm. Roof pockets, three dimensional mazes of tubes, fretted rock and spans fulfil the phreatic criteria of Bretz (1942) but the red clay of his fill stage is absent – all sediments having been carried in by past rivers and more recent flood torrents. Selminum Tem and associated systems were formed under phreatic conditions by sinking rivers powerful enough to transport pebbles and cobbles through 30m diameter tunnels for 4km (2½ miles) or more, and up reverse gradients.

To reach the resurgences, the caves (past and present) must run against the dip. In spite of the 600m thickness of available limestone the chosen routes were not deep phreatic as envisaged by Bretz but are relatively shallow and more akin to Swinnerton's (1932) model. The main trunk route of Selminum Tem takes advantage of variations in dip direction to maintain a shallow course close to the strike and hence keep the overall resistance across the phreas to a minimum (Brook, 1974). To do this the passage "tacks" through the steeper beds and a fine dip tube (Ford, 1971) between Tycho and Keplar indicates a phreatic amplitude of 50m (165ft). A tube in the higher Trinity/Upper Selminum Tem conduit has a similar form and these features carried the rivers up or down dip.

Widely differing phreatic processes are at work beneath Finim Tel. The sporadic input to the river caves results in regular floods, damming of passages by mud and debris and consequent solution during periods of flood phreas. The various levels of the sumps in the river caves, Selminum Tem and the Kaakil Resurgence System show the presence of perched phreas and its step-like character. The elevation of the Finim Tel caves, however, shows the great extent of former water rest levels (thus ruling out flood and perched phreas) and they were probably directly related to former resurgence levels (Fig. 50). From the available evidence the following reconstruction of past events has been deduced.

a) In Pliocene times the overthrust crest of the Bahrman scarp rose above the sea and the Finim Tel limestone became a marine erosion surface. As uplift progressed, the eroded material from the emerging mountains was deposited to the south as the coastal Birim Formation. During uplift the marine erosion surface was tilted and a proto-Kaakil river draining the Bahrman shale formed the Stage 1 phreatic conduit; probably at sea level.

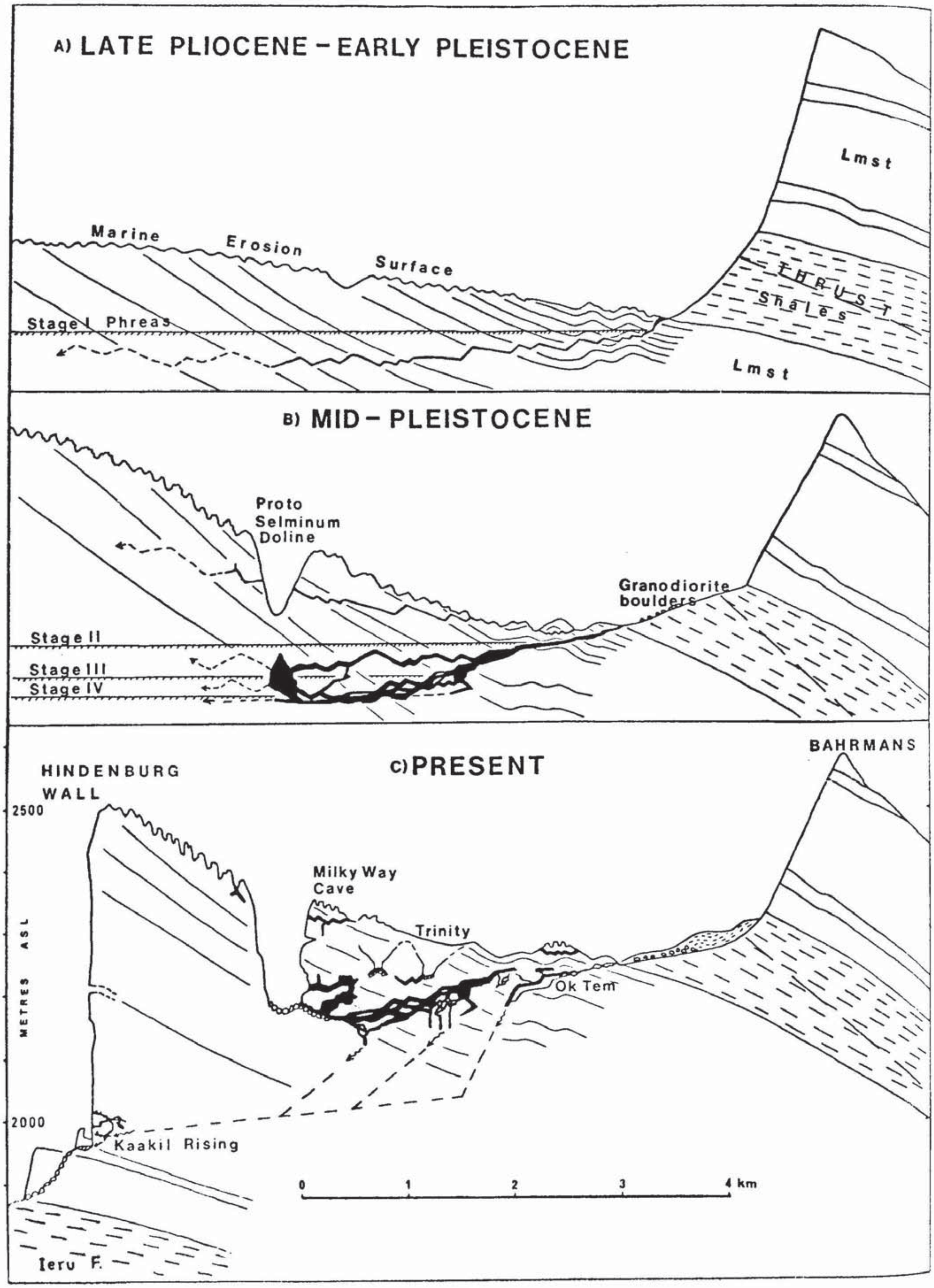
b) Uplift and tilting of the whole block continued, thus applying a reverse gradient to the Stage 1 tube which was abandoned for the Stage II conduit to a lower resurgence. The new drainage route was much larger than Stage I but whether this was due to higher rainfall, greater drainage area or a longer development is not clear. Yet another fall of resurgence level produced the enormous Selminum Tem trunk route and towards the end of its development masses of quartz microdiorite pebbles and pyrite-rich shale mud were washed into the conduit as far as Warp Drive. Similar pebbles occur in the Kaakil river and 2m boulders of the same are found in the headwaters of the Finim. Boulders of microdiorite and chert were noted in section always resting directly on bedrock shale and covered by thick clay with ill-sorted blocks of local limestone and siltstones. No outcrops of quartz microdiorite exist to explain the ribbon distribution of the boulders and from their sudden appearance in cave sediments and it is concluded that they (and the chert) are erosion on resistant remnants of glacial deposits transported from large intrusions west of Mount Aiyang. They certainly do not date from the last glacial event when ice only descended to an altitude of 3100m (10,200ft) in the Star Mountains. During this event the solifluction clays which overlie the boulder bed were probably deposited below the Bahrman escarpment. The boulder bed must date from a more severe earlier glaciation whose deposits are now all but obliterated. Fragmentary evidence for such an event has been noted on Mount Giluwae (Loffler, 1972).

After the near approach of the ice, the base level fell again to its Stage IV position. Low level oxbows bypassed the high loops, and vadose canyons became active, first at Hadley Rille and then at Coprates Canyon which drained to a sump at Monolith Cavern and thus began to open up the phreatic network of the Great Nebula. Meanwhile surface lowering had begun to direct the fossil passages of Stage I.

c) The Finim River pirated a large section of the Kaakil headwaters and diverted them into its own cave systems, formed as the shale receded towards Mount Fugulil. In Selminum Tem the reduced Kaakil finally deserted the low level mazes and formed Ok Tem; first the upper series and later the vadose canyon. Surface lowering and collapse has fragmented the Stage II conduit to create the Trinity and Upper Selminum Caves and at the back of the bench Stage III has been unroofed. The collapse of Selminum Doline has breached Stages I, II, III and IV and must have been due to a large cavern on the fault.

Apart from an old tube 70m(230ft) above the Kaakil Resurgence there is no direct evidence of long standstills since Stage IV. The last fall in base level has created a confusion of perched phreas separated by flood prone vadose links. Thus, a normal flood pulse takes 6 hours to pass through the caves but in consistently wet periods a sudden storm pulse is transmitted in one hour.

Fig. 50.


A) LATE PLIOCENE - EARLY PLEISTOCENE
Marine
Erosion
Surface
Stage I Phreas
Lmst
THRUST
Shales
Lmst
B) MID - PLEISTOCENE
Proto
Selminum
Doline
Granodiorite
boulders
Stage II
Stage III
Stage IV
C) PRESENT
HINDENBURG
WALL
BAHRMANS
2500
2000
METRES ASL
Milky Way
Cave
Trinity
Ok Tem
Kaakil Rising
0
1
2
3
4 km
Ieru F.

The simplest mechanism to account for the events outlined above is a fault close to the Hindenburg Wall along which the cliff has risen. Scarp retreat, accelerated by earthquakes, must also have played a part although the amount of debris below the cliff in this region is nothing compared with the vast quantities at Golgobip when retreat has been phenomenal. The evidence from the Finim Tel caves indicates rapid but jerky uplift, although not restricted to the Pleistocene (Verstappen 1964). Further exploration will furnish a more detailed record.

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(b) SPELEOBIOLOGY – Phil Chapman

Introduction

The biological objectives of the expedition were simple. We planned to collect animals from all the caves explored by the team and to measure various physical parameters of their habitats. Using the results of this fieldwork we hoped to answer several questions: How do the cavernicoles cope with the problems of life in the caves of Papua New Guinea? How did they embark on cave life? Where did they originate? How do the cave communities interact, and how do they differ from their surface counterparts? How do various highland cave communities differ from each other and from lowland cave communities?

Obviously such aims required the study of surface as well as cave communities over a very wide area. In addition the biologists had individual interests which they wished to pursue. Thus the caves studied by the biological team were very diverse, ranging from the cool highland caves of Mt. Fugilil at 3,100 metres altitude, to the warm island caves of New Ireland almost at sea-level. In addition, a great variety of surface groups, mostly invertebrates, were collected over a similar altitudinal and geographical range.

At this time it is not possible to collate information about all the caves and other biotopes which received the biologists attentions, and so it is the author's intention instead to deal in some detail with the most studied (and in many ways the most interesting) cave fauna – that of the Finim Tel plateau. A fuller account of the biological results of the expedition will eventually appear as a separate publication.

Climate of the Finim Tel Plateau

The climate of the Finim Tel plateau is essentially temperate (avoiding extremes of both cold and heat) and wet. Typical daily temperatures range from a night-time low of around 8°C to a daytime high of 20–25°C. Rainfall for a fairly typical week during September to November, 1975, was about 8-10cm., though our Wokkamin carriers, who were familiar with plateau conditions, regarded the weather as unusually dry. Mean annual rainfall is probably 600-800cm. The highest daytime temperature recorded at the bottom of the deep, forested Selminum Tem doline was 18°C, and a maximum early afternoon temperature of 15°C was recorded at the bottom of a 180 metre deep pit (The Sting), close to the Girtoil campsite. Underground temperatures across the plateau were surprisingly constant – with extremes of 13.9° (Mudstone Hole, near Girtoil) and 12.6°C (Bone Wells, below Tranquility in Selminum Tem). This is a similar temperature range to that found in many southern European caves.

The epigean environment

Most of the Finim Tel Plateau is covered with virgin rain forest. This is dominated by the canopy of tall evergreen hardwoods with many towering Auracarian and Casuarina pines, and shorter Pandanus "palms". Tree ferns and Cycads, which are normally found at higher altitudes (3,000 metres), occur in a few steep-sided dolines, perhaps as a result of localised temperature inversion. A large belt of vine bamboo borders the Ok Finim in the centre of the plateau and appears to be slowly engulfing neighbouring ridges to the east and west.

The floor of the dominant canopy forest is shady, wet and cool. Vegetable detritus is superabundant and supports a large, if inconspicuous fauna. Rotting logs contain large numbers of passalid and staphylinid beetles, millipedes, and centipedes. The litter contains a host of Acari, Collembola, pselaphid and other small beetles, millipedes, spiders, and woodlice. Some of the more conspicuous forest dwellers include bright pink gammarid shrimps, which appear unexpectedly on forest tracks after rain, and the large, night-flying cerambycid beetles with their long, sweeping antennae.

THE HYPOGEAN ENVIRONMENT

(a) Stream Sinks

The plateau has a very rugged profile and most surface streams have such a steep gradient that they are able, particularly when swelled by the frequent downpours, to carry very large organic burdens. As they sink, these streams bring an abundance of food into the caves of Finim Tel.

Many of the smaller streams disappear into a mass of boulders, or a muddy, log-choked fissure, but occasionally one of the larger streams sinks into a caver-sized passage. The Ok Kaakil normally vanishes into a tight, log-choked fissure from which a dry, sandy stream bed winds on into the forest for over a kilometre. When in flood, the river overflows down this channel and enters a number of flood drains which connect with the Kaakil Tem labyrinth. The Ok Kaakil eventually exits from Union cave, only to disappear once more into the clean washed canyon passage of Ok Kaakil Tem. There is a great deal of food input into the labyrinth, and yet there is practically no animal life. This is due to the severe scouring effect of the large abrasive particles carried by the fast moving water which destroy any animals present in the cave. The frequency of the floods prevents successful recolonization of the cave by epigean species.

In Ok Kaakil Tem even the most severe flooding does not reach the higher levels of the canyon passage. Here are found long-legged pholcid spiders which eat the flying insects carried into the cave by the stream-induced draught. These highly mobile troglophiles are characteristic of partially-flooding passages, where their mobility allows them to escape rapid rises in the stream level.

Yaromdeng Tem to the west of Selminum Tem's Keyhole entrance contains a stream which is small and not very flood liable. In the main stream passage, the ubiquitous pholcid spiders are joined by other predators -- pale, long-legged harvestmen, and by small white Collembola which feed on detritus stranded at the high water mark of the downstream sump. Two "strays" were also collected from this passage - a clubionid hunting spider (an accidental trogloxene) and a blind harpaline carabid beetle (a troglobite normally found in more remote cave passages). Close to the sump, a short high level passage connected with a muddy, slow-flowing underground canal. The high level passage has a gentle draught which sways the delicate webs of small, dark nesticid spiders. These troglophiles are less stenohygrobic than the larger pholcid spiders and, together with large grey woodlice, are regular inhabitants of the shallower abandoned passage of Finim Tel caves.

The canal passage receives the Ok Feram Tem water, and a small inlet stream, but has no obvious outlet. Water swirls slowly around the canal and appears to sink in a narrow, blind alcove which was plumbed to a depth of 5 metres. During heavy rains the Ok Feram backs up and almost fills the canal passage, depositing a thick layer of evil-smelling, rich organic mud mixed with a great deal of organic detritus. Gradual flooding of this sort has quite a different effect from the flash flooding which occurs in the nearby Ok Kaakil system. The slugglish water is unable to support an abrasive load, and some epigean animals are deposited damp, but alive, as the floods recede. The mud banks of the canal support a variety of such accidental cavernicoles which live in the midst of plenty, in an environment quite similar to their normal dark, damp, forest-floor habitat. The commoner (presumably more successful) accidentals collected included at least two species of small staphylinid beetles; collembolans; and Acari. A species of water striders (Heteroptera: Veliidae?) skimmed about the water surface, and large carabid beetles (possibly troglophiles rather than accidentals) patrolled the mud banks and cave walls throughout the passage.

The canal itself contained at least two accidental colonizers -- a species of small bivalve; and the larvae of a caddis fly (Trichoptera). Adult caddis flies were present in the canal passage, and may form an important source of food for the numerous pholcid and nesticid spiders.

The distribution of freshwater crabs on Finim Tel is peculiar. They are found in the Ok Kumun Tem, Finim Tem and Hydra Hole, all of which are flood-liable sinks related to the waters of the Ok Finim and its eastern tributaries. Two specimens were also taken from a short, truncated relict cave which passes under the track linking La Buum Tem with the Finim Tem camp. The stream in this cave flows east and probably joins the Ok Finim waters. The crabs are not found in any waters related to the Ok Kaakil, nor the streams to the west (Ok Feram, etc.), nor are they found in any of the numerous stream inlets in Selminum Tem. Below the Hindenburg Wall the crabs are found in a large pool which receives the waters of the Ok Kaakil rising (the only place they were observed above ground). They also occur at lower altitudes in Kabim Tem in the Ilam valley north of Finim Tel, in Tina Bu Tem and the Nong river cave, in Agim Tem, and in Kitkil Tem near Telefomin. Finim Tel probably lies close to the upper limit of their range, but it is difficult to understand why they should be confined to just one drainage basin within a reasonably homogenous area.

Almost every crab collected on the Finim Tel plateau had several small, white, hydra-like creatures attached to the dorsal and ventro-lateral aspects of its carapace. These belong to a little known order – the Temnocephala. The Finim Tel species probably belongs to the genus **Temnocephala** E. Blanchard. Temnocephalans are known to feed on small crustaceans and rotifers, and occasionally on oligochaetes, algae and diatoms (Baer, 1961). The pool in Hydra Hole contains a species of white cyclopoid copepods, **Acanthocyclops viridis** (V. Naidenow det.), which may well provide an important food source for the temnocephalan population. On the other hand a few temnocephalan species are known to parasitise cavernicolous crustacean hosts, feeding on haemolymph obtained by dissolving away the chitin between segments of the host's carapace (Matjasic, 1957).

(b) Shallow, abandoned cave passages

During the early development of Feram Tem, a maze of small, interconnected passages were dissolved in the Miocene limestone. The stream now flows along a lower level and surface erosion has produced a large number of small entrances into the abandoned phreas. It is possible to follow several narrowing passages from inside the cave to reach entrances which are too narrow to admit the caver. At least two of these entrances are used by Cuscus (**Phalanger** spp.), locally called Kapul. These are true trogloxenes which use the cave for shelter, building a platform of leaves to sleep on, and feeding outside the cave. Cuscus faeces were found in a number of caves, and form an important food source for several cavernicoles such as catopid beetles, and at least three species of millipedes. Parasitic ticks occur on and around the leaf platforms, which, when abandoned provide food for collembolans and small mites.

The upper Bitip cave is a very ancient fragment of a fossil phreatic tube which runs through a ridge with an entrance on either side. The only apparent food input is in the form of small patches of faeces of the cave swiftlet (Apodidae: **Collocalia** spp.), which support a few coprophile catopid beetles. Scattered pholcid spiders predate the airborne fauna passing through the cave, and large grey woodlice cling to the walls here and there, but otherwise the passage is deserted. Close to the western entrance a ramp leads down to an isolated lower chamber containing drip pools among slimy black boulders. This is the habitat of a troglobitic collembolan (Sminthuridae?) whose water repellant covering enables it to move freely over water films

The upper level of Ok Kaakil Tem is an abandoned phreas – notable for a colony of bats (Rhinolophidae?), whose accumulated faeces provide food for catopid and silphid beetles, guanobious Diptera (dung flies), and their larvae. The large grey woodlice, pholcid and nesticid spiders are present yet again, and also two species of pale, troglophile harvestmen: one long-legged species; and one short-legged species similar to those commonly found in the forest floor litter. The silphid beetles probably belong to the species **Diamesus osculans** Vigors, a carrion bettle known from Australia, New Guinea, Indonesia and even India. Adults are primarily necrophages but may cannibalise their own larvae (Britton, 1970).

Unaanbonogo Tem just south of the Finim river sink is the habitat of a very unusual creature – a cavernicolous herbivore. This is a sap-sucking bug (Homoptera: Cixiidae) which feeds on tree roots which have penetrated the thin cave roof.

(c) Selminum Tem.

Selminum Tem consists essentially of a huge fossil phreatic trunk channel which has been invaded by numerous small misfit streams. These link up in two places (the Maze and Sump Series) into extensive networks of small, muddy passages.

There are two southern entrances to the cave. The upper of these is the home of a small colony of flying foxes (**Dobsonia** spp?) which are shot for meat by Wokkamin hunters. The faeces of these bats provides the major energy source of the upper cave fauna. This includes: pholcid spiders; large grey woodlice; millipedes; and a large, handsome species of troglophile staphylinid beetle (probably close to the Australian genus **Actinus**). Flying foxes are not common on the plateau, and the only other population known to the local hunters lives in the great blocked cave entrance of La Buum Tem.

There are three northern entrances to the cave, and these are used by swiftlets and cuscus, both of which travel considerable distances into the cave. Their faeces provide food for small white collembolans, millipedes, and catopid beetles.

The main trunk of the cave between the north and south entrances receives little energy input, and is practically devoid of life, though occasionally pale, long-legged harvestmen may be seen stalking across mud banks in the damper regions.

The main biological interest of the cave is provided by the muddy, active stream passages which intersect the main passage. The fauna of the three passages of quite different character which are discussed below, illustrate all the major characteristics of the deep-cave community of Selminum Tem.

(i) Bone Wells

The "Bone Wells" is entered by descending a narrow, 24 metre shaft in the silt floor of Tranquility, some 1½ kilometres from the southern entrances. The pitch drops into a narrow passage which may be followed upstream to where the fossil vertebrae and ribs of a desmostylid (a primitive sirenian, similar to modern sea-cows) protrude from one wall (preliminary identification by Dr. Rod Wells, Flinders University).

Downstream of the pitch, the passage is highly flood liable and the walls, and in some places the roof, are covered with wet, black, sticky mud. Close to the pitch is a muddy pool, beyond which the passage continues above a climb of about 2½ metres. Two white, eyeless, terrestrial triclad turbellaria (flatworms) were collected on the freshly-deposited mud just above the pool. Further downstream is a small side passage with a damp, but deeply cracked mud floor. Two remarkably interesting troglobites inhabit this side passage and the main flood-liable passage from which it leads. One is a long-legged, white and eyeless millipede; and the other an eyeless harpaline carabid beetle.

This millipede (the first known troglobitic species of the family Paradoxosomatidae (det. R.L. Hoffman) is by far the commonest and most ubiquitous troglobite in Selminum Tem. It is found only where the humidity approaches saturation, and usually close to water. The Bone Wells passage was visited only hours after a serious flood had passed through, and at this time millipedes could be seen emerging from cracks in the mud where they had taken refuge from the flood. Others had already emerged from their refuges and had moved onto the freshly deposited mud. The tolerance of this species to total immersion in water is remarkable. In another part of Selminum Tem, considerable numbers of millipedes of this, and a smaller species, were observed on the floor of a large, shallow pool, while other individuals of both species were walking on the surface film. The pool was fed by a small trickle, and had a dark brown floor which was in contrast to the surrounding pale, grey-brown silt of the cave floor. It is possible that micro-flora on the pool bottom were providing an energy-rich food source for the millipedes in an otherwise energy-poor environment.

The harpaline carabid beetle is also widespread in Selminum Tem, though it is never found in great concentrations. In addition, a single specimen was collected from Yaromdeng Tem; and a single specimen from Okemimal Tem on the north side of the Ilam valley. This beetle bears a close superficial resemblance to the European trechine carabid: **Aphaenops,** and the American anchomenine carabid **Rhadine.** It appears in fact to represent a new genus of the tribe Agonini (det. B.P. Moore). (Fig. 51). **Rhadine subterranea** Van Dyke feeds on the eggs of cave crickets, which it scoops from the silt using its elongated, flattened head as a shovel (Mitchell, 1965), whereas **Aphaenops pluto,** with a similar morphology feeds on Collembola and nematoceran Diptera (Vandel, 1965). Many American troglobite trechines feed principally on minute tubificid and enchytraeid worms which burrow in the silt along cave streams (Barr, 1968). The Finim Tel harpaline beetles may have any of these modes of nutrition, though a single observation of their feeding behaviour suggests that they are probably polyphagous opportunists: Biscuits dropped upsteam of the pitch during a hurried escape from a flood were deposited in the downstream section as the waters receded. On a visit the following day, two beetles were surprised while apparently feeding on a piece of damp biscuit, which was found to have small indentations covering the exposed surface. Both the beetles had extended abdomens indicating their replete condition.

Further downstream the Bone Wells passage drops into an impassable boulder choke, where flood deposits cover the roof, walls and floor of the passage. Close to this choke, a single specimen of a second species of troglobite harpaline carabid beetle was collected. This is a rather smaller species with longitudinally grooved elytra, and a distinctive keel bordering the thorax. It bears a superficial resemblance to the American cave trechine: **Neaphaenops tellkampfii** Erichson, which, like **Rhadine,** feeds on the eggs of cave crickets, which it ex-

FIG. 51.

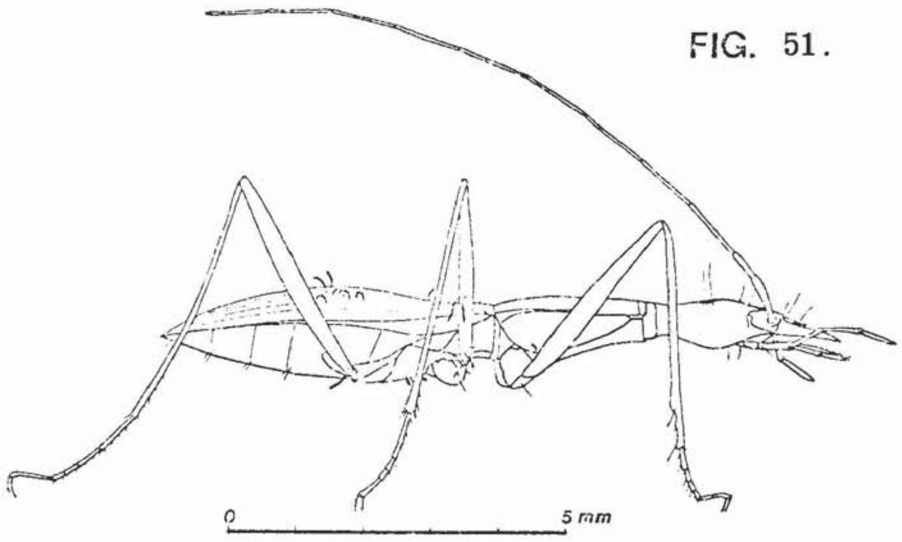


FIG. 52.

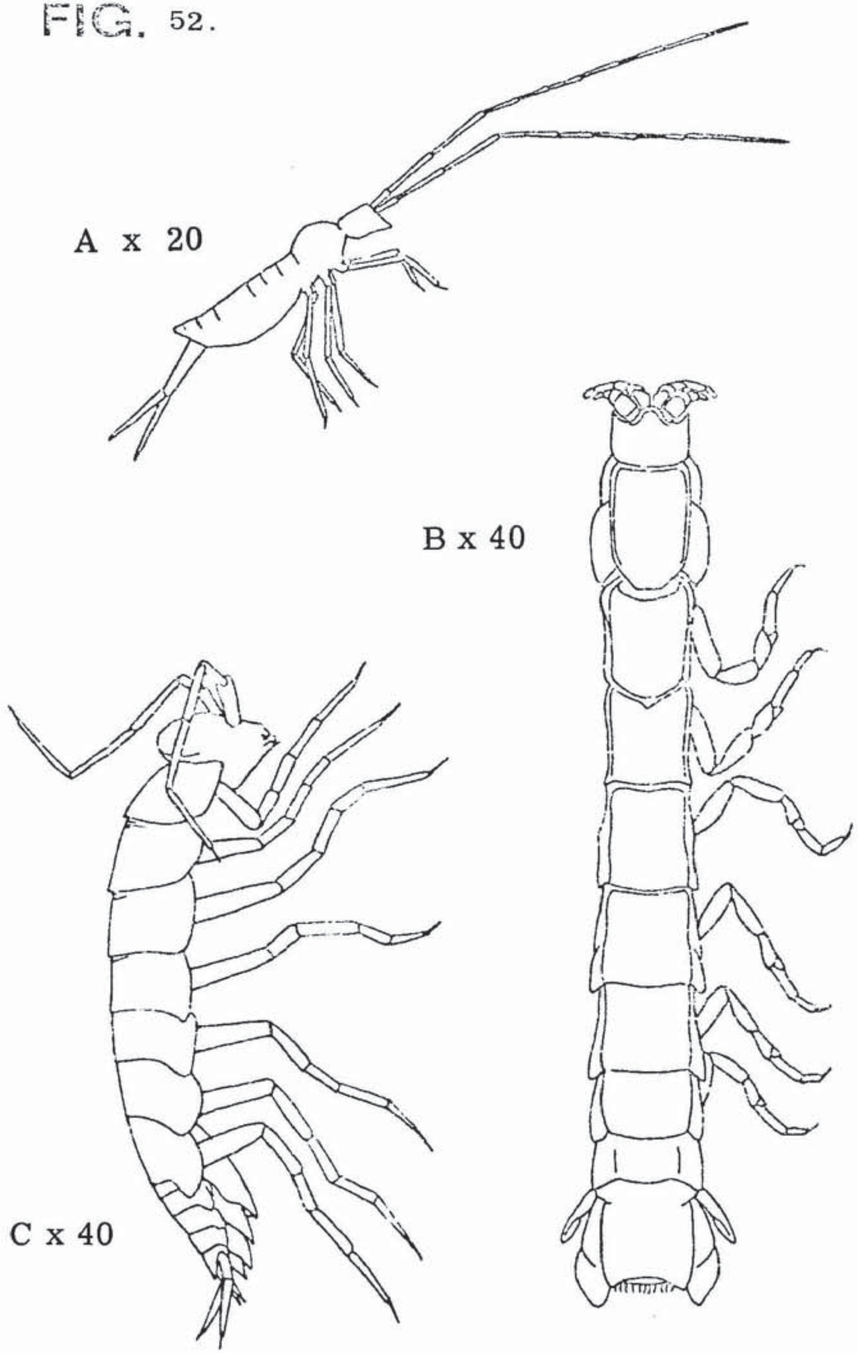


Fig. 51. Troglobitic harpaline carabid beetle from Bone Wells passage, Selminum Tem, representing a new genus of the tribe Agonini. Drawing from a preserved specimen. Left appendages not shown.

Fig. 52. A. Troglobitic "hump-backed" collembolan (Entomobryidae) from Mud River passage, Selminum Tem (lateral view). From a photograph showing the "take-off" position.
B. Troglobitic anthurid isopod from Stoat Inlet, Selminum Tem (dorsal view). Drawing from a preserved specimen (left legs not shown).
C. Troglobitic woodlouse (Oniscoidea) from Mud River passage, Selminum Tem (lateral view). Drawing from a preserved specimen (left legs not shown).

tracts from the silt using its long mandibles (Barr, 1962). It appears to be a new species of the genus **Gastragonum** Darlington (det. B.P. Moore). The discovery of this species was not altogether unexpected as its remains (especially the distinctive grooved elytra) are common on the fine silt floors of Tranquility and Moondust Oxbow. In one area of Tranquility, it had been noticed that the silt floor was covered in tiny pock-marks, as if it had been worked over with a minute pneumatic drill. In retrospect it seems possible that these indentations were due to foraging by the smaller species of harpaline carabids, though how long ago, and what it was they were finding to eat, may never be known. My own guess is that these beetles may once have flourished in the main passage of Selminum Tem when it was liable to extensive flooding and supported a large population of arthropods whose eggs provided the beetles with food. The opening up of new conduits ended flooding of the main passage, and the undisturbed silt of Tranquility preserves a record of the era before lack of food drove a reduced population of the beetles into the younger, deeper, energy-rich passages.

During floods, the troglobite beetles of the Bone Wells probably behave like the millipedes and take cover in convenient cracks. This is a behavioural reaction well known in troglobitic carabids. For example, **Aphaenops** in caves of the Pyrenees scurry into burrows to escape being washed away by flood waters (Vandel, in litt.); and American trechine beetles react to splashing water by rapidly crawling away from the edge of the stream (Barr, 1968). Some American trechine beetles can survive total immersion in water for several hours (Barr and Peck, 1965), an ability which is probably shared by the carabids of the Bone Wells.

Mention should also be made of another troglobite found in the same passage as the above species. This was a long-legged, fast moving, white trombidiid mite. A specimen belonging to the same species was collected in the Mud River passage, an account of whose fauna now follows.

(ii) Mud River

Mud River passage is a low-level loop in the north-western part of Selminum Tem. It connects at its southern end to the Stargate, and at its northern end to the Main Passage a little way south of the Astradome. The passage contains a vast deposit of mud, through which winds a small, damp flood channel, which marks the path taken by escaping floodwaters. At the northern and southern ends of the passage, the flood channel is shallow, and the mud floor is flat and lies close to the passage roof. Towards the mid point of the passage, escaping floodwaters have cut deeply through the flat mud floor to form the Mud Canyon. A small stream enters the passage close to its northern end, and flows for about 50 metres before disappearing beneath the western wall. The only other obvious outlet from the Mud River passage is a conical sink-hole quite close to the Stargate. Both outlets are tiny in comparison with the volume of the surrounding passages, and are probably totally inadequate as flood drains. A sudden, large water input into this part of the cave will therefore lead to very rapid inundation of the whole of the Mud River passage, and a substantial area of floor in the main passage south of the Stargate. During such inundations, the existing mud deposits are thoroughly mixed and redeposited together with freshly introduced organic matter. When the waters finally escape, the energy-rich sediments become available as food for terrestrial cavernicoles.

At the time this passage was visited, there had been no large scale flooding for a considerable period, as shown by cracks in the surface of the mud floor above the mud canyon. However a small flood must have recently occurred, as the mud floor close to the flood channel was damp and sticky, and the channel itself contained isolated pools in which frog tadpoles (accidentals) were living. Three species of troglobite millipedes were collected on the freshly-inundated mud. Two of these were numerous: — the large, long-legged and highly mobile species which was present in the Bone Wells passage; and a very small, white, stubby, rather sluggish species. Rather less common was another large, mobile species (the "spinybacked" millipede), easily distinguished by its flat dorsal plates, ending in recurved points. Two other troglobites are common to this and the Bone Wells passage. They are the **Rhadine**-like carabid beetle, and the long-legged trombidiid mite (both from Mud Canyon). A single white troglobite dipluran (Campodeidae) was found on the freshly-inundated "mud flat" continuation in the Main Passage south of Stargate.

The stream entering the northern end of the Mud River passage contained a troglobite dytiscid beetle (genus **Platynectes**), and also two probable accidentals: — a large dipteran larva (20mm. long) and a long white gordioid nematomorph. Close to the stream were several long-legged troglophile harvestmen of the species found throughout Selminum Tem, and in many other Finim Tel caves. The parasitic gordioid nematomorph may be a troglophile (or even a troglobite?), as Selminum Tem contains a number of potential troglobite hosts — e.g. dytiscid and carabid beetles and diplopods. However it is probably an epigean parasite, perhaps introduced into the cave by a streamborne host such as a caddis-fly, or dragonfly larva.

To the sides of Mud River passage, the gently domed roof approaches the flat mud floor in a progressively narrowing wedge. As the point of intersection is approached, the microclimate becomes more humid and more stable due to the gradual reduction of air currents which affect the centre of the passage. Unfortunately, observation and collection of animals becomes increasingly difficult as the gap between roof and floor narrows. Despite this, a rich fauna was observed, and in some cases collected. In addition to the three millipede species and single mite species mentioned above, two species of troglobite Collembola were collected, and a small, white, possibly troglobitic harvestman was observed. The larger of the two collembolan species (family: Entomobryidae?) has extremely long antennae and a large thoracic hump, features which are typical of the more highly adapted troglobitic collembolans. These modifications probably result from adaptation to existence in open spaces in cave chambers, rather than the restricted spaces in soil and leaf litter usually inhabited by collembolans (Christiansen, 1961). The smaller species was the more numerous and was also present in large numbers among wet rocks in the conical sinkhole close to the Stargate. Collembola may have a very varied diet. One species, **Hypogastrura purpurascens** (Lubb.), is known to feed on decaying vegetable matter, mycelia and spores of fungi, soft animal matter (dead flies, collembolans, earthworms etc.) and also on its own exuviae. It is probable that the Selminum Tem species indulge in similar unspecialised, opportunist feeding.

A small bedrock channel runs down from a wet, muddy boulder pile in one wall of Mud River passage almost to the edge of the conical sinkhole. Rounded cobbles in the floor of this channel have trapped bits of detritus, and here were found a species of white, long-legged troglobite woodlouse (Oniscoidea), (Fig. 52C) and a small-eyed troglophile (or troglobite?) centipede. The wet, muddy boulder pile yielded a small white troglobite spider (Linyphiidae?), and one of the large "hump-backed" troglobite Collembola. (Fig. 52A). The boulder pile also, presented a mystery. Several rocks were turned over to reveal small clay cells containing the exuviae of small spiders whose legs were arranged in a laterigrade fashion, characteristic of the family Sparassidae. However, a prolonged search in the vicinity of the remains failed to produce even a single living specimen. A fairly large, possibly troglobitic spider was seen close to the large splash pool between the Keyhole Entrance and the Astradome in Selminum Tem. This looked like a drassid, and may have belonged to the same (or a similar) species of white troglobite spider as is found in Okemimal Tem in the Ilam valley.

Both of the passages described above (Bone Wells and Mud River), are liable to severe flooding. The Bone Wells passage is small and frequently floods to the roof, whereas Mud River passage is large, and though liable to frequent flooding, usually only a relatively small area of floor is affected. In complete contrast, the final passage whose fauna will be described in this account is one which never floods.

(iii) Stoat Inlet

Stoat Inlet is a short stream passage leading from the undercut eastern wall of the Main Passage just to the north of Coprates Canyon. The passage receives two small inlets. The larger of these issues from an aven as a splashing waterfall, and flows down a well-worn pebble-floored channel. The smaller one seeps from a bedding crack only a few millimetres high, and trickles down a flowstone wall through several small gour pools on its way to the passage floor. The united waters of both inlets flow into the shallow main stream of Stoat Passage, at the point of its emergence into the Main Passage.

The water issuing from the bedding inlet carries a considerable organic burden considering its size. The flowstone wall is stained brown below the seeps, and the gour pools are mud-floored. Three troglobite species were collected in the gours: – a pale, microphthalmic dytiscid beetle (and a beetle larva, possibly of the same species); a hydrobiid gastropod; and an anthurid isopod. (Fig. 52B).

The dytiscid beetles belong to an undescribed species of the genus **Platynectes** (determination by V.B. Gueorgiev, Sofia), and are one of the commoner troglobites of Finim Tel. They are found throughout Selminum Tem and in two or three other caves on the plateau, usually in small muddy streams with diffuse connections to the surface. They are seldom found in highly flood-liable passages. Molluscs form a common food of epigean Dytiscidae, so it is probable that this troglobite species preys on the gastropods described below.

The hydrobiid gastropods are small and blunt-spired, with almost perfectly transparent shells. They were only found in Selminum Tem, and then only in the deeper, non-flooding streams. However, similar gastropods were found in an epigean stream on nearby Mt. Fugilil, at almost 3,000 metres altitude. It therefore seems probable that the Selminum Tem species is a cryophilic relict from a colder climatic period.

The anthurid isopod (Fig. 52B) is a particularly interesting troglobite. Its elongate shape, and short appendages suggest a phreatobite existence, however its large size (8.5mm long) belies this. Most Anthuridae are marine dwellers, and it may be that the ancestors of this species entered interstitial crevices in the limestone during a period of marine invasion, and have gradually been isolated in their freshwater environment by later withdrawal of the sea. This is thought to be a relatively common pathway to isolation in hypogeous freshwater habitats, of aquatic troglobites which belong to predominantly marine groups (Barr, 1968).

A similar origin may be postulated for another singularly interesting troglobite – an errant nereid polychaete – which lives in muddy drip pools in Bem Tem, near Telefomin.This animal appears to be very closely related to an epigean species of the genus **Namanereis** found in the Black Sea! (preliminary determination by Marinov). Unfortunately the cave which is the only known locality of this species is both well-known and easily accessible, and is visited by sightseers who trample heedlessly over the pools in which the small white "sea-worms" live. The worms are obviously very ancient troglobites, which have successfully adapted from sea to freshwater life, then to cavernicolous life, and finally have survived orogenic uplift of their limestone habitat to its present altitude of 1,600 metres. It is sad that they should now at last be in imminent danger of extinction at the hand (feet?) of man.

The stream channel of the aven inlet contains small, pebble-filled pockets and shallow pools, connected by a series of riffles. The pools and pockets are the habitat of large, pink, lumbriculid(?) worms, and grey triclad flatworms. Both species are probably troglophile, though a similar troglobite species of flatworm is found in small, slow-flowing streams in southern Selminum Tem. The white, troglobite flatworms of Okemimal Tem (Ilam valley) live in drip-fed pools which receive a large energy input in the form of bat faeces. In contrast to the Selminum Tem troglophile species, they are usually found gliding about beneath the surface film of their pools, rather than on the substrate.

The main Stoat Passage streamway is wide, shallow, and pebble-floored. It contains a mixture of accidentals, troglophiles, and troglobites. The accidentals include frog tadpoles, and a small dark dytiscid beetle. The troglophiles are: lumbriculid(?) worms; flatworms; and smooth, pink leeches. These and the pimply-skinned terrestrial leeches found in Okemimal Tem and Kabim Tem (Ilam valley), may be thermophilic troglobites (see section (e) below). Two previously mentioned troglobites are also present in the Stoat Passage streamway. They are the hydrobiid gastropod and dytiscid beetle, which are also found in Stoat Inlet.

Possibly because of the lack of flood-borne detritus, Stoat Inlet contains very few terrestrial cavernicoles. A single specimen of the "spiny-backed" troglobite millipede (cf. Mud River) was observed, and there is a

Table 1. Taxonomic and ecological relationships of terrestrial cavernicoles of the highlands of Papua-New Guinea

Phylum	Class	Order	Description in text	Cavernicolous status[1]	Presumed mode of nutrition	Characteristics of habitat: degree of flood liability[2]	type of substrate[3]	nature of available food[4]
Platyhelminthes	Turbellaria	Tricladia	Triclad Turbellaria (flatworms)	Tbt	Predator	2, 3	C	iv
Annelida	Hirudinea	Gnathobdellida	Pimply-skinned leeches	Tph/Tbt	?	1	C, D	i, ii
Arthropoda	Arachnida	Araneae	Pholcid spiders	Tph	Predator	1, 2	A, C, D	i, ii, iii
			Nesticid spiders	Tph	Predator	1, 2	A, C, D	i
			Clubionid spider	Acc	Predator	2	A	i, iii
			Small white spider (linyphiidae?)	Tbt	Predator	2	C	iv
			White drassid ? spiders	Tbt	Predator	1, 2	C	i, ii, iv
		Opiliones	Short-legged harvestmen	Tph	Predator	1, 2	D	i, ii, iii
			Pale, long-legged harvestmen	Tph	Predator	1, 2	A, C, D	i, ii, iii, iv
		Acarina	Long-legged white, trombidiid mites	Tbt	Predator	2	C	iv
			Parasitic ticks (Ixodidae)	Acc	Parasite	1	D	i, ii, iii
			Various epigean mites	Acc	Predators/Detritivores	1, 2, 3	B, C, D	i, ii, iii
	Crustacea	Isopoda	White long-legged woodlouse (Oniscoidea)	Tbt	Detritivore	2	A, C	iv
			Large grey woodlice (Oniscoidea)	Tph	Detritivore	1, 2	A, D	i, ii, iii
	Chilopoda	Scolopendromorpha	Small-eyed centipede	Tph	Predator	2	A, C	iv
	Diplopoda	Polydesmoidea	"Spiny-backed" millipedes	Tbt	Detritivore	1, 2	C	iv
			Large, long-legged, white millipedes	Tbt	Detritivore	2, 3	C	iv
		Limacomorpha?	Very small, white, stubby millipedes	Tbt	Detritivore	2, 3	C	iv
		?	Other millipedes	Tph	Detritivores	1, 2	C, D	i, ii, iii
	Insecta	Collembola	Small, white Collembola	Tbt	Detritivore	2	A, C	i, ii, iii, iv
			Large, white, "hump-backed" Collembola (Entomobryidae?)	Tbt	Detritivore	2	C	iv
			Collembolan with a water-repellent covering (Sminthuridae?)	Tbt	Detritivore	1, 2	A	i, iv
			Other Collembola	Tph/Acc	Detritivores	1, 2, 3, 4	A, B, C, D	i, ii, iii
		Diplura	White dipluran (Campodeidae)	Tbt	Detritivore	1, 2	C, D	iv
		Diptera	Guanobious Diptera (dung flies)	Tph/Acc	Coprophage	1	B	i, ii
		Hemiptera	Sap-sucking bug (Homoptera: Cixiidae)	Tph	Sap-feeder	1	D	tree roots
		Trichoptera	Adult caddis flies	Acc	Non-feeding	1, 2, 3	A, C, D	i, iii
		Coleoptera	Catopid beetles	Tph	Coprophage	1	B	i, ii
			Silphid beetles (**Diamesus osculans** Vigors?)	Tph/Acc	Omnivore/Coprophage	1	B	i, ii
			Large, handsome staphylinid beetles (**Arctinus?**)	Tph	Necrophage/Predator	1	B, D	i, ii, iii
			Small staphylinid beetles	Acc	Omnivores	3, 4	C	i, iii
			"Rhadine-like" carabid beetles (harpalinae)	Tbt	Omnivore	2, 3	A, C	i, iii, iv
			"Neaphaenops-like" carabid beetles (Harpalinae)	Tbt	?	3	C	iv
			Large carabid beetles	Tph	Predator/Necrophage	3	C	i, iii
Chordata	Aves	Apodiformes	Cave swiftlets (Apodidae: **Collocalia** spp.)	Tx	Insectivore	1, 2	A, D	
	Mammalia	Marsupiales	Cuscus, or Kapul (**Phalanger** spp.)	Tx	Omnivore	1	A, D	
		Chiroptera	Flying foxes (Dobsonia spp.)	Tx	Frugivore	1	A	
			Bats (Rhinolophidae?)	Tx	Insectivore	1	A	

[1] Tbt = troglobite; Tph = troglophile; Tx = trogloxene; Acc = accidental.

[2] 1 = non-flooding; 2 = flooding usually partial, some "refuge habitats" unaffected; 3 = total flooding due to backing up of stream; 4 = passage flash-floods" to the roof.

[3] A = clean-washed rock and boulders; B = guano bed; C = abundant sticky mud; D = drier, firm, well-consolidated clay.

[4] i = epigean flying insects present; ii = trogloxene faeces/bodies; iii = leaves, twigs, logs, iv = any detritus present is finely triturated and well decomposed.

Table 2. Taxonomic and ecological relationships of aquatic cavernicoles of the highlands of Papua-New Guinea.

Phylum	Class	Order	Description in text	Cavernicolous status[1]	Presumed mode of nutrition	Characteristics of habitat: degree of flood liability[2]	type of substrate[3]	nature of available food[4]
Platyhelminthes	Temnocephalida	Temnocephala	Temnocephala (**Temnocephala** spp?)	Acc	Predator/Parasite	2, 3	A, B	i
	Turbellaria	Tricladia	White flatworms	Tbt	Predator/Necrophage	1	B	ii
			Grey flatworms	Tph	Predator	1	A	ii
Aschelminthes	Nematomorpha	Gordioides	Long, white gordioid nematomorphs	Acc/Tph?	Parasite	2, 3	B	i, ii
Annelida	Polychaeta		Errant nereid polychaetes	Tbt	Detritivore	1	B	ii
	Oligochaeta	Prosopora	Lumbriculid (?) worms	Tph	Detritivore	1	A, B	ii
	Hirudinea	Gnathobdellida?	Smooth, pink leeches	Tph/Tbt	?	1	A	ii
Mollusca	Gastropoda	Mesogastropoda	Hydrobiid gastropods	Tbt	Detritivore	1	B	ii
	Pelycopoda	Eulamellibranchia	Small bivalves	Acc	Filter-feeder	2	B	i
Arthropoda	Crustacea	Cyclopoidea	Cyclopoid copepods	Tbt?	Predator/Filter-feeder	1, 2	B	i
		Isopoda	Anthurid isopods	Tbt	Omnivore	1	C	ii
		Decapoda	Freshwater crabs	Tph	Omnivore	2, 3	A, B	i
	Insecta	Hemiptera	Water striders (Heteroptera: Veliidae?)	Acc	Predator/Necrophage	2	B	i
		Trichoptera	Caddis fly larvae	Acc	Omnivore	1, 2	A, B	i
		Coleoptera	Pale micropthalmic dytiscid beetles	Tbt	Predator	1	B	ii
			Small, dark dytiscid beetles	Acc	Predator	1, 2	A, B	i, ii
		Diptera	Large dipteran larva	Acc	?	2	B	ii
Chordata	Amphibia	Anura	Frog tadpoles	Acc	Omnivore	1, 2	A, B	i, ii

[1] Tbt = troglobite; Tph = troglophile; Acc = Accidental

[2] 1 = non-flooding; 2 = floods due to backing up of stream; 3 = "flash floods".

[3] A = clean washed rock/stones/gravel; B = mud.

[4] i = leaves, twigs or logs; ii = any detritus present is finely triturated and well decomposed.

Table 3 The ecological composition of the faunas of various types of terrestrial cave habitats.

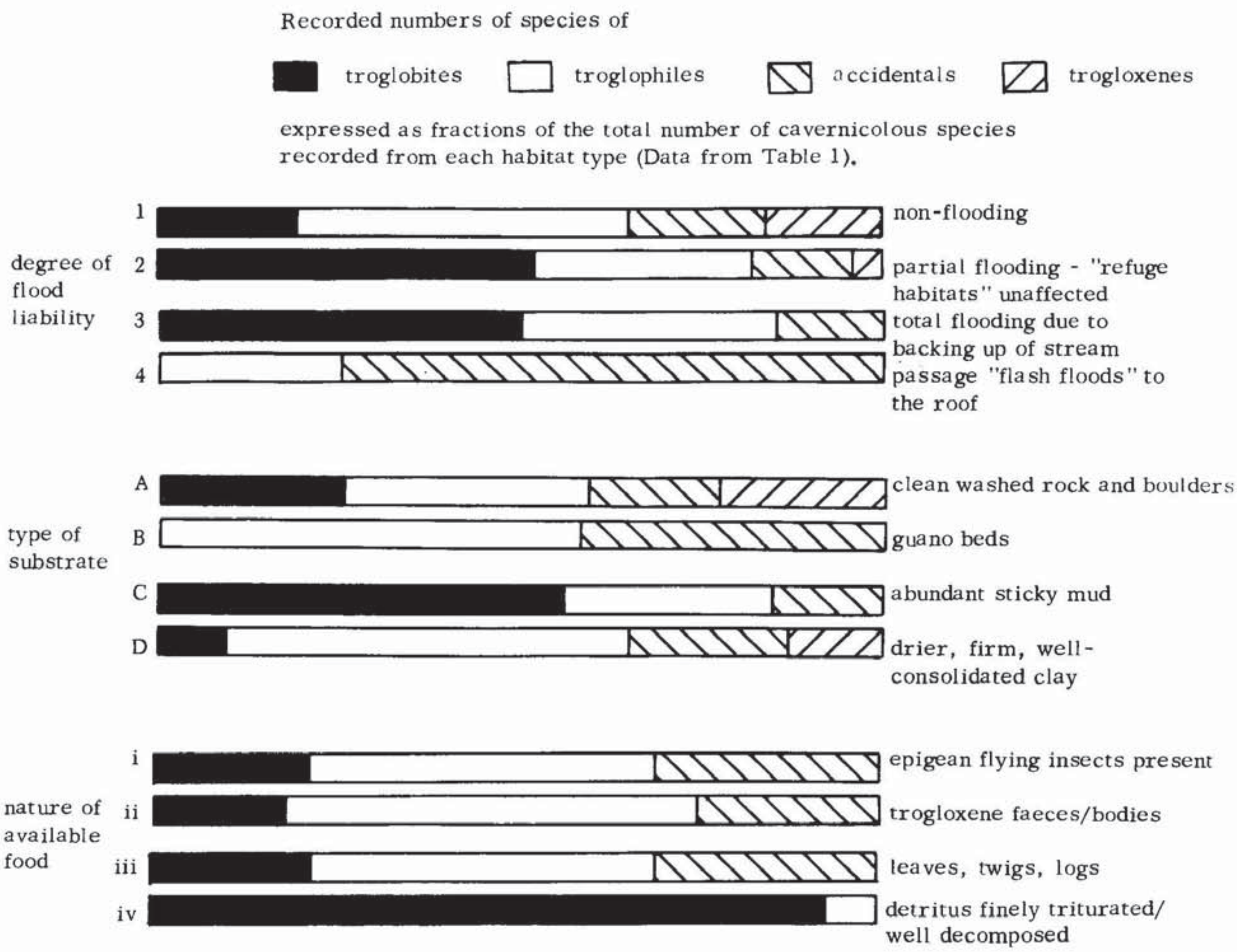
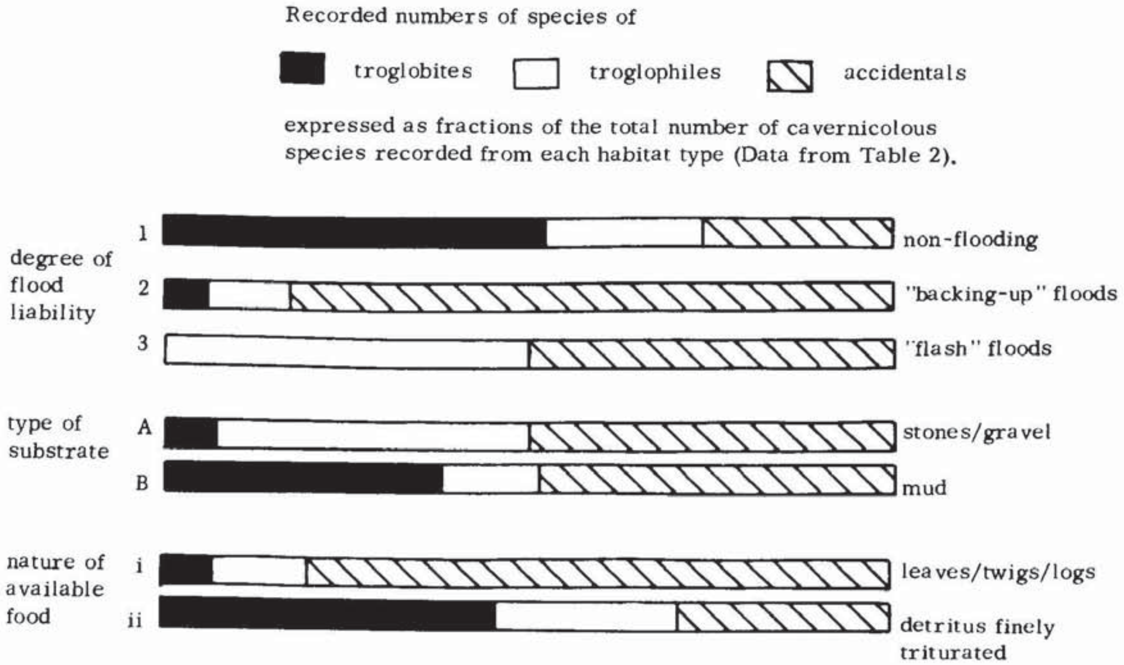


Table 4 The ecological composition of the faunas of various types of aquatic cave habitats.



well-established population of troglophile pholcid spiders, including egg clusters, and juveniles of all sizes. It is possible that the spiders feed on the imagines of streamborne insect larvae (such as Trichoptera), but such food cannot be plentiful.

(d) The habitat preferences of troglobites on Finim Tel.

In Tables 1 and 2, the various cavernicoles mentioned in this account are listed together with their distributions within various types of habitats defined according to: liability of flooding; type of substrate; and nature of available food. Tables 3 and 4 analyse the composition of the faunas of these habitat types according to the recorded number of species of troglobites, troglophiles or accidentals (and in some cases trogloxenes) as a fraction of the total number of cavernicolous species recorded from each habitat type. Table 3 shows that terrestrial troglobites tend to dominate the cavernicolous fauna in passages which flood periodically, but not violently, and which contain abundant sticky mud and finely triturated, well decomposed detritus. Table 4 shows that aquatic troglobites form a major component of the cavernicolous fauna in mud-floored, non-flooding pools and streams where organic input is again in the form of finely triturated, well decomposed detritus. Some possible underlying causes of these distribution patterns are discussed below.

(i) Requirement for cave mud

The dependence of aquatic and terrestrial troglobites on cave mud was first evaluated seriously after Heuts and Leleup (1954) correlated faunal richness with lithology of different cave-bearing strata. The importance to troglobites of limestone lithology may be trace minerals, and that of mud, organic content. Gounot (1960) found that clays where troglobites occur contain 15-70 million bacteria per g. dry weight, including 15-40 million ferrobacteria. It is possible that ferrobacteria are an important food source even around organic debris where nitrate concentrations exceeding 1mM result in heterotrophy, or that bacteria are secondarily important to troglobites because they break down organic matter and make it available (Caumartin, 1963; Poulson, 1964). Ferrobacteria also have an antibiotic effect which may help to explain the impaired survival of troglobites without clay. For example, eggs of the cave beetle **Aphaenops** are laid and develop where clays have many bacteria, but are attacked by mold in the absence of bacteria (Caumartin, 1959). Bacteria may also be important in supplying essential vitamins to troglobites, because of the absence of green plants in the subterranean environment (Vandel, 1965). Marzolf (1965) has observed that the amphipod **Pontoporeia affinis** selected conditioned substrates containing large populations of bacteria, while not selecting similar substrates which did not contain bacterial populations.

(ii) Requirement for well triturated, well decomposed detritus

Very abundant, fresh detritus may be swarming with troglophiles and accidentals, but it rarely attracts many troglobites. Finely triturated or well decomposed detritus can apparently be utilised much more efficiently. It is probable that troglobite detritivores use only decomposition products of wood and leaves, or perhaps the bacterial and fungal decomposers themselves (Barr, 1968). Large molecules such as cellulose, starch, and lignin are resistant to bacterial decomposition, but are readily decomposed by fungi (Andrews, 1973). These subunits may then be utilised by troglobites.

Studies conducted on both epigean and hypogean collembolans indicate that a number of species feed directly on the hyphae of various fungi and that the distribution of various fungi is a major factor in the distribution of certain collembolans (Christiansen, 1964). A number of epigean stream detritivores have been found to exhibit a clear preference for leaves containing fungal colonies over autoclaved leaves (Hynes, 1970). Studies by Barlocher and Kendrick (1973) on the amphipod **Gammarus pseudolimnaeus** have indicated that the largest weight gain in young individuals occurred on a diet consisting of several types of fungi, rather than on diets of autoclaved leaves or leaves containing bacterial populations. Dickson (1975) has found a significant positive correlation between the density of fungal populations in the mud bank sediments of Madison Cave, Virginia, and the presence of large gatherings of terrestrial troglobite invertebrates.

(iii) troglobite distributions in relation to flooding.

The destructive effect of flash floods on cavernicoles has already been mentioned (see "Stream Sinks"). The most rapid recolonisers after such floods are the stream borne or winged accidentals. The main energy source in flash flooding passages is usually fresh vegetable detritus, sometimes in the form of large logs. Such detritus is seldom utilised by troglobites, and so it is not surprising that no troglobites were found in flash flooding passages on Finim Tel. However flooding streams would seem to be the only means by which food energy can be transported from the surface and made available to terrestrial cavernicoles inhabiting remote passages. Deposition of organic detritus is not the only importance of floods, Caumartin (1959) has shown that the differential distribution of bacteria is dependent on flooding which replenishes PO_4^{3-} and Fe^{2+}, and maintains an excess of Cl^- over SO_4^{2-}.

Because of the very high rainfall of the Finim Tel plateau, and the absence of a dry season, underground floods probably occur frequently all the year round. This is seldom the case in temperate regions, or for that matter in most other tropical regions, where flooding is usually seasonal. Some of the troglobites inhabiting Finim Tel caves have evolved behavioural and possibly physiological characteristics which enable them to survive frequent inundation by floods (see "Bone Wells"). These adaptations are responsible for the absolute domination by a frew troglobite species of the terrestrial environment in the totally flooding deep-cave passages of Selminum Tem, such as Bone Wells. However, the most diverse faunas are found in those passages in which flooding is limited and the terrestrial troglobites have the advantages of a frequently renewed source of food adjacent to a refuge area. An excellent example of such a passage is "Mud River" in Selminum Tem where the flat, frequently inundated mud floor provides a large, energy rich grazing area flanked by high, deeply cracked mud banks which provided a very safe refuge during floods.

Poulson and Culver (1969) found a significant negative correlation of faunal diversity with intensity of flooding in terrestrial habitats in the Flint Ridge – Mammoth Cave system, Kentucky. They also found a positive correlation of diversity with food standing crop, which is increased primarily by floods depositing organic debris at the high water mark. At first sight these two sets of correlations seem paradoxical. The paradox disappears if flooding is seen as a "necessary evil", which destroys the cavernicole if too intense, but which is necessary for its survival as the main source of energy input into the terrestrial cave ecosystem.

Most non-flooding, mud floored cave streams and even drip pools probably contain sufficient food energy to support low density populations of troglobites. Dickson (1975) found fairly dense populations of bacteria and fungi inhabiting the mud floor of drip pools in Molly Wagle Cave, Virginia. Flooding is therefore probably an unnecessary evil to aquatic troglobites, which is why they favour non-flooding environments.

(e) Origin of the Finim Tel troglobites in relation to the history of the Finim Tel plateau and its caves

It is probable that uplift of the Finim Tel limestones began about 8 or 9 million years ago towards the end of the Miocene. Cave formation probably began as soon as the limestones were exposed, and while they were still poorly jointed and horizontally bedded (Fig. 50a). Transgression by the sea at this time allowed colonization of fissures and caves by marine animals such as the anthurid isopods of the Finim Tel plateau and the **Namanereis** of the Telefomin area. Withdrawal of the sea, or further uplift of the limestone resulted in the isolation of these marine animals in the caves.

Further rapid uplift and tilting of the limestone (accompanied by jointing and some faulting) preceded the second stage of development – the formation of the phreatic passages of Upper Selminum Tem (Fig. 50b).

During this stage the original phreatic tube cave probably became available for colonization by the terrestrial epigean ancestors of the present day troglobites of the Finim Tel plateau. The troglobite anthurid isopods may have survived the period of orogeny and drainage of their cave habitat by adopting a phreatobite existence or they may have begun hypogean life as inhabitants of interstitial crevices in the limestone.

By the Pleistocene, uplift of the Finim Tel plateau was probably complete, and the Ok Kaakil, fed by a large catchment, had abandoned the upper phreas to form the large diameter Main Passage of Selminum Tem (Fig. 50b). The terrestrial fauna of the cave at this time probably included numerous troglophile species of edaphobite origin, such as collembolans, campodeid diplurans, catopid and pselaphid beetles, diplopods, pseudoscorpions, linyphiid spiders and mites. With this preadapted cave fauna existing in conditions favourable to troglobite life, the profound climatic variations of the Pleistocene provided the isolating mechanism needed to initiate troglobite evolution. The ice sheet centered around Mount Aiyung appears not to have reached the limestone shale boundary to the north of Selminum Tem, but terminated ¼ to ½ mile upstream of the present sinks. We have no evidence to suggest whether the plateau experienced more than one period of glaciation, or whether glacial periods were separated by periods of warm, dry climate as in many northern temperate regions. What does seem probable is that many of the pre-glacial cavernicoles did not survive the glaciation(s), and that a cryophilic fauna (probably including the troglobite harpaline carabid beetles and the hydrobiid gastropods) colonised the caves during a cool climatic period.

The post-glacial warming up of the Finim Tel climate marked the easing of the conditions underground. Food input into Selminum Tem at this time was almost certainly high, with good passage integration and few connections to the surface. These are the conditions under which troglobites are most commonly found in caves and it seems likely that all the troglobite species known from Finim Tel originated during this period (except the anthurid isopods).

The troglobites which have been mentioned in this account fall into three broad categories of origin:
(a) The marine relicts which are very ancient troglobites.
(b) Thermophilic relicts including many species of edaphobite origin and also possibly the leeches and flatworms. These are the descendants of troglophile species whose epigean populations were unable to survive the Pleistocene glaciations.
(c) Cryophilic relicts whose ancestors colonized the caves during cold climatic periods and which were isolated in caves due to an inter-glacial or post-glacial warming of the climate.

The next stage in the development of the caves of Finim Tel was marked by the beginning of erosion and collapse of the older, higher cave levels, and formation of the lower levels of Selminum Tem (Fig. 50b). Flooding of the main passages of Selminum Tem during this period resulted in the deposition of large quantities of energy-rich sediments. Troglobites were probably at their most numerous at this time. Continued surface erosion resulted in the formation of the huge Selminum Tem doline which allowed easy access by epigean colonisers into the lower and upper cave. The end of this period was marked by solifluction on the steep southern wall of the Bahrman Mountains which may have caused a diversion of the Ok Kaakil headwaters and led to their eventual capture by the Ok Finim.

After losing its headwaters to the Ok Finim, the much reduced Ok Kaakil eventually cut through the floor of the phreatic tubes of its entrance series to form the vadose canyon of Ok Kaakil Tem, deserting Selminum Tem completely (Fig. 50c) Invasion of the deserted Main Passage by misfit streams resulted in erosion in some places and deposition in others. Upper Selminum Tem continued to be affected by surface erosion and collapse until now it has reached the final stages of degeneration as a suitable habitat for troglobites. Selminum Tem main passage is also declining in this respect. However, the great thickness of the limestone of the Finim Tel plateau and the large vertical distance between sinks and resurgences suggests a hopeful future for the Finim

Tel troglobites. For as one level becomes uninhabitable due to surface erosion and collapse, so a lower level becomes available for colonization.

In conclusion, there are three major factors which have contributed to the wealth of troglobite species found on the Finim Tel plateau. Firstly, an extensive system of caves has been available for colonization by epigean animals since before the Pleistocene. Secondly, climatic fluctuations during the Pleistocene have provided a mechanism for the isolation of potential troglobites in hypogean environments. Thirdly, depite the rapid rate of cave development and destruction, new, suitable cave biotopes are continually becoming available for colonization by troglobites due to the thickness of the limestone and the perched nature of the phreas.

(f) Future possibilities

The work done by the biologists during this expedition was necessarily very basic and very limited. Much has been found, but much still remains to be discovered. Several taxa which might have been expected to have troglobite representatives on Finim Tel were represented only by epigean or troglophile species. For example, no troglobite pselaphid or catopid beetles or pseudoscorpions were found. Only a single troglobite campodeid dipluran and linyphiid spider were found in Selminum Tem, and only a single specimen of the small "**Neaphaenops**-like" harpaline beetle. Systematic trapping of cavernicoles rather than the somewhat haphazard visual census which we employed seems likely to discover a large number of new troglobite species.

A cave as varied and complex as Selminum Tem cries out for more detailed study. The microflora of this cave and its relationship to the distribution of the various troglobite species would form a rewarding study. So too would the characteristics of vagility, physiological tolerance (including tolerance to submersion in water) and feeding habits of the terrestrial Selminum Tem troglobites.

Possibilities for even more interesting biological discoveries may lie beyond the unexplored entrance of "the hole in the wall". If the proposed road link between Tifalmin and the Ok Tedi is ever completed, and the plateau becomes easily accessible, such studies will become a practicable project.

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(c) TELEFOMIN ANTHROPOLOGY – K. A. WILDE

The anthropological material is, in the main, taken from accounts published by anthropologists Barth, Craig and Cranstone who have carried out field-work in the area; the material for the sections dealing with legends, rock-art, ancestral and prehistoric sites is mainly the product of expedition research and exploration. Some of the material relating to legends was taken from Craig and also Quinlivan, and includes a contribution by D. Jorgenson, an anthropologist resident in the Telefomin area at the time of the expedition.

The People and their Environment

The Telefomin area is dominated by the central mountain range of Papua New Guinea, which in this area forms a relatively narrow spine of massive marine limestones and karst features running at about 2600 – 3600 metres above sea level. To the north the ranges drop steeply down to about 1500 metres at Telefomin, with the main Telefomin valley being orientated approximately east-west and drained by the Ilam and Sepik Rivers. To the south of the range the land drops even more rapidly across a series of east-west ridges to the alluvial plains at only a few hundred metres above sea level. The landscape is then highly dissected by the tributaries of the Fly and Strickland Rivers partly with extensive karst and sink-hole formations. The most dominant feature is the Hindenburg Wall, an immense limestone cliff with up to 1000 metres relief and passable only in a few precarious places. (Fig. 53).

Ecology

Altitude and physical features combine to produce a series of markedly distinct ecological zones. Below the unused high mountain zone lie the moss forests of the cloud belt, reaching as low as 1600 metres in places. Then follows a middle zone of fairly luxuriant forest, including various species of wild pandanus with their highly prized nuts, covering the ridges and high valleys. In the main valleys from about 1000 metres and below one finds areas of gallery forest, including a species of breadfruit. The Telefomin valleys, a feature of which is the open 'kunai' grasslands (1000 – 1500m asl) are located in the middle and upper-lower zones (author). Finally the lowest valleys and particularly the alluvium, are covered by stunted jungle and occasional sago swamps. The whole area is characterized by heavy, though locally highly variable, precipitation and a virtual absence of seasons (although the latter part of the year has a tendency to be the driest) to the extent that most groups seem to have no calendrical system based on a year. The ecology of the area is thus distinctive but in many ways comparable with the slopes of the Bismark or Owen Stanley Ranges. (This description is mostly drawn from Barth (1974).)

Most villages and settlements are located in the upper part of the lower and the middle zones, scattered beneath the mountains or through the 'kunai' valleys. A number of small groups inhabit the lowland ridges and valleys, whilst the sago swamp areas in the alluvial plains are virtually uninhabited. The overall population of the Telefomin area numbers something in the order of 22,000 (1973-74 census).

The People: Physical Characteristics, Dress and Personal Adornment

The mountain people or 'min', are on the whole short and stocky in stature with the average height of the males being around 5ft 2ins, whilst the women are generally shorter and of smaller build. They are mainly darked skinned, but range from a light copper colour to almost black. The hair (since european contact) is worn short and is negroid in general characteristics.

Before contact with Europeans the hair was worn in a variety of styles, the most common being pigtails (Kienzle and Campbell, 1938) which were gathered together into a 'long stiff, tapered tail hanging down the back', which was then bound with string and usually painted red. Other hairstyles were the topknot which was made up by tying the hair into a bundle which was then held together by a net and kept in place with bone pins, and decorated with feathers; and, a less common style, which is still occasionally practised today, is the headdress refferred to as 'Taro Coiffure' (Kienzle and Campbell, 1938), and known as **sel**. This style is similar to the pig-tail style, but instead of being made up into a long tapered tail, the grass-wrapped tufts of hair are brought together and spread around a **taro** shaped cane frame and tightly bound with string. The whole arrangement is then painted with red clay and decorated with feathers. **Sel** wearing signifies a certain stage of initiation for males.

The nostrils of the male are generally pierced at the sides (although this custom now appears to be on the decline) and a pair of cassowary quills are inserted and worn sticking up the front of the forehead. The front of the nostril is often pierced for the insertion of beetle claws; likewise the septum in order to accommodate pig tusks. Pierced ears are not uncommon and in the past the ear lobe was pierced to carry a short length of decorated bamboo in which was carried a red dye for use in certain ceremonies (Kienze and Campbell 1938); shell and dog's tooth necklaces along with woven arm and leg bands are worn for personal adornment.

Today European style dress is quite common but far from general. Older males still favour wearing penis gourds, or phallic crypts, which are made out of a hollow, curved and tapering gourd, into which the penis is inserted and held in place by a string loop, attached to a split cane waist band. A second type is short, hollow and elliptical and is held in place by the nature of its tight fit. This form of 'dress' is now uncommon among the younger males who tend to prefer short trousers or a 'laplap' (cloth skirt or wrap-around). Many of the elder women continue to wear traditional dress in the form of a number of short grass skirts which are worn in two sections; one part to the front and one to the rear with several layers of skirt worn on top of each other. The breasts are left uncovered but since the advent of the mission this practice has become less common amongst the younger females.

Villages and Village Life

In general a village or settlement may consist of six to twelve houses, but may have as few as two or as many as thirty to forty as is the case of the main villages around Telefomin station itself. The village is usually constructed around a cleared square of land with the men's house **(yoram)** dominating one end and in some cases the 'spirit house' dominating the other. ('Spirit house' in Telefol is **amemam**, i.e. sacred or forbidden house, and in Tifal **amowk** or mother house). A short distance away from the village is the women's menstrual house, contact with females during menustration being generally prohibited. Women's houses **(unangam)** were observed in some villages and below the Hindenburg wall it was seen that these houses were occupied by women, children and pigs, and that, whereas an adult male was able to enter the women's house(s) freely, no woman was even allowed to look inside the men's house.

The houses are raised a foot or more off the ground and are built of sticks placed vertically. They are lined with split and flattened pandanus bark which is also used as a covering for the floor. A square fireplace (sometimes two, made of flat river stones) occupies the centre of each house. Above these are situated racks used either for the storage of wood or the drying of tobacco leaves. A standard type of gable roof with a very low pitch is used. This is covered with thatching which, though consisting originally of raw sugar cane tops, has, through the accumulated repairs of years, now become a heterogeneous mass of bark, grass and leaves. Roofs are generally constructed from pandanus leaves and sometimes giant ginger, bamboo or grass. The doorway consists of a flat slab of wood about one metre wide reaching from the floor to the roof and having a hole cut in the centre about twenty centimetres from the floor This hole, elliptical in shape and about 50cm high by 40cm wide is closed when the owner of the house is away by a barricade of planks laid closely together across the door. Above the door opening the slab narrows away to a point near the ridge pole. The upper portion invariably carries a crude design (the writer would describe these designs as attractive and colourful) usually coloured with red, white and black pigments (fig. 54 c & e). The floor is extended beyond the front wall of the house for a distance of about 40cm and forms a kind of verandah or platform on which to sit and scrape the mud off one's feet (author).

The inside of the house is devoid of furniture of any description and contains nothing except plates (the large slabs of bark or wood used for grated taro), bamboo or calabash water bottles, firewood, weapons, tobacco leaves hung up to dry, and an assortment of string bags. Occasionally the walls are decorated with a few pig or Kus-Kus (tree kangaroo) jaws.

Much of the above description was taken from Kienzle and Campbell (1938) and little has changed with the exception of a few European trade goods and the construction of a number of European-styled houses near Eliptamin and Telefomin itself.

Apart from a regular village house a family may have one or more pig houses and a garden house. Much of the family's time is spent away from the central village at such a house, and it is not uncommon for the main village to be abandoned for long periods of time. Garden houses are usually less elaborate than those in the village, but are of the same basic construction.

Farming is performed at a subsistence level with taro the staple crop of the higher agricultural zones, being the most valued food and sago in the lower swampy zones. Taro is cultivated by shifting swidden agriculture with only a single crop in the garden at any one time and a forest fallow cycle of about fifteen years. In the higher altitude this is supplemented by some sweet potato and bananas; in the low altitudes bananas become increasingly more important to the diet. Below 1000 metres breadfruit is planted in abandoned gardens, while red pandanus and in the higher areas pandanus nuts are harvested and are an important supplement to the diet. Finally there is extensive collecting of wild yams and a variety of leaves, shoots, roots and pith, etc. (Barth, 1971). Maintenance and tending of gardens is usually the responsibility of the female; males will sometimes participate, but in general only carry out the physically harder tasks such as clearing and fencing.

Domestic animals are dogs, pigs and fowl; pigs depending on wild boars for impregnation (Barth, 1971). Telefomin pig husbandry is generally poor by other highland-style community standards, but pigs are highly prized and are considered to be very valuable assets. Hunting of wild pigs, marsupials, birds, snakes, lizards and cassowaries is the main concern of the male; whilst gathering of grubs, insects, frogs and small reptiles is usually left to the women. The best hunting areas for pig and cassowary are considered to be in the middle zone, and the moss forest in the higher zone for marsupials. Hunters are generally armed with a bow and arrow and carry a vine loop for ascending tree trunks; they are often accompanied by one or more dogs and usually hunt during the night by moonlight. They will not venture out on a dark night.

In general daily village life is peaceful and pleasant; looking after one's gardens, tending to the needs of the children, looking after one's spiritual welfare, and hunting and gathering. With occasional garden clearing and re-construction of houses. The men's house **(yoram)** is the scene of endless discussions, ritual and story telling and is the centre of 'government' for the village with the elder males being in great standing. Respected young men and sometimes women may also participate in group decisions.

Polygamy is practised and a male may have as many wives as he can afford, but generally the average is about two. Marriages are often planned by the parents and/or group and payment in the form of pigs, bows, cowrie shells, string bags, and now money must be made to the girl's parents by the intending husband or husband's group. Ritual cannibalism was practised traditionally, but has now ceased.

Tribes and Inter-tribal Relationships

Trade alliances were generally north to south across the ranges; the main trade goods being stone adzes, (until the importation of the steel axe), tobacco, cowrie shells, pigs, bows and arrows, bird-of-paradise feathers and sometimes magical objects and seeds. (Barth, 1971). (This was also confirmed by the expedition). For traditional trade routes see map 'Rock Art, Ancestral and Prehistoric sites'. Trading partners were usually established over long friendships and trade was carried out on a delayed exchange basis, i.e: one gave one's partner an object such as a stone adze, but requested nothing in return until a later date when he was obliged to provide it. For distribution of tribes and tribal names see map 'Ok (Min) Tribes and Neighbours'.

Tribal fighting was generally orientated on an east-west basis, with the Felamin (Feramin) being traditional enemies of the Telefomin, the Telefomin and Urapmin being allies and the enemies of the Tifalmin groups. There were some exceptions such as the four Tifalmin groups who fought against each other but would also form an alliance to fight against the Urapmin (Cranstone, 1968). One of these groups, the Bufulmin, is said to have migrated from Feramin within the last eighty years (Cranstone, 1967), but the other groups seem to have been living in the valley for a considerable period of time. The expedition was mainly involved with these groups.

Warfare amongst tribal groups was endemic, but as a general rule component groups did not war against each other, however brawls with non-lethal weapons were known amongst such groups. Warfare is considered to have taken two basic forms – suprise and ambush and strategical, where opposing forces met in open fighting. Apparently all those killed were eaten regardless of sex or age (Cranstone). Trading friends were allowed to kill each other whilst their respective communities were at war, but would regret it later (Barth, 1971). Weapons of war were generally bows and arrows, stone axes and sometimes, but rarely stone clubs, wooden spatula clubs and small picks. Decorative war shields were carried for defence (Fig. 54d). According to the missionaries these picks or killing sticks, which have a cassowary claw at the sharp end, are new to Telefomin, having been acquired by trade from across the Strickland river. Decorative war shields were carried for defence (see Fig. 54d).

'Carrying the shield was the sole responsibility of a man. He was accompanied by one or more archers who used their bows from behind the cover of the shield. The shield-bearer controlled the tactics of his group, since where he went the archers had to follow: his therefore was a post of responsibility and honour. He sometimes carried a stone club with which to sweep down the front of the shield to break off arrows embedded in it. I was told that a notable warrior would sometimes rush at the enemy and bear him to the ground beneath the shield, immobilising him until the bowmen could shoot him. An elderly Urapmin demonstrated how he would creep through the grass, dragging his shield, and leap to his feet with a shout when near the enemy. In spite of the size and weight of the shields, the tactical emphasis seems to have been on rapid manoeuvre and mobility.' (Cranstone, 1968).

It is said that the selling of such a shield will cause a deficiency in the taro crop. Telefomin shields are said to bear individual names and have **sinik** (spirit, life, essence). When fighting is about to break out, they are informed, and when fighting is imminent, it is said that they make a low drumming or knocking noise. They are also supposed to become lighter in weight when going into battle (Cranstone, 1968).

There has been relatively little fighting since the establishment of the government station at Telefomin, and particularly since the 'kiap' (Patrol Officer) murders in the Elip Valley (see recent history).

Although nowadays tribal raids and ritual murders tend to be confined to the very remote areas of the sub-district (e.g. the borders with Irian Jaya and the Om river), Telefomin are very wary of travelling alone in enemy territory. The expedition noted no cases of Telefomin on their own in the Tifalmin valley and on at least one occasion a request for accommodation in our cookhouse was received from Telefomin who did not wish to trust the hospitality of their Tifal neighbours.

Inter-marriage between clans is common and a 'highly connected kinship web is formed.' Affinal ties, such as these, almost certainly lead to co-operation in gardening and housebuilding, and a certain amount of visiting between villages and clans, but also implies liabilities as well as rights. Occasionally women taken in battle were married rather than being killed and eaten. An affinal relationship implied a prohibition on killing, but did not mean non-participation in a raid, so long as one did not kill one's affine (Barth, 1971). Such communities are also brought together by infrequent and secular pig kills, and feasts, initiations and spiritual ceremonies.

Rituals and Cults

'Religious cult throughout the area takes the form of secret ritual directed at growth and garden fertility, and is associated with ancestral sacrae. Crucial formal variations in this cult are found in the organisation of male initiations and the constitution of different cult houses and their associated rituals.' (Barth, 1971). Although these observations were made amongst the Faiwolmin they apply equally to most of the **min** groups. There are several stages in male initiation and the ritual varies from clan to clan, but a common factor is the need for absolute secrecy, for only secret information has any value or power. These initiations and the instruction in folklore that accompanies the ritual are generally performed in the cult or spirit house. Many of the central villages have such houses and are known as **amamem** (Telefomin) or **amowk** (Tifalmin).

Generally these spirit houses, or temples are well constructed buildings (similar to normal villages constructions) often with colourful ancestral boards showing complex abstract designs displayed to the front of the house (Fig. 54). These temples generally contain ancestral relics, jaw bones of pigs (in very large numbers) and other sacred items such as ancestral skulls and bones and occasionally crocodile skulls. It is said (by legend) that the bones of a Feramin and a Tifalmin man killed by Afek are distributed amongst all the cult houses (see 'Legends and Mythology').

A central and unique **amamem** of special construction is located at Telefolabiip (Telefolip) and is said to have been the first cult house built by Afek a 'culture heroine' who travelled through the area constructing cult houses from Telefomin through to Bultem (see 'Legends and Mythology'), and is considered to be the ancestral mother of the **min** . A sacred grove near the approach of the Telefolip **amamem** is said to have been created by the death throes of Afek's husband, who is said to have taken the form of a serpent – only males are allowed to use this approach (Cranstone, 1968) and today the landrover track from Telefomin stops short of the village because the trees cannot be felled.

The Telefolip **amemam** is constructed out of plaited sago palm fronds and is in a bad state of repair: it has no external decoration and is raised about 3m above the ground. The original temple and its contents are believed to have been destroyed by fire sometime in the 1890's (pers comm by D. Jorgensen) and the existing one is said to have been constructed to replace it. It is traditional that the house cannot be repaired, only re-built. The importance of this central cult house is paramount and is the magico-spiritual force of many of the **min** groups. An interesting feature of the cult is that rival groups often join together and meet at the more important cult houses forgetting their previous animosity for the purpose of cult practise.

The **yoram** (men's house) also a prominent building in central villages is constructed along the lines of a normal village house. None were observed to be displaying ancestral boards, but it is believed that some have house boards similar to those in Fig. 55A. It may contain pig jaw bones and ancestral relics but its importance is secondary to the **amemam** or **amowk.**

As mentioned above the previous Telefolip **amemam** was burnt down; the tale associated with this occurrence demonstrates the significance of both the central cult and the building:- Apparently approximately 90-100 years ago a man of the Iligimin tribe came down to Telefolip and decided that he would destroy the cult house (the reason is so far unknown as far as the author can ascertain) with magic fire. He set fire to the dry walls and gave it instructions not to burn until he was safely away from the village. At the time all the villagers were away in their gardens and he was able to approach and retreat unseen. As soon as he was far enough away he instructed the fire to ignite the building. The villagers returned and were enraged by its destruction; they saw that the smoke was blowing towards the land of the Iligimin and interpreted that they were responsible. A complete genocidal campaign was instigated and all adult **Iligimin** males were slaughtered, sparing some of the younger women who were taken for wives and some of the young children who were adopted by the Telefolmin. Some of the Telefolip people then migrated to the lands of the Iligimin and now constitute the present tribe of Eliptamin. (This account is gathered from many sources, including D. Jorgensen and a number of Eliptamin informants).

Recent History

The Fly headwaters were visited by Austen in 1923, patrol officers Karius and Champion travelled through the area in 1927 and Bourke's geological expedition in the 1930s, but further contact was minimal, apart from the Americans extending the small airstrip, constructed by Bourke at Telefomin, until 1948 when the Australian Administration established a Patrol Post, again at Telefomin. It was not until the mid-1950s, however that the administration had much effect on the people. In 1952 two patrol officers and two policemen were murdered in the Elip valley (see Quinbuan, 1954) and the Telefomin experienced for the first time the extent of the government's resources in manpower, with extra Patrol Officers (Kiaps), army and large numbers of police. Ten men were later arrested, committed for trial and convicted of murder. This episode in the Telefomin's experience has had a profound effect on pacification. A mission was established in the late fifties and owns Telefomin's only trade store and sawmill. By the mid-1960s Olsobip and Oksapmin Patrol Posts were established and the Administration extended its influence to outlying areas. There are regular light aircraft schedules, but relatively few Telefomins have seen anything of the outside world. A primary school has been established for a number of years, but few adult people speak any English. There are little or no cash crops and no industry; a cattle project has recently been developed by the government. Two copper prospects, Ok Tedi to the south-west and Frieda to the north-east, have been discovered in recent years and, if viable, will be mined in the relatively near future.

The impact of European contact to date has been comparatively slight, but will be considerable when mining operations commence in the area. One can already see the affluence in the Elip Valley (adjacent to the Frieda Prospect), when one sees the many glittering corrugated iron rooftops when flying overhead. A change in life-style and abandonment of traditional building methods will rapidly be followed by the abandonment of traditional beliefs and customs. The future is uncertain, but it will be a future of both national and local conflicts, particularly over land issues (i.e. Companies and government versus villagers around the mining sites and access routes) and traditional values against progress. But, because Papua New Guinea has become a part of the modern economic world it cannot turn back. (For a full discussion of Papua New Guinea land problems see Sack, 1974)

Artforms

Artforms are varied and well developed occurring in personal adornment such as arm and leg-bands and self decoration with coloured pigments for ceremonial dances. Weapons of war such as arrow shafts and fighting shields, hand-held drums and on such things as bamboo smoking tubes. Elaborate and abstract designs also occur on house-boards and spirit-house boards (Fig. 54 & 55).

KEY TO FIGURES 54 & 55

Fig. 54

A. Three arrows made from 'pitpit' (a variety of wild sugar cane) with black-palm or bamboo points.
B. Hand-held wooden drum with carved painted base – colours red, white, orange and black.
C. Detail of carved decorative bamboo smoking tube – the pattern appears to be similar to those found on house-boards and war shields.

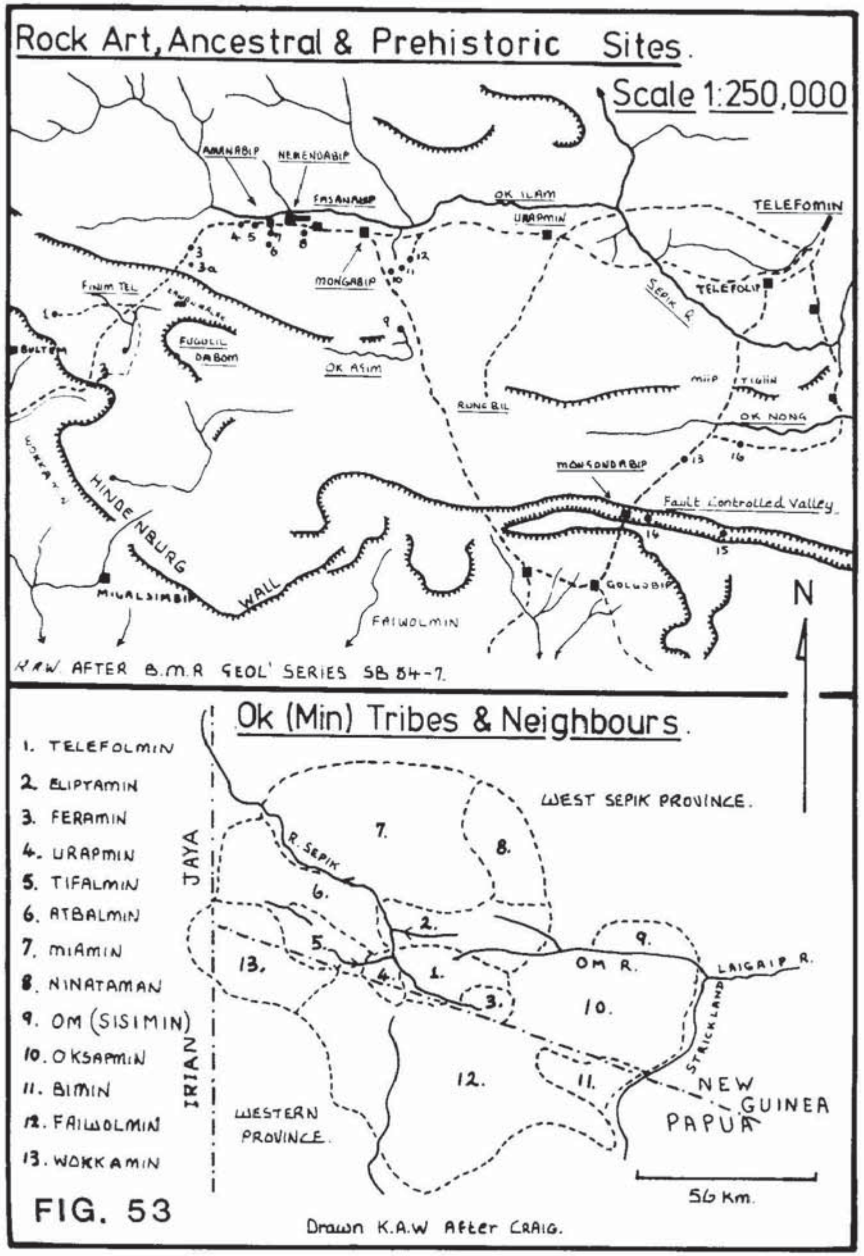

Rock Art, Ancestral & Prehistoric Sites.
Scale 1:250,000
TELEFOMIN
OK ILAM
URAPMIN
FASANABIP
MONGABIP
TELEFOLIP
SEPIK R.
FINIM TEL
DABOM
OK ASIM
RUNGBIL
OK NONG
MONSONDABIP
Fault Controlled Valley
HINDENBURG WALL
FAIWOLMIN
N
K.A.W. AFTER B.M.R GEOL' SERIES SB 54-7.
Ok (Min) Tribes & Neighbours.
1. TELEFOLMIN
2. ELIPTAMIN
3. FERAMIN
4. URAPMIN
5. TIFALMIN
6. ATBALMIN
7. MIAMIN
8. NINATAMAN
9. OM (SISIMIN)
10. OKSAPMIN
11. BIMIN
12. FAIWOLMIN
13. WOKKAMIN
WEST SEPIK PROVINCE.
R. SEPIK
OM R.
LAIGAIP R.
STRICKLAND
IRIAN JAYA
NEW GUINEA
PAPUA
WESTERN PROVINCE.
56 Km.
Drawn K.A.W After CRAIG.

FIG. 53

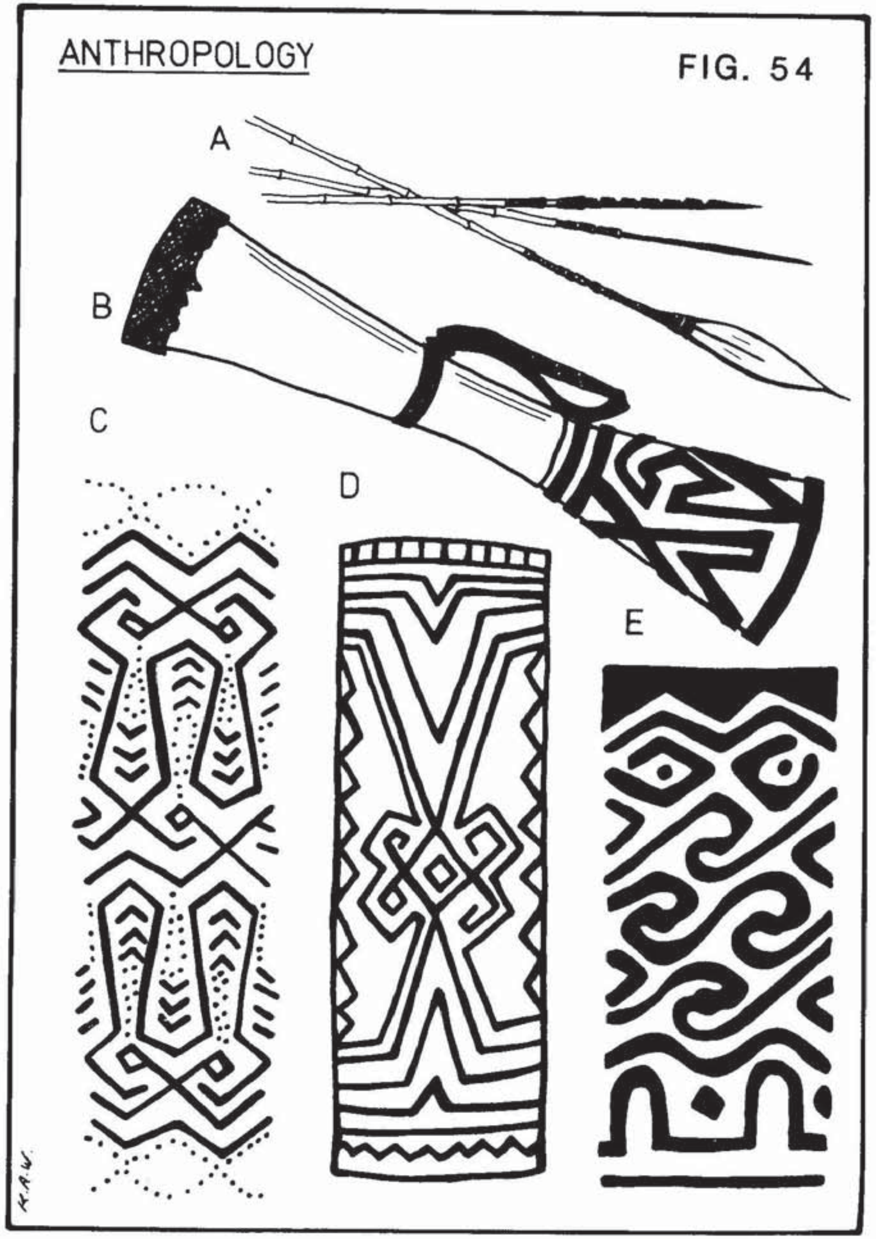
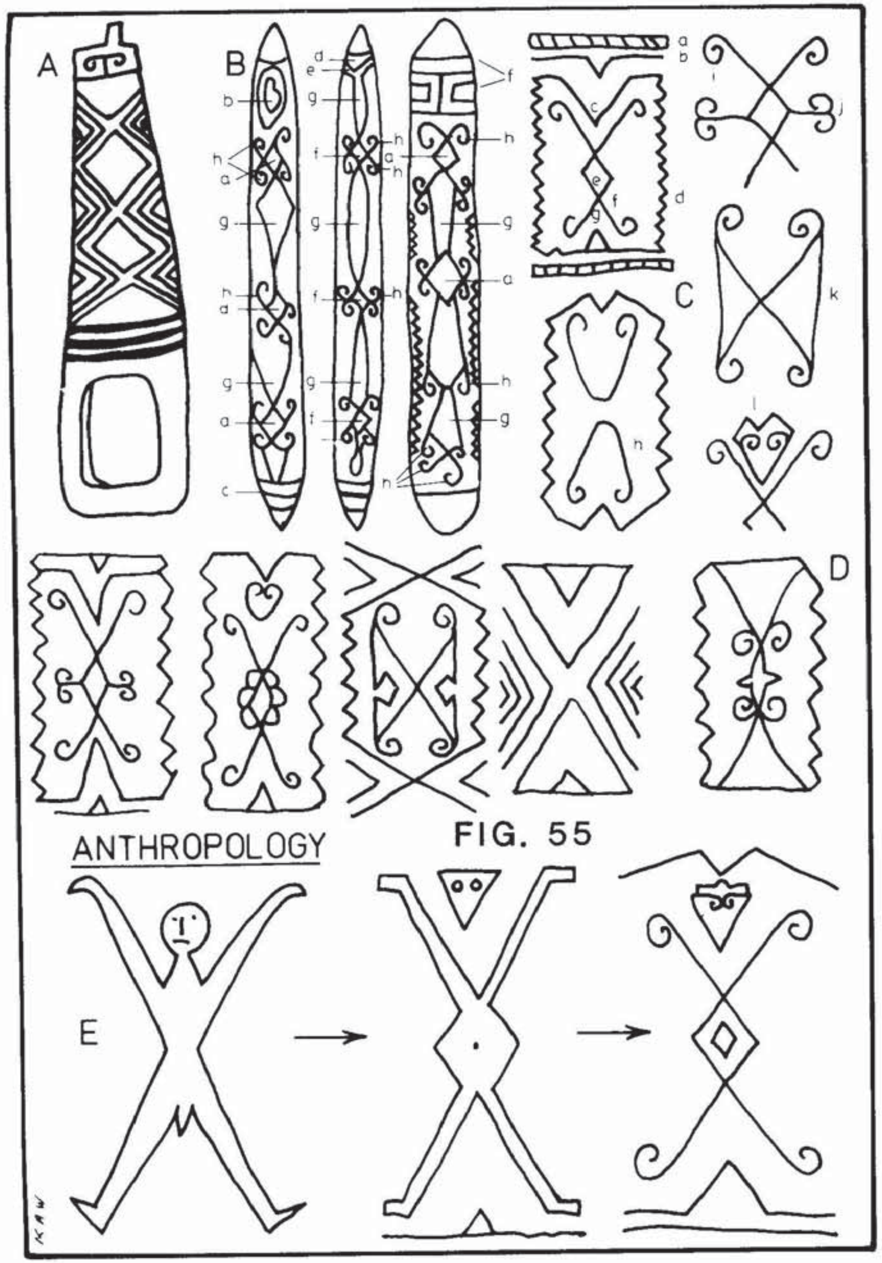

ANTHROPOLOGY
A
B
C
D
E
K.A.W.

FIG. 54

ANTHROPOLOGY

FIG. 55



ANTHROPOLOGY

FIG. 56

Anthropomorphic figures located on the walls of spirit house at Bufulmin by 1965 Star Mountains Expedition.

After HALLYER

R.A.W.

D. War shield, approximately 70cm wide and 1.5m high. The design is carved in relief and painted with red, yellow, white and black pignments. (Note similarities in design elements occurring on house-boards).
E. Carved detail from arrow shaft.

Fig. 55

A. House-board, typical of those found in the Telefomin area – colours red, yellow, white and black on carved relief.
B. Details from **amowk** boards at Amanabip Village, Tifalmin – after Cranstone (1967). Colours – black pigment; obtained by boiling charcoal and water, red ochre, and white 'paint' made from weathered limestone – the design is painted on a carved relief. Craig (1966) noted that the overall pattern has no complete meaning, but Cranstone (1967) was informed that the individual designs have the following meanings:- a) man's belly. b) man's head. c) man's belt? (uncertain). d) man's eye. e) man's arm. f) man's forehead. g) water (or stream). h) bird's feather (probably bird-of-paradise). i) snake or snake track. j) jew's harp. Cranstone notes that if allowance is made for the difference in proportion to length and width the patterns resemble some Tifalmin war shields.
C. The following meanings are taken from Craig (1967) and describe design elements in Telefomin house-boards such as those shown in Fig. 55A.
a) tracks of snakes. b) cockatoo's beak. c) cassowary's beak. d) tracks of a snake. e) vagina, lizard's liver, conus shell, moon (Urapmin); man's belly, spider's abdomen, umbilicus (Miamin). f) fore or hind leg of a crocodile, tail feather of bird-of-paradise, mark by a woodborer, Miamin; man's eye. j) mark made by wood borer, cooked taro grub. k) hawk's wings. l) cassowary's or other head, with eyes.
It is again interesting to note the relationship with the designs that appear upon war shields and spirit-house boards (author).
E. Shows Craig's hypothesis for the development of the central anthropomorphic design.
D. Shows a spectrum of house-board designs after Craig (1972).
Other artforms in the Telefomin area are known to occur on rock faces and cave walls (see section 'Rock art, Ancestral & Prehistoric Sites') also upon the back walls of houses (see below). It is not clear whether the art styles of the Telefomin are related to the Fly River people to the south, the Sepik to the north, or the highland groups to the east, but a certain degree of influence is apparent in all cases.

Fig. 56 shows a number of anthropomorphs 'discovered' on the walls of the Tifalmin **amowk** by the 1965 Australian Star Mountains expedition (Hallyer, 1965). Craig (1968) also recorded a number of bark wall paintings amongst the Wokkamin and Atbalmin which are very similar to those recorded by Hallyer. Craig postulates that there is a 'tendency towards dynamic representation' and a possible correlation with hunting and food gathering economies with a 'mental outlook based on magic which seeks to obtain results through action . . .' But, his informants denied the existence of any magico-spiritual significance. They also informed him that the act of drawing and painting was a form of entertainment and a means of passing the time. It is the opinion of the author, however, that there may be several categories of such art. This opinion is based on the consistency of design elements and the significance of some of the locations, such as inside cult houses and upon the wall of a cave such as Selminum Tem. The rock art could of course be considerably older than the present culture – most informants say that the rock art recorded in this paper was executed before living memory.

Legends and Mythology

An unusual factor of the **min** is their claim to a common genesis and the almost universal belief in **Afek**, an ancestral mother figure of great importance.

It is said that in the beginning the Telefomin Valley was a lake and when it finally drained away down the Sepik Gorge it left behind a 'desolate and sultry place' devoid of beauty. And, into this unpleasant environment there came a woman from an unknown land. Her name was Afek; which, directly translated, means old lady (Quinlivan, 1954). The myth says she came from Oksapmin with her younger brother and settled in the Telefomin Valley near Irintigin. The legend of Afek is long and complex with variations in the telling from group to group. It was told to us in confidence but normally is only revealed to initiates of the cult, hence it is not given in detail here. A full account has been deposited with the University of Papua New Guinea to preserve a written record and the following are aspects associated with caves.

Afek killed her brother by sorcery and he took the underground road of the dead to a place called Bagelam. It began beneath the spirit house at Telefolip and he surfaced periodically at such places as the Ogalbil and Wintem resurgences and Bultem. He did not return so she followed him, creating tribes and spirit houses as she went. Below Urapmin she formed a rock shelter (Win Imal) and declared that its location must be kept secret (and so we made no attempt to find it). A rock shelter under mount Aiyang was also created before Afek crossed the Bahrman Range to Finim Tel. Striking the ground she opened the Selminum Doline and slept in the Upper Cave, declaring it a place to hunt flying fox and for men to use. Next morning she created the Lower Cave and continued her underground journey towards Bultem. On emerging below the Hindenburg Wall she closed the exit and declared the Kaakil Resurgence sacred although a nearby cave was for flying fox hunting.

Another legend associates Afek with the sun in the creation story (Craig, 1967) and others link spirits with some of the caves in the Tifalmin and Nong valleys. It is said that a party perished whilst hunting flying fox in Agim Tem because an evil female spirit appeared and cut the long vine on the entrance pitch. A similarly tragic story is told about a cave near the Ok Ilam which was visited by a group of children hunting bats. The entrance closed of its own accord and the children were never seen again. Self closing caves are quite common in Papua New Guinea, particularly in the Chimbu and Eastern Highland Provinces (Wilde, 1975; Parker, 1967).

Ok Miben (site 16) is named after an old woman who is said to have brought snakes and frogs up the Sepik to the Nong valley and settled in the Ok Ket area. Much later the Alekelmin people who lived near the Nong resurgences were all killed by sorcery in a single day and this story explains why the region is uninhabited.

It is very obvious, then, that the caves and karst features constitute a very significant element in the Telefomin culture. It is interesting to note that the Faiwolmin trace their origin to a karst hole in the mountains (Barth, 1971). There are stories of entire villages disappearing beneath the ground at a place near Telefolip, and it is said that the spirits of these people still live underground and are seen, from time to time, on the surface. It is also said that the souls of dead persons live in caves and manifest themselves in the form of flying foxes and bats (Pers. Comm by Jorgensen).

A few caves are so sacred that they are tambu and may only be visited by masters of the cult. By always consulting local elders we kept well clear of such sites and from what they told us such features are usually rock shelters or impenetrable resurgences. All were at low altitudes and very few high altitude caves had any significance to our guides apart from rare flying fox roosts.

Rock Art, Ancestral & Prehistoric Sites

The following briefly describes a number of rock art, ancestral and prehistoric sites 'discovered' by the expedition (including the reconnaissance). The sites are presented from east to west and follow a numerical system for easy cross-reference with the main report. Detailed description of the environment surrounding the sites has been omitted as this is dealt with in the main body of the Expedition report.

Site No. 1 Selminum Tem (upper cave) (Fig. 57)

As this is a very significant site it is proposed that it be dealt with in some detail.

Approximately 40km west of Telefomin, and 15km west-south-west of Bufulmin (Tifalmin) nearest village Amanabip; and 10km north-east of Bultem (Wokkamin). Elevation approximately 2,500m. This site has two areas of interest (see cave survey); a large, mainly dry cave, and an over-hanging smoke-blackened cliff face. Located in a relatively large doline some 2km south-west of the main Finim Tel clearing. The main features are two man-made pits (Fig. 58A) of obvious antiquity and both located in the dark zone. Their purpose remains an enigma, but they may have been used as storage pits (?) or traps (?); or most likely, they may have had a magico-spiritual function.

Although there were no hearths observed within the interior of the cave there are remains of burnt wood and 'bombom' (grass) torches. The entrance area is dry and situated behind the drip line of the cliff, hence little current deposition is taking place and the soil profile appears to be dry and deep (?). The overhanging, smoke-blackened cliff-face to the south is dry and appears to be well used. The writer was informed that the cave features strongly in the local mythology (see Legends and Mythology) and that the cliff-face could be used as a cooking and sleeping place whilst hunting, but the cave itself was prohibited.

*Papua New Guinea National Site Survey Code

Selminum Tem (lower) (CER)

Only linked to the upper cave by an excavated passage this cave is the largest 'discovered' by the expedition, and the fact that we weren't the first humans to enter was a surprise to many expedition members. There is however, substantial evidence of intensive use, and penetration up to 200m from daylight. Local informants say that they do not enter the cave because of harmful spirits; the lack of footprints and the virgin appearance of the cave floor testify to this.

No objections were made to us entering the cave. Because of the complicated process of describing the locations of points of interest they have been listed and numbered below and can be easily related to the cave survey:

(1) Engraved bird, said (by local people) to be **kawel** (hornbill); scratched on a large, upright rock slab. Much of the engraving follows the natural cracks and morphology of the rock surface, but is undoubtedly man-made and is cut into soft, weathered limestone. A number of scratched parallel lines occur on the right-hand adjacent slab.

(2) Incised horizontal and parallel lines.

(3) Engraved lines of no apparent form to the writer.

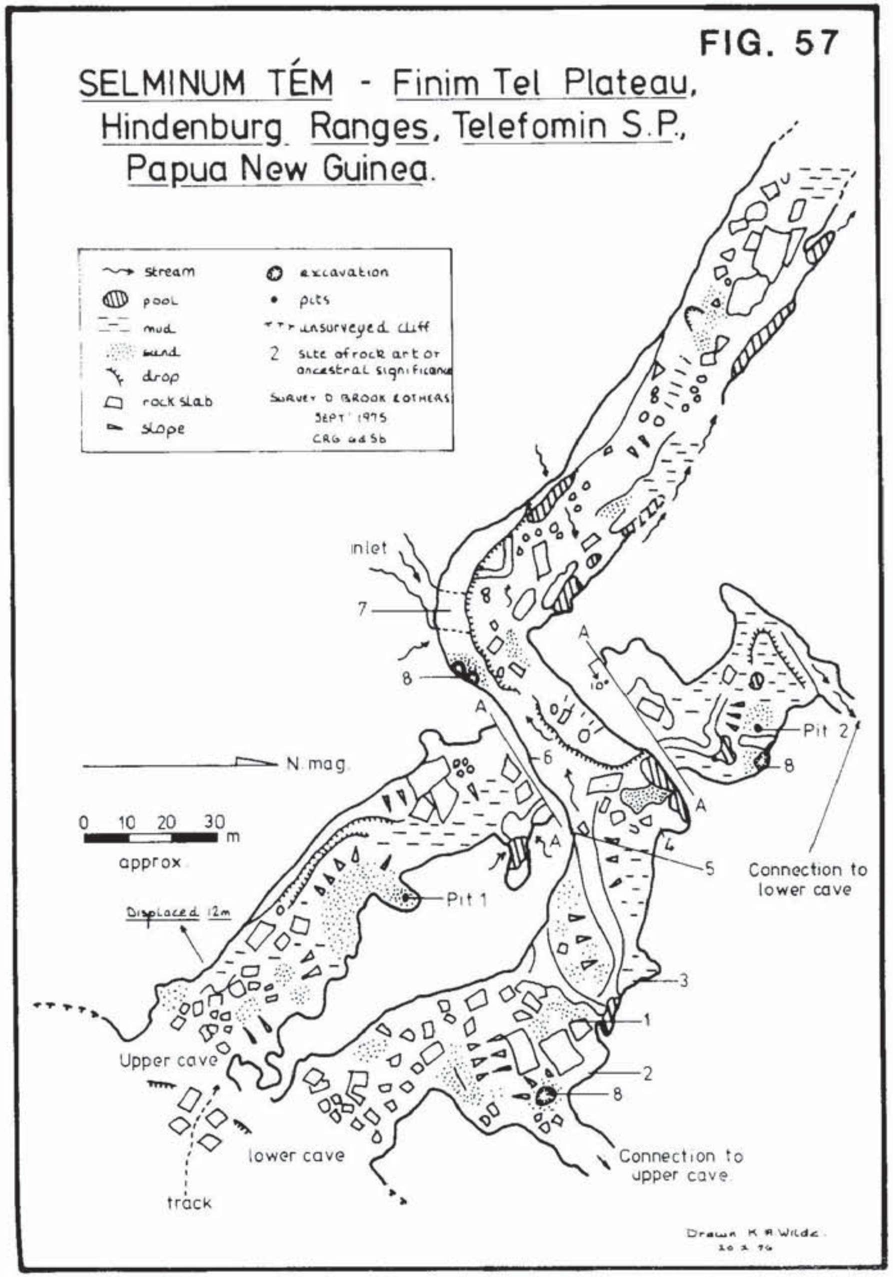
(4) Faded and almost indistinguishable and enigmatic motifs executed in a white mineral (possibly weathered limestone). The faded appearance gives the impression of antiquity – protected and dry.

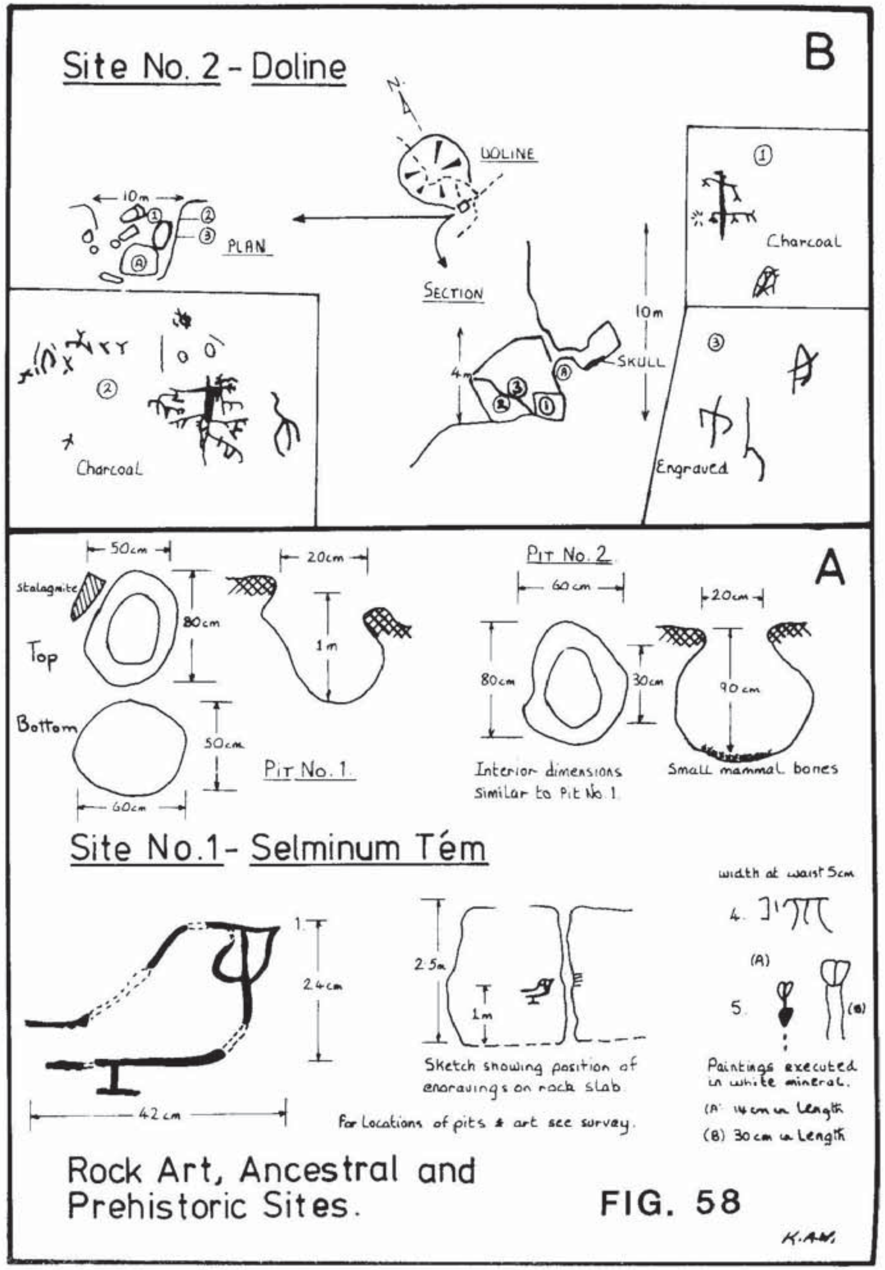
(5) Two paintings also executed with a white mineral, (a) a vulva with filled-in plectrum shaped form below and followed by two filled-in elliptical forms and less than 0.5m above floor level. (b) A form of no apparent meaning to the writer but possibly phallic, and similar to (a).

(6) Two extremely faded possible anthropomorphic forms executed in white mineral (as previous). These figures are exceedingly difficult to distinguish and accordingly have not been copied or photographed. The lower figure which is approximately 4m above floor level has bent upraised 'arms', and an open circular 'head' with radiating lines, and a filled-in rectangular and elongated 'body'; no 'legs' are visible. The second figure is 1m above and to the left of the first; and consists of a 'stick' like linear form with an open circular 'head' and outstretched linear 'arms' and 'legs'. The 'body' is linear, open and elliptical in shape with a stylized linear penis. Both these forms or figures are located beneath an area of percolation water. These forms are similar to others observed at the Aibura Site in the Eastern Highlands Province (Wilde, 1975a).

(7) Charcoal and decomposed wooden material – 'bombom' torches. Chert flakes that may be the product of tool making (?) were also observed and small flying fox and mammal bones were present in the same area. Dried and unidentified faeces was observed under a small overhang.

(8) Excavations, the purpose of which is unknown but appear to be considerably ancient (?).





Rock Art, Ancestral and Prehistoric Sites.
FIG. 58

Site No. 2 Bileldabom (Diroc)

A rock shelter in a limestone outcrop situated on the edge of a huge doline 20 metres to the west of the track from the Kam river to Fugilil dabom, some 5 minutes south of the junction of this track and the track cut by the expedition from Girtoil to La Buum Tem. Two charcoal anthropomorphic or zoomorphic forms possibly representing lizards, and one engraved form, possibly anthropomorphic. It is interesting to note that the lizard-like forms occur at site 6 and were observed by Craig (1968) on rock faces in the Wokkamin area (below the Hindenburg Wall). They have also been observed in the Western Highlands (Bulmer, 1966), the Eastern Highlands (Wilde, 1975b and 1975c) and also in Irian Jaya (Gallis, 1957b). 'Lizard-like' forms have been recently recorded at the Piri Caves in the West Sepik Province (Bragge, 1976). The 'bent arm' characteristics of these figures is similar to those recorded by Halleyer (1965) (see page 12 and fig. 57). Also present at this site are a number of enigmatic linear designs (see fig. 50b), some being similar to bird tracks. A human skull and leg bones were observed behind some boulders in the further recesses of the site. Environmentally identical to site 1. (Reported by A. White and recorded by D. Brook).

Site No. 3 Skel Waap Imal (CEP)

Approximately 24km west of Telefomin, and 5km west-south-west of Bufulmin, the nearest village being Amanabip. Located at an elevation of approximately 2,000m on the main Tifalmin–Tabubil traditional trade route (see map). A rock shelter formed by a limestone slab on the edge of a large doline. Well protected, dry and smoke blackened with evidence of intensive use over a long period of time. Located in the lower montane forest of the middle zone and used for hunting and gathering. This site is frequently used by the Tifalmin and Wokkamin groups.

Site No. 3A name not recorded

This is situated approx. ½ hour higher up the track than site 3 and lies about 100 metres to the east of the track. Its relative seclusion means that it is used more frequently. A well protected, smoke-blackened shelter with no art forms apparent.

Site No. 4 Wok Dubim Tem

Approximately 18km west of Telefomin and 1.5km west of the Bufulmin Villages. Located in the habitated zone of 'kunai' valleys. Burial alcove in limestone cliff face, with a number of comparatively recent burials, said to have been persons of the Winurapmin killed during a pre-contact days fight over a gourd containing highly prized pig grease. The informant stated that the fight had taken place within living memory. Cranstone (1968) refers to a group known as Wimerapmin who were apparently forced out of the Tifalmin Valley by a Feramin group, who are now known as the Bufulmin. The remains may be of the group referred to (?).

Site No. 5 Keneng-keneg Tem (CEW)

Approximately 18km west of Telefomin and 1km west of Bufulmin villages. A limestone overhang, located in an identical environment to Site No. 4. Smoke blackened, overhanging wall with a dry earth floor, situated mainly behind the drip line. Two elongated, narrow and split river stones were observed at the site and may have been used as strikers, or crushers; it seems that these stones were transported from the river for a specific purpose as no other similar stones were seen **in situ** in the geological sequences. A number of human bones were seen to have been placed on ledges and wedged into solution features.

Some art in the form of three red 'diamond' motifs, one diagonally set 'cross' motif and a linear charcoal design, is present. It is interesting to note that White (1969) observed a diagonally set, red ochre 'croix enveloppe' at the junction of the Strickland and Tumbuda Rivers. And, red diamond motifs have been observed in the Chimbu area of the highlands of Papua New Guinea (Bulmer 1960). Cross motifs have also been noted at Kainantu in the Eastern Highlands (Wilde, 1974), in the Western Highlands (Bulmer, 1966) and by Gallis (1957a) in Irian Jaya.

Site No. 6 At Tem Luun Tem (CET)

This site is a short distance south of No. 5 and is located in an identical environment, and consists of a cave 6m wide, 3m deep and 4m high with an entrance of similar dimensions that commands a magnificent view of the upper Bufulmin Valley and Mount Aiyung. It has a dry earth floor which appears to be suitable for archaeological excavation (?) and a smoke blackened roof. Many faded charcoal drawings and a red painting, which from their appearance and position behind the drip line give the impression of considerable age. Motifs and forms present are:-

Circles + concentric circles + a 'lizard' like zoomorph + meandering lines + rectangular grids + 'cross' motifs + an anthropomorphic form, partly obscured by algae and deposition. All executed in (monochrome) charcoal. A diagonally set red 'cross' motif also occurs.

All the drawings are comfortably situated behind the drip line and there is very little current deposition on the walls, which are in the main dry, with some mineral flow and algae being present. The drawings are well protected.

Site No. 7 Name unknown (CES)

Approximately 18km west of Telefomin and 2km west-south-west of Nememdabip village at an elevation of approximately 1500m and located in an identical environment to Site No. 6. A small burial cavity in a limestone ridge.

Site No. 8 Bal Kurinon or Bal Kuun Luun Tem (?) (CEU)

Approximately 500m south of Nemedabip Village. Small burial cave in a limestone ridge, measuring

6m long, 1.5m wide and 1.5m high (at highest and widest points) and containing the skeletal remains of some twenty or more persons.

Site No. 9 Agim Imal (Unlisted)

A small damp fissure or rock shelter near Agim Tem – used for sleeping and cooking whilst hunting flying foxes. Probably not suitable for archaeological excavation due to dampness and its little used appearance.

Site No. 10 Karimuk Imal (CEX)

Approximately 15km west of Telefomin and 5km south-west of Mongabip Village and located on the Tifalmin – Faiwolmin track at an elevation of approximately 2200m. A limestone rock shelter with indications of being used over a long period of time and having an apparently deep soil profile mainly situated behind the drip line. Located in montane forest used for hunting and gathering.

Site No. 11 Dabandu Imal (CFA)

Approximately 12km west of Telefomin and a short distance from the Malakaamin garden area. A rock shelter located in the bottom of a collapsed sink-hole, at an elevation of approximately 2000m above sea level. Smoke blackened walls and a number of used hearths. Environmentally similar to no. 10 and used by the Tifalmin – Urapmin groups as a base for hunting.

Site No. 12 Mokfuuma Imal (CFB)

Approximately 1km north-east of Site No. 11. Rock shelter located along a limestone cliff face in a valley floor. Smoke blackened and well used with a number of currently used hearths. Environmentally similar to Site No. 11. All three sites are used by Tifalmin groups.

Site No. 13 Borem Imal (CEY)

Approximately 12km west-south-west of Telefomin, located on a traditional trade route between Telefomin and Faiwolmin groups, at an elevation of approximately 2000m. Limestone overhang, smoke blackened with indications of frequent use over a long period of time through to the present day. Appears to have a deep dry soil profile with a number of hearths located along the wall. Situated in montane forest used for hunting and gathering.

Site No. 14 Kuruku Neng Imal (CEZ)

Approximately 1km east of Mongondabip (hunting hut), located in 'fault controlled valley' approximately 15km due south of Telefomin at an elevation of approximately 2500m. A limestone rock shelter with a small chamber at the rear. Smoke blackened roof with an apparently deep soil profile situated behind the drip line. Shows signs of intensive use over a long period of time and is still used as a base by Faiwolmin hunters. Environmentally similar to Site No. 13.

Site No. 15 Langlang Imal (unlisted)

A reported (unvisited) rock shelter 2km east of Site No. 14.

Site No. 16 Miben Tem (unlisted)

Approximately 10km south-south-west of Telefomin a resurgence cave that flows into the Ok Ket. Collapsed open feature between two caves with bones calcited into ledge (reported by A. Goulbourne). Elevation approximately 1500m near an abandoned garden area.

The bones are said to be those of persons from a clan known as Alkelmin who, by legend, are said to have been destroyed by sorcery. A short distance west of this site is an old abandoned village area, which according to informants was formerly inhabited by the Alkelmin.

* * * * * *

Discussion

There can be no doubt then that the area has a large number of sites that are suitable for archaeological investigation. A number of other sites apart from those reported here are said to exist, but were not visited by the expedition. It is the opinion of the writer that many other rock art sites are to be found within the area dealt with in this report, but are either unknown to the people (as with Selminum Tem (lower)), or more likely, are considered to be **amemtem** (prohibited caves). It is also the writers' opinion that it is unlikely such relatively advanced and involved artforms could exist at so few a number of sites, and that such a developed level of parietal art could not have been attained without more intensive activity. More exploration and further studies are obviously required before any positive conclusions can be drawn.

Craig (1968) noted a number of parietal art sites among the Wokkamin and Atbalmin and he states that the artforms normally occur in charcoal, but ochre paintings were also observed. This conforms with the writers' observations, but he also states that charcoal and ochre drawings occur on rock surfaces, usually shelters – **never** caves which is inconsistent with the writers' observations: Selminum Tem (Wokkamin) and at Tem Luun Tem (Bufulmin) are both cave sites. It is interesting to note that Craig's informants placed magico-spiritual significance upon the paintings and drawings observed by him. The paintings and engravings found in Selminum

Tem feature in the local mythology (see Legends and Mythology) and are obviously significant, however the Tifalmin people seemed to place no such value on the rock art sites in their valley. In all cases it was stated that the art had its origins beyond living memory.

Craig (1968) also recorded a number of bark wall paintings amongst the Wokkamin and Atbalmin which are very similar to those recorded at Bufulmin by Hallyer (1965). Craig postulizes a tendency towards dynamic representation' and a possible correlation with hunting and food gathering economies with a 'mental outlook based on magic which seeks to obtain results through action . . . ' But, as mentioned above his informants denied any magico-spiritual significance. They also informed him that the act of drawing and painting was a form of entertainment and a means of passing the time. But, it is the opinion of the writer that there are several categories of such art within such a society: this opinion is based on the consistency with design elements in adjacent areas, and the significance of some of the locations such as inside the **amowk** (spirit house) at Bufulmin and on the walls of a cave, and well within the zone of permanent darkness, such as Selminum Tem. Furthermore the fact that the art is associated often with burials is indicative of magico-spiritual significance rather than an art for art's sake attitude or that the artist was merely passing away time.

Several references have been made to similar rock art forms and styles in this report, and comparisons have been made with rock art throughout other areas of Papua New Guinea and Irian Jaya, but because of the limited amount of material available no proper attempt can be made at correlating the styles and materials or geographical distribution. Probably the most significant factor to date is the consistency of the occurrence of 'lizard-like' forms throughout the Eastern and Western Highlands, West Sepik and parts of Irian Jaya.

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And, last but not least, the Telefomin people for their willingness in assisting with the collecting of material.

The author and expedition members respected the wishes of the people at all times and that the sites included in this paper were shown to us willingly and without any soliciting on our behalf. Most of our informants seemed to be aware of the necessity for preserving their culture for future generations and were pleased that outsiders were sufficiently interested to make an effort in learning some aspects of the Telefomin culture. I should like to point out, once again, that the legends relating to Afek are considered to be secret information and discussion of such esoteric material with non-initiates should be avoided.

The author takes complete responsibility for his own opinions of interpretation and for any errors or omissions in the text.

* * * * * *

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(d) THE LANGUAGE AND ORIGIN OF THE TELEFOMIN AND THEIR NEIGHBOURS – P.S. EVERETT

Telefol is a language spoken by about 4,000 people and is an integral part of the Ok (river) group of languages. The writer worked with people from the Telefol, Wokkamin and Oksapmin langage groups. No serious attempt was made to learn the languages as the primary aim of the expedition was speological and many of the people we met could understand 'pidgin' English.

As Telefomin is the administrative and alleged cultural centre of the whole area visited by the expedition, and as Telefol people were working for us all the time, most of the names on existing maps and maps drawn up by the expedition tend to use words of Telefol origin. A glossary of words (partly based on Healey's Telefol-English dictionary) has been compiled which throws some light on to the origin of certain place names and at the same time illustrates the economic use of a vocabulary, less rich than that normally encountered in a European language. Nouns tend to be built up as multiple words: therefore if 'am' means 'day' and 'isak' means 'blood', 'am isak' means 'sunset'. The significance of certain place names becomes immediately obvious. 'Ok Tigiin' ('Ok Tekin') becomes 'river of creation'; 'Okkemimaal' becomes 'rock shelter by the river'; but whether 'Ok Ilam' is 'dream river' is open to conjecture.

The spelling of Telefol words is a European interpretation of the sounds uttered, and hence liable to variation, particularly as pronunciation varies between villages. In this report the most simple spelling has been used to show the meaning of many of the words e.g. Wokkamin (meaning people of the river Kam) is used in place of Wopkeimin.

GLOSSARY

*Asterisked words are also numbers, based on counting by parts of the body

abal	tree fern
abiip	village
afek	old woman
alop	two
asuno	three
am	house, day, weather
amdu	mountain
amem	sacred
aamin	bite (of animal)
aamin tanum	murderer
amitem	hole in house board
aning	fish
aning kuum	fossil
at	tree
at dan	sap
at kaal	bark
at kom	shield
at iip	clum of trees
at tem	bush (jungle)
atem	frog
atiim	lizard
ayok	butterfly
bakengtem	gorge
ball	ball
ban	*7; left forearm
belel	large fly
beleng	cicada
bem	earthworm
bem unaanbo	ca. 3 a.m.
bem unu	ca. 4 a.m.
biil	arrow shaft
bĩil	wide valley
biningok	star; firefly
boon	jaw
boon koon	beard
boon tem	mouth
bonang	string of shells
bukub	*6; wrist
bukubsan	beads
dabom	head
dabomkun	skull
daal	pig arrow
dan	juice
dili	fighting arrow
doonsuk	spider
doonsuk mumel	spider's web
duu	ridge
dung	arm
dung am	menstrual house
etam	tall watch tower
et	penis
et ok	urine
falfal	bog
fubi	stone axe
iip (ip)	abiip
ifaan	*8; left inner elbow
ifip	dust, dirt
igaal	steel axe
igaal kuum	whetstone
ikilik	sandstone
ilam	dream
ilang	clear
ilep	path
il et	high burial platform
ilum	slope
iluun	lid, cork
tiin iluun	eyelid
ilung	gully
imak	bird arrow
imaal	rock shelter
inap	snake
ingalang	club
ingalang kun	rib
isak	blood
am isak	sunset
kafan	awake
kafin	ground
kalbinim	*4; left index
kamen	penis gourd
katip	small
katibam	old men's house
kayop	moon
kem iip	cleared place
et kem	naked man
nook kem	naked woman
kom	broad
koon	leaf
am koon	roof
dabom koon	hair
kong	pig
kong bem	small earthworm
kong afek	sow, female
	swineherd

koot	cliff	ok isak	dysentry	uun maakap	egg
kum	11; 1ft side of neck	ol kun	constipation	un	arrow
kun	bone	ol tem	toilet	unaanbo	it will go
kún	inheritance	om	sago palm	unal	bowstring
unang kun	dowry	sep	bush	unang	woman
kuung	stone	sek	steel axe	unuk	bow
kuung muuk	stalectite	suuk	cigarette	unu	it has gone
kuun bal	stalgmite	suuk et	cigarette holder	uunin	big bird, 'plane
kuung tem	cave	taman	valley	uunin abiip	airstrip
maagup	one	tanum	man	uunin am	Hangar
mafak	bed	tanum dabom meen	bag of ancestral bones	waasi	enemy
maatuup	crocodile	tem	hole	waasilip	road to/from enemy territory
meen	bilum, net bag	ilep tem ok	route of underground stream	waasi am	enemy territory
min	people, race	tibin	narrow valley	wep	rain
mit	*14; nose	tigiin	creator	wepbal	rainbow
mumaal tem	sink	tin	bee	yakal	steel axe
mumel	vein	tin ok	honey	yakal tuum	file
ok	water	tiin	*13; eye	yaan	foot, leg
ok at	petrol	tuu	*9; left upper arm	yaan ilom	shoe
ok et	water container	tulum	*12; left ear	yaan tem	footprint
ok ilang	spring	uun	bird	yool	salt
ok uum	water gourd	uun am	hide, nest	yool ok	sea
ook	*5; left thumb	uun koon	feather	yoolokam Wewak	Moresby
ol	excrement			yom	first wife
ol beleng	house fly				

Despite the fact that the basic vocabulary is small, every speaker encountered was fully conversant with the names of insects and other inhabitants of the bush. Although every beetle had its own individual name, the myriads of gaudy butterflies and moths, some as big as saucers, are known simply as 'ayok'. They do not warrant individual names as they cannot be eaten and do not harm man. Similarly the ladybird is also not named. (Beron & Everett 1976).

One of the most fascinating aspects of Papua New Guinea is the diversity of language. The country is geographically divided into many areas and rough terrain has slowed down the process of unification. As can be seen from the map in the anthropological report, the Ok language group borders on the mighty Strickland river which today forms the divide between the penis gourds of the western highlands and Irian Jaya and the 'arse grass' and 'laplap' of the eastern highlands. But trade routes have existed over the Strickland since before the arrival of the European.

As one travels upstream along the Strickland until one approaches the confluence of the Om and Lagaip rivers, one finds that the Sisimin (west bank) and Hewa (east bank) are in close contact with each other, often travelling across the river with their families on single logs. The older people from Gawantiamin (near Oksapmin) can speak with people from Yokona on the other side of the gorge but the language is completely different. It was observed that people on their first visit across the river understood nothing and understandably never travelled alone. Today there appears to be no visible signs of enmity between the two cultures partly because in the past one or two tribes have sought permanent refuge on the eastern side of the Strickland following harassment by the Telefolmin (personal communication from T. Marecek, anthropologist from Phoenix, Arizona, working in the Duna, Heira and Oksapmin areas).

When one sees the Strickland gorge one can only marvel that contact has been established between the two cultures bearing in mind that most writers about Papua New Guinea emphasise the total isolation of the various tribes.

To a lesser extent the Sepik river (Ok Tigiin) near Telefomin forms a cultural divide. As one looks west from the Telefomin airstrip one can see the village of Ulapmin and, beyond the two round grass-covered hills, the head of the Tifalmin valley and Mt Aiyung. The Sepik river, which flows between Telefomin and Urapmin, can almost be jumped across in one or two places, and yet before the early 1950s the only contact between the Telefomin and the Tifalmin was by occasional trade and war..

Many words are the same in each language and a Telefol can understand about 60% of what a Tifal says. Differences certainly occur in the names of animals and insects but although the individual terms may not be understood, the ensuing descriptions of the species in question are readily understood (Beron & Everett 1976).

Continuing from Tifalmin along the main trade route from Telefomin to Tabubil in the Western District of Papua, one crosses the Bahrman mountains and drops down into a noman's area where Selminum Tem lies. Beyond this the path continues to the Hindenburg Wall and down into the Kam valley, home of the Wokkamin. Once again their language is different but they have no trouble communicating with the Tifalmin with whom they have long traded and apparently rarely fought. Premium tobaccos will not grow below the wall and so the Tifalmin are constantly exchanging tobacco for foods which grow below the wall (e.g. sweet potato and sago) and, more recently bush knives from the mining camp at Tabubil.

Our Eliptamin porters had great difficulty understanding the Wokkamin and usually had to resort to 'pidgin' when dealing with them. The Eliptamin speak a dialect of Telefol which is presumably even further removed from Wokkam than Telefol. Because the Wokkamin were friendly with the Tifalmin, they were distrusted by the Telefolmin and the Eliptamin and as a result the two groups always slept in separate huts whilst at the Finim Tel advance camp.

In the past the Wokkamin have always fought against the Faiwolmin and their respective languages are very close (Healey 1964). The Wokkamin bought a vast amount of land stretching from the Finim to the Migal but even so as soon as one of our Wokkamin porters reached Faiwolmin country he felt it was his duty to try and set fire to it.

While passing through Oksapmin, which lies some five to six days walk east of Telefomin, the writer noted from his very limited vocabulary of Telefol that only about 20% of words were similar in the language of the Oksapmin. But those Oksapmin who had seen Telefomin confirmed that a Telefol could make himself understood in that area, although admittedly with some difficulty.

Personal observations confirm that in the areas visited one language family exists. The anthropological report confirms one basic cult or religion throughout the Telefomin area, which was also noted in the Oksapmin area.

This leads to the obvious conclusion that all these peoples have a common origin. But it still remains to be proved (a) whether they migrated 'en masse' to one particular point in the area covered by the expedition (e.g. Telefomin) and then gradually split up or (b) whether each group migrated separately and at different times and chose different valleys in which to live. The fact that the various peoples speak different languages rather than dialects does suggest several waves of migration possibly for different reasons. Had they moved in one group and then split up, it is very unlikely that one particular group would break off all contact with its neighbours to the extent that they almost lose the power to communicate with each other.

The theory of separate migration is certainly confirmed by the Afek legend which hints that the Tifalmin and the Feramin existed before the creation of the Telefomin. The 'amemam' at Bultem (Kam valley) was created after that at Telefolip and Afek is supposed to have come from Oksapmin. This in turn would suggest that Oksapmin people were the first arrivals as they were created first and gradually they were pushed further east by successive waves of migration of the Ok peoples which started in the South or the West, in what is now West Irian (Indonesia). As succeeding waves of migrants or refugees arrived, they pushed their predecessors further on. Thus the Telefomin could conceivably have arrived on the Telefomin plateau, having crossed the Bahrman Hills after being prevented by the Feramin from going down the Nong river, and thus forced the Tifalmin to retreat up the valley of the Ilam. These separate waves of migration would also explain the flight of certain tribes over the Strickland river.

Unfortunately no history of these peoples appears to exist. One porter hinted that their forefathers spoke a different language from that which is spoken today and other rumours point to a mysterious book. No archeological digs have been carried out but it is unlikely that these would bear much fruit as the people have so few possessions although excavations of fireplaces could give some indications of length of use. It would appear that the various rock shelters have been used by hunters and traders for some considerable time. This is not the case with huts which tend to be built in different places, once they have fallen into disrepair or been destroyed by falling trees. The writer was shown the sites of two former huts and one 'elam' and only at one site was there any obvious evidence of previous residence.

Comparison of art forms could well turn out to give the most useful information and possibly indicate whether the Strickland was a complete barrier for a long time but once again difficulties arise in the fact that even today art forms are very primitive. Whilst walking up the east side of the Strickland gorge, a rock shelter with drawings was noted. Although there was no time for a detailed examination, it was possible to inform a local anthropologist who was staying close by. It is unlikely that anything conclusive could be drawn from the site as it is known that over recent years there has been a west-east movement of population (pers. com. T. Marecek).

One day we may have a more complete picture of the history of this remote people. Gradually more and more people are visiting the area and the people themselves are beginning to understand the ways of the European. But it could be that the key to their history lies in West Irian, and as yet the remote areas of that country are not readily accessible.

ADDITIONAL REFERENCE

Beron, P. & P.S. Everett — 1976 unpublished paper on insect and animal names in Telefol, Tifal and Wokkam languages together with local information.

EXPEDITION REPORTS

Logistics and Finances – A.J. Eavis

The reasons for **not** going to Papua New Guinea to search for caves were considerable. Previous attempts at organising caving expeditions to these remote parts of the world had been thwarted by the logistics involved. Various discussions towards the end of 1973 about an expedition to New Guinea produced such comments as "we can't even get a trip to the Mendips together", and "nobody in British Speleology could organise such a venture". Once the ball began to roll however, it became obvious that there were people prepared to devote enormous amounts of time to the task of preparation and more importantly, there were individuals capable of the organisation.

Once the nucleus of a team had picked itself, they decided on 20 people for six months to one of the PNG Highland areas. It was then simply a question of WHEN, WHERE and HOW. As much information on the highlands as possible was needed for the first two and then help both financially and in kind for the latter.

A very large number of people were contacted, including a prospective Liberal Member of Parliament who had returned to the U.K. to fight in the election, and a visiting Bishop from Port Moresby. Geologists all over the country were interviewed by telephone or in person, e.g. Embassy officials, airline pilots and Ministry of Defence personnel; aerial photography organisations and many other people were also contacted. WHEN proved difficult for none of the people who had been to the western highlands could agree as to the time of the wet season. It soon became obvious that the seasonal climatic variations were extremely local. This was borne out in the field: a particular example was the wet season above and below the Hindenburg Wall, widely different though only 2 miles apart. In the end the departure was fixed by being the earliest mutually acceptable date by which we thought the preparations could be completed and by good luck we reached Telefomin at the start of the driest 5 months in 1975 (see Fig. 45).

It was decided that the highest region with the thickest limestone should be the target area. Various geologists who had worked in Papua New Guinea suggested the western highlands and the sensational article in *Descent* by Malcolm Robb brought the Hindenburg Wall–Star Mountains to everybody's attention providing good publicity material. The Muller range to the east of this area was another possibility but this was the Australian Speleologists' territory.

Satellite and preliminary non-stereo aerial photographs of the Star Mountains – Hindenburg area were obtained. These showed bare limestone peaks, huge vertical walls and massive karst features. The area looked impressive and the geological and topographical information available showed great depth potential, so it was put to the top of the area list and further information sought. Other literature on the region spoke of "waterless areas" and "cavernous limestone" and once again made good publicity material. Access was possible via two routes, either the airstrip at Tabubil or that at Telefomin which was higher, cooler and of a similar elevation to many of the cave entrances. It was also where the limestone was supposed to be the thickest and looked as though it would make a good base camp. Stereo aerial photography was now obtained of as much of the district as possible. There are two series: one by the Australian Bureau of Mineral Resources and the other at smaller scale by the Australian Defence Department. Two series of maps had been produced from the photographs: a border series along the nearby Indonesian border at 1:100,000 with a larger area in the same series at 1:250,000. The second series was a recent and very useful geological map also at 1:250,000. Another series of maps had been produced by British Petroleum from a Radar survey showing only rivers. Unfortunately none of these maps were contoured: the only topographical details were either shading or spot heights, escarpments and river courses.

HOW was probably the hardest to answer, how could we get there and back within a limited budget? What did we need to take and how did we get it there and some of it back?? The R.A.F. were approached and after very encouraging correspondence decided that with the reduction in the number of flights to the Far East, we could not rely on them to squeeze us in. An international airline then showed great interest: their U.K. division decided to fly the entire expedition including all the equipment, to Port Moresby free of charge. It was an offer too good to believe and sure enough the head office in Australia decided No! It was then clear the expedition was going to be reasonably expensive, some said £30,000 but the rest said much too high! When it was found that normal 2nd class air fares were £880 return this figure looked possibly too low and the expedition was in jeopardy.

Later it was learned that special excursion fares existed and some travel agents contacted came up with return fares less than half the normal second class. The freight would have to go by sea and it was soon found that only Bank Line shipped U.K. to Papua New Guinea so they were contacted. Estimates of 8 tonnes of freight could be transported reasonably cheaply to one of several coastal ports in Papua New Guinea and an expedition member could travel as a passenger on the same ship: things were moving again. The choice of port was made by the members in Papua New Guinea. They had been offered free goods transport from the port of Lae to the highland town of Mount Hagen via the tortuous highlands highway, so Lae would be the Port. From Hagen to Telefomin would have to be by Air Charter using the cheapest plane capable of moving the gear in a reasonably short period. It was expected that this air charter would be expensive and in reality the 14 tonnes of freight rather than the estimated 8 tonnes took six trips in a DC3 and was far from cheap.

In retrospect the choice of Lae – Hagen – Telefomin was probably an error: two other routes would almost certainly have been cheaper. The first was to transload the gear onto a smaller vessel at Port Moresby, then ship it up the Fly river to Kiunga, and fly it from there to Telefomin or cheaper still to Tabubil. This route is used by Ok Tedi Development Mining Company based at Tabubil who would probably have allowed the expedition to use their airstrip, which is of course much nearer the Finim Tel plateau than Telefomin is. The other possible route, probably of intermediate cost, would be to use the port of Wewak which the U.K. ships also served, then fly direct to Telefomin. This route is used as the normal supply route for Telefomin and had several distinct advantages. Wewak is at sea level so that a DC3 could take off with almost twice the payload of Mount Hagen at 5,000 feet. Flying time is similar or less and part loads could be shared with the Mission or Government who have stock-piles at Wewak. It is easy to be wise after the event; at least for the gear return Wewak was used, saving an appreciable amount of money.

Since the expedition accounts are still incomplete a very detailed account would be inaccurate. A comparison of estimated costs against actual are included as well as details of the financial income.

Income to October 1976

Donations, etc.

Sports Council	£5,000
Winston Churchill Memorial Trust	£1,000
Ghar Parau Foundation	£140
Mount Everest Foundation	£750
University of Leeds	£100
Yorkshire Bank	£100
Wexas	£75
Many smaller donations	£360
Members contributions and repaid bank loan (N.B. this was complicated by some people paying reduced amounts due to only one-way travel, etc.)	£12,370
Excess food and used equipment sales in P.N.G.	£1,479
Used equipment sales in U.K. to date	£1,200
Slide shows, talks, etc.	£700
Newspaper articles, T.V. appearances, etc.	£220
Profit from sale of posters	£150
Total	£23,644

Expenditure

			Estimated	Actual
Personnel London/Port Moresby by return			£7,300	£8,524
Personnel Port Moresby/Telefomin			£1,500	£1,823
Freight London/Lae/Hagen			£1,500	£1,626
Return Freight Telefomin/UK				£639
Freight Hagen/Telefomin			£5,500	£3,700
Food			£2,500	£2,830
Equipment, Stationery, etc.			£2,500	£2,800
Reconnaissance			£500	£1,000
Airdrops and local flying			£1,000	£290
Porters			£1,000	£882
Photo Materials	Still		£700	£716
	Cine			£555
Visa Fees etc.			£250	£558
Contingencies 10%			£2,425	£1,827
*Insurance		£842		
Customs Agents				
Docking charges				
Freight Leeds/London etc.		£435		
General expenses phone calls, postage		£250		
Bank interest to date		£300		
		£1,827	£26,675	£27,770

Although some sections show marked departure, the total estimated cost was very close to the actual.

On our return the Yorkshire Bank loan stood at more than £8,000 but by the end of October 1976 it had been reduced to £4,116. This is being repaid by an increased contribution from each member. In addition the expedition is owed nearly £1,000 mainly by expedition personnel. Assuming the unsold film and book are successful, the finances look reasonably healthy. The main logistic failure of the expedition has been the inability to sell it to the media. A total of £220 from this source is abysmal. An unenthusiastic Deputy Leader resigned as such shortly before departure. It was unfortunate that Mr. Greenfield had not the same interest in the venture as the many people who seen the lectures and slide shows which have produced reasonable reimbursement and continue to do so.

With a total cost of £27,760 the expedition was ludicrously cheap considering 22 people spent 5 months on the other side of the world. A comparison of New Guinea '75 with other similar scale expeditions to far away places underlines the very low cost. We are very grateful to our many generous sponsors who made this possible.

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Communications – A.J. Eavis and K.A. Wilde

Three types of communication equipment were taken: (1) Large transceivers for inter-camp communication and communication with the outside world; (2) Walkie-talkie two-way sets for communication between field parties and big shaft work; and (3) Conventional telephone sets for underground use.

(1) Transceivers

There were three types:-

(a) **Squadcall TRA 906** (Manufactured by Racal of Reading U.K.) Two were used: one was set up in the base camp at Telefomin and the other one in the field. Both were supplied by the Division of District Administration, one from Vanimo and one from Telefomin. **Specifications included:**- 29 channel operation in the crystal controlled 2 to 7 MHz range. One of our sets had one channel only and the other three channels. Solid State SSB at 5 watts with volume control clarifier and tuner so a station slightly different from the crystal can be contacted. The unit is hermetically sealed and appears very robust, batteries lasted about two weeks of twice daily contact provided it was not left turned on. The weight including haversack, whip and dipole aerial, earth spike, three spare 6 volt lantern batteries, was about 30lbs. The units in general performed well and with a good dipole aerial very clear speech communication was possible in bad atmospherical and topographical conditions. On several occasions we contacted Port Moresby, nearly 500 miles away, from both Telefomin and the Finim Tel base camp.

(b) **Teleradio SS70** (Manufactured by Amalgamated Wireless (Australia) Ltd). Three of these sets were kindly loaned by the Carpenteria Exploration Company Pty. Ltd. One was left at the base in Telefomin while the other two were used in field camps. A dipole aerial was set up at Telefomin and end fed wire aerials used in the field. These sets were SSB (Single Side Band) at 25 watts with up to 6 crystal controlled channels between 2 and 10 MHz, although the ones we used only had two crystals. The units were primarily designed for vehicle mounting and consist of the radio attached to a battery pack of 12 volts rechargeable nickle cadmiun batteries. Total weight was about 25lbs with aerials, battery pack and haversack. Fully charged batteries provided 30 hours receiving time and 2¾ hours of continuous two-way communication assuming equal transmit-receive times. The batteries required 12 hours to be recharged either from the field generator or the 250 volt supply via a special charger at Telefomin.

The units worked very well and enabled us to talk between our camps and Telefomin and also to the Carpenteria Exploration Company, giving us an excellent system. They were not usually quite as clear as the Squadcalls and were more susceptible to atmospherics. A major disadvantage was that in not being sealed they tended to be affected by dampness and often required drying out in the sun.

(c) **Radio Station A14** (Manufactured by Racal of Reading, U.K.). Three sets were kindly loaned by the Ministry of Defence. The A14 is an earlier generation radio than the other two types. It can transmit at about 30 watts non SSB and is free tunable over a range of 2 to 8 MH3. Due to several problems the sets were only used in Telefomin, but did provide a useful backup in case of breakdown or emergency. The main problem with the sets was the complicated tuning procedure which almost required a qualified radio operator. Furthermore, because the sets were so powerful and free tunable, the authorities in Port Moresby refused to give us transmitting permission. Other problems were their weight without dipole aerial at 40lbs and their high value of £3,000 each made insurance very expensive. A reasonable base camp set in competent hands, but not the ideal for this type of expedition.

(2) Walkie-Talkies

There were two main types:-

(a) Marconi RC505

A pair kindly loaned by Marconi Communication System Ltd., for which we are grateful. They are small U.H.F. transceivers weighing only a couple of pounds each with a six inch spring aerial and rechargeable battery pack. They have a remote speaker/microphone with a transmit button and shoulder strap. They could be conveniently carried under a kagoule or in a rucksack with only the microphone exposed to the elements. Three channels were available, although the ones taken had only one crystal. Squelch and volume were the only other controls. The sets worked well and gave clear line of sight speech over a couple of miles, communication up and down subterranean shafts was not very satisfactory however. Towards the end of the expedition one of the sets got damp and its operation thereafter was intermittent. The rechargeable nickle-cadmium batteries were also not very compatible with our field charging facilities.

(b) Sony Transceiver CB-147W

A pair was loaned by Peter Beron and brought over from Bulgaria. They operate on the American citizen band of 27 MHz and are of a telephone receiver type, with a speaker at the top and microphone at the bottom and a rod aerial sticking out 4 feet at the end. Facilities consist of transmit receive button, on/off volume control and Squelch control. A battery level indicator is also incorporated. These sets worked considerably better than expected with performance equalling that of the Marconis, and no problems were encountered with reliability. They were not quite as convenient and not as clear.

(3) Telephones

Two pairs of Stanaphone self-contained telephone units were taken to New Guinea and several miles of wire. Due to the lack of remote underground camps the telephones were not used, and now form the main equipment of the Oksapmin Telephone system.

Radio Frequencies and Emergency organisation

Radio schedules with Carpenteria at Frieda 40 miles from Telefomin were maintained on a daily basis with the AWA sets on 3.712 KHz and 3.158 KHz. This company also stood by for five minutes on the hour during the day so in an emergency contact could be established and the availability of the company helicopter ascertained. Helicopter pads were constructed at Finim Tel base camp, Selminum Tem Doline, Fault-controlled valley, Wamtakin camp and several pads prepared in the Star Mountains. Three times a day internal radio schedules were maintained with the expedition base at Telefomin, where one expedition member was stationed initially on a rota system, but later Steve Crabtree took the job. These schedules were at 7 and 8.30 a.m. and 6 p.m. The times seemed to cause the minimum of disturbance to other users. We were given temporary call signs for the duration of the expedition.

Frequencies:-

Squadcall;- 3.785 MHz – Kiap post frequency (used by our internal).
In addition one was equipped with:-
3.732 MHz – National Civil Defence Frequency (Emergency and occasional schedules).
6.666 MHz – Civil Aviation Authority
6.815 MHz
Carpenteria (AWA sets) – 3.712 MHz – Normal
– 3.158 MHz – Emergency
Oktedi Development Company – 4.535 MHz
Police at Telefomin – 3.2115 MHz
– 5.3665 MHz
– 7.6665 MHz
Assistant District Commissioner Telefomin – 2.931 MHz
– 5.050 MHz
– 5.885 MHz
Protestant Mission – 3.195MHz
– 5.498MHz
– 5.895MHz

There were also other radio users in the area and other allocated frequencies. Post and Telegraphs at Port Moresby should have a complete list. In addition, Ok Tedi Development Company hope to have a microwave link with the outside world before too long.

Equipment Report – A.J. Eavis

In general we had most things we needed but an enormous amount of things we did not really need. Slightly under 5 tonnes of equipment were taken. This was composed of 1½ tonnes underground, 2½ tonnes surface and ½ tonne equally split between scientific and filming gear and ¼ tonne of medical supplies. Of these the surface equipment could probably have been halved and the underground reduced by ½ tonne: this would have saved nearly 2 tonnes or a DC3 load and about £1,000!!

The purchase cost of the equipment was very low indeed due to the large support from many firms and individuals, for which we are extremely grateful.

The selection of equipment was complicated by the known variation in climate and vegetation across the expedition area, from average daytime temperatures well in the 30° in some areas to average nighttime close to 0° Centigrade in others. Vegetation varied from dense tropical jungle to bare limestone plateaux. Two things were general: the rainfall was high, probably the highest in the world, and the natural vegetation was lacking anything edible.

The variation in underground conditions was unknown: would it be largely horizontal river passages or vertical shaft systems? Would wet suits be needed or would waterproof overalls be sufficient? Again the common denominator was that the caves were expected to be very wet. All situations had to be catered for in surface and underground, and thus the equipment pile had to be a large one.

It was planned from the outset that the team of 20 would split into smaller groups. Originally this split was to take place at the start of the expedition, but later it was decided to stay together for the first 5 weeks. Further, the groups were to split into 2 or 3-man units with a small number of porters, so this all had to be taken into account, planning sizes and numbers of articles of equipment, etc. etc.

Surface Equipment

General

Our home-made accommodation was almost always roofed with fly-sheets. Thick PVC was used at the Finim Tel base camp and some of the subsidiary camps. Draped over a ridge pole supported on two forked poles at the ends this proved quite adequate. Tents were unnecessary in the bush and difficult to erect in the forest. Wood fires were used for cooking most of the time, the only exception being a Primus double gas burner which faultlessly cooked many meals in Telefomin. The excellent petrol burner kindly donated by Optimus was also used from time to time.

Terylene-filled sleeping bags were used and proved to be ideal. Like down they are light and warm, but unlike down they are little affected by water. They are warm and dry out very quickly. Condensation was no problem and they were sufficiently warm for the high altitude camps where regular frosts occurred. The double layered bags by point 5 were particularly liked by everyone and thought to be virtually ideal for the conditions. A mosquito net was a necessity at lower altitudes.

The choice of clothes was as variable as the numbers of members. All clothes were supplied at ludicrous prices by Johnson of Great Yarmouth and were in general of excellent quality. Shirts, shorts (without underpants), gaiters, socks and boots formed the most widespread walking wear with a set of waterproofs and a warm sweater close at hand. A few die hards insisted on wearing long trousers, which did give good protection against cuts and scratches and hence tropical ulcers, but also meant more sweating. Two similar types of waterproofs were taken, both supplied by Johnsons. They consisted of an open jacket with side pockets and hood and simple trousers with press studs at the ankles. One was made from an ordinary nylon backed PVC material, whereas the other material was brush nylon backed. The brush nylon suits were by far the best waterproofs any of us had ever used, being exceptionally light and strong, stretching rather than tearing, and their remarkable comfort was enhanced by the material's absorbing capacity. The only leak was down the front zip in very heavy rain and all the suits were still serviceable at the end of the expedition. In wet weather at low altitude only the jacket was worn which came to below one's shorts. At high altitude the whole suit was a virtual necessity and made wet weather walking far more bearable. Footwear was divided equally between the wellington brigade and the rest. Almost everyone wore the same boots on the surface and underground to save carrying extra gear. Everybody wore gaiters to stop water entering boots down the leg, gaiters were even worn at the top of wellingtons. Personal preference was for a pair of Scarpa Bronzo walking boots which I thought were ideal and survived the 1,000 miles of walking and many hours of caving with flying colours.

Everybody had two rucksacks, a frame sack for general backpacking and a frameless for porter or underground work. Berghaus supplied these at a very reasonable price. The frameless sacks were excellent and stood up to the conditions with only a couple of zip failures. Unfortunately the same could not be said of their larger frame sacks which were well designed but had weak construction. High sacks are tiresome in dense bush so efforts were made to keep loads low and streamlined. Cyclops bags were fairly successful although many repairs were needed and back sweating a problem. Waist belts were thought to be essentials to transfer weight of the large loads frequently carried. All the rucksacks taken leaked in wet weather, the useful sleeping bag compartments being particularly susceptible. It was therefore essential to pack all contents in waterproof bags.

Porter Equipment

In addition to food porters were supplied with a waterproof jacket, blanket, rucksack, sweater, dish for eating, spoon, machete, cooking pot, tobacco, newspaper (to roll cigarettes) and weekly box of matches. In addition, each small party needed an axe and sharpening file. For high altitude work the porters were supplied with sleeping bags being lighter than the equivalent in blankets. Some porters used packframes rather than rucksacks and in general larger rucksacks would have made packing the 60 pound loads easier. Food was often transported in 50 litre square extruded polythene drums with waterproof lids: these were strapped to packframes and gave complete protection.

Underground Equipment

General

We tried to take equipment to cover every eventuality. In practice no remote underground camps were established so the telephone, hammocks, stoves, tents, etc. were little used. The deepest caves were only just over 400m so some of the vertical gear was not used and only a little subterranean climbing undertaken.

In the dry caves a Ladysmith boiler suit worn over Damart Thermal underwear was ideal with either wellington or leather boots. As the temperature of the caves varied with altitude so a sweater could be added or the Damart removed. It is a great shame that the seams of the otherwise excellent Ladysmiths are not waterproof. If they were they would have made a wet suit unnecessary for all but the very wettest caves.

Most personal lighting was by carbide although electric miner lamps were used for filming, scientific work and in very aqueous conditions. Carbide lights make good torches for evening surface work since it gets dark soon after 6 p.m. every night. Two generators were taken to charge the filming lights so these were used for the miners lamps as well. Nearly two hundred pounds of calcium carbide were consumed. Texolex helmets were used by nearly everyone: it is a shame that this superlative headgear is no longer manufacturered. In the Nong River cave life-jackets, dinghies and polypropylene rope were used to explore this wet horizontal system. Underground surveying techniques were standard with compass and clino kindly supplied by Sunnto and Fibron tapes similarly supplied by Rabone Chesterman.

A collapsible rescue stretcher loaned by G.Q. Parachutes was taken and used very successfully in the Selminum Tem rescue. Although this stretcher has serious weaknesses of structure and design, it is almost certainly the best available for this type of expedition. The only present alternative would be a conventional cave rescue Neil Robertson stretcher, but this would be far more unwieldy on the surface.

Underground Climbing Equipment

It was expected that most of the caves would be essentially vertical, so a lot of gear was taken for ascending and descending. This was to be done almost exclusively using single rope techniques, only a couple of hundred feet of ladder being taken. Further it was expected that due to the depth, difficult terrain, the abrasive nature of the rocks, etc., that a lot of these ropes would be consumed. Five thousand metres of rope were therefore taken in 200 metre lengths in strong PVC coated nylon bags. Half of this was 10mm 16-plait Marlow Polyester and the rest 10mm Polyester Superbraidline. The choice of these ropes had been made after an extensive series of tests (Eavis, 1974). In practice rather more of the Marlow was used than the Superbraidline. Severe abrassion occurred on several occasions although extensive use was made of rope protection and rebelaying. On three occasions the sheaths were worn right through and the core damaged but luck was with us. One occasion of severe damage occurred after only two abseils; an alternative exit was found which was just as well since a prussik would almost certainly have been fatal. On this occasion the rope ran over a clay bank in which a sharp boulder was buried, the rope wore its way through the clay and then the boulder wore into the rope. Very bad jumar slip occurred on several occasions when the rope was covered in mud of just the right consistency to block jumar teeth but not wash out. Cleaning the teeth proved to be superfluous since they reblocked instantly. The expedition got through over 3,000 metres of rope even though systems only 400m deep were discovered. Possibly if 2000m pots had been found, the original estimates would have been correct. Rope protection and rope bags were absolutely essential and after the abrasion problem became apparent everybody was descending shafts looking like carpet salesmen!

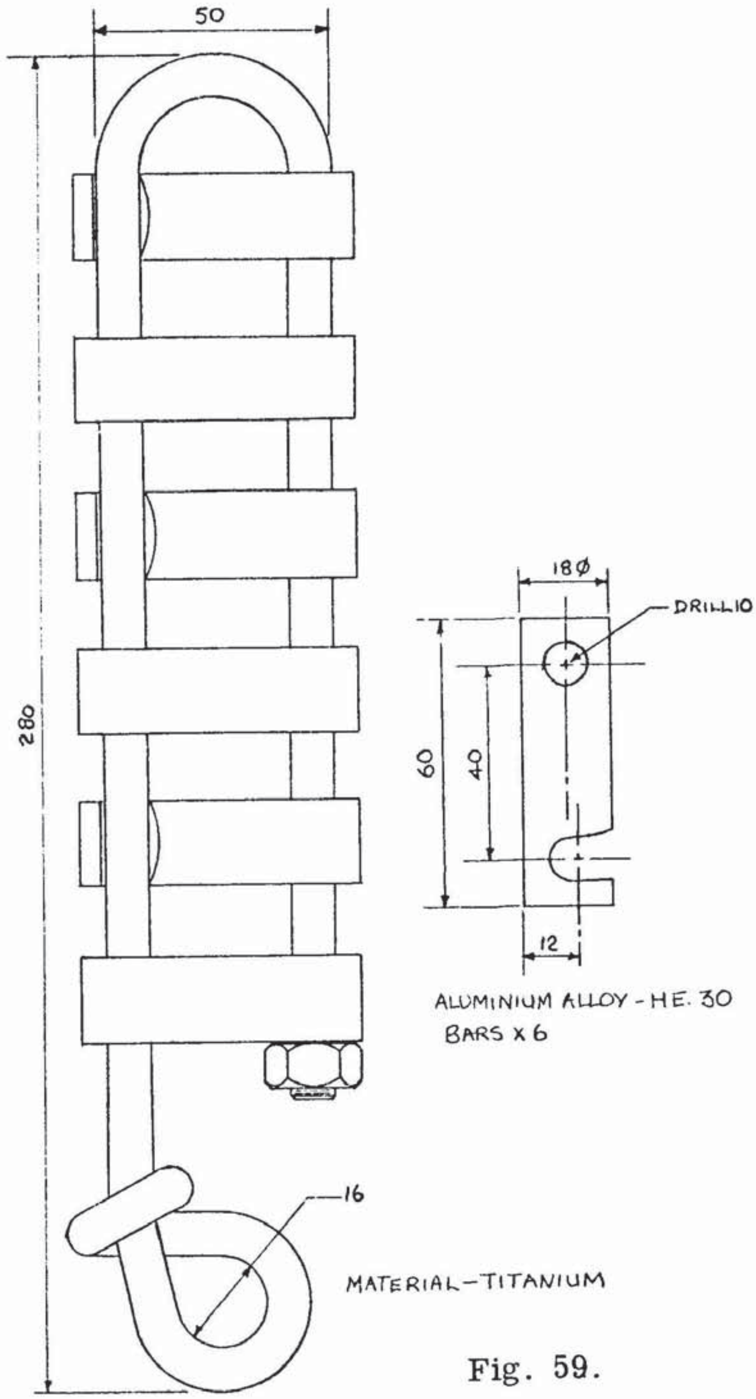

Fig. 59.

Whenever possible natural belays were used, but in several of the Fault-Controlled Valley caves an absence of natural belays meant many hours of bolting. This was done by conventional self-drilling anchors and also by a rotary type drill. This was supplied by Tornado and proved a useful tool. The tapered drill fitted into a rubber covered tool holder that was struck with a hammer in conventional star drilling fashion. The drill was rotated with one hand while being hit with a hammer in the other and reasonably fast penetration rates obtained in the generally hard limestone. A thin-walled anchor was placed in the drilled hole and a wedge driven in with a special drift and a bolt then screwed in. This set up had the advantage of the screw being almost as large as the hole, hence maximum strength. On one or two occasions pegs were used for belaying and often tape slings used for extra belays below the lip, etc.

Personal ascending gear was variable with certain common factors. Most people used a Whillan's harness; virtually everybody used rappel racks, although some Clog figure of eights were taken, and two people had whaletails. More than half the expedition used the rope walking technique of ascending: the remainder had various jumar or Clogger systems too numerous and also too well documented previously to mention here. (Thrun, 1971; Halliday 1973). Each member of the expedition was supplied with a rappel rack (Fig. 59) and a pair of rope walkers made expertly by Allan Goulbourne. The racks had six conventional 18mm diameter bars of aluminium alloy HE 30 and a frame made from 9mm diameter titanium bars an incredibly light rack of adequate strength (see diagram). Tests with thermocouple on the racks showed that the temperature dissipation was little different from a stainless rack. The rope walkers manufactured by Allan were similar to a Gibbs but these had sheaths made of titanium sheet, once again giving a light, strong device. Titanium was utilised in bolt hangers, pulley sides, water generator blades and other pieces of equipment. We are grateful to Imperial Metal Industries for the donation of this expensive commodity.

Needless to say good natured rivalry developed between the people using rope walkers and the prussikers on the expedition. Choiceof system is primarily a matter of personal preference and much experimenting is recommended before the decision is made. Several things of interest were emphasized on this trip. As mentioned previously, jumars slipped badly on rope covered in mud of a certain consistency but rope walkers never slipped and could not be made to slip once they had closed. If a sheath is severed on a rope jumars tend to pull the sheath down the core; this problem is eliminated using rope walkers and further the lack of sharp teeth on rope walkers tend to reduce surface damage to the rope. Going around lips and overhangs is as easy or easier with rope walkers than with jumars, but the main disadvantage of rope walkers is taking them on and off ropes to go round knots and at the top of pitches. Also the replacement of rope protectors below an ascending caver is easier if the devices are positioned high rather than at one's feet. If pitches have to be climbed in waterfalls it is faster, less effort and the hands can be kept free for feeling one's way, etc. with rope walkers but they do lack the versatility of jumars if a knot or rope protector is in the water.

Before the trip to Papua New Guinea our American member, Frank Binney had a friend killed in the U.S.A. when using a two jumar system. Since then the Americans strongly recommend three device systems. Rope Walking necessitates a third device for resting and balance, usually the jumar being used between sit and chest harness. Frank also proved conclusively on one 140m pitch that using the Texas Inchworm and wearing shorts can be very abrasive to the crutch – he did not prussik again on the expédition and could hardly walk for several days.

An obvious simple idea that worked very well at the top of the big bush surround shafts was for the first person to carry the entire rope with him. If the 200 metre bag was suspended from both chest and sit harness the weight was manageable. It allowed the best route through the vegetation to be chosen and eliminated tangling. The rope was allowed to pay itself out, and owing to the lack of variation in friction one-handed abseiling was easy which allowed "gardening", etc. with the minimum of effort; also no rope was below to be damaged by falling stones or a swinging machette. It was somewhat disconcerting however after 150m when you were not sure exactly how much rope was left in the bag: the solution was to stop at the appropriate point and lower the rest down, noting if it reached the bottom – if not it was straight back up for more rope.

Scientific Equipment

Good results were obtained with a minimum of equipment, providing the methods had been perfected beforehand. Close liaison between biologists and chemist saved much duplication of apparatus and materials but in retrospect some was still superfluous. A good chemical balance gave our programme versatility but preweighted and sealed sachets or tubes of reagents would have been adequate for the routine water analyses. Most chemicals were kindly provided by BDH or Leeds University and dyestuffs by Hallidays of Huddersfield and ICI. Wherever possible polythene containers and apparatus were used but due to careful packing all the glassware we took survived the outward journey.

A portable Environmental Multiprobe was provided and used for estimation of pH, conductivity, dissolved oxygen and temperature. At first it worked well but under our extreme field conditions it became damp and very unreliable. A more robust and damp proof version would be ideal for rapid field measurements.

Surface surveys were made with the underground equipment and longer sights were possible through the bush at night. A discussion of our survey results and methods will be published in the B.C.R.A. Bulletin. Altimeters, a barograph and triangulation equipment were hired from the RGS. The altimeters were in constant use but only one triangulation project was carried out (from Fugulil summit) and the charge for a theodolite for 8 months was considerable.

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Equipment U.K.

Ministry of Defence
Johnsons of Great Yarmouth
Marlow Ropes
Bridon Fibres & Plastics Ltd.
Optimus Ltd.
Primus Ltd.

Anchor Chemical Developments Ltd.
Ladysmith Busywear
Damart
Tuf
Dunlop
B.T.R.
Star Sportswear Ltd.
Pointfive
David Moore Ltd.
Troll Products Ltd.

Polypak Ltd.
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Van Heusen
Brough Nicholson & Hall
Suunto
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Hiatt
Clogwyn Climbing Gear
Tirfor
Imperial Metral Industries
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Centresport
Ultimate Equipment
National Coal Board
Ralph Martindale

Hilti
Tornado Bolts
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Beaufort (Air-Sea) Products Ltd.
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G.Q. Parachute Co. Ltd.
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Record Ridgeway Tools Ltd.
Varta (Great Britain)
Marconi Ltd.

Scientific Apparatus

Walden Precision Apparatus
The Royal Geographical Society
B.D.H. Ltd.
Sandoz Products Ltd.
L.B. Halliday Ltd.
I.C.I. (Dyestuffs Div.)
Leeds University
Electronic Design Associates
Service Trading Co.

Equipment Australasia

Mount Hagen Pharmacy
Chloride Batteries (Aust.)
Every Ready Australia
I.C.I. Lae (PNG)
Department of Civil Defence & Emergency PNG
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Food Report – C. Pugsley

Planning

Using a directory about 800 letters were sent out to the British food industry. Those firms we thought most likely to be helpful received individually typed letters for which we used punched tape and flexiwriter machines, and brochures with glossy photographs which were specially printed for this purpose. Because of the size and duration of the expedition large amounts of food and equipment were involved so it seemed worthwhile to go to these lengths. Ten per cent of the firms eventually helped either by giving us free supplies or by providing them at reduced cost. We found that many small firms previously unknown to us were generous whereas some larger companies had been approached too often in the past and were therefore uninterested. Firms which offered assistance received hand-written letters from then on, which was time-consuming but rewarding.

With final orders we gave a last delivery date, sometimes only a few days in advance. All firms delivered free of charge and on time for which we were most grateful. We were very fortunate in being allocated a block of rooms at Leeds University for storage and deliveries.

Once we had received helpful letters from firms we were faced with the problem of considering the types and amounts of food needed. We decided that being in the tropics would make little difference to our appetites or to the kinds of food we would want to eat. As we later discovered some stores could have been ordered locally, but they were very expensive.

Our main concern was how to provide cheap protein. We resolved this by taking large quantites of soya protein to supplement our tinned meat. Lyons Catering supplied us, free of charge, with enough Kesp Readymeals for 50% of our main meals. We were also given vast quantities of unflavoured Textured Vegetable Protein (TVP). These formed the bulk of our main meal foods at no cost to the expedition. We found it perfectly adequate. Another of our important concerns was to ensure variety in the meals, as this might be our only luxury for five months. Fortunately Yorkshire Relish and Humber Pickles gave us a tremendous amount of spices, herbs and sauces, and from William Lusty of Crawley we received many exotic curry pastes and pickles which greatly enlivened most meals. Home Brewing kits were probably the most appreciated 'luxury' items. Also in pursuit of variety we bought small supplies of dearer and more unusual foods such as dried peppers, brown bread mix, tinned french pate, fruit bars and dried apricots. We also had to consider the problem of weight as we were using porters over long distances, and air drops. For this reason we ordered large quantities of dried foods.

The greatest headache of all in determining our list of provisions was how much to take. We contemplated planning a calorie- and protein-controlled diet but we thought this might prove to be impracticable in Papua New Guinea. Amounts were decided by amateurish guesswork which proved to be surprisingly accurate. We worked in man-days of which there was originally 3,600 (20 men for 6 months). Having weighed individual portions on kitchen scales we multiplied these by the number of man-days which would be required. Using this method we arrived at figures such as 2cwt flour, 710lbs sugar, 1,000 cans of fish, 312 lbs. oats. A table of food actually consumed is appended.

Packaging and Transport

As the store room filled another problem presented itself. The packaging of most of the food was not adequate for a tropical environment. Luckily a visit to an industrial packaging exhibition in Leeds solved this one. There I saw for the first time a 'blue drum'. Anchor Chemical Developments later provided us with 100 of these 50 litre, lightweight, airtight, resealable, plastic kegs. They doubled as rucksacks for the porters, used with frames, and did not break when, packed with supplies, they were dropped from 500 feet. All the food except biscuits, canned goods and peanuts, was repacked into resealable clip-top bags and then heat-sealed into 1 or 2 outer layers of polythene. In this way the supplies were made more manageable and waterproof. The biscuits canned goods and peanuts were all sealed into polythene sacks by the case to prevent rusting, mildew and other damage.

The food was then labelled and equally divided into 5 parts (by this time we realised we could only go for 5 months). Loose polythene bags were packed into the blue drums and the cases squashed into wooden crates. The drums were secured onto pallets and with the packing cases were shipped to Papua New Guinea, a three month journey. The food was unaffected by heat and damp and arrived in good condition.

Unfortunately we had not researched enough into the types of food allowed into Papua New Guinea and the documentation required. As a result of our system of month-boxing, nearly half of the 100 drums and 20 crates were opened and the goods replaced haphazardly. All the egg powder, milk powder and suet were removed and destroyed. Our tinned meat and margarine were impounded until documents arrived from the UK giving the temperatures at which the food had been processed. Some of the canned food arrived in Telefomin only a month before we were due to leave there but this was partly due to transport difficulties.

Telefomin

The food arrived in Telefomin by chartered DC3. It was in a hideous jumble, some of the packing cases having been ditched en route because of weight. We were lucky to have a food store in an empty house and the job of resorting began immediately. The expedition bungalow at Telefomin had a wood-fired stove so we were able to bake bread, cakes and puddings. Here the emphasis was on tinned foods, the A10 catering tins of fruit and vegetables, bottled spices, sauces and pickles and the canned meat which had been salvaged from the customs provided the greatest possible variety of diet. Delicious curries, pizzas, trifles, chocolate cakes and so on made returning to Telefomin from sorties doubly attractive.

All provisions for bush camps had to be carried, except for two airdrops to the Finim Tel plateau. Soya protein was substituted for 70 per cent of canned meat, and dehydrated fruit and vegetables were used. Spices, sauces and preserves were still used but repacked into plastic tubs and polythene bags.

A large item on our food bill was the porters' rations. Working from the amount of food consumed I estimate that we employed 16 on average.

Each porter's rations included 1lb 2oz (2 mugs) dry rice, ½ can of meat or fish and tea and sugar each day.

Provisions for the first month's camp at Finim Tel were sorted and packed by the food officers. Alas the food arrived at Finim Tel before we did. When the last members of the group arrived there, supplies consisted only of staple foods. Without supervision the advance party had wolfed all the tasty and luxury items first. We therefore devised a daily ration list stating the amount and kind of certain more popular foods which each person could eat without jeopardising variety and balance in the long run. In time every member of the expedition knew this list by heart and in general it was followed. To combat the same problem we asked groups to order rationed food in man-day units. The people at base camp would then consult the lists and send up the

the appropriate amounts. Non-rationed foods could be ordered as required.

Conclusion

We were satisfied with the food we took and the policy of taking large amounts of unusual and exotic foods were very successful. Methods of packing were ideal, but dividing into month units caused more problems than it solved.

We employed a customs agent, but the most useful work was done by sending a forceful member of the expedition to argue our case. Ideally he should have been there before the goods arrived and it would have helped if we had written personally to the customs officials to ask advice and warn them of our coming. We made a bad mistake in not acquiring documents relating to the cooking temperature of our canned meats. We should also have arranged to buy our dairy products in PNG or Australasia.

We owe many thanks to the members of the Food Science Departments of Leeds Polytechnic and the University, for advice and practical help on packaging.

Product	Amount Used	Comments
BREAKFAST		
Tea	6,000 bags 100 lbs loose	Shared by porters
Coffee	1,800 2 cup bags 8 x 1½ lb. tins	Bags good but wasteful
Sugar	1710 lbs	Shared by porters
Golden Syrup	220 lbs	
Salt	100 lbs	In 1½ lb plastic containers Some given away
Milk powder	60 x 5 lb tins 150 x 1 lb pkts	
	6 x 25 kg bags	Destroyed by PNG customs
Egg powder	56 lbs	
Cornflakes	36 x 8 oz pkts.	
Porridge Oats	302 lbs	
Muesli	125 lbs	Insufficient but made own from Oats peanuts and raisins
Baconburgers in beans	288 x 7½ oz cans	Small cans mixed and shared between two people
Baked beans	72 x 6 lb (A10) cans 480 x 7¾ oz cans	
Tomatoes	30 x 5½ lb (A10) cans 24 x 2 lb cans	Small cans unnecessary
Baconburgers	72 x 9 oz cans	Delayed by customs. Arrived 4 weeks before end of expedition
Liverburgers	60 x 9 oz cans	
Frankfurters	72 x 9 oz cans	
Pancake mix	19 x 7 lb pkts	A popular pastime
Cooking oil	4 x 1 gal tins	
Kippered herrings	36 x 12 oz cans	Insufficient and expensive
Rise and Shine	200 x 1pt. pkts	Insufficient and expensive
SNACK MEAL		
Ryvita	624 x 7½ oz pkts	Always in perfect condition
Ry King	340 x 7 oz pkts	Tended to get damp
Cream Crackers	144 x 7 oz pkts	
Cheese Biscuits	160 x 6½ oz pkts	
Daily Break	380 x 5½ oz pkts	
Margarine	48 x 1 lb cans	Insufficient. 528 x ½ lb cans from UK banned by PNG customs.
Sardines	310 x 4 oz cans	Insufficient – could double amount
Tongue and Turkey Roll	60 x 7½ oz cans	
Chicken Supreme	25 x 5 oz cans	Insufficient and expensive
French Pate	168 x 5½ oz cans	Very popular
Honey	96 x 12 oz plastic tubes	Very practical packing
Jam	32 x 7 lb cans	
Processed Cheese (Australian)	48 x 16 oz cans	Insufficient – too dear in UK
Meat and Fish Spreads	48 x 1¼ oz	Glass jars too heavy

Product	Amount Used	Comments
SNACK MEAL (Cont'd)		
Soup Mix	94 x 1 gal. pkts	Some used by porters
Cheese Spread	60 x 8 oz bottles 240 x 5½ oz tubes	Kept well. Glass jars too heavy Most gone bad by start of expedition.
Peanut Butter	30 x 12 oz bottles	Glass jars too heavy. Insufficient
Salted Peanuts	36 x 5 lb bags	
Peanuts and Raisins	34 x 5 lb bags	Good for Muesli-making
Cherry Sultana Cake	2 x 96 individual slices	Kept well. Insufficient.
Dates	180 x 8 oz bags	
Condensed Milk	96 x 3/8pt. tubes	Good underground rations
Chocolate (asst.)	1800 bars 40 x 12 oz cooking blocks	Ration of ½ bar per day insufficient, could be doubled
Quiggins Mint Cake	240 x 3 oz bars	
Sweets (asstd.)	107 lbs	Boiled sweets popular.
Sweet Biscuits	412 pkts	Insufficient but expensive
Jacobs Biscuits	680 biscuits	Insufficient but expensive
Ribena	8 gallons	
Orange/lemon power	20 x 7 lbs	
EVENING MEAL		
Unflavoured Soya Protein (TVP)	150 lbs	
Flavoured Soya Protein (Kesp)	110 x 12 portion pkts	With extra dried veg. 1 pkt. gave 10 generous portions
Stewed Steak	120 x 15 oz cans	Good for field camps — worth carrying
Minced Beef	108 x 15½ oz cans 156 x 7½ oz cans 42 x 3 lb cans	 Used for snack meal cold on biscuits
Beef Casserole	24 x 15½ oz cans	
Chicken Casserole	24 x 15½ oz cans	
Beefburgers	24 x 15½ oz cans	
Steak and Kidney Pies	60 x 15½ oz cans	Insufficient — very popular
Irish Stew	24 x 15½ oz cans	
Ravioli	60 x 16 oz cans	
Chicken Breast	6 x 3 lbs	12 x 3 lb cans banned by PNG customs
Meat Balls	72 x 15½ oz	Unpleasant flavour and texture
Corned Beef	216 x 12 oz cans	Mainly for Porters
Herring in Natural Oil	1080 x 14 oz cans	Shared with porters
Mackerel in Tomato	132 x 14 oz cans	
Complete Potato Mix	42 x 5½ lb cans	
Dried Veg.		
Peas	60 lbs	
Onions	10 lbs	
Other	35 lbs	Not worth bothering with.
Canned Veg (asstd.)	34 x 6 lbs (A10)	Broad beans, sweet corn, mushrooms most popular.
Canned Fruit (asstd.)	24 x 6 lbs (A10)	Insufficient. Could be increased at expense of canned veg.
Fruit Pie Filling	96 x 15½ oz	
Mixed Dried Peppers	8 kg.	Adds colour to TVP stews
Yellow Lentils	14 lbs	Not necessary
Gravy Mix	10 gallons	ditto
Dried Fruit		
Prunes	33 lbs	
Apricots	51 lbs	
Apples	66 lbs	Apple Flakes preferable
Mixed	42 lbs	

Product	Amount used	Comments
EVENING MEAL (Cont'd)		
Sultanas/raisins	60 lbs	
Apple Flakes	39 lbs	Ideal for field camps
Jelly Crystals	7 lbs	
Jellies	40 1 pt. pkts	
Custard Powder	19 lbs	Insufficient – could treble amounts
Blancmange Mix	7 lbs	ditto
Crumble Mix	28 lbs	ditto
Cake Mix	28 lbs	
Bread Mix	36 x 3 lbs	Good at field camps
Plain Flour	220 lbs	Used for bread-making. Insufficient.
Yeast	80 sachets	ditto
Rice	6 x 112 lbs	Mainly for porters
Macaroni	140 lbs	
Spaghetti	98 lbs	
Horlicks	8 x 10 lb tins	
Cocoa	5 lbs	
Lager Extract		
Bitter Extract		
PICKLES asstd.	120 x 12 oz jars	
Spices and herbs	18 x 3 oz jars	Useful in field if repacked
Cake essences	4 x 1 oz bottles	
Yorkshire Relish	24 bottles	Insufficient
Tomato Sauce	2 x 1 gall. plastic cans	
Chop Sauce	ditto	
Cheese Sauce	10 pkts.	
Stock Cubes	8 lbs	Essential for TVP
Parmesan Cheese	8 cartons	
Marmite	8 lg. bottles	
Vegemite	24 8 oz jars	
Worcester Sauce	5 bottles	
Lemon Juice	5 x ½ pt. bottles	
Xmas Puddings	15	Insufficient. Kept well – eaten as cake
Salad Cream	10 bottles	
Tartar Cream	10 sachets	
Horseradish Sauce	8 bottles	
Curry Paste	36 x 10 oz tins	Popular in field camps
Asstd. Indian spices and Chutneys	48 x 12 oz bottles	High quality – much appreciated
Cranberry Sauce	10 bottles	
Chili Sauce	5 bottles	
Mustard	30 bottles	

List of firms supplying food (donated or cutprice) U.K.

Anchor Chemical Developments Ltd.
Lyons Catering Supplies Ltd.
Sleaford Trading Co. Ltd.
Tate and Lyle Refineries Ltd.
The Proctor Dept – University of Leeds

Goodalls Ltd.
Herring Industry Board
Humber Pickles Ltd.
Lyons Tetley Ltd.
Manley Pure Foods Ltd.
Morning Foods Ltd.

Hammonds Sauce Ltd.
Hall Brothers (Whitefield) Ltd.
James Marshall (Glasgow) Ltd.
James Robertson and Sons
John Morrell and Co. Ltd.
Kavli Ltd.
Lockwoods Foods Ltd.
Marshall and Co. (Aberdeen) Ltd.
Milk Marketing Board
Ministry of Defence
Norpak Machines Ltd.
S. Parkinson and Son (Doncaster) Ltd.

List of firms supplying food (donated or cutprice) U.K. (cont'd)

Munton and Fison Ltd.
Supreme Plastics Ltd.
Packseal Industries Ltd.
Daniel Quiggin and Son
Unilever Export Ltd.
William Lusty Ltd.
Yorkshire Relish Ltd.

Associated Health Foods Ltd.
Associated Biscuits Ltd.
Automatic Catering Supplies Ltd.
Batchelors Catering Supplies Ltd.
Beecham Foods
S. Behr and Mathews (Sales) Ltd.
Bowyers
British Everest Expedition
British Oxygen Co. Ltd.
Cadbury Schweppes Foods Ltd.
Campbells Soups Ltd.
Craigmillar
Crosse and Blackwell Ltd.
Dymo Business Systems Ltd.
A.C. Fincken and Co. Ltd.
Glenville Ltd.
Gill and Duffus Ltd.
C and T. Harris (Colne) Ltd.

Plysu Containers Ltd.
Polymeric and General Service Developments Ltd.
Quaker Oats Ltd.
Read Woodrow Ltd.
RHM Foods Ltd.
Ringtons Ltd.
Rowntree Mackintosh Ltd.
The Ryvita Co. Ltd.
C. Shipham Ltd.
Smedley HP Foods Ltd.
E.T. Sutherland and Son Ltd.
Supreme Salt Co.
Thames Rice Milling Co.
Tower Brand Nuts
United Biscuits Ltd.
United Yeast Co. Ltd.
Unilever Export Ltd.
Weetabix Ltd.
Welch and Sons Ltd.
Whitworths Holdings Ltd.
Winterbotham Darby and Co. Ltd.
Wm. Morrison Supermarkets Ltd.
Walls Meat Co. Ltd.

Food donated or supplied cutprice by Australasian firms

Rice Industries Lae.
Robert Cheung Trading Co.
Nestles (Australia) Co.
Kraft Foods (Australia)
Wrigleys (Australia)
Kurumul Plantations PNG
Lae Biscuits Co.

PHOTOGRAPHY – A.S. White

Cameras

Photography on the expedition was done exclusively on 35mm equipment. All cameras were people's personal equipment and most were good quality single lens reflexes. The majority of the underground work was done using a Canon EF with standard lens and 24mm wide angle, a Yashica TL Electro with 38 – 100mm macro zoom and 24mm lenses and an Olympus OM-I with standard lens. The wide angle lenses were found most useful for underground use as it was very often impossible to get far enough back in a passage to use a standard lens effectively. The zoom was very versatile and rapid to use and, although used mainly on its 38mm setting, when larger focal lengths were required, the exact framing could be achieved in a second, obviating the need to remove lenses and risk getting grit into the camera. It was also useful for close-up work. Other equipment used included a Minolta, a Nikkormat and a Nikonos II underwater camera which could have been ideal in adverse conditions.

Film

Because of the expected duration of five months in a tropical climate, the film was not ordered until just before leaving. For colour, Ektachrome X (64 ASA) was chosen for most surface work and High Speed Ektachrome (160ASA) for cave shots and for use in the bush where light values are generally low. Black and white film was bought in bulk and loaded into cassettes at Telefomin from a daylight loader. Two types were ordered: Tri-X Pan (400ASA) and Plus-X-Pan (125ASA). However on the day we left the film was collected and the 'Plus-X' was found to be Panatomic X (32ASA). This was really too slow and was exposed at 64ASA but produced excellent results. Great care was taken in passing through security checkpoints at airports to avoid exposing the film to X-ray machines. Despite these precautions one batch of film, contained in a plastic daylight loader, did become fogged. This may have been saved if it had been stored in a metal container.

Lighting

Lighting underground was entirely by flash. Bulbs were preferred to electronic flashguns since they are more powerful; an electronic unit of equivalent power is a very bulky item. Bulbs used were Phillips PF5B with a recommended guide number of 260 with 160ASA film and Atlas Type 1B with a guide number of 170. However because of the low reflectivity of most cave surfaces, guide numbers of 160 and 100 respectively are more realistic.

Ten Tickystar flashguns were supplied by Boots Ltd., which proved to be excellent. They have an open flash facility but suffer from a slight design fault. If the synchronisation lead is unplugged from its socket after firing on open flash, the gun will test positively without a bulb even being inserted. This resulted in a number of flash failures during the first photographic trip. Once the 'fault' had been discovered and overcome by testing each bulb twice, they proved totally reliable and in two trips 140 bulbs were fired without a failure.

A Toshiba QCC 10 auto-electronic flash was loaned to us by Johnsons of Hendon and was very useful around camp but, owing to its size and low output (1½ stops less than an Atlas IB), it was not used much underground. However a small electronic unit with a recommended guide number of 130 (160ASA) was used for close-up work.

General

Besides providing a pictorial record of features and events, photography on an expedition should show the full variety of conditions experienced. However it is very often too dark in the bush and a photographer is understandably reluctant to bring out an expensive camera into dripping moss forest whilst up to his knees in mud. Most aspects were covered well but there was a strong tendency to take photographs only in fine weather and comfortable situations. Hence a rosy picture maybe painted of jungle conditons.

Underground Photography

A PF5B bulb will illuminate to a maximum distance of sixty feet with 160ASA film and an f/2.8 lens. So to photograph in the huge passages we encountered, up to five flashguns were distributed along its length and fired simultaneously while the camera shutters were left open. Such techniques need to be worked out beforehand because photographic trips can become long, slow and tedious for the models and promises such as "This photograph will make you famous" lose their effect after a few hours, even if they have not realised by then that they are often silhouetted pinpoints in the background (see D. Yeandle: Memoirs of an abused photographer's model (unpublished).) So the idea is to move fast and efficiently.

In the main trunk route of Selminum Tem we had a team of ten people, six flash operator/models and four photographers. Two photographers used colour and two black and white. One could set up the shot as he wished, while the other three, perhaps using different focal length lenses, would take it from different angles, occasionally from in front of the flashguns. This created a large variety in the type of photograph. To save time in packing and setting up equipment, cameras were carried fixed to closed tripods and wrapped in a cloth, or polythene bag, inside a rucksack.

In smaller passages we invariably had two photographers and two helpers. If an extra person were required to operate a flashgun, then one photographer operated both cameras using locking cable releases.

Storage of film and equipment

The need to protect equipment against the harsh environment in equatorial regions is well known and, before experiencing bad conditions, it is very easy to have nightmares about gelatin-eating insects living inside one's camera hungrily waiting for the next exposure to be wound on. However we found conditions to be much milder than expected.

Heat is not a serious problem to cameras and accessories but when it is coupled with high humidity, the growth of fungus on cases, shutter fabrics and even lenses is possible. One lens which was in New Guinea for over a year did suffer from fungal growth which started as fine white fibres growing from the edge of the lens to the centre. But in general we had little trouble. Whenever possible cameras were stored with Silica Gel in airtight ammunition boxes which also provided adequate protection underground in small passages or muddy or wet situations.

Unexposed film was kept refrigerated in its original packaging. Unfortunately the refrigerator was run from a generator which operated morning and evening allowing the contents to thaw out during the day. If space had allowed, the film would have received additional packaging in polythene with silica gel. Even though on occasions the film canisters got wet on the outside, only two colour films showed ill effects of blobs, and streaks where the emulsion had been in contact with the film in the cassette and had become glazed by it. The damage to the outer emulsion surface produced a blue tint in these areas.

Close-ups

For medium close ups the macro zoom was ideal, and quick enough to catch fleeting shots. In dull conditions its maximum aperture of f3.5 was a limitation. Small insects demanded the greater magnification provided by an Olympus macro-lens and bellows unit but the small depth of field of the sytem meant that f22 was regarded as the normal working aperture. In both systems fast film was desirable for good results under the range of light conditions encountered.

Processing

The latent image on exposed photographic material suffers a gradual fading under the combined influence of heat and moisture, so the policy was to send exposed colour film to Britain for processing at the earliest opportunity and to develop black and white film ourselves.

We were lucky to have a hut made available to us at Telefomin with running water collected in a tank on the roof. This was converted into a dark room using a tarpaulin and black polythene, and electricity was installed. This meant that films could be processed with the minimum delay; we could monitor our results and correct any mistakes or equipment defects whilst still in the field and we could produce prints for friends, newspapers and for public relations.

A five spiral developing tank and a daylight loading tank were taken, the former being found invaluable. Lack of water could have been a problem so amongst the chemicals donated by May and Baker Ltd. we took Thiolim fixer eliminator and Thiodet washing test kit but these were not used. The use of Veribrom resin-impregnated printing paper further reduced the problem of washing as it absorbs far less liquid than conventional papers. It also possesses the excellent qualities of rapid processing times and drying flat without heat. Prints were made on a contact proof printer and by using a Zenith autofocus enlarger which has the advantage of neatly packing away into its own baseboard. Although water from the header tank rose in the afternoon to 33 °C, the main storage tank supplied water at generally less than 24°C so processing temperatures were not a problem. Above 27°C sodium sulphate must be added to the developer to prevent swelling of the gelatin.

Materials used in the field

Kodak Ektachrome X 135-36 exp (daylight)	70 rolls
Kodak High Speed Ektachrome 135-20 exp (daylight)	110 rolls
Kodak Tri-X-Pan	120m
Kodak Panatomic-X	34m
Kodak Veribrom paper grade 3 10" x 8"	100 sheets
Kodak Veribrom paper grade 2 10" x 8'	200 sheets
Atlas Type 1B flashbulbs	250
Phillips PF5B	250
May & Baker Suprol Paper developer	1.5 litres
May & Baker Qualitol film developer	2.0 litres
May & Baker Promicrol film developer	2 packs
May & Baker Glacial Acetic Acid stop bath	100 ml
May & Baker Cascade wetting agent	25 ml
Johnsons Aculux film developer	1.0 litre
May & Baker Suprafix	4.5 litres

Apart from those mentioned specifically in the account the following gave a generous discount to the expedition:

Arrowtabs Limited
Boots — Leeds (Briggate) Branch
Leeds Camera Centre
Warren Jepson Limited — Leeds
Worth Photofinishers — Keighley

DOCUMENTARY FILM REPORT — S. Perou and N. Plumley

Introduction

From the outset it was apparent that New Guinea 75 offered some fascinating film material so that from the early planning stages an expedition film was considered a natural part of the venture. It was important, both from creative and practical standpoints, that we clearly defined the approach of the film right from the beginning, consequently the expedition was filmed primarily from an adventure point of view rather than concentrating wholly on the scientific aspects.

The selection and construction of the film equipment demanded careful consideration of the main factors involved, these being remoteness of the expedition area, climatic conditions and finance. There were also the lighting and the other technical problems involved with filming underground, considerably enhanced by the location plus the fact that we anticipated caves of considerable proportions with a great quantity of active underground water. Added to this a shipping deadline imposed a time limit on preparations and also involved a degree of total commitment months before the expedition team left the United Kingdom.

From the start we aimed to shoot a film of a high technical standard. This required a camera/tape recorder combination capable of recording a syncronised pulse; and also two different rated film stocks, not only to allow for the low light level of cave filming but also in anticipation that there would be a large light intensity difference between tropical jungle and savanna.

Keeping underground filming equipment to a minimum was helped by shooting with the largest aperture on the fastest available film stock, force processed by one stop where necessary. Nevertheless filming particularly larges caves, still requires a great deal of lighting power, consequently a large proportion of the film crew's weight consisted of battery units and recharging facilities. Most of the filming equipment had to withstand total immersion during both surface and underground transportation, which meant packing it in watertight containers. These further increased the film crew load and along with a constant supply of petrol for the battery generator consumed valuable portering time.

It was anticipated that the constantly high humidity would encourage corrosion and fungal growth on lenses and leather cases, and in conjunction with the underground conditions we could expect a large amount of wear and tear on equipment.

It was obvious that self sufficiency, in the form of duplication of equipment and the ability to carry out our own repairs and maintenance in the field, was imperative to keep up a filming programme. We were equipped with a compact yet comprehensive tool kit which was also used extensively by members other than the film crew.

The film production costs were expected to be reasonably expensive, film stock alone costing approximately £500, with a total cost in excess of £1000, which included new lighting batteries, generator, camera and sound accessories, etc. A considerable amount of work was put in a year previously in planning and building equipment on the assumption that financial backing from a television company would be forthcoming due to the unusual nature of the expedition. As it happened what had appeared to be likely backing evaporated a matter of weeks before departure to Papua New Guinea, and the expedition was faced with the situation of abandoning filming altogether or else finding the necessary funds to go ahead independently in the hope that we would be in a stronger position to sell the film on our return on the grounds that we would have actual material to offer an interested party. In spite of the precarious financial situation it was decided to continue with the film additional bank loans being required.

Technical Report on Separate Filming Aspects

Lighting Batteries

Since we needed to obtain the maximum flexibility of operation, having anticipated a transportation problem, there appeared to be no alternative to a battery powered system. Whereas ideally a nickel-cadmium based system would have seemed best, on its virtue of lightness and compactness, the initial outlay to supply such cells would have been prohibitive. In view of the fact that the cells would be in continuous use, and with the experience of success on previous occasions, a lead-acid system was opted for using readily available motor cycle cells. Having taken steps to minimise electrolyte leakage, these were placed in pairs in ammunition boxes fitted with specially manufactured waterproof electrical sockets, rendering them fully submersible, to provide 12 volt 11 amp hr units. We had 18 such units and by numbering each one they could be used in a sensible rotation.

A few units were required for use shortly before the expedition equipment left for Papua New Guinea by boat and were consequently shipped in a fully charged and filled condition, the remainder of the units being shipped dry with a separate supply of electrolyte. On receiving the cell consignment in Telefomin 4 months later, it was found that the filled cells had suffered badly, their plates being partially sulphated and a great deal of acid spillage had caused their metal box housings to corrode. These were soon abandoned in favour of the dry-shipped cells which had arrived in perfect condition.

Constant supervision was needed when packing battery units onto pack frames, since otherwise our local porters could sometimes arrange the battery packs the wrong way up with subsequent spillage of the electrolyte. Our efforts in this direction were on more than one occasion thwarted when porters arrived carrying the pack frames themselves sideways (with one of the shoulder straps used as a headband) and once even completely upside down.

Lamp Units

The basic lamp unit to work in conjunction with one battery unit was a commercial lamp housing adapted to take a 12 volt 100 watt quartzhalogen bulb, giving ½ hr. of light but only providing a 10ft working distance with full aperture, f1.6 at 400 ASA, normally processed. We had 8 of these units.

In addition we had 4 specially designed lamp units each holding two 30 volt 250 watt quartz-halogen bulbs in a single reflector, giving a working distance, in similar circumstances to the 100 watt units, of between 20 and 30ft. These were designed to operate from three 12 volt standard battery units connected in series to give a nominal 36 volt supply. This was then regulated to 30 volts by built in power transistors fitted onto the rear of the lamp units. These light units could thereby provide 500 watt of light yet were only 5 inches in diameter and 6 in. deep. When packed in pairs in ammunition boxes they were a good example of the overall objective of all underground filming equipment which is to maintain small units capable of being carried in one hand and at the same time being able to withstand a considerable amount of rough handling and wet conditons.

Certain filming situations benefit by using a spotlight. For cave filming all commercially available units designed for photographic use are too bulky, heavy and usually designed to operate from mains voltage. Spotlights intented for other purposes such as display or car headlamps gave too narrow a beam or very uneven illumination. This problem was solved by two specially constructed units. The first was based on a 12 volt 100 watt projection bulb which had its own built in reflector. This was built into a small homemade spotlight housing with a 3 in. fresnel lens and incorporating a cooling fan, giving a unit of dimensions 3 in. diameter by 8 in long. The second spot consisted of a 7 in. fresnel lens which could be attached to the front of a 500 watt lamp unit. We had one each of these types, both types being adjustable to give varying angle of beam.

Lighting techniques underground are a subject in themselves and are outside the scope of this report. However an important aspect not to be neglected is the conservation of battery life which requires the duties of a separate lighting manager, good teamsmanship, and a high degree of cooperation from people in shot in order to cut any rehearsals or retakes to a minimum.

Battery Charging

Luckily Telefomin had its own township electrical supply so that mains charging facilities were available at base camp. The two petrol generators we took, a Honda 250D and a TAS were only required for field charging. We used the Honda exclusively and since it never gave any trouble, the TAS was not used and only held in reserve. Each generator operated via a distribution box which enabled 6 charging channels to be separately controlled and monitored. The generator was used primarily to charge the lighting battery units but also required to charge camera, taperecorder and field radio batteries, run a soldering iron for maintenance work, and to recharge cap lamp cells, the latter being beneficial in exploratory and filming trips.

Because the anticipated problems of supplying fuel to the generators at a remote base, some time was spent in manufacturing a water wheel driven generator which could be assembled at a suitable stream, above or below ground, and would hope to supply sufficient power to charge one or two cells at a low rate of charge. In this manner all cells could have been charged over a period of a few days without any dependence on outside supplies. Although initial tests carried out on an experimental wheel suggested that this would be feasible, difficulty was encountered in providing a generator designed to operate at low revolutions, so this project was not completed for its use on the expedition. As it was the fuel supplies for the generator did not prove to be the acute problem originally envisaged.

Camera and Camerawork

The camera used for the bulk of the filming, both above and below ground was a Bolex EBM. This was a 16mm battery powered electric camera with synchronised picture/sound pulse facilities, fitted with a reflex view-finder. Normally a 16mm to 100mm zoom lens was used, but for the majority of underground filming this was replaced by lenses of fixed focal length, a Switar 16mm f1.6 lens being our standard underground shooting lens. This lens has four distinct advantages for underground use. The wide angle is necessary in most underground situations where the ability to 'get back' from the subject is limited. The wide maximum aperture permits work at minimum light levels, while the large depth of field offers minimum focussing problems at this aperture. The final advantage lies in the excellent construction of the lens which makes it less prone to internal misting of the lens surface than other lenses previously tried.

We were also equipped with 3 spare cameras, these being 2 clockwork Bolexes and a cartridge loading Bell and Howell, the latter adapted to fit on the side of a motorcycle helmet in order to film while abseiling.

A 400 ft magazine was used for surface filming, 100ft reels being used for underground work, and a large changing bag was found to be an essential piece of equipment to dispense 100 ft. rolls from a 400ft roll, and to deal with jammed films.

The effect of the high humidity of the Papua New Guinea highlands was reduced as much as possible by storing the camera and lenses in ammunition boxes along with bags of dry silica gel. The volume of the air concerned, the number of times the boxes were opened, and the fact that equipment was sometimes literally saturated after a day's filming, ensured that the silica gel was quickly exhausted, calling for the almost daily ritual of its dehydration over the campfire. In practice therefore it was difficult to maintain a good dry atmosphere and while working in the Fault Controlled Valley film left in the camera overnight invariably jammed in the camera gate on the first shot of a morning's filming.

In certain instances, notably while filming underground sequences again, the combination of working at low light levels with a misted viewfinder, of an initially high light absorbtion index, forced almost 'blind' filming to be carried out. Also the zoom lens misted up internally on occasions which resulted in frustrating waits for the lens to clear by drying out in the sun, before filming 'once in a lifetime' shots that were slipping away before the eyes of the cameraman.

An almost endless supply of dry, clean and soft cloths was needed to soak up any surface moisture while filming, and inevitably minor difficulties were experienced with electrical connections through exposure to mud and wet. Here a silicone spray, had we taken one, may have minimised these problems.

Care had to be taken so that no silica gel dust came into contact with lenses and delicate equipment, while any possible fungal growth was counteracted by keeping small bags of crystallised fungicide in the silica dried atmospheres.

All camera and sound equipment was protected by individually tailored covers made from wetsuit neoprene material. These served to guard against spray, bumps and abrasion, and also cut down mechanical noises emitted by camera and taperecorder during filming.

Both in cave and bush filming 'Ladysmith' coveralls were not only excellent protective caving clothing but their bright colours enabled people to be seen easily and thus enhanced the filming.

Although from a practical standpoint we could not have clear plastic to cover camps, as this would have acted as a greenhouse, an unforeseen difficulty arose from the yellow plastic sheet giving a strong yellow cast to any filming done under daylight within the camps themselves. Other than having opaque white plastic in the first place, no easy solution is apparent. A certain amount of the cast can be corrected to some extent at the printing stage in the laboratory. The other solutions would have required blue correction filters either on the camera lens, which would have needed a fair degree of experimentation, or on the front of a 'fill in' light, this latter method would have used valuable charging facilities.

Film Stock

It was decided to use a reversal film stock as we hoped to send back newsreel reports to the U.K. and this was more acceptable to the news media. For underground filming a relatively new film stock, Fuji RT400, provided the unusually fast film speed of 400ASA, with the possibility of force processing by 2 stops to give a remarkable 1600ASA. However results have shown that the losses at 1600ASA are considerable, in terms of grain and contrast ratio, and while this speed remains valuable in otherwise unworkable situations, forced processing is not to be recommended. A fair compromise seems to be force processing by one stop to give a film speed of 800ASA. The policy throughout the film was not to force process at all, unless circumstances demanded it, in order to maintain the best available quality from the film stock.

For surface filming Fuji RT100 has a rating of 100ASA. One difficulty envisaged, and encountered, was the large range of light levels existing between the darkest bush and the brightest grassland, which at times was more than a single film stock could cope with. This really required two separate magazines loaded with fast and slow film stocks which could have been interchanged as required. As it was we only had one 400ft magazine since it was known that we would not be using RT400 in such a bulky piece of equipment underground. The less desirable alternative to this problem neutral density filters introduced difficulties in the Bolex EBM due to the low light level received in the viewfinder.

The film stock aperture range was 1600ASA at f1.6 to 100ASA at f22, both film stocks being ideally balanced for filming at 3200°A, i.e. tungsten light, and were used with Wratten 85B correction filters in daylight conditions.

We were fortunate in having a refrigerator available in Telefomin to store exposed and unused film stock. Failing this it was thought that a cave would have proved to be the next best way of protecting the film from the extremes of outside temperatures, some consideration being needed to maintain a reasonably dry storage space.

Being aware that shipping the film stock unaccompanied may have caused it irreparable damage, we decided to take the stock when the expedition personnel left by air from the U.K. Excess baggage problems however forced us to send the stock by airfreight and as a result the filming programme was put into considerable jeopardy when the film stock went astray, only being located and delivered 3 weeks after the expedition's arrival in PNG. Equal or worse difficulties dogged our attempts to get news film out of New Guinea. Our first attempt to send an urgent newsreel package results in its return to us after circling PNG for 3 weeks, while our second dispatch was seen by chance in a Porty Moresby airport frieght terminal, clearly marked 'URGENT ITN LONDON', having sat for 3 months on the same shelf. The lesson to be learnt from this is to ensure cast iron arrangements before becoming isolated in the bush, otherwise you can trust few people since one is in complete ignorance of a dispatch's progress or powerless to act if mishaps occur.

14,000 ft. of film was shot, a total of 7 hours continuous viewing, giving an approximate 7-8: 1 editing ratio. This can be considered to be a minimum cutting ratio for a film of this nature, where many sequences were shot which may prove unimportant to the final film storyline.

Sound

For operational convenience the main sound recordings were done on a high quality cassette recorder, a Sony stereo 152SD, one track being used for the film sound with the second track serving to record the camera synchronising pulse. In addition this recorder was used extensively for taping native songs. A Uher ¼ in. taperecorder provided with synchronised pulse recording facilities, acted as our reserve. Both recorders were designed to be used with normal 'U2 type' dry cells but it was more efficient to replace these with rechargeable Varta nickel-cadmium batteries since the recording time could be considerably extended between battery changes, thus cutting down on the soundman's equipment. A small Philips cassette recorder provided a third recording facility, and since it fitted a ammunition box it could provide adequate quality for sound effects in inaccessible underground areas.

An AKG 90 gun microphone was found very valuable for surface work, although a little bulky and delicate for use underground. 2 Sony electrostatic microphones gave high quality but difficulty was encountered because damp conditions tended to cause the electrostatic charge, on which they operate, to leak, resulting in a high loss of output. In practice a robust dynamic microphone, of which we had one, was found to be more reliable.

One failing of the Sony was a lack of microphone gain available making recordings of low level sounds, such as background atmospheres and birdsong, difficult to achieve. The Uher was better in this respect but was constantly prone to annoying minor mechanical and electrical failures.

Tragedy struck the sound side of the film shortly before the end of the expedition, when both the Sony recorder and gun microphone were swept away by a falling boulder to make a high speed descent 200ft down a shaft. Needless to say neither survived the resultant deceleration effects.

Conclusion

It has to be remembered that an expedition does not necessarily provide good film material and that a fair degree of luck and good management is required to give a strong storyline with appropriate climaxes. Inevitably some of the key events on a geographically spread out expedition of this nature happened without the camera's presence, and in any case even if it was possible to film every event indiscriminately it would involve incredible film wastage, thereby considerably increasing film costs. Consequently many events were filmed immediately after they occurred, either by reconstruction or more often by retrospective reporting techniques.

The difficult nature of terrain and climate meant that a large proportion of film crew time and effort was concerned in getting equipment to a filming location, with the aid of much porterage, and also maintaining its gear in working order under difficult conditions with minimal facilities.

Production of an expedition film particularly a caving expedition cannot be purely incidental to the expedition and involves special filming trips which are heavy on both manpower and time. It is therefore important that the expedition be as highly committed initially to the film production as it is to its objectives. However there will always be a compromise between two commitments and it is only too easy to regret afterwards that a small amount of effort may have produced even better film sequences. Naturally when things get really tough the first thing to go is the enthusiasm to film or assist in filming. As these feelings are also applicable to the film crew themselves a great deal of personal drive is required to maintain an acceptable degree of compromise.

It is difficult to draw a distinct dividing line between film costs and expedition expenditure so that a film cost of about £2000 may be a truer figure than that already mentioned in this report's introduction. What is not often appreciated is that the main costs of a film begin when filming is completed, the total cost of converting raw exposed film stock and tape recordings into a finished film could well amount to £4000-£5000. Even with the film 'rushes' developed there are difficulties in selling it independently to a television company, since the original film is very valuable and should under no circumstances be projected. A viewing copy of all our film material will cost something in the order of £500 and in order to synchronise the taped sounds with the film they would be required to be professionally transferred onto 16mm magnetic tape stock and laid in synchronisation with the moving picture, Until these stages are complete it is extremely difficult to give an adequate impression of the available film to an interested buyer.

At the present stage (July 1976) much of the film stock remains unprocessed, due to financial considerations. Nevertheless the key sequences have been processed and they indicate that we have the makings of an unusual and often dramatic film.

It is unfortunate that the climate in television at present is moving against semi-professional expedition films, because firstly in a tightening monetary situation less money is available to outside units compared to a television company's own film crews; secondly, fewer television 'slots' are being left available for the 'one off' films of this nature; and thirdly, the technical standards of television have risen to a very high level and the sheer cost of equipment to achieve such standards runs to tens of thousands of pounds, well outside the means of most expeditions.

In conclusion, the days when 'the expedition film' was an integral part of every expedition have gone and any expedition considering a film as a source of 'easy money' should seriously think again. Nevertheless the film and television media offer the sort of access to a mass audience which is the only way that the important work being done by British Speleological Expeditions abroad can achieve wider acceptance.

MEDICAL REPORT – Dr. Jon Buchan

Preparation

When I first joined the expedition I knew nothing about Papua New Guinea. Trying to get information was like trying to penetrate a Masonic Lodge. The books about New Guinea all seemed more concerned with aeroplanes and the colonial administration than with the climate and possible health hazards. What I did not know then, but have subsequently learned, is that the key letter, giving vital information, from Kevan Wilde, our local contact, had somehow been mislaid (see Section I). Much of what I wanted to know was in it. I wrote for help and advice to as many people as I could think of, and received invaluable assistance from Dr. F.C. Rodgers, Senior Medical Officer to the explorers group, Dr. J. Frankland of Lancaster, Professor B.G. Magraeth Dean of Liverpool School of Tropical Medicine and the Public Health Laboratory at Liverpool. I am most grateful to them for their help.

The problem of keeping twenty five men healthy in what was allegedly a hostile environment 6° south of the equator seemed formidable. There were basically two aspects:-

1. Illness due to tropical conditions
2. Illness and accident associated with caving.

The former I judged would not include many true tropical diseases which are essentially the product of an uneasy balance an efficient parasite and a debilitated host. We were obviously starting out as a healthy team. Tropical ailments would not attack us if we were adequately protected and kept ourselves reasonably fit.

This led to the next steps.

1. Adequate prophylaxis wherever possible
2. Education about how to keep well.
3. Vigilance concerning health standards.

Prophylaxis

In addition to the usual quota of vaccinations, smallpox, tetanus, T.A.B. and cholera, I inoculated everyone against rabies (said to be a hazard in the bat population of guano caves), and immediately before departure gave everyone a dose of Gamma globulin to protect against hepatitis. My malaria prophylaxis was daily Proguanil, kindly donated by I.C.I. Limited to be started 48 hours before departure and continued one month after return. In spite of this two members had attacks of malaria after the expedition.

Education

It was surprising how hypochondriac the team was. Health was of considerable interest to everyone, and far from me having to browbeat people into being interested, I tended to have to spend time correcting misapprehensions and refuting 'old wives' tales. There was always the maverick, of course, who insisted on eating all the most unsavoury parts of a local marsupial. He developed severe symptoms and was subjected to the indignity of a full abdominal examination. I had to try and answer impossible questions about the efficacy of vitamins, whether or not to wear underpants, the nutritional value of the local cucumbers, and so on. There was never any opportunity for formal health talks, so I was very grateful for this receptiveness in my colleagues.

Everyone was keen to help maintain standards of hygiene. There were a few minor points which came to my notice. We needed a separate bowl for handwashing and washing up and the field latrine had been dug above the camp where it would drain into the stream we used for water. During an epidemic of diarrhoea late in the expedition some were keen to have a hand rinsing bowl with bleach in it. I thought that washing thoroughly with soap and using a nailbrush in the fast moving mountain stream would be more effective since gram-negative bacteria can live in detergent solutions.

Medical Equipment

Table I shows the list of equipment taken on the expedition. This was all generously given by the Pharmaceutical Industry to whom I am enormously grateful. I simply wrote begging letters to all the advertisers in MIMS (Monthly Index of Medical Specialities) and the cooperation I received was overwhelming.

TABLE 1 – List of Medical Supplies

Bandages	Plaster of Paris 3" x 6 – 4" x 7 Glasson Splints 4" x 5 Acitone 300mls x 2 Triangular Cotton conforming 2" x 12, 3" x 12 Adhesive 2½" x 8 (Elastikon) Transpore 2½" x 4 Durapore 1" x 12" Dericell 1" x 5yds x 2 Setoplist 1" x 12. Tubular elastic Tubigrip 7.55cc x 10m 6.25cc x 10m 3.75cc x 10m 6.75cc x 10m Tubular bandage 01 x 20m x 2 12 x 20m x 2 56 x 20m x 2 Applicators x 2 Crepe 6" x 6 4" x 3 3" x 2 2" x 2 Elasticated 3" x 12 2" x 8 NETALAST size C x 9, E x 11, F x 9, G x 5
Gauze	**Absorbent** 3" x 3" x 8 **Non-Absorbent** 2 packets Sofratulle 50 x 10cm x 10m Strips 10 x 30cm x 10cm Ribbon gauze
Cotton Wool	25g x 27
Suture Materials	Miscellaneous 50 with thread/needles Needle holders
	Scissors x 3 Forceps X Spenser Wells x 2 Mosquito x 1 Dissectors toothed x 1 non-toothed x 1 Steristrips 50 packets
General Surgical	Cetavlon Lignocaine 50mls x 4 x 1 with adrenalin Ethyl chloride spray x 4
Ears/Nose/Throat	Ear syringe Forcepts (Tilley type) Oint. Neo-cortef 1.5% x 6 Drops Neo-cotef 5mls x 4 Occ. Amethocain 1% 10mls x 2
Miscellaneous	2ml x 100 syringes. 50 x 10ml Needles 100 x short, 100 x long Condoms – 1 gross (anti-leech! not used) Meditisone x 100 Surgical towels. 6 packets Insect repellent cream. 1 gallon Insect repellent liquid. 300mls x 2 Insect repellent tubes x 20 Insect repellent cream 50g x 12 Nobecutane Spray x 1 Unguentum Merck x 5 Dusting Powder x 24 D.D.T. powser x 1lb.
Analgesics	Distalgisic tabs x 500 Safaplynx 250 Safaplynx Co. x 100
Steroids	Prednisone 100 x 5mgm. Injectable Kenelog 1m x 4 Ndrocortisone 10 amps
Head/Neck	Soframycin 8mls x 9 Otoseptil 8mls x 2 Xerumanex 5mls x 2 Andax 5mls x 1 Midrilate 5mls x 1 Sofradex Fluoroscein Gargle and mouthwash Betadine
R.S.	Tabs. Asmac x 100

C.V.S.	Tabs. Saluric x 100
Anti-emetic	Dramamine x 100
Antihistamine	Oral: Tabs. Lergoban x 800 Tabs. Fabahistin 50
Abdomen	Antacid: Tabs. Adursil x 70 Tabs. Altacite x 100 **Anti-Diarrhoea** Cremostrep x 2 litres Kaomycin x 2 litres Lomotil x 850 Carbomucil 50g x 16 **Anti-amoebics** Diodoquin x 300 **Laxatives:** Dulcolax x 200 Dulcolax suppos. x 1 doz. **Pile remedies:** Proctosedyl supp. x 24
Skin	**Creams and ointments** **Barrier:** Sun screen x 9 Kamilosan oint. 50gr. x 50 **Anti-biotic:** Fucidin Gel. 10grms x 20 Chloromycetin x 6 Fucidin Oint. 25grm x 22 **Anti-fungal:** Nystatin Oint. 15grm x 20 Nystatin cream 15g x 20 Pot perm 1½ kilos Canesten 20grm x 4 **Sterid:** Halciderm 30grm x 5 Tri-Adcortyl 15g x 4 Hydrocortisone 1% 15grm x 12 Soframycin. 15g x 12 **Cleansing and de-sloughing** Crystal violet x 1 Savlon 30g x 20 Mercurochrome Malehite Green Betadine shampoo x 3 **Powders:** **Anti-fungal** Tinaderm 50g x 3 Zinc Undecenoate Dusting Powder Nystatin powder 15g x 7 **Powders** **Anti-biotic:** Riko-spray 110gr x 3 **Antiseptic:** Morhulin 110gr x 2
Resuscitations	Plasma 400mls x 3 Plasma ub. Dextran 70. 500mls x 8 Giving Sets x 8 Saline 500mls x 8 Laryngoscope Guedel airways Air viva resuscitator
Nutrition	Beneroc 10grms x 100
Antibiotics	Injectable: Ampicillen 10 x 40 Chloromycetin x 6 Crystamycin 50 x 50 **Oral** Tabs. Penicillin 250mg x 200 Tabs. Penbritin. 500gsm x 120 Tetracycline 250mgs x 250 x 1 Ta. Dalcin 16 x 6C. Chlromycetin x 100
	Hypnotics Ativan 1 mgm. x 525 **Antidepressants:** Tryptizol. 10mgm x 500
Drugs carried by air	Tineafax ointment Diconal Lasix ampoules 1 x 5 amps Camoquin Alcopar Banocide Cicatrin Powder Cicatrin Cream Otosporin 5mls x 1 Paludrine Audax Dramamine Predisone Coprolox x 1000 Streptotab x 500 Phenergan inj. 50mg x 20 Ninaquine 500 x 3 Stemetil Neo-Cortef x 2

TABLE II – List of Conditions Treated

Sore Feet	7
Sores in other sites	15
Diarrhoea	12
Tonsillitis	4
Abdominal pain	3
Headache	3
SRT phobia	2
Lethargy	2
(1 flu & 1 histoplasmosis)	
Undiagnosed	1
Supraclaviculr fossa pain	1
Injuries:	
Lacerations:	
with suture	2
without suture	1
Burns (second degree)	2
(1 rope – 1 exploding battery)	
Haemarthrosis	1
Head injury	1
Sprained ankle	1

TABLE III

	Quantities Used
Oral Penicillin	156
Lomotil	over 500
Tetrabid	100
Ampicillin 500	76
Canestan	
Cremostrep	
Rikospray	
Sofratulle	
Crystomycin	
Safapryn	
Neocortef	
Flagyl	
Distalgesic	
Potassium Permanganate	
Mercurochrome	

Comments

1. General

Skin sepsis was the commonest problem although it was not the worst. There is a rumour that the atmosphere in Papua New Guinea breeds tropical sores. At first sight this may seem true, but if it were true it is difficult to explain why some men had recurrent lesions, but others had none. I think that a high work rate, particularly in the early unacclimatised, unfit days, usually associated with a high degree of drive and personal commitment caused the most sores. It would be interesting to follow the group over a number of years to see if the same men developed coronary artery disease.

Many ulcers responded to simple antiseptic dressings. My favourite was mercurochrome. We had a water bottle filled with 1% solution and people happily daubed their minor cuts and abrasions with the brilliant red paint. Next came dressings with Sofra Tulle, antibiotic sprays and washing with diluted potassium permanganate solution. As a last resort I used systematic antibiotics which were always effective. The twice daily routine of Tetrabid Organon was particularly convenient.

Diarrhoea was with us throughout the trip. It was unpredictable and affected everyone at some time. It became particularly common towards the end of the expedition in the team exploring those areas where conditions were worst.

Standard treatment was with Lomotil tablets, Cremostrep or Kaomycin. All these products were freely available to expedition members in all camps. Mostly people treated themselves. One case only was accompanied by fever and abdominal pain and responded to ampicillin. One case responded to metroniazole and one did not clear up until after the expedition ended. This was diagnosed later, in Australia as tropical sprue.

Some blamed the diet for our diarrhoea. We lived mainly on reconstituted dehydrated food. There was little meat and we derived our protein mainly from knitted expanded soya protein (KESP) or textured vegetable protein (TVP). At first we followed the instructions to soak for ½ hour then cook for ½ hour. We finished by soaking all day and cooking much longer. Even when we were well bowel actions were more frequent and the stool more bulky than on home food. The amount of offensive flatus produced in each camp was a standing joke, but most eventually reverted to some semblance of normality. We were always hungry. and loss of appetite was hardly ever a feature of the diarrhoea. Because the meat substitutes were so tasteless we tended to use lots of spices and curry to flavour the food. This, no doubt, worsened our predicament.

Otherwise there was the usual crop of minor injuries and tonsillitis – UK pattern with no surprises.

Accidents

1. There were only two major underground accidents. The first and worst involved a caver who fell from a 20ft. high boulder and sustained a head injury with a laceration to his right frontal region.

Entirely adequate and competent first aid was administered by those on the spot. By the time I arrived the worst was over. The patient was rouseable but would lapse into unconsciousness from time to time. Perfunctory examination revealed no other injuries and he was clearly fit to move. An efficient five hour stretcher haul brought him to the surface. I sutured the wound, gave prophylactic antibiotics and waited until he recovered. It took some five days in all. Retrograde amnesia approximately 30 minutes, postgrade amnesia five days.

2. A falling boulder narrowly missed one of the team while he was dangling from a rope in a deep shaft. Not many days later another boulder did, in fact, strike a caver as he was waiting to climb the rope. Fortunately he had the presence of mind to climb immediately while he still had mobility. He managed to get into a safe position at the top of the climb but from there had to be lifted to safety in an upright attitude along a narrow rift. The injury which kept him inactive for ten days was either a haemarthorosis or a traumatic synovial effusion.

Summary

This was a healthy expedition. Because caving is a minority sport our sponsorship and external finances were not massive. Therefore everyone who came had to make considerable financial sacrifices. Publicity was not guaranteed so there was little chance of a wealthy exhibitionist applying. This made for a well integrated team which was desperately anxious to stay well and stay working. Although Dave Brook was the acknowledged expedition leader there was no hierarchy or chain of command. There were no instructions only suggestions and most decisions were made by consensus. Because of this everyone shared equal responsibility and every expedition member had to work out for himself how he was going to contribute and how he was going to ensure a continuing contribution.

Morale rarely flagged. Only in the last few weeks when fatigue diarrhoea and poor conditions made life uncomfortable in the Fault Controlled Valley were there any problems of personality clash. These were treated in the same way as the decision making, a kind of spontaneous group therapy. At no stage was there any likelihood of having to administer psychotropic drugs, nor was there much danger of the expedition halting because of mental problems.

It speaks volumes for caving as a sport that twenty three men living cheek by jowl in camp conditions for up to five months were sufficiently well adjusted to get on with each other and enjoy themselves most of the time.

List of Medical firms who supported the expedition

A.H. Robins and Co. Limited
Wright Layman and Umney Limited
Dunster Laboraties Ltd.
Stafford-Miller Limited
Richardson-Merrell Limited
Pharmax Limited
Pharmaceutical Research (STD) Limited
I.C.I. Ltd.
Wellcome Foundation Ltd.
Hoechst Pharmaceuticals
BOC Medishield
Searle Laboratories
Stiefel Laboratories (UK) Ltd.
Evans Medical Ltd.
Beecham Research Laboratories
Wyeth Laboratories
Leo Laboratories Ltd.
Norgine Ltd.
Syntex Pharmaceuticals Ltd.
Travenol Laboratories Ltd.
3M Laboratories
LR Industries Ltd.
E. Merck Ltd.
Glaxo Laboratories
Dome Laboratories
Ph armitalia
E. Lilly and Co. Ltd.
Dista Products Ltd.
Roussel Laboratories Ltd.
Bayer UK Limited
Geigy Pharmaceuticals
Lundbeck Limited
Swann-Morton Ltd.
Pfizer Ltd.
Seton Products Ltd.
Pharmaceutical Manufacturing Co.
Ortho Pharmaceuticals Ltd.
E.R. Squibb and Sons Ltd.
Abbott Laboratories Ltd.
Boehringer Ingelheim Ltd.
Smith Kline and French Laboratories Ltd.
Ayerst Laboratories Ltd.
Roche Products Ltd.
Organon Laboraties Ltd.
Dales Pharmaceuticals
Knox Laboratories
J. Pickles and Sons

Notes on Histoplasmosis Exposure - Dr. John C. Frankland

This article describes the exposure of the New Guinea '75 expedition to histoplasmosis which is the colonisation of some part of the body, almost invariably the lungs, by the fungus known as **Histoplasma Capsulatum.** This fungus is endemic in many areas of the world but has not been found in the United Kingdom nor has histoplasmosis been identified in the British native population (Edwards and Billings, 1971). In the endemic areas certain moist and damp environments favour the saprophytic growth of the fungus and it is from these that the disease can be contracted by inhaling the fungal spores. Such environments include caves particularly when guano is present, but also underground storm shelters, pigeon lofts and chicken runs have been documented as sites of infection.

In many parts of tropical Asia histoplasmosis is endemic, a study in New Guinea having shown 19% of a total of 795 members of the native population to have confirmed evidence of the disease (Wijsmuller 1958). Thus it could be predicted that amongst the hazards facing this expedition was the possibility that they would be exposed to histoplasmosis.

However, it should be explained that in some areas of the world particularly in Mississippi and the Ohio River valley of the United States, up to 86% of the population have been infected by histoplasmosis (Palmer 1945) without clinical disease of any form of disability.

In contra distinction to this in the African continent detailed studies on speleologists showed that in 61 of 66 cases studied by Murray (1957) and by Dean (1957) an episode of a typical pneumonia with a protracted and occasionally severe systemic illness was a feature of exposure to histoplasmosis fungus in caves. The publicity given to these findings together with descriptions of pneumonic illness from histoplasmosis contracted in caves in South America (Campin 1956; Aranell 1955; Pietri 1956) and Southern U.S.A. (Halliday, 1949) and Çyprus (Stoker 1964), gave the perhaps understandable impression that exploration of guano caves in endemic areas carried a high risk of hazard from pneumonia the illness lasting several weeks.

However, in 1974 the writer tested the British Karst Research Expedition to Venezuala and found that of eight members five had contracted histoplasmosis and none had suffered clinical illness. This totally asymptomatic infection had not been described previously following cave exploration where 95% of those exposed in previous series had appreciable clinical illness.

It was suggested after the Venezuela expedition findings that further studies on British Speleologists visiting endemic areas would be appropriate both to further epidemiological knowledge on histoplasmosis and to further assess the true risk of this hazard facing cave explorers in endemic areas.

The members of the New Guinea '75 expedition kindly cooperated in allowing histoplasmin testing (the injection of a measured amount of sterile filtrate on laboratory prepared **Histoplasma capsulatum** culture the reaction to which demonstrates whether antibodies to the fungus have been formed) before and after the expedition together with blood sampling for immunological testing for histoplasmosis antibodies.

Results

On pre-expedition testing all were histoplasmin negative save one member known to have converted on the 1974 Venezuela expedition. On post-expedition testing 7 members were "doubtfully" positive (probably of no diagnostic importance — Mackenzie) 3 were positive (including one positive on pre-expedition testing) and the remaining 5 remained negative.

In summary these results show that two of the fifteen members tested had shown convincing evidence of histoplasmosis infection acquired in New Guinea.

Serological testing

Post-expedition serological testing gave a universally negative complement fixation result and only a trace positive precipitin test (CIE) in five members including two of the three known to be histoplasmin positive. The negative serology is compatible with a mild infection with insufficient antigenic stimulation to produce detectable antibodies. The trace positive precipitin test in one member with a negative histoplasmin skin test and

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None of the expedition members (in particular the two members converting to a histoplasmin positive state) had any respiratory symptoms compatible with the previously described picture of clinical illness due to histoplasmosis (Frankland 1974). The two individuals who acquired histoplasmosis had rarely caved together on the expedition, and never as an isolation duo. Hence others must have been exposed to histoplasmosis but have not reacted to it. No masks (or similar protection) were used whilst guano caves were explored. The positive pair had chest x-rays after return to UK with no abnormal findings.

These findings perhaps support the writer's hypothesis that histoplasmosis can be acquired from cave exploration in endemic areas without the clinical illness traditionally associated with acquiring the disease via cave exposure previously described in the medical literature. A benefit to those thus contracting histoplasmosis is that if further exposure to histoplasmosis occurs, e.g. on a subsequent expedition it is very likely that they will have immunity from any clinical illness from the fungus. (Murray, 1957).

Perhaps the quantitative risk of cave exploration in endemic areas remains as yet unknown but further studies as described here may help to clarify the problem.

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