KARST AT NEW GUINEA, SNOWY RIVER, VICTORIA

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Abstract

One of the features of the Snowy River Gorge northeast of Buchan, Victoria, is a small but spectacular area of karst, at New Guinea. This is developed in an isolated occurrence of massive limestones of the Early Devonian Buchan Group, downfaulted into the Lower Devonian Snowy River Volcanics; and is one of several small outliers of the Buchan basin. The limestone occurs as a dissected bench along the gorge and is characterised by substantial cliffs, well developed dolines, and a number of interesting caves. Speleological investigations at New Guinea in recent years indicate that the geomorphology, hydrology, cave biology, and surface vegetation of the area are of considerable interest. This paper summarises the discovery and exploration of the area and describes the main characteristics of the karst and associated features. A number of issues in land use planning and management of an area such as this are discussed.

Introduction

The name "New Guinea" is applied to an area on the Snowy River just south of the Tulach Ard Gorge and some 25 km northeast of Buchan (Fig. 1). The area probably gets its name from the relict rainforest communities in the gullies, and the rugged terrain. It includes a small area of karst which is part of a larger and discontinuous belt of limestone outcrops which extends from Buchan to Jacksons Crossing and New Guinea. This paper is concerned with the northern end of this belt.

Geology

The limestone at New Guinea is of Early Devonian age (VandenBerg 1976) and is dense, dark to light bluish in colour, massive, well bedded, and often highly fossiliferous. It is one of several small outliers of the Buchan Caves Limestone along the Snowy River to the east of the Buchan Basin (Teichert and Talent 1958). In outcrop, it appears as a roughly rectangular block, some 1.5 km wide and 6 km long, extending from New Guinea in the north, to Jacksons Crossing in the south.

During the late Devonian, the limestone was subjected to complex faulting and tilting down into the unconformably underlying (Bradley 1969) Early Devonian Snowy River Volcanics (Howitt 1876; VandenBerg 1976). The general structure is of a roughly north-south strike and a 10-30° westerly dip. A number of faults have been identified along its margin but, due to poor outcrop and severe dissection, the exact nature of the limestone/volcanics boundary is rather obscure (Bradley 1969; VandenBerg pers comm).

Talent (1956) and Teichert and Talent (1958) correlate the limestone at Jacksons Crossing as equivalent to the Buchan Caves Limestone of the Buchan Basin; it is similarly dolomitic at the base and has a somewhat richer fauna. Talent describes a sequence of about 200 m of limestones and dolomitic limestones, commencing with over 30 m of calcitic dolomite and dolomite limestone, and passing upwards successively through pure limestones, muddy limestones, mudstone, and pure limestone. The upper portion of the Buchan Basin sequence – the Taravale mudstones and Murrindal limestones (Teichert and Talent 1958) – is unrepresented in the area.

The underlying Snowy River Volcanics comprise a thick and massive sequence of acid volcanics including rhyodacites, rhyolites, andesites, tuffs, agglomerates and occasional sediments (Ringwood 1955; Bradley 1969). An interesting feature of the volcanics is an outcrop, near the base of the limestone on the northern side of New Guinea spur, which shows strong columnar jointing (Ferguson 1899).

River gravels and cobbles occur in a number of scattered places, especially capping ridgetops

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Proceedings of the 11th Conference of the ASF 1976

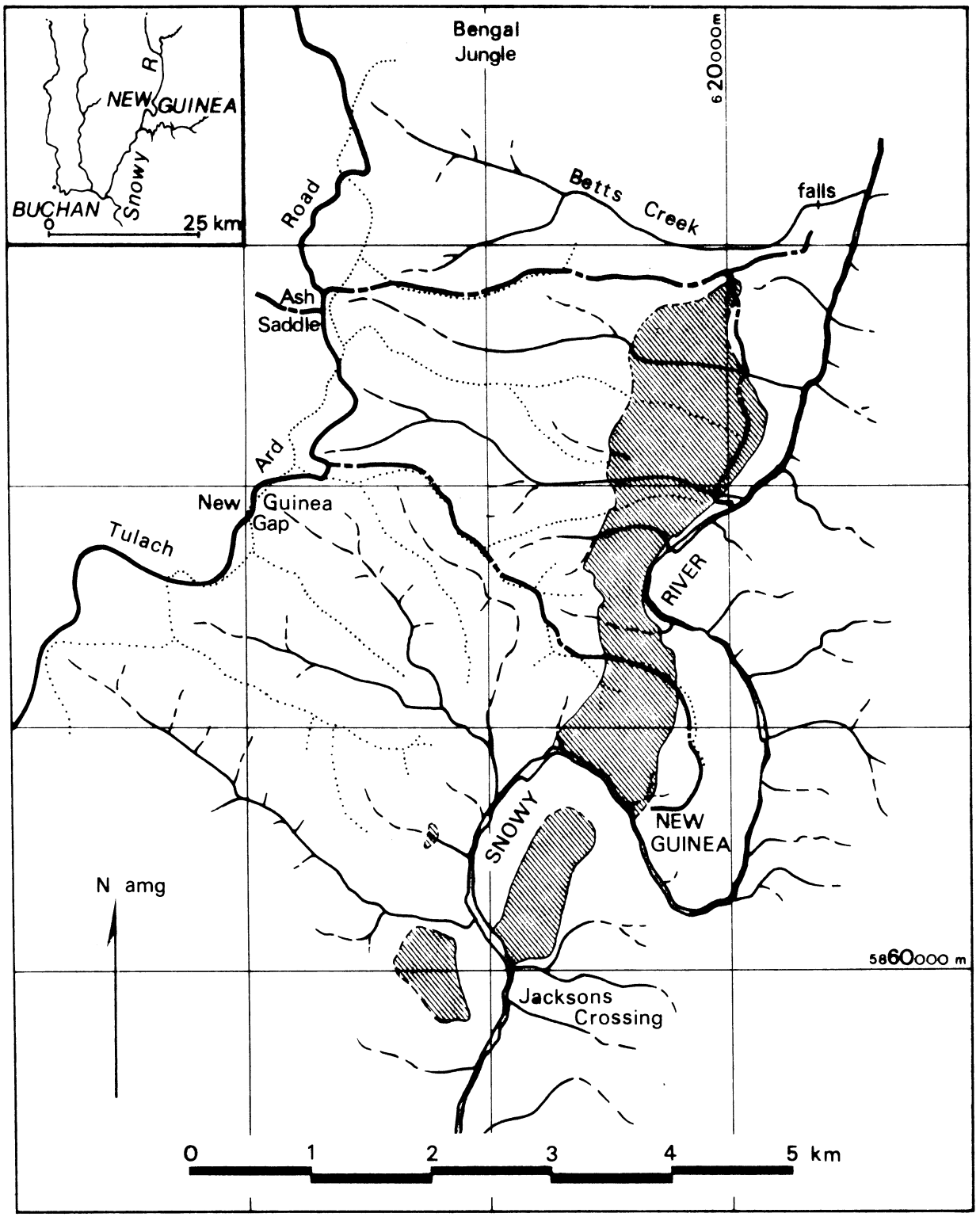


Fig. 1. Approximate extent of the limestone at New Guinea, showing the catchments which drain across the outcrop to the Snowy River.

along the gorge. These are most likely to be of Pleistocene age (VandenBerg pers. comm.) although Ferguson (1899) regarded them as Pliocene. These sediments are indicative of a broad valley floor in an earlier stage of downcutting the Snowy valley. One such deposit outcrops on top of the limestone on New Guinea spur.

Topography

The setting of the New Guinea area is of a probable Tertiary erosion surface uplifted in the Pliocene or early Pleistocene and deeply dissected by the highly active Snowy River to form an impressive tract of gorges, steep valleys, and rugged terrain. The general relief of the area is about 800 m, ranging from 80 m at the Snowy to 900 m elevation on plateau remnants to the west.

The limestone outcrops as a bench in the western side of the gorge. The Snowy initially flows parallel and a little to the east of the outcrop, but then cuts a broad bend into it (at some high limestone cliffs) and swings east to flow round New Guinea spur before heading back west across the limestone and then away to the south. It is interesting to note that the Snowy has incised this great meander in volcanics, rather than cutting directly through the more readily eroded limestone of New Guinea spur. The gravels on top of the spurs, and the broad former valley that their setting implies, suggest that this meander is a superimposed drainage feature.

Three major spurs, New Guinea spur being the southernmost, descend steeply from the plateau to the limestone. At the contact of the volcanics with the limestone, there is a marked break in slope, characterised by a small saddle. The limestone on the spurs is fairly level and they then drop relatively steeply to the Snowy River.

Drainage

The northern section of the New Guinea limestone is dissected by three gullies. These are partially filled with coarse gravels and have dry stream channels. The channels probably flow only after exceptionally heavy rain, since the surface streams normally sink as they approach the limestone/volcanics contact. In the case of the northernmost gully on the limestone, it is uncertain whether the stream enters an underground karst drainage system, or merely seeps through the deep gravels in the gully floor.

The next two gullies south apparently sink and enter the NG5-6 and NG2 systems respectively. It would appear that these systems developed only after the gullies were cut to their present level. Downcutting of the gullies has kept pace with the downcutting of the Snowy River and there has clearly been no underground capture until relatively recently. It would appear, especially from evidence in NG1, that there may have been considerable phreatic preparation of the limestone prior to downcutting.

Climate in the area is temperate, with cool winters and hot summers. The rainfall varies considerably with topography. Stands of Mountain Ash (*Eucalyptus regnans*) occur at 700-900 m in the heads of the main gullies, and these indicate an annual rainfall of about 1500 mm. However, the Snowy valley is considerably drier and the rainfall decreases rapidly down to river level (at 80 m). The woodland and open forest on the limestones (from 80 m to 300 m) is indicative of annual rainfall of about 400 mm.

This rainfall pattern is significant, since it means that the runoff on the karst area itself is likely to be considerably smaller in volume than the runoff flowing onto the limestones from the volcanics. Although summer flows may be as low as 0.1 $1s^{-1}$, these streams from the volcanics are virtually perennial, and would carry higher flows (typically in the 1-10 $1s^{-1}$ range) for most of the year.

Caves and Karst Features

To date, three cave systems and one small spring have been found at New Guinea. The only other obvious karst features are two substantial limestone cliffs, a number of dolines, and a few apparently minor caves.

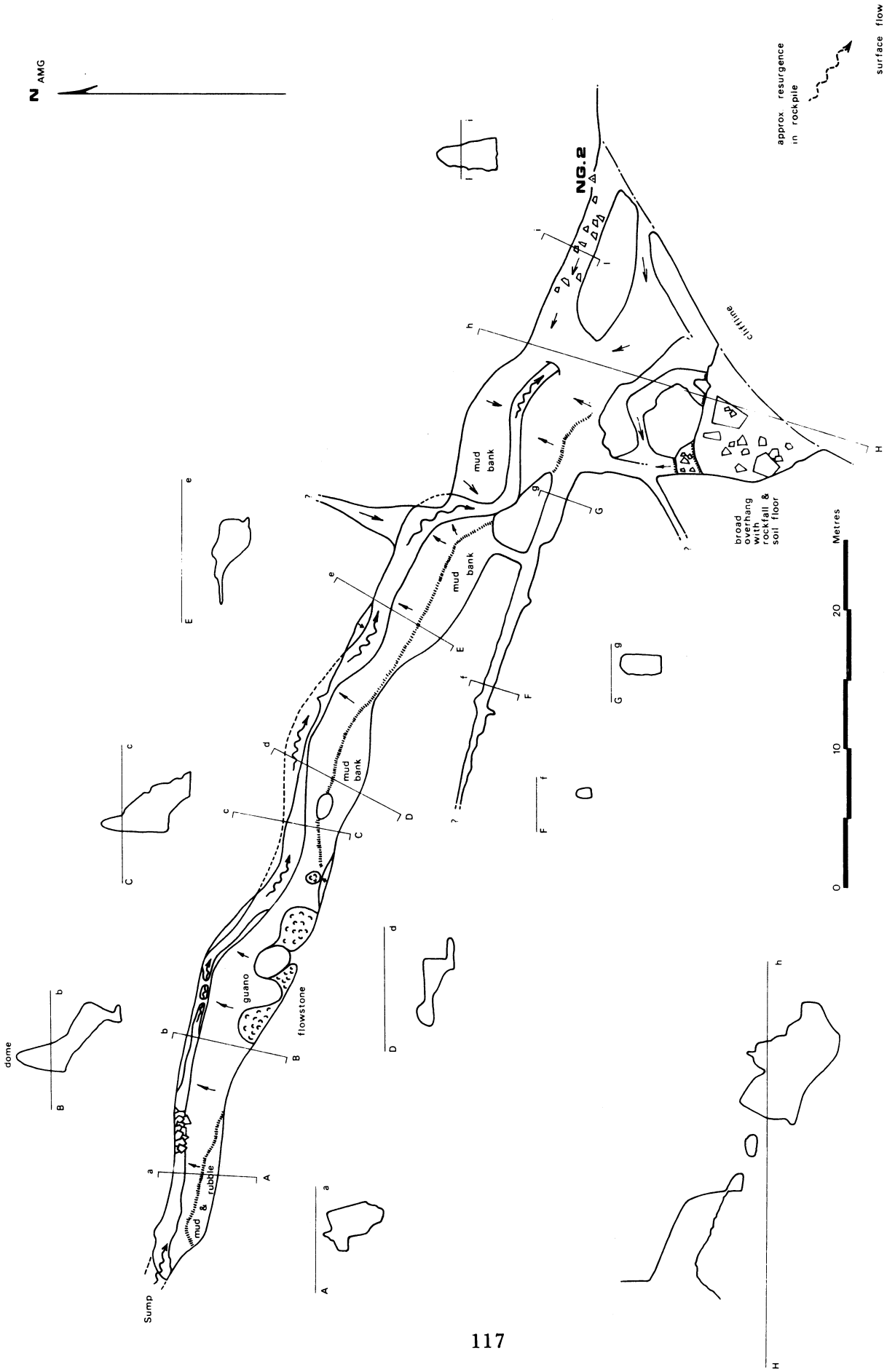


Fig. 2. Plan of NG 2 cave, as far as the sump.

NG2 cave (un-named)

This cave is the outflow of a relatively substantial (1-5 ls^{-1}) permanent stream. Its entrance is in a short section of low cliff about 100 m back from the Snowy River. The cave consists of a large chamber with several entrances, and a roomy stream passage with several dry side passages; all joint-controlled (Fig. 2). About midway, the stream sumps off and the inner section can only be reached through it by excavation of gravels and a very low wet crawl. The termination of known cave is a substantial rockfall; total length of the cave is about 150 m.

Near the entrance, the cave is partly developed along bedding planes, with collapse creating a large balcony looking out towards the river. This has a floor of large fallen blocks and earth. From the evidence of shell, bone and stone fragments, it would appear that this balcony and the large bank above the stream in the entrance chamber were occupied at some time by aborigines.

The source of the water flowing from NG2 is not known. Its volume is too substantial for it to be solely derived from a catchment on karst. It probably originates from the surface stream in the gully to the north, which has its headwaters to the west of the cave, and sinks just 50 m or so upstream of the contact with the limestone. However, this is a substantially smaller (and lower, and drier) catchment than that feeding the NG5-6 system (which has a flow comparable to that of the NG2 system). It seems likely that NG2 depends on other, as yet unknown, surface catchment areas as well.

Nuigini Namba Faiv Cave (NG5), and NG6 (un-named)

NG5 and 6, together with an un-numbered resurgence, form an interesting underground drainage system. Nuigini Namba Faiv is an extensive (500 m) stream passage cave (Fig. 3) which is more or less parallel to, and only a few metres below, the surface flood channel in a gully which crosses the limestone. The surface stream sinks into fractured volcanics some 50 m upstream of the contact with the limestones (about 500 m upstream of NG5). Between these two points there are several dolines quite close to the flood channel.

The cave has a tight rockfall entrance and the stream passage is generally low and rather wet; it meanders considerably, mainly controlled by jointing, and alternates from bedrock to frequent sections of rockfall. At the upstream end of the cave is a large chamber (approximately 60 m long and 25 m wide) which extends at the far end to about 25 m above stream level. The stream is blocked by a massive rockfall.

At the downstream end of the cave, the stream likewise disappears in rockfall. It almost certainly reappears in NG6, which consists of a large doline with a stream flowing out a short section of tight cave on one side of the doline, and promptly disappearing into rockfall on the other. A substantial resurgence on the surface flood channel some 100 m downstream is presumably that of the NG5-6 system. Total underground course of the stream would be about 1.5 km ("as the crow flies").

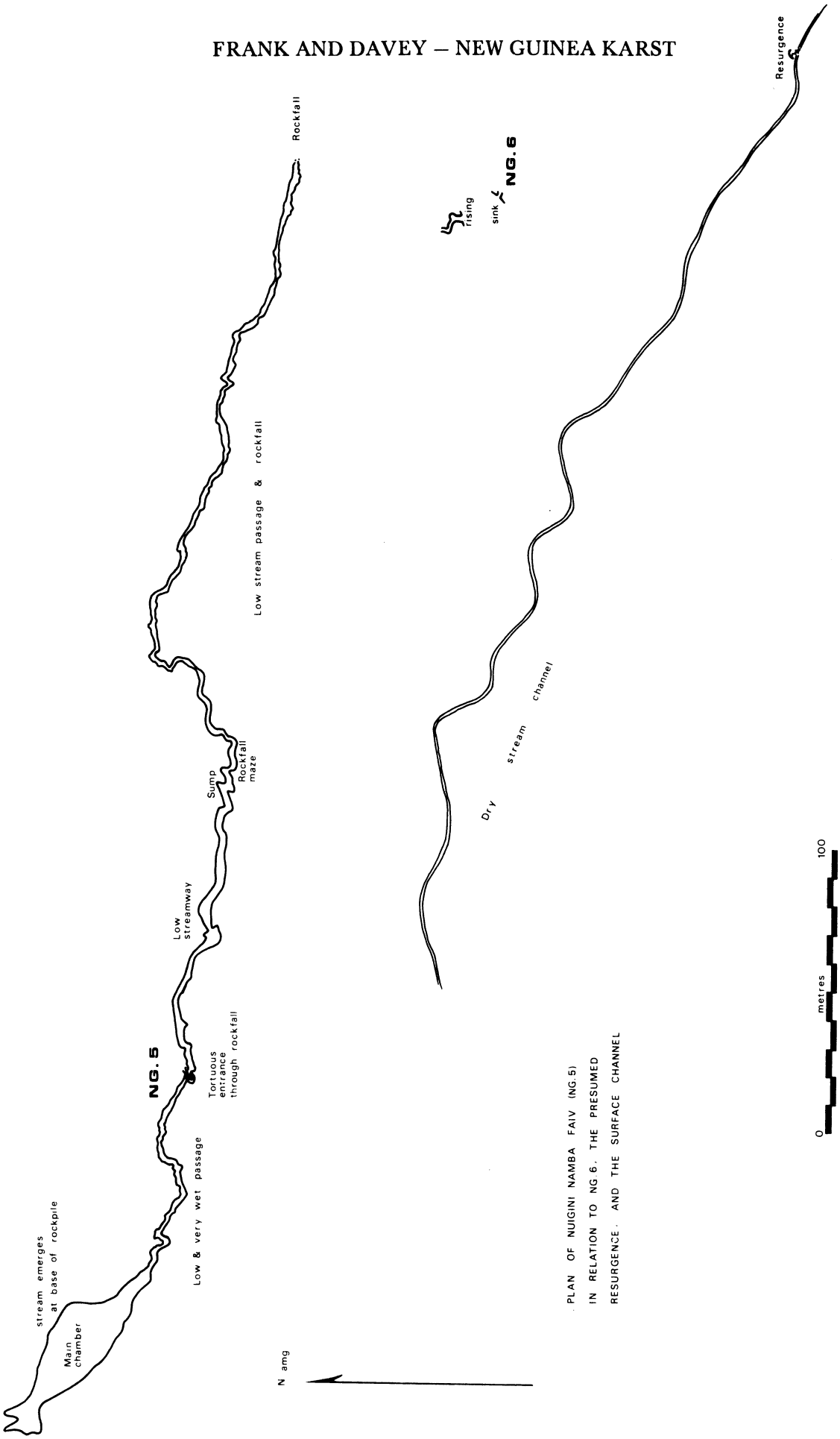
New Guinea Cave (NG1)

New Guinea Cave has a surveyed length of 400 m, and is 70 m deep (Fig. 4). It appears to be essentially joint-controlled in that the initial 250 m is north-south along strike joints, and the last 150 m is east-west down dip joints. Although the general trend in these two sections is straight, the cave is occasionally offset, or minor chambers developed, along joints more or less at right angles to the trend of the main passage.

Generally the stream passage is a high (up to 20 m), narrow, vadose canyon, and has upper levels along most of it. These run parallel to and at times slightly offset from the main stream passage. The upper level passages are frequently modified by rockfall and are normally partially infilled with clayey gravels, mud, and guano. Higher level phreatic development also shows a marked north-south and east-west structural control; it consists of low passages, blocked by heavy clay fill.

The cave stream is a small trickle between occasional pools, and presumably flows only after very heavy rains. The gravelly stream bed falls at a fairly consistent gradient, bounded by occasional banks of cemented gravel and silt. In one section, along the east-west leg, the gradient steepens for 25 m or so, where a narrow sinuous passage in bedrock has been sculptured into a series of short falls and splash pools.

The initial phreatic development of NG1 probably took place when the Snowy River was at a level above the present spur and the gravels had not yet been deposited. As downcutting proceeded, the phreatic system would have progressively drained, allowing the present vadose stream system to



PLAN OF NUIGINI NAMBA FAIV (NG.5)
IN RELATION TO NG.6. THE PRESUMED
RESURGENCE AND THE SURFACE CHANNEL

Fig. 3. Plan of Nuigini Namba Faiv cave and NG 6 in relation to the dry surface channel and the presumed resurgence.

develop. The solution doline must also post-date this downcutting. It is interesting to note that had the spur been slightly narrower – even by 100 m or so – it is unlikely that any more than the initial phreatic phase would have developed, since all drainage would have been run directly off one side of the spur or the other, instead of draining into the large entrance doline. As it is, the surface catchment to the doline is not only small, but is directly on top of the spur. The old gravel beds, permitting rapid infiltration in an otherwise small catchment, may have been an important factor in cave development.

The ultimate rising of the stream at NG1 is unknown. Its sump is about 150 m above the level of the Snowy, and gullies with small streams in them occur on both sides of the spur. Neither has any obvious springs.

Other Features

Just south of the New Guinea Cave doline, a small valley of degraded dolines and small limestone outcrops heads south in the direction of the Snowy. One of these dolines contains a small cave formed in large corroded boulders of limestone.

A small spring with an estimated average flow of about 0.2 $1s^{-1}$ rises on the main cliffs just north of New Guinea spur, at about 150 m above the river. The stream from this spring has deposited a large bank of tufa at the base of the cliffs.

The northernmost of the gullies crossing the limestone has not yet been adequately investigated, but a preliminary reconnaissance over just part of the area revealed several blind dolines, and a fairly substantial catchment without any surface stream flow. Like the streams associated with NG2 and NG5-6 in the gullies to the south, the surface stream sinks into the gravels and/or fractured volcanics at or just upstream of the contact with the limestone. A major tributary gully in limestone, and a doline area identified from air photos, have yet to be investigated!

Vegetation

Vegetation communities at New Guinea include tall open forest, open forest, woodland, and remnants of closed sub-tropical rainforest in the lower gullies.

The gully heads contain tall wet forest of Mountain Ash (*Eucalyptus regnans*). At slightly lower elevations, and more exposed sites, the vegetation is an open forest dominated by Silvertop (*E. sieberi*) and Messmate (*E. obliqua*). In drier sites still, the forest is more open and dominated by White Stringybark (*E. globoidea*) and associated species.

On the limestone, and on other dry sites in the gorge, the vegetation varies from open forest to woodland, and is dominated by Red Box (*E. polyanthemos*), But But (*E. bridgesiana*), and Yellow Box (*E. melliodora*). Other species of interest include Kurrajong (*Brachychiton populneum*) and Austral Grass Tree (*Xanthorrhoea australis*), both of which are locally characteristic of the limestones, and occur on the volcanics very rarely. Groundcover on the limestones is generally more grassy than on the volcanics.

The relict rainforest gullies are dominated by pittosporum (*Pittosporum undulatum*) and Lilly Pilly (*Eugenia smithii*), and are characterised by a diverse assemblage of lianas.

Much of the limestone was once partially cleared (at the turn of the century) and then abandoned. All but a few areas have now regenerated, though not necessarily to their original condition.

Cave Fauna

New Guinea Cave and NG2 both frequently contain larger number of the Bent Winged Bat (*Miniopterus schreibersii* Kuhl). In both cases, the bats tend to congregate in relatively large chambers well inside the caves, near the terminal sump. These bats are almost certainly part of the population based at Nowa Nowa, 20 km to the southwest (Hamilton-Smith 1965). New Guinea Cave is regarded by Hamilton-Smith (pers. comm.) as one of a few caves in the Buchan area used by pregnant females, prior to the birth season, for acclimatisation.

The guano piles in both of these caves support a characteristically rich invertebrate fauna, including guano mites, beetles, and spiders. Elsewhere in the caves, several spider species and wetas are fairly common.

Invertebrate species of interest which have been recorded from New Guinea Cave include the troglophiles *Notospheophonus castaneus consobrinus* Moore, and an as yet undescribed species of

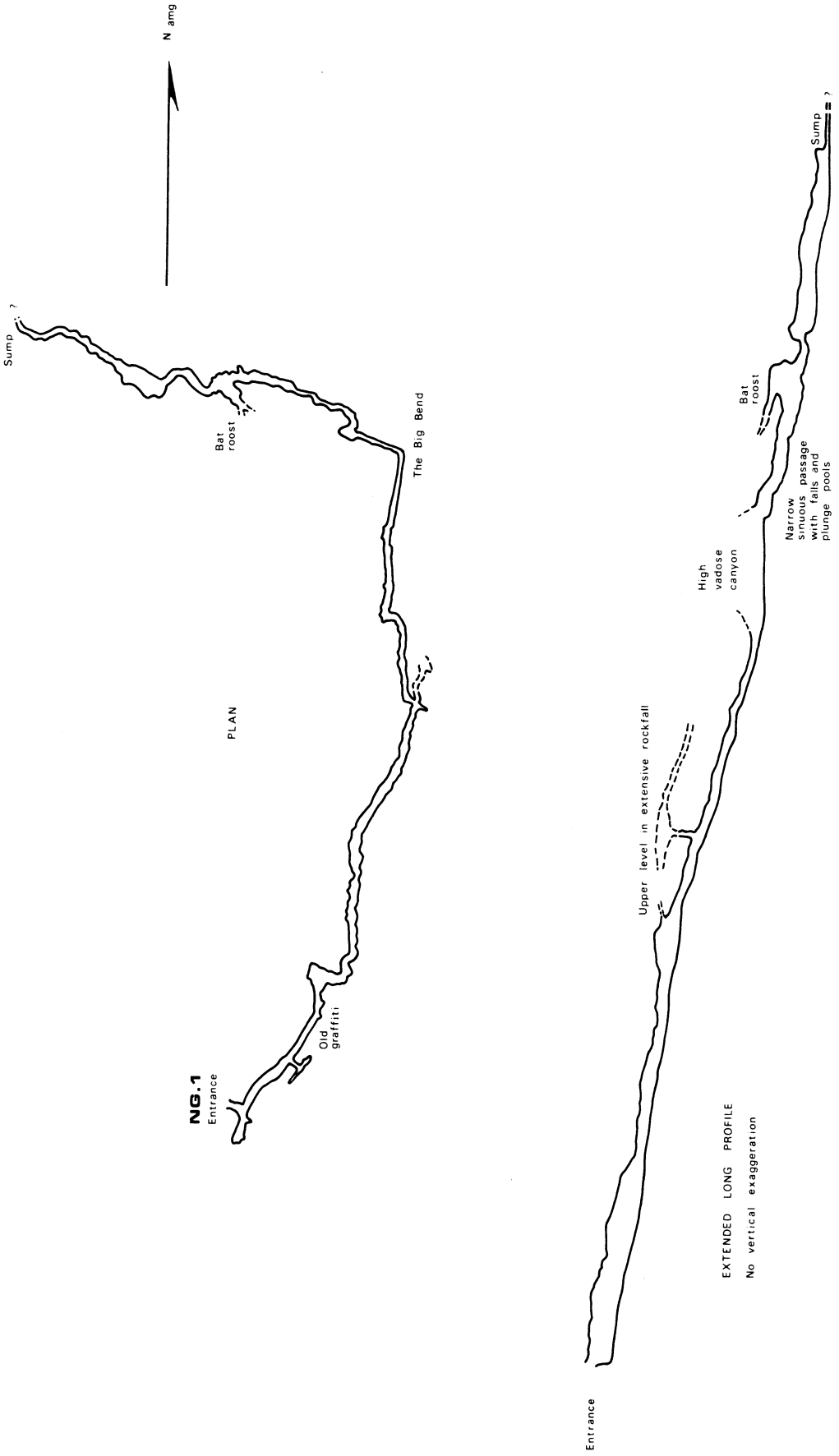


Fig. 4. Plan and profile of New Guinea cave

Triaenonychid harvestman, which are both endemic to the Buchan area; and an interesting mollusc, *Elsothera funerea* Cox, which is only recorded from caves in two other localities – East Buchan, and Bungonia, N.S.W. (Hamilton-Smith pers. comm.).

History

The first recognition of the limestones of the Buchan area appears on a geological map produced by Taylor in 1866. Soon after, Selwyn and Ulrich (1867) and McCoy (1867) established the age of the limestones; but it was not until the work of Howitt (1876) that the geology of the Buchan district, including the limestone and some of the outliers along the Snowy River, was first described. Later, Howitt (1878) described some detailed stratigraphic sections for the limestones; Whitelaw (1899) also provides a description of the Buchan limestone.

First specific description of the limestone in the New Guinea area was in 1899, following a survey of the Snowy River gorge by Ferguson. An unpublished Geological Survey of Victoria map, which includes the New Guinea area in some detail, resulted from this survey.

Initial selection of land at New Guinea took place around the turn of the century. Three allotments, totalling 270 ha, were surveyed between 1897 and 1902. These covered approximately one third of the total limestone outcrop area, and little other country. Commenting on the scope for further settlement, a Lands Department surveyor reported in 1901 that ". . . the Crown lands adjoining are rocky slopes almost precipitous, impossible to fence, and absolutely useless to any grazier" (Department of Crown Lands and Survey 1901). As it turned out, the only other settlement in the area was to be that further south, at Jacksons Crossing and on the Rodger River.

Freehold title was never granted for the leases at New Guinea, mainly, it seems, because of objection from the Mines Department on grounds of potential for mining (Department of Mines 1911). It seems that, apart from periodic leasing of the area for forest grazing, the area has steadily regenerated since being abandoned ten or fifteen years after selection. Several old fences in the area presumably date from this later grazing.

The early surveyors and lessees were certainly aware of the extent of the limestone, and of the existence of the big cliffs, but there seems to be no early reference to the large doline at New Guinea Cave, or the major spring at NG2. However, New Guinea Cave at least must have been known from about the time of first selection, as there are dates in the cave from 1906 to 1920. Interestingly, none of the names in this early graffiti are those of the surveyors or lessees.

Speleological Investigation

Caving trips to the area commenced in the early 1960's with visits to New Guinea Cave and some surface exploration. The mid sixties saw several bat-banding trips to New Guinea Cave, but little other exploration until 1967, when much of the central area was investigated. The section of NG2 upstream of its sump was first entered at this time. More recent investigations, particularly between New Guinea Cave and NG2, confirmed that there was not likely to be any connection between the two, and failed to locate a resurgence for the New Guinea cave drainage.

In 1974, the northern part of the limestone was explored for the first time, and Nuigini Namba Faiv and NG6 discovered, together with the resurgence of that system, and several dolines upstream. A major extension of Nuigini Namba Faiv Cave, downstream of the sump, was first entered in 1976. Considerable further investigation is warranted; for example, a survey party in New Guinea Cave late in 1976 discovered new upper levels which extended the known cave by 50 per cent or so! As mentioned above, the northern section of the limestone awaits systematic exploration.

Land Use Planning and Management

The New Guinea area is currently unreserved Crown Land administered by the Forests Commission as "protected forest" (*Forests Act* 1958). Apart from canoeing and bushwalking along the river, caving on the limestone, and some infrequent recreational use of the tracks by four-wheel-drives or trail brikes, the only active land use is (or has been) logging.

The Mountain Ash forests and the taller of the "mixed species" forests above an altitude of about 500 m are the only timber resources here of interest for commercial sawlog production. Most of the

commercial timber within the catchments of the New Guinea karst has been cut during the last five or so years. Some limited production could continue for another few years.

The logging has not been a serious conservation problem, apart from the usual landscape effects. Perhaps the main cause for concern is that regeneration of the mixed species forests under a low-intensity cutting regime is not easy to contrive. There is no evidence that the caves have been affected by siltation.

As a land use issue, however, it was unfortunate that logging ever took place here. The scenic and wilderness qualities of the area are such that there is good reason to suggest that the timber should never have been cut. The timber resource within the main valley of the Snowy is both small in volume and scattered in nature, so it must have been far from the most valuable of the various resources available to the timber industry in the region.

As long ago as 1899 it was proposed that New Guinea and the rest of the Snowy Gorge should be a National Park:

> "The scenery is wild and rough and grand in the extreme. In no place else in Victoria are there such dizzy precipices, such sheer bluffs, or gorges with such vertical sides . . . The gorge between the Broadbent River and Campbells Knob is perhaps the finest in Australia ... For miles along the Snowy River the land is not likely to be in request for settlement purposes, and it would make a splendid National Park. If the place were made accessible by a track along the river, and the native animals and plants protected the year round, it would be an ideal recreation reserve for generations of Australians as yet unborn." (Ferguson, 1899).

Ferguson's sentiments have been echoed many times over the intervening years, but the gorge and associated wild lands have still not been reserved.

There are now indications that this situation might change. An agency of the State government, the Land Conservation Council, recently released new regional land use proposals for public land in East Gippsland, including the eastern side of the Snowy valley (Land Conservation Council 1976). The Council makes recommendations to the government after a process of investigation which successively involves publication of a descriptive report, receipt of submissions from the public, publication of proposed recommendations, and receipt of additional submissions from the public. Only then are the final recommendations published and submitted to the government. It is a system which has gained a substantial degree of political acceptance, and, elsewhere in the state, has already resulted in a considerable increase in the number and extent of National Parks, Wildlife Reserves, and so on.

For the Snowy Gorge, the Council's proposals involves a new land use concept – that of Wilderness Area, to be reserved in its own right. This concept is similar to that of National Parks, but more specialised. Use of such an area would be by walking and canoe only. It is not known whether the final recommendations will be the same as the proposed – there may yet be adjustments to the policy or boundaries. Although New Guinea itself is not actually within the area of the recommendations – the boundary was down the Snowy – the outcome of the East Gippsland study area will almost certainly influence the outcome for the western side of the gorge, when it is reviewed in a year or two.

So, 75 years or more after the first description of the gorge, it is still not reserved and still gets no deliberative management. When (if?) its significance is finally recognised by reservation, the New Guinea karst will be a valuable and interesting component of this larger national asset.

Acknowledgements

We are indebted to a large band of speleologists who over the years have explored and documented the New Guinea area. In particular, we are grateful for the patience of those who have assisted with surveys. Peter Matthews and Elery Hamilton-Smith assisted with information of early exploration, and cave fauna, respectively. Cliff Beauglehole gave us access to his botanical records for the area, and A.H.M. VandenBerg provided details of Ferguson's geological work.

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Note added in press:

A preliminary reconnaissance by the Victorian Archaeological Survey has now confirmed that NG2 is an important aboriginal site. There are several areas on the walls and roof with linear markings similar to those of Koonalda Cave on the Nullarbor; this is the first such occurrence recorded in Victoria.

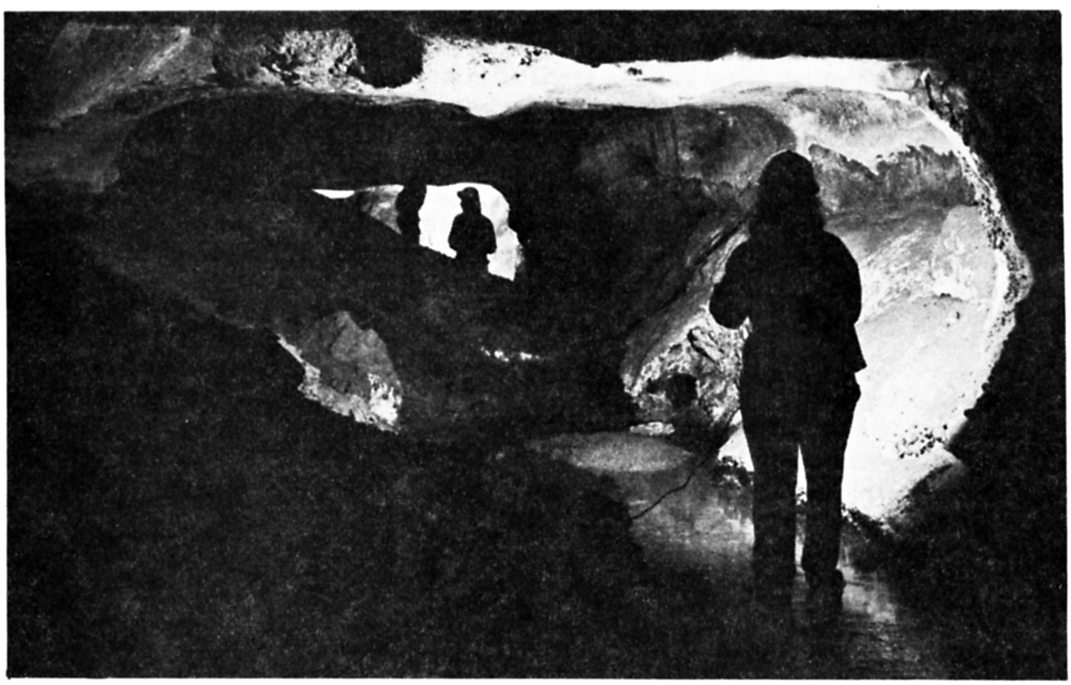

Plate 7. Main stream passage in NG2 cave.

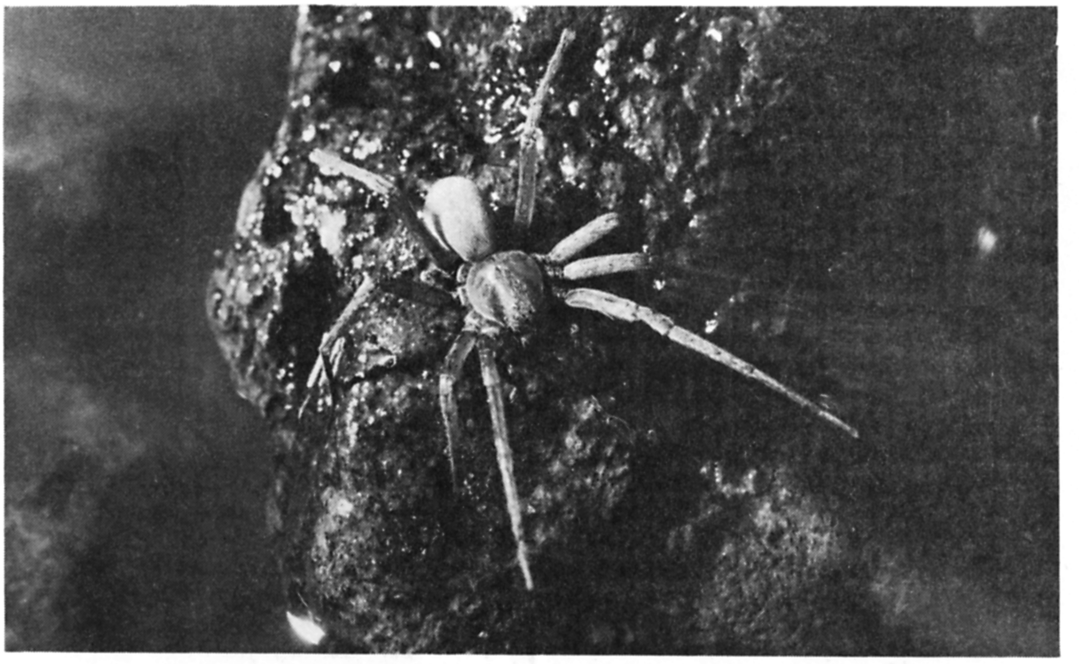

Plate 8. Spider (unidentified) near stream in Nuigini Namba Faiv cave.

Plate 9. Cave pearls, Nuigini Namba Faiv cave.

Plate. 10. Bent-winged bats *(Miniopterus schreibersii)* in NG2 cave.

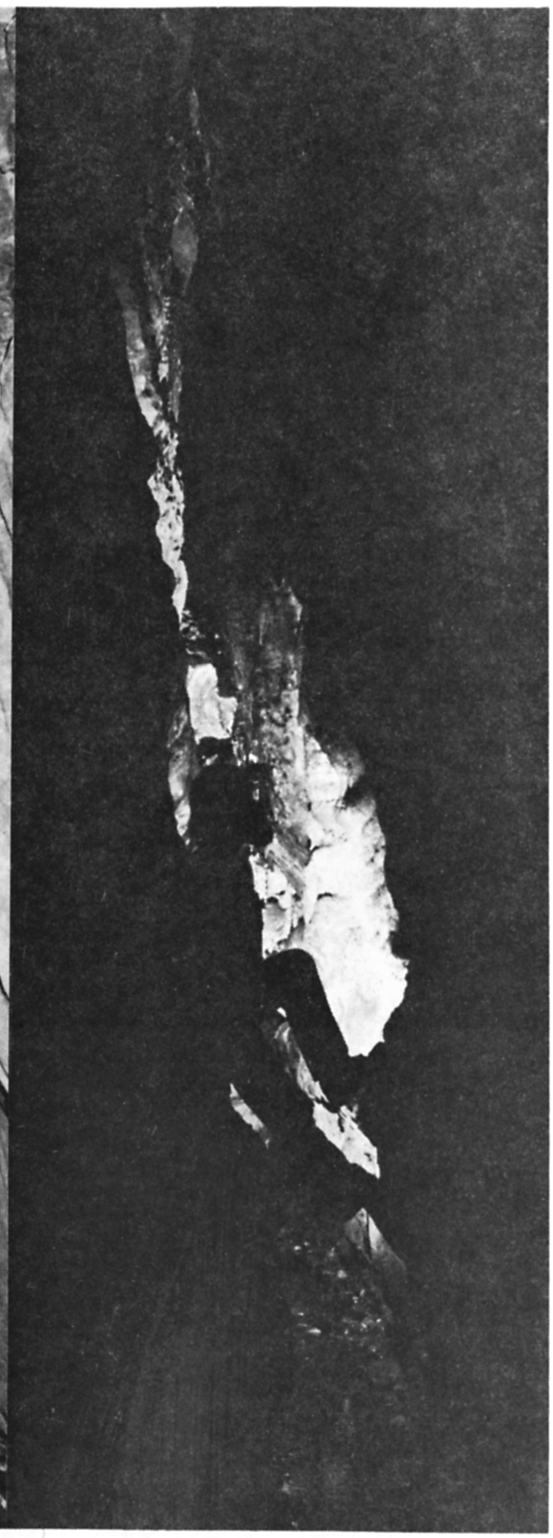

Plate 11. Vadose canyon in the east-west section, New Guinea cave.