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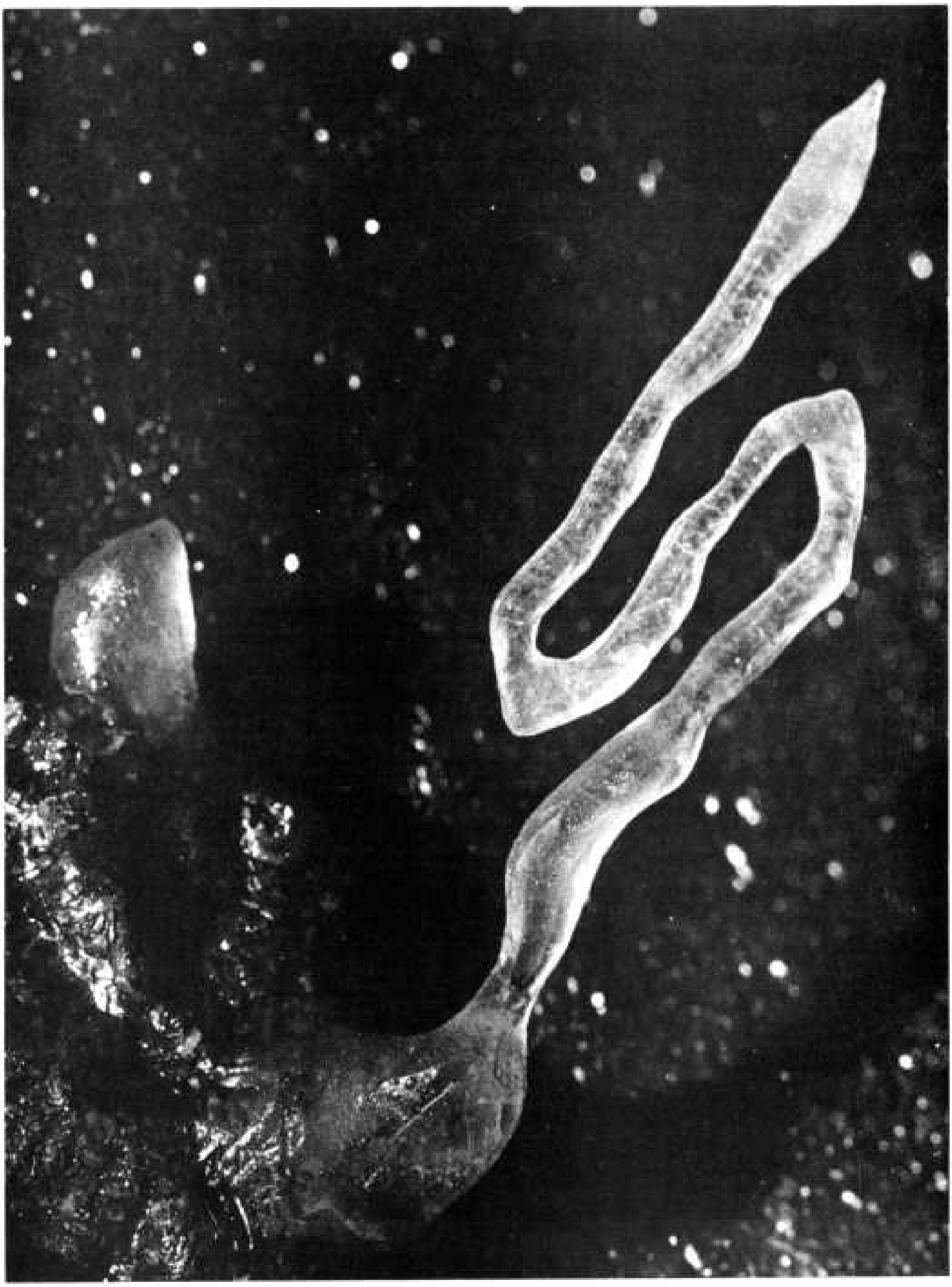

Helictite in Gem of the South formation, Temple of Baal, Jenolan, N.S.W.

Photo: A. HEALY

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ABSTRACTS

100,000 YEARS OF STONE AGE CULTURE IN BORNEO. By T. Harrisson. Roy. Soc. Arts, 112, 1964 : 174 - 187, plus Discussion, 187 - 191.

This paper is a general report on the prehistory of Borneo, but is mostly devoted to the exploration and excavation of the Great Cave at Niah. Harrisson stresses, too, that in considering prehistory in the context of a place such as Borneo, it is necessary to recognise that as well as extending far back into the past it continues, living, in the present. Archaeology must be considered in parallel with folk-lore, as well as ethnology, anthropology and linguistics.

Digging began at Niah in 1954 in the Great Cave which covers an area of more than 25 acres. This vast cavern, whose main entrance is about 600 ft wide and up to 300 ft high, has more than two million edible birdsnest swiftlets and about half a million bats living in it, and has now become one of the world's most important archaeological sites. Up to the end of 1963, the work under the control of the Sarawak Museum had reached down to the level of approaching 100,000 B.C.

Harrisson says that what appeared to be an earth floor to the Great Cave west mouth is really almost solid human deposit, back at least into the Middle Paleolithic. The outer part of the mouth was used primarily for "frequentation" in the Neolithic, and for regular habitation in the earlier phases of stone age (Paleolithic-Mesolithic). Further in, the whole floor is netted with burials. Burials also occur in the outer area though mostly at deeper levels. The deepest of these is a young Homo sapiens corresponding to a carbon 14 dated level of c. 38,000 B.C. This represented the earliest Homo sapiens (modern man) found so far East. Harrisson infers that Homo sapiens was much more widely distributed considerably earlier than had been supposed previously.

He briefly discusses the excavation of stone tools, cult objects, burial procedures, cave paintings, death-ships, etc. He refers to pecularities of the cave such as the shortage of workable, durable stone in the area, in fact of West Borneo generally, and the absence of fossilization. At deep levels (below 120 in) the main indication of human activity was through chemical analyses of the soil, by certain pollens and by the presence of stone tools and fire-strikers. He includes a preliminary Niah Phaseology covering a period from 45,000 B.C. (Middle Paleolithic) to 1,300 A.D. (Early Iron). He believes that the situation at Niah is not unique and that further cave exploration in Borneo could yield similar results. Literally scores of caves in the Niah massif had been found with archaeological importance. The great value of Niah is that the floor is undisturbed and can be studied properly in stratification. Future work in caves in Borneo, Indonesia, Thailand, Malaya, Palawan (and doubtless New Guinea), he believes will eventually prove a wide early Homo sapiens activity in this part of South-East Asia, together with a vigorous stone age culture. - E.A.L.

OBSERVATIONS ON THE EASTERN HORSE-SHOE BAT IN NORTH-EASTERN NEW SOUTH WALES

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Summary

Between July, 1960, and December, 1963, observations were made on the natural history of Rhinolophus megaphyllus Gray in north-eastern New South Wales. Typically the species occurs as small colonies in a wide variety of cave and mine roosts. It appears to be absent from available roosting sites at higher altitudes in this area. Seasonal changes in the sizes of testes and epididymides suggest that mating occurs in May and June. The single young are born at maternity colonies through November, and nursing lasts about eight weeks. Field weights do not reflect seasonal variation other than that associated with pregnancy. However, seasonal differences in day-time level of activity are noted and these correlate with behavioural changes apparently related to temperature selection. Changes in colony size are described for several roosts and three movements made by marked individuals are recorded. Males appear to be more sedentary than females. Considerable aggregation of females and their young at maternity colonies (size, 15 to 1,500 individuals) characterizes the spring and summer population.

Introduction

Troughton (1957) records the range of Rhinolophus megaphyllus Gray as "eastern Australia, from southern New South Wales to Cape York." Recently, however, George and Wakefield (1961) have recorded its presence at Buchan, in Victoria, while Dwyer and Hamilton-Smith (1965) have observed it further south at Nargun's Cave (N1), near Nowa Nowa. The species apparently does not extend into western Victoria (Ryan, 1964).

While the biology of several species of Rhinolophus has been studied in Europe (e.g., Bels, 1952; Hooper and Hooper, 1956; Bezem, Sluiter and van Heerdt, 1957; Lewis and Harrison, 1962), little information has been recorded for the Australian species. Troughton (1957) considered R. megaphyllus to be gregarious and cave-dwelling, while Tate (1952) and Harrison (1962) refer to individuals day-roosting in houses in North Queensland. George and Wakefield (1961) refer to the solitary roosting habits of individuals observed in the Buchan Caves, Allen (1939) comments on segregation

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of sexes evidenced for a "large colony" in northern New South Wales, Purchase and Hiscox (1960) record the December birth period for a maternity colony of about 100 females at Wee Jasper (Southern Tablelands, N.S.W.), and Dwyer (1965) has discussed flight pattern and commented on feeding habits. The present paper is, therefore, an attempt to provide a more complete picture of the biology of this species than has hitherto been available, by recording observations made in north-eastern New South Wales (lat. c. 28 - 32°S) between July, 1960, and December, 1963.

Distribution and Habitat Selection

Within north-eastern New South Wales, R. megaphyllus has been recorded from 51 different caves and mines (Figure 1). It was present in 36 out of 43 possible sites of the coastal Northern Rivers area and the lower coastal escarpment (below c. 2,000 ft), and in 15 out of 18 sites on the inland North-western Slopes. It was not found in any of 40 different sites on the Northern Tablelands, which include higher altitudes of the coastal escarpment and the Nandewar Range west of the Great Dividing Range. Of the seven coastal caves and mines without R. megaphyllus, five were within yards of sites containing the species. The other two sites were of doubtful suitability. One of the North-western Slopes sites without the species was also close to several others in which R. megaphyllus was found, while skeletal remains of several individuals were present in a second site. It should be pointed out that 33 of the Northern Tablelands sites were mine tunnels in the Baker's Creek gorge and that in this sense, therefore, the Tablelands sample is biased. In total, these distribution records suggest that in north-eastern New South Wales, R. megaphyllus is absent from the coldest sites. But it should be noted that R. megaphyllus occurs in the Wee Jasper caves of the Southern Tablelands and has been observed in a few caves of the Bungonia group (February and December, 1963). Cave temperatures in both these areas are as low as, or lower than, temperatures for Northern Tablelands sites. Perhaps some factor other than temperature alone accounts for the absence of R. megaphyllus from this latter region.

Caves and mines occupied by R. megaphyllus occur in a wide range of vegetation types, from rain forest, through sclerophyll forests and woodlands, to grassland areas. Small (c. 10 ft deep) or large caves and mines may be occupied, and bats are often found roosting well within the twilight zone. In the Macleay Valley, I have located a single R. megaphyllus hanging in a small limestone dome overhanging a rain forest stream - Stockyard Ck. Mr. G. Carter (personal communication) has observed others in similar situations. Many of the roosts have small, restricted entrances with access via narrow, vertical drops, and in some caves R. megaphyllus sometimes may be found well down in rock piles where the interstices barely permit human crawling. Many surfaces may be used for roosting - sloping walls, flat roofs, or indentations. Flat walls forcing ventral surface contact are seldom used, but deep ceiling domes are frequently occupied by single animals, groups (unclustered individuals in close proximity), or clusters.

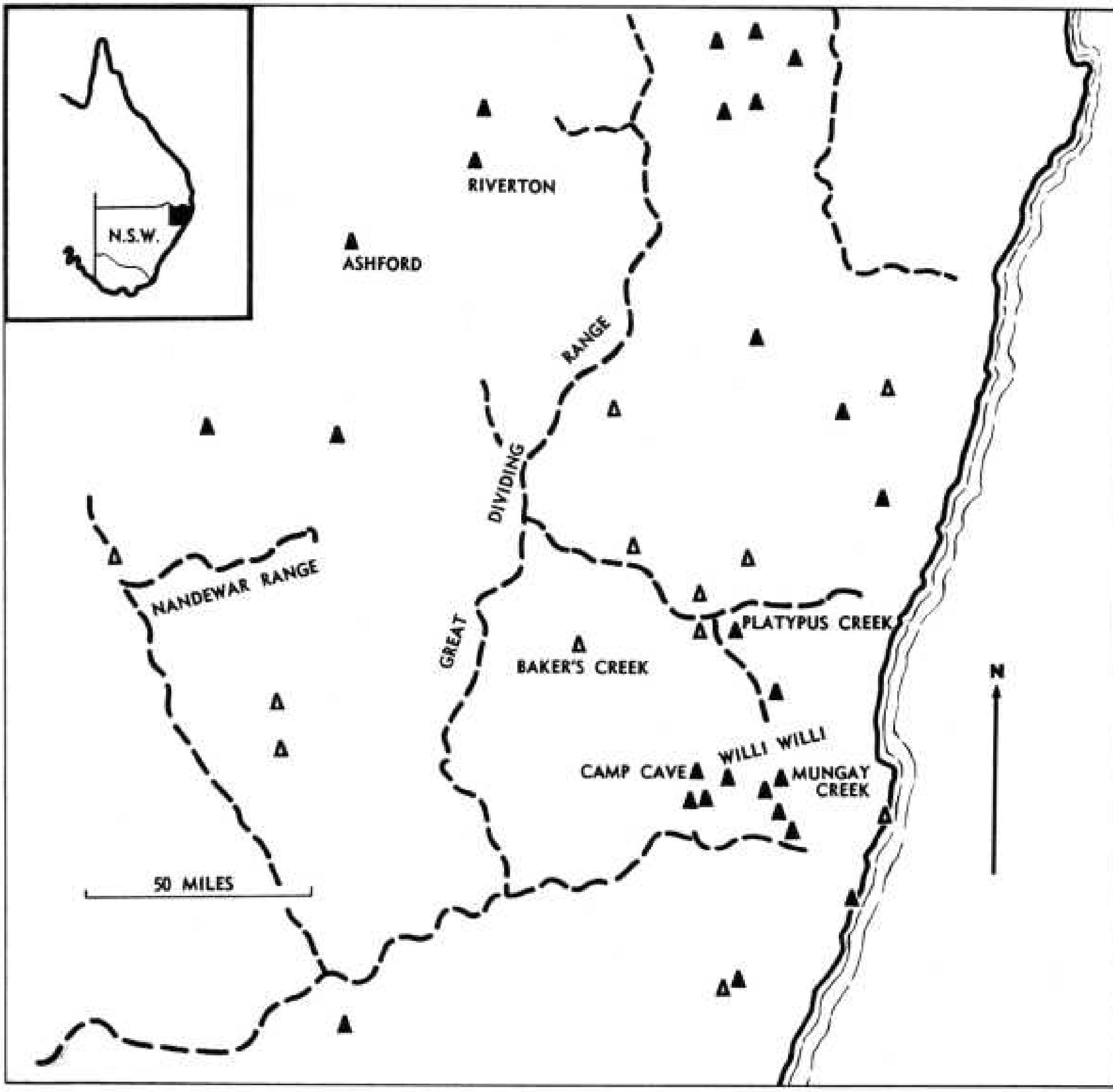

Figure 1. Study area, showing distribution records (solid triangles) for *Rhinolophus megaphyllus*. Sites at which *R. megaphyllus* was absent are shown as open triangles. Note that a single triangle may represent more than one cave or mine. Specific localities mentioned in the text are indicated on the map. The inset map shows the study area as a solid colour.

Miniopterus schreibersii (Kuhl), Miniopterus australis Tomes, Eptesicus pumilus (Gray), and Chalinolobus dwyeri Ryan, have been found occupying the same roost as R. megaphyllus. Mixed clusters of Miniopterus spp. and R. megaphyllus have sometimes been observed in circumstances of extreme disturbance and, for these instances, it is considered that Miniopterus occasionally select a solitary R. megaphyllus as a focus about which to cluster. In addition, observations at a mixed maternity colony of the three species found at Willi Willi showed that newly born Miniopterus are sometimes deposited amongst clustered R. megaphyllus juveniles.

Biology

In north-eastern New South Wales, data on the reproductive cycle in males was obtained by recording the gross size of testes and epididymides in the field. For the entire study period 104 males were examined during the months April to August, and an additional 21 during the months September to March. In R. megaphyllus the testes lie just forward of the penis, and the caudal epididymides run onto the base of the penis. The field data obtained reflected maximal development of testes during April and May when they measured about 5.5 x 4.5 mm. Swollen testes of 2.5 x 2.5 mm were recorded for some individuals in October. Expansion of the caudal epididymides was evident in May and persisted in some males till about September or October. These observations suggest that effective mating, if it does coincide with peak epididymal sizes, would occur in May and June. Individuals with minute testes were observed throughout the autumn and early winter months and were probably juveniles.

A copulating pair of R. megaphyllus were observed on May 21, 1962, at Riverton Cave. The pair was noted at about midday. Both individuals were hanging from the roof by the claws of the toes alone, and the male had mounted the female from the rear. Possible sexual ("courtship") behaviour was seen at Platypus Creek mine in May, 1962. On the evening of May 5, two R. megaphyllus were observed "chasing" at the mine entrance in the early dusk from 5.39 - 5.45 p.m. They were flying one behind the other, in and out of the mine entrance, and amongst shrubs outside the mine. They called continually during this period. The same behaviour was seen next morning between 5.49 and 5.52 a.m. The dates of these two observations correspond with the probable copulatory period suggested by testes and epididymides data.

No information demonstrating possible winter sperm storage by females, or showing commencement of pregnancy, is available from this study. Data obtained on the reproductive status of breeding females covers the late spring and summer periods. This is summarised in Table 1 for females from the maternity colony at Willi Willi Bat Cave. The 49 females examined on October 14, 1961, were all heavily pregnant. They were taken from two clusters of R. megaphyllus numbering about 100 individuals. All other R.

TABLE 1

Reproductive status of breeding females at Willi Willi Bat Cave

Date	Sample	Pregnant	Lactating	Mammary regression
Oct. 14, 1961	49	49	-	-
Nov. 9, 1962	3	3	-	-
Nov. 16, 1961	8	4	4	-
Dec. 6, 1961	14	1	11	2
Jan. 1, 1962	24	-	18	6
Jan. 28, 1962	10	-	4	6

megaphyllus in the cave were hanging singly. In 1962, many females present at Willi Willi on November 8 were seen carrying young only a few days old. A number of young were present as several scattered clusters on the roof and others were deposited in the clusters by their mothers during disturbance in the cave. On November 16, 1961, many of the adult females were seen carrying young and the birth period was apparently well advanced. No pregnant females have been taken later than December 6. Observations at the Riverton and Ashford maternity colonies of R. megaphyllus similarly reflect a late spring (early November - early December) birth period. Careful observation of many adult females flying with young did not reveal more than one young per female.

The last lactating females at Willi Willi Bat Cave were observed on January 28, and no juveniles were seen being carried after this date. One female taken at Ashford Bat Cave on February 6, 1962, showed evidence of recent lactation. Since the last pregnant female was recorded on December 6, and nursing is completed by about the end of January, it appears that juvenile R. megaphyllus are nursed for about eight weeks. Measurements and weights recorded for a number of juveniles at Willi Willi Bat Cave suggest that growth to adult size (forearm 47 - 51mm and weight 10 - 11g) takes from five to six weeks. During this period of growth, clustering of juveniles appears to be general. Individuals with forearms of 45 mm are capable of short flights and those with forearms of 46 mm may fly quite well. When about eight weeks old, presumably once they have ceased nursing, the juveniles leave the breeding chamber during the night to fly through adjoining chambers or to fly back and forth at the entrance of the cave.

Lactating females are characterized by very enlarged thoracic and pubic teats. These decline somewhat in size after lactation and, in fact, may regress almost completely after a long period. Thus, in one banded individual, the pubic teats regressed from being "moderately large" in October, 1961, to being "very small" 18 months later. Apparently this female had not given birth in the spring of 1962.

When being carried in flight, or nursed, juvenile *R. megaphyllus* are attached to the underside of the female, facing posteriorly, with their legs spread well around the thoracic region of the female. They obtain strong attachment by gripping the pubic teats of the female with their teeth. When nursing, they do not reverse their position but simply turn their head forwards, beneath one or other forearm, to reach the thoracic teats. Juveniles may be carried in this way even when they are as large as the parent, and well after they are able to fly. If such large juveniles are disturbed while nursing they characteristically release the hold on the teats and swing free to hang below their mother by the feet alone. Further disturbance causes these "double-decker" horse-shoe bats to separate and fly from the cave wall.

Field weights for 68 male and 47 female *R. megaphyllus* are given, according to season, in Table 2. No juveniles are included in the November to April figures. The only seasonal differences apparent are those associated with pregnancy in the females.

TABLE 2

Seasonal weights of male and female R. megaphyllus.

1 = number of individuals in sample. 2 = mean weight in grams. 3 = standard deviation in grams. No juveniles are included in the November to April figures.

Season	Male			Female		
	1	2	3	1	2	3
Summer (Dec.-Feb.)	9	10.6	+ or - 1.0	13*	12.3	+ or - 1.3
Autumn (Mar.-May)	10	10.3	+ or - 0.8	19	10.7	+ or - 0.5
Winter (Jun.-Aug.)	38	10.8	+ or - 0.7	11	10.9	+ or - 1.1
Spring (Sep.-Nov.)	11	10.6	+ or - 0.9	4°	13.8	+ or - 2.7

* Nine of these were taken in December.
° Two were pregnant (15.4 g and 16.7 g respectively).

However, while seasonal differences in weight are not in evidence, conspicuous seasonal changes occur in the level of activity of roosting bats. These changes may be summarised as "active" from October to March, "increasingly torpid" from April to June, and "decreasingly torpid" from July to September. Evidence of temperature selection behaviour correlating with these levels of activity was obtained at Willi Willi. During the colder months many *R. megaphyllus* moved out of the relatively warm breeding chamber (c. 19°C) and were found hanging singly in the cooler corridor (c. 16°C) that led to this chamber. In addition, changes in wing-folding are associated with the changes in level of activity. Active bats characteristically have their wings folded about the body, while inactive bats often have the wings furled to the sides. This observation is interesting for it appears to be the antithesis of the situation Bartholomew, Leitner and Nelson (1964) have recorded for species of Pteropus. Here, the wings are folded about the body when environmental temperatures are low and are furled at the sides when environmental temperatures are high. In north-eastern New South Wales, wintering R. megaphyllus are probably attempting to attain cave temperature while in summer they are "competing" with it. (M. schreibersii behaves similarly; see Dwyer, 1964). By reversing the wing-folding sequence recorded for Pteropus they are best able to achieve this end, since, with wings furled at the sides, much body heat will be dissipated while maintenance of body heat will be aided by folding the wings about the body.

Clusters of female R. megaphyllus, including up to 50 individuals, have been observed at some roosts during the winter. Winter clustering of males, however, has not been confirmed.

Population Pattern

Colonies of R. megaphyllus in north-eastern New South Wales are typically small. Of the 51 colonies located, 37 included less than 10 bats, nine had between 10 and 50, three between 50 and 200, and only two included more than 200 individuals. Both of the largest colonies, and one of the colonies with from 50 to 200 individuals, were maternity colonies. These were at Willi Willi Bat Cave, Riverton Cave and Ashford Cave. The first named was the largest colony observed and, at peak, numbered about 1,500 R. megaphyllus. A colony of between 15 to 20 individuals was located at Camp Cave (Stockyard Creek, Macleay Valley) and was probably another maternity colony.

Number changes were followed at several roosts by visual assessment of colony size or, in winter, by counting individuals. The habit of R. megaphyllus of roosting singly, and often in inconspicuous portions of a roost, means that some individuals were probably overlooked during a census. At Willi Willi Bat Cave colony size was least in March and early April when less than 50 bats were present. Colony size increased through the winter months to about 100 or more individuals. In October and November the colony increased conspicuously as pregnant females arrived and gave birth to their young. Estimates of peak colony size during December suggested that about 1,500 R. megaphyllus were present. Late January estimates reflected little decrease in size so, presumably, the colony does not disband until February.

At Riverton Cave less than 50 R. megaphyllus were present from February to May. December visits in 1962 and 1963 revealed a maternity colony numbering several hundreds and in 1962 an estimate, by count, of 331 + or - 20 juveniles was made after the adults had left the cave to feed.

At Ashford Cave the small humid chamber used by the maternity colony was not located until the winter of 1963 (K. Angel, personal communication). On November 22, 1963, about 70 juveniles were present and perhaps 100 females (one year old individuals and adults). Number changes in the main portion of the Ashford cave system reflected an increase from 10-15 individuals during February, to perhaps 50 in May, and a drop thereafter to 10-15 in October and to a few scattered individuals during November and December. The pattern in this portion of the cave system is therefore that of a winter colony. Another probable winter colony was located in a coastal mine at Mungay Creek and included 16 bats in April, 1962, and about 150 in the following August.

The small colony at Camp Cave was observed on December 31, 1960. Two juvenile males and a recently lactating female were captured. It is doubtful whether any juveniles would have commenced to leave their natal roosts by this date (see previous section) and consequently the colony at Camp Cave is interpreted as a maternity colony.

The sex ratios of bats handled in this study are given according to season for a maternity colony (Willi Willi), a winter colony (Ashford), and for all other roosts (Table 3). Most of the bats taken at "other roosts" were from very small colonies. At Willi Willi it is clear that females are most numerous in the spring and summer, and males in the autumn and winter. Most of the spring and summer males are juveniles and, in fact, an October to January sample of 125 non-juvenile bats included only two males. In addition, there is some evidence that most of the autumn and winter females are juveniles. Certainly at the Riverton Cave a May sample included seven adult males, six juvenile males and six juvenile females. At Ashford the situation is reversed, for males are more abundant in the small spring and summer samples while females are more numerous in the autumn and winter samples. Finally, samples from "other roosts" give equal autumn and winter sex ratios and are biased for males in the spring and summer.

Between October, 1961, and July, 1963, 446 (181 males and 265 females) _R. megaphyllus_ were marked. Of these, 33 bats were recovered 51 times (42 males and nine females). Only three recoveries were taken after movement. These were all females taken in August at the Mungay Creek mine, two having moved about one-quarter of a mile from another mine and one having travelled 14 miles from the Willi Willi breeding cave. The higher recovery rate for males is striking and, when combined with the fact that one third of the female recoveries were taken after movement, suggests that the former sex is more sedentary.

The above observations suggest the following possible population pattern for _R. megaphyllus_. Males occur as colonies of varying sizes, but

TABLE 3

Sex ratios in seasonal samples of R. megaphyllus.

SEASON	WILLI WILLI		ASHFORD		OTHER ROOSTS	
	Male	Female	Male	Female	Male	Female
Summer	58	114	4	1	7	1
Autumn	27	9	16	40	32	38
Winter	56	13	7	7	18	18
Spring	19	68	2	-	6	3

usually of less than 50 individuals, at a very wide range of roosts. They remain at these almost permanently or, at the most, move between a few roosts within a highly localised area. During the spring and summer, females are highly aggregated as maternity colonies at special breeding caves. The sizes of the maternity colonies may vary greatly (15 - 1,500, including young) and there may be many within a relatively confined area. Thus, Willi Willi Bat Cave and Camp Cave are less than 10 miles apart, Ashford Cave and Riverton Cave are about 32 miles apart, and in eastern Victoria maternity colonies at the Anticline Cave (Buchan) and Nargun's Cave (Nowa Nowa) are about 20 miles apart. Male colonies may occur at breeding caves and, if so, they persist there through the parturition and nursing period. Once nursing duties have ceased, in mid-summer, the females move from breeding caves to enter male colonies. Mating occurs through late autumn and early winter. Some segregation of adult males and females is probable in late winter. The juveniles presumably disperse widely from breeding caves and may be found with either adult females or adult males.

Acknowledgments

The author is grateful to Kempsey Speleological Society, Clarence River Valley Naturalists Club, University of Queensland Speleological Society, Messrs. K. Angel, J. Calaby and C. Carter, for their assistance in locating colonies, and to those landowners, especially Mr. and Mrs. T.E. McIver of Willi Willi, who have permitted access to their properties.

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JIŘÍ V. DANEŠ AND THE CHILLAGOE CAVES DISTRICT

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It would be an injustice to a perceptive geographer and geomorphologist of an earlier generation and one of the comparatively few scientists of other than British origin to carry out field investigations in Australia, to fail to draw attention to the fact that many of the observations in E. Hamilton-Smith's "Caves of the Chillagoe District, North Queensland" (Helictite, 4 (1966) : 53 - 59) repeat findings published long ago by Professor Jiří V. Daneš, a Czech who made two sojourns in this country (Brandt, 1928).

The first of these was in 1909-10 for scientific purposes and resulted amongst other writings in a number of papers on Australian physical geography, including two relevant to the present context. These are "Physiography of Some Limestone Areas in Queensland", Proc. Roy. Soc. Queensland, 23 (1910) : 73 - 86, and, more important, "Karststudien in Australien", Sitz. Kgl. Böhm. Ges. Wiss, No. 6 (1917 for 1916) : 75 pp.

The second visit took place in 1920-22 when Daneš was Consul-General in Sydney for the newly-created State of Czechoslovakia. If Daneš made any further scientific travels in this period, they do not appear to have added to his knowledge of Australian karst because a subsequent publication, "Limestone Physiography in Australia", pp. 337 - 340 in "Receuil de travaux offert à M. Johan Cvijić", ed. P. Vujević, Beograd, 1924, is almost entirely a summary of the last-named paper.

There is no need to set out the many corresponding points between the descriptions of Chillagoe by Daneš and Hamilton-Smith; here attention will only be drawn to additional matters in Daneš' papers and an attempt made to draw out some further conclusions from the published literature.

Hamilton-Smith states that the Chillagoe area constitutes typical tropical karst; this helps us little because there are many types of karst within the tropics (cf. Jennings and Bik, 1962). However, Daneš was more specific and contrasted the Chillagoe district with the Goenong Sewoe area of south central Java, a cockpit karst, with which he was also familiar; in particular he pointed out that the precipitously sided residual hills of limestone were regimented in lines along the strike. In fact, the Chillagoe karst constitutes in modern terminology an "aligned towerkarst" (gerichtete Turmkarst).

Daneš draws attention to the virtual absence of rounded solution dolines, citing only a few shallow dish-shaped ones near Mungana. On the other hand, he says there are many collapse dolines within the residual hills, leading down into the caves. That some at least of these collapses are derived in part from karst corridors, themselves due to surface solution, is argued convincingly by Hamilton-Smith. In all these respects the Chillagoe karst resembles that of the Limestone Ranges of West Kimberley (Jennings and Sweeting, 1963).

How closely these two karst areas resemble one another depends much on the nature of the plains between and around the residual hills. Whereas the towerkarsts of the humid tropics such as those of Malaya, Sarawak or the Celebes have alluvial plains surrounding their towers, bare-rock pediments make up a significant proportion of the equivalent plains in the Limestone Ranges, giving it a character peculiar to semi-arid or strongly seasonally dry tropical climates. Unfortunately, neither Daneš nor Hamilton-Smith are informative in this regard. However, the new geological maps (Bureau of Mineral Resources One Mile Geological Series, Sheets 54, 55 and 60 Zone 7) show extensive alluvial plains in the Chillagoe Formation belt, and Keyser and Wolff (1964, p. 45) comment on how easily such plains are developed on the soluble limestone and incompetent shale of this formation. Daneš comments on the fact that drainage is still mainly on the surface and that Chillagoe Creek receives little water from the caves and runs underground for a small way only - all characteristics to be associated with this extensive development of alluvial seals over the bedrock. Parts of the limestone are covered by sands and gravels derived from the surrounding and intervening impervious rocks such as granites, quartzites and shales. So far the facts do not dissociate the Chillagoe karst from those of humid tropical karst, though the modest and strongly seasonal rainfall would lead us to expect such divergence. However, Keyser and Wolff (1964, p. 19) state that "low-lying smoothly worn limestone pavements are...exposed in several broad valleys"; moreover, comparison of the geological maps and the air photographs shows that residual towers by no means occupy all the areas of limestone mapped as without alluvial cover. It seems probable that pediments are a significant feature of the Chillagoe karst and therefore its closest congener is the tropical semi-arid karst of the type of the Limestone Ranges. Daneš notes another characteristic further supporting this comparison and this is the common occurrence of calc-sinter deposits on the surface of valleys; he quotes a thickness of several metres where Chillagoe Creek crosses a granite barrier.

All of the Chillagoe karst seems comparable therefore with the Limestone Ranges, but it is with the advanced stages in the development of the latter karst only. An obvious factor inducing the removal of all earlier stages is the fact that, although the Chillagoe Formation occupies a substantial area, the limestones within it do not constitute large compact areas but instead consist for the most part of narrow strike belts dipping nearly vertically. Chert, greywacke, mudstone, sandstone, siltstone and conglomerate are interbedded with the limestone members, which themselves include chert lenses and tongues. These dispositions would promote the dissection of the limestone into isolated residuals encroached on from many directions by pediments and alluvial plains. North of the Mitchell River, the limestone of the Chillagoe Formation is mapped on the Bureau of Mineral Resources Four Mile Geological Series Mossman Sheet as occurring only in isolated, comparatively small reef masses so that at no stage could the limestone have formed broad plateaus only later to be dissected into towers; the latter would be engendered from the beginning.

One of the most interesting of Daneš' observations relates to smooth, rounded limestone hills present in addition to the jagged, steep-walled residuals illustrated in Hamilton-Smith's paper. This relates to the occurrence of rock mills (fluvial potholes) on the top of two such hills, Lions Head Bluff near Chillagoe itself and another hill lying between Mungana and Redcap; these rock mills contain quartz and granite pebbles. Daneš explains these rather surprising features in the following manner. The hills and ridges in his view belong to an old peneplain (better "pediplain", cf. Dury and Langford-Smith, 1964) since largely removed by erosion. The river courses have shifted in this process but the rock mills survive on these hilltops as witnesses of the former trend of the streams. This history certainly conforms to the geomorphological evolution of the area postulated by the later workers, Keyser and Wolff (1964), who would attribute the main erosion surface to the lower Tertiary. However, it is difficult to conceive of such a small feature as a rock mill with its generating pebbles surviving even from the upper Tertiary. The possibility that these features are instead comparatively modern small solution pits in the limestone, which have inherited pebbles from a former general gravel cover of a valley strath surface, needs consideration by any future worker in the area.

A further pointer for future work is contained in Daneš' 1917 paper, where he describes exposures in a Chillagoe quarry of solution pits filled with calc-sinter, clay and bone breccia. Only the identification of rock wallaby, a living species, is reported but there still may be palaeontological finds of greater interest to be made in such locations in the area.

Both Daneš and Hamilton-Smith stress joint control of both surface solution features and cave passages, though as Daneš points out one of the joint systems involved in most parts is along the strike. Hamilton-Smith refers to the "boxwork" plan of the caves resulting from joint control but this is a misleading usage of this term, which correctly refers to peculiar detail of weathering of rock faces on the surface and in a few cases underground. "Network" is to be preferred in the present context.

Daneš was able to examine some of the caves in the wet season. He found caves at Mungana largely water-filled, whereas at Chillagoe they were largely dry but with many watertrap pools. He thought that general flooding would occur only at the biggest floods in the latter place.

Speleogens were very rarely found in the caves because of rock fall and secondary encrustation. He as well as Hamilton-Smith, recognised that the entrances to the caves were higher than the surface of both the plains outside and the horizontal silty clay floors of the caves within. But he failed to recognise, as did Hamilton-Smith, that impounding of flood waters behind these barriers might be the cause of formation of the network caves. Instead he regarded the debris piles as blocking the entrances from the plains of former streams which had excavated the caves in the past.

Daneš also inferred a discrepancy between the quite modest water dripping in the caves nowadays, even in the middle of the wet season, and the substantial development of dripstone and flowstone. He thought that the present climate is not favourable to such development; in the short wet season, the intense rainfalls flow quickly through the very open cave systems with many gaps in their thin roofs, and in the dry season there is no dripping whatever. Nevertheless he cites instances of growth of up to 1 cc of calcite on stalactites broken off 20-35 years before.

From these lines of argument, Daneš concludes that the caves are in a very old stage of development, not that climate has changed. Relying on Daneš' data, however, Maksimovich (1962) infers that this karst was developed in a climate different from the present subhumid one; indeed he boldly ascribes it to a Tertiary time of more abundant rainfall.

Thus the dilemma already propounded by Jennings and Sweeting (1963) in respect of the Limestone Ranges recurs here. Many of the karst features there can be explained by postulating that relief, developed in former wetter conditions, was modified in a succeeding drier climate. But can an explanation in terms of the present annual alternation of processes during a short, very wet season and a long, dry season be excluded? Independent evidence of climatic change is needed. In the W. Kimberley the only certain evidence seems to be that of fixed desert dunes relict from a phase of even drier conditions than now. However, there are in that area, as apparently also in the Chillagoe district, extensive surface deposits of calc-sinter or caliche. If these can be shown not to be forming in present conditions, or if fossils can be found in or in association with them which bear witness to wetter conditions, the simpler hypothesis of origin of these karsts in terms of the present strongly seasonal climate would have to be abandoned in favour of one proposing their evolution through climatic changes which include a wetter climate than the present one.

From what has been written, it is clear that Daneš' work on Chillagoe still usefully promotes discussion today. It will therefore be worthwhile in a further article to examine what he had to say about other karst areas of Australia.

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MORTALITY FACTORS OF THE BENT-WINGED BAT. By P.D. Dwyer. Vict. Nat., 83 (2), 1966 : 31 - 36.

Mortality factors affecting the bent-winged bat, *Miniopterus schreibersi* (Kuhl), in north-eastern New South Wales from 1960 - 1963 are discussed. These include predation, disease and infection, reproductive deaths and juvenile mortality. The significance of these observations is assessed in terms of an estimated annual mortality in one population of the species. It is concluded that these causes can only account for a very small proportion of total deaths, and it is suggested that starvation could be a significant cause of death. - A.M.R.

AUSTRALIAN BIOSPELEOLOGICAL EXPEDITION TO NEW CALEDONIA, 1965-1966

Over the period December, 1965 - January, 1966, ten Australian speleologists including representatives of various scientific disciplines, together with four local, French-speaking counterparts, explored, mapped and collected fauna in the main cave systems of New Caledonia. Much of the available time was spent at Poya, near the central west coast of the island, where the party examined more than two miles of continuous river cave without reaching the far end of the system. Shorter pilot investigations were made also in caves at Koumac (north-west), Houailou and Hienghene (east coast), and in the New Hebrides.

Numerous animals were found to be established in most of the cave systems and collections covered many different groups including bats, rats, insects, arachnids, and both terrestrial and aquatic crustaceans. The material is being studied now by specialists and a representative collection will ultimately be deposited in the South Australian Museum, Adelaide.

It would be premature to attempt an overall assessment of life in the caves, but the general on-the-spot impression obtained was of a modern fauna of troglophiles and trogloxenes with few, if any, true troglobites present. Many of the species, although obviously established in the caves, were also noted in above-ground (epigean) habitats. Of those not so observed, most showed little obvious morphological adaptation to a cavernicolous existence. Amongst the insects, giant cave crickets and fast-running cockroaches were the most often seen. Beetles were not plentiful in the caves and only two carabid species were encountered, one Tachys and one Lecanomerus, both of which also occurred along stream margins in monsoon forest. The two genera have previously been noted in caves in New Zealand and Australia, respectively.

A number of aboriginal burial sites, with human remains and artefacts were also discovered in caves at Poya and Koumac

It is expected that the main scientific findings of the expedition will be published in appropriate specialist journals. - B. P. MOORE.

EXOTIC COLLEMBOLA FROM JENOLAN CAVES, N.S.W.

For several years small numbers of Collembola (springtails) have been observed on moist formation in the Right Imperial Cave, on the north side of the Grand Arch at Jenolan, New South Wales, and recently in the Orient Cave, on the south side of the Arch. In the Right Imperial Cave the insects live on a continually damp, 5 ft 8 in high stalagmite (Lot's Wife) which is about 1,000 ft from the entrance of the Right Imperial. B.T. Dunlop in his book, Jenolan Caves, (1950) p. 36, refers to "a lowly type of living organism" on the stalagmite.

In May, 1966, three or four specimens were collected by J. Poleson, one of the guides at Jenolan, from the Indian Chamber in the Orient Cave. The position is about 1,000 ft also from the present entrance to the Orient, and several thousand feet from the site in the Right Imperial on the opposite side of the Grand Arch.

The specimens were sent to Professor J.T. Salmon, of New Zealand, who is a world authority on these insects. He has identified them as belonging to the species Lepidosinella armata Handschin. The type locality for this species is from a termites' nest in Java. The Jenolan cave occurrence is of interest, particularly as this is only the second record of the species outside Java.- AOLA M. RICHARDS and E. A. LANE.

A B S T R A C T S

THE DEVONIAN TETRACORAL HAPLOTHECIA AND NEW AUSTRALIAN PHACELLOPHYLLIDS. By A.E.H. Pedder. Proc. Linn. Soc. N.S.W., 90 (2), 1966 : 181 - 189.

This paper is concerned with the taxonomy of Australian Lower Devonian corals. Two new phacellophyllids are described from New South Wales. Bensonastraea praetor Pedder is from the Timor Limestone, Portion 133, Parish of Lincoln, County Brisbane, and is of probable Eifelian age. Macgeea touti Pedder occurs in the Loomberah Limestone in Portion 58, Parish of Loomberah, County Parry, and uppermost Sulcor Limestone at the northern end of the outcrop in Portion 249, Parish of Burdekin, County Inglis. Both limestones are late Emsian or early Eifelian in age. - A.M.R.

DISTRIBUTION OF CAVE-DWELLING BATS IN VICTORIA. By E. Hamilton-Smith. Vict. Nat., 82 (5), 1965 : 132 - 137.

This paper discusses the distribution of the bent-winged bat, Miniopterus schreibersi (Kuhl), the eastern horse-shoe bat, Rhinolophus megaphyllus Gray, and the large-footed bat, Myotis adversus Horsfield in Victoria. It is suggested that the recording of the little brown bat, Eptesicus pumilus Gray, in a Victorian cave is due to mis-identification. Seasonal movement patterns of M. schreibersi are discussed, and it is shown that the Victorian population of this species is provided by four reservoirs centring respectively upon maternity colonies at Naracoorte, South Australia; Warrnambool, Victoria; Nowa Nowa, Victoria; and Wee Jasper, New South Wales. - A.M.R.

ETUDE CRYSTALLOGRAPHIQUE DES PAVEMENTS POLYGONAUX DES COUTEES POLYCRYSTALLINES DE CALCITE DES GROTTES. By C. Andrieux. Bull. Soc. franc. Miner. Crist., 86, 1963 : pp 135 - 138, two plates, two text figures.

The author describes the morphology and development of odd shaped calcite crystals growing on the submerged polycrystalline floors of various caves in Dordogne, France. They are reasonably common in other caves throughout the world.

When crystals reach the water level their upward growth is arrested (apex cannot continue to form) and only lateral growth is allowed. The crystals thus appear truncated, having flat truncation surfaces where shape depends on (i) the habit of the calcite crystals, (ii) their orientation, and (iii) the stability of the water level.

When the habit is a simple rhombohedron, its upper three faces are truncated, and the surface is thus triangular. When the crystal habit is a combination of two rhombohedra, the upper six faces (combination of two sets of three) are truncated, and the surface is a semi-regular hexagon. The shape of the triangle or hexagon naturally depends on the orientation of the crystal in respect to the water surface.

The nature of the calcite crystals also depends on the stability of the water level. When variable, a flat surface is not produced - the triangular or hexagonal truncation surface has a hopper-shaped hollow in from its margin. The hollow contains water which is less saturated than the water around the crystals as shown by its electrical conductivity.-G.S.HUNT.

DISTRIBUTION OF THE LARGE-FOOTED MYOTIS, *MYOTIS ADVERSUS* IN AUSTRALIA. By J.L. McKean and L.S. Hall. *Vict. Nat.*, *82* (6), 1965 : 164 - 168.

The distribution of the bat *Myotis adversus* in Australia is discussed in detail. The validity of several localities is questioned. Possible factors for its comparative rarity are discussed. The species frequently lives in close proximity to streams or lakes. In the southern part of its range it is apparently only cave dwelling, but this is not so in the far north. *M. adversus* is recorded from the following caves: Dry Creek Cave, Guano or Amphitheatre Cave and Kates Slide Cave, all on the Glenelg River around the South Australian-Victorian border; Cloggs Cave, East Buchan, Victoria; and Narrengullen Cave on Burrinjuck Dam, near Wee Jasper, New South Wales (a maternity cave for the species). - A.M.R.

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