THE BAT POPULATION OF THE NARACOORTE CAVES AREA

by

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Introduction

The Bent-winged bat, *Miniopterus schreibersii* (Kuhl 1819), probably has the most wide-ranging natural geographical distribution of any mammal (Brosset 1966). It occurs throughout Southern Europe, the Middle East, Africa, Southern and Eastern Asia, the Malay-Indonesian archipelago, New Guinea and Australia. This is the only bat recorded from the caves of the Naracoorte area.

The bats of the sub-family Miniopterinae, which contains only the genus *Miniopterus*, are all remarkably similar, and their proper classification into species remains confused. A great number of sub-specific names have been erected for the forms which are generally considered to comprise *M. schreibersii*. Many of these have been based on differences in colouration and it is now generally recognized that colour differences in bats are an inadequate basis for taxonomic differentiation, as these are subject to wide ranges of individual, seasonal or regional differences. Two such sub-species have been recognised in Australia, with *M. s. orianae* inhabiting the Kimberleys and Arnhem Land regions and *M. s. blepotis* occurring along the Eastern and South-Eastern coastlines. There is a geographical separation between these two major populations and there are minor but apparently consistent differences (J.E. Hill, pers. commun.).

This paper summarises some results of studies on the "Naracoorte" population of *M. schreibersii*. Although this population is not able to be separated from others in South Eastern Australia on morphological grounds, it has a clear distinctiveness on biological grounds.

M. schreibersii and the territorial concept

Australian studies, ably summarised by Dwyer (1968), indicate that in South-eastern Australia it is possible to distinguish a number of relatively discrete populations of *M. schreibersii*. Each such population is based upon a specific maternity site which is used annually for the birth and early development of young. Furthermore, each such population generally only moves about in the course of each year within a specific territorial range. These territorial ranges may overlap with each other, but even when this occurs, transfer of any individual bat from one population to another appears to be the exception rather than the rule.

It is extremely difficult to compare these results with those from studies in other countries. Many of the studies on *M. schreibersii* have been extremely limited, either in the number of individuals or in the geographical area studied, Kuramoto et al (1969) in Japan, as an example, have only studied the movements and behaviour of this species in several caves of the Akiyoshi-dai plateau. It is clear from their report that these caves are used throughout the year by males, but females are rarely found in summer, having presumably moved to the maternity site which remains unknown at this stage (Kuramoto, pers. commun.). Most European studies have been based upon hibernating sites and little attention has been given to maternity sites or to differences between young and mature individuals. However, a careful examination of results from Hungary (Topal 1956, 1962), Czechoslovakia (Gaisler & Hanak 1969) and Spain (Balcells 1964) strongly suggests similar patterns to those of Australia.

Territory and movements of the "Naracoorte" population

What I have chosen to call the "Naracoorte" population of *M. schreibersii* is based upon the maternity site at the Naracoorte Bat Cave (S3 in Matthews 1968). The use of this cave as a maternity site has been described by Dwyer and Hamilton-Smith (1965) and will be further discussed below. Since 1961, bats from the population have been captured, marked by numbered aluminium or monel metal bands being clipped to the forearm, and released (Simpson & Hamilton-Smith, 1965). An analysis of recaptures then enables deductions to be made about the movements and geographical territory of the population concerned.

Some results of these studies on the Naracoorte population have already been reported by Hamilton-Smith (1965) and Dwyer (1968). Dwyer demonstrated the integrity of the Naracoorte population, reporting only five exchanges of membership with other populations but did not fully resolve the status of the populations found at Portland and Byaduk. Eighteen movements were recorded between the Portland-Byaduk and Warrnambool districts, with ten movements between the Portland-Byaduk and Naracoorte districts.

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TABLE 1. RECAPTURES WITHIN THE APPARENT NARACOORTE POPULATION TERRITORY (CAVE NUMBERS FROM MATTHEWS 1968)

			S6	S5	S9-10	S11-12	S33	S68	S69	NON-CAVE	S42	S101	S113	NOONAN'S	S52	S54	ROBE	BENARA	S109	SNAKE
NARACOORTE AREA	BAT CAVE (S6)	149																		
	BIG CAVE (S5)	15	-																	
	TOMATO-STICK CAVE (S9-10)	44	-	2																
	CATHEDRAL CAVE (S11-12)	1	-	-	-															
	FOX CAVE (S33)	4	-	-	-	-														
	"CAVE PARK" CAVE (S68)	-	-	-	-	-	-													
	HODGES CAVE (S69)	11	-	3	1	4	-	-												
	VARIOUS NON-CAVE SITES	8	-	-	-	-	-	-	-											
LOWER SOUTH-EAST AREA	QUARRY CAVE (S42)	1	-	-	-	-	-	-	-	-										
	MT. BURR CAVE (S101)	38	-	4	-	-	-	9	-	-	1									
	GLENCOE WEST CAVE (S113)	13	-	-	-	-	1	-	1	-	11	13								
	NOONAN'S CAVE	5	-	-	-	-	-	-	-	-	2	1	2							
	FIVE CORNERS CAVE (S52)	3	-	1	-	-	-	-	-	-	1	2	-	-						
	DROP DROP CAVE (S54)	18	-	-	-	-	-	2	-	-	3	14	3	4	7					
	MARINE CAVE, ROBE	25	-	1	-	-	-	1	-	-	-	-	-	-	2	1				
	UN-NAMED CAVE, BENARA	-	-	-	-	-	-	-	-	-	-	3	-	-	5	-	-			
	UN-NAMED CAVE, WANDILO (S109)	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
	SNAKE HILL (VICT.)	18	-	1	1	-	-	1	-	-	1	-	1	5	39	-	-	2	61	
	PORTLAND	11	-	-	-	1	-	1	-	-	-	2	2	-	4	-	-	-	2	
	BYADUK	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

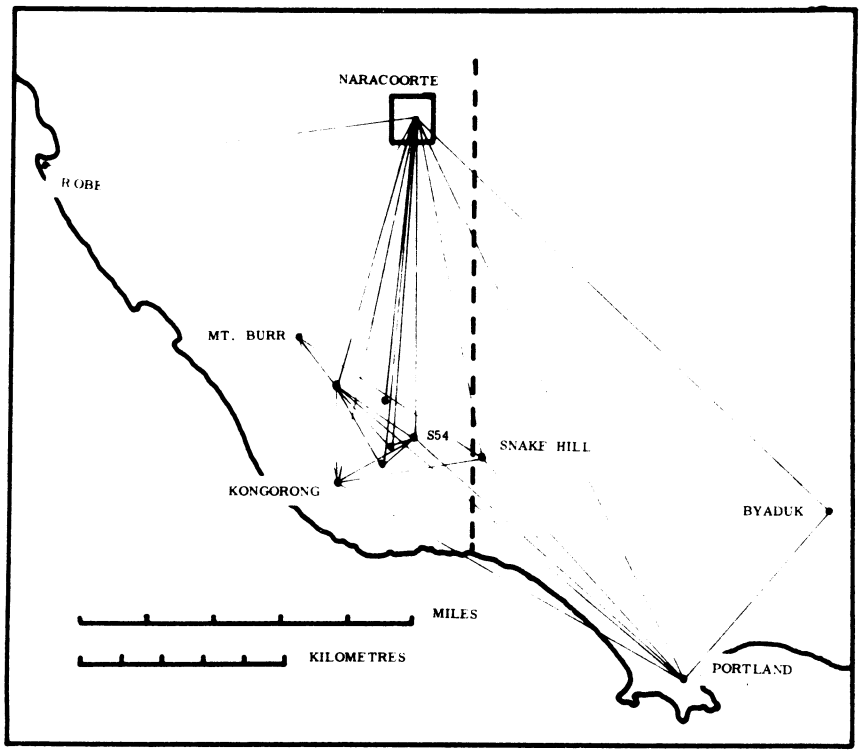

FIG. 1 PATTERN OF RECORDED MOVEMENTS WITHIN THE TERRITORY OF THE NARACOORTE POPULATION

A further analysis is presented here. The data upon which Dwyer (op.cit.) is based was obtained from an inspection of records held by the banding office at the C.S.I.R.O. Division of Wildlife Research. That given here is based upon my own records and so although the earlier parts of my data will have been available to Dwyer, there may well be further data available at the Banding Office which have not yet been made available to me. (This suggestion is supported by four reports from Dwyer and from Purchase (1969) shown in table 2 which do not appear in my own records.) Table 1 and Figure 1 show all recaptures recorded within the South-East of South Australia (including Snake Hill, which is in fact marginally inside Victoria but geographically can well be considered as part of South Australia's lower South-East) together with all movements between this region and the Portland-Byaduk area. Table 2 and Figure 2 show all movements (which are known to me) between the Naracoorte population and other populations. Cave names and numbers cited have been taken from Matthews (1968) and Sexton (1965). A complete list of

Band Number	Sex	Banded	Re-captured
20/05638	M?	North Sydney, N.S.W. 23.vi.63	S113, Glencoe W., S.A., 30.viii.65, 30.i.66 (F?)
20/08723	F	Cheitmore, N.S.W. 31.iii.63	Snake Hill, Vict. 27.v.67 (Purchase, 1969)
20/15324	F	S5, Naracoorte, S.A. 13.vi.64	Fig Tree Cave, Wombeyan, N.S.W., 13.vi.66
20/15620	F	Spring Creek Cave, Buchan, V., 18.vii.64	S52, Mt. Gambier, S.A. 23.vii.66
20/16760	F	S3, Naracoorte, S.A., 18.ix.65	Maroondah Aqueduct, Healesville, V., 5.vii.66 (Seebeck & Hamilton-Smith 1967)
20/27401	M	Grasmere Cave, Allansford, V., 3.iv.66	S3, Naracoorte, 4.ii.67
	M	S69, Joanna, S.A., 6.xi.61	Panmure Cave, Panmure, V., 21.iii.65 (Dwyer 1968)
	F	S3, Naracoorte, S.A., 13.vii.64	Wombeyan, N.S.W., 23.ix.64 (Dwyer 1968)
	F	S3, Naracoorte, S.A., 13.viii.64	Wombeyan, N.S.W., 13.vii.66 (Dwyer 1968)

TABLE 2 : Movements between the Naracoorte population and other populations.

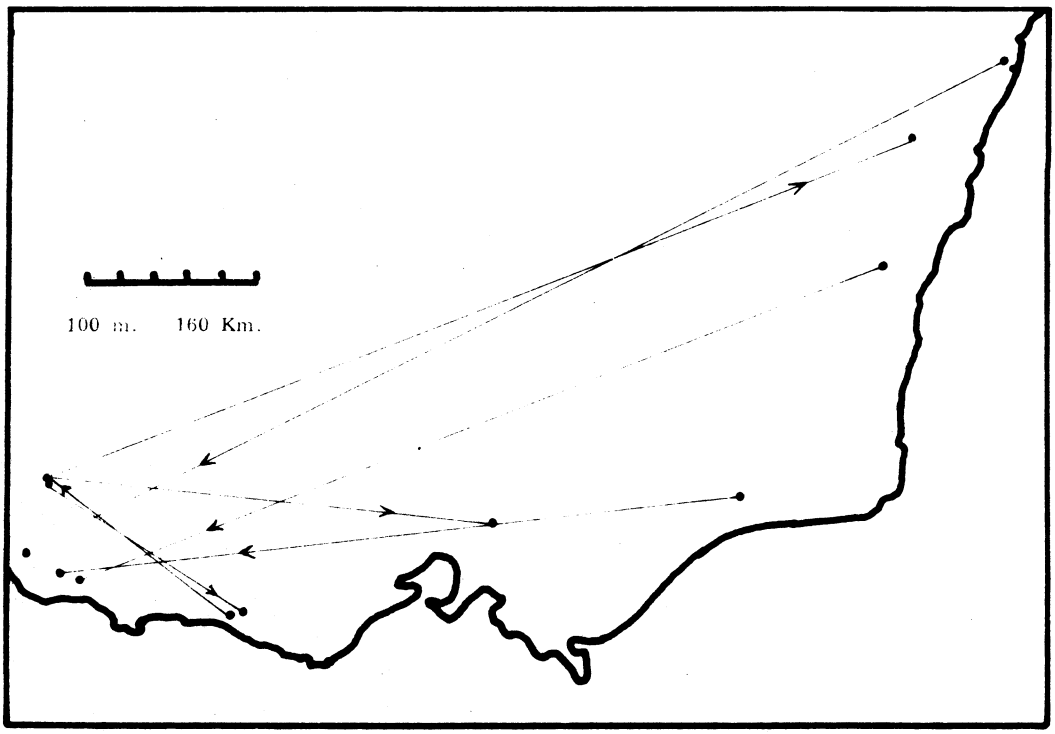

FIG. 2. MAP SHOWING MOVEMENTS BETWEEN THE NARACOORTE POPULATION AND OTHER POPULATIONS.

sites known to have been used by bats within this area is also given in Appendix 1.

To summarise these tables, 622 bats banded in the South-East of South Australia have been re-captured. 236 of these were re-captured at the site of banding, 355 elsewhere within the South-East of South Australia, 26 in the Portland-Byaduk district, and 5 in other areas.

Thus, this analysis gives strong support to Dwyer's conclusions, and does not significantly add to it nor further clarify the status of the Portland-Byaduk district. I have not attempted to assign any significance to relationships between various sites, as it could be clearly demonstrated, at least in this case, that such apparent relationships are due to factors arising out of patterns in search intensity and timing, rather than to real bio-geographical factors.

The Annual Cycle and Cave Use

As with most temperate-zone bats, *M. schreibersii* exhibits an annual reproductive and movement cycle. This has been described for the North-eastern New South Wales population by Dwyer (1965), while Dwyer and Hamilton-Smith (1965) have discussed some differences in the Naracoorte population. Our data showed that the Naracoorte population differed from others in South-Eastern Australia in that parturition occurred from mid-October to late November as contrasted to the early December to mid-January period of other populations. In addition, the maternity cave population at Naracoorte contained approximately 50% of male bats, while in other populations no more than 10% of males were found in such sites and these were all yearlings.

More recent data confirm these observations, but it is now possible to add some details on the general year-round patterns of use in the Naracoorte Bat Cave and other caves in the area. The greater part of the population departs from the Bat Cave during February and early March. The small number which remain consist of both male and female adults in approximately equal proportions throughout autumn, but the number of females decreases until nearly all bats in this cave during early spring are adult males which roost in a solitary way. Large numbers of animals commence to return to the cave during September, and form clusters, largely of pregnant females, which roost separately from the few solitary males. Thus, on 1-2 September 1962, collecting 160 bats which were roosting alone or in very small groups yielded only 12 females, while 80 collected from a cluster of several hundred included only 3 males. By late September and early October, the population has usually returned to its equal division between males and females, and solitary roosting is virtually replaced by roosting in large clusters, although segregation between various groups is preserved. However, the basis of this segregation is not completely clear – some groups are comprised almost entirely of a single sex while others are mixed, and at least some such groupings appear to retain their integrity over at least several weeks.

Population increase continues throughout October, and parturition commences towards the end of October, but is generally completed by the end of November. The young bats are placed in domed areas of the roof, which unfortunately from a research viewpoint, are too high to be accessible. The most recently born are placed in the central areas of each dome, so that the eldest of each year's new population are found around the outer edges of the nursery cluster. By the second week of January, the oldest move away from this clustering and commence to re-group in another part of the cave. These older juveniles are weaned and flying actively, but because of the inaccessibility of the nursery groupings, it is impossible to establish the exact sequence and timing of these developmental stages. The juveniles commence their flying within the cave, but rapidly progress to flying in and out of the cave entrance following the evening exit flight of the adults as a preliminary to the progressive establishment of the adult feeding flight pattern. By early February, all juveniles have moved into the new grouping, and their distributive flights from the maternity cave to other parts of the population territory then begin.

It is also of interest to report further data on the climate of this cave, as that contained in Dwyer & Hamilton-Smith (1965) was somewhat incomplete. The Cave is entered through a collapse into a large tunnel which runs in a roughly South-Easterly direction to an extremely large domed room in which the bulk of the bat population is generally found. The temperature in the tunnel ranges from 13.0°C to 15.0°C between winter and summer. In the big room, winter temperatures may drop as low as 16°C while in summer temperatures near the floor range from 19°C to 25°C. The air temperature in the small roof domes where the juvenile bats roost has been recorded at 30°C, while placing the sensing unit amongst the clustered bats registered 33°C. This demonstrates in a more spectacular way than similar caves in warmer areas the "incubator" effect of these maternity sites.

A number of caves in the immediate vicinity (e.g., Big Cave, Tomato-Stick Cave, Cathedral Cave) are generally devoid of bats between September and March. During the March to September period, these have populations of varying size, but up to several thousand, consisting of roughly equal numbers of males and females. Juveniles are rarely seen in these caves, Hodges Cave (S69) seems to have no regular patterns of use by bats; groups of up to 1,000 have been seen in this cave at various times of the year and have had varying sex-age compositions: for most of the year, bats are absent. By contrast, caves in the Lower South-East (e.g., Drop-Drop, Mt Burr Cave, Snake Hill, etc.) have large populations (up to perhaps 10,000 but generally less) during autumn, winter and spring which again are generally equally divided between males and females but often contain juveniles. A small population remains in these caves throughout summer.

The Portland-Byaduk area, as pointed out by Dwyer (1968), appears to be within the territory of both the Naracoorte and Warrnambool populations. The Portland Bat Ridges caves certainly have a year-round occupancy by bats, with movement to and from Byaduk and other caves in the Portland area. On my own visits to the Bat Ridges (generally in summer), I have found the population to consist largely of adult males; the lowest percentage of males I have recorded at this site is 75%. However, this may not be the case at other times of the year. Dwyer (op cit) has suggested that a further maternity site may exist in the Portland area, but this has not been located, and unless there are a larger

number of female bats in this region at other times of the year than can be accounted for from Naracoorte and Warrnambool, there seems to be little evidence to substantiate this suggestion at present. By contrast with Dwyer's experience in N.S.W., this is the only cave frequented by the Naracoorte population from which I have consistently found such an inbalance in the population.

Some Notes on Associated Organisms

Parasites on the Naracoorte population of *M. schreibersii* include the widespread tick, *Ixodes simplex simplex* Newmann; several mites, including *Ichoronyssus aristippe* Domrow, *Spinolaelaps miniopteri* Zumpt & Patterson, and *Spinturnix* sp. nov.; and two Nycteribiids, *Nycteribia parilis vicaria* Maa and *Penicillidia* sp. nov. The most interesting of these are the two undescribed new species listed here, both of which are currently in the process of study and description, and both of which appear to be virtually confined to bats of the Naracoorte population.

The Naracoorte Bat Cave houses an interesting population of invertebrates, the numbers of which reach staggering figures in mid-summer and decline almost to extinction in winter. The widespread guano mite, *Cilliba coprophila* Womersley, which was first described from this cave, may reach densities of 1,000 individuals per square inch of surface area. Harris (1970 and in prep.) has been studying a similar community of guanophiles in the Carrai cave of N.S.W. and although the general features of these communities appear similar, there are clearly a number of differences in detail. Interestingly, the Naracoorte cave appears to have a much greater diversity of species at the macroscopic level and although the microscopic life has not been examined, the remarkable temperature fluctuations of the Carrai guano reported by Harris do not appear in the same way at Naracoorte, where guano temperature generally seems close to that of the cave atmosphere. Unfortunately, no studies have been yet made of the micro-fauna (and flora) of the Naracoorte community.

A listing of the recorded species from this cave is presented in Table 3 for comparison with other similar caves (e.g. Hamilton-Smith 1969). It will be noted that the Diplopoda (millepedes), Opiliones (harvestmen) and parasitic Hymenoptera (wasps) which occur in many similar caves of the Eastern states are absent.

CRUSTACEA	
Isopoda	"Slaters" – various species, all undetermined, found on drier patches of guano, cave walls, etc.
ARACHNIDA	
Araneida	Various spiders, all undetermined, live amongst guano and on cave walls
Acarina	*Cilliba coprophila* Womersley (Fam. Cillibidae) *Asternolaelaps australis* Womersley & Domrow (Fam. Ichthyostomatogasteridae) *Tyroglyphus dewae* Womersley (Fam. Acaridae) These three species are all from guano in the cave.
Pseudoscorpiones	*Protochelifer naracoortensis* (Fam. Cheliferidae) Endemic to this cave and found in guano throughout the year.
INSECTA	
Collembola	Undetermined species found in drier parts of the guano
Dictyoptera	*Gislenia australica* (Brunn.) (Fam. Blattellidae) is common throughout the cave in summer
Orthoptera	*Novotettix naracoortensis* Richards (Fam. Rhaphidophoridae) has only rarely been collected, and then always near the entrance.
Pscoptera	*Lepinotus reticulatus* Enderlein (Fam. Trogiidae) has been collected from a dead bat near the entrance. *Psyllipsocus ramburi* Selys-Longchamp (Fam. Psyllipsocidae) lives on drier parts of the guano
Diptera	Families of which representatives occur in association with the guano include Chironomidae, Psychodidae, Sciaridae, Phoridae, Sphaeroceridae, Anthomyiidae, Muscidae
Lepidoptera	*Monopis* sp. (Fam. Tineidae) occurs on the guano and may reach densities up to 50 per sq.ft.
Coleoptera	*Speotarus lucifugus* Moore (Fam. Carabidae) roves over the guano in summer A small Histerid, undetermined, may reach densities of 150 per sq. ft. *Quedius* sp. (Fam. Staphylinidae) occurs throughout fresh areas of guano *Nargomorphus minusculus* Blackburn (Fam. Anisotomidae) is found occasionally. *Ptinus exulans* Erichson (Fam. Ptinidae) is common, and occurs in both fresh and dry areas of guano. *Corticaria* sp. (Fam. Lathridiidae) is found throughout the fresh guano, but only in small numbers. A small beetle belonging to the Fam. Jacobsoniidae and probably to a new genus occurs in fresh guano with a density of up to 10 per sq. in.

TABLE 3: Summary of invertebrate fauna found in Bat Cave, Naracoorte.

The Biological Status of the "Naracoorte" Population

This presentation has highlighted a number of ways in which this population differs from others in South-Eastern Australia. These are summarised in Table 4. It will be clear from this data that the Naracoorte population is biologically distinct, although some aspects remain unclear. The timing of spermatogenesis and mating is not known precisely enough to indicate whether mating between individuals from different populations would be likely, nor is it known to what extent an individual moving from one population to another might acquire some of the behavioural and biological characteristics of the "adopted" population.

Naracoorte population	Other populations
Parturition occurs mid-October to late November	Parturition occurs December to mid-January (except Warrnambool – mid-November to end December)
Adult males present in maternity cave during summer	Adult males absent from maternity cave during summer
Other caves generally house roughly equal proportions of males and females	Other caves generally house groups with dominance of one sex (except Warrnambool)
Parasites include *Spinturnix* sp. nov. and *Penicillidia* sp. nov.	Parasites include *Spinturnix psi* and *Penicillidia oceanica*

TABLE 4: Summary of differences between the Naracoorte population and other South-Eastern Australian populations.

One can note here the usefulness of detailed observations on any individual which is known to have moved from one population to another. This, unfortunately, is rarely possible, and could only be established by checking the details of each bat recaptured at the actual time of re-capture. To cite an annoying example: Bat no. 20/05638 was recorded as a male when banded in North Sydney; it was re-captured at S113, Glencoe West but its sex not noted; it was again recaptured at the same site, and on this occasion, its sex was recorded as female. Obviously, one observer was in error. *If* the bat concerned is actually a female, then the fact that it was obviously not breeding in the summer of 1966 *might* be significant. Similarly, examination of the parasitic fauna on any such bat would be extremely useful.

It will be seen from table 4 that the Warrnambool population, which overlaps with that of Naracoorte in the Portland-Byaduk district, shows some similarity, although it is certainly more akin to the general pattern of Eastern Australian populations than to that of Naracoorte. It might be noted here that the Warrnambool population is also characterised by extreme localization within a few caves over a comparatively small geographical range, even though other caves exist within reasonably close proximity.

There is general acceptance of the view that Australian bats are of Asiatic origin and entered this continent by a series of migrations from New Guinea (Simpson 1961). The South-Eastern *M. schreibersii* of Australia provide a good example of a "stepped cline" in biological variation and this is generally accepted as evidence of former isolation of particular populations. It seems reasonable to suggest from the available evidence that the *M. schreibersii* of South-Eastern Australia have resulted from at least three successive but separated migrations which entered Australia at different times and which enjoyed long periods of geographical isolation. That population now based at Naracoorte might represent the first entry to Australia, the Warrnambool population the second entry, and others N.S.W. and Victorian populations a third entry (or series of entries). The isolation of these populations permitted the gradual differentiation of characteristics which is now evident.

Even if mating between individuals from different populations does occur, today it is clear that this is likely to be rare and gene flow between populations would be restricted, thus tending to preserve the integrity of each population.

Further Research Questions

Two kinds of further research are worthy of discussion. On the broad scale, it will clearly be useful to seek definition of the various populations occurring in *M. schreibersii* throughout its range. Studies paralleling those of Dwyer and myself will not only clarify the taxonomic questions raised in this genus, but could probably contribute a great deal to our knowledge of historical zoogeography. As a minor example, it would be of considerable interest to define the population characteristics of *M. s. orianae* in Northern Australia and to compare these with those of Timor, New Guinea and other Australian populations.

However, it is probably more immediately useful to list some outstanding and relatively simple research tasks in relation to the Naracoorte population.

1. Further analysis of available data, including
   (a) extension of the analysis presented in this paper to include all records held by the banding office
   (b) full analysis of sex-age data in relation to all caves in South-Eastern South Australia
   (c) full analysis of all data relating to the Portland-Byaduk district, including sex-age ratios of samples.
2. Continuing banding studies with particular attention to the biology of individuals which are detected as having moved from one population to another.
3. Further field work throughout South-Eastern South Australia to examine the timing of cave use throughout the area and the measurement of sex-age composition throughout the year.
4. Studies to clearly define the nature and timing of the reproductive cycle in this and other populations.
5. Replication of the studies by Harris on ecology of the guanophile community.

Acknowledgments

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APPENDIX

Caves from which *M. schreibersii* has been recorded in South-eastern South Australia and South-western Victoria.

S3	Bat Cave, Naracoorte
S5	Big Cave, Naracoorte
S7-8	Blackberry Cave, Naracoorte
S9-10	Tomato-Stick Cave, Naracoorte
S11-12	Cathedral Cave, Naracoorte
S15	Sleeping Cave, Glenelg River
S19	Monbulla Cave, Penola
S30	Robertson Cave, Joanna
S33	Fox Cave, Joanna
S42	Quarry Cave, Mt Burr
S52	Five Corners Cave, Mt Gambier
S54	Drop Drop Cave, Mt Gambier
S59	Lost Cave, Naracoorte
S61	Graveyard Cave
S62	Un-named Cave
S63	Rendlesham Cave, Rendlesham
S68	Cave Park Cave, Naracoorte
S69	Hodges Cave, Joanna
S72	Standing Cave
S90	Gran Gran Cave, Mt Burr
S101	Mt Burr Cave, Mt Burr
S109	Un-named Cave, Wandilo
S110	Un-named Cave
S113	Glencoe West Cave, Glencoe West

Noonan's Cave, Kongorong
Marine Cave, Robe
Un-named Cave, Benara

Amphitheatre Cave, Glenelg River
Snake Hill Caves, Myora
Cave Hill, Heywood
Fern Cave, Portland
Bat Ridges, Portland
Cape Bridgewater Caves, Portland
Byaduk Caves, Byaduk

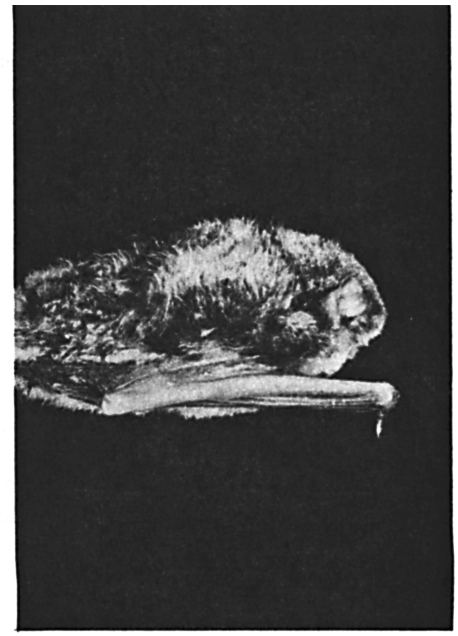

Plate 1: The Bent-winged Bat *(Miniopterus schreibersii)* from Naracoorte, South Australia. The second photograph shows the folding of the wing which accounts for the common name ("long-fingered bat" in German) and which is a distinctive feature in recognition of the genus.

DISCUSSION

Q *Is that the only albino bat that has been seen in Australia?*

A It is the only one that has been seen in Australia. We have seen one other that had white on the bottom half, that's if bats have a bottom half. The only other albino *Miniopteris* recorded is one that has been seen by Russ Mumford in Kenya about three months after this one was seen in Australia. It is the only other white *Miniopteris* known. White bats are in fact very rare and probably the reason for this would be that an albino bat would be an even more obvious target for an owl than the normal coloured one, and so the selection out of albinos would be pretty effective.

C *Quite often you see bats with little patches of white only a ¼ inch in diameter.*

A Yes.

Q *I am wondering if the caveless country between Rockhampton and Riverton might be one factor involved in segregation of bat populations?*

A What we don't really know at the moment, although Peter Dwyer is gradually getting it sorted out, is what happens with *Miniopteris* in Queensland, how many populations are there, what are their patterns, and Peter is still trying to sort this out. There's a maternity cave at Riverton. There are two maternity sites at Rockhampton and the status of each of these in respect to the other is not clear, but by the time we get to Rockhampton we are moving into tropical patterns rather than temperate and this bat in tropical areas in other parts of the world does not have this dependence on a single enormous colony but tends to have a number of smaller colonies. I know Peter has located maternity sites further north in the Mt Surprise area and at Chillagoe, but again we still do not know the full significance or status of these. But once we do, this will probably give a lot more evidence as to what might have happened with the southern ones.

Q *There seems to be yet another factor in making for relatively few incursions across this say tropical barrier. Is it combined with the geographical limitation of possible maternity sites?*

A That is right, and in fact of course it is only being able to spread south of Queensland because it has found sites in which it can get domes and conserve hot air. Without some sort of incubator sites this bat cannot spread out of the tropics.

Q *At Naracoorte especially in the summer, all the bats there, juveniles, females, plus the ones involved in giving birth and feeding and what have you, are in huge clusters in the hottest parts of the cave at the hottest time of the year. In the winters, springs and autumns at Naracoorte and Buchan they tend to be individuals lower down the walls in colder and harsher environment. Care to comment?*

A Peter Dwyer has done work on this. It is one of the obvious things that in summer one gets this incredible clustering in terribly hot caves. In winter, if the same cave is used the roost moves from the domes down on to the exposed points and you get bats resting in what appear to be the colder parts of the cave. Now at the same time those bats are in fact entering a period of torpidity and it is in their interests to remain fairly cool as there is very little food available for them outside. As long as they remain fairly cool they will remain in deep torpidity and not use up energy. Peter's proposal is that this movement to the cooler areas enables them to remain in torpidity, conserve energy, until such time as food is available and they can move into the warmer conditions and again become active.