

Synthesis and Prospect

A.R. Main, Senior Honorary Research Fellow, Zoology Department, University of Western Australia, Nedlands, Western Australia 6009.

Introduction

The authors of the papers on this symposium (Humphreys 1993a) were asked to present the current scientific knowledge of the biogeography of Cape Range and I was asked to give a synthesis and then offer a prospect of the future. To summarise the presentation of such disparate information as has been given in this symposium is difficult but to then give a prospect of the future is perhaps impossible in other than a personal or idiosyncratic manner.

The reasons for having this symposium arise from (a) the geology of the area which with its sedimentary structure and the presence of limestones is unlike that of the craton to the east; (b) the tectonic and eustatic history of the area; (c) the presence of abundant caves some of which contain cave faunas as well as mammalian fossils. The presence of the caves has been known and their exploration has been pursued by speleologists for some time but the scientific study of the fauna has virtually only just begun. The results of these early studies suggest a prospect that fuller exploration and study will reveal an even more astonishing fauna than has been reviewed here today. Yet the foregoing is not the only prospect. There is the attractiveness of the area for tourist development with its attendant need for access to water, sewerage and waste disposal. There are possible uses for the limestone by industry and the area is not fully explored for its oil potential. The area contained within the conservation estate is limited, many interesting faunal elements occur outside the limits of the estate. Everyone has been clear that little is known and there is more to know about the scientific value of the caves and cave faunas. In the presentations there has been a clear but unexpressed worry that likely developments may eliminate important elements before they are adequately studied or conserved. Despite these misgivings a summary of the present information does allow a consideration of future prospects and what might be done about them.

What has been said today can be summarised as:

1. the taxa that are present
2. their historical, biological and biogeographic significances
3. the scientific and conservation values ascribed to what is present
4. by implication the need for careful management of the above so as to ensure the retention of important elements.

I review what I see as the highlights of what has been reported here today and then present my thoughts on how we might proceed when making decisions or choosing between alternative courses of action designed to retain or enhance the prospects of retaining elements of conservation value on the Cape Range peninsula.

Review

In his introduction Bill Humphreys (1993b) pointed out that there is a great underground fauna about which little is known but, as we become more familiar with it, it ranks more and more as a world class subterranean fauna. George Kendrick (Wyrwoll *et al.* 1993) and Tony

Allen (1993) have dealt with the geomorphology, geology, the hydrogeology and an interpretation of what the past climate has meant to this area. In regard to this I would like to make one point; from what people have said the implications of the climate change are very obscure. There is a mention in Bill's paper (Humphreys 1993c), for example, that the Cape Range peninsula has always been north of 60 degree south, with the implication that it had some significance in the sense of the border with the *Nothofagus* forest. The climate of Australia is not entirely dependent on the way the continent has moved. The point has been made that the climate changed and began to deteriorate in the early Miocene; it was at that time that the continental plates were moving so that the gap between South America and Antarctica allowed an increased volume of water to flow past South America, thus the West Wind Drift and a circum-Antarctic circulation was established. Following the altered circulation Antarctica became refrigerated and the temperature gradient between the poles and the equator intensified and there developed first an unreliable and then a desert climate at the latitudes where arid and desert regions now occur. This dramatic change was possibly independent of what happened in a geographic sense at North West Cape.

These two papers on the geomorphology (Wyrwoll *et al.* 1993) and climate (Wyrwoll 1993) integrate very well with the work that Greg Keighery (Keighery and Gibson 1993) reported on the richness of the vascular plants. The richness is in part caused by the fact that the Cape is situated on an area of recent fluctuations of climate, consequently, neither the southern, northern or desert floras have been absolutely dominant.

The opposite happens with the stygofauna. Brenton Knott (1993) emphasises that the caves were inhospitable yet as he points out they are comparable in terms of biota to the other caves of the world acknowledged to contain a rich fauna. The interesting thing that Brenton brought out was that the affinities of these animals at family level and above, not at generic or specific level, indicate that they are relatives of very ancient groups and he talked about Pangean or Tethyan relationships. The Tethys was the sea that separated the landmasses of the northern continents from the southern continents; it spread from the Caribbean, through the Mediterranean, to the north of Australia. Thus when Brenton talks about elements of Tethyan age, he is really talking about an incredibly ancient set of affinities. At this stage of the presentation it was possible to see an individual history around the North West Cape faunas and to conclude that parts of these faunas are extremely old. Moreover, in many cases there are aberrant situations where some of the crustaceans in the Cape Range area, are the only known representatives at the order level, of the group from the southern hemisphere. This really reflects the fact that somewhere or other on the border of southern Tethys there were relict populations that moved as the environment changed until they were finally trapped in these caves.

The next groups treated were the Chelicerata and Myriapoda by Mark Harvey (Harvey *et al.* 1993). These are again another extraordinarily ancient group. Mark's interpretation was less ambitious than Brenton's, I think Mark must be a little more cautious than Brenton, but in essence the Chelicerata follow the same pattern as the Crustacea, that is there is some evidence of very ancient relationships. The ancient relationship now is not to an aquatic fauna but to a terrestrial one associated with forest having a moist understorey and wet litter. It is because the caves still maintain some of the attributes of moist litter that these organisms can persist. Again there are relationships both to the north and to Gondwanaland and indicating the remarkable significance of relict faunal assemblages now in these caves. There was some discussion as to whether they could be found underneath the rivers, such as the Ashburton,

where the boulder beds at the bottom of the rivers in gorges could perhaps retain some of these relicts but the significance of their presence in caves is not modified by the fact that they may occur somewhere else.

In the other presentations there was emphasis on both the genetic and taxonomic diversity in the area but I would like to draw attention to one group of termites (*Drepanotermes*). The total number of species in the genus is 23 and within 500 km of North West Cape, 14 of those species are represented (Watson and Perry 1981). In other words in that region there has been an aberrant history which is reflected in the caves, the fauna in them and the diversity of even dryland species which are living outside the caves. Thus the area is unique in the sense that there is the possibility of a total fauna with a biotic radiation that is quite different from anywhere else in Australia. In the cave ecology paper Bill Humphreys (1993c) talked about the sorts of caves that were present, whether there were other caves within the range or voids surrounding the caves. This possibility offers the opportunity for a two stage evolution. One which was the first isolation when the cave fauna was separated from the ground water now surrounding, while the second was the ground water itself which fluctuated in the Pleistocene. This possibility clearly indicates that more work ought to be done, that there are testable hypotheses of the way this fauna has radiated. A methodology for approaching the study of the radiation is exemplified by the paper on the genetic diversity by using electrophoresis to demonstrate the pattern in the general fauna (Adams and Humphreys 1993).

The molluscs were dealt with by Shirley Slack-Smith (1993). She pointed out that while the molluscs are not cave faunas they do represent faunas that seek refuges in caves, that is they represent the last end product of a depletion of a fauna because of aridity. So the molluscs themselves, while not cave fauna, in a sense support the *Drepanotermes* story that somewhere out there, if we could only get hold of it, there is an explanation of why this area is so rich in species.

When we get to Peter Kendrick (1993) on Terrestrial vertebrates and Alex Baynes (Baynes and Jones 1993) on mammals, we leave behind the animals that reveal a very ancient history. The mammals that are left don't really tell a story, we don't even know why they survive. The fossil material is rich in species and Alex shows the degree to which one has to go in order even to extract something from what one comes across. So the interpretation of the mammals, and the vertebrates generally, is for the people interested in the history of these groups. In terms of what we have been trying to do today, that is in terms of the biogeography of North West Cape, and its biotic uniqueness mammals and vertebrates generally do not tell quite such a good story.

Last of all Kate Morse (1993) pointed out that, inhospitable as it might be, and as variable as the climate may have been, while the shoreline changed as sea level rose and fell during the Pleistocene, the coast was still occupied and people used, or exploited its resources.

Prospect

The information presented offers a glimpse of the palaeohistory of the area from Tethyan times through the Miocene, Pliocene, Pleistocene and Quaternary to the present, the biological adaptation associated with cave life such as loss of eyes or pigmentation and the way subterranean life is dependent on pulses of nutrients which follow the occasional heavy rainfall experienced in the region. The participants in this symposium (Humphreys 1993a) were specifically asked to document the scientific values. This they have done in an exemplary manner. There can be no doubt from the documentations provided that the area ranks as

unique and scientifically of world class. I perceive that this demonstration raises two matters which will dominate the future. A reading of these proceedings will inevitably lead to questions being asked; first, what steps are being taken to pursue the scientific studies and, can they be placed on a firm financial footing given present financial conditions? And second, given the demonstration of the immense scientific value of the biota, what steps have been, are being or can be taken to ensure its retention? How can likely tourist development, waste disposal, needs for water, industrial use of limestone or oil exploration be accommodated while retaining the caves and their biota? These questions dominate any consideration of prospects.

Those not fully aware of the way science progresses might suggest that research endeavours be increased e.g. place more physical and monetary resources at the disposal of the researchers. Undoubtedly this would, to a limited extent, increase the rate at which knowledge is acquired. However, some important information will depend upon the frequency of events which replenish or fail to replenish the nutrients and water of the cave environment. These events are essentially unpredictable. Their study may be budgeted for in any particular financial period but this does not ensure that the event will then occur. Some funds need to be available for such contingencies.

A further difficulty can be seen from the institutional affiliations of the participants in today's symposium. For many of them study of the cape area is not their primary responsibility, its study must be fitted in as and when possible, or perhaps important information will arise incidentally to their other studies. Also taxonomic expertise is not solely in Perth, it is spread widely and workers are few. Taxonomic determinations which will stand for long periods require considerable research and reflection, especially is this so with a novel fauna such as occurs at the Cape. Bill Humphreys has done a remarkable job in obtaining the determinations that he has. Finally further appreciation of the significance of the Cape biota depends on more than its study alone. As information on fossil, cave and terrestrial faunas throughout the world increases so will our appreciation of the significance of the Cape biota develop. Undoubtedly it would be desirable to increase the rate at which knowledge is acquired but, as indicated above, those directing the current programme have little control over important contributors such as taxonomists and are dependent on goodwill to further understanding and interpretation.

Implicit in this systematic presentation of the information is that documentation of the outstanding scientific significance of the area should, on its own, be sufficient to ensure the retention of the caves and its faunas. It is a valid use of scientific information to conclude that scientific value justifies conservation. Conservation of an area has societal implications and especially is this so when there are, as indicated above, other potential users of the resources. Ultimately decisions or choices between social goals will be made at a political/administrative level. It is not helpful to merely assert or infer that scientific values stand before others. There needs to be a basis for rational discussion so that the consequences of alternative courses of actions (gains, losses, costs) can be discussed prior to any decision on extending conservation areas or exploiting the physical resources of the area. This appears to be the crux of the issue that we are facing today, we have a well documented statement on what is known, suggestions that more research is required and hints that extended conservation areas and better or more active management are needed to ensure the retention of important elements. Implementation of each of these goals bears a cost either in cash spent or income foregone, in each case the conservation debate becomes a social and political issue and quite different from a simple

documentation of the scientific significance of observations.

As I see it there is now an appreciation that tourism and other possible developments have potential impacts both on the established scientific values of the caves on the Cape Range peninsula as well as social and economic values. So it is possible to ask what will be the effect of tourism, waste disposal, water extraction, oil drilling, limestone quarrying, possible drying of caves or saltwater intrusion on the scientific values of important elements of the Cape Range region? In other words, how interconnected are the components; the extent and quality of water or limestone will limit the absolute degree of exploitation but once these values have been established the issues ought to be capable of discussion and a rational set of decisions reached. That there is even an implied call for additional areas to be included within the conservation reserve suggests that without an increased area either the total fauna will not be conserved or what is at present within the conservation estate is at risk of being lost. To request a larger area implies that an unacceptably high risk of loss can be reduced. A reasonable question would be to ask by how much would the risk be reduced? Is high risk 80 percent chance of loss and is it to be reduced to 50 percent or to zero? It may not be feasible to extend the conserved area or it may only be practical to include some but not all caves on scientifically important areas within the conservation estate. So what procedure is possible?

In other fields there are well organised sets of decision procedures by which the consequences of alternative courses of action can be considered. I see a prospect for advancing conservation goals by adapting these procedures to decision making when conservation issues may be in potential conflict with social and commercial goals.

The changes needed in our attitudes are not changes in terms of evaluating scientific information but in considering the consequences that follow from decisions. Decisions by themselves do not ensure the desired outcome. Depending on how chance operates the outcome may be anything but that sought when the decision was made. Established decision procedures allow these possibilities to be considered in a rational way. As an example, among the possible decisions relating to the Cape the following are possibilities; no further land for conservation, limited/unlimited tourism, water or limestone extraction, ground water pollution from waste disposal. Consider the case that no further land is forthcoming for conservation. What will happen to the fauna there? It is not helpful to say we can say nothing or need more research which will provide an answer in perhaps 25 years or so. The information needs to be timely and useful which means being available now. In the case of no further land, the possibilities of loss or retention will depend on chance events, weather and climate or how management of adjacent areas might affect the periodic flooding (see Humphreys 1993c); or whether there will be polluted water entering the caves; a failure of ground water recharge because of exploitation outside the reserve? Conversely if the area is included in a reservation how will the chances of preservice be enhanced? What is the likelihood of failure?

A belief in the likelihood that events will occur in the future can be expressed as probabilities. However, it can be argued that the assignment of probabilities to events e.g. extinctions that may occur in the future within the Cape area are not possible because there is no historical record from which to establish such possibilities in the traditional way. However, what is believed to be most likely, the so-called subjective or prior probabilities can be assigned and on this basis alternative courses of action considered and preferred action taken, on the basis of least cost, most likely retention, fewest regrets or other basis chosen. It should be noted that those who consider by inference an implication that extraction of water or limestone or failure to extend the conservation estate are likely to jeopardise the retention of

biota of scientific and conservation value have already made such a judgement. They have not put precise probabilities on their judgement but the possibility of loss would seem to be nearer one than zero. Examples of the way such judgemental or prior probabilities may be used in decisions involving conservation issues are provided in the literature cited by Main (1992).

Decisions relation to complex issues cannot be arrived at without the participation of all involved. They need workshop conditions and much time and patience so that differences are resolved and all expectations and assumptions are exposed before consensus is reached.

References

- Adams, M., and Humphreys, W.F. (1993). Patterns of genetic diversity within selected subterranean fauna of the Cape Range peninsula, Western Australia: systematic and biogeographic implications. *Records of the Western Australian Museum, Supplement 45*: 145-164.
- Allen, A.D. (1993). Outline of the geology and hydrogeology of Cape Range, Carnarvon Basin, Western Australia. *Records of the Western Australian Museum, Supplement 45*: 25-38.
- Baynes, A., and Jones, B. (1993). The mammals of Cape Range peninsula, north-western Australia. *Records of the Western Australian Museum, Supplement 45*: 207-225.
- Harvey, M.S., Gray, M.R., Hunt, G.S. and Lee, D.C. (1993). The cavernicolous Arachnida and Myriapoda of Cape Range, Western Australia. *Records of the Western Australian Museum, Supplement 45*: 129-144.
- Humphreys, W.F. (Ed.) (1993a). The biogeography of Cape Range, Western Australia. *Records of the Western Australian Museum, Supplement 45*.
- Humphreys, W.F. (1993b). Introduction to the Cape Range Symposium. *Records of the Western Australian Museum, Supplement 45*: ix-x.
- Humphreys, W.F. (1993c). The significance of the subterranean fauna in biogeographical reconstruction: examples from Cape Range peninsula, Western Australia. *Records of the Western Australian Museum, Supplement 45*: 165-192.
- Keighery, G. and Gibson, N. (1993). Biogeography and composition of the flora of the Cape Range peninsula, Western Australia. *Records of the Western Australian Museum, Supplement 45*: 51-85.
- Kendrick, P.G. (1993). Biogeography of the terrestrial vertebrates of the Cape Range peninsula, Western Australia. *Records of the Western Australian Museum, Supplement 45*: 193-206.
- Knott, B. (1993). Stygofauna from Cape Range peninsula, Western Australia: Tethyan relicts. *Records of the Western Australian Museum, Supplement 45*: 109-127.
- Main, A.R. (1992). Management to retain biodiversity in the face of uncertainty. Pp. 193-209 in R.J. Hobbs (ed.). *Biodiversity of Mediterranean Ecosystems in Australia*. Surrey Beatty and Sons, Chipping Norton, N.S.W.
- Morse, K. (1993). Who can see the sea? Prehistoric Aboriginal occupation of the Cape Range peninsula. *Records of the Western Australian Museum, Supplement 45*: 227-242.
- Slack-Smith, S.M. (1993). The non-marine molluscs of the Cape Range peninsula, Western Australia. *Records of the Western Australian Museum, Supplement 45*: 87-107.
- Watson, J.A.L. and Perry, D.H. (1981). The Australian Harvester Termites of the genus *Drepanotermes* (Isoptera: Termitinae). *Australian Journal of Zoology, Supplement Series No. 78*: 1-153.
- Wyrwoll, K-H. (1993). An outline of Late Cenozoic palaeoclimatic events in the Cape Range region. *Records of the Western Australian Museum, Supplement 45*: 39-50.
- Wyrwoll, K-H., Kendrick, G.W. and Long, J.A. (1993). The geomorphology and Late Cenozoic geomorphological evolution of the Cape Range- Exmouth Gulf region. *Records of the Western Australian Museum, Supplement 45*: 1-23.

documentation of the scientific significance of observations.

As I see it there is now an appreciation that tourism and other possible developments have potential impacts both on the established scientific values of the caves on the Cape Range peninsula as well as social and economic values. So it is possible to ask what will be the effect of tourism, waste disposal, water extraction, oil drilling, limestone quarrying, possible drying of caves or saltwater intrusion on the scientific values of important elements of the Cape Range region? In other words, how interconnected are the components; the extent and quality of water or limestone will limit the absolute degree of exploitation but once these values have been established the issues ought to be capable of discussion and a rational set of decisions reached. That there is even an implied call for additional areas to be included within the conservation reserve suggests that without an increased area either the total fauna will not be conserved or what is at present within the conservation estate is at risk of being lost. To request a larger area implies that an unacceptably high risk of loss can be reduced. A reasonable question would be to ask by how much would the risk be reduced? Is high risk 80 percent chance of loss and is it to be reduced to 50 percent or to zero? It may not be feasible to extend the conserved area or it may only be practical to include some but not all caves on scientifically important areas within the conservation estate. So what procedure is possible?

In other fields there are well organised sets of decision procedures by which the consequences of alternative courses of action can be considered. I see a prospect for advancing conservation goals by adapting these procedures to decision making when conservation issues may be in potential conflict with social and commercial goals.

The changes needed in our attitudes are not changes in terms of evaluating scientific information but in considering the consequences that follow from decisions. Decisions by themselves do not ensure the desired outcome. Depending on how chance operates the outcome may be anything but that sought when the decision was made. Established decision procedures allow these possibilities to be considered in a rational way. As an example, among the possible decisions relating to the Cape the following are possibilities; no further land for conservation, limited/unlimited tourism, water or limestone extraction, ground water pollution from waste disposal. Consider the case that no further land is forthcoming for conservation. What will happen to the fauna there? It is not helpful to say we can say nothing or need more research which will provide an answer in perhaps 25 years or so. The information needs to be timely and useful which means being available now. In the case of no further land, the possibilities of loss or retention will depend on chance events, weather and climate or how management of adjacent areas might affect the periodic flooding (see Humphreys 1993c); or whether there will be polluted water entering the caves; a failure of ground water recharge because of exploitation outside the reserve? Conversely if the area is included in a reservation how will the chances of preservice be enhanced? What is the likelihood of failure?

A belief in the likelihood that events will occur in the future can be expressed as probabilities. However, it can be argued that the assignment of probabilities to events e.g. extinctions that may occur in the future within the Cape area are not possible because there is no historical record from which to establish such possibilities in the traditional way. However, what is believed to be most likely, the so-called subjective or prior probabilities can be assigned and on this basis alternative courses of action considered and preferred action taken, on the basis of least cost, most likely retention, fewest regrets or other basis chosen. It should be noted that those who consider by inference an implication that extraction of water or limestone or failure to extend the conservation estate are likely to jeopardise the retention of

biota of scientific and conservation value have already made such a judgement. They have not put precise probabilities on their judgement but the possibility of loss would seem to be nearer one than zero. Examples of the way such judgemental or prior probabilities may be used in decisions involving conservation issues are provided in the literature cited by Main (1992).

Decisions relation to complex issues cannot be arrived at without the participation of all involved. They need workshop conditions and much time and patience so that differences are resolved and all expectations and assumptions are exposed before consensus is reached.

References

- Adams, M., and Humphreys, W.F. (1993). Patterns of genetic diversity within selected subterranean fauna of the Cape Range peninsula, Western Australia: systematic and biogeographic implications. *Records of the Western Australian Museum, Supplement 45*: 145-164.
- Allen, A.D. (1993). Outline of the geology and hydrogeology of Cape Range, Carnarvon Basin, Western Australia. *Records of the Western Australian Museum, Supplement 45*: 25-38.
- Baynes, A., and Jones, B. (1993). The mammals of Cape Range peninsula, north-western Australia. *Records of the Western Australian Museum, Supplement 45*: 207-225.
- Harvey, M.S., Gray, M.R., Hunt, G.S. and Lee, D.C. (1993). The cavernicolous Arachnida and Myriapoda of Cape Range, Western Australia. *Records of the Western Australian Museum, Supplement 45*: 129-144.
- Humphreys, W.F. (Ed.) (1993a). The biogeography of Cape Range, Western Australia. *Records of the Western Australian Museum, Supplement 45*.
- Humphreys, W.F. (1993b). Introduction to the Cape Range Symposium. *Records of the Western Australian Museum, Supplement 45*: ix-x.
- Humphreys, W.F. (1993c). The significance of the subterranean fauna in biogeographical reconstruction: examples from Cape Range peninsula, Western Australia. *Records of the Western Australian Museum, Supplement 45*: 165-192.
- Keighery, G. and Gibson, N. (1993). Biogeography and composition of the flora of the Cape Range peninsula, Western Australia. *Records of the Western Australian Museum, Supplement 45*: 51-85.
- Kendrick, P.G. (1993). Biogeography of the terrestrial vertebrates of the Cape Range peninsula, Western Australia. *Records of the Western Australian Museum, Supplement 45*: 193-206.
- Knott, B. (1993). Stygofauna from Cape Range peninsula, Western Australia: Tethyan relicts. *Records of the Western Australian Museum, Supplement 45*: 109-127.
- Main, A.R. (1992). Management to retain biodiversity in the face of uncertainty. Pp. 193-209 in R.J. Hobbs (ed.). *Biodiversity of Mediterranean Ecosystems in Australia*. Surrey Beatty and Sons, Chipping Norton, N.S.W.
- Morse, K. (1993). Who can see the sea? Prehistoric Aboriginal occupation of the Cape Range peninsula. *Records of the Western Australian Museum, Supplement 45*: 227-242.
- Slack-Smith, S.M. (1993). The non-marine molluscs of the Cape Range peninsula, Western Australia. *Records of the Western Australian Museum, Supplement 45*: 87-107.
- Watson, J.A.L. and Perry, D.H. (1981). The Australian Harvester Termites of the genus *Drepanotermes* (Isoptera: Termitinae). *Australian Journal of Zoology, Supplement Series No. 78*: 1-153.
- Wyrwoll, K-H. (1993). An outline of Late Cenozoic palaeoclimatic events in the Cape Range region. *Records of the Western Australian Museum, Supplement 45*: 39-50.
- Wyrwoll, K-H., Kendrick, G.W. and Long, J.A. (1993). The geomorphology and Late Cenozoic geomorphological evolution of the Cape Range- Exmouth Gulf region. *Records of the Western Australian Museum, Supplement 45*: 1-23.

ISBN 0-7309-5947-3

