

**AVIAN FAUNA, PALAEOENVIRONMENTS  
AND PALAEOECOLOGY  
IN THE LATE QUATERNARY  
OF THE  
WESTERN AND SOUTHERN CAPE,  
SOUTH AFRICA**

GRAHAM AVERY

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## ABSTRACT

Avian remains in coastal archaeological samples from Eland's Bay Cave, Die Kelders Cave 1 and Nelson Bay Cave in the Cape Province, South Africa, cover the periods between 80 000 and 40 000 B.P. and 18 000 and 300 B.P. Results of modern comparative surveys indicate that beached birds provide a predictable food supply. Kolmogorov-Smirnov two-sample nonparametric tests confirmed the close resemblance between the relative proportions of seabirds in archaeological and beached assemblages and earlier assumptions that the composition of seabird samples in archaeological sites could not otherwise have been achieved. It is shown that this simple but effective practice has a history going well into the Middle Stone Age. Kolmogorov-Smirnov tests for differences between the relative proportions of skeletal elements of Cape cormorants preserved in archaeological and modern jackal accumulations provided a useful means of drawing attention to possible activity of jackals and/or domesticated dogs. Recognition that diagenesis in some earlier samples may mimic the characteristics of modern jackal samples has established the need to extend the comparison of skeletal elements to additional species and to study the relative durability of avian skeletal elements. Similar comparison with the proportions of modern mammalian and avian predator prey species and size (mass) categories provided no indication that black or martial eagles might have contributed to the samples. Similarly, present knowledge of Cape eagle owls argues against their being likely inhabitants of caves suitable for occupation by people. It is concluded that people were the primary accumulators of the assemblages studied and that the role of small food items in prehistoric subsistence can be addressed with greater confidence.

Correspondence analysis was used to determine the existence of seasonality in the modern beached seabird samples. The profiles of the archaeological samples are plotted in relation to months in which they were most likely to have been collected. Seasonal evidence from species not subjected to the correspondence analysis supported these results. The results obtained closely supported the hypothesis for seasonal exploitation of the coast. It was also possible to indicate that visits were probably of short duration and that their timing varied. Exploitation of seabirds did not coincide with the period of maximum availability of beached birds. Comparison of the avian evidence with that from seals, Cape dune molerats and steenbok/grysbok suggested that small food items comprised part of a seasonal

strategy that made maximum use of a range of seasonal resources. Evidence for significant local environmental change in addition to, and in support of, existing information has been obtained. Fluctuations in marine, freshwater and terrestrial birds at Eland's Bay Cave have been related to evidence for changes in terminal Pleistocene and Holocene sea levels and the position of the coast, and in the morphology of Verlorenvlei. At Die Kelders Cave 1 between 80 000 and 40 000 B.P., previously drier conditions were ameliorating and mixed scrub and grass and freshwater existed on the coastal foreland in the vicinity of the cave. Fluctuations in frequencies of seabirds indicate that the sea level rose slightly and then receded during the period of deposition. At Nelson Bay Cave samples indicate the approach of the coast after the Last Glacial Maximum, the disappearance of grassland and its replacement by scrub and bush as significant elements of the vegetation. Freshwater birds did not respond as expected, however, indicating that their interpretation at Nelson Bay Cave is complex and not consistent with evidence for wetter or drier conditions. A possible link has been shown to exist between fluctuations of albatrosses, petrels and shearwaters at Nelson Bay Cave and the intensity of wind patterns which are related to oceanic and atmospheric circulation. Further investigation should establish whether seabirds will provide an index of climatic conditions without support from other sources.

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## 1. INTRODUCTION

### GENERAL

Bird bones occur regularly in prehistoric coastal midden deposits throughout the world (e.g. Howard 1929; Dawson 1969; Coutts & Higham 1971; Rick 1975; Avery 1977a; Anderson 1979, 1989; Yesner 1977; Leach 1979; Sutton 1979; Munzel 1983; Avery & Underhill 1986; Reitz 1988) and have been used to provide information on diet and exploitation strategies.

With increasing latitude the marked effect of climatic extremes (Schalk 1977) causes the movements and breeding of many species to be highly restricted (McArthur 1972; Cramp 1977; Nelson 1977). Because the availability of birds for exploitation by recent prehistoric peoples in these regions is highly seasonal it can be accurately determined. This knowledge has been based on the occurrence of particular migratory species and the bones of juveniles where the annual cycle of the birds (migration, egg-laying, incubation, nestling, fledging) is known, often to within a matter of days (e.g. Munzel 1983). Even accurate sources of seasonal information may, however, be misleading due to the variety of ways in which people could respond to the choice of exploitation options open to them. For instance, Coutts & Higham (1971) commented on the seasonal exploitation of shearwaters, but added that they were dried for use at other times and places which could complicate interpretations based on their presence. To a lesser extent, the close relationship between birds and environmental conditions, which places definite constraints on their seasonal movements and distribution, has led to the use of avian data to provide information on climatic and environmental change over time (Moreau 1954).

In the coastal region of South Africa a reasonable amount of information is becoming available on taxa from the Early Pliocene (5-3 myr) fossil avifauna, prior to the first hominid records, at the Langebaanweg and Duinefontein fossil sites (Figure 1) (Simpson 1971, 1975, 1979; Rich 1980; Olson 1983, 1984, 1985a, 1985b, 1985c, 1985d; Rich & Haarhoff 1985; Haarhoff 1988). However, little is known of avian populations or their exploitation by people during the Pleistocene and Holocene. Elandsfontein provides the only Middle Pleistocene (ca 500 000-125 000 B.P.) avian material (Hendey 1969; GA pers. obs.), but this is extremely scanty and not at this stage suitable for palaeoecological interpretation. More recent material from the late Upper Pleistocene (18 000-10 000 B.P.) and the Holocene (10 000 B.P. to present) forms the basis of this study.

#### AVIAN ARCHAEOLOGY IN SOUTH AFRICA

In spite of the long record of Quaternary vertebrate fossils in South Africa, the quantitative study of faunal remains from archaeological sites (zooarchaeology) is relatively new here; pioneering work was almost exclusively on mammals. Studies by Hendey & Singer (1965) and Brain (1967) during the late 1960s and particularly by Klein (1972a, 1972b) during the early 1970s are examples. Voigt (Maggs & Speed 1967) initiated work on molluscs. There was, however, only limited appreciation in South Africa of the usefulness of bird remains in archaeological and palaeoecological research.

Although there were notable exceptions elsewhere in the world, where much of the pioneering work arose from studies of the Danish (Steenstrup 1857) and Californian (e.g. Howard 1929) shell middens, and later those in New Zealand (e.g. Duff 1956; Scarlett 1972), workers in South Africa were slow to investigate the potential offered by avian remains. This was undoubtedly for reasons similar to

those outlined by Dawson (1969) for the slow development of this field in Europe. In the coastal regions samples were dominated by molluscs and mammals which comprised the most important elements of diet. It is not surprising that their study was emphasised in the belief that they provided adequate information on which to base interpretations of human diet and life. Avian remains, on the other hand, were normally relatively uncommon and provided a far smaller return for effort expended. Moreover, avian bones were considered difficult to identify, because of their small size, the fact that birds are chiefly represented by postcranial bones and a lack of comparative material on which to base identifications to species level. At the time, mammalian comparative collections generally lacked postcranial remains, possibly because cranial remains were considered taxonomically easier to deal with and provided adequate species lists. It is interesting to speculate that this contributed psychologically to the resistance, which appears to have led to birds being generally ignored. Perhaps the most important factor, however, was the lack of interested specialists. Such similarities in attitude between continents are not surprising as archaeological work in South Africa was initially almost exclusively influenced by European-trained archaeologists. In North America and New Zealand avian remains were more common and interest in the information to be gleaned from them was therefore greater.

The relative wealth of avian osteological material from Upper Pleistocene and Holocene archaeological occurrences, which has subsequently become available for this study, played an important role in drawing attention to the great potential of this material for providing information in this field in the western and southern Cape coastal regions.

## A PROJECT EMERGING

With the development during the 1960s and 1970s of major archaeological projects on the coasts, involving carefully documented excavations in which faunal remains were retained (Klein 1972a; Schweitzer 1979; Robertshaw 1979; Parkington 1981; Schweitzer & Wilson 1982; Singer & Wymer 1982; Inskeep 1987), it became apparent that bird remains were not always an insignificant component of coastal assemblages, and the rationale for their study became more obvious.

During excavations by F.R. Schweitzer (South African Museum) in the Agulhas region of the southwestern Cape at Die Kelders Cave in 1969 and R.G. Klein (then at the University of Washington) at Nelson Bay Cave on the southern Cape coast in 1970, quantities of bird bones were recovered and it became apparent to us that the potential for their study was at least as good as elsewhere in the world. Further material was obtained by J.E. Parkington (University of Cape Town) during excavations on the west coast at Eland's Bay Cave. In the light of this and the encouragement of Klein in particular, who was starting to pursue his own interest in mammalian remains, I decided to investigate the potential for studying the avian remains from South African coastal sites.

This immediately drew me into the midst of the problems outlined by Dawson (1969). The study of osteological remains is normally conducted with skills acquired through experience rather than formal training. Furthermore, there was virtually no comparative skeletal material available with which to identify avian remains even to family level.

Specimens were originally obtained through the kind co-operation of the South African National Foundation for the Conservation of Coastal Birds. In this way I was able to obtain carcasses of common seabirds which appeared to predominate in the samples. As more archaeological material was examined, however,

it became apparent that skeletons of terrestrial birds were also needed. Specimens were obtained through judicious use of a permit from the Cape Department of Nature Conservation and from the collection of road kills by myself and other interested people. My initial development of the comparative collection and preparation of the specimens was a slow process. Subsequently, however, preparation and curation of the collection was taken over by the Department of Quaternary Palaeontology at the South African Museum, and has been enlarged to the extent that most identification needs can now be accommodated.

#### THE NEED FOR EXPERTISE

Having previously had some experience in identifying mammalian bones, I was able to identify some of the avian remains with the newly acquired comparative material. This was only the beginning, however; the need for more comparative material grew and with each species identified more information on the behaviour and ecology of birds was also required.

Dawson (1969) had, however, emphasised that specific identifications should be made by trained zoologists with experience in osteology who would also publish papers in relevant biological journals in order to disseminate information on the prehistory of birds. As mentioned above, however, a suitable specialist did not exist. Most qualified zoologists I had access to knew little about avian osteology and were not particularly interested in entering the field. This problem has not been an isolated case, however, as exemplified in particular by Ron Scarlett in New Zealand and his later colleagues (Scarlett 1972; Anderson 1979), who were pioneers in the field.

As it happened, the problem resolved itself. As a result of preparing skeletons, I rapidly became familiar with the structure and osteology of birds. In a

number of ways I found the recognition of morphological characters distinguishing different taxa even on fragmented bones, similar to but less subjective than making decisions demanded in classifying cultural material. It seemed to be less a case of having expertise than being willing to learn the fundamentals of a new discipline and then to apply this to the archaeological problems with which I was familiar.

As the direction and scope of the research programme developed, so did the need for more specific ecological background, both biological and physical, on the birds themselves. Another issue that became prominent was the need to understand more about the nature of the samples themselves, with particular reference to the extent that the preserved bones could provide an accurate picture of the avian communities and populations from which they were originally derived.

With assistance from ornithologists from the Percy FitzPatrick Institute for African Ornithology at the University of Cape Town and through the literature I gained a sound background in the practicalities of relevant aspects of ornithology and ecology. This has bridged the gap in my original training and has also led to the publication of various biological papers (e.g. Avery 1978, 1979, 1980a, 1981a, 1982, 1984a, 1985a, 1988a, 1989; Avery *et al.* 1985, 1987, 1988). Although this track may not be ideal, I believe, as undoubtedly do others who for one reason or another have also followed similar paths, that the standards required by Dawson (1969) can be achieved through less formal training.

Of particular interest to me was the fact, of which I soon had experience, that highly complex biological situations which appear to be clear-cut to the uninitiated and useful for explaining archaeological results, may not have been thoroughly studied or understood by specialists yet. Beveridge (1961) emphasized that creative thought should always be tempered by consideration of a reasonable number of alternatives before a favoured explanation is selected. He also emphasized the need to recognise the distinction between data which can be observed and treated as facts

and the tentative conclusions derived from the interpretation (generalizations) of such facts. If sufficient observations are collected to provide a wide basis for verifying (or disproving) our predictions, greater confidence may be placed on interpretations of observational facts. However, while they may then be accepted in practice, they always remain generalizations, subject to further testing under new conditions.

#### MORE PROBLEMS AND POTENTIAL

My pilot study (Avery 1977) confirmed the potential for obtaining seasonal information from birds. It also suggested that a number of oceanic species in the samples would rarely be accessible to people onshore unless washed up sick or dead. This introduced a potential source from which birds could be acquired by means other than hunting. It therefore became apparent that I needed to acquire information on the nature and timing of natural mortality and on the factors affecting seabirds and their potential availability to coastal hunter-gatherers. Initially interest centred around those species utilized by prehistoric people and for which ecological information existed which might assist in the study of human activity. To this end a reasonable baseline of primary information on aspects of avian biology such as habitat preferences, diet, breeding, moult and movement was readily available in the literature.

At this point Professor Nic van der Merwe of the University of Cape Town suggested that I register for a Ph.D and extend my study of bird bones in the form of a thesis. It soon became evident, however, that interpretation of the results was not to be a simple matter of extracting existing information on the species present in the samples. In middle and lower latitudes climatic conditions are neither as extreme nor as seasonally constrained as those in the higher latitudes of the northern and

southern hemispheres. The distribution, movements and breeding of birds are consequently more variable, with the result that precise statements about the timing of events cannot always be made. Thus, although the western and southern Cape coasts support a number of seasonally breeding species, their breeding period tends to be protracted and may be further complicated by re-laying after accidents, predation or failure of the food supply (Hutchinson 1950; Siegfried *et al.* 1975).

The project now assumed a more complicated framework which encompassed far more than people and the avian species they utilized. Interrelationships between the birds themselves and the biological and physical environments in which they lived took on greater importance. These aspects are all related to availability of food and adaptation to habitat and are all more or less predictable (Lack 1954). Concomittantly, the effects of changing environments on the availability of food and habitat should in turn be evident in changes in the composition of avian populations through time. It seemed feasible, therefore, to use modern information on the ecology of species represented by bones in archaeological samples to provide the basis for interpreting aspects of avian and human palaeoecology. Furthermore, as the samples come from periods during which it is known that environmental conditions changed, the evidence from avian remains might provide supporting or new evidence on the nature of such changes.

A difficulty with birds, however, is that they are mobile and their movements often cut across a variety of oceanic and near-shore habitats which might limit their usefulness as indicators of environmental change. If, however, care is taken to account for this problem, it seems reasonable to investigate the possibility that changes in bird numbers and species composition in archaeological assemblages can indicate environmental change and its effect on human activity.

## COMPARATIVE MATERIAL

## BEACH SURVEYS

In order to investigate whether exploitation of beached birds was an important aspect of the way in which people acquired birds it became necessary to obtain information on availability through this means. This led directly to the institution of modern comparative studies aimed at establishing as good a modern baseline as possible with which to compare the archaeological data. Enquiry of experts revealed that such information was scanty but the subject was potentially of interest to biologists as well.

With the help of ornithologists at the Percy FitzPatrick Institute for African Ornithology, the African Seabird Group was established. Members record coastal observations of seabirds, particularly oceanic species such as albatrosses and petrels. With a view to establishing a database on mortality and seasonal occurrence, I, along with others, organized regular monthly surveys for dead seabirds washed up on beaches in a number of localities on the west and south coasts (Cooper 1977). Results of the first six years of surveys were analysed and used to establish whether different species of seabird are seasonally available (Avery & Underhill 1986). This proved to be the case, and these results were then successfully compared with numbers from archaeological samples to establish the time of the year during which the birds were most likely to have been exploited (Avery & Underhill 1986). It was also shown that proportional representation of seabird species in the archaeological samples closely resembled those of present populations. This was very encouraging as it confirmed the prediction that archaeological samples provided a reasonable reflection of the living populations from which they were drawn and could be used

to study the possible influence of environmental change on avian populations (Avery 1987a).

#### AGENCIES OF BONE ACCUMULATION

Developments in taphonomy (e.g. Brain 1981; Behrensmeier & Hill 1981) pointed to the need for further expansion of the scope of the project to include investigation of alternative agencies which could have contributed to the accumulation of the avian samples under study (Avery 1984b). Additional modern comparative studies were initiated on the bone-accumulating habits of mammalian and avian predators such as the brown hyaena, black-backed jackal (Avery *et al.* 1987), black and martial eagles and Cape Eagle owl. In this I have been assisted in the acquisition of material by members of the Directorates of Nature Conservation in the Cape Province of South Africa and in Namibia, and a number of other interested individuals.

#### THE RELEVANCE OF THE PROGRAMME

This research programme aims to investigate the availability of birds, primarily sea-birds, and their exploitation by prehistoric hunter-gatherers of the Cape coastal region. (Avian remains are not normally common in inland sites [Avery 1980b, 1984c] which is not surprising in view of the much smaller populations of suitably-sized bird species that occur inland, especially when compared to the particularly high densities along the west coast [Rand 1963]). Archaeological excavation has revealed that birds (including marine, freshwater and terrestrial) form a regular part of the food and artefactual remains in Upper Pleistocene and Holocene coastal sites (Klein 1975; Avery 1977b, 1981b, 1985b; Robertshaw 1977, 1978, 1979; Parkington

1981; Smith 1981). However, birds normally contribute only a relatively small proportion of the overall energy that can be determined from preserved components as shown by Buchanan (1987). So what is their importance? Their availability is predictable and they could therefore have provided a reliable source of food and raw materials. Additionally, in the light of suggestions made by Noli & Avery (1988) that coastal diets may be in danger of including too much protein, birds may have been important providers of an alternative more-balanced source of energy because of their relatively high fat content.

A more specific aim is to test the model of seasonal transhumance by Late Stone Age hunter-gatherer groups between the coast (winter) and the inland mountains (summer) of the western Cape set out by Parkington (1972, 1976). Since Parkington's original statement others have attempted to explain resource utilization by both hunter-gatherers and pastoralists within this framework (Avery 1976; Robertshaw 1977, 1978, 1979; Smith 1984), and Parkington (e.g. 1981) has himself modified his original model. Moreover, from a logistical point of view, avian remains are important to the archaeologist, because in providing seasonal information for yet another of the many components of human dietary remains, they help to reduce the unknown/unknowable factors which are common in archaeological interpretation. The establishment of the season or period of occupation at both coastal and inland localities is clearly essential to test the seasonal model. A more accurate measure of environmental change would also be possible in palaeo-ecological assessments if the effects of seasonal changes on avian population composition could be recognized in archaeological samples.

My preliminary studies of avian samples, the recognition of certain shortcomings and the establishment of collecting programmes to limit them have confirmed the potential of this study. It remains to combine this unique body of

archaeological and modern comparative observations to establish a greater understanding of the information bound up in the archaeological samples.

Samples from three important coastal caves will be examined: Eland's Bay Cave on the western Cape coast; Die Kelders Cave 1 on the southwestern Cape coast; and Nelson Bay Cave on the southeastern Cape coast. Before examining the archaeological material, however, the nature of archaeological samples will be discussed in the light of the various stages of modification that the hunted animals undergo, from their relationship to the populations from which they were drawn to that which finally reaches the archaeologist for study. Thereafter results from the modern comparative studies on beached seabirds and on some mammalian and avian predators will be discussed in order to provide further background information with which the archaeological samples will be compared.

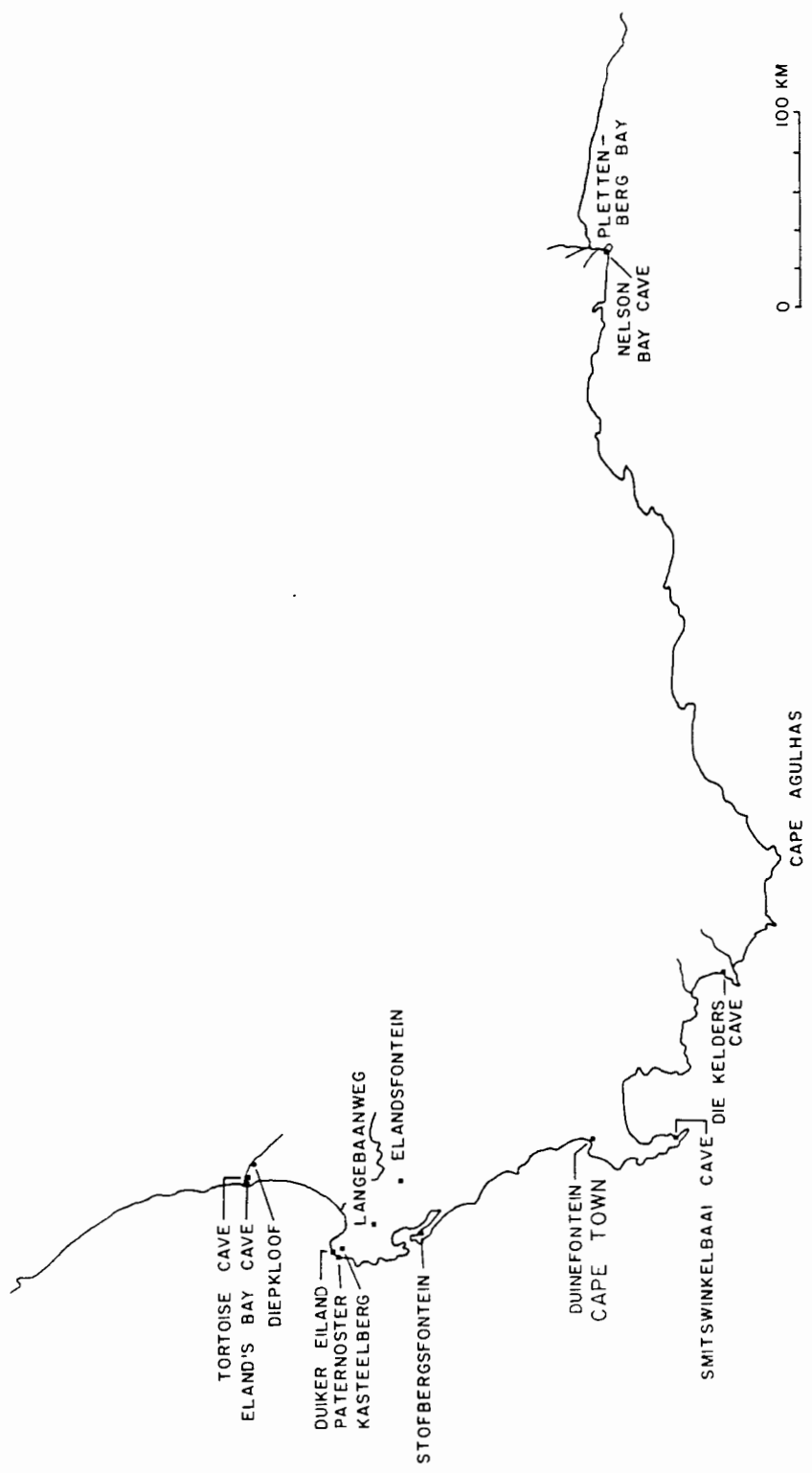


Figure 1.1. Distribution of sites mentioned in the text.

## 2. THE NATURE OF ARCHAEOLOGICAL SAMPLES

### INTRODUCTION

Interpretation of biological evidence from archaeological sites is essentially an exercise in palaeoecology, be it of animals or people. In reviewing the relationship to archaeology of taphonomy and palaeoecology, Gifford (1981) commented favourably on the strong tendency among archaeologists to focus on modern comparative studies in order to achieve a greater understanding of the processes leading to site and assemblage formation and the kinds of archaeologically relevant information that can be deduced from them. Important problems of palaeoecological research are, first, that the recovered samples represent a much altered sub-set of the living populations from which they were drawn and, second, that interpretation relies on comparisons with modern analogues.

The discipline of taphonomy developed as palaeontologists sought to study processes that potential fossils undergo after death (Olson 1980). Although 'taphonomy' originally dealt primarily with burial factors, common usage nowadays includes the study of any factor that may affect interpretations drawn from osteological assemblages. This includes experimental simulations of the effects of natural processes, studies of modern analogues and independent assessment of evidence against that from other disciplines. The understanding that emerges from these studies provides greater support for the use of physical and ecological principles to recreate as reliable a picture as possible of past life assemblages and the conditions under which they existed.

Without a clear understanding of the many variables and biases that can affect bones *post mortem* any interpretation of their significance may be misleading

or bear no real relationship to past populations and conditions. Clark *et al.* (1967:115) pointed out that a collection of fossils (equivalent to the archaeological faunal sample) does not provide a direct sample of the living population or community (life assemblage) from which it was drawn. They recognized three successive stages or universes as the original characteristics of the life assemblage are reduced through the death assemblage, the total fossil assemblage and the collected assemblage to the fossils finally available for study. At any point on this scale the assemblage can be subjected to additional sub-sampling by the effects of interacting factors which may lead to even greater abstraction of information (Table 2.1). These stages and the factors that affect them were developed during a study of Oligocene fossils being exposed by erosion. The principles are universal, however, and provide a useful template for assessing taphonomic processes.

Criticism has been levelled at palaeoecologists for unwarranted reliance on assumed uniformitarianism. It has also been argued that extrapolations made from contemporary ecological analyses to patchy palaeoecological situations require potentially misleading simplifications which belie ecological complexity (Lawrence 1971; Dodd & Stanton 1981). This argument may be valid in the case of extinct species for which there are no modern relatives (Clark *et al.* 1967) but palaeoecologists argue that, while they cannot directly match the observational standards of neontologists, they can make a positive contribution to biological history provided they remain within the limitations of fossil evidence. It goes without saying that problems of uniformitarianism that apply to the interpretation of lifestyles of animals that lived many millions of years ago are increasingly reduced as the time gap between sample and suitable analogue is narrowed. Indeed, Blondel (1987) has gone so far as to maintain that human interference in the Mediterranean region over the past 9000 years has so changed habitats that the present distribution of birds cannot be interpreted without reference to the past.

In the New World (Howard 1950, 1962; Campbell 1976) and elsewhere in the Southern Hemisphere (Olson & James 1984; Anderson 1989), there is evidence that some species became extinct during the Upper Pleistocene and Holocene, sometimes at the hand of people, but such is not the case in South Africa. It can reasonably be assumed, therefore, that the ecological requirements of the species recorded in the archaeological samples, which will be discussed, are unlikely to have differed from those of the present. Global environments, on the other hand, have gone through cycles of major change (e.g. Shackleton & Opdyke 1973, Hays *et al.* 1976, Lorius *et al.* 1979), which can be assumed to have affected the distribution and density of avian populations (e.g. Moreau 1954; Olson 1975; Avery 1987a).

## TAPHONOMY

### LIFE ASSEMBLAGES

A variety of biotic factors, including climatic, oceanographic, topographic and historic controls, influence the presence and density of different species within the habitats or ecological niches in which they normally occur. Complications arise because some species are not confined to specific habitats but may regularly range over different habitats or even traverse continents, as in the case of migratory bird species. This could give rise to what might appear to be a mixed assemblage. The problem applies to mammalian and avian predators as well as to people, who typically range over several habitats.

Like other animals, birds are also affected by short-term atmospheric oscillations which cause cycles of wet and drought conditions (Tyson 1986) or affect ocean temperatures and nutritional status which may ultimately influence the distribution and availability of food taken by seabirds (Barber & Chavez 1983; Duffy *et al.* 1984;

Schreiber & Schreiber 1984). Such changes may exert physiological stress on animals or cause them to move into unfamiliar habitats in which they may be more susceptible to mortality or predation. In the case of breeding seabirds, which are restricted by foraging range, even localized unfavourable conditions can lead to heavy mortality and breeding failure (Crawford *et al.* 1980; Duffy *et al.* 1984; Avery 1988a). In any event, changes in relative seabird mortality generated by short-term fluctuations may lead to misleading interpretations of gross environmental change. At a local level, Avery *et al.* (1988) and Braine (1988) showed how berg winds could account for the transport of certain species as vagrants across the Namib desert to unsuitable coastal habitats in which they are unlikely to survive. Longer-term cyclical fluctuations of natural conditions and major natural changes which affect climate and sea level also lead to changes in the distribution and relative proportions of species. Such gross changes are easier to detect than short-term variability as they are more likely to leave an unambiguously recognisable signal, which could be independently supported by correlation with other lines of evidence such as deep-sea cores and other faunal components.

#### DEATH ASSEMBLAGES

Various factors combine to produce the death assemblage, which is the sum of the fresh corpses or their remnants that come to rest upon a surface prior to burial by the next episode of sedimentation.

#### Predation

Predation is a potential cause of significant biases which affect the range of species and age-classes taken. Depending on the size and habits of the predators and prey

involved, predators may form death assemblages that closely resemble life assemblages or, through selectivity, may be biased.

### *Human accumulators of bones*

People typically choose from a number of alternatives those species they wish to take. Interpretation of archaeological data is complicated by the fact that there is little direct ethnographic evidence to indicate how coastal birds might have been procured and the degree to which methods may have been selective or changed over time. People are known to concentrate on a range of species with predictable habits. Also, cultural remains such as ornaments, bone tubes and beads, could be misleading even though they may have been made on bones from species with intrinsic seasonal or environmental significance. They may be incorporated in archaeological accumulations at any time after collection and manufacture; furthermore, bones might be kept for later preparation or could have been collected from long-dried carcasses. Before seasonal and environmental inferences can be made it is necessary, therefore, to exclude any cultural or other considerations on the part of the people that might have biased the extent to which the sample represents the community from which it was drawn.

Several means of obtaining birds seem to have been available, at least to Late Stone Age peoples. Inland, snares, bow and arrows and sticks (e.g. Steyn 1971) were used. The extent of these practices is not well known, although the paucity of bird remains found in inland sites suggests that it was not great (Avery 1984c, 1987b). On the coast, however, the situation was different. Jacobson & Noli (1987) recorded an account by a "sea Bushman" of how he used to kill and eat whitebreasted cormorants breeding at the Hoanib River mouth in Namibia and take their eggs. Avery (1984d) discussed records of coastal Topnaar Hottentots

occasionally chasing and catching young penguins on the beach, clubbing juvenile cormorants roosting on the beach and shooting gulls with bows and arrows. Large numbers of birds were taken during the breeding season. Swimming to offshore rocks and sand banks with the aid of logs or wading (Backhouse 1844; Budack 1977) enabled people to gain access to both birds and eggs. This requires calm and/or shallow water, which is not a common feature of western and southern Cape coasts, and a reasonable expectation of finding a suitable log.

Another obvious and easy method of acquiring birds in coastal contexts would have been the collection of dead or sick birds on the shore (Avery 1977a, 1977b; Avery & Underhill 1986). This would involve people in a far less selective strategy and, significantly, one which could be examined by collection of modern observations on beached birds. Indeed, regular seasonal availability and periodic mass mortality may serve to increase the likelihood that people would have made accumulations that are reasonably accurate reflections of the life assemblages they represent. This could also apply to the shores of vleis and river estuaries where large numbers of birds might also be expected to congregate regularly.

#### *Other accumulators of bones*

People are not the only predators that accumulate osteological remains of their prey. In South Africa sites that are attractive for human occupation may also have been used by other mammalian predators and scavengers such as the brown hyaena, black-backed jackal, leopard, water mongoose, and by birds such as the black and martial eagles, barn owl, and Cape and spotted eagle owls (Brain 1981; D.M. Avery 1982; Avery 1984b, 1987a; Klein & Cruz-Urbe 1987). The size and nature of prey taken by these species overlaps with that taken by people.

The species most likely to contribute to accumulations of bird remains in sites along the western Cape coast are the brown hyaena and black-backed jackal, the black eagle and martial eagle and the Cape eagle owl. Brown hyaena and jackal, which regularly scavenge birds, fish and marine mammals from beaches (Shortridge 1934; Avery *et al.* 1984, 1987), accumulate bones in caves as well as in the open (Klein 1981a; Klein & Cruz-Uribe 1984; GA pers. obs.). Mammalian predators and scavengers, including domestic dogs, may also cause secondary damage to, or add and remove bones left by people and other predators, thereby causing some elements to be over- or under-represented (Binford & Bertram 1977; Klein & Cruz-Uribe 1989). The eagles, particularly the black eagle, nest on ledges, which may coincidentally be located above caves (Brain 1981; Avery 1984b, 1987a), and the Cape eagle owl roosts and nests in caves (Steyn 1982). Observations on the composition of samples collected by these predators are presented for comparison with the archaeological samples. In addition remains of these predators and other species such as speckled rock pigeon, alpine swift, rock martin and redwinged starling, which utilize ledges for roosting and breeding (e.g. Brooke 1981a), may become incorporated in cave deposits through natural mortality. There is no reason, however, why Late Stone Age people, or other predators, could not have used such carcasses if they came upon them.

These problems do not necessarily affect the evidence for palaeoenvironments, provided that there is some control over selective biases they might introduce, but it is essential to exclude other agencies of bone accumulation if meaningful information on human activity is to be obtained.

### Natural mortality

It is not normally possible to isolate the cause of death of beached seabirds which could result from a combination of factors (Crawford *et al.* 1980; Ryan *et al.* 1989), leading ultimately to their becoming available as food. It is clear from the beach surveys, however, that many of the birds found are emaciated and have low body-fat reserves, although the degree to which this is as an indirect result of other causes is not known. It appears that stress, often seasonal and particularly on breeding adults and juveniles, when insufficient food is available, is the most important cause of mortality in colonial species (Crawford *et al.* 1980). In the Peruvian region significant fluctuations in population size of guano-producing birds (guanay cormorant) resulting from alternating periods of high mortality and rapid population recovery, are seen to be responses to widely fluctuating availability of food caused by El Nino events of the Southern Oscillation (Duffy 1980).

In addition, Cox (1976) established that pelagic birds trapped in the lee of strong winds are highly susceptible to death through exhaustion. Physical accident and poison are probably minor factors, unlikely to have a major impact on samples. The incidence of botulism, which affects avian groups like ducks and gulls as seasonal pans dry, up may be worth investigating.

Under most circumstances it can be assumed that mammals originated reasonably close to the site of accumulation and thus represent local conditions. Seabirds, on the other hand, are buoyant, and could theoretically float for long periods and be transported naturally over considerable distances. Cox (1976) noted, however, that floating bird carcasses are consumed or sink within two days as a result of predation by copepods which suggests that those found on the beach probably died in the vicinity.

### Age classes

It is well established that mortality of different age classes differs (Ashmole 1971; Lack 1954). Bones of most birds grow to adult size while the bird is still in the nestling stage, however, and are virtually completely ossified at or soon after the time the bird fledges. This reduces the potential for distortion of the sample that could be caused by the fact that incompletely ossified bones are not very durable and may therefore be under-represented. On the other hand, there is differential likelihood of the very young of various species being included in the samples. Most of the resident South African seabirds breed on inaccessible islands and stacks (Maclean 1985) and are not readily available in large numbers. In birds such as ostriches, francolins, and cranes, bustards and korhaans, which have precocious young, the young are free-ranging during this period of osteological development and may be more readily taken by terrestrial predators.

### Physical damage

Before burial the sample available for preservation is further reduced by exposure to climatic effects and trampling, which cause cracking and breakage of bones of medium-sized animals in particular (Clark *et al.* 1967; Andrews & Cook 1985). Fortunately, most of the material to be discussed is unlikely to have been exposed for too long as shell middens and their sedimentary matrix appear to accumulate rapidly (D.M. Avery 1982). Trampling does not seem to have been a major problem, although bones are damaged by this and/or compaction in some instances. Processing of bird carcasses during preparation and eating seems to have been limited to disarticulation rather than destructive activities such as the breakage

involved in the extraction of marrow from mammal bones (Binford 1981). Fire also weakens the structure of bones, resulting in increased fragmentation.

### Scavenging

Scavenging from kills of higher predators has been suggested as a mechanism for the acquisition by people of parts of larger mammals (Binford 1984), although this is presumably not likely to occur with smaller mammals or birds. Conversely, the effect of scavengers removing remnants and causing some components to be under-represented is also a consideration. The introduction of domestic dogs to southern Africa some 2000 years ago probably raised the level of scavenging and removal of bone from accumulations; this influence should be recognisable by an increase in damage to bones in the samples (Avery 1984b, 1987a). Klein & Cruz-Urbe (1989) have demonstrated this effect on seal bones.

## FOSSIL ASSEMBLAGES

### Taphic factors

Taphic or burial factors relate specifically to processes which affect the nature of the final assemblage that is fossilized. Variable reaction to such factors further skews the structure of the sample.

In middens accumulation can be assumed to have been fairly rapid. This, and the fact that concentrations of shell create a relatively stable environment which is resistant to erosion and the effects of acidic groundwater, thereby reducing the destruction of fragile bones, helps to instill confidence that, at least in the more recent deposits, very little additional distortion of the assemblage has occurred at

this stage. Should, however, the contents of a midden be exposed through erosion, the weathering effects of climatic conditions and salt in the atmosphere and sediments would lead to rapid disintegration of bone. Older deposits do, however, show varying degrees of preservation. In the Middle Stone Age levels at Eland's Bay and Nelson Bay Caves leaching has removed the organic content totally, leaving a lag of stone artefacts. At Die Kelders, on the other hand, bone is well preserved in the Middle Stone Age levels. Klein (1972a) and Butzer (1973) noted that shell in the lower Later Stone Age levels at Nelson Bay Cave had been removed through decalcification, but that bone was relatively well preserved.

Post-depositional action of roots and burrowing animals was probably minimal in most cases, exceptions being some bones from open station sites such as Paternoster, Duiker Eiland and Stofbergfontein (Avery & Underhill 1986). At these sites, apart from cracking caused by weathering of bones exposed on the surface, furrowing caused by rootlets is common and severe acid attack on bones, often associated with root material, suggests that some bones might have disappeared. Burrows, presumably of dune molerats, occur in open (Avery 1976; Noli 1988) and cave sediments (Schweitzer 1979) and it has been suggested that black-backed jackals were responsible for burrowing disturbance in certain Eland's Bay Cave layers (Parkington 1981). The problem seems to be minimal in most caves and care normally taken during excavation to separate burrow fills will have helped the effects of redistribution to be recognized.

### Size factors

Some species, particularly small types, may be under-represented as they decompose relatively faster, are difficult to find or were not sought after. On the other hand,

the occurrence of an individual of a rare species, may result in its being over-represented in a small sample.

Body size, which relates to bone size, often determines whether the bones of certain species will be preserved in fossil accumulations. The structure and durability of bones and the age at death of the individual determine the extent to which *post mortem* factors (see below) can affect the degree to which a bone is likely to be preserved (Brain 1981; Klein 1981a; Behrensmeyer & Hill 1981). It must, however, be noted that the bones of very small animals such as those in owl accumulations are often remarkably well preserved (e.g. Brain 1981; D.M. Avery 1982).

#### AVAILABLE COLLECTION

##### Collecting and processing strategies

Subsequent collecting and processing factors are liable to reduce the fossil assemblage even further. Excavation and sampling strategy and the methods and detail of recovery and recording vary, as does the consistency and competence with which small components, in particular, are recovered during sorting in the field or in the laboratory. This determines the nature and reliability of the sample that is available for study, and deficiencies cannot be rectified thereafter.

Material to be used in this study was recovered from 3 mm screens. Subject to the competence of sorters, it can reasonably be assumed, therefore, that virtually all identifiable bones were recovered. Body-part representation, particularly of smaller elements like phalanges and digits, is also likely to have been biased by the variable abilities of sorters. In spite of these qualifications, minimum numbers of

individuals determined are thought likely to represent reasonable estimates of sample composition at least.

#### ARCHAEOLOGICAL SAMPLES

Samples of avian remains from three important coastal archaeological cave sequences, covering parts of the Upper Pleistocene and Holocene, will be examined. These are from 13 600 B.P. to about 300 B.P. at Eland's Bay Cave (Parkington 1980, 1981), approximately 80 000 B.P. to 1500 B.P. at Die Kelders Cave 1 (Tankard & Schweitzer 1976; Schweitzer 1979) and 18 000 B.P. to 300 B.P. at Nelson Bay Cave (Klein 1972a, 1972b; J. Deacon 1978; Inskeep 1987). These sequences include substantial depositional hiatuses, however, and the period represented by accumulation is not the same at every site. In fact, the impression that cave stratigraphy represents continuous long-term use or deposition belies its complexity (Binford 1968; Schiffer 1972). As well as containing the aggregated remains of complex human activity and interaction, most 'sequences' are broken by intervals during which there was no occupation. These hiatuses range from very short periods to several thousands of years (Klein 1972a, 1972b; Tankard & Schweitzer 1976; Parkington 1981). For instance, the period during the Last Glacial between about 40 000 and 16 000 B.P. is normally not represented in coastal deposits due to the fact that sea level was as much as 120 m lower than at present. As a result the coast was located at distances of up to 80 km from its present position and coastal sites of that period would now be inundated (Dingle & Rogers 1972; Klein 1972a; Tankard & Schweitzer 1976; Parkington 1981). There is also stratigraphic evidence that people cleared out or modified earlier deposits thereby removing or redistributing them (e.g. Schweitzer 1979; Parkington 1981; Robey 1987).

On a finer scale we have no accurate means of determining the time intervals between individual episodes of occupation, deposition of the death assemblage (or food debris) and sedimentation. Furthermore, as will be discussed below, our ability to distinguish short-term depositional increments during excavation of shell middens is also limited. In most cases, therefore, excavated stratigraphic units are the cumulative results of multiple increments over shorter or longer intervals. Individual samples, then, are in some way similar to long-term means, sometimes covering many years, but without the implied time control over short-term fluctuations. It must also be accepted, however, that some units will indeed represent short-term conditions, and might appear as 'anomalies' in the overall pattern. For this reason it is essential to have an idea of the nature and extent of short- and long-term variability in modern seabirds.

Cave and open-site deposits may, when viewed separately, yield evidence which represents only a part of typical everyday life. Each may sometimes be used for specific purposes or under certain conditions and the period of use may vary. Stratigraphic subdivisions in shell-midden accumulations often appear to be relatively thick and well-defined. In discussing the process of midden accumulation, various authors have, however, commented on the difficulty of recognising single-episode depositional units, which may have been added to on the surface or laterally, and also of distinguishing between areas in which debris was disposed of (middens) and those on which people lived (Klein 1972a; Schiffer 1972; Avery 1974, 1976; Parkington 1981; Schweitzer & Wilson 1982; Inskeep 1987). Recognizable stratigraphy may therefore represent 'homogenized' units of far more complex short-term depositional entities which are no longer recognizable because of the smoothing effect of mixing. It may be virtually impossible, particularly in caves where activities are concentrated over a restricted area, to sample short-term periods of human occupation and absence of variable length, which may have been

more typical of site use. Furthermore, radiocarbon dating is equally unlikely to provide a means of separating closely spaced occupations because standard error margins, even on very good samples, are still of the order of three or four decades rather than of individual years, months or even days required to resolve the scale of human activity in current hypotheses.

We have, therefore, to consider what 'homogenized' accumulations will mean in terms of short-term predator or human activity. If they are a palimpsest of different activities over time little can be deduced about everyday activities or strategies. Even thin, vertically and horizontally prescribed units may represent the accumulation of more than one set of activities/strategies; combination of excavated units to increase sample size, although often archaeologically expedient or even justifiable in instances, merely exacerbates the problem. Over the long-term, distinct, highly seasonal but temporally variable activities, which individually monitor a range of annual variation, may be combined to incorporate a greater suite of species and age classes; analysis of such a collected sample would yield a more general result, which covered the whole period, than analyses based on smaller stratigraphic units (Avery & Underhill 1986), or even single episodes if they could be recognized. The danger that interpretations may be based on the cumulative availability of birds throughout the year rather than on real, possibly seasonal short-term human activity should therefore be carefully weighed.

The best solution open to archaeologists is to excavate the smallest possible stratigraphic units over as large an area as possible. Inskeep (1987) is an example of the degree to which obvious stratigraphic divisions can be further subdivided on the basis of textural and depositional features and used in later analyses. The small numbers of individuals that can be determined from smaller units, usually with limited horizontal extent as well, means that sample size is an important limiting factor in the reliability of such results. This disadvantage is offset by the increased

likelihood that results will be a more realistic approximation of actual activities/strategies over shorter periods e.g. months and, most importantly, that individual units can still be combined in order to increase sample size for second tier analysis and assessment.

#### IDENTIFICATION OF SPECIES AND AGE DETERMINATION

Although species determinations can often be made on relatively small fragments of bone, some bones are more difficult to identify than others. The problem of extinct species does not arise in this study, but the identification of congeneric species within the francolins, ducks and cranes, for instance, can be difficult. It is, however, important that correct identifications be made because misidentifications or confusion of closely related, but ecologically distinct species, will influence both ecological and palaeoecological determinations.

Archaeologists have used age criteria based on dentition (e.g. Klein & Cruz-Uribe 1984; Payne 1973) and other cranial and postcranial features (e.g. Boessneck & Von den Driesch 1979) to establish age profiles of ungulates represented in their samples. In birds, however, rapid completion of ossification reduces the potential for identifying young individuals to a very short period after fledging. This reduces the potential not only for studies of age profiles but also for accurate determination of the likely period of acquisition, unless obvious instances of incompletely ossified bone occur in samples (Avery & Underhill 1986).

#### COMPARATIVE DATA SETS

It has been noted that modern comparative studies can help in the interpretation of past situations for which there are no records beyond the results of analyses on

recovered samples. The question of how representative modern collections are of natural conditions prior to recent human-induced changes to environments, and the density and distribution of species, should be addressed. It is known or strongly suspected, for example, that farming from the introduction of pastoralism 2000 years ago, the introduction of alien plants and animals, veld burning, hunting and over-fishing have influenced the nature of our biota (Brooke *et al.* 1986; Cooper & Brooke 1986; J. Deacon 1986; Macdonald & Richardson 1986; Berruti 1989; Randall 1989; Ryan & Rose 1989; Ryan *et al.* in press). Provided that such problems are taken into consideration in determining collection strategies, it should be possible to be reasonably certain that we have the best possible approximation to natural habitats and that comparisons within certain limits are acceptable. The greater difficulty may be to set limits to the level of interpretation that can reasonably be made from archaeological samples, given the discrepancy between the low temporal resolution of such samples and the natural short- and even long-term physical and biological fluctuations that will have affected their composition.

#### SUMMARY

Technically, although archaeologists select deposits for excavation that they believe were formed by the debris of human activity, other agencies may have been responsible for the accumulation of bones. Should this indeed be the case, interpretations of human activity are likely to be biased or incorrect. To obviate this problem as far as possible observations on modern assemblages of bones left by known mammalian and avian predator/scavengers and on the occurrence of beached seabirds are necessary. This will provide primary comparative observations with which to assess the origins and biological context of samples. Such a body of information should provide criteria for the recognition of the contribution of other

agencies to excavated assemblages. These observations should also enable us to assess the degree of bias introduced by acquisition and feeding strategies, including human selection.

Once this level has been reached, a study of avian remains from archaeological sites should contribute to our knowledge of prehistoric methods of acquisition and the role of birds in coastal subsistence strategies. It should also be possible to investigate whether changes in composition and species proportions reflect changes in acquisition strategy in response to factors such as technological or social development or environmental change.

Following from this, it should also be possible to determine whether a sample is likely to reflect accurately the composition of avian communities/populations living at the time of acquisition. Once biases, such as prey selection and seasonal acquisition, that affect the preserved composition of bone assemblages, can effectively be ruled out or recognized and accounted for, changes in species composition and proportions in archaeological assemblages can be assumed to reflect the natural fluctuations of avian populations in response to changing physical and biological environmental conditions. Evidence from such changes over time can thus be used to deduce information concerning the nature and timing of environmental change.

Finally, the fossil history of birds in southern Africa is not well known (Clancey 1980; Clancey *et al.* 1987). This study will therefore add a new and important perspective to records on the species and the past nature and history of avian populations/communities.

**Table 2.1.** Summary of stages of abstraction and factors that influence the relationship between the Life Assemblage and the collected sample (after Clarke et al. 1967).

ASSEMBLAGE	FACTORS AFFECTING ASSEMBLAGE	BIAS EFFECT
LIFE	habitat type species density and range seasonal availability	differential availability
DEATH	predator and prey size preferential predation susceptibility to disease predator damage susceptibility to damage scavenging butchery post-mortem transportation	differential inclusion
FOSSIL	sediment type groundwater action chemical damage root action burrowing erosion	differential preservation
COLLECTED	recovery methods personel abilities identification methods recording procedures	differential recovery

### 3. OBSERVATIONS FROM BEACH SURVEYS

#### INTRODUCTION

A major problem in the reconstruction of past human life is the fact that we can never be sure of the exact nature of the conditions under which people lived or the manner in which they chose to exploit the various resources or the land available to them. Avery (1977b) presented evidence that the major source of seabirds used by coastal people was carcasses of birds washed up on beaches either dying or dead. Assuming that the menu of beached bird species has remained constant, a study of present beached birds would therefore provide a sound basis for testing this proposition and reconstructing patterns of avian exploitation in the past. Birds are a relatively unimportant dietary component of archaeological assemblages (Buchanan 1987), reflecting the sparse availability of beached birds, including otherwise inaccessible species such as albatrosses, petrels, shearwaters and Cape gannets, rather than numbers of live birds. Furthermore, if people were collecting beached seabirds as they came across them, the fact that seabird mortality is related to physical and biological conditions of the marine environment will provide an empirical interface between the people and palaeoenvironments. Although European visitors commented on the disagreeability of the flavour of some seabirds, this is less likely to have been a factor amongst prehistoric people familiar with local resources. If it can be shown that selection by people was not an important factor in the accumulation of bird remains, archaeological samples can be taken to represent natural populations closely. This would further strengthen reconstructions of both human activity and palaeoenvironments.

Available information on the nature of seabird populations and their inter-relationship with their physical and biological environments has been collected

subsequent to large-scale human intervention associated with economic development. This may place limitations on them as comparative baselines from which to deduce past conditions. Most of the species found in archaeological samples still occur naturally in the western Cape, however, and it is possible to acquire quantitative data in spite of the fact that recent human activities, such as the exploitation of birds' eggs and pelagic fish stocks, have caused seabird populations to drop (e.g. Crawford & Shelton 1981; Shelton *et al.* 1984). When comparing beach survey data with archaeological samples, it must be borne in mind that overall numbers of resident breeding seabirds have dropped significantly (over 60% since 1956 in the case of jackass penguins) as a result of commercial exploitation of eggs, guano deposits and fish (Berruti 1989; Randall 1989). Oil pollution, which can result in mass mortality of seabirds (e.g. Morant *et al.* 1981), is generally not a serious factor, except in the case of severe spills, and can be taken into account.

Most of the above limitations can be accounted for and should, in any event, be borne in mind when comparisons with older samples are made, together with the fact that seabird populations may also change in response to natural factors. It was decided, therefore, that monthly surveys would provide the most appropriate potential for testing the assumption that beached seabirds were exploited by pre-historic people. At the same time it would be possible to examine various key questions. For example, is the mortality (as reflected by beaching) of various species indicative of their relative abundance, is mortality seasonal, does long-term variation in mortality exist and how may seabird mortality be related to environmental conditions at local and regional levels? Species which are discussed and brief summaries of background information are listed in Table 3.1.

## BEACH SURVEYS

Surveys of beached seabirds are conducted in a number of other countries in the world (e.g. Ainley *et al.* 1980; Powlesland 1989, and references). They have covered vast distances of coastline, but lack an essential ingredient, however, as they have not necessarily been conducted over the same stretch of beach every month. This is the first occasion that results of beach surveys have been applied to an archaeological problem.

Monthly surveys of a number of stretches of beach on the west, southwest, southeast Cape and Natal coasts have been conducted since 1977 (Cooper 1978; Avery 1979, 1980a, 1981a, 1982, 1984a, 1985a, 1989; Figure 3.1; Table 3.2). Results from four regions can therefore be compared. This enables regional comparisons and the comparison of archaeological observation with the most appropriate beach survey results.

The aim has been to determine the existence and extent of seasonality in the natural mortality of seabirds and the relationship between proportions of beached species and living populations of seabirds. Nothing was known of the range of natural interannual and monthly variation in frequencies of beached seabirds. It was therefore important to conduct the observations for as long as possible in order to observe natural cycles of various kinds and make the results more comparable with the long-term nature of archaeological evidence.

Surveys were conducted according to guidelines given in Cooper (1977). Observations were made, on foot or from a slow-moving vehicle, at monthly intervals along the same length of beach over as long a period of years as possible. After recording, carcasses were removed from the beach to prevent duplication in subsequent months. Information was collected in categories compatible with the archaeological record. Birds were identified to species, and were classed as nest-

lings, juveniles (very recently fledged), immature/sub-adult (slightly older, but not in adult plumage) or adults. Because immature birds cannot be recognized osteologically, this category is combined with adults for comparison with archaeological material. Birds of indeterminate age are included in samples in which age classes have been combined.

Predation by modern fishermen of birds at sea, which leaves characteristically broken humeri and skins with cut tarsometatarsi after butchery, is responsible for the deaths of a proportion of albatrosses, petrels and shearwaters and, to a lesser extent, Cape gannets found on surveys. Such individuals are readily recognized and have been excluded from this analysis.

Observations from the surveys were subjected to correspondence analysis in order to establish the existence of any patterning in the monthly occurrence of species and age classes. Results were used to characterize assemblages that might be expected at different times of the year. Avery & Underhill (1986) conducted a successful pilot study based on results from the first six years of west coast surveys. Correspondence analysis (Greenacre & Underhill 1982; Greenacre 1984, 1986; Underhill & Peisach 1985; Avery & Underhill 1986) was used to produce a simultaneous graphical display of both the rows and columns of the contingency table formed by the number of beached seabirds of each species in each month. It considers the data as two multi-dimensional clouds of points, one representing the rows (species), the other the columns (months), and finds the 'best' projection into a low-dimensional space - for the purposes of this study, a two-dimensional plot has been adequate.

Months with similar 'profiles' of species are plotted close together, as are species with similar profiles over the months. The separation between two months or between two species is an approximation to the "chi-squared distance" (Greenacre 1984; Underhill & Peisach 1985) between the species or months. It is

important to note, however, that in correspondence analysis no significance may be attached to the distance between a month and a species. The joint display of months and species is justified by the transition formulae (Greenacre 1984; Underhill & Peisach 1985) which express the relationship between the co-ordinates for the months and the co-ordinates for the species. The effect of the transition formula for expressing the species co-ordinates is to attract the species away from the origin in the direction of those months in which they are beached most frequently and to repel them away from the origin in the opposite direction from months in which they are rarely or never beached. Species beached throughout the year are attracted towards all months, and their resultant position in the correspondence analysis is close to the origin. Species which are poorly represented in two dimensions also tend to be displayed nearer to the origin of the two axes.

In addition, the transition formula which expresses month co-ordinates in terms of species co-ordinates may be used to plot the archaeological data as supplementary (illustrative) points which do not affect the active components of the analysis (Greenacre 1984; Underhill & Peisach 1985; Avery & Underhill 1986). The species profile of the archaeological sample then determines its position amongst the months. This provides an objective method of determining to which months, if any, the archaeological samples are most similar. In addition, the effect on the analyses and plots of species, which may be overemphasized in the beach surveys as a result of recent human-induced population changes, can also be removed by treating them as inactive supplementary data points (Avery & Underhill 1986; Greenacre 1986).

Species recorded on less than two occasions were excluded from the correspondence analyses; it was found that there was no marked effect on results when three and five individuals were used as minima. Combined samples of different age

classes and indeterminate individuals of a species were plotted as supplementary points amongst the months and do not influence the analysis.

## RESULTS

### OCCURRENCE OF SPECIES AND AGE CLASSES IN BEACH SURVEY DATA

Figure 3.2 demonstrates the similarity between breeding-population estimates for the jackass penguin (Shelton *et al.* 1984), Cape gannet (Crawford *et al.* 1983), white-breasted cormorant (Brooke *et al.* 1982), Cape cormorant (Cooper *et al.* 1982), bank cormorant (Cooper 1981), crowned cormorant (Crawford *et al.* 1982) and kelp gull (Crawford *et al.* 1982), and the proportions of these species in the beached seabird samples. Kelp gulls are overrepresented in the west coast sample because a large number breed on nearby islands and feed and roost on Yzerfontein beach, thereby increasing the possibility that carcasses will be deposited on the beach. Apart from the local effect of kelp gulls, Figure 3.2 suggests very strongly that beached bird samples reflect natural systems.

The monthly incidence of all beached seabirds (Figure 3.3) shows a clear dichotomy between the austral summer and winter months, with 81% of west coast and 77% of southwest coast birds being recorded between October and April (Table 3.3). There is, however, a distinct seasonal shift eastward, with a drop during these months to only 42% on the southeast Cape coast and a mere 9% on the Natal coast. The same pattern was evident in the number of birds recorded per kilometre covered (Figure 3.3). Monthly densities ranged from 8.42 to 0.91 (annual mean 2.75) on the west coast, 1.59 to 0.33 (mean 0.74) on the southwest coast, 1.05 to 0.29 (annual mean 0.58) on the southeast Cape coast and 0.21 to 0.00 (annual mean 0.05) in Natal. The highest densities recorded so far were on Diaz Beach, adjacent to a

large colony of Cape cormorants which breed on the cliffs at Cape Point, with 90 birds per kilometre recorded in 1981 and 260 in 1987 when Cape cormorant mortality was exceptionally high on the west coast. Large numbers of carcasses are predictable under such circumstances at breeding colonies. Annual results varied, however, as is shown by the six-year range between 2.89 and 0.48 (annual mean 1.45) (Avery & Underhill 1986) and annual figures noted in reports on surveys (Cooper 1978; Avery 1979, 1980a, 1981a, 1982, 1984a, 1985a, 1989). Such phenomena represent elements of the natural distribution of seabirds around the coast and long-term fluctuations in their mortality.

The summer/winter dichotomy is also demonstrated to varying degrees at the species level (Figure 3.4 and 3.5). Small petrels such as the prions, with the exception of the broadbilled prion, occur strongly in winter, often as the result of 'wrecks' involving many birds (Batchelor 1981; Ryan *et al.* 1989). Sooty shearwaters, Cape cormorants and common and arctic terns occur in summer, the latter two peaking at the time they arrive after migrating from the Palaearctic. The August peak for the west coast represents a single wreck of 73 individuals and coincides with the early arrival date for the bulk of this species (McLachlan and Liversidge 1978). To a lesser degree, jackass penguins, Cape gannets, bank and crowned cormorants and kelp gulls tend to occur in summer and autumn months. Albatrosses (combined species), whitechinned petrels, whitebreasted cormorants and swift terns occur throughout the year. Small sample size is a problem with some less common species.

The mortality of different age classes does not necessarily coincide, particularly for seasonal breeders such as the Cape gannet (juveniles), Cape cormorant (all age classes), kelp gull and swift tern (juveniles and adults) (Figures 3.4 and 3.5). It is evident that there is a lag between adult mortality, presumably caused by food and other stress when birds are confined in their feeding range to the area around

colonies during brooding and raising of chicks, and that of nestlings (after incubation) and of juveniles, which peaks at fledging when young birds leave the nest and start to fend for themselves. Although only bones of nestlings and recently-fledged birds can be aged, this differentiation is important in the correspondence analysis to provide the maximum number of distinguishing parameters, particularly of species such as Cape cormorants which can be recorded at any time of the year. The introduction of age classes to analyses provides additional seasonally-specific variables and, therefore, greater seasonal resolution. On the other hand, while age classes of jackass penguins and bank and crowned cormorants, which breed over protracted periods are less-seasonal, juvenile jackass penguins do show a tendency to have peaks of summer mortality, and their presence with other species contributes to the distinguishing characteristics of the monthly 'profiles'. From this it follows that the minimum sample sizes, from both beach surveys and archaeological sites, must be large enough to be representative of species and age classes to yield useful results. Diversity of species is an important element, but large samples may obscure higher diversity which would be more characteristic of short-term assemblages, both modern and past. It is for this reason that the beach survey results can be analysed for patterns of short and long periods (within that sampled), and archaeological samples should be large enough to be representative of the shortest possible period (single depositional events) before combination of excavated units is contemplated.

Further support for the existence of seasonal mortality and the hypothesis that beach-survey samples reflect natural populations is provided by recoveries of dead birds from ringing programmes (T.B. Oatley, pers. comm.). Results of ringing programmes (SAFRING files) are given for jackass penguins, Cape gannets and Cape cormorants (Figure 3.6). Bearing in mind that these results are not subdivided regionally as are those in Figures 3.3 and 3.5, which are also heavily influenced by

winter species such as prions, particularly in the southeast Cape and east coast, the overall pattern for ring recoveries of all ages is very similar to that of the beach surveys (Figure 3.6a). The similarity is also apparent when the seasonal mortality of juvenile beached birds is compared with the monthly recovery of ringed first year birds (Figure 3.6b). Figure 3.6c illustrates that juvenile mortality of jackass penguins (85-89%), of Cape gannets (80-86%) and of Cape cormorants (64-75%) peaks within the first two to three months of ringing, after which it becomes negligible, although Cape cormorants, and to a lesser extent jackass penguins, have slight peaks at six and seven months respectively. This is important as it correlates closely with the period of peak mortality in beach survey results and, from the point of view of ageing archaeological material, coincides with the period in which incomplete ossification can be detected.

#### DAILY RATE OF BEACHING

Little information is available on the rate at which birds might be beached in any given area. Available observations suggest that the rate will be variable depending on local conditions of wind and current, the particular species available at a particular time, the proximity of a source, particularly of numbers of birds e.g. in the vicinity of a breeding colony, and its location in relation to the recovery site and prevailing transport agencies and the potential availability of a reasonable number of birds (Avery 1984). It can be expected, therefore, that density will vary from beach to beach and regionally, with distance from breeding sites.

During March 1982 and March 1984 G.D. Underhill patrolled the same stretch of beach in Saldanha Bay over 11 consecutive days, following the method described in Avery (1984a). In 1982, 73 individuals of eight species and two individuals of non-seabird species were recovered (Table 3.4). However, as noted

previously (Avery 1984), initial searches include birds washed ashore over a longer period and only after the first day or two can totals be taken as representing the daily accrual. Because visibility was obscured by wrack (washed up seaweed, etc.), results for the first two days of the 1982 set have been excluded from the calculations. This represents a total of 49 birds (67%), many of which would have been available for exploitation. Of a total of 24 birds over nine days, the daily record of newly-beached carcasses ranged between 7 and 0 (two days with zero) with a mean of 2.7 per day and a density of 0.9 birds per kilometre. In March 1984 60 seabirds of nine species and three individuals of two non-seabird species were recovered during daily patrols of the same area (Table 3.5). In this case the beach was clear of obscuring wrack and only the first day total of 34 birds (57%) was excluded, although the second may have included a small element missed the day before. The same stretch of beach yielded 26 birds over 10 days. The daily records ranged between 8 and 0 (two days with zero) with a mean of 2.6 per day and a density of 0.9 birds per kilometre. Although proportions of species varied, results in 1984 were very similar to those recorded in 1982. Relative proportions of adults and juveniles were recorded in 1984 only.

This section of beach lies in the path of the southeast winds which prevail in summer and this, together with the proximity of large breeding colonies of seabirds in Saldanha Bay, may account for both the consistency and relatively high density of beached birds. Bearing in mind that beached birds are not transported over great distances (Cox 1976), the low densities on the Skeleton Coast and Natal are therefore likely to reflect low densities of live birds since densities of beached birds are controlled by numbers of live birds in an area (Avery 1980a, 1981a, 1982). Overall densities for specific localities vary annually, but remain relatively low in spite of the effects of wrecks (Avery 1984a, 1985a; Ryan *et al.* 1989). It is predictable that the daily rate of beaching will correlate with density but that periods of higher mortality

of local species and wrecks of Southern Ocean species (albatrosses, petrels, including prions, and shearwaters) will increase the rate over the short term.

#### INTERANNUAL AND MONTHLY VARIATION

Avery (1988a) described considerable monthly variation in densities of jackass penguins, Cape gannets and Cape cormorants, the three most common species recovered on west coast, southwest coast and southeast Cape coast surveys. Monthly (Figure 3.7A-C) and interannual (Figure 3.8) variation existed for each species and between study areas.

Comparison with long-term monthly means showed variation in monthly frequencies of all individuals recovered which, particularly for Cape cormorants and Cape gannets, reflected the relatively consistent seasonal pattern outlined above (Figure 3.7A-C). Essentially it was numbers and proportions that changed. The picture is complicated, but not obscured, by interannual trends. Peaks in mortality are evident for some years, while others remain below the mean. The exceptionally high frequencies of Cape cormorants at Yzerfontein during the summer of 1986/87 raised the long-term mean, which had been 11.7 individuals per month between 1977 and 1985, to 35.5 for 1986 and 1987 and an overall mean of 22.3 between 1977 and 1987. The result is that, while longer-term variation is illustrated, the seasonal pattern that is otherwise evident in annual results is obscured (Figure 3.7A-C). At Cape Recife the high frequencies during the first three months surveyed had a similar effect although the annual pattern remains obvious. Fluctuations at the southwestern sites do not always coincide with those at Cape Recife.

Interannual patterns, given for adults only, show differences between species and sites, with trends towards higher or lower mortality leading to periodic switches from positive to negative values around the long-term mean (i.e greater or less than

the mean) (Figure 3.8). A particularly marked trend is illustrated in years preceding and succeeding the end of 1982 and beginning of 1983. The trend followed by jackass penguins at Yzerfontein varies inversely with those of Cape gannets and Cape cormorants, which are similar. At False Bay, the three species tend to covary. At Cape Recife jackass penguins and Cape gannets covary, and appear to follow a pattern similar to that of Cape gannets at Yzerfontein. There is a strong tendency, particularly after 1982, for trends of Cape gannets and Cape cormorants at Yzerfontein and Strandfontein to be inverse. Figure 3.9 illustrates the relative changes in the proportions of all jackass penguins, Cape gannets and Cape cormorants at Yzerfontein and overall numbers of birds per kilometre searched. Avery (1984a, fig. 2, 1989, fig. 2) illustrated changes in the relative proportions of the eight most common seabirds recorded between 1978 and 1988. Cape cormorants were always the most common species, but in no year was the contribution from these eight species less than 80% of the total, suggesting that the underlying pattern at the population level is robust.

Observations from Natal were collected over a total of only 28 months and, in spite of the fact that over 32 000 km were checked on routine patrols by Natal Parks Board officials during this period, numbers are too few (three jackass penguins, eight Cape gannets, three Cape cormorants) to warrant illustration. It is, nevertheless, clear that the Natal coast is very different from the other areas.

It has been shown that proportions of the common breeding seabirds recovered are similar to those of living populations, and may thus provide an index of their mortality in response to changing oceanic and climatic conditions (Avery 1985a, 1987a; Avery & Underhill 1986). The higher summer mortality of Cape gannets and Cape cormorants is related to food stress during their summer-breeding cycle and is strongly influenced by juvenile mortality, particularly of Cape gannets. Further distinction is possible when adults and juveniles are treated separately.

Differing local conditions, such as wind, orientation of the coast, locality of breeding populations and availability of food, could account for some variation between sites.

The 1982/83 change in values coincided with a strong Southern Oscillation (Avery 1985a), although it must be borne in mind that the changes evident in the beach survey results are not sudden, but the result of trends over more than a year.

Although Cape gannets switched from a negative to positive value at Yzerfontein, they were clearly not as severely affected as were Cape gannets in False Bay where the incidence of beaching was higher than had been previously recorded. Oatley & Ross (in prep.) demonstrate that the incidence of recoveries of juvenile Cape gannets ringed in Algoa Bay rose dramatically in 1983 when compared to results between 1982 and 1989. Oatley & Ross (in prep.) attribute the higher mortality of Algoa Bay Cape gannets to the fact that hake offal, which sustained west coast Cape gannets during the Southern Oscillation warm water event (Duffy *et al.* 1984), was not available when pelagic species were scarce. Cape gannets on the south and east coasts, particularly juveniles, experienced difficulty in finding food and, consequently, mortality rose (Oatley & Ross in prep.).

La Cock (1986) found that periodic high mortality of Cape cormorants tended to coincide with the year preceding a warm event rather than the year itself. An example of this is evident in the 1982 peak in mortality followed by lower figures in 1983 when the strong Southern Oscillation took place (Figure 3.8). The exceptional peak in mortality in 1986/87, followed by lower figures in 1988 and 1989, however, coincided with a local warm event in the Benguela region and not a world-wide oscillation, illustrating another finding of La Cock (1986) that, while there was some correlation with strong El Ninos in the Pacific, not all mass mortality events coincided with El Nino events.

Crawford *et al.* (1980) found that local food shortages that led adults to desert nests were the most important cause of mass mortality of juvenile Cape

cormorants, while heavy rainfall, disease and heavy seas were contributory factors. Fluctuations, particularly of Cape cormorants in the Benguela region, correlate strongly with local changes of mean sea temperatures (Benguela warm events having a notable impact) and with some trends in the recruitment and local availability of pilchard and anchovy on which they prey (Crawford & Shelton 1978, 1981; Crawford *et al.* 1980; Crawford *et al.* 1983; Shannon *et al.* 1984; Walker *et al.* 1984; Avery 1985a; Shannon and Taunton-Clark 1988; Hulley & Lutjeharms 1989; Shannon *et al.* 1989). The inverse responses of different species (Figure 3.9) probably relate to different foraging ranges and adaptability of the three species to changes in food availability (Duffy *et al.* 1984). The Benguela upwelling system is driven by prevailing summer southeasterly winds which cause nutrient-rich cold water to rise within the coastal region. The nutrients in turn drive phytoplankton productivity and the recruitment of pelagic fish which are essential for seabirds (Crawford 1987). Figure 3.10 illustrates the inverse relationship that exists between good easterly winds in the west coast region and upwelling which is signified by negative values around the long-term mean. Failure of the winds results in low productivity, low recruitment of fish and stress on breeding and newly-fledged seabirds, resulting in higher mortality which is monitored by the beach surveys.

The overall numbers of birds recovered are a reflection of local population numbers and the type of coast surveyed. This may be complicated further by patterns of dispersal (mainly juveniles and non-breeding birds) around the coast towards Natal where the absence of breeding populations is reflected in the extremely low incidence of beached individuals near the limits of their distributions.

## CORRESPONDENCE ANALYSIS OF BEACH SURVEY DATA

West coast

The combined plot of species and months for the first two principal axes of the analysis of combined west coast surveys accounts for 67% of the inertia (Figure 3.11). This is ten percent higher than the six-year result (Avery & Underhill 1986). Axis 1 (horizontal), which accounts for 48% of the total inertia, contrasts blue, pintado, softplumaged, Kerguelen and, to some extent, whitechinned petrels, prions and adult Cape gannets, which tend to occur in winter between June and August, against species occurring in other months. Axis 2, which accounts for a further 19% of the inertia, contrasts February, March and April against October, November and December. The months of January, May and September appear to be intermediate. In terms of the species, axis 2 contrasts Cape cormorants (nestlings and adults), kelp gulls (adults), sandwich terns (all ages), common terns (all ages) and Arctic terns (all ages), which tend to occur during the early summer months between October and December, with sooty shearwaters, Cape gannets (juveniles), Cape cormorants (juveniles) and kelp gulls (juveniles) which occur between February and April.

Analysis of the Yzerfontein sample alone shows a remarkable similarity with the result from combined samples (Figure 3.12). This is not surprising given the size and duration of that sample. When Yzerfontein is excluded from the analysis (Figure 3.13), the plot becomes more difficult to interpret in terms of months and birds, although the basic seasonal pattern remains. In order to check the possible effect on this analysis of all-year availability of common breeding species in the Lambert's Bay survey which was adjacent to the Bird Island breeding colonies, results for Eland's Bay and Koeberg only were analysed (Figure 3.14). Because of

small sample sizes, the distribution of species through the year is more erratic and the seasonal pattern, though clear, is more subject to random fluctuation.

A test of the analysis was run using the March observations given in Tables 3.4 and 3.5. Results were analysed as a supplementary column as will be done with archaeological samples, and their resultant position on the plot had no effect on the position of months and species (Point Sal.Bay on Figures 3.11 - 3.14). Their position on the plot correlates closely with the month in which the samples were collected and illustrates the efficiency of the analysis as a means by which the seasonal profile of a sample can be determined.

### Southwest coast

The combined plot of species and months for the first two principal axes accounts for 61% of the inertia (Figure 3.15). Results are similar to, but distinct from, those for the west coast. Axis 1, which accounts for 45% of the total inertia, contrasts blue, pintado, softplumaged and Kerguelen petrels and prions, which tend to occur in winter between July and September, against species occurring in other months. Axis 2, which accounts for a further 17% of the inertia, contrasts February, March, April and May against October, November and December. The months of January and June are intermediate. In terms of the species, axis 2 contrasts whitechinned petrels, adult Cape gannets, adult Cape cormorants and swift terns (all ages), which tend to occur during the early summer months between October and December, with sooty and Cory's shearwaters, Cape gannets (juveniles), Cape cormorants (juveniles), kelp gulls (juveniles) and Sabine's gulls, which occur between February and May. Jackass penguin (juveniles) and Hartlaub's gulls fall mainly between September and October, with Sandwich and common terns (all ages) and adult jackass penguins being associated with January.

If the False Bay results only are analysed (Figure 3.16), a very similar pattern is illustrated, again as the result of this being the major sample for the region.

### Southeast Cape coast

The combined plot of species and months for the first two principal axes accounts for 54% of the inertia<sup>1</sup> (Figure 3.17). This can be compared with results from Cape Recife (Figure 3.18), which is near to relatively large breeding colonies of jackass penguins and Cape gannets, and those from Port Alfred and Rockcliffe (Figure 3.19), which have different 'profiles'.

Axis 1 of the southeast Cape plot, which accounts for 31% of the total inertia, contrasts blue, softplumaged, Kerguelen and whitechinned petrels and prions, which tend to occur in winter between June and August, against species occurring in other months. Axis 2, which accounts for a further 23% of the inertia, contrasts March and April against October, November and December. The months of January and February, May and September are intermediate. In terms of the species, axis 2 contrasts swift and common terns (all ages), which tend to occur during the early summer months between October and December, with juvenile Cape gannets, which occur strongly between March and April. Jackass penguin (adults), sooty shearwaters and adult kelp gulls fall mainly around May, with juvenile jackass penguins, pintado petrels, slenderbilled prions and juvenile and adult Cape cormorants falling between August and September. Cory's shearwaters, adult Cape gannets, juvenile kelp gulls and arctic terns (all ages) are associated with January and February.

Onshore winds on the Cape Recife coast are from the direction of breeding colonies of jackass penguins, Cape gannets and Cape cormorants in Algoa Bay, whereas the combined Rockcliffe and Port Alfred samples are from open coasts. Cape Recife (Figure 3.18), which is the major long-term sample for the region,

illustrates a clearer seasonal pattern than the combined samples, although results are not different. On the other hand, the Port Alfred and Rockcliffe samples (Figure 3.19), which are small, are more complex and show marked differences in the seasonal occurrence of species such as common and arctic terns (CT, AT), although it cannot be ascertained whether this is real or an artefact of sampling due to small sample sizes.

### East coast (Natal)

The combined plot of species and months for the first two principal axes accounts for only 47% of the inertia. This is a reflection of the extremely low density of birds, with no birds recorded between January and March (months fall on origin) and virtually none from April to June and October to December (Figure 3.20A-C). Axis 1, which accounts for 27% of the inertia, contrasts those months in which almost no birds are recovered against July to September when most birds, specifically prions, are recovered. Axis 2, which accounts for 20% of the inertia, contrasts jackass penguins and prions occurring between July and September against species which occur at other times of the year.

In this analysis, in order to 'open' up the cluster of points near the origin, prions were treated as supplementary points in order to reduce their effect of forcing the months in which they occur well away from the origin. This was only partially successful, due to the general paucity of birds, and it must be accepted that, while the general pattern is likely to reflect local conditions on the east coast, interpretation in terms of archaeological samples would be difficult. As no such samples are available from this region it will not be necessary to use the east coast results further.

## SEASONAL PROFILES

West coast

The correspondence analysis demonstrates that the year can be split into three internally homogeneous periods: February-April, June-August, and October-December with January, May and September being transitional months falling intermediately.

Profiles of the proportions of the major groups of seabirds within the seasonal subdivisions determined by the correspondence analysis, together with data for each month and a control for the year's data combined, are given in Figure 3.21A-B.

Seasonal data for species occurring in the archaeological samples are summarized in Figure 3.5 and compared with periods during which breeding takes place (Figure 3.4). There is a clear relationship between peak adult, nestling and juvenile mortality in the case of species which breed seasonally along the west coast. Less-seasonally restricted breeders and those with more than one breeding peak during the year have a more complex pattern of mortality although this is often partly related to peaks in breeding. Any pattern for species breeding on sub-Antarctic islands is obscured to some extent by the presence throughout the year of non-breeding birds. While mortality of albatrosses appears to occur throughout the year, that of prions is highly seasonal and possibly related to weather conditions and the arrival of recently fledged birds from the south (Ryan *et al.* 1989). Age classes of albatrosses have not been separated in the analysis, but Ryan & Avery (1987) report on mortality of juvenile blackbrowed albatrosses during storm weather. Although some individuals overwinter in southern Africa (McLachlan & Liversidge 1978) the mortality of Palaearctic breeders such as the Sandwich tern and the common tern

occurs in early summer, when these species arrive in bulk from the Northern Hemisphere.

### Southwest coast

The correspondence analysis demonstrated that the year can be split into three internally homogeneous periods: February-May, July-September and October-December with January (although close to Feb-May) falling separately.

Much the same factors affect the mortality profiles (Figure 3.22A-B) although monthly groups and proportions are different. It must also be noted that this region is further away from breeding colonies on offshore islands and that, being a closed system, mortality of some species in False Bay, particularly albatrosses, petrels, shearwaters, is affected by the shore being in the line of strong southeasterly winds prevailing in summer (Cox 1976).

### Southeast Cape coast

Shorter periods of time and shorter distances are covered by the surveys. In general the most common species tend to be jackass penguins or Cape gannets. Cape cormorants, albatrosses, petrels, shearwaters and whitebreasted cormorants form a consistent proportion. It is noteworthy that Cape cormorants, which are good indicators of October to March/April exploitation on the west coast (Avery & Underhill 1986), are not as common and occur between August and September.

The correspondence analysis plot from birds collected on beach surveys in the southeast Cape demonstrates that the year can be divided into three periods: January to May, July to September and October to December, with June falling

separately. It is possible that January to March and April and May could be further split.

Again, much the same factors affect the mortality profiles (Figure 3.23A-B) although monthly groups and proportions are different. It must also be noted that this region includes breeding colonies on offshore islands in Algoa Bay. Furthermore, Algoa Bay is a closed system in the line of strong summer southeasterly winds; the mortality of species such as albatrosses, petrels and shearwaters, which can become trapped in bays during periods of persistently strong onshore winds and die of exhaustion (Cox 1976), is therefore relatively high.

Proportions of the major groups in each of these periods are given in Figure 3.23A-B. This shows that the January to May period is fairly homogeneous as far as seabird mortality is concerned. This period includes high proportions of jackass penguins and Cape gannets and gulls, while albatrosses, petrels, shearwaters and cormorants are low. June is characterized by low numbers of jackass penguins and higher numbers of Cape gannets and cormorants. The July to September period shows a change to even lower jackass penguin numbers and very few Cape gannets, while albatrosses, petrels, shearwaters and cormorants are high. During October to December overall proportions are similar, with albatrosses, petrels, shearwaters and cormorants relatively common.

## SUMMARY

Results of surveys for beached seabirds in three coastal regions in the Cape Province and one in Natal have been described and analysed in terms of how the samples resemble natural populations and illustrate natural fluctuations in the mortality of a wide variety of species over the very short-term (months) and longer-term (10 years). Observations do not yet cover longer periods, although even the

current span represents a unique baseline which has not been assembled as systematically elsewhere in the world.

At this stage, the amplitude of long-term variation in fluctuations of beached-seabird mortality shows that periodically it reaches very high peaks. In spite of this, the amplitude of the monthly variability remains strong enough to maintain its characteristics interannually. Results can therefore be examined at monthly, annual and long-term levels (periodic), although the latter is so far poorly covered. The importance of this is that it enables the investigation of causal factors which influence seabird mortality. In addition, it provides the opportunity to check whether the effects of anomalous global events such as strong Southern Oscillations or more local Benguela warm events can be recognized. This is relevant to the possibility of recognizing their effects in short-term archaeological depositional increments and making correct interpretations of avian mortality and human subsistence. From the palaeoecological point of view, it is essential to have an idea of the relative scale of anomalous changes over the short-term as opposed to the long-term in order to separate them from long-term shifts in response to changing sea levels and environments.

The first implication of this for people is the fact that the occurrence of beached seabirds is predictable even with the short-term fluctuations and this makes their utilization viable.

Assemblages drawn from beached seabirds closely resemble natural populations and regional differences can be explained in these terms.

The numbers of beached seabirds vary in response to physical and biological factors which are an integral part of the natural climate and environmental regime both on a very short-term and longer-term basis.

If it can be shown that people were exploiting beached birds in the past it will be possible to use the observations described in this chapter as a comparative base-

line with which to determine whether prehistoric people took seabirds seasonally and, if so, at what time of the year. It is also likely to be possible to relate changes through time of archaeological sample profiles to seabird populations responding to environmental change.

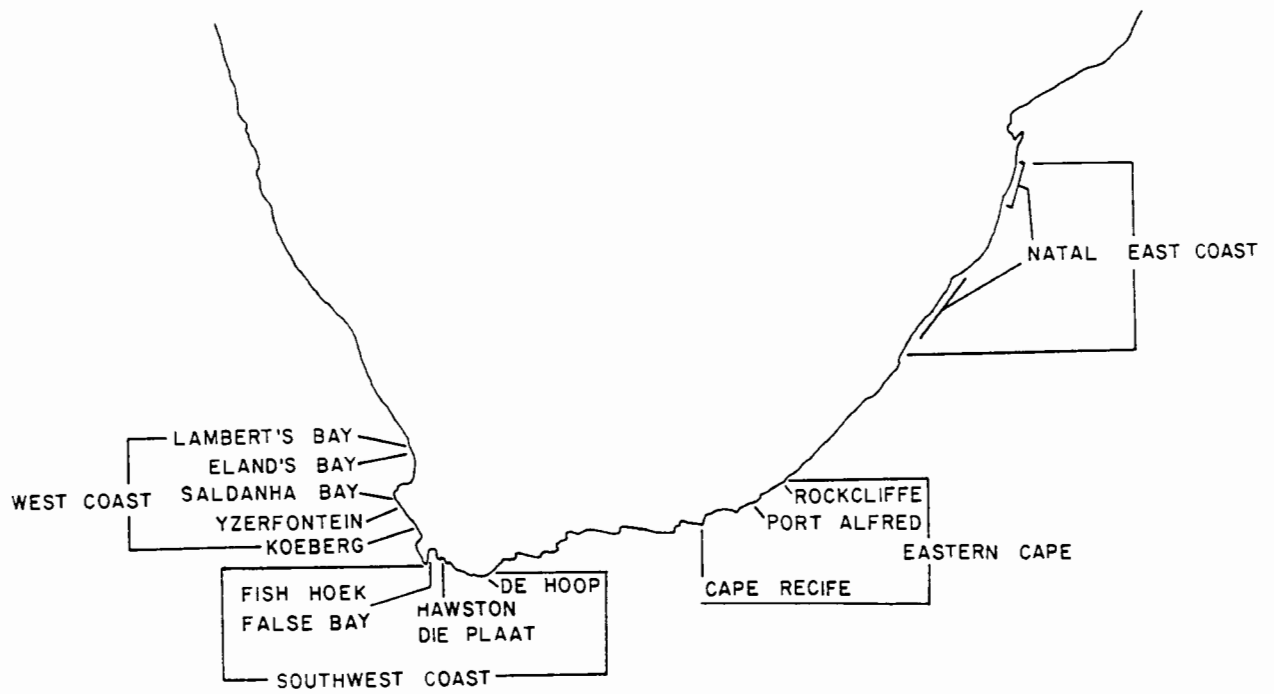


Figure 3.1. Location of beach survey areas within four coastal regions.

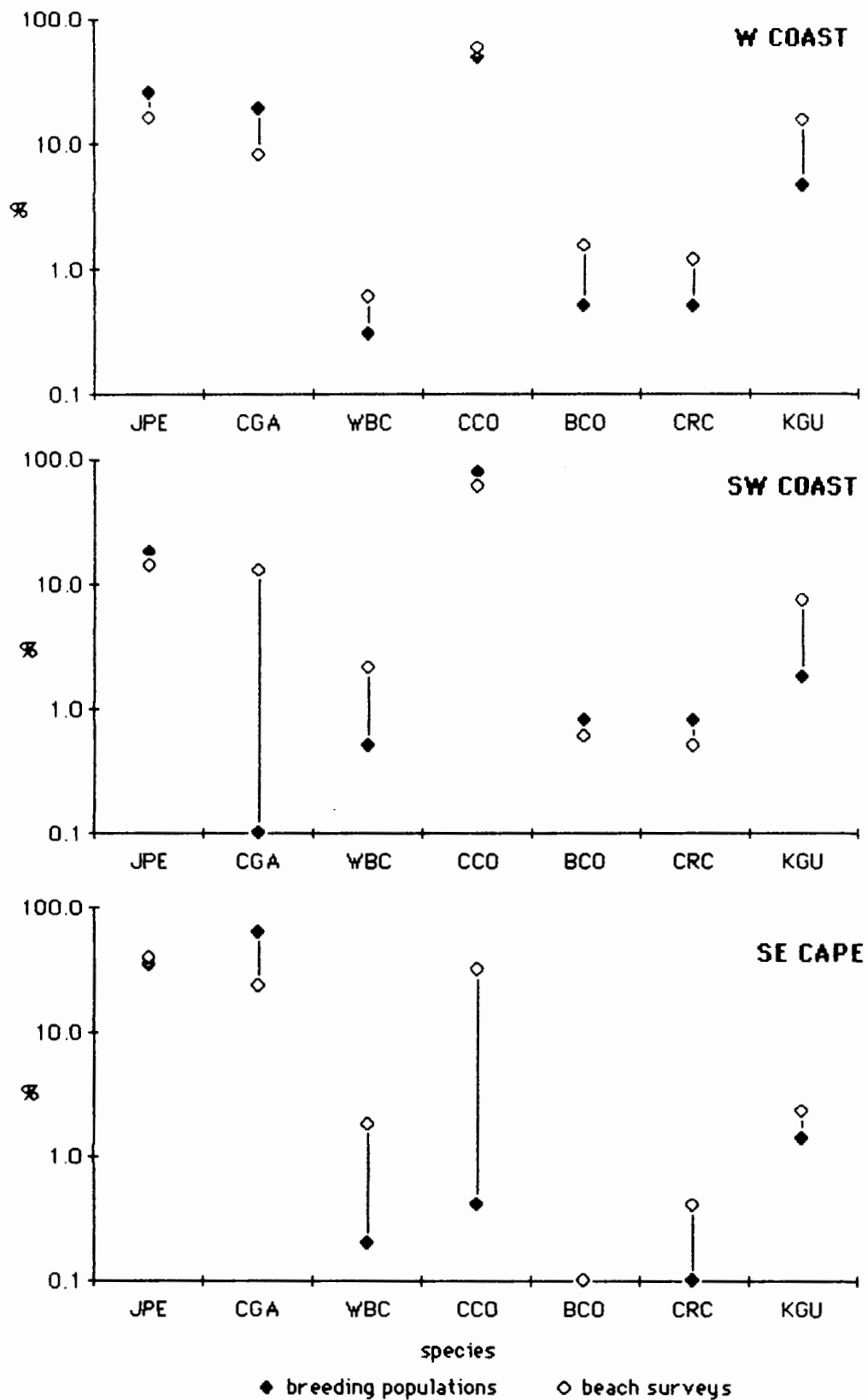


Figure 3.2. Comparison of relative proportions of common seabird breeding populations with beach survey data from the west and southwest coasts, and southeast Cape. JPE = jackass penguin, CGA = Cape gannet, WBC = whitebreasted cormorant, CCO = Cape cormorant, BCO = bank cormorant, CRC = crowned cormorant, KGU = kelp gull. Note semi-logarithmic scale.

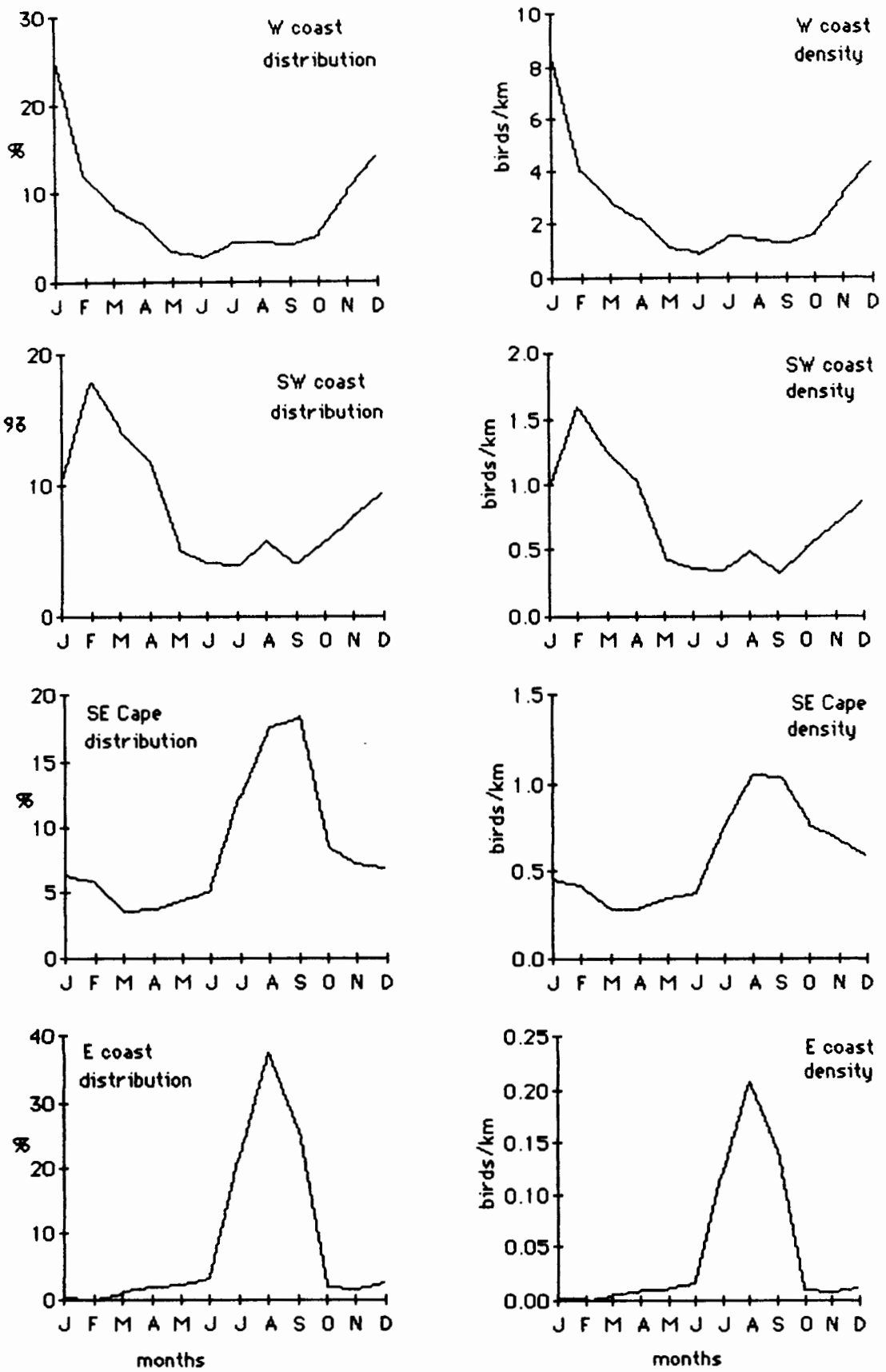


Figure 3.3. Monthly distribution (%) and density (birds/km) of seabirds recorded regionally on beach surveys. Note different vertical scales.

	BREEDING												REFERENCES (breeding)
	J	F	M	A	M	J	J	A	S	O	N	D	
J penguin	■	■	■	■	■	■	■	■	■	■	■	■	Cooper 1980
Albatrosses	■	■	■	■	■	■	■	■	■	■	■	■	Watson 1975
Prions	■	■	■	■	■	■	■	■	■	■	■	■	Watson 1975
Cape gannet	■	■	■	■	■	■	■	■	■	■	■	■	Maclean 1985
Wb cormorant	■	■	■	■	■	■	■	■	■	■	■	■	Brooke <i>et al.</i> 1982
Cape cormorant	■	■	■	■	■	■	■	■	■	■	■	■	Berry 1976
Bank cormorant	■	■	■	■	■	■	■	■	■	■	■	■	Maclean 1985
Cr cormorant	■	■	■	■	■	■	■	■	■	■	■	■	Crawford <i>et al.</i> 1982
B oystercatcher	■	■	■	■	■	■	■	■	■	■	■	■	Summers & Cooper 1977
Kelp gull	■	■	■	■	■	■	■	■	■	■	■	■	Crawford <i>et al.</i> 1982
Hartlaub's gull	■	■	■	■	■	■	■	■	■	■	■	■	Tuck & Heinzel 1979
Swift tern			■	■	■	■	■	■	■	■	■	■	Maclean 1985
Sandwich tern					■	■	■	■	■	■	■	■	Maclean 1985
Common tern					■	■	■	■	■	■	■	■	Maclean 1985

Figure 3.4. Breeding seasons of some seabirds commonly found during beach surveys.

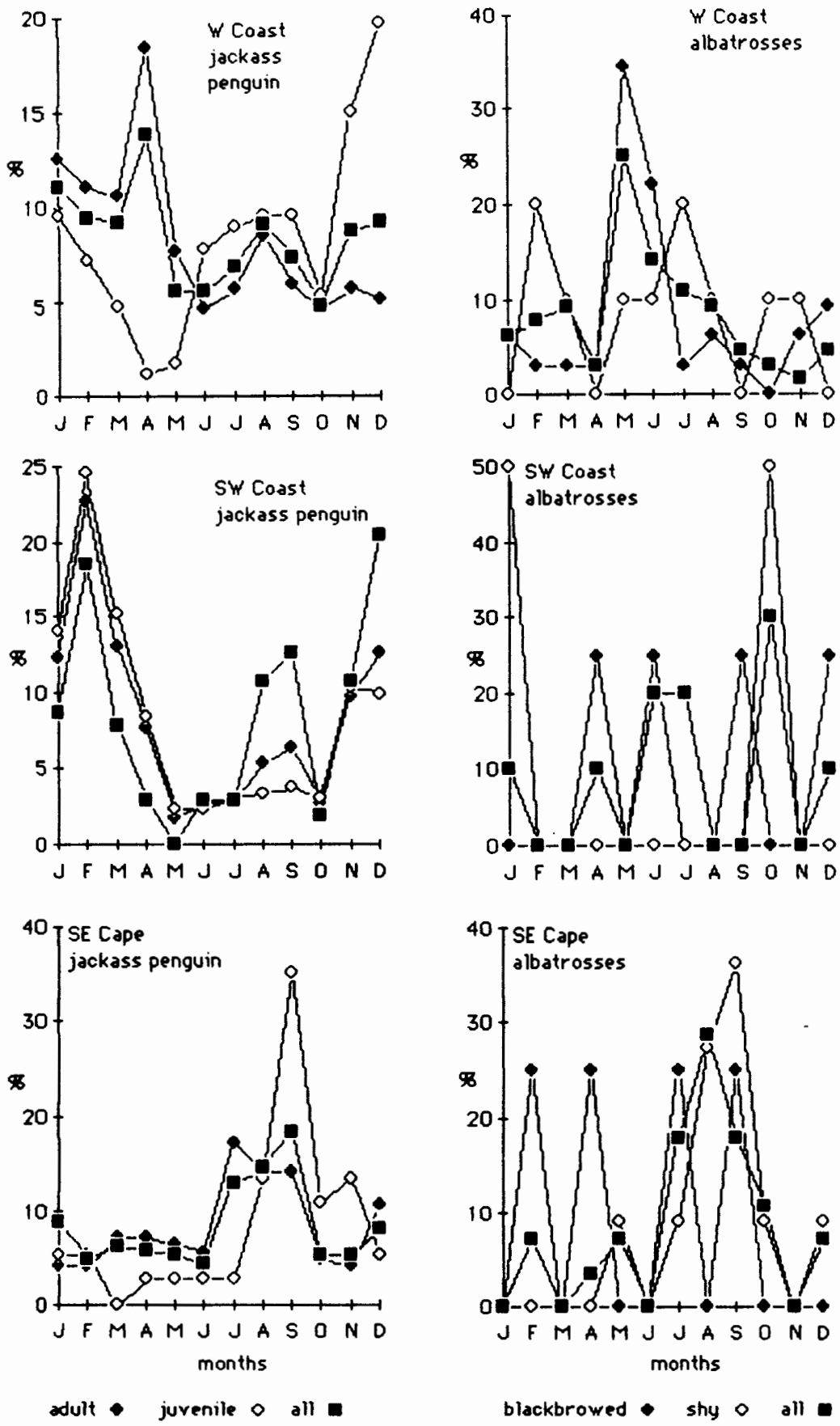


Figure 3.5 (part 1). See Figure 3.5 (part 5) for caption.

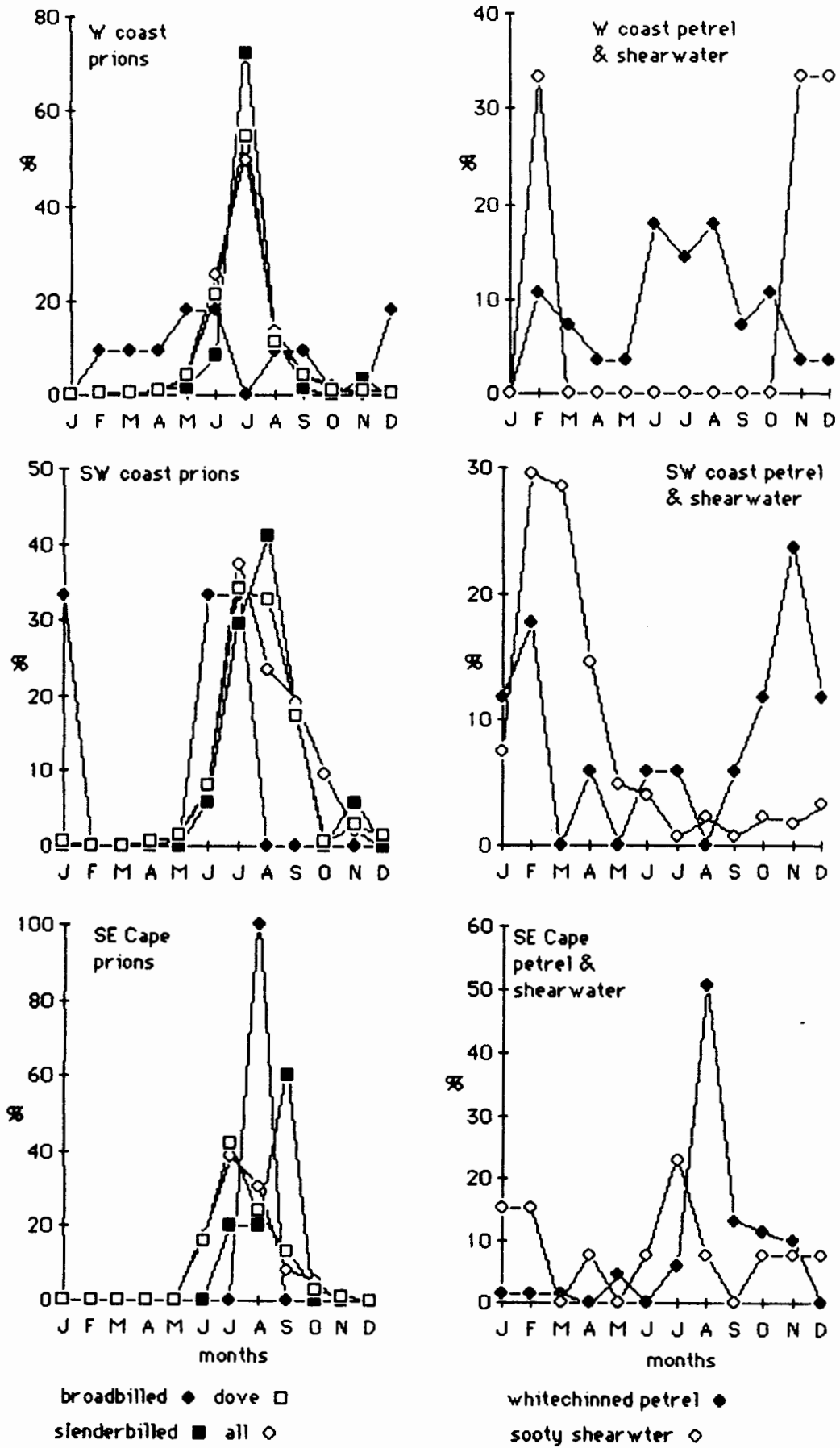


Figure 3.5 (part 2). See Figure 3.5 (part 5) for caption.

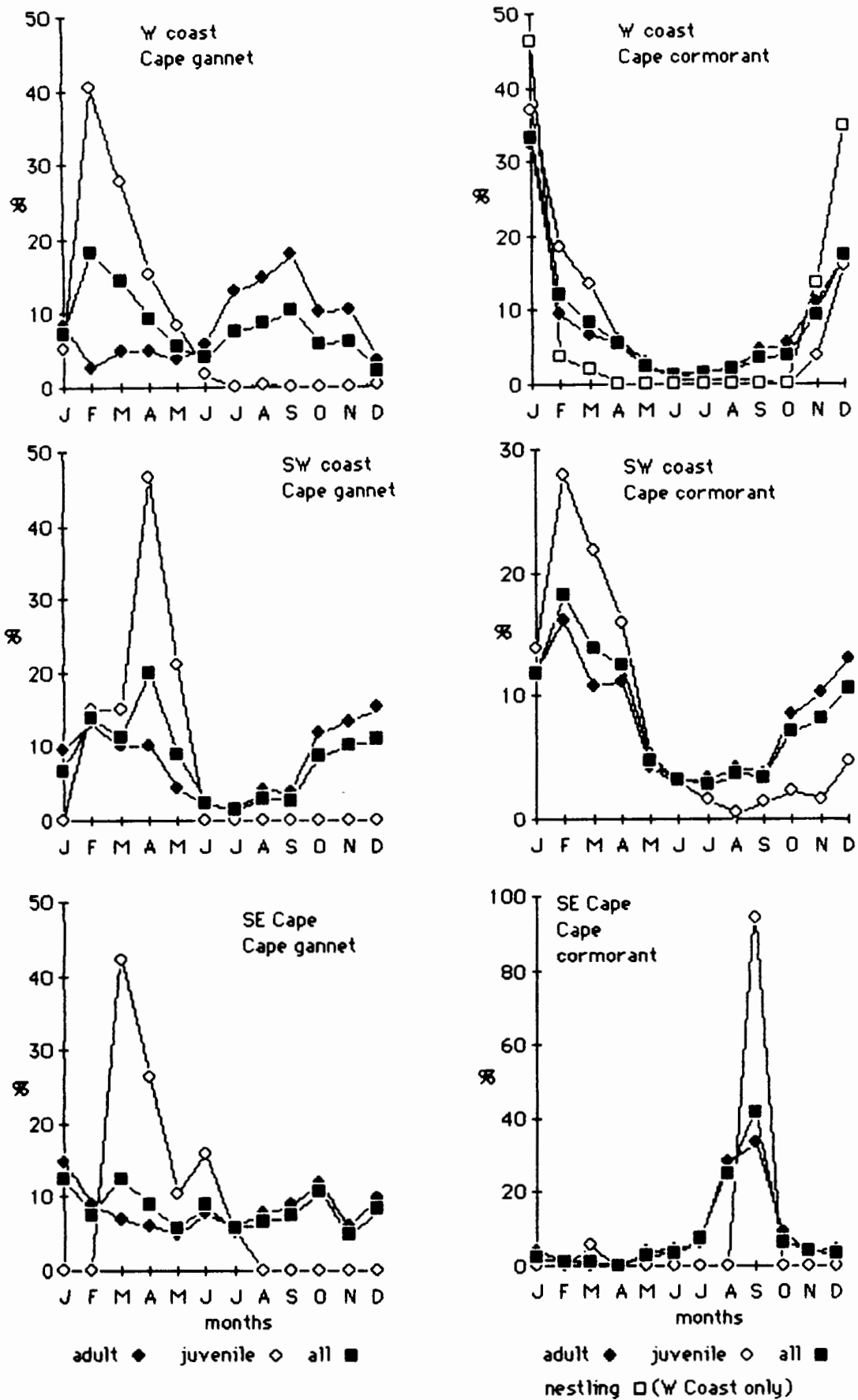


Figure 3.5 (part 3). See Figure 3.5 (part 5) for caption.

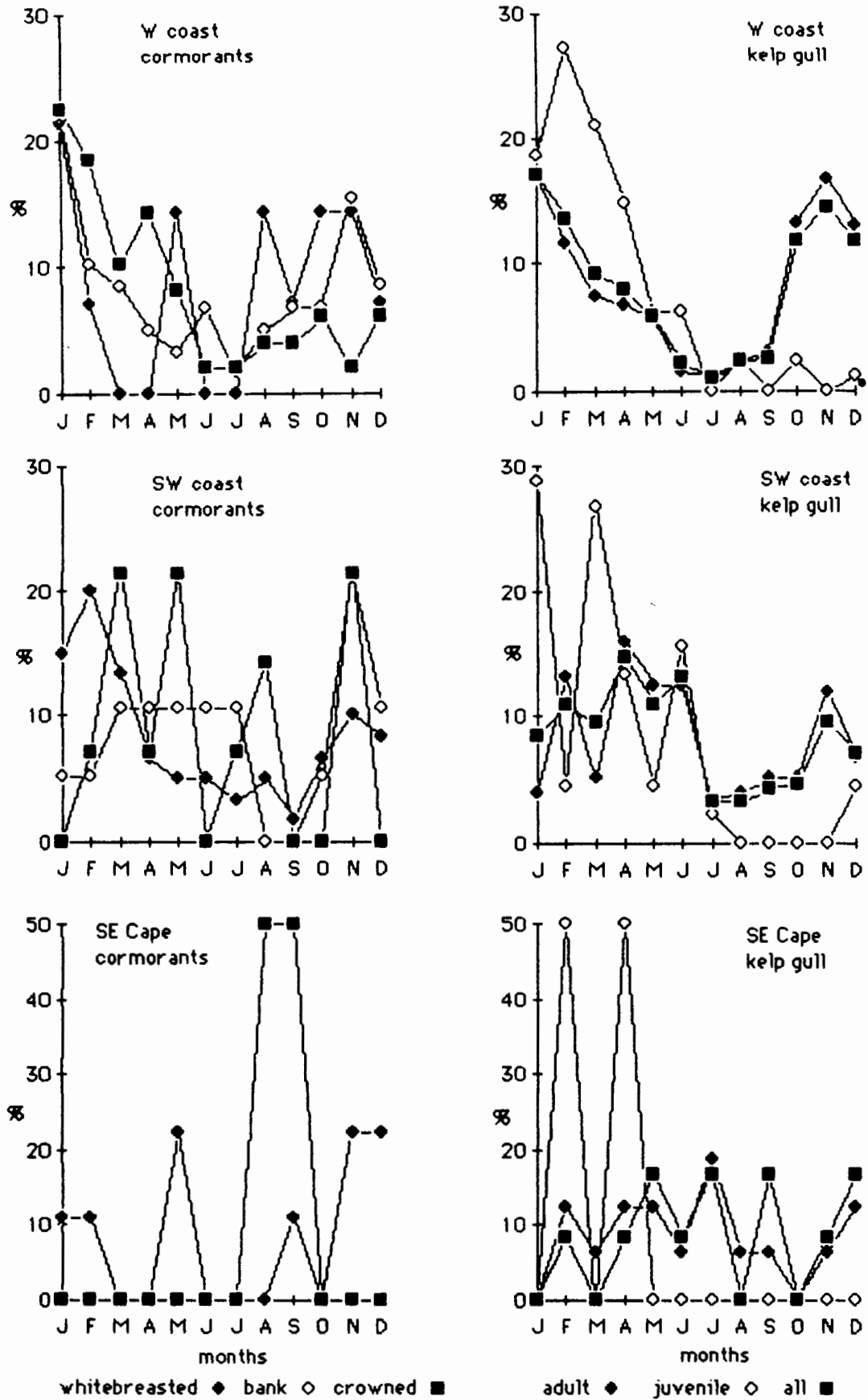


Figure 3.5 (part 4). See Figure 3.5 (part 5) for caption.

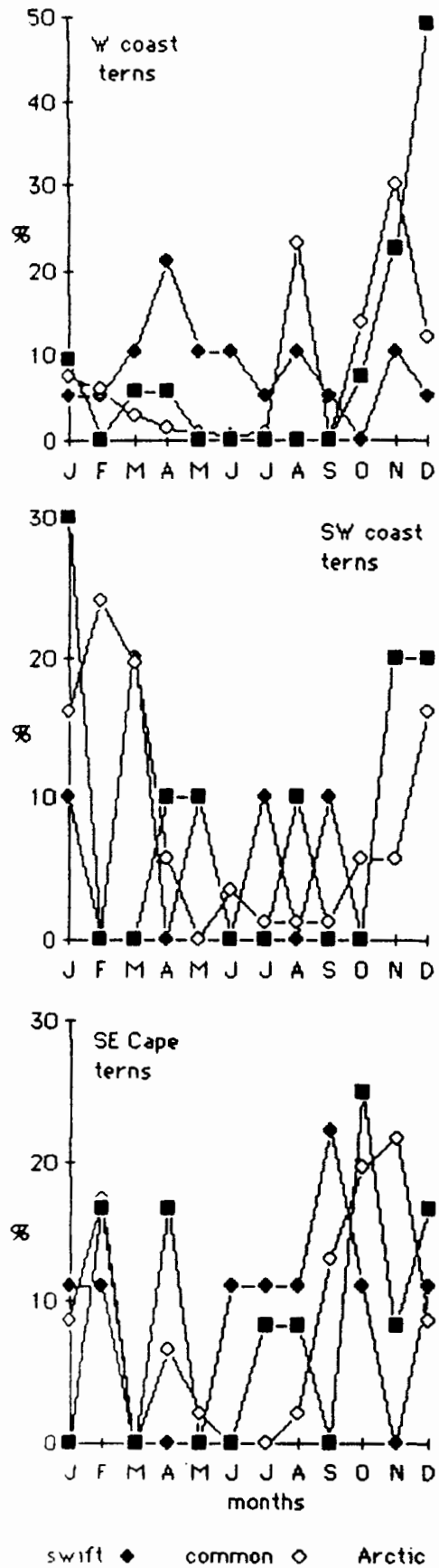


Figure 3.5 (part 5). Monthly distribution (%) of various species and age classes to illustrate seasonality or lack of it. Note different vertical scales.

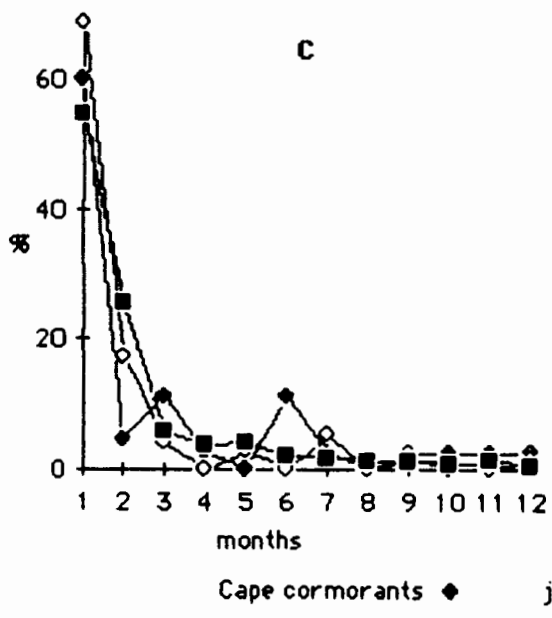
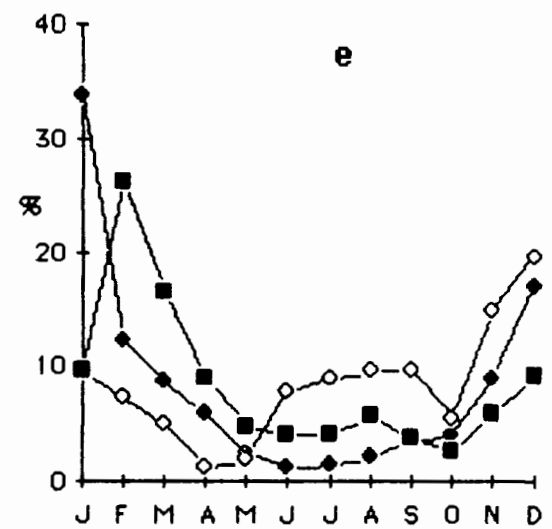
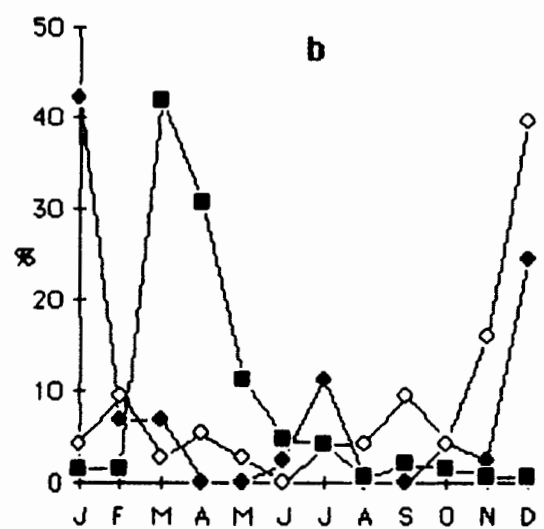
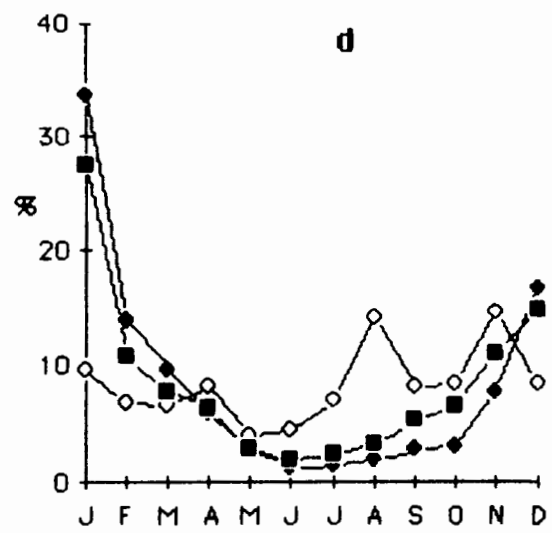
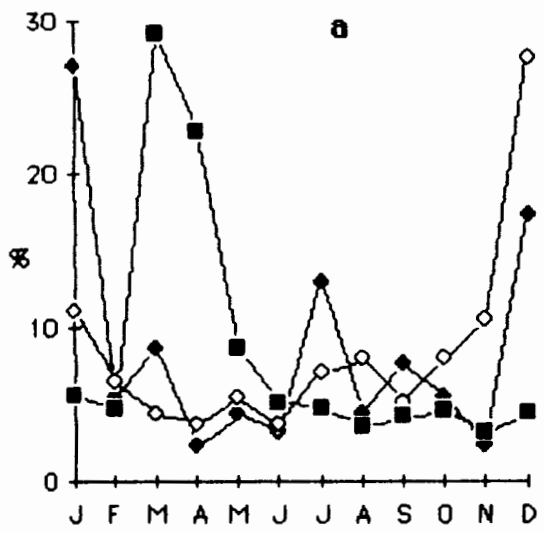


Figure 3.6. Recovery of jackass penguins, Cape gannets and Cape cormorants ringed since 1981 and recovered during beach surveys; a) recovery month of all ringed birds, b) recovery month in the first year of birds ringed as nestlings, c) age at death in the first year of birds ringed as nestlings, d) recovery month of all beached birds, e) recovery month of all beached juveniles.

Cape cormorants ◆      jackass penguins ◇      Cape gannets ■

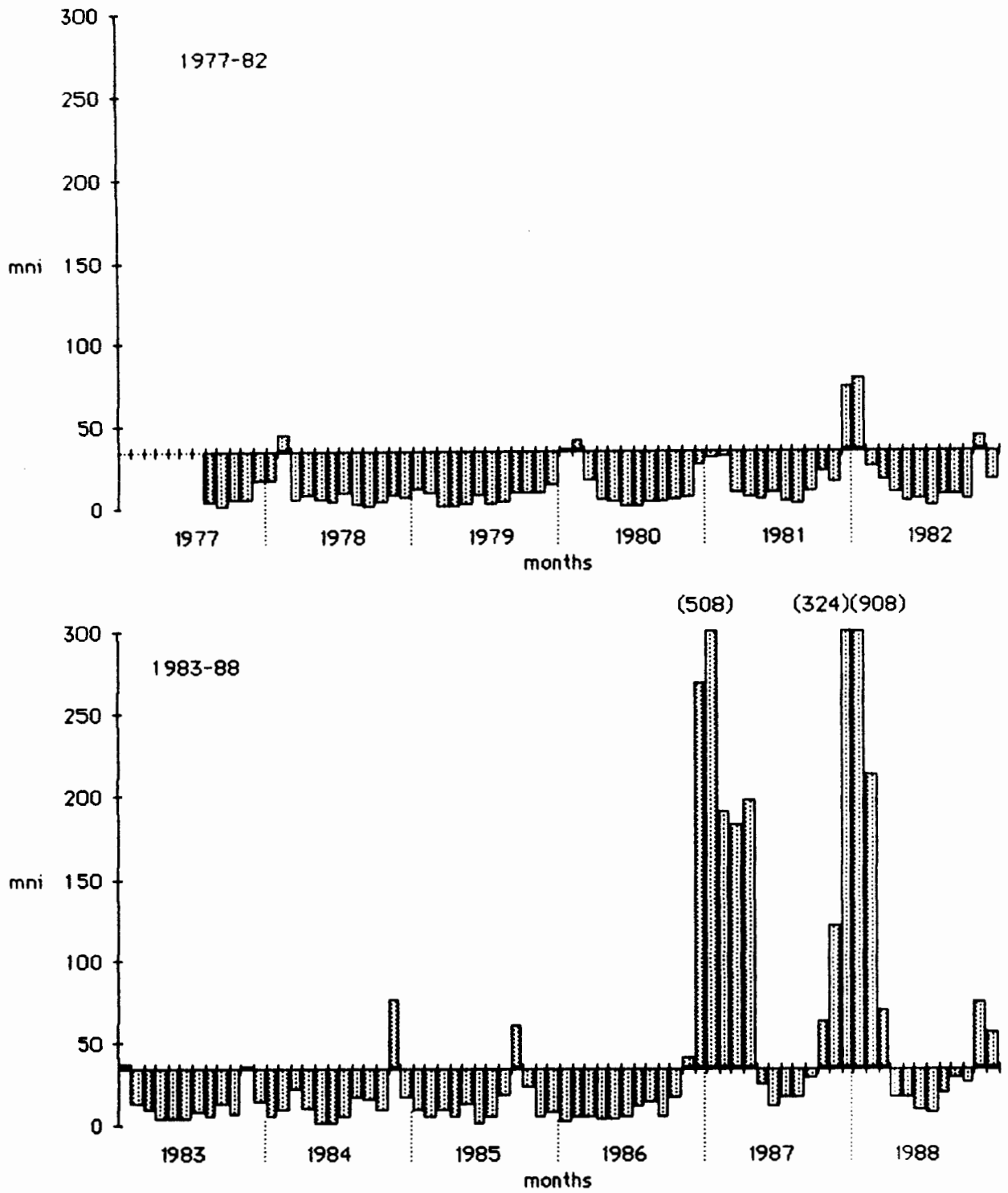


Figure 3.7A. Variation from the mean in monthly frequencies of all individuals of Cape cormorants recorded at Yzerfontein during the period August 1977 to December 1988.

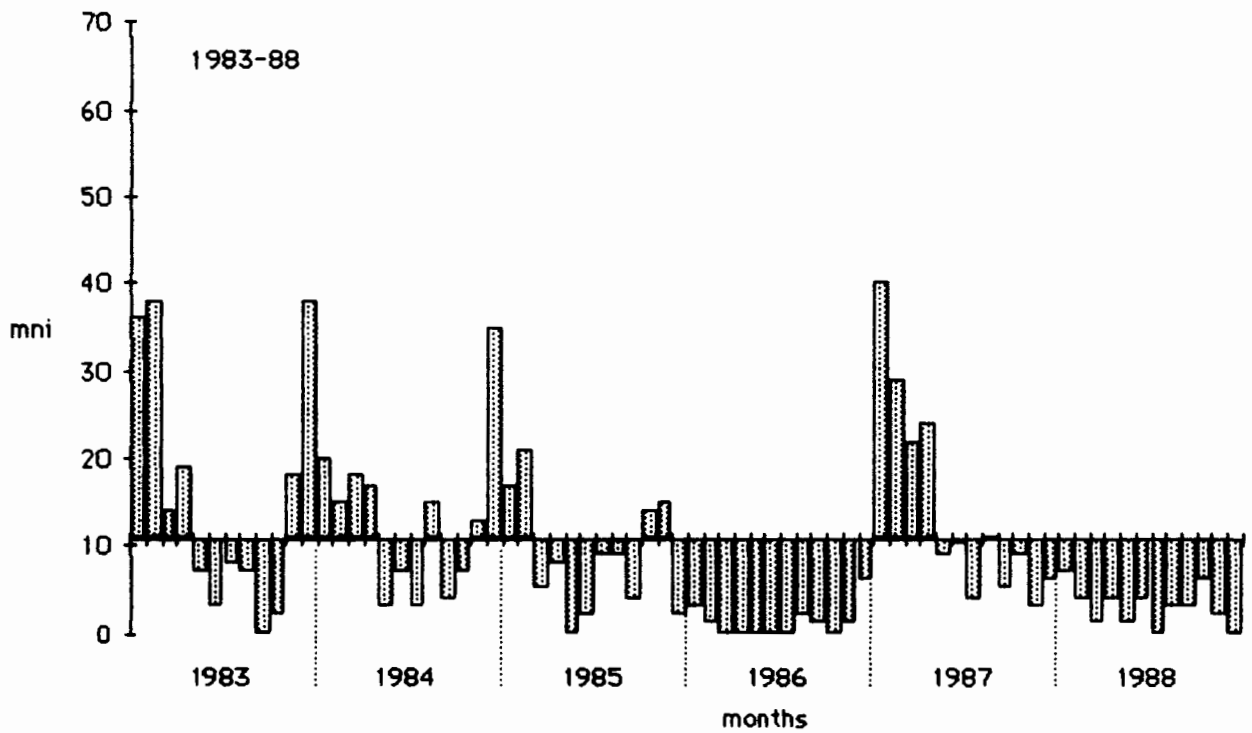
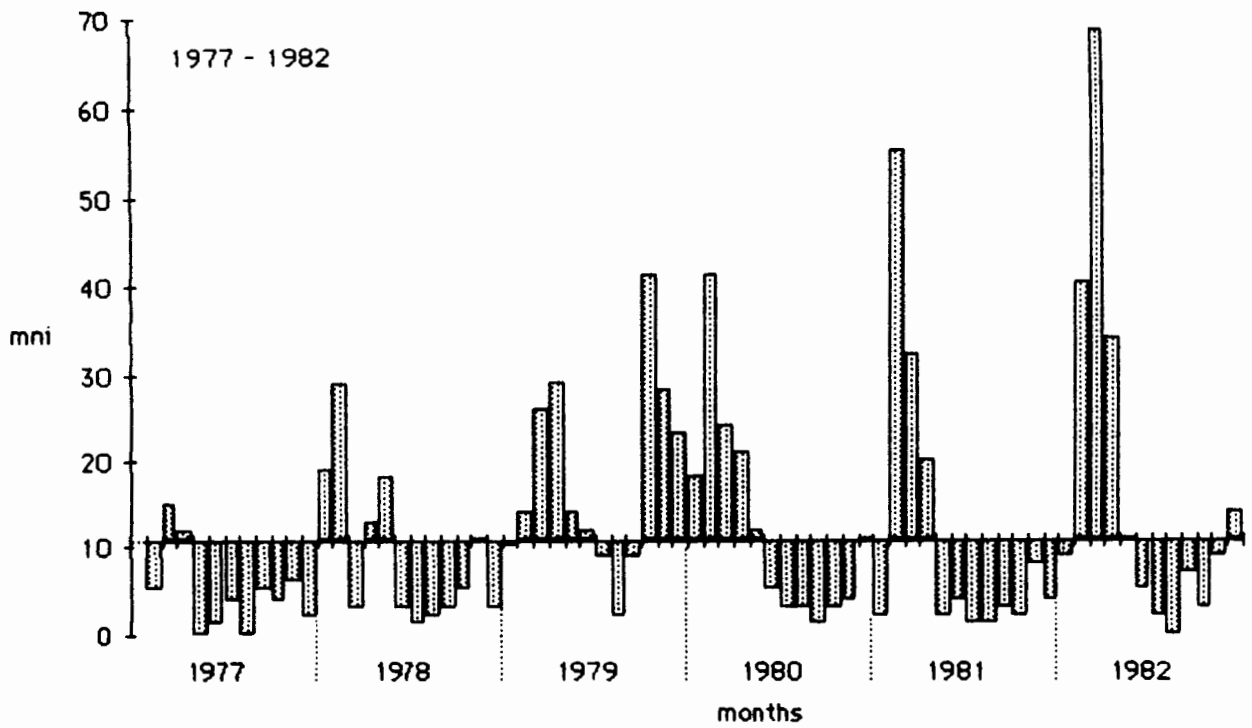


Figure 3.7B. Variation from the mean in monthly frequencies of all individuals of Cape cormorants recorded at False Bay during the period February 1977 to December 1988.

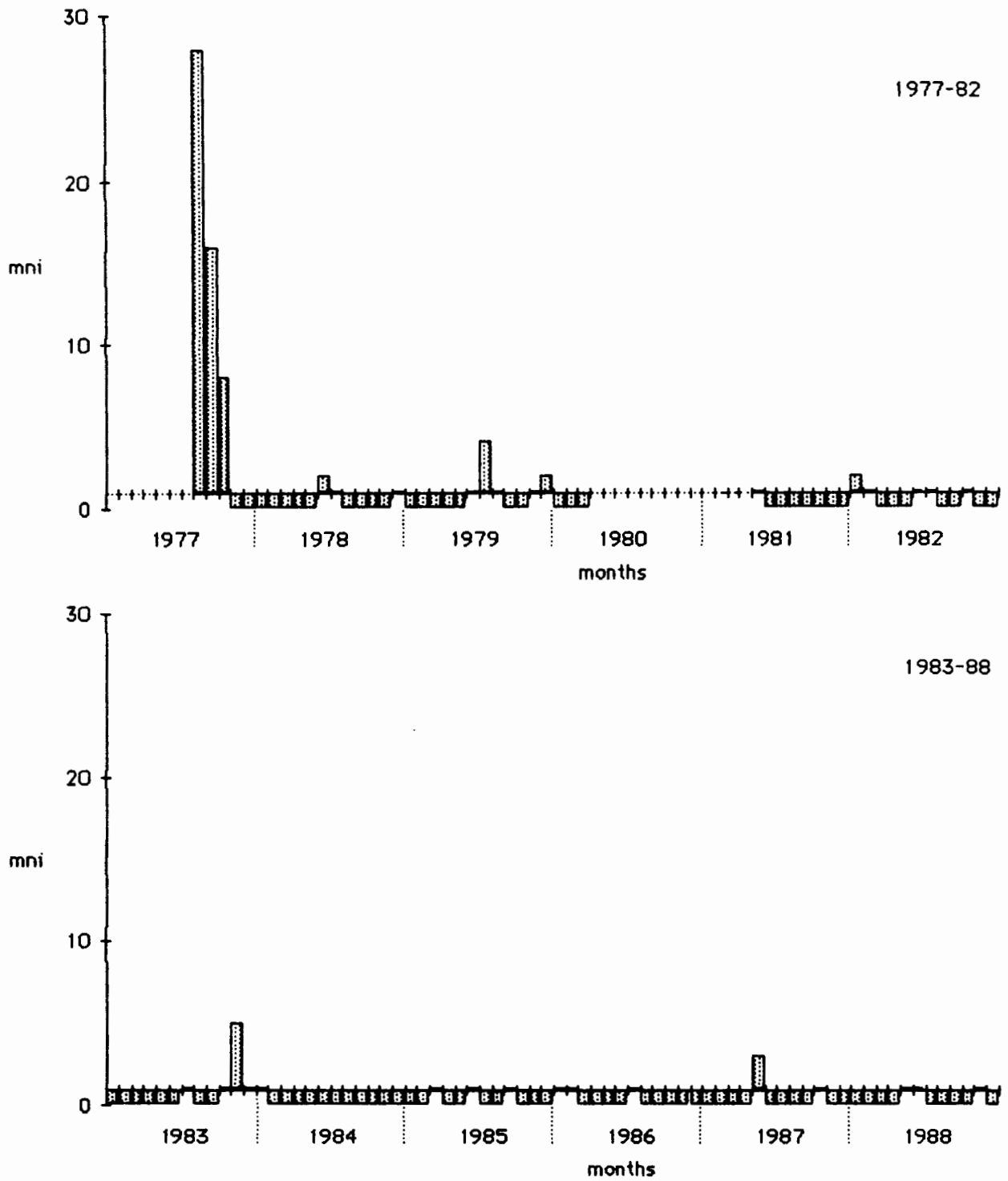


Figure 3.7C. Variation from the mean in monthly frequencies of all individuals of Cape cormorants recorded at Cape Recife during the periods August 1977 to March 1980 and May 1981 to December 1988.

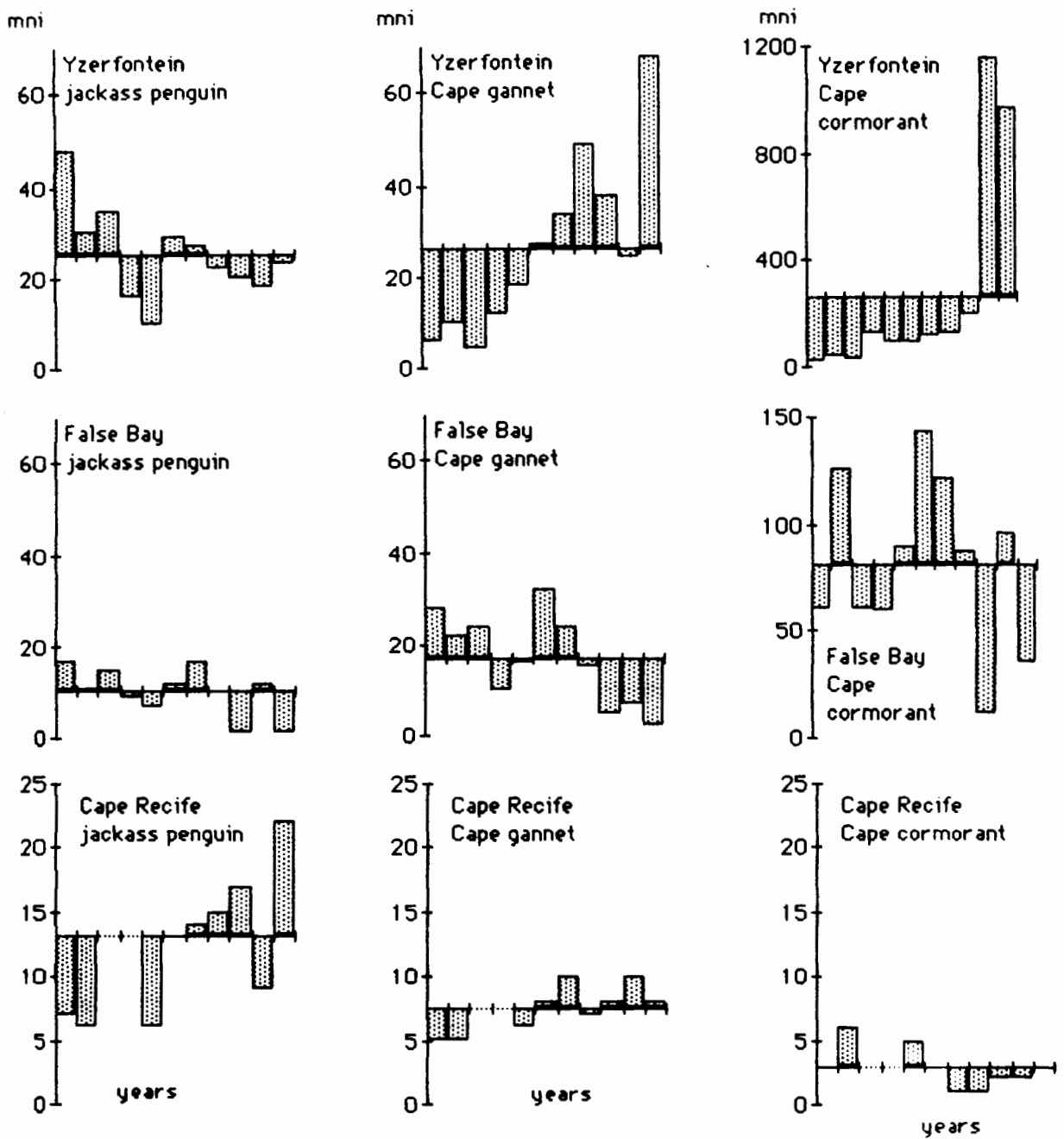


Figure 3.8. Variation from the mean in annual frequencies of adult jackass penguins, Cape gannets and Cape cormorants at Yzerfontein, False Bay and Cape Recife for the years 1978 to 1988, except 1980-81 at Cape Recife. Note the different vertical scales.

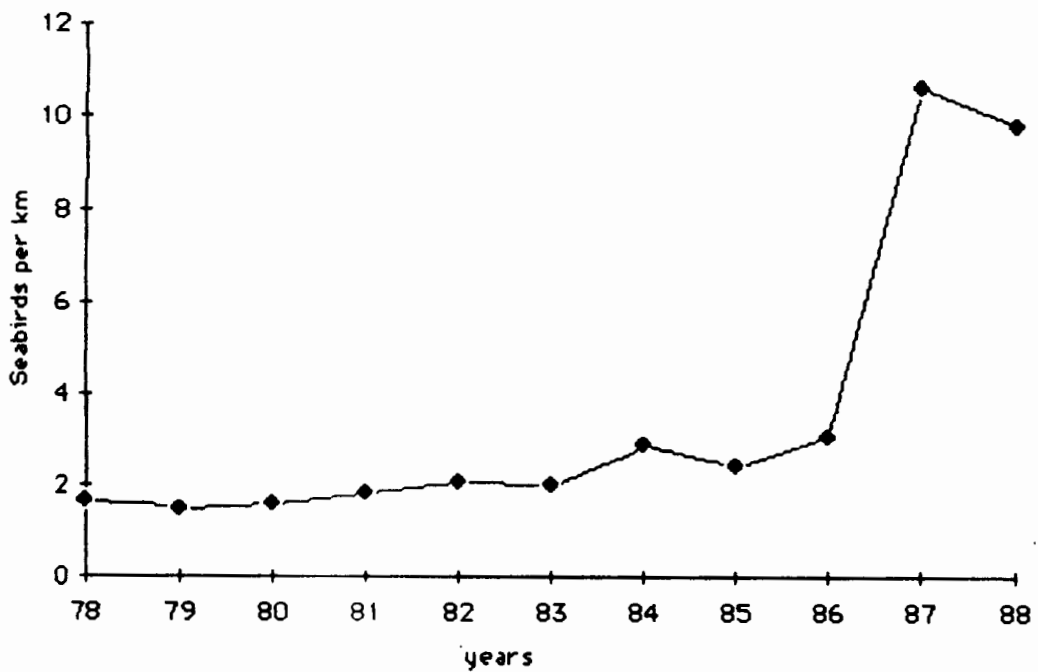
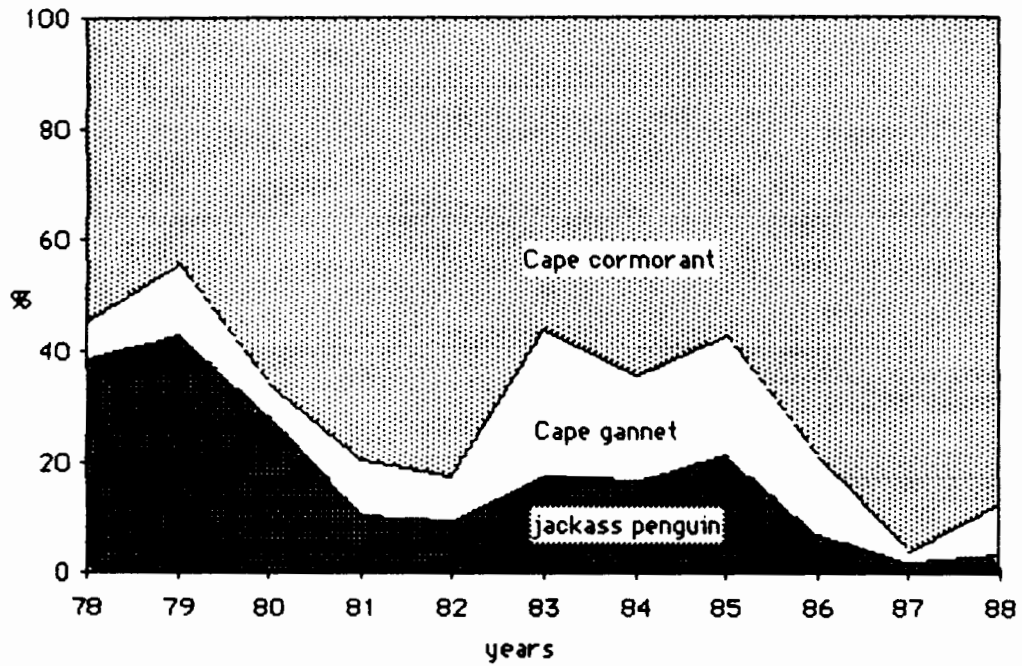


Figure 3.9. Relative proportions (%) of jackass penguins, Cape gannets and Cape cormorants, and densities (seabirds per km) recorded on Yzerfontein beach surveys between 1978 and 1988.

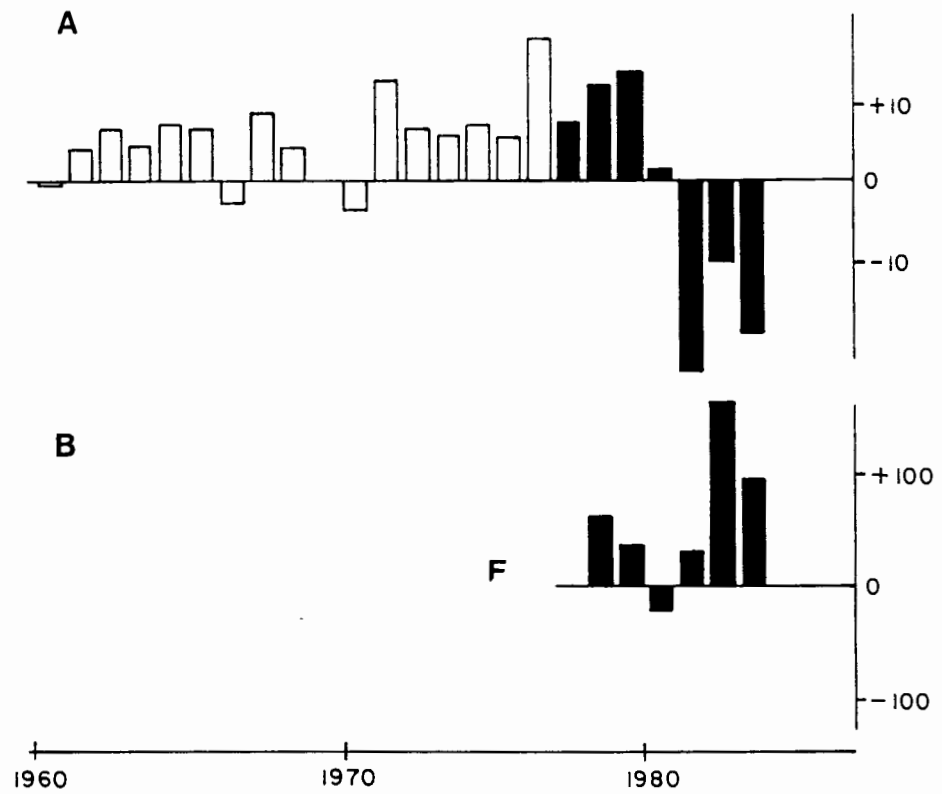


Figure 3.10. Relationship between sea-surface temperatures (A) and the high incidence of easterly winds (B) in the west coast region of the Benguela upwelling system (after Shannon & Taunton-Clark 1988).

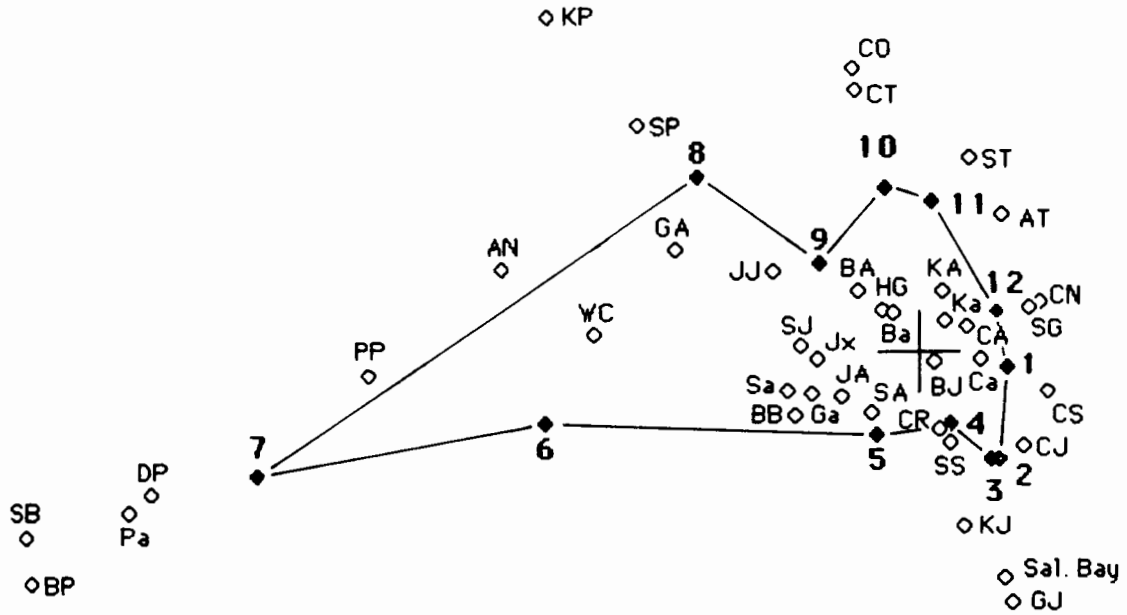


Figure 3.11. Result of correspondence analysis plot based on monthly data for combined west coast beach surveys between 1977 and 1989. Months are numbered consecutively from January to December. In the second letter of a code A = adults, J = juveniles, lower case = combined samples. Codes are given in Table 3.1.

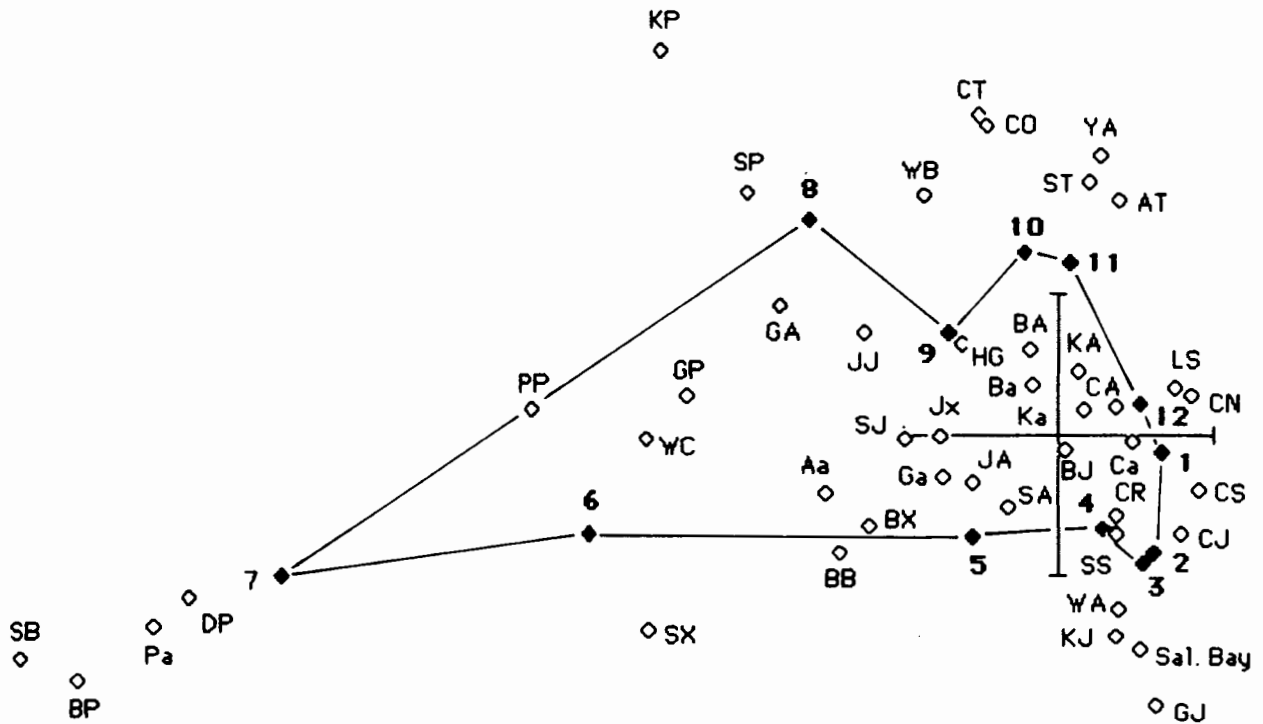


Figure 3.12. Result of correspondence analysis plot based on monthly data for Yzerfontein beach surveys between 1977 and 1989. Months are numbered consecutively from January to December. In the second letter of a code A = adults, J - juveniles, lower case = combined samples. Codes are given in Table 3.1.

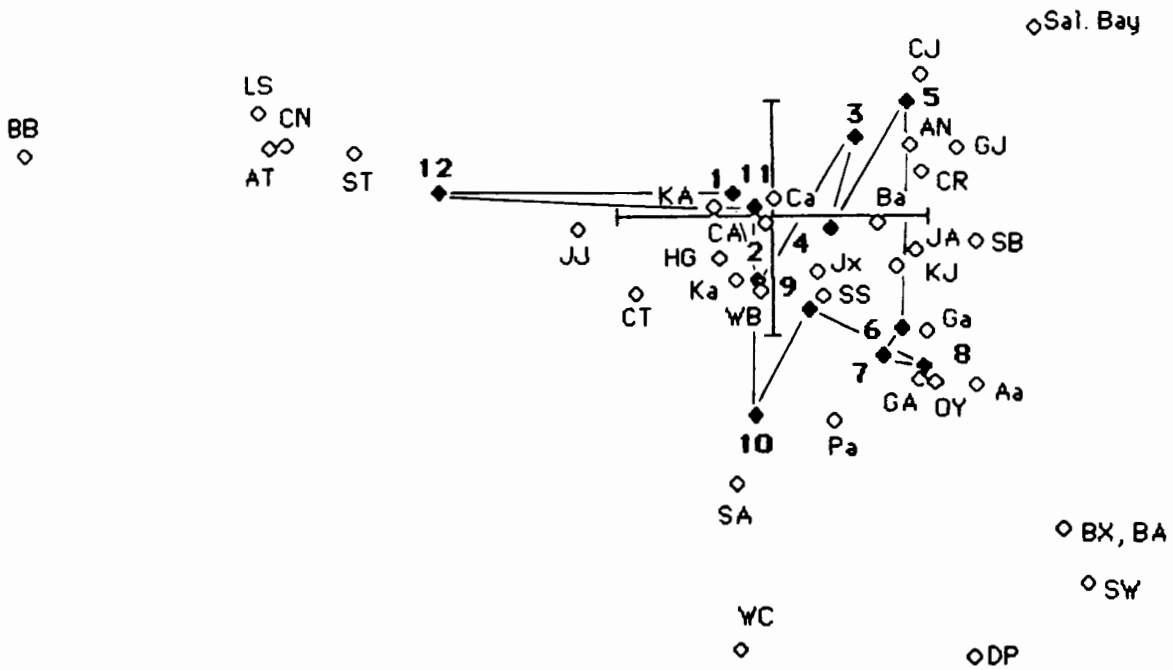


Figure 3.13. Result of correspondence analysis plot based on monthly data for west coast beach surveys, excluding Yzerfontein, between 1977 and 1989. Months are numbered consecutively from January to December. In the second letter of a code A = adults, J = juveniles, lower case = combined samples. Codes are given in Table 3.1.

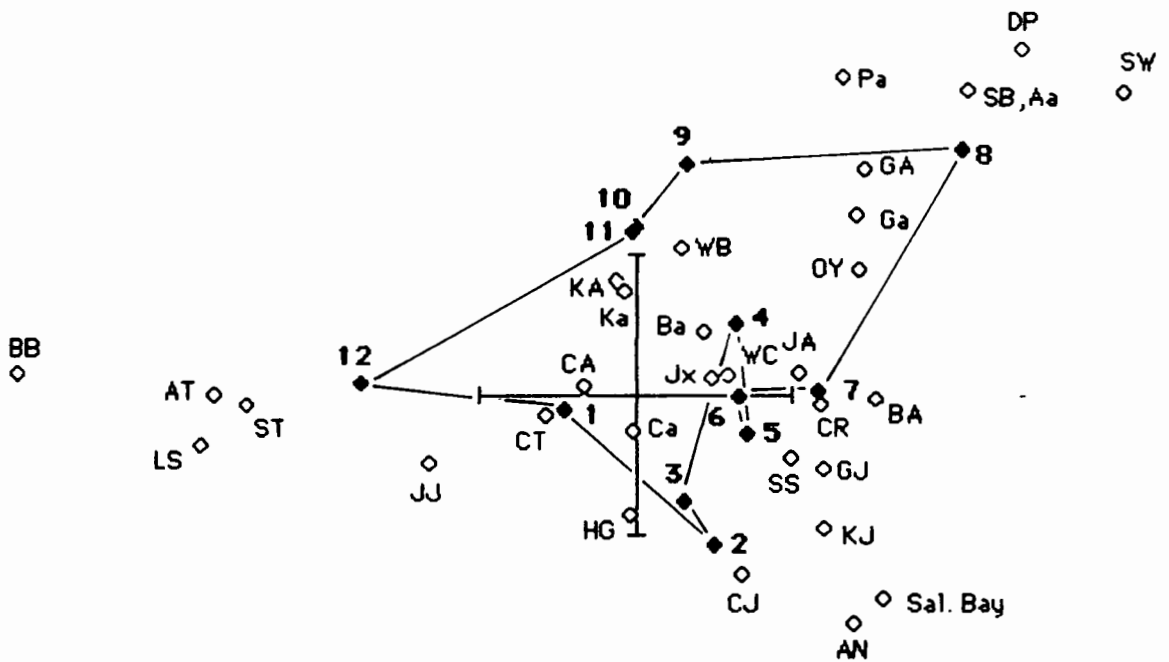


Figure 3.14. Result of correspondence analysis plot based on monthly data for Eland's Bay and Koeberg beach surveys only between 1977 and 1981. Months are numbered consecutively from January to December. In the second letter of a code A = adults, J = juveniles, lower case = combined samples. Codes are given in Table 3.1.

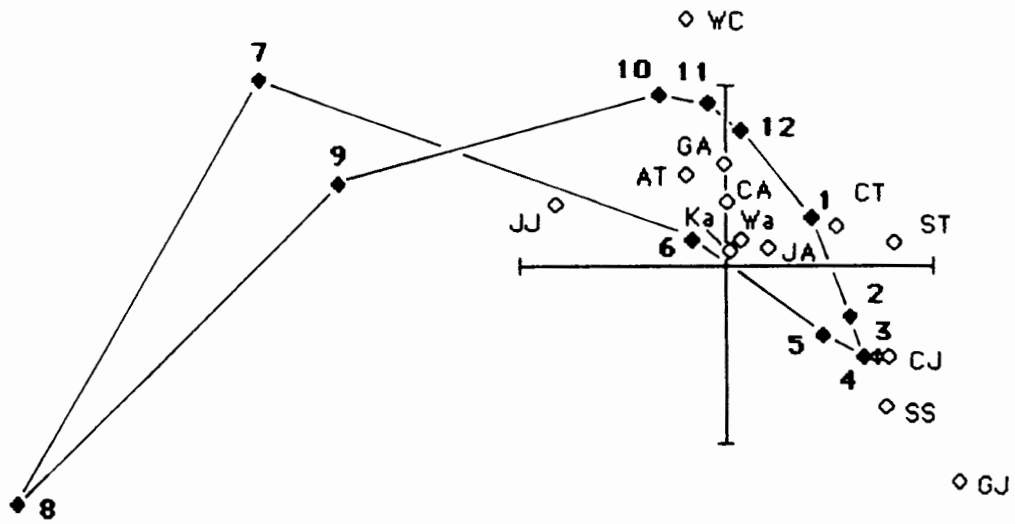


Figure 3.15. Result of correspondence analysis plot based on monthly data for southwest coast beach surveys between 1978 and 1988. Months are numbered consecutively from January to December. In the second letter of a code A = adults, J = juveniles, lower case = combined samples. Codes are given in Table 3.1.

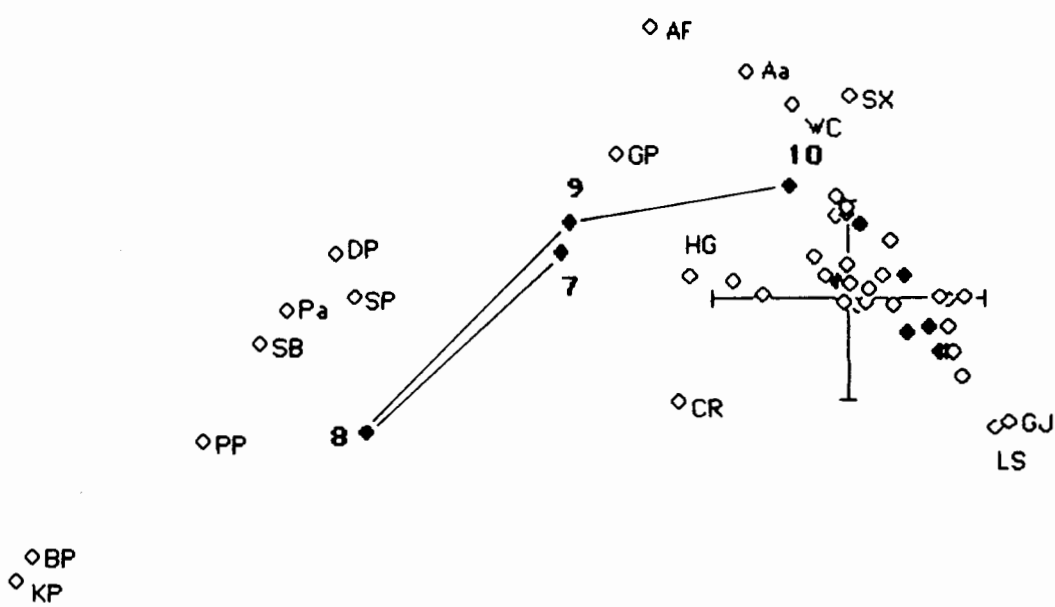
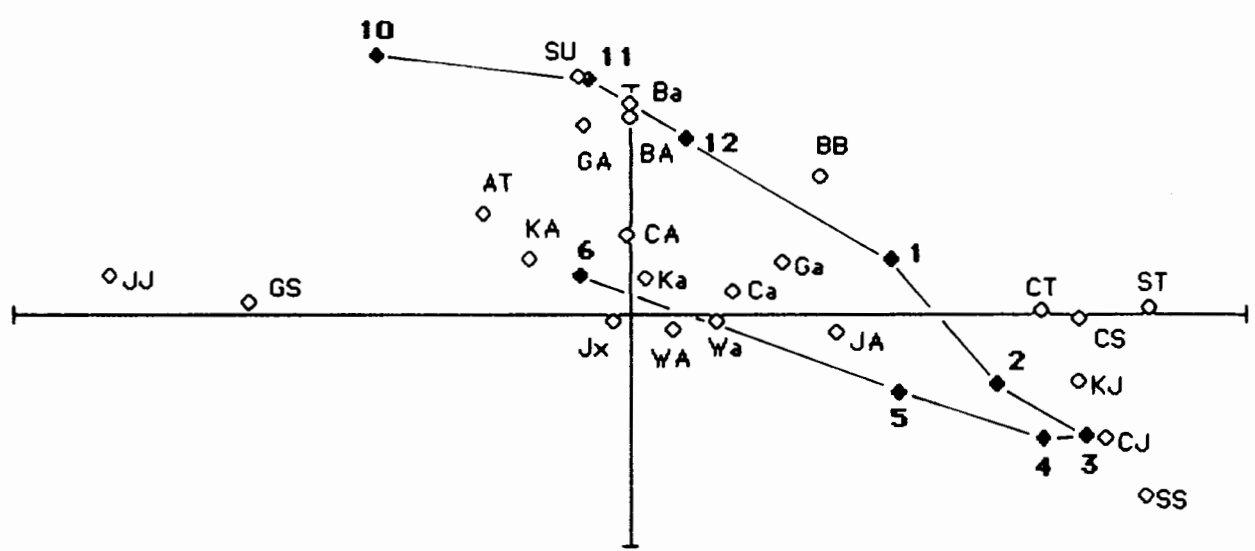


Figure 3.16. Results of correspondence analysis plot based on monthly data for False Bay beach surveys between 1978 and 1988. Months are numbered consecutively from January to December. In the second letter of a code A = adults, J = juveniles, lower case = combined samples. Codes are given in Table 3.1. An enlarged plot around the origin is given below.



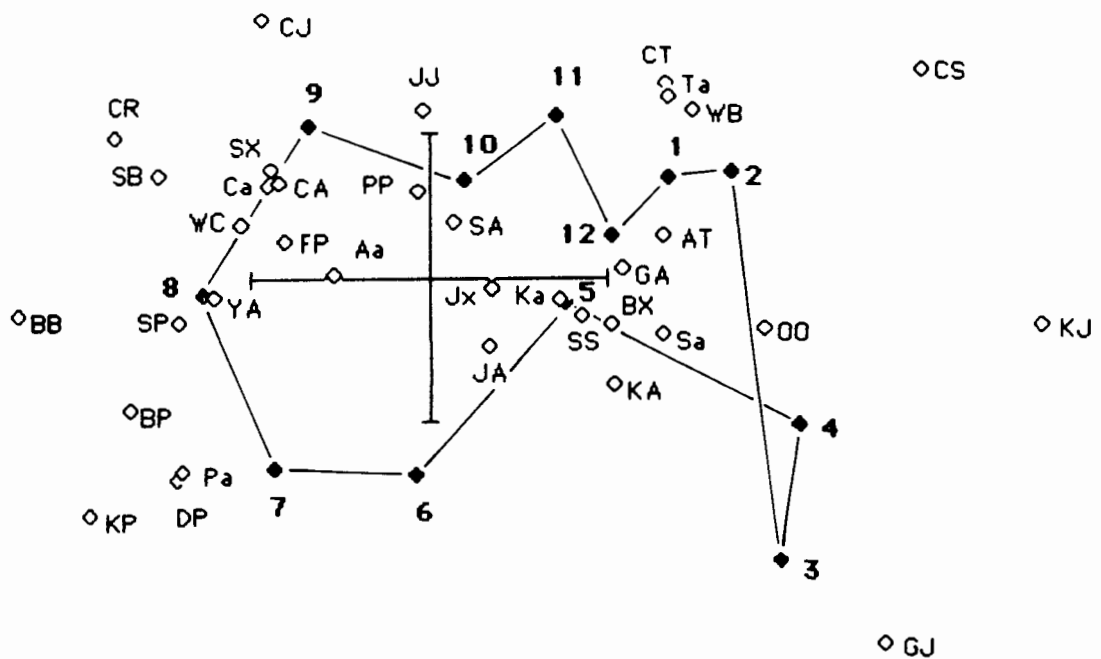


Figure 3.17. Result of correspondence analysis plot based on monthly data for southeast Cape coast beach surveys between 1978 and 1989. Months are numbered consecutively from January to December. In the second letter of a code A = adults, J = juveniles, lower case = combined samples. Codes are given in Table 3.1.

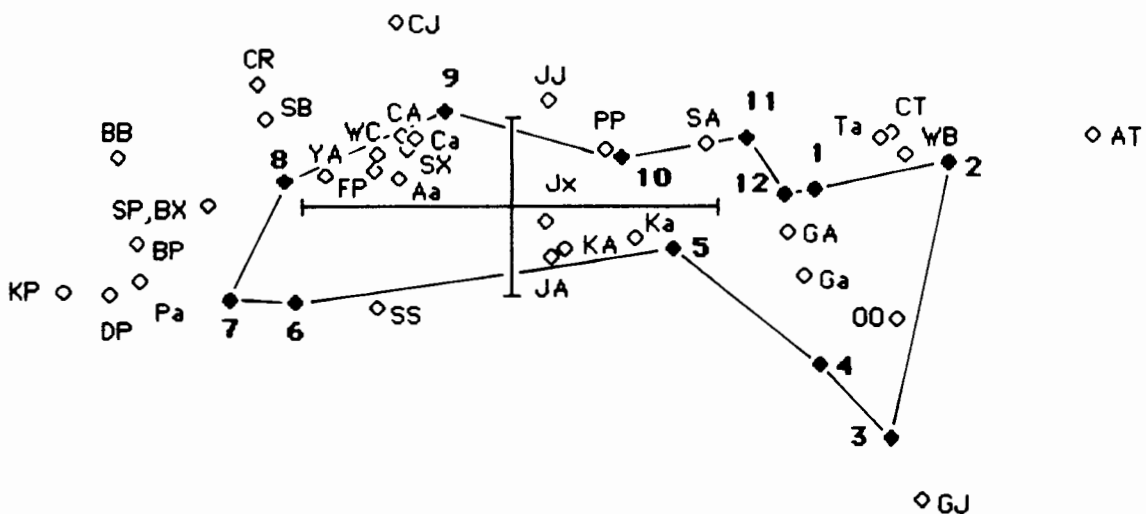


Figure 3.18. Result of correspondence analysis plot based on monthly data for Cape Recife beach surveys between 1978 and 1989. Months are numbered consecutively from January to December. In the second letter of a code A = adults, J = juveniles, lower case = combined samples. Codes are given in Table 3.1.

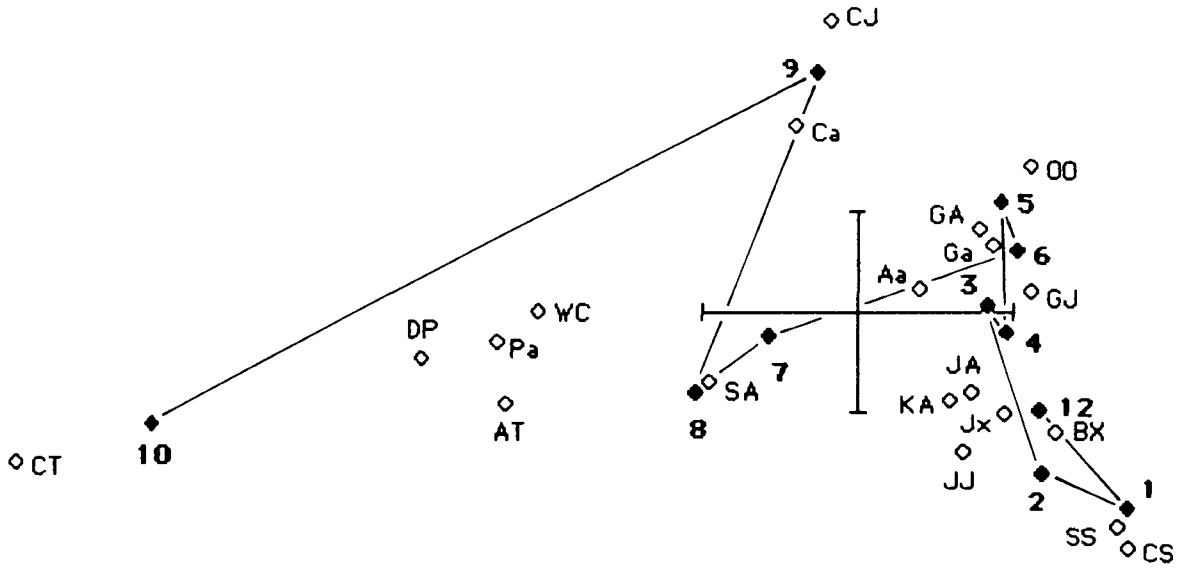


Figure 3.19. Result of correspondence analysis plot based on monthly data for Port Alfred and Rockcliffe beach surveys between 1978 and 1983. Months are numbered consecutively from January to December. In the second letter of a code A = adults, J = juveniles, lower case = combined samples. Codes are given in Table 3.1.

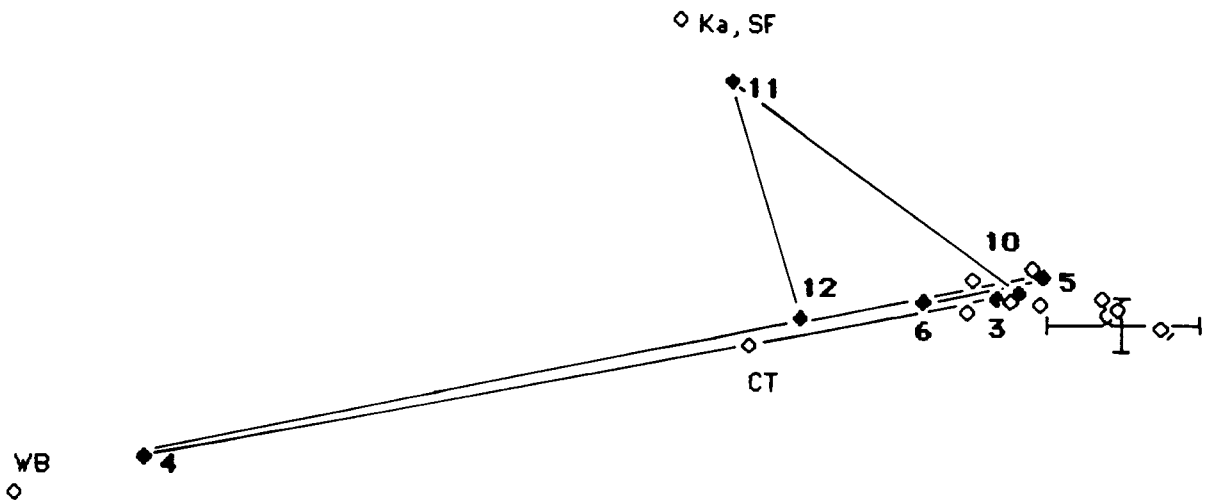


Figure 3.20A. Result of correspondence analysis plot based on monthly data for east coast beach surveys between 1978 and 1983. Months are numbered consecutively from January to December. In the second letter of a code A = adults, J = juveniles, lower case = combined samples. Codes are given in Table 3.1.



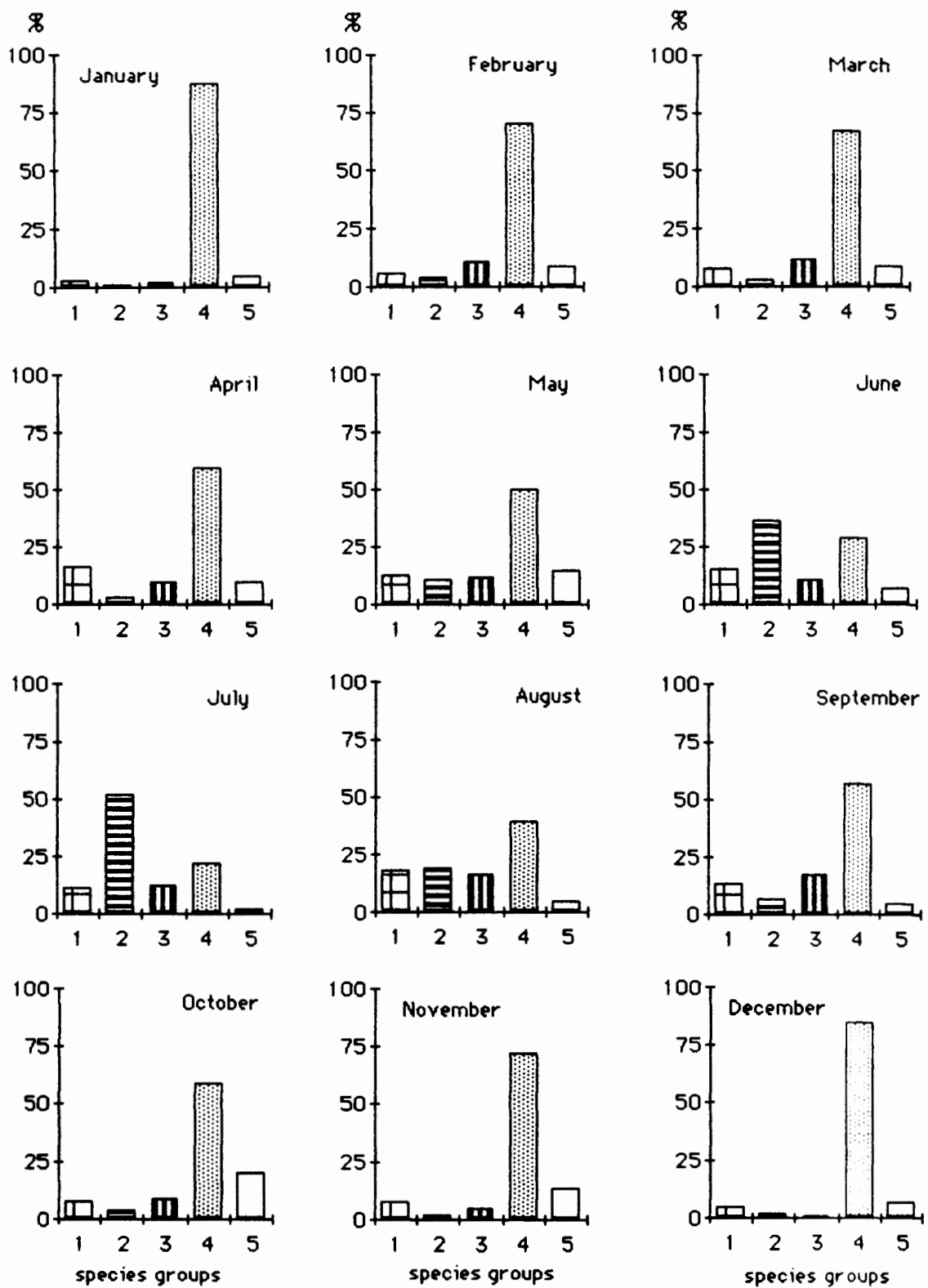


Figure 3.21 A. Profiles of main species or groups of species occurring in individual months of west coast beach surveys. 1 = jackass penguin, 2 = albatrosses, petrels, shearwaters, prions, 3 = Cape gannet, 4 = cormorants, 5 = kelp gull

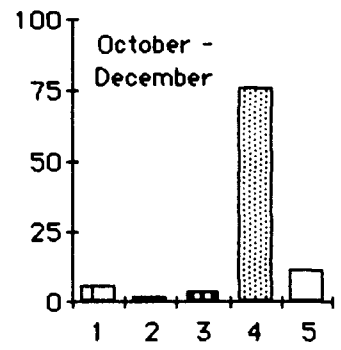
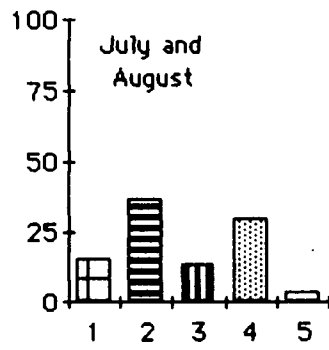
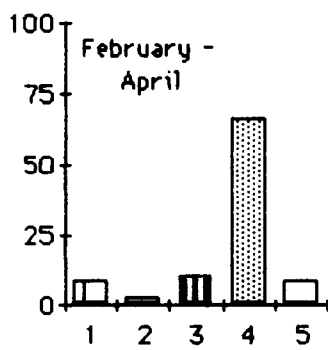
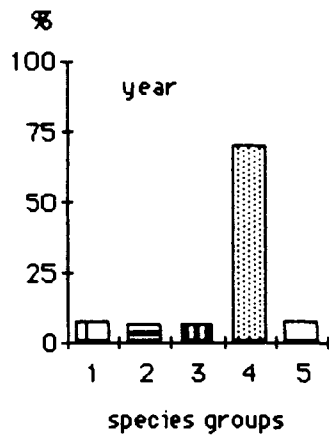


Figure 3.21B. Profiles of main species or groups of species occurring in seasonal groups for west coast beach surveys. 1 = jackass penguin, 2 = albatrosses, petrels, shearwaters, prions, 3 = Cape gannet, 4 = cormorants, 5 = kelp gull.

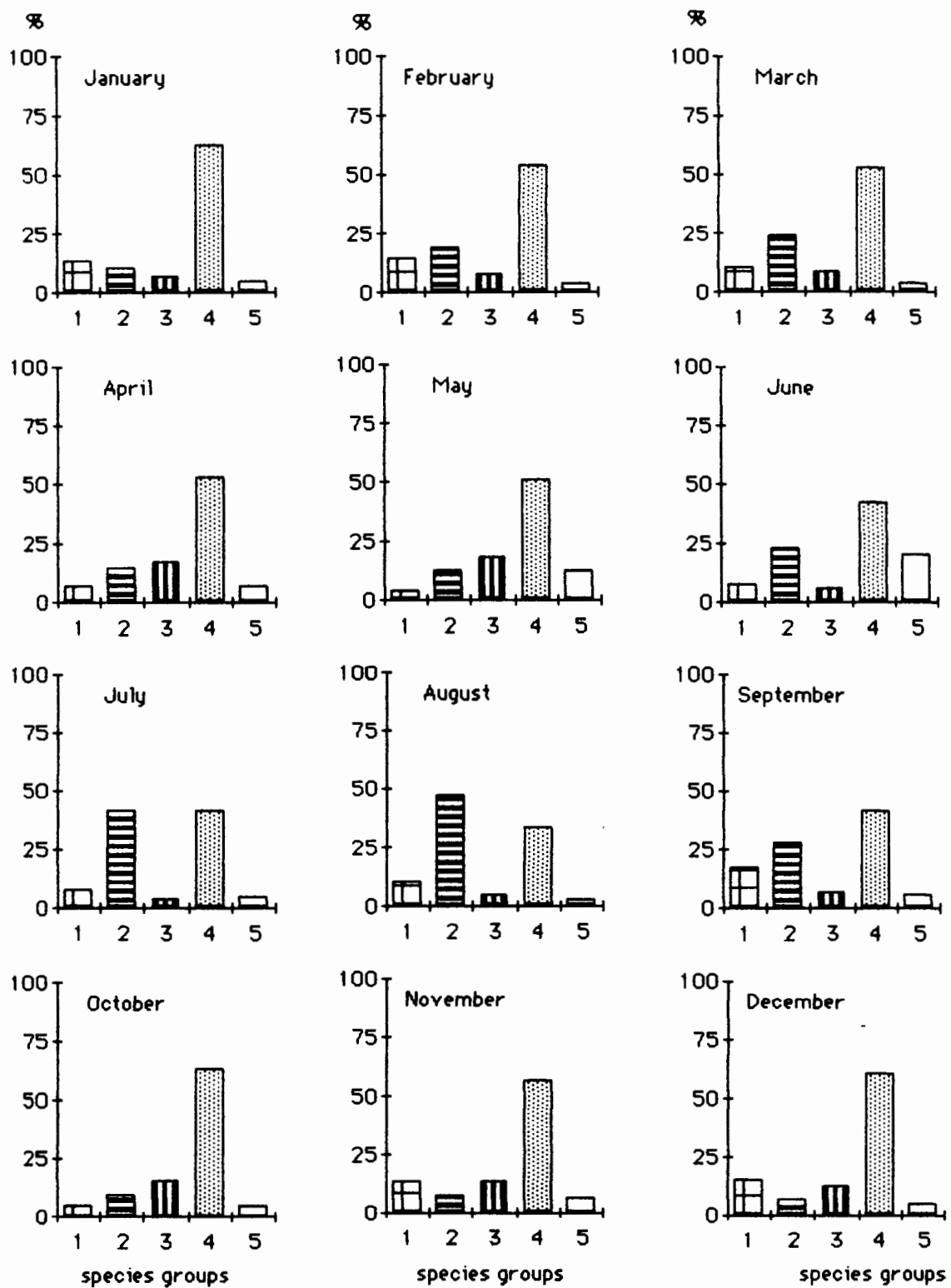


Figure 3.22A. Profiles of main species or groups of species occurring in individual months of southwest coast beach surveys. 1 = jackass penguins, 2 = albatrosses, petrels, shearwaters, prions, 3 = Cape gannet, 4 = cormorants, 5 = kelp gull.

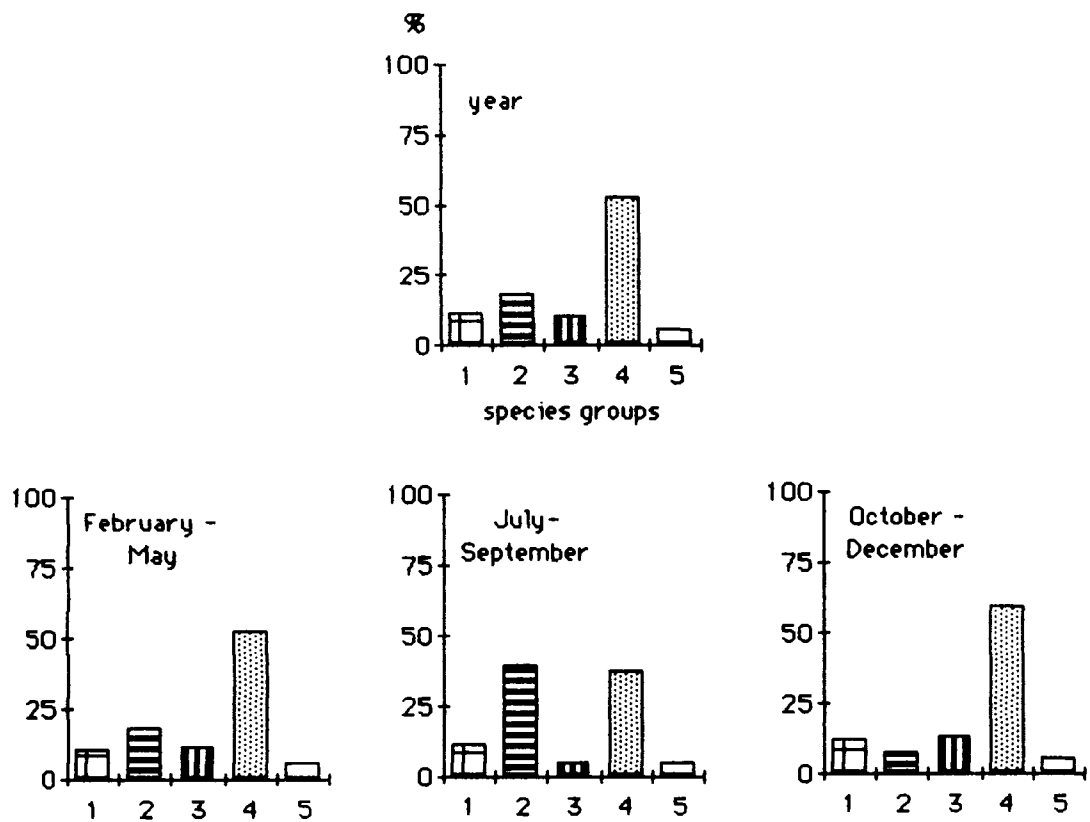


Figure 3.22B. Profiles of main species or groups of species occurring in seasonal groups for southwest coast beach surveys. 1 = jackass penguin, 2 = albatrosses, petrels, shearwaters, prions, 3 = Cape gannet, 4 = cormorants, 5 = kelp gull.

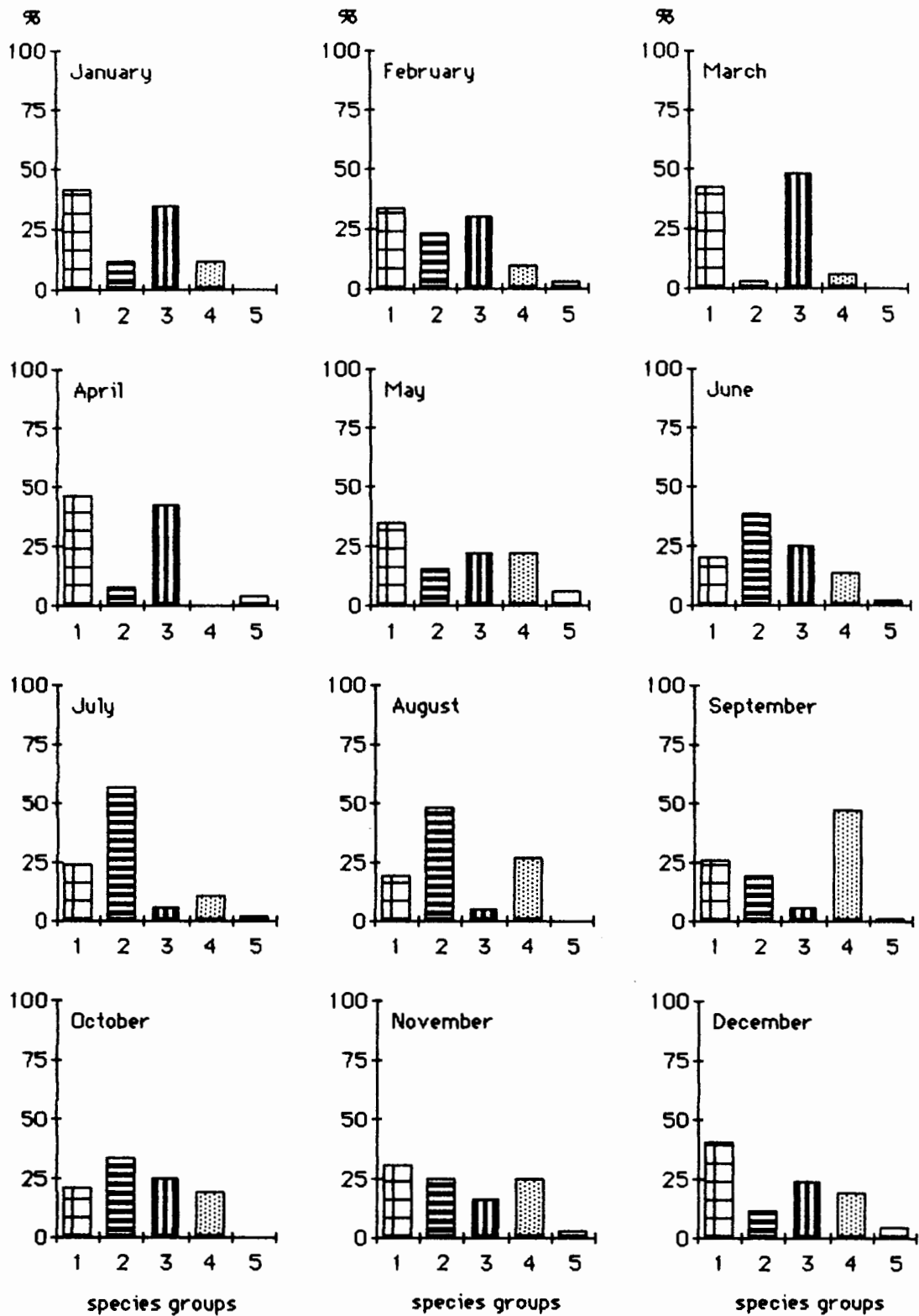


Figure 3.23A. Profiles of main species or groups of species occurring in individual months of southeast Cape beach surveys. 1 = jackass penguin, 2 = albatrosses, petrels, shearwaters, prions, 3 = Cape gannet, 4 = cormorants, 5 = kelp gull.

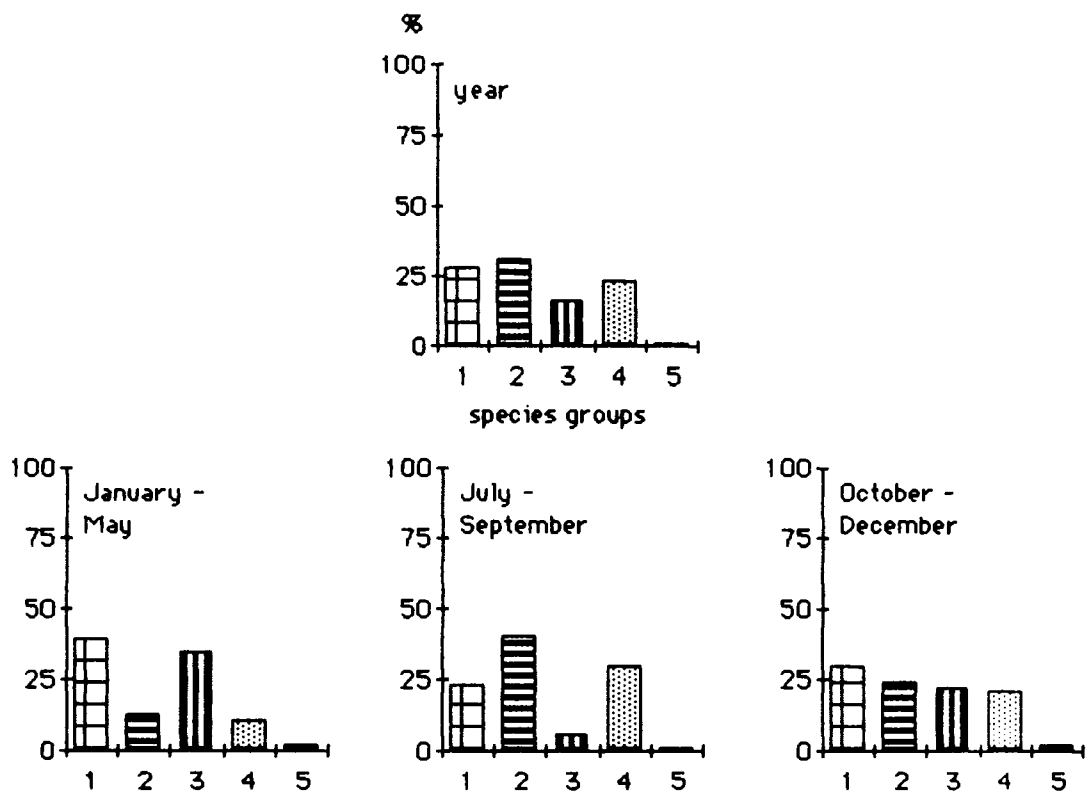


Figure 3.23B. Profiles of main species or groups of species occurring in seasonal groups for southeast Cape beach surveys. 1 - jackass penguin, 2 = albatrosses, petrels, shearwaters, prions, 3 = Cape gannet, 4 = cormorants, 5 = kelp gull.

**Table 3.1.** Common and scientific names of species and groups with codes used in the Tables and Figures. Brief details on main prey, group size and breeding are given (see Figure 3.4 for breeding season and references).

CODE	SPECIES	DESCRIPTION
JA = Ad JJ = Juv Jx = All	Jackass penguin	Pelagic shoaling prey; solitary/small groups; range up to 15 km offshore; colonial breeder on offshore islands. Flightless.
WA SX BX YA Aa	Wandering albatross Shy albatross Blackbrowed albatross Yellownosed albatross All albatross spp.	Squid, fish; solitary/small groups; oceanic; colonies on Subantarctic islands.
GP	Giant petrel	Squid, fish, carrion; solitary/gregarious; oceanic; colonies on Subantarctic islands.
PP	Pintado petrel	Krill, squid, fish, carrion; gregarious; oceanic; colonies on Subantarctic and Antarctic islands.
SP	Softplumaged petrel	Squid, fish; solitary; oceanic; colonies on Subantarctic islands.
KP	Kerguelen petrel	Squid, crustaceans; solitary/small flocks; oceanic; colonies on Subantarctic islands.
BP	Blue petrel	Krill, small squid, fish; solitary; oceanic; colonies on Subantarctic islands.
BB DP SB Pa	Broadbilled prion Antarctic prion Slenderbilled prion All prion spp.	Plankton; gregarious; oceanic; colonies on Subantarctic islands.
WC	Whitechinned petrel	Squid, fish, krill; solitary/gregarious; oceanic; colonies on Subantarctic islands.
CS	Cory's shearwater	Fish, plankton, squid; solitary/gregarious; oceanic; colonies in Mediterranean region.
SS	Sooty shearwater	Squid, crustaceans, fish; gregarious; oceanic; colonies on Subantarctic islands.
GA = Ad GJ = Juv Ga = All	Cape gannet	Pelagic shoaling/other species; small groups/highly gregarious; up to 100 km offshore; colonial breeder, offshore islands.
WB Wa = All	Whitebreasted cormorant	Fish; solitary; inshore, up to 8 km offshore; colonial breeder, offshore islands/rocks/cliffs. (cont.)

Table 3.1 (cont.)

CODE	SPECIES	DESCRIPTION
CA = Ad CJ = Juv Ca = All	Cape cormorant	Pelagic shoaling fish; highly gregarious; up to 10 km offshore; colonial breeder, offshore islands/rocks/cliffs.
BA Ba = All	Bank cormorant	Fish/crustaceans; solitary/small groups; inshore, up to 10 km offshore; small groups, offshore rocks/islands.
CR Cr = All	Crowned cormorant	Klipfish (Clinidae); solitary/small groups; close inshore; small groups/colonies, offshore islands/rocks/cliffs.
KA = Ad KJ = Juv Ka = All	Kelp gull	Mussels/limpets/fish; solitary/groups; beaches/offshore; colonial breeder, offshore islands/rocks/cliffs.
HG	Hartlaub's gull	Carrion, invertebrates; groups; beaches/offshore/wetlands; colonial breeder, offshore islands/wetlands.
LS	Sabine's gull	Invertebrates; solitary/gregarious; oceanic, shore; non-breeding palearctic migrant.
SA = Ad SJ = Juv Sa = All	Swift tern	Fish; gregarious; marine shores/estuaries; colonial breeder, offshore islands.
ST	Sandwich tern	Fish; highly gregarious; marine shores/estuaries;
CT	Common tern	non-breeding Palearctic migrant.
AT	Arctic tern	
CO	Comic' tern = CT + AT indet.	

**Table 3.2.** Distances covered per month (km) and duration of beach surveys since 1977. Localities shown on Figure 3.1.

NAME	KM	DURATION
Lambert's Bay	5	March 1982 - February 1985
Eland's Bay	14	January 1980 - December 1981
Yzerfontein	15	August 1977 - ongoing
Koeberg	7	September 1977 - December 1982
Fish Hoek	1	January - December 1979; February 1981 - December 1982
False Bay	20	February 1977 - December 1988
Hawston	5	April 1978 - ongoing
Die Plaat	5	June 1979 - ongoing
De Hoop	12	September 1985 - ongoing
Cape Recife	5	September 1977 - March 1980; May 1981 - ongoing
Port Alfred	13	January 1977 - September 1978
Rockcliff	4	December 1977 - February 1981
Natal	491	August 1979 - December 1981

**Table 3.3.** Percentage of the total number of each seabird age-class found on west coast beach surveys between October and April.

SPECIES	AGE CLASS			
	Adult	Juvenile	Nestling	All
Jackass penguin	76.09	75.00	-	74.84
Albatrosses	-	-	-	56.25
Prions	-	-	-	9.17
Cape gannet	61.54	92.00	-	74.30
Whitebreasted cormorant	61.54	-	-	61.54
Cape cormorant	84.15	94.56	100.00	87.45
Bank cormorant	75.86	100.00	-	78.79
Crowned cormorant	68.18	75.00	-	69.23
Black oystercatcher	-	-	-	28.57
Kelp gull	86.36	100.00	-	86.84
Swift tern	0.00	0.00	-	100.00
Common tern	-	-	-	97.41
MEAN	-	-	-	81.40

**Table 3.4.** Birds found on a three kilometre stretch of sandy beach near Saldanha Bay, 14-24 March 1982.

SPECIES	DATE IN MARCH 1982											Total
	14	15	16	17	18	19	20	21	22	23	24	
Jackass penguin	1	1	1	-	-	-	-	-	-	-	-	3
Cape gannet	9	-	-	-	-	-	-	-	-	-	-	9
Whitebreasted cormorant	-	1	-	-	-	-	-	-	-	-	-	1
Cape cormorant	21	9	4	3	-	3	4	2	1	-	-	47
Crowned cormorant	3	-	-	-	-	-	-	-	-	-	-	3
Kelp gull	1	2	-	-	1	-	-	1	-	-	-	5
Hartlaub's gull	2	-	1	-	-	-	1	-	-	-	-	4
Swift tern	-	-	1	-	-	-	-	-	-	-	-	1
Sacred ibis	-	1	-	-	-	-	-	-	-	-	-	1
European starling	-	-	-	-	-	-	-	1	-	-	-	1
Totals	37	14	7	3	1	3	5	4	1	-	-	75

**Table 3.5.** Birds found on a three kilometre stretch of sandy beach near Saldaña Bay, 13-27 March 1984. Values without or preceding a / indicate the number of adults; those following a / the number of juveniles.

SPECIES	DATE IN MARCH 1984													Total
	13	14	15	16	17	20	22	23	24	26	27			
Jackass penguin	1	-	-	-	-	-	-	-	-	-	-	-	1	
Cape gannet	3/11	/1	-	-	/2	-	-	-	-	-	-	-	3/14	
Whitebreasted cormorant	/1	-	-	-	-	-	-	-	-	-	-	-	/1	
Cape cormorant	2/8	/2	/1	/2	-	1/5	/3	-	/1	-	-	-	3/22	
Bank cormorant	1	-	-	-	-	-	-	-	-	-	-	-	1	
Crowned cormorant	/1	-	-	1	-	-	-	-	-	-	-	-	1/1	
Kelp gull	3	-	-	-	-	1	-	-	-	-	-	-	5	
Hartlaub's gull	1	2	-	-	-	-	-	-	-	-	-	-	3	
Swift tern	-	2	-	-	-	-	-	-	-	-	-	-	2	
Sacred ibis	1	-	-	-	-	-	-	-	-	-	-	-	1	
Rock pigeon	1	-	-	-	-	1	-	-	-	-	-	-	2	
Totals	13/2	14/3	/11	/2	/2	3/5	/3	-	/1	-	1	-	22/38	

#### 4. OBSERVATIONS ON NON-HUMAN ACCUMULATORS

##### INTRODUCTION

The presence of cultural remains in a site is incontrovertible evidence that people had been there. Eating is not, however, unique to humans, and the study of food residues presents problems of interpretation. Before embarking on interpretations of human activity based on food residues, it is essential to establish that bone assemblages were indeed left by people. Assemblages should therefore be examined for evidence to confirm that other agencies did not contribute to them as well. The problem, which has been addressed by many, is just how this can be achieved. Variation in the composition and morphology of accumulations of the prey of the different species reveals characteristics by which predators can be distinguished from one another.

As discussed in Chapter 2, predation is a potential cause of significant biases which affect the range of species and age classes taken, the potential for their preservation and the interpretations that may be based on them. While it is clearly essential to identify correctly the accumulator in order to discuss human activity, recognition of non-human accumulators does not necessarily affect the evidence for palaeoenvironments, provided that there is some control over possible selective biases.

Depending on their size and habits, predators may form assemblages that closely resemble natural populations or, through selectivity, may bias the sample. It must also be borne in mind that, to different degrees, the archaeological sites to be studied have been affected by changing sea-levels during the Upper and Terminal Pleistocene and that the direct coastal component of their environmental contexts

varied. This would have affected the 'role' of the sites as catchments for different bone-accumulating agents and the nature of the accumulations.

The species most likely to have contributed to accumulations of bird remains in sites along the Cape coasts are the brown hyaena and black-backed jackal, the black eagle and martial eagle, the barn owl and spotted and Cape eagle owls. While other predators, particularly the water mongoose, have been observed to feed on beached seabirds at least up to the size of whitebreasted cormorants (GA pers. obs.), their potential contribution is likely to have been small. Observations on modern bone accumulations left by the most likely predators are presented for comparison with the archaeological samples. Localities in southern Africa are given in Figure 4.1.

These predators, like many others, take a broad spectrum of prey, subject to the size each is able to subdue and prey availability both regionally and through time. A problem difficult to address is that many predators take carrion, and may therefore contribute bones of animals too large for them to kill. Variability in prey size and overlap between species is also the rule rather than the exception. In spite of this, however, some of the patterning found appears to be strong and suggests that most predators take prey in very close proportion to what is available, although preservation factors may lead to some species ultimately being underrepresented.

#### MAMMALIAN PREDATOR/SCAVENGERS

##### BROWN HYAENA AND SPOTTED HYENA

Brown hyaenas, which regularly scavenge birds, fish and marine mammals from beaches (Shortridge 1934; Avery *et al.* 1984; Siegfried 1984; Stuart & Shaughnessy 1984), accumulate bones in caves as well as in the open (Brain 1981; Klein 1981a;

Klein & Cruz-Uribe 1984; GA pers. obs.). Spotted hyaenas, on the other hand, do not normally occur on the coast (Skinner & Van Aarde 1981; Skead 1980) and do not usually accumulate bones, although these have occasionally been recorded in dens in rocky areas in the Kalahari (Mills & Mills 1977) and in East Africa (Kruuk 1972; Sutcliffe 1970). Spotted hyaenas do not take many small animals and are not considered likely to have contributed to the accumulations that will be discussed. Examination of an assemblage of bones, collected by A. Sutcliffe of the British Museum of Natural History from a spotted hyaena den in East Africa, leads to the suggestion that, while damage caused by the two species is almost identical, accumulations could be distinguished on the basis of the prey spectrum and size range.

A brown hyaena nursery den in the Skeleton Coast Park, Namibia (Avery *et al.* 1984) yielded only a few highly fragmented remains of seabirds (4% of the total number of individuals) in the accumulation which was dominated by springbok, gemsbok and Cape fur seal (81%) (Figure 4.2A). Species and groups of species are listed in Table 4.1. In addition to single individuals of whitechinned petrel, Cape gannet and Cape cormorant, represented by a total of nine fragments (Figure 4.3A), two ostriches were represented by only 13 bones. Skeletal elements are listed in Table 4.2. Three or four Cape cormorant wings were found some distance away from the den itself. This general paucity of avian remains is not surprising, however, given the well-known ability of hyaenas to digest bones of even large mammals; more birds were undoubtedly consumed, but it is assumed that they were completely ingested. It is possible, however, that remains of birds may be more common at dens located in the vicinity of offshore islands where many more birds would be available. In southern Namibia, for instance, remains of birds were observed to be relatively common in the vicinity of a brown hyaena den (J. Skinner, *in litt.*) near an offshore island bird colony.

Examination of an 18th century brown hyaena accumulation near Sutherland, Cape Province, supported the observation that bird remains are sparse (GA unpublished). Preservation of fragmentary bones of small and very small mammals which sometimes show signs of having been ingested, indicated that, while brown hyaena accumulations may not reflect actual numbers taken, hyaenas do take very small animals; a vlei rat tooth was found in a calcareous scat. It would be expected that bones of juvenile steenbok and grysbok, relatively large numbers of which have been reported from sites such as Eland's Bay Cave and Die Kelders Cave 1 (Klein 1981b, Parkington 1981), would normally have been totally consumed and destroyed. Characteristically-gnawed bones, deciduous teeth of juvenile hyaenas, bones of small- and medium-sized carnivores and quantities of coprolites, which are common in nursery accumulations (Klein 1981a; Klein & Cruz-Uribe 1984; Avery 1988b, pers. obs.), would also be expected in samples generated by brown hyaenas.

Although brown hyaenas occurred regularly along South African coasts in the past (Skead 1980), they can probably be excluded as an important contributor of unbiased samples of bird bones other than those of ostriches. Their influence would be more readily recognized from features other than avian remains. However, while bird bones are not a feature of their bone accumulations, hyaenas may have scavenged remains of carcasses from archaeological sites.

#### BLACK-BACKED JACKAL

Black-backed jackals are opportunistic and regularly scavenge birds, fish and marine mammals from beaches, and accumulate bones at resting areas and dens (Shortridge 1934; Stuart 1976; Avery *et al.* 1984, 1987; Stuart & Shaugnessy 1984; Nel & Loutit 1986).

Observations on remains of the prey of black-backed jackals near the Huab River on the Skeleton Coast (Avery *et al.* 1984, 1987) showed that black-backed jackals accumulate remains of beached animals, mainly the common seabirds (79%) and Cape fur seal (17%) (Figure 4.2B). Unlike brown hyaena samples, accumulations made by jackals contain virtually all avian skeletal elements, although proportions vary. Relative proportions of skeletal elements of whitebreasted cormorants (Figure 4.3B) and Cape cormorants (Figure 4.3C) show overall similarities to one another, but there is variation which can only partially be accounted for by the larger size of whitebreasted cormorants. Difference in sample size and feeding intensity may also account for some of the variation. Skeletal elements are listed in Table 4.2.

In discussing the relationship of jackal accumulations to other situations, two samples will be examined separately. Each shows considerable, but different, variation from the beach survey results with which they are compared and the suggestion might be made that jackals sometimes select from the spectrum of available prey. The discrepancies can, however, be explained in terms of natural systems.

Sample 12b from the Skeleton Coast Park, which was stratified beneath 12a, must be older than the other samples from the park, which were accumulated within the last year or two. Moreover the relatively high proportion of jackass penguins (33%) in 12b (Figure 4.4A) suggests that it was accumulated before the penguin population crashed by some 80% to the present low level (Avery *et al.* 1987; Nel & Loutit 1986). These results would probably show a greater resemblance to natural populations of forty or more years ago.

The derelict Oil Drilling Rig (ODR) sample differs at a very local level. The rig provides a suitable nesting substrate for a relatively large breeding colony of whitebreasted cormorants. Natural mortality provides a ready supply of avian prey

for the jackals (Figure 4.4B) and whitebreasted cormorants are consequently very well represented (78%) (Avery *et al.* 1987). These differences emphasize the need for modern comparative observations to cover as many alternatives as possible if they are to provide appropriate explanations of past situations and conditions.

If the 12b and ODR samples are excluded, however, the combined results from the other samples show a very close correlation with the contemporary beach surveys (Figure 4.4C). Species represented by alphabetical codes are listed in Table 4.3. This demonstrates that jackals do take beached birds unselectively (Avery *et al.* 1987).

Further comparison shows that beach survey results and, concomitantly, jackal accumulations yield extremely close approximations of the breeding populations of common seabirds and migrant common terns in Namibia (Figures 4.4D). This link between bone accumulations and avian populations confirms that coastal jackal accumulations closely reflect natural situations and can be used to assess the nature of past seabird populations provided that one can deal with the kind of local anomalies found in 12b and ODR.

In other coastal contexts, relative proportions of prey also change according to availability. For instance, in the vicinity of the Cape Cross seal colony, Nel & Loutit (1986) found that over 95% of the prey was Cape fur seal, whereas this dropped to less than 50% (min. 10%) in other coastal habitats and further inland, in accordance with local availability of birds, fish and invertebrates. Nel & Loutit (1986) concluded that the density and predictability of food determined the density of black-backed jackals along the coast and the diversity of prey types taken and that, although jackals may move considerable distances inland at times, they derive almost all of their food from the coast where predominantly marine species are taken. Jackal accumulations can thus be used as indicators of local prey abundances and therefore habitat. The effect of a highly localized source of whitebreasted

cormorants on the overall pattern can be extrapolated to sites in the immediate vicinity of coastal bird colonies and to habitats such as vleis which sustain large populations of freshwater birds.

In inland contexts, jackals take relatively large numbers of small mammals (Bothma 1971), including steenbok/grysbok, and neonates of medium-sized gregarious antelope species (Pienaar 1969) in close proportion to availability (Smithers 1983). This aspect of jackal behaviour is particularly relevant in the case of archaeological samples such as Eland's Bay Cave (Klein 1981b; Parkington 1981) at times when the lowered sea level turned this into an inland site.

Serious consideration should therefore be given to the possibility that black-backed jackals also made use of the caves to be discussed. On the assumption that people exploited beached seabirds in the same manner as did jackals, the composition and relative proportions of species would be indistinguishable, but damage left by gnawing and, possibly, relative frequencies of preserved skeletal elements would be different. The characteristics of an exclusively human-collected assemblage of bird bones are not known, however, and an undoubted further complication is the fact that jackals would have scavenged from accumulations that had been collected by people.

#### OTHER

Domestic dogs, probably indistinguishable in size from black-backed jackals, were apparently introduced into southern Africa around 2000 B.P. (Klein & Cruz-Urbe 1989). This would undoubtedly have caused a higher level of scavenging and removal of bone from accumulations. The results of their foraging or scavenging around campsites would, however, probably mimic those of jackals. It is unlikely that dogs would add to human accumulations but, through scavenging, they are

likely to have damaged and reduced the number of bones left by people (Avery 1984b, 1987a). A study of patterning through time and the spatial distributions of site components might hold the key to this problem.

Cape foxes, which are smaller than black-backed jackals, take birds (Smithers 1983). Bothma (1966) found only feathers in 16% of the stomachs examined but Cape foxes have been observed to remove seabird carcasses from a west coast beach into nearby scrub (GA pers. obs.) and to feed on carcasses in the vicinity of vleis (P.A.R. Hockey, pers comm.). Although they may use rock cover (Bothma 1966), it seems unlikely at this stage that Cape foxes would create accumulations of bones.

The possible role of leopards as contributors to archaeological assemblages in caves has been examined by Brain (1981). Virtually nothing of small mammals such as hyraxes is left undigested, and very little of larger animals such as small and medium-sized antelope; the composition of remaining skeletal elements is, however, characteristic and bones would show signs of gnawing by a large carnivore. Leopards take birds but it appears that they, together with most smaller prey, are more or less totally ingested; such remnants as occur in scats are characteristically broken up and eroded by gastric juices (Norton *et al.* 1986).

Mongoose, including both water and Cape grey, take birds (Smithers 1983; Louw & Nel 1986; MacDonald & Nel 1986). Cape grey mongooses are considerably smaller than water mongooses and are not considered likely to contribute seabirds to any accumulation. They may, however, have scavenged from carcasses. One was observed (R.A.G. Davies, pers. comm.) to remove remains of hyraxes from under a black eagle nest and to cache them under a nearby rock. Bones showed distinct toothmarks from a small carnivore. Remnants from scats of both species would be characteristically broken up and eroded. Much of the seabird component of coastal water mongoose food debris appears to derive from carcasses scavenged on the

beach and from opportunistic killing (Louw & Nel 1986; MacDonald & Nel 1986; GA pers. obs.). Louw & Nel (1986) showed that birds formed less than two per cent of the water mongoose diet at Betty's Bay; MacDonald & Nel (1986) found that birds on the west coast contributed 46% of which jackass penguins contributed 32%, Cape cormorants 11% and kelp gull 4%. Although the degree to which a mongoose might drag carcasses to a den is unknown, it can probably be assumed to have been minimal but, like any carnivore, they may have scavenged from remnants left by other predators or people. While it may not be possible to determine the history and circumstances of such interaction, this should be recognizable as 'small carnivore' from the nature of gnawing on the extremities of small bones.

## AVIAN PREDATORS

### INTRODUCTION

Some confusion is evident in South African archaeological literature regarding distinctions between the distribution and habits of local species of owls, particularly the eagle owls, *Bubo* spp., and thence details of the likelihood of their being contributors in particular sites and of prey they are able to take (Klein 1981b; Klein & Cruz-Urbe 1987; Parkington & Poggenpoel 1987). Use of the generic term 'eagle owl' is properly restricted to the Eurasian eagle owl, the largest of the eagle owls, which also occurs in North Africa. It is not therefore appropriate to make unspecified reference to the eagle owl in southern Africa. It is also potentially misleading for interpretational purposes in view of the wide range in the size (Figure 4.5) and predatory capabilities of the various species. Moreover, while the size range of prey is relatively consistent, there is annual and geographic variation in the relative proportions of particular prey types and size taken. In the Eurasian

eagle owl this has been related to availability (Hiraldo *et al.* 1976) which is in keeping with observations on some other owls (e.g. Rusch *et al.* 1972; Marti 1974; Avery *et al.* 1985)

#### BARN OWL

The bone-accumulating propensity of barn owls, which readily occupy rock shelters and caves, is well known and has been dealt with in detail (e.g. D.M. Avery 1982). Accumulations of barn-owl prey are usually substantial and easily recognized. Virtually all barn owl prey is ingested completely and regurgitated bones are characteristically unbroken and uneroded by gastric juices (Andrews 1990).

Figure 4.6A illustrates that, in the samples used (Dean 1977), the size range of barn-owl mammalian and avian prey is restricted to very small mammals and birds up to 0.01 kg in mass. This alone makes it unlikely that the barn owl's contribution would cause confusion in interpreting human activity in coastal shell midden contexts (D.M. Avery 1982). It should be borne in mind, however, that San are known to utilize small birds opportunistically, while hunting and gathering.

#### SPOTTED EAGLE OWL

The spotted eagle owl is the smallest of the eagle owls that will be dealt with and it may also utilize rock shelters and caves (Steyn 1982) but not to the extent of barn owls. Figure 4.6B illustrates that, in the samples used (Dean 1977), the size range of their mammalian and avian prey is restricted to very small mammals and birds up to 0.15 kg in mass. Virtually all spotted eagle owl prey is broken up during consumption and ingested completely. Remains from pellets are characteristically eroded by gastric juices, and would be recognizable as not representing human activity but

would show similarity to those from small carnivore scats. As in the case of barn owls, the prey of spotted eagle owls is unlikely to be a factor in determining human activity.

#### CAPE EAGLE OWL

Two subspecies of the Cape eagle owl occur in southern Africa. The smaller nominate Cape eagle owl is distributed in South Africa while the larger Mackinder's eagle owl occurs in Mozambique and Zimbabwe and extends north to Malawi and East Africa (Steyn 1982). The two will be discussed together here.

Cape eagle owls are known to roost and breed in sheltered, shady areas and to use ledges and small caves (Brooke 1973; Gargett 1977; Steyn 1982). P. Steyn (pers. comm.) believes, however, that Cape eagle owls are not likely to breed in caves suitable for human habitation; on present knowledge, they use open ledges in small overhangs or caves located in very steep and inaccessible areas.

Accumulations of Mackinder's eagle owl prey at breeding sites are substantial and include skulls, large numbers of postcranial elements and fragments (Gargett 1977). A feature of nest sites is the presence of complete red rock hare legs (Gargett 1977), although these owls are capable of ingesting them (Jackson 1973), and, consequently, of well-preserved limb bones. Limb bones in the samples include those of hyraxes, which are an important prey item, and many small rodents (Gargett & Grobler 1976; Gargett 1977; GA pers. obs.). Cranial remains are distinctive; all that generally remains is the maxillo-frontal region and intact mandibles (Gargett & Grobler 1976; Gargett 1977; Brain 1981). Pellets contain fragments and complete remains of all skeletal elements and prey sizes (Gargett 1977) and bones eroded by gastric juices would be present in a sample. These observations are supported in the southwestern Cape (GA unpubl.).

Cape eagle owls in general take a wide diversity and size range of prey (Clancey 1964; Sessions 1972; Brooke 1973; Gargett & Grobler 1976). The wide variation in prey type and size is not entirely a factor of owl size and killing ability. Although there is an upper limit to the size of prey each species can take, there is no lower limit, and small prey are an important element of many large species of owl. In the southwest Cape (GA unpubl.), Cape eagle owls' prey includes relatively high proportions of very small mammals (0.025-0.05 kg) and small mammals and birds up to 1.5 kg in mass (Figure 4.7A). Smaller prey, up to 0.1 kg and mainly vlei rats, predominate (85%); hares contribute only 23%, hyraxes less than 2% and small birds 6%. A smaller sample from a Cape eagle owl roost in the Transvaal (Brain 1981) included essentially the same spectrum of prey, but with vlei rats contributing only 47%, whereas hares were almost as common at 40%; hyraxes comprised 4% and birds (species not given) 8% (Figure 4.7B). Size of prey varied, with the southwestern Cape sample having a higher proportion and species richness of smaller prey (67% less than 0.2 kg) than that from the Transvaal (56% less than 0.2 kg) in which vlei rats predominated in this size category. Birds, all the small species, are not an important element of the diet. Clancey (1964) mentioned unspecified fawns, but Cape eagle owls have not yet been observed to take live steenbok/grysbok. This is not out of the question, however, as juveniles (0.9 kg at birth) fall well within the size range of prey they are readily capable of taking. Clancey (1964) also noted that in Natal and Zululand the Cape eagle owl takes prey as large as springhare and large species of birds. It also takes Natal red rock rabbits in Natal (GA unpubl.), the common species in Zimbabwean Mackinder's eagle owl samples, which is larger than Jameson's red rock rabbit in the Transvaal and even larger than Smith's red rock rabbit found in the southwestern Cape.

In Zimbabwe, on the other hand, small species (less than 0.2 kg mass) contributed only 6% of the prey of Mackinder's eagle owl (Gargett & Grobler 1976).

The major proportion of the prey (93%) being between 0.8 and 2.5 kg in mass (Figure 4.7C). Hares contributed 56%, hyraxes 30% and birds only 1% of the total sample, although these included francolin and guineafowl. Sessions (1972) and Coe (1967) recorded that the vertebrate prey of Mackinder's eagle owls in parts of Kenya was almost exclusively root-mole (small molerat of 0.25 kg) and vlei rats (0.1 kg).

Differences observed are readily explained in terms of local availability and habitat. In spite of their tendency to concentrate on a narrow spectrum of prey, particularly where colonial species dominate communities (Avery *et al.* 1985), Cape eagle owl accumulations would have palaeoecological significance for comparison with modern conditions. Separation of the Cape eagle owl prey from that of other owls and eagles would be assisted by the fact that, although Cape eagle owls, giant eagle owls and black eagles coexist regionally, each tends to exploit different habitats (Gargett 1977; Avery *et al.* 1985).

The Cape eagle owl's habit of accumulating considerable quantities of bones (of species likely to have been used by people) below overhangs and in small caves has led to the suggestion that it is a prime candidate for consideration when assessing archaeological samples (Brain 1981; Klein 1981b, 1984b; Avery 1984b, 1984c, 1987a; Klein & Cruz-Urbe 1987). The presence of large numbers of characteristically-broken maxillae rather than other cranial elements, a high proportion of complete mandibles and limb bones (some eroded by digestive juices) of small mammals such as hares, molerats, and hyraxes in particular, would be strongly suggestive of this agency. This assumption needs to be investigated further, however, in the light of P. Steyn's (pers. comm.) comment above, which is based on extensive experience.

## GIANT EAGLE OWL

The largest of the eagle owls occurring in South Africa, the giant eagle owl can, to some extent, be excluded as a possibility. The giant eagle owl prefers to hunt in savanna woodland or valleys where riverine vegetation, especially *Acacia* trees, provide suitable conditions (Steyn 1982). The giant eagle owl was one of the two species believed by Klein (1981b) to have been possible contributors to cave accumulations. Giant eagle owls nest in large trees and old eagle nests, however (Steyn 1982), and are unlikely to accumulate remains of their prey in caves which are the focus of this discussion (Avery 1984c, 1987a). Their present distribution excludes the western region, except for a record near Cape Agulhas where introduced trees provide suitable habitat (Avery *et al.* 1985). Nowadays, giant eagle owls normally only occur as far west as the southern Cape. Changed environmental conditions in the western Cape are unlikely to have included habitat suitable for giant eagle owls. Even were this to have been the case, a nest would have to have been located in the catchment of a cave (Brain 1981) in order for this species to become a factor in determining human activity in the western region.

Figure 4.8A illustrates the fact that, in the sample examined, giant eagle owls take a wide range of prey, including very small mammals (0.025-0.050 kg) and small mammals and birds up to 3 kg in mass (Avery *et al.* 1985). This includes a range of avian and mammalian species such as ducks, francolin, guineafowl, coots and hares, which are known to be taken by people. Giant eagle owls are also known to make opportunistic use of local abundances of animals such as hedgehogs and birds (Brown 1965; Pitman & Adamson 1978; Steyn 1982; Avery *et al.* 1985). Although far west of its normal distribution range, the observations from De Hoop show the wide variety and size range of prey typical of giant eagle owls elsewhere. A characteristic of the prey of giant eagle owls is a relatively high proportion of birds,

particularly other raptors, although the De Hoop proportion (73%) is high even by this standard. Giant eagle owls are omnivorous, however, and the overall factor determining what is taken by this widely distributed species must be availability (Avery *et al.* 1985).

Giant eagle owl prey remains are not all ingested; wings and other elements were found beneath roosts. Most, however, including whole limbs of crows, appeared to have been regurgitated in pellets as they were fragmented and showed signs of having been eroded by gastric juices. Giant eagle owl prey remains would be distinct from the results of human activity, but may superficially fall within the range of carnivore scats. Species composition may indicate which predator was most likely to have contributed to the accumulation of bones, assuming that confusing factors like multiple agencies (e.g. giant eagles using black eagle nests) were not operating. The presence of many fragmented and eroded bones would, however, alert the analyst to the existence of an agency other than, or additional to, eagles and people.

#### EURASIAN EAGLE OWL

The Eurasian eagle owl is the largest of all the eagle owls and is included to illustrate the possibility of confusion if the predator is simply referred to as 'the eagle owl'. Being well studied, it also provides additional observations on the prey and habits of this group of owls. Also known as desert eagle owls, they are widespread in Europe and occur in North Africa and on the southern fringes of the Sahara Desert (Fry *et al.* 1988). Eurasian eagle owls breed in both trees and rocky areas, using clefts and small caves (Frey 1973) from which the large quantities of their prey remains could become mixed with human accumulations.

Eurasian eagle owls appear to have very similar hunting strategies to Cape and Mackinder's eagle owls, with very high proportions of gregarious species such as hares and small rodents, Phasianidae (partridges, pheasants, etc.) and members of the crow family. Variation is attributed to differences in the availability of prey. Figure 4.8B and 4.8C provide relative proportions of prey types in two regions; Spain which is drier (Hiraldo *et al.* 1975) and Lower Austria which is wetter (Frey 1973). The samples are quite distinct in their composition, although many species occur in both. The Spanish sample is dominated by hares and rabbits (64%), with birds contributing 24%. Small rodents contributed 9% and there were no larger rodents. The Austrian sample is far more diverse, with more even proportions of insectivores (mainly hedgehog) (10%), hares and rabbits (14%), small rodents (24%), larger rodents (12%) and Phasianidae (20%). Prey over 0.5 kg, which includes the Phasianidae, contribute 79% of the total in the Spanish sample. In the Austrian sample, however, the diversity of prey types is reflected in the size ranges, but prey over 0.5 kg contribute only 48% of the sample, Phasianidae alone contributing 42% of this range. Remains of a few deer, the new born of which range between 10 and 24 kg, have been found in accumulations of Eurasian eagle owl prey (given in the 11 kg category of Figure 4.8C.) The possibility that this may represent carrion is, however, not addressed by the authors.

These differences match those found in a wider comparison of Eurasian eagle owl prey in the Iberian Peninsula with that in humid Europe (Hiraldo *et al.* 1976). They argued that, although it would have been energetically more economical to take hares and rabbits, which are common in the Mediterranean region, rather than smaller mammals and birds, changes in the density of potential prey accounted for regional variability. Rabbits and hares are not readily available in humid Europe and the owls switched to a greater diversity of prey, particularly small rodents. At a more local level, as Hiraldo *et al.* (1975) pointed out, a similar switch

existed between those of their samples taken from natural areas in which hares were common and those from agricultural areas. This difference has been masked by amalgamation of the samples in the present study (Figure 4.8B).

It is clear from this brief survey that, while differences exist between species, the influence of environment and local conditions is a major determinant of the range and size of prey taken by any one (the spotted eagle owl excepted in the upper size ranges) of the species of owl discussed.

#### BLACK EAGLE

Brain (1981) commented that, while black eagles probably never entered caves, remains of prey that were dropped from a nest or feeding perch in the catchment of a cave would contribute to the bone accumulation there. He gave some details of the prey, mainly hyraxes, in samples available to him and indicated that, while most of the postcranial skeleton was ingested, skulls with characteristically damaged braincases were left. He concluded that damage caused by black eagles and leopards would be readily distinguishable if preserved in fossil contexts.

Observations based on recent studies of black eagle prey (Boshoff *et al.* in prep.) confirm Brain's observations (1981) and provide additional observations on a wider spectrum of prey. Black eagles regularly nest on ledges in cliffs of variable height and take a wide variety of small mammals, game birds, reptiles and even carrion. Prey includes large numbers of rock hyrax, augmented by hares, tortoises, small carnivores such as mongooses and Cape fox (jackals have been eradicated), Cape dune molerats, and juvenile and adult steenbok/grysbok (Steyn 1982; Boshoff *et al.* in prep.).

Only those results from samples in the Fynbos biome will be discussed at this stage (Figure 4.9A). Mammals contribute 89% and birds, mainly freshwater birds,

guineafowl and francolin, 11% of the prey. The major characteristic of black eagle prey is the high proportion of hyraxes taken. The proportion (54%) from the Fynbos is the lowest recorded in the biomes studied by Boshoff *et al.* (in prep.), but the mean of 90% for the Karoo Biome shows very clearly the association of black eagles with hyraxes and rocky habitats. The next most common element of their prey in the Fynbos is large rodents, exclusively represented by Cape dune molerats (11%), followed by hares (10%), antelope/domestic bovids (8%), Phasianidae (7%) and Mustelidae/Viverridae (5%). Black eagles take a wide range of prey, the size of which ranges from 0.5 kg to 11 Kg in the case of adult antelope, but the majority do not exceed 4 kg. The juvenile component of small antelope (domestic animals excluded) is 79% (Boshoff *et al.* in prep.).

Although a source of hyraxes seems to be a constant prerequisite for the location of black eagle breeding sites, the importance of hyrax contributions and diversity of other prey species are explained by variability in habitat and availability of suitable prey (Boshoff *et al.* in prep.). Thus, while black eagles tend to concentrate on a narrow spectrum of prey in the Karoo, a generally higher prey diversity is found in the Fynbos and Grassland Biomes (Boshoff *et al.* in prep.). This habit of adapting to local conditions means that samples from different areas will provide analogues for interpreting changed environmental conditions in the past from archaeological samples.

Separation of black eagle prey from that of owls, particularly the Cape eagle owl, and other eagles, would be assisted by the fact that although black eagles, Cape eagle owls and giant eagle owls and black and martial eagles coexist regionally, they tend to exploit different habitats (Gargett 1977; Avery *et al.* 1985; Boshoff *et al.* in press; Boshoff *et al.* in prep.).

The condition of prey remains of black eagles is very variable but the eagles' digestion is strong enough to destroy most bones ingested. This means that fewer

eroded bones are found in their accumulations than in those of the eagle owl species. As noted above, hyrax cranial bones and mandibles are not generally ingested, whereas those of hares and smaller species and most postcranial bones of hyraxes and small species are, and are consequently underrepresented. This pattern does not necessarily hold for larger prey, including small antelope, the postcranial elements of which are better represented.

Provided that bones were not subjected to selection or sorting processes during transport into a cave, residues would be distinct from those of Cape eagle owls because the range of habitats and size of prey exploited by each species are largely distinct, and may provide clues to the predator's identity. An important contrast with Cape eagle owls would be the lack of large numbers of postcranial bones of small mammals such as hares, Cape dune molerats, and hyraxes in black eagle accumulations.

Because prey spectra may be dominated by one or two species, they can provide useful quantitative data on population structure and individual size variation for comparison with palaeoecological evidence to enable studies such as that by Klein & Cruz-uribe (1987) of changes of Cape dune molerat size in response to climatic change during the terminal Pleistocene.

#### MARTIAL EAGLE

In the Cape Province martial eagles take mainly hares, rock hyraxes, mongooses and Karoo korhaan supplemented by a small proportion of steenbok, mainly juveniles and sub-adults (Boshoff & Palmer 1980; Boshoff *et al.* in press.). Martial eagles normally breed in trees (Steyn 1982) but are known to use ledges on cliffs in the Karoo (Boshoff & Fabricus 1986; Boshoff *et al.* in press). Since their distribution is wide and cliffs would have been the most likely nest substrate available to them in

the Fynbos, it is necessary to consider martial eagles, like black eagles, as potential contributors of bones.

No samples from the Fynbos biome are available and it must be borne in mind that the southeast Nama-Karoo Biome example (Figure 4.9B) may not necessarily accurately reflect conditions in the Fynbos. Mammals contribute 87% and birds, mainly bustards, 11% of the prey. The major characteristic of martial eagle prey is the high proportion of hares (50%) rather than hyraxes (5%) taken. This is an indication of the association of martial eagles with open habitats (Smithers 1983). Even where nests are located in cliffs the proportion of hares in individual samples is not exceeded by that of hyraxes as in black eagle accumulations. The next most common element of martial eagle prey is Mustelidae/Viverridae (14%), followed by antelope/domestic bovids (13%), bustards and korhaans (10%) and small carnivores (7%). This provides a further contrast with black eagles, and again shows the greater association of martial eagles with open habitats. Martial eagles take a wide range of prey and sizes range from 0.4 kg to 11 Kg in the case of adult antelope, but the majority do not exceed 4 kg. The juvenile component of small antelope (domestic animals excluded) is 87%.

The condition of prey remains of martial eagles is also very variable, but some eroded hare long bones are found in pellets which suggests that martial eagles are less able than black eagles to cope with this size of bone.

An important feature of martial eagle prey remains is the occurrence of many hare limbs, particularly hind limbs, which are stripped of muscle, leaving the bones of the lower leg and foot intact. Whereas hyrax cranial bones and mandibles are not generally ingested (braincases have been broken in the same manner as those taken by black eagles), those of hares are ingested and virtually absent from samples. Crania of Mustelidae and Viverridae are more common than postcranial elements. This pattern does not necessarily hold for larger prey, including small

antelope, the postcranial elements of which are sometimes better represented, while those of bat-eared foxes include both elements.

Like black eagles, martial eagles could contribute bones to cave accumulations if a suitable transport mechanism existed. Provided that such assemblages were not subjected to selection or sorting processes, residues would be distinct from those of Cape eagle owls and black eagles.

As in the cases of the other predators discussed, the habitat included in the territory of the eagles determines the species richness and diversity of available prey and is thus reflected in samples in spite of their being dominated by hares.

## VULTURES

Cape vultures breed on cliffs and are known to bring bones back to their nests (Steyn 1982; Plug 1978). Cape vultures have, however, very specific cliff requirements (Steyn 1982) which are not generally met by the sites to be studied, although vultures may have used the cliffs above archaeological sites as temporary roosts from time to time.

Cape vultures collect bone, possibly to offset mineral deficiencies, and Plug (1978) cited a wide variety of species, including small mammals and medium-sized birds but mostly larger species, in her comparative analysis. Relative proportions of ribs and vertebrae were much higher than any other identifiable skeletal element. Plug (1978) also noted that carnivore damage was common on fragmented bone collected mainly by whitebacked vultures. It could be expected that this would be more prevalent in Cape vultures under natural circumstances.

The wide variety of species represented in the samples and particularly the low numbers of bones, suggest that Cape vulture accumulations would not reflect availability of prey at all accurately; in any event they would appear to be a minor

element amongst the potential agencies discussed, and it is emphasised that the sites to be discussed would not have been suitable breeding localities at any stage. Cape vultures can therefore be excluded as significant contributors to the archaeological assemblages.

#### SUMMARY

Table 4.4 summarizes the characteristics of the predators and prey that are considered likely to have been involved in the accumulation of archaeological samples. Of the species discussed, black-backed jackals and Cape eagle owls appear to be the most likely to have been important in the formation of the avian bone assemblages to be studied. In addition the potential of both black eagles, which currently breed in the cliffs adjacent to Eland's Bay Cave, and martial eagles should be considered.

A cautionary word is necessary at this stage. The distinctions drawn appear to be real but considerable variation in prey taken is evident under different conditions, even for the same species. The prey project is still in its early stages, particularly with regard to comparisons of the damage and destruction caused during consumption and the preservation of skeletal elements after burial. It would be advisable at this stage, therefore, to keep an open mind and to consider any predator that may take prey sizes which overlap with those of people. I nevertheless believe that the results obtained so far will provide a good basis for assessing whether agents other than people have contributed avian (and other) remains to the assemblages.

There are upper limits to the size of prey that each species can take. Within these limits, however, many differences and similarities between the prey taken by black-backed jackal, various owls and the eagles can be explained in terms of hunting habitat. Availability within the habitat is a very, if not the most important,

factor in determining whether and in what proportions different prey species are taken by predators of different sizes.

The study of non-human accumulators of bones is potentially an invaluable source of information for both archaeologists and palaeoecologists. It provides a control against biases that, left unrecognized, would mislead archaeologists in their interpretations of human activity. At another level, equally important information concerning the presence and palaeoecology of the predator, whether human or not, can be obtained.

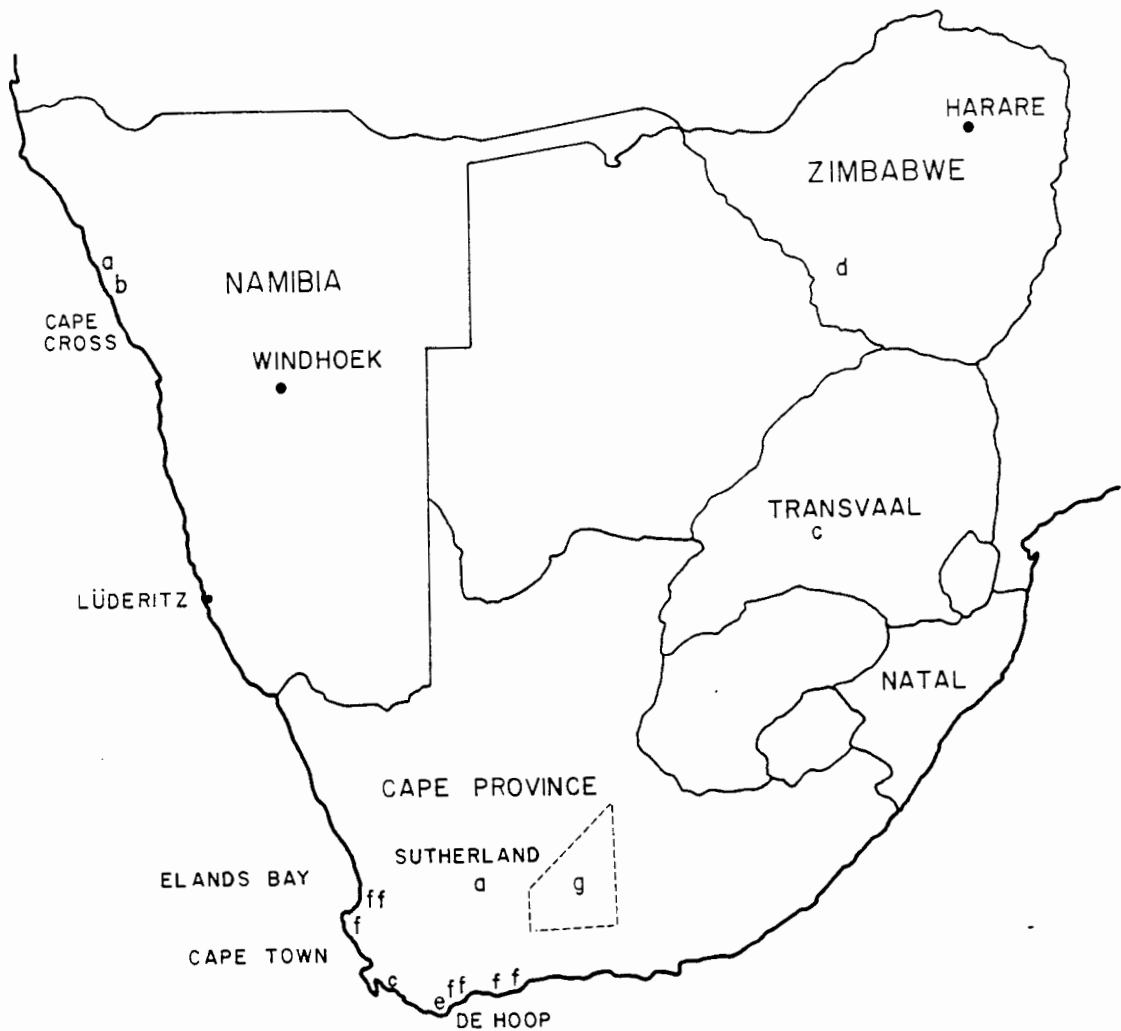


Figure 4.1. Localities from which samples were collected. a) brown hyaena; b) black-backed jackal; c) Cape eagle owl; d) Mackinder's eagle owl; e) giant eagle owl; f) black eagle; g) martial eagle.

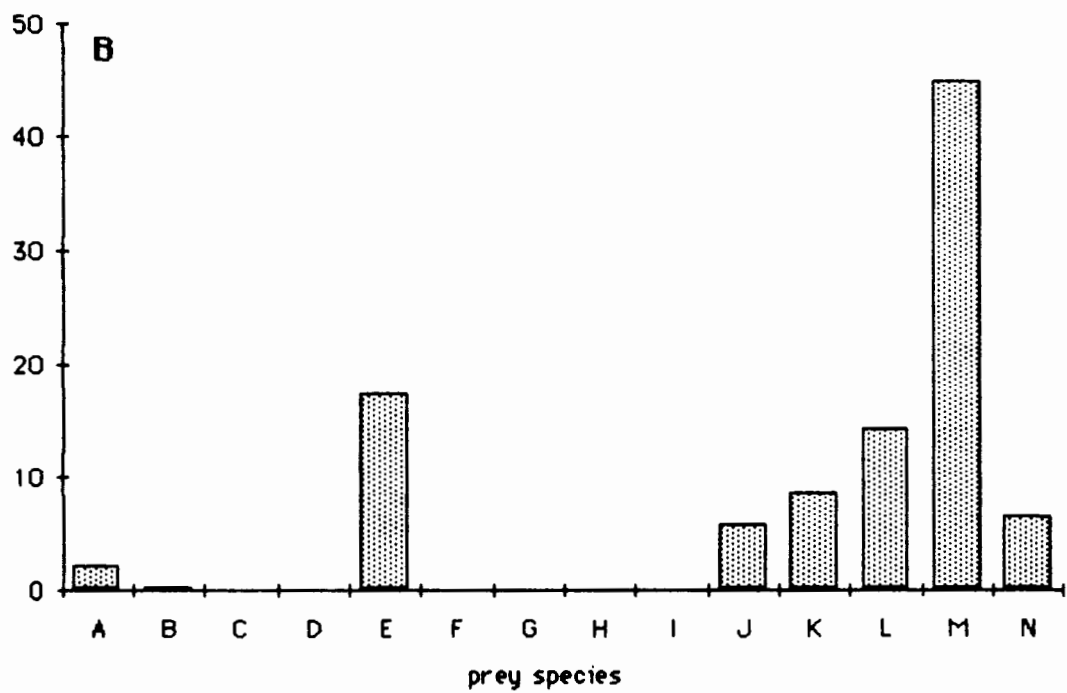
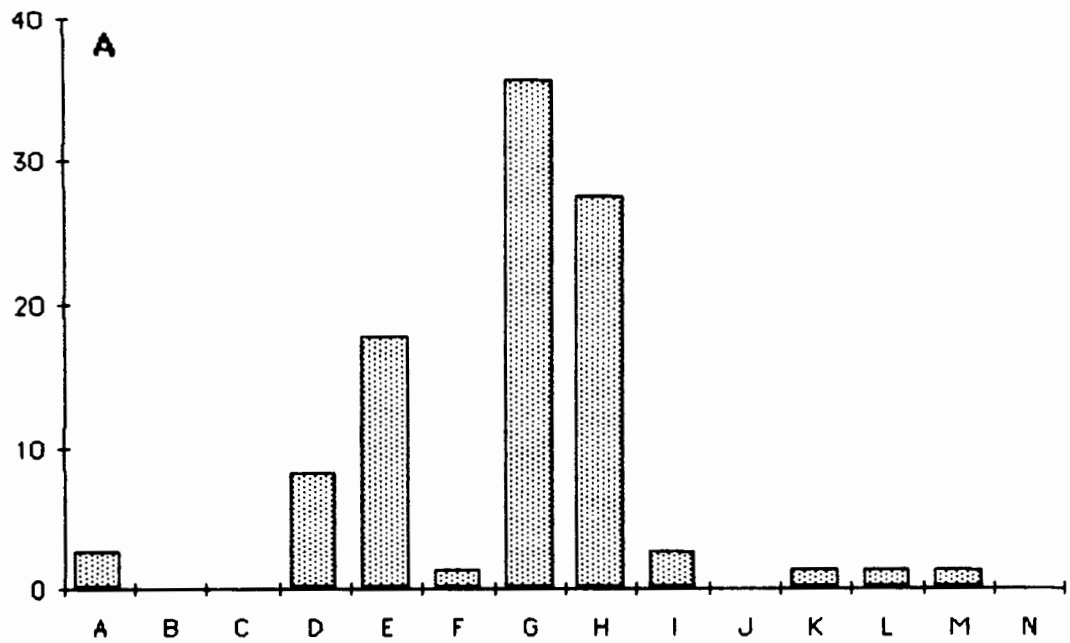


Figure 4.2. Prey taken by coastal brown hyaenas (A) and blackbacked jackals (B) in the Skeleton Coast Park, Namibia. Species and groups of species represented by alphabetical codes are listed in Table 4.1.

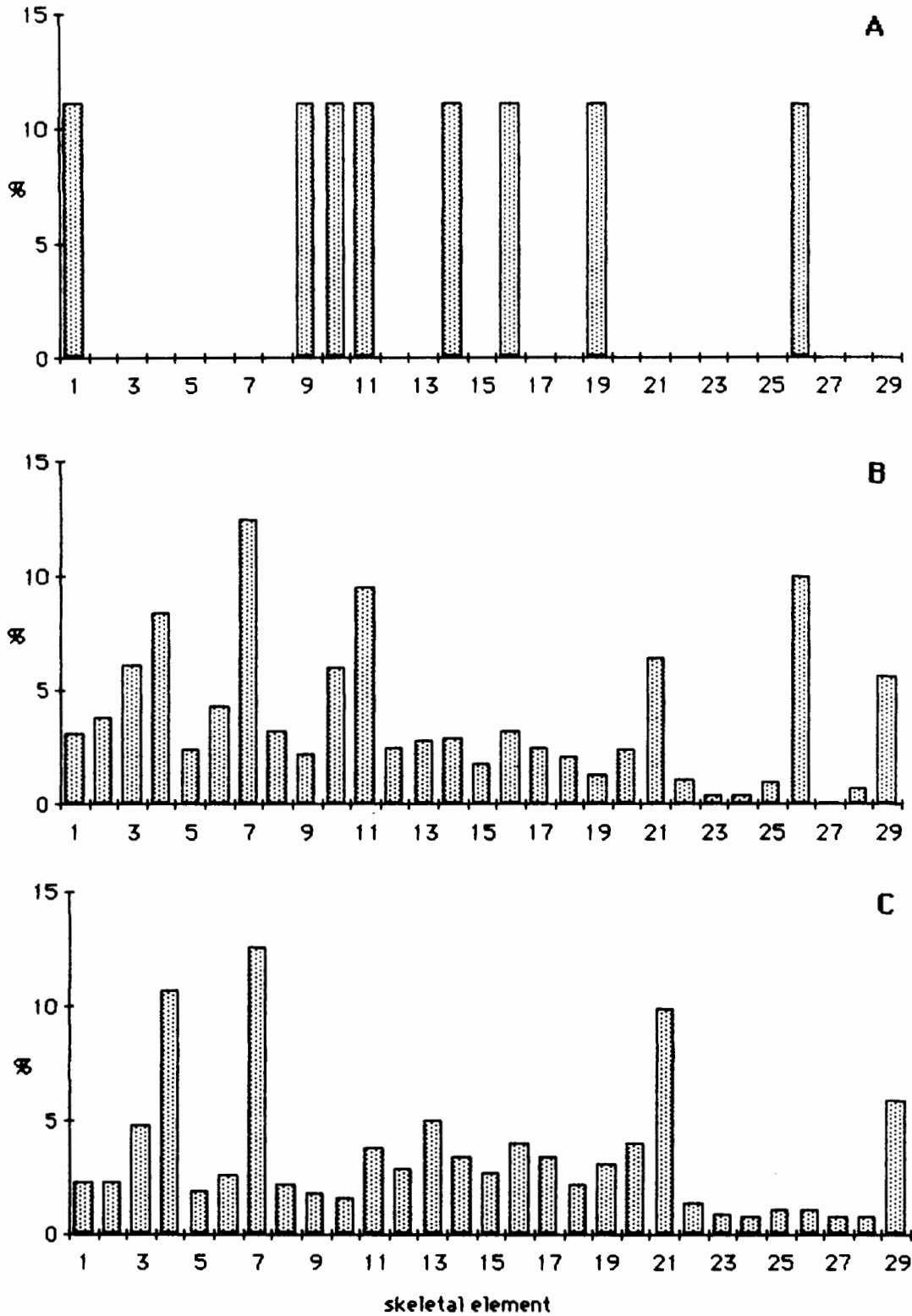
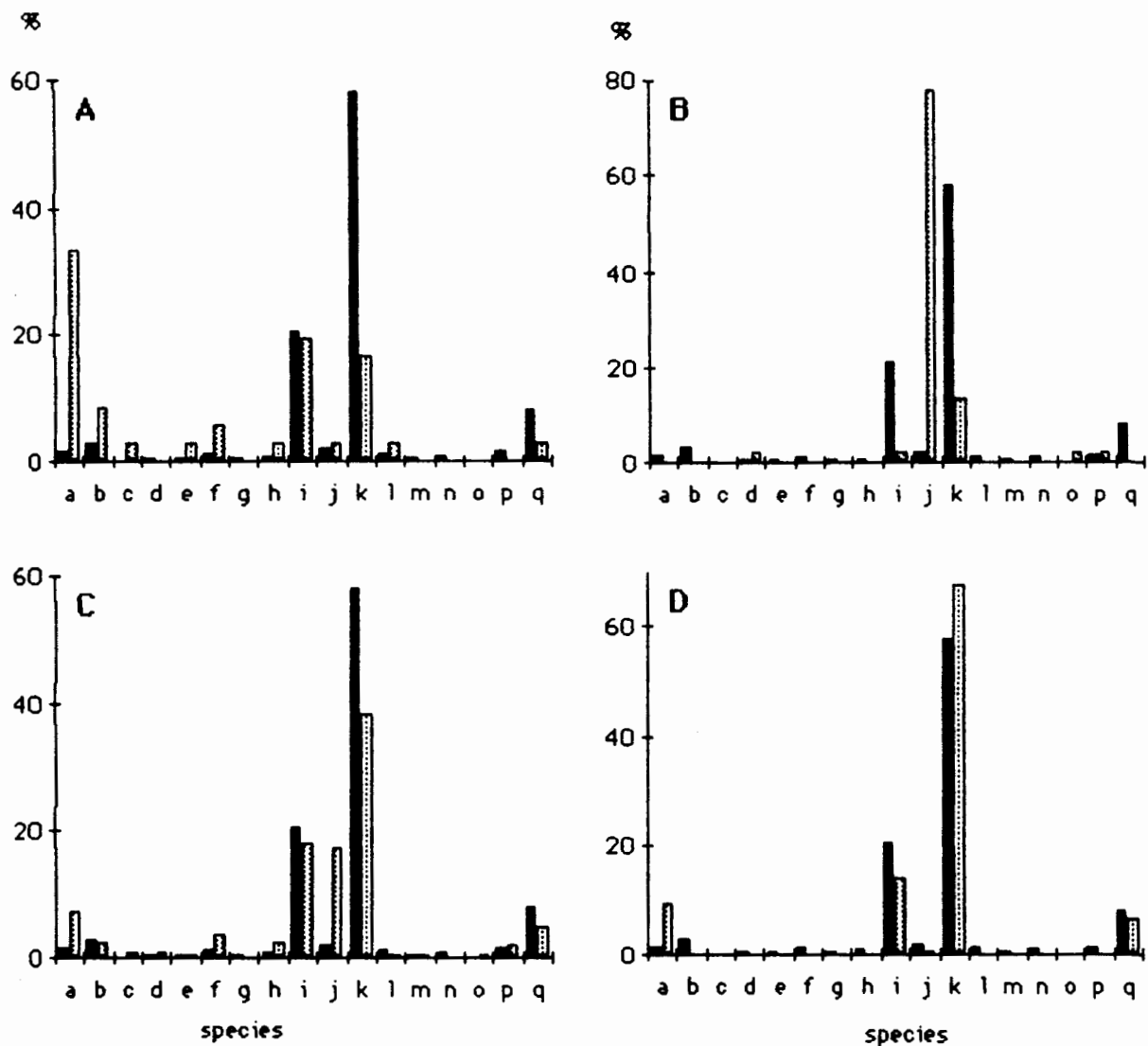


Figure 4.3. Relative proportions of skeletal elements of seabirds at the brown hyaena den (A) and of whitebreasted cormorants (B) and Cape cormorants (C) accumulated by black-backed jackals in the Skeleton Coast Park, Namibia. Elements represented by numerical codes are listed in Table 4.2.



black columns - beach survey data in all cases

Figure 4.4. Comparison of results from surveys for beached seabirds in the Skeleton Coast Park, Namibia, with results from black-backed jackal accumulations (A - 12b; B - Oil Drilling Rig; C - Other) and modern breeding populations of common resident seabirds and migrant common terns in Namibia (D). Species are listed in Table 4.3.

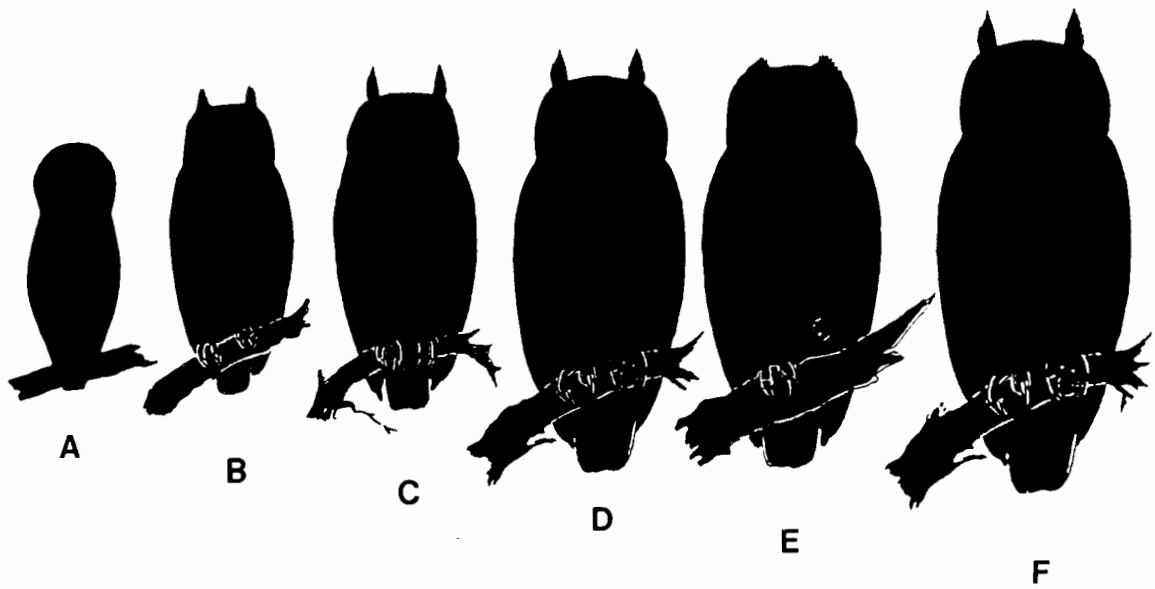
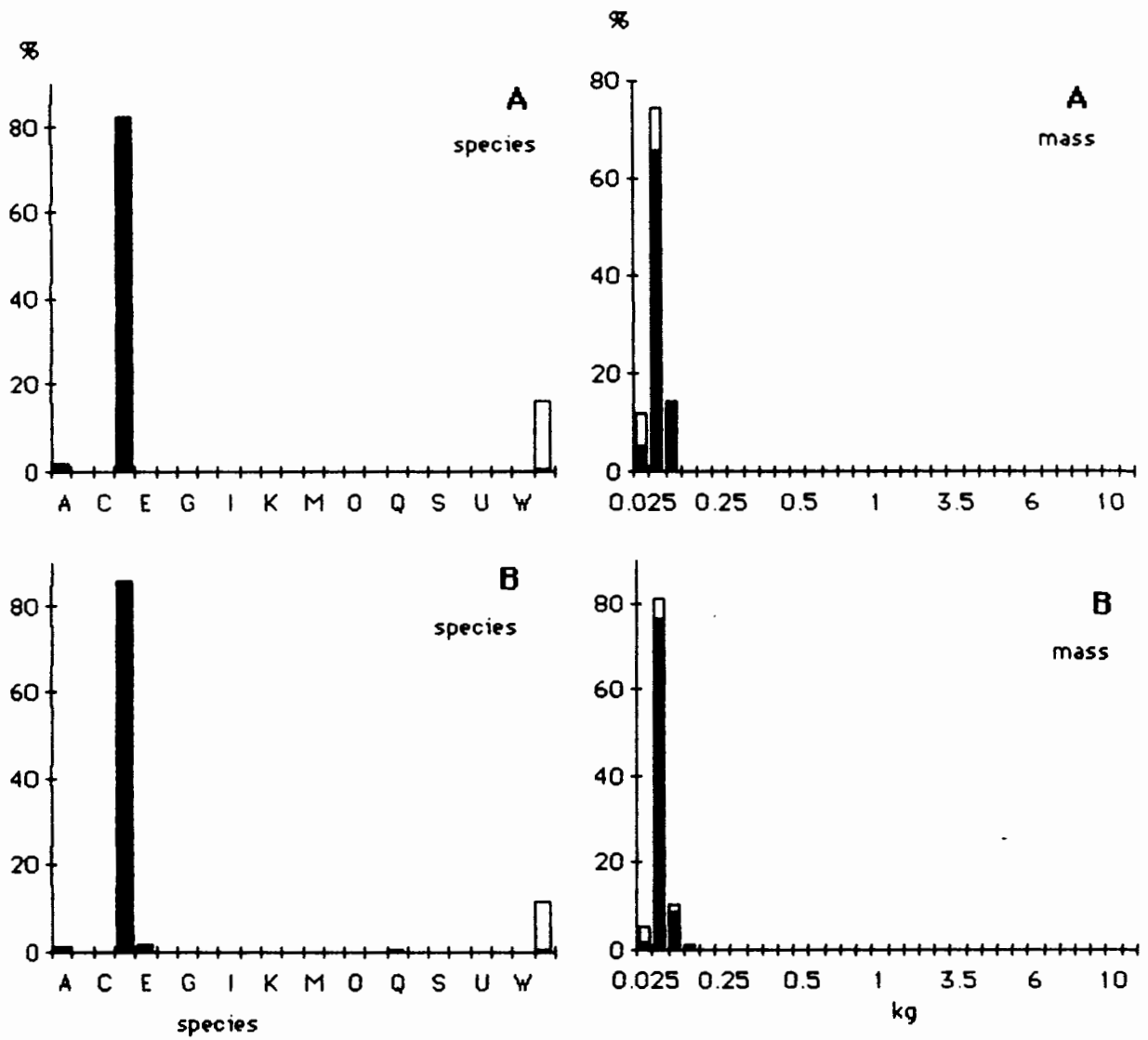


Figure 4.5. Relative sizes of owls discussed. Barn owl (A), spotted eagle owl (B), Cape eagle owl (C), Mackinder's eagle owl (D), giant eagle owl (E) and Eurasian eagle owl (F) (after Steyn 1982: 267).



black columns - mammals; white columns - birds

Figure 4.6. Comparison of prey species and groups of species, and mass categories of prey of barn owl (A) and spotted eagle owl (B). Prey are listed in Table 4.1.

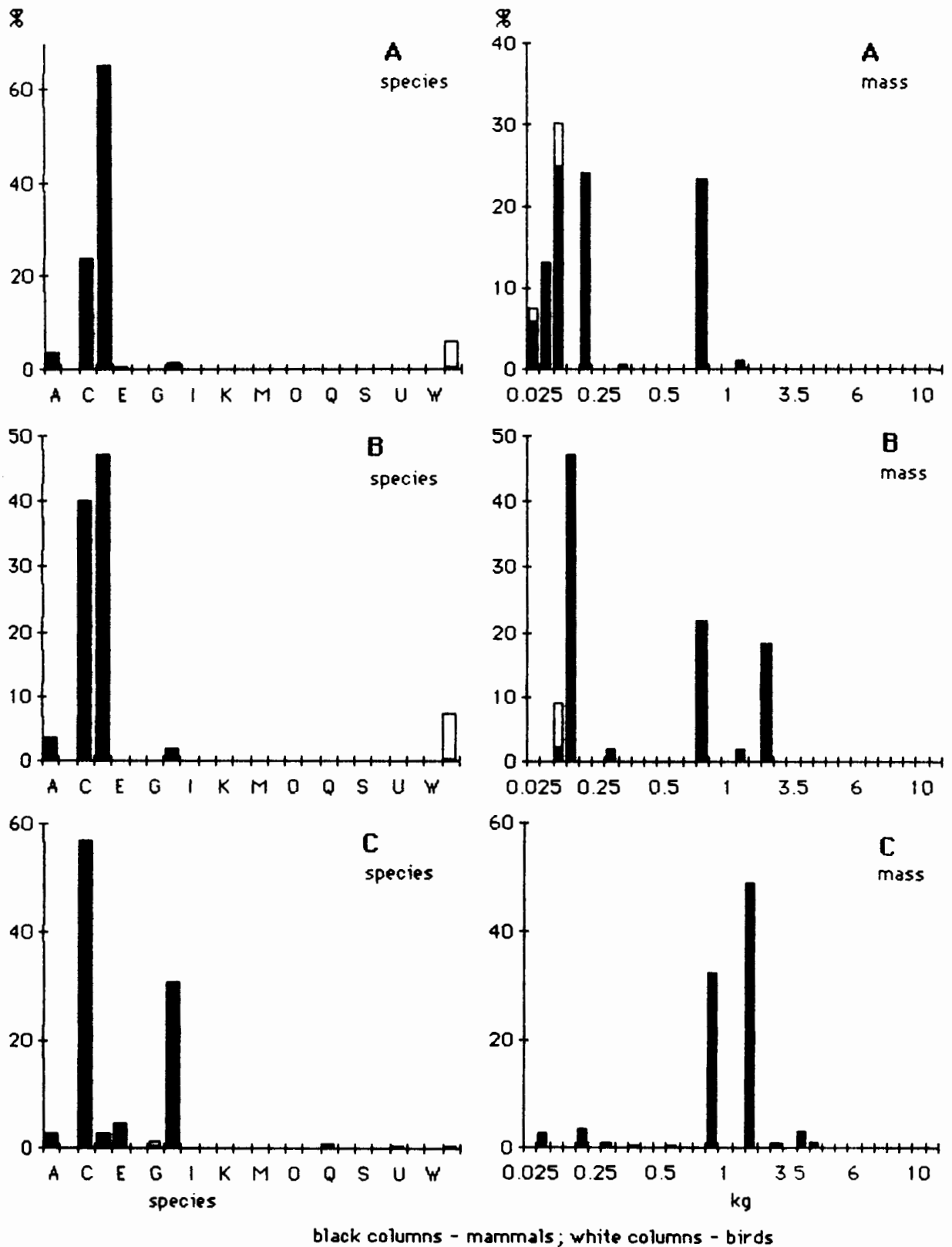


Figure 4.7. Comparison of prey species and groups of species, and size categories of prey of Cape eagle owl in the southwestern Cape (A) and Transvaal (B), and Mackinder's eagle owl in Zimbabwe (C). Prey are listed in Table 4.1.

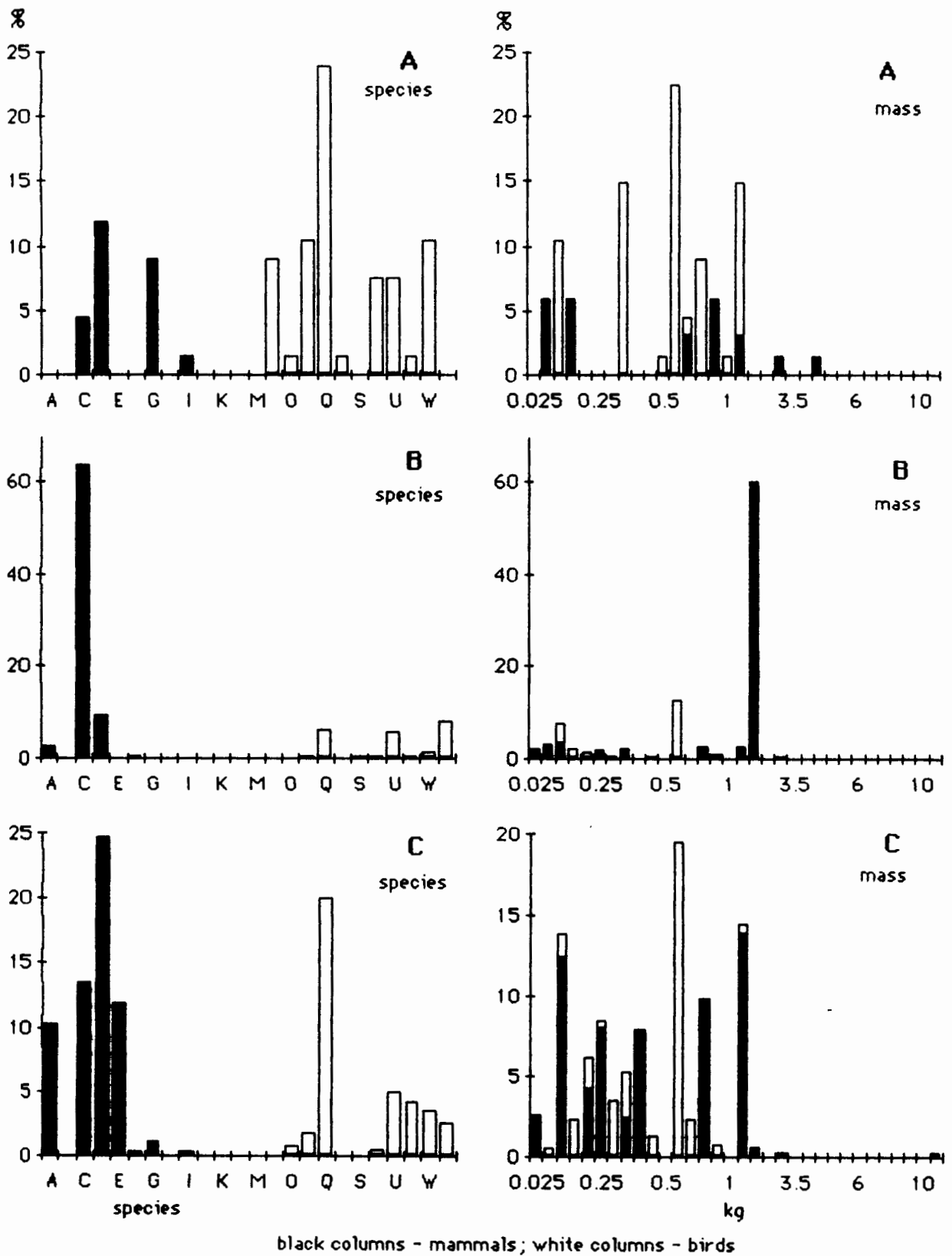


Figure 4.8. Comparison of prey species and groups of species, and size categories of prey of giant eagle owl in the southwestern Cape (A), and Eurasian eagle owl in Spain (B) and lower Austria (C). Prey are listed in Table 4.1.

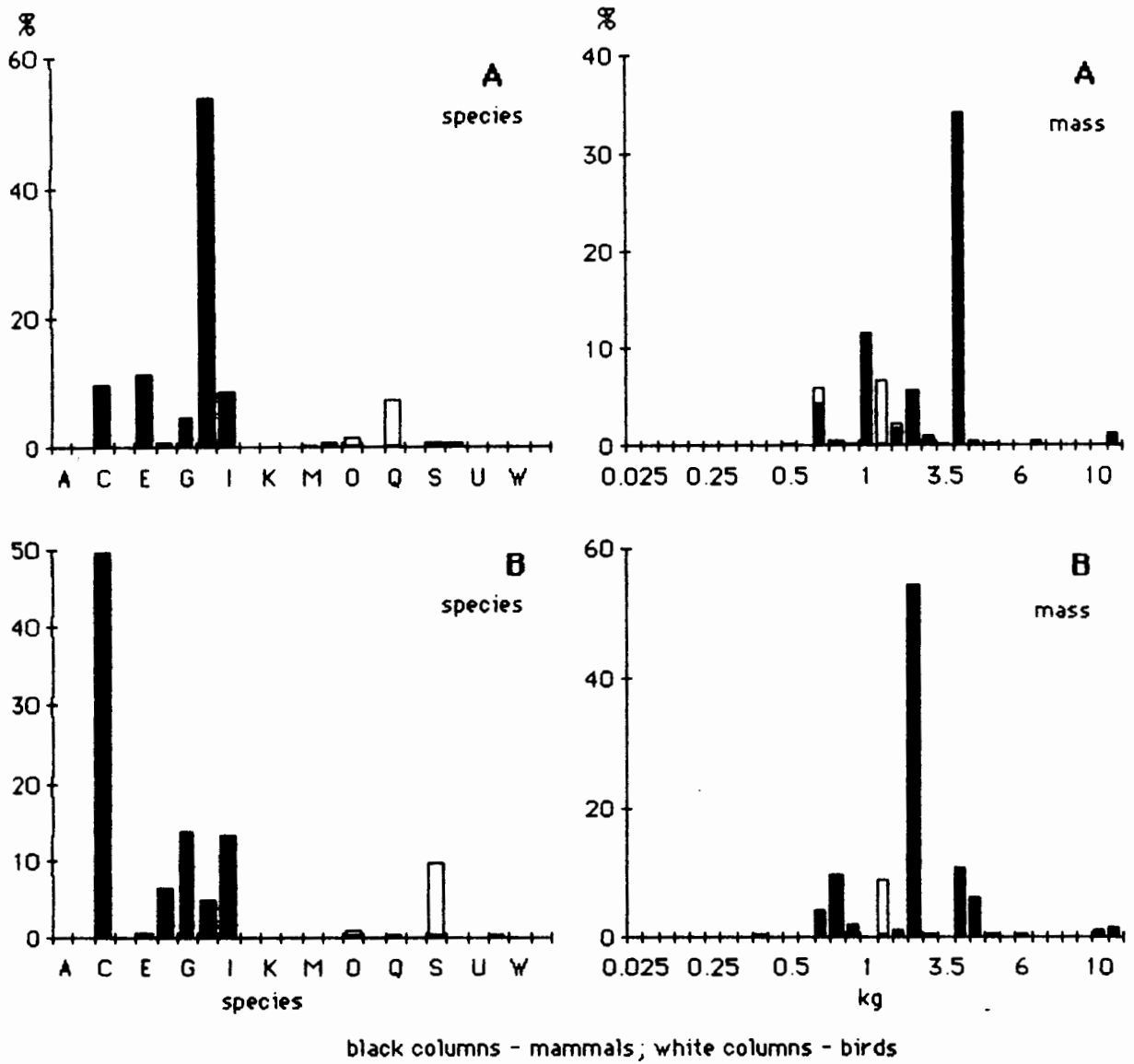


Figure 4.9. Comparison of prey species and groups of species, and size categories of prey of black eagle in the Fynbos Biome (A) and martial eagle in the southeast Karoo (B). Prey are listed in Table 4.1.

**Table 4.1.** Alphabetical codes used for prey taken by brown hyaenas and black-backed jackals (Figure 4.2) and owls and eagles (Figures 4.6-4.9).

SPECIES/GROUPS	HYAENA	OWLS
	JACKAL	EAGLES
<b>MAMMALS</b>		
Whales/dolphins	A	-
Insectivores/bats (incl. hedgehog)	-	A
Primates (monkey)	-	B
Hares/rabbits	-	C
Small rodents/microtines (rats/mice/voles)	B	D
Large rodent	-	E
Small carnivores (foxes, jackal)	C	F
Mustelidae/Viverridae (polecats/mongoose)	-	G
Medium carnivores (hyaenas)	D	-
Cape fur seal	E	-
Hyraxes	-	H
Warthog	F	-
Small/medium antelope, sheep/goat	-	I
Medium antelope	G	-
Large antelope	H	-
<b>BIRDS</b>		
Ostrich	I	-
Jackass penguin	J	J
Albatrosses/petrels/shearwaters	K	K
Cape gannet	L	L
Cormorants	M	M
Heron/stork/ibis/spoonbill/flamingo/grebe	-	N
Ducks/geese	-	O
Vultures/eagles/hawks, etc.	-	P
Francolin/partridges/quails/guineafowl	-	Q
Coot/moorhen	-	R
Bustards/korhaans	-	S
Plovers/avocet/dikkop/gulls/terns	N	T
Pigeons	-	U
Owls	-	V
Crows and family	-	W
Other birds (small)	-	X

**Table 4.2.** Skeletal elements listed by numbers in comparisons of bird remains left by brown hyaenas and black-backed jackals (Figure 4.3).

SKELETAL ELEMENT	CODE
Cranial fragments	1
Maxillary fragments	2
Mandibular fragments	3
Vertebrae	4
Synsacrum	5
Pelvis	6
Ribs	7
Sternum	8
Furcula	9
Scapula	10
Coracoid	11
Humerus - proximal	12
Humerus - distal	13
Radius - proximal	14
Radius - distal	15
Ulna - proximal	16
Ulna - distal	17
Carpals	18
Carpometacarpus - proximal	19
Carpometacarpus - distal	20
Digits	21
Femur - proximal	22
Femur - distal	23
Tibiotarsus - proximal	24
Tibiotarsus - distal	25
Fibula	26
Tarsometatarsus - proximal	27
Tarsometatarsus - distal	28
Phalanges	29

**Table 4.3.** Alphabetical codes used for avian species found in black-backed jackal accumulations and on beach surveys in Namibia (Figure 4.4).

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SPECIES	CODE
Jackass penguin	a
Albatrosses	b
Giant petrel	c
Pintado petrel	d
Prions	e
Whitechinned petrel	f
Great shearwater	g
Sooty shearwater	h
Cape gannet	i
Whitebreasted cormorant	j
Cape cormorant	k
Grey plover	l
Arctic skua	m
Kelp gull	n
Sabine's gull	o
Sandwich tern	p
Common tern	q

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**Table 4.4.** Summary of the main characteristics of the predators and prey likely to have been involved in the accumulation of archaeological samples (from personal observations and references cited in the text).

PREDATOR	LOCATION	PREY (MAMMALS AND BIRDS)	BODY PARTS PRESERVED	CRANIAL AND POSTCRANIAL	DAMAGE
BROWN HYAENA	open, caves	0.1 kg to v. large scavenged mammals. Wide range mainly small-medium mammals, as available	?most in medium to large mammals except extremities, few bird remains	variable	deep pitting, scoring, flaking; seal bones almost totally digested; except ostrich, bird bones almost totally digested; eroded fragments of large bones phalanges and teeth from disintegrated scats.
BLACK-BACKED JACKAL	open, ?caves	0.025 kg to large scavenged mammals as available	most, in varying proportions, seal extremities common	variable in small mammals and seabirds; pc in larger mammals	pitting and scoring on seal bones and phalanges; breakage and tooth marks on bird bones; preservation related partly to muscle cover; eroded fragments from scats
DOMESTIC DOG	human living areas	scavenge human refuse & on beach; hunt small birds, mammals, probably similar to jackals	?similar to jackals	depends on available refuse; ?other similar to jackals	?similar to jackals; also secondary damage to refuse
BARN OWL	caves	up to 0.15 kg. Mainly very small mammals, few birds	all	both	no damage
SPOTTED EAGLE OWL	open, caves	as barn owl	most	both	fragmented

(cont.)

Table 4.4  
(cont.)

PREDATOR	LOCATION	PREY (MAMMALS AND BIRDS)	BODY PARTS PRESERVED	CRANIAL AND POSTCRANIAL	DAMAGE
BCAPE EAGLE OWL	open. small caves	0.025 to 2.5 kg. Mainly hares, hyraxes and smaller rodents as available; few birds	most	both	characteristic damage to cranial bones; ingested bones eroded; small punctures as in small carnivores
GIANT EAGLE OWL	trees	0.025 to 4.5 kg. Wide range small mammals and especially birds, including birds of prey, herons, crows	all, in variable proportions	both	some bones heavily fragmented, many (especially from lower limbs) completely ingested; bones normally completely digested; punctures and fracturing as in small carnivores
BLACK EAGLE	cliffs, trees	0.5 to 11 kg. Mainly hyrax; hares, molerats, small carnivores and antelope (including juveniles) as available; birds, e.g. ducks, francolins	all; proportions vary according to prey species	hyrax and molerats mainly cranial, antelope variable but pc commoner, hares mostly pc	some fragmentation, many (especially lower limb bones) complete; ingested bones normally completely digested; punctures and fracturing as in small carnivores
MARTIAL EAGLE	trees, cliffs	0.4 to 11 kg. Mainly hares and bustards. Otherwise similar to black eagle	as black eagle	mainly pc, especially hare hind limbs	as black eagle

## 5. WEST COAST ARCHAEOLOGICAL SAMPLE: ELAND'S BAY CAVE

### INTRODUCTION

The most important coastal archaeological sequence on the west coast is undoubtedly that of Eland's Bay Cave. This and other cave and open sites form the focus of a major project on prehistoric subsistence strategies in the Verlorenvlei catchment, adjacent coastal region and mountains further inland (Parkington 1987; Parkington *et al.* 1988). Eland's Bay Cave is located in cliffs of a Table Mountain Sandstone promontory on the coast some 200 km north of Cape Town (Figure 5.1). Except in the immediate vicinity of the promontory, sandy beaches extend many kilometres to the north and south. Two kilometres to the north of the cave the coast is intersected by the dry mouth of Verlorenvlei, a shallow, saline estuary which develops into a freshwater lake about 4 km from the coast (Grindley & Grindley 1987). The combined rocky coastline and lake catchment provides a wide range of marine, freshwater and terrestrial resources within a relatively confined area.

The Eland's Bay Cave sequence is complex and interrupted by a major hiatus between 8000 and 4000 B.P., with at least one other of shorter duration between 3500 and about 1600 B.P. after which the occurrence of domestic sheep indicates the addition of pastoralism to the purely hunter-gathering economy that had existed previously (Table 5.1; Parkington 1980, 1981). An apparent hiatus between 20 000 B.P. and 13 600 B.P. (John Parkington, pers. comm.) precedes the starting point for the sequence of avian samples to be discussed.

Stratigraphic and palaeoenvironmental information is summarized in Table 5.1. Parkington (1976, 1981), J. Deacon *et al.* (1984), Yates *et al.* (1986), Miller (1987), Poggenpoel (1987), Rogers (1987) and Deacon & Lancaster (1988)

discussed evidence for environmental change and its effects on the resources and physical characteristics of the coast and lake. D.M. Avery (1983) and Klein & Cruz-Uribe (1987) provided evidence for vegetation change based on micro- and macro-mammalian remains respectively. Avery (1987a) commented on evidence for change in the marine and freshwater environments. Major climatic trends for the western Cape region are summarized in Partridge *et al.* (submitted).

## METHODS

Avian remains were initially separated from the excavated samples by John Parkington and his student helpers; subsequently R.G.Klein provided more remains from samples he analysed. Bird remains were identified with the aid of the comparative osteological collection at the South African Museum and minimum numbers of individuals (MNI) for each species/taxon were calculated from the most common element represented (Table 5.2A-H). The problems associated with the calculation and use of MNIs to represent life or death assemblages (Grayson 1979) are acknowledged but alternatives also have inherent problems, and it is beyond the scope of this study to discuss the matter in detail. In general, however, biases are likely to be limited because a large volume of the available deposits of Eland's Bay Cave have been excavated and the samples are from well-defined stratigraphic and spatial units with good bone preservation. It is believed, therefore, that the frequencies provide a reasonable reflection of remains brought to the site and preserved. The frequencies also enable comparisons to be made between the results of this study and published analyses of Eland's Bay Cave faunal remains (Klein & Cruz-Uribe 1984, 1987). The number of specimens identified per species (NISP) has been provided to give an indication of the degree to which the identified bones/fragments represent complete animals.

Age classes were determined using the criteria described in Avery & Underhill (1986). Some difficulty was experienced with material from the older levels because obvious weathering and diagenetic damage to the surfaces of bones, and shrinkage caused by burning or proximity to fires may mimic the effects of aging. For this reason a number of bones were not considered to be of juveniles. A more important factor that may have affected the representation of young individuals is the degree of chewing prevalent on bones in the more recent samples.

It should be noted that in some cases graphs have been used in preference to bar diagrams for reasons of clarity and ease of comparison. The equal weighting given to layers or grouped layers may be artificial, since not all levels represent the same period of time, and should be seen purely as a convention.

Faunal lists from Klein & Cruz-Urbe (1987) have been used to obtain prey categories for comparison with the modern samples of predator accumulations. Mass was calculated primarily from means given by Smithers (1983) and Maclean (1985). Estimates of the number of juvenile steenbok/grysbok were made by calculation of the relative proportions given in Klein & Cruz-Urbe (1987), and a mass of 2.5 kg was allocated to the very young juveniles and 11 kg to adults. Given the gross nature of estimates of mass represented by prey remains, these estimates may not be too far out.

Results for seabirds have been subjected to correspondence analysis and have also been compared with beach-survey results and those from the study of modern bone accumulators. Correspondence analysis yields specific information irrespective of archaeological sample size but many of the sub-units are so small that only a few of the possible species may be present. As a result, each species in a sample exerts considerable weight on the correspondence analysis. Although the level of analysis used is relatively unsophisticated compared to the potential of the method, results for small samples may still be unrepresentative, and should be

compared with those for the larger and grouped samples which are likely to be more stable (Avery & Underhill 1986). On the other hand, the west coast beach surveys now include more observations on less common species, which should have improved the possible results over those of the previous study (Avery & Underhill 1986).

## RESULTS AND DISCUSSION

### COMPOSITION OF SAMPLES

The species and MNIs listed in Table 5.2A-H have been grouped according to gross habitat preference. Although apparently anomalous, combined layers 3-8-9 and 11-12-10 are in correct stratigraphic order. These anomalies arose during the first field season; layer 3 underlay a sleeping hollow dug into earlier deposits at the rear of the cave, and layer 10 was initially thought to postdate the major hiatus. Excavations in later seasons revealed their lateral extent and true associations (John Parkington, pers. comm.). Results for the smaller sub-units selected for analysis are given separately and combined to give totals for the layers within which they occur (Tables 5.2A-G). Totals for layers have, in turn, been combined in groups (Table 5.2.H) based on chronology (Table 5.1). Sample sizes are very variable and those of sub-units predictably very small. The NISPs from which the MNIs were derived are also variable and many individuals are present on the basis of one or very few bones. Given that whole birds are likely to have been brought to the cave for processing and that the area covered by the excavation was large, some loss of bone has clearly taken place. It is also possible that bones of one individual may appear in more than one sub-unit. In spite of this, however, the composition of the marine element

in sub-units and the layers within which they occur is relatively consistent, with Cape cormorants being the most common species overall.

Species associated with the marine environment contribute more than 60% in each group of layers (Table 5.2.H). The marine species make up 100% of some of the post 1600 B.P. sub-unit samples, with proportions closer to 60% tending to occur in the earlier combined layers (13-15, 16-20), although the proportion in layers 12 and 10 exceeds 80%. At the other extreme, seabirds contribute only 38% to sub-unit NKR6 (Table 5.2B), 43% to DIN8 and 50% to the single sub-unit of layer 9 examined (Table 5.2C) and 27% to PWB11 (Table 5.2D).

Comparison of the relative proportions of jackass penguins, Cape gannets and Cape cormorants (Figure 5.2A) in all layers shows wide fluctuation through time (Table 5.2A-H). Overall, however, jackass penguins and Cape cormorants show a tendency to increase through time, whereas Cape gannets have decreased markedly (Figure 5.2B). The relative stratigraphic associations of sub-units within layers has not been finally determined (John Parkington, pers. comm.) and the meaning of variability between these units cannot be assessed sequentially as yet. It is tempting, however, to suggest that such fluctuations within relatively short periods may have resulted from slight variations in the timing of each visit to the cave. At the same time, although the period covered by sub-units cannot be determined, the degree of variability may also reflect the superimposition of longer-term fluctuations on a far more rigid schedule of visits by people (Avery 1988a).

The marine-bird component increased through time (Figure 5.3). After dropping slightly from 67% in combined layers 16-20 to 62% in layers 13-15, it rose to 79% in combined layers 11-12-10 and, in spite of lower numbers in combined layers 3-8-9 and 5-7 after the major hiatus, reached 91% in the uppermost layers after 1600 B.P. The possibility that this is an artefact of the economics of diminishing distance required to walk to the coast, is offset by the relative import-

ance maintained by other marine elements throughout the sequence. The possibility that there was a switch in the time of the year during which the site was used as a base from which to exploit the coast will be investigated below.

Terrestrial elements, which contributed 29% to combined layers 16-20 and 31% to combined layers 13-15, dropped sharply to 12% in combined layers 11-12-10 (Figure 5.3). After the major hiatus, this level was maintained at 11% in combined layers 3-8-9, but again dropped sharply, to zero, in layers 5-7. The terrestrial component was only 2% in the most recent layers. As with the marine contribution, the proportion of individuals associated with terrestrial habitats varied at the level of sub-unit and layer (Table 5.2). Birds of prey, including black eagle, spotted eagle owl and whitenecked raven, which make up an important proportion of the samples, occur in all but the 5-7 layers. The PWB11 unit (Table 5.2D) is notable for the high number of nestling birds of prey (a total of 4 out of 5), although whitenecked raven nestlings also occurred in layers of the 13-15 and 16-20 groups.

The proportion of species associated with fresh water increased steadily from 7% in combined layers 16-20 and 13-15 to a peak of 26% in combined layers 5-7 and then dropped sharply to 9% in the most recent layers associated with the present sea-level and lake conditions (Figure 5.3).

#### AGENCY OF ACCUMULATION

As discussed in previous chapters, it is necessary to establish the means by which bones were introduced into caves in the first place. In the light of the importance of marine birds in the samples, it is really only this group that is sufficiently large and diverse for quantitative assessment. Because sample sizes of the sub-units are often small, most of the assessments will be based on the larger sub-units and grouped samples.

Parkington (1981), Klein (1981b), Avery (1987a) and Klein & Cruz-Urbe (1987) have discussed the possibility that agents other than people may have been responsible for the accumulation of bones in some of the excavated units, notably the 11-10-12 and 13-15 groups of layers. Avery (1987a) has, however, already discounted the possibility that brown hyaenas had more than a passing influence on the Eland's Bay Cave samples. In the light of this and the results presented in Chapter 4, no further attention will be paid to hyaenas.

#### Black-backed jackal

Parkington (1981) and Klein (1981b) discussed the possibility that jackals might have contributed to the disproportionately large numbers of rock hyrax, Cape dune molerat and very young steenbok/grysbok lambs in layers 11-13. Parkington (1981) concluded, however, that the change in faunal sample composition reflected a shift in the period spent at the coast and in the availability of resources but also noted (Parkington 1984), without further comment, that disturbance of the cave surface during the major hiatus was probably caused by jackals. Klein (1981b) argued that the bone assemblages in layers 11-12-10 had been produced by predators, the most likely of which was the black-backed jackal, although he later (Klein & Cruz-Urbe 1987) suggested that an eagle owl was more likely to have left the suite of small mammals in the 11-13 layers.

Avery (1987a) pointed out that coastal jackals take a wide variety of beached seabirds and that, inland, jackals take relatively large numbers of small mammals (Bothma 1971), including steenbok/grysbok, and neonates of medium-sized gregarious antelope species (Pienaar 1969) in close proportion to availability (Smithers 1983). As a result he considered black-backed jackals to be among the possible accumulators of some Eland's Bay Cave remains, including those of very young

steenbok/grysbok. Assuming, however, that people also exploited beached seabirds in close proportion to availability, the composition and relative proportions of seabird species in human and jackal accumulations would be indistinguishable. Avery (1987a) suggested, however, that human and jackal accumulations might be distinguished on the basis of damage left by gnawing and on relative frequencies of skeletal elements. The incidence of damage caused by chewing and digestion was therefore recorded on bones of Cape cormorants which are best represented in both the modern jackal comparative samples and archaeological samples. Figure 5.4 compares the incidence of jackals ( $n = 11$ ) in the layers with the relative proportions of damaged Cape cormorant bones. There is no close correlation, and the number of jackal remains is lower than might be expected if the cave were used as a den. However, except in layer 4, the incidence of chewing increases towards the present as does the density of shell middens. It appears, at least as far as seabirds are concerned, that the incidence of chewing may have increased together with more frequent and intense human occupation of the cave. This suggests that the damage recorded was secondary to human accumulation. The increase in damage after 1600 B.P. is, however, not distinct enough from that in earlier layers to provide a definite indication of the introduction of dogs by this time.

The relative proportions of Cape cormorant skeletal elements in grouped layers from Eland's Bay Cave were then compared with those from the modern jackal accumulations (Figure 5.5). Although some similarities are apparent, differences appear to be considerable and, with the exception of the samples from layers 16-20 which were too small to give reliable results, Kolmogorov-Smirnov two-sample tests (Siegel 1956) showed the grouped layers to be significantly different from the jackal sample at the level of 0.001 or below. There does, however, appear to be a pattern of similarity between sub-units within layers. Kolmogorov-Smirnov two-sample tests run on the proportions of Cape cormorant skeletal elements

showed that there was no significant difference between sub-units, although significant differences exist between some layers.

The conclusion to be drawn from the evidence is that jackals were not responsible for accumulating the seabirds in the samples. This conclusion is further supported by the absence, from seal or other mammal bones (Avery 1987a), of the degree of damage of the type believed by Marean (1985) and Klein & Cruz-Urbe (1989) to have been caused by similar-sized dogs. More damage to the extremities of limb bones might also have been expected, as well as relatively fewer bones of smaller mammals such as Cape dune mole rats and hyraxes than is indicated by a comparison of numbers of individual Cape dune mole rats from Eland's Bay Cave with numbers of (measured) humeri tabled in Klein & Cruz-Urbe (1987). On the other hand, at least some of the damage on bones in the uppermost layers was caused by a relatively small predator such as a water mongoose or Cape fox. The picture is further complicated by the presence of bones, including tarsals of steenbok/grysbok in a number of layers, that had passed through the digestive tract of a larger predator (Avery 1987a) and look remarkably similar to those from leopard scats studied (Norton *et al.* 1986). Apart from this, the samples in no other way appear to resemble what would be expected from leopard accumulations (Brain 1981). Should a jackal encounter a steenbok or grysbok during the course of foraging, there is no doubt that it could subdue such an animal (Pienaar 1969) and, although the antelope practise anti-predator behaviour, jackals could have been responsible for the very young steenbok/grysbok in the samples (Klein 1981b).

Finally, cut marks or working, which are clear evidence of human involvement, have been noted on seal and jackal remains in layers 11 and 10, on bones of prion, Cape gannet and whitebreasted and Cape cormorant in layers 11, 12, 10 and 16, and on Egyptian goose in layer 13. On present evidence, therefore, while at least one species of mammalian predator caused the bone assemblage to be

modified, this appears most likely to have been secondary scavenging of human refuse.

### Owls and eagles

Klein & Cruz-Uribe 1987 believed that an eagle owl was the most likely animal to have produced the suite of small mammals in layers 13-11. Avery (1987a) pointed out that, of the eagle owls, the Cape eagle owl was the only species that took large numbers of prey similar to those in the archaeological samples, although juvenile steenbok/grysbok probably fell beyond the range that it could kill. Avery (1987a) also pointed out that black and martial eagles could take the whole range of small mammals noted.

Figure 5.6 illustrates the categories of species and mass of species in Eland's Bay Cave grouped layers and in layers 1, 11, 12 and 10. The categories of species and mass are the same as used in Chapter 4 (Table 4.1) to describe modern owl and eagle prey. In every case, samples include the range of prey taken by barn and spotted eagle owls. This is not surprising in the light of the presence of bones of spotted eagle owls in the deposits and the likelihood that barn owls also used the cave, although presence or absence of the remains of a predatory species does not prove or disprove its role as a possible contributor. Scanning Electron Microscope (SEM) examination of damage to bones of the very small mammals would help to clarify this (Andrews 1990). This is, however, beyond the scope of the current project.

Given the overlap of small prey taken by many of the predators described in Chapter 4 and Table 4.4, it is not a simple matter of excluding prey on the basis of size in order to determine which predators were responsible for the composition of the samples. Seasonal behaviour in both predator and prey also plays a part. Black

eagles and Cape eagle owls breed between April and June, and from May to August respectively (Maclean 1985). While chicks are in the nest the breeding site is the focal point for adult black eagle and Cape eagle owl activity, and food remains can be expected to accumulate there. Thereafter, however, both black eagles and Cape eagle owls desert the breeding site and feed at perches elsewhere or where kills are made (P. Steyn, pers. comm.). Accumulation of prey remains is not therefore concentrated at this time and it follows that at breeding sites the composition of prey should only reflect prey available during the breeding period.

The breeding season of the Cape eagle owl and, to a lesser extent, of the black eagle, coincides with the period when Cape dune mole rats are most likely to be found on the surface in any numbers. This occurs when they are actively burrowing in damp soil during the wet season, when they are forced to the surface by flooding during the winter months, particularly around August, and when males surface to search for females, primarily between June and August (Smithers 1983; J.U.M. Jarvis, University of Cape Town, pers. comm.). At such times short-term abundances of Cape dune mole rats are predictable and many predators, including jackals, birds of prey and farm labourers and their dogs, converge on suitable localities to take advantage of their being on the surface (F.W. Duckitt, pers. comm.). The South African hedgehog, which is primarily nocturnal and is also present in some of the earlier samples, is less active during colder months and may also be susceptible to flooding (Smithers 1983).

Steenbok and grysbok lambing peaks in September/October (extending into December) and March (Smithers 1983; Manson 1974; Novellie *et al.* 1984). The March births were from captive animals, however, and are unlikely under normal conditions in the wild (R.C. Bigalke, University of Stellenbosch, pers. comm.). To prevent lambs from being detected by predators such as jackals and birds of prey, they are hidden during a roughly one-month lying-out period when their urine and

faeces are consumed by the mother. The estimated mass of 2.5 kg used in the comparisons for very young steenbok/grysbok is for animals of approximately one month old for this reason.

The proportions of prey in the samples do not closely resemble any one of the comparative spectra (Figures 4.7, 4.8 and 4.9). It is in any case difficult to assess whether this is an appropriate expectation, given changed environmental conditions and the fact that avian predators take suitable prey on availability. For instance, if the very small elements are ignored, virtually all of the layer groups include the elements of the comparative black eagle samples, including Cape dune molerats, but in different proportions. Also, given the range of prey taken by Cape eagle owls and their habit of making use of local abundances, they too should be considered, certainly on the basis of Cape dune molerats and almost certainly very young steenbok/grysbok, the estimated mass of which does fall within the size range of prey they are known to take. Given the terrestrial nature of the Eland's Bay Cave catchment in the earlier 11-20 layer groups, and evidence that conditions were wetter, an increase in Cape dune molerats (? at the expense of hyraxes) would not be unexpected. The proportion of hares is relatively low, and the possible role of martial eagles does not appear to warrant further investigation.

If Cape eagle owls were breeding at Eland's Bay Cave and taking Cape dune molerats in lieu of other prey recorded in the comparative samples, their accumulations could certainly be expected to look more like samples in the 11-12-10, 13-15 and 16-20 groups, provided that they were also taking very young steenbok/grysbok in large numbers. Kolmogorov-Smirnov two-sample tests between the prey of Cape eagle owls and grouped archaeological layers showed them to be significantly different at the 0.001 level or below, with the exception of the 3-8-9 group which was, nevertheless, significant at the 0.01 level or below. Similar results were obtained on testing the mass categories of mammalian prey.

The results for the Cape eagle owl comparison are not considered to be entirely satisfactory, however, in the light of the fact that the prey spectra and size categories of key species were different. Probably more significant is the observation that as a general rule Cape eagle owls do not breed in caves such as Eland's Bay Cave which makes the Cape eagle owl an unlikely possibility in any event.

Under the same conditions of prey availability, black eagles might produce similar accumulations. The numbers of hyrax in the archaeological samples are, however, lower than would be expected if black eagles were breeding at Eland's Bay. Also, the numbers of postcranial bones of small mammals appear to be relatively higher in the archaeological samples than would be expected. This, and the fact that black eagle breeding is over by the time very young steenbok/grysbok and, to a lesser extent, Cape dune mole rats are readily available, argue against them being an important factor in the accumulation of the Eland's Bay Cave samples. Kolmogorov-Smirnov tests also showed that the black eagle comparative samples and archaeological samples differ significantly. Although there was some similarity with the 16-20 group, this could have been due to the changed environment.

If the small mammals and birds are excluded, there is a core of prey ranging between about 0.5 and 5 kg in all grouped layers of the archaeological samples (Figure 5.6). This is also evident between the comparative owl and eagle samples and again underlines the complexity of unravelling the contributions of individual agents of accumulation, particularly when similar species and size of prey are taken.

Kolmogorov-Smirnov two-sample tests determined that there was no significant difference between the mass of species in layers 11, 12 and 10. Samples from the other layer groups were then compared with layer 12. Highly significant differences at the 0.001 level or below were shown between layers 5-7 and 16-20 but the difference was not significant for layers 1-2-4 and 13-15. This lack of consistency

amongst the denser shell middens and non-terrestrial samples suggests that the differences between samples may have been environmentally controlled.

### People

The problem of overlap in the species and size of prey taken by various avian and mammalian predators has been addressed, but what of overlap between the hunting and gathering strategies of people and the predators themselves? What do the similarities and differences mean in the light of the fact that many species will switch prey according to local availability and abundance? Undoubtedly, people would have been able to catch any of the species in the samples, including very young steenbok/grysbok, although they probably did not take the micromammals. If, however, the key species such as Cape dune molerats, hyraxes and very young steenbok/grysbok which occur in relatively high frequencies in dense shell layers in the Holocene levels of Eland's Bay Cave, Die Kelders Cave 1 and Byneskranskop Cave 1 have been accepted without question as being human debris (Schweitzer 1979; Schweitzer & Wilson 1982; Klein & Cruz-Uribe 1987) and age and mortality profiles of steenbok/grysbok in each site are virtually indistinguishable (Klein 1981b), why should this not also have been the case in the terminal Pleistocene? If people were visiting the cave less frequently, there would have been more opportunities for predators to use the cave. But people are also opportunistic and are known to be familiar with animal habits and with factors that lead to local abundances and to take advantage of them when they occur. Why not take Cape dune molerats, hyraxes or very young antelope?

Apart from being caught on the surface, Cape dune molerats are relatively easy to catch when the soil is moist and burrowing activity peaks; individuals rapidly come to close up an opened burrow, and could be speared then or when pushing

sand out of the burrow (J.U.M. Jarvis, pers. comm.). During the deposition of the layer 11-20 complex the lower sea level would have extended the coastal foreland, thus providing suitable habitat for Cape dune molerats. This and the possibility of slightly wetter conditions than today (D.M. Avery 1983; Deacon & Lancaster 1988) could account for increased numbers of Cape dune molerats. At densities reaching 20 individuals per square kilometre (Bigalke 1974 cited in Klein 1981b), highly territorial steenbok/grysbok would provide a highly predictable resource, including very young individuals at the breeding peak. But the important question to be answered is whether people were using the cave at the time of year when availability of these species and age classes would peak. As will be shown below, this appears to have been the case in the layer groups in which Cape dune molerats and steenbok/grysbok are common and also holds for some of the non-seabird species for which seasonal information is available.

It is evident from the above that the argument for an agent other than people accumulating bones in the Eland's Bay Cave deposits is equivocal at this stage. In view of this and of the fact that cultural remains of undeniable human origin (including cut or worked bones) are present throughout the period of accumulation, it seems reasonable and parsimonious to accept that people were primarily responsible for accumulating the bird remains and, very likely, those of the small mammals discussed as well. Future, more detailed quantitative and Scanning Electron Microscope investigation of the bones in the 11-20 layer groups might throw further light on the matter.

#### SOURCE OF SEABIRDS

Normally inaccessible pelagic and oceanic species such as jackass penguins, albatrosses, petrels, shearwaters and Cape gannets, which seldom approach the

shore unless sick, dying or washed up dead, are present in virtually all South African coastal archaeological sites. This led Avery & Underhill (1986) to the assumption that beached birds provided an important source of carcasses for coastal hunter-gatherers. Avery *et al.* (1987) subsequently demonstrated that coastal black-backed jackals also exploit beached seabirds and take prey in proportion to availability. The possible role of jackals in accumulating bones in the Eland's Bay Cave samples has been discussed above.

In order to assess further the assumption that seabirds found in archaeological sites were mainly collected from the beach, results from the archaeological samples were compared with the modern observations. Figure 5.7 compares the relative proportions of common breeding seabirds recovered from west coast beach surveys and the results of a two-year survey conducted monthly over a 14 km stretch of coast at Eland's Bay with results from Eland's Bay Cave layer 1. There is a general similarity between the pattern of relative proportions in all of the samples, adding support to the contention that the archaeological remains were derived from beached birds. When results from the Eland's Bay beach survey and the Eland's Bay Cave layer 1 sample are compared, the similarities are remarkable.

The apparent distinction between the Eland's Bay (1980 and 1981) and west coast beach surveys can be explained by the extremely high Cape cormorant and, to a lesser extent, kelp gull mortality recorded in 1987/88 (Figure 3.9) after the Eland's Bay survey had been discontinued. In spite of this the apparent difference between the two beach surveys is not statistically significant for either the pre-1984 sample (Avery & Underhill 1986) or the overall sample (Kolmogorov-Smirnov  $z = .6363961$ ). The relatively high proportion of whitebreasted cormorants may be influenced by the fact that, although this species forages at sea, there is a breeding colony in the reed beds 4.5 km up Verlorenvlei which could be the cause of the local

increase. Hence the Eland's Bay beach survey sample is somewhat different from the general west coast pattern.

Results of Kolmogorov-Smirnov two-sample tests of whether the archaeological samples from other layers differ significantly from the modern observations are given in Table 5.3. Sample size is a problem when dealing with sub-units and some layers. At the grouped level, however, the earliest samples are significantly different from the modern comparative samples because of the virtual absence of jackass penguins and the high proportion of Cape gannets in particular in the latter. Most other samples are not significantly different from one or both beach surveys.

Time of acquisition is likely to affect the relationship of archaeological samples to the beach-survey observations if there were a restricted season of collection. At the sub-unit level it was clear that some samples differed for this reason. In general, the more recent archaeological samples are not significantly different to the modern samples. In some cases, however, where different proportions of, for example, jackass penguins affect the results, differences can be explained on the basis of variation in monthly profiles. It is also relevant to note that the low frequencies of individuals in sub-units are similar to those recorded on a daily basis in Saldanha Bay (Tables 3.4 and 3.5). Although the significance of this is difficult to assess in real terms, it lends some support to the contention that sub-units represent short-term accumulations.

It is to be expected that numbers and even species of birds may vary, depending on the morphology of the adjacent coastline, its orientation to prevailing winds and currents, and the availability of rocks and islands suitable for breeding and roosting (Cox 1976). The common species are widely distributed, however, and local conditions appear to have a greater effect on the overall density of birds than on relative proportions of various species, and to have no effect on the accuracy of

seasonal data derived from different age classes, as observed by Avery & Underhill (1986).

The results of the above comparisons, in addition to the regular presence of normally inaccessible species in archaeological samples, are taken to be extremely compelling evidence that seabirds in the samples were acquired by exploiting beached birds.

#### EVIDENCE FOR SEASONALITY

##### Correspondence analysis of archaeological and beach survey observations

Only those species occurring in the archaeological samples have been included in this analysis. Species such as prions, which exert strong seasonal weight on the display, have been included in the active rows because they affect the shape of the plot of the distribution of months but not the other aspects of the analysis. Tests showed that their effect on the display was not great and, because small numbers of prions may be beached in any month of the year, they have been included in the active rows in order to increase the variables contributing to sample profiles. The archaeological samples have been treated as inactive supplementary points. Samples from sub-units were analysed in groups according to the layers in which they occur. To simplify the display only co-ordinates of months and archaeological units have been plotted. The result of the correspondence analysis plot for west coast beach surveys is given in Figure 5.8 for reference to the co-ordinates of species. Species in small samples (Table 5.2A-H) may exert undue weight on the display, thereby giving unsatisfactory results (Avery & Underhill 1986), and such results should be viewed together with those from the larger samples and layer

totals which will be made more stable by the wider diversity of contributions to the column and row profiles.

#### *Layers 1-2-4*

The first two principal axes accounted for 78% of the total inertia and confirmed the seasonal grouping of species and months of the year (Figure 5.9A). The distribution of samples clusters around October, with some tending towards September and November. Two samples do not follow this pattern; K1 falls close to January and J4 between July and August. The February to June components of the year do not appear to be represented in any of the samples.

#### *Layers 5-7*

The first two principal axes accounted for 77% of the total inertia and confirmed the seasonal grouping of species and months of the year (Figure 5.9B). The distribution of samples is not as tight as in the uppermost group. The single layer 5 unit is plotted in the direction of November; the units in layer 6 tend to cluster between August and September, with G6 between October and November; and the two units in layer 7 fall between September and October. The December to July components of the year do not appear to be represented in any of the samples.

#### *Layers 3-8-9*

The first two principal axes accounted for 69% of the total inertia and confirmed the seasonal grouping of species and months of the year (Figure 5.10A). The samples are widely distributed around the year, but with the February-May and October-

November components of the year unrepresented in any of the samples. Sample size appears to be influencing the plot, however, and results for S8 and the totals for layer 3, layer 8 and the combined total are likely to be the most stable. Occupation at this time appears to have been between June and September, possibly closest to July and August.

#### *Layers 11-12-10*

The first two principal axes accounted for 79% of the total inertia and confirmed the seasonal grouping of species and months of the year (Figure 5.10B). The distribution of samples is between August and November, with C10 and M11 possibly including July-August and November-December respectively. Again different layers tend to cluster at different times. Layer 11 units tend to fall between October and December, layer 12 units between September and October, and layer 10 units between August and September. The January to July components of the year do not appear to be represented in any of the samples.

#### *Layers 13-15*

The first two principal axes accounted for 79% of the total inertia and confirmed the seasonal grouping of species and months of the year (Figure 5.11A). The distribution of samples falls in September and, although sample size has clearly weighted some results, the co-ordinates for the two layer totals and group total support the overall pattern. The December to August components of the year do not appear to be represented in any of the samples.

### *Layers 16-20*

The first two principal axes accounted for 90% of the total inertia and confirmed the seasonal grouping of species and months of the year (Figure 5.11B). The distribution of samples falls between June and August and, although sample size has clearly weighted some results, the co-ordinates for layer 17 and the group total supports the overall pattern, which is also a reflection of the changed species composition. The September to June components of the year do not appear to be represented in any of the samples.

### Archaeological sample profiles

Profiles of the proportions of the major seabird groups (jackass penguin; albatrosses, petrels, shearwaters; Cape gannet; cormorants; kelp gulls) are given for each layer and group of layers (Figures 5.12-5.17). Profiles confirm some of the seasonal variability that is evident from the beach survey data (Figure 3.21A-B) and is represented in the correspondence analysis plots. Variability within the archaeological samples is apparent and no sample is directly comparable with any of the seasonal groups, although points of similarity do occur.

### Other evidence of seasonality

Further evidence for seasonality is available from the presence of juvenile individuals, and adults with medullary bone, which is only formed in females between copulation and egg-laying (Rick 1975). The seasonal evidence for non-seabirds supports that from the correspondence analysis and adds to the body of evidence that people were the main accumulators of the Eland's Bay Cave samples.

*Layers 1-2-4*

The presence of relatively few juvenile Cape cormorants, which would be typical of the earlier part of the breeding season which starts in September (Maclean 1985), is consistent with the correspondence analysis which indicates that the archaeological samples were accumulated between September and December.

*Layers 5-7*

Medullary bone was noted in two species, the Cape gannet and redknobbed coot. Cape gannets breed from August to December, but mainly between October and December (Maclean 1985), and this is consistent with the correspondence analysis plot of layer 7 between September and October. Redknobbed coot breeding has been recorded in January, April and from July to December, with a peak between August and October (Urban *et al.* 1986), which is consistent with the August to September-November plot for layer 6.

*Layers 3-8-9*

The presence of a juvenile redknobbed coot in layer 8 is consistent with the breeding season (above) and the correspondence analysis results.

*Layers 11-12-10*

Grey herons may breed at any time of the year (Maclean 1985) and are not therefore particularly useful seasonal indicators. Breeding of greater flamingoes and ducks is dependent on the availability of water and a suitable food supply

(Maclean 1985), which would tend to be during the wet season between June and September; presence of juveniles is consistent with the correspondence analysis results indicating collection between October and December in layer 11. The presence of a juvenile white pelican in layer 10 is not absolutely consistent with information in Maclean (1985) that pelicans breed mainly from October to January; it seems either too early or too late, but it is not impossible that such observations represent occupations extending beyond the period indicated for seabirds by the correspondence analysis.

#### *Layers 13-15*

Lesser flamingoes breed between June and July (Maclean 1985) and the presence of a juvenile in layer 15 is consistent with the correspondence analysis result of September. Lesser flamingoes are highly mobile, and were not necessarily breeding in Verlorenvlei at the time.

#### *Layers 16-20*

Medullary bone found in a Cape gannet bone in layer 16 and from two individuals in layer 17 is entirely consistent with the June to August result from the correspondence analysis, suggesting that at least part of the occupation coincided with the onset of the breeding season during August. Egyptian geese may breed at any time of the year (Maclean 1985).

Seasonal evidence shows a clear emphasis throughout the Eland's Bay sequence on the late winter/spring period between August and October, although individual units and layers show wide variation. There is a tendency for grouped layers to be different from each other and, within the groups, layers differ from each

other and sub-units vary in position around the combined layer result. In general, however, the evidence strongly supports Parkington's (1981) conclusion that the Late Holocene (post-hiatus) occupations took place in late winter or early spring months between July and October. The correspondence analysis results for the pre-hiatus samples show a wider range of timing than the specific October peak suggested by the seals (Parkington 1981). Analysis of the seal data in smaller units may, however, reveal a wider range between the samples than is otherwise evident in results obtained so far on combined samples (Parkington 1972, 1976, 1981). Exceptions cannot always be explained in terms of small (unrepresentative) samples and, while confirming that occupation of Eland's Bay Cave was seasonal, the correspondence analysis has also demonstrated the existence of a wider range of timing than was previously considered. Occupation of the sites in the Saldanha Bay region to the south appears to have been timed to take advantage of nestling and juvenile cormorant availability (Avery & Underhill 1986). Bearing in mind the fact that breeding colonies were unlikely to have existed near Eland's Bay, a different factor or factors appears to have determined the timing at Eland's Bay.

#### EVIDENCE FOR PALAEOENVIRONMENTS

The low proportion of marine birds in the earliest layers supports Parkington's (1981) contention that, while the site was relatively close to the coast (16 km), it had an essentially terrestrial catchment during the early Holocene when sea level was rising and the lake was riverine or estuarine. The cave is thought to have been used only periodically, probably in much the same manner as was Diepkloof Rock Shelter which is now 18 km upstream (Avery 1987; Parkington & Poggenpoel 1987). This scenario is supported by the bird evidence in layers 20 up to 13. The terrestrial component ranges from 27 to 31% and the cave could not have been the important

breeding site for predatory birds that it appears to have been unless it was periodically abandoned by humans. In spite of the fact that seasonal evidence suggests that occupation coincided with winter months when water was more available, the freshwater component was only 7% (Figure 5.3). This suggests that the nature of the river was such that it did not provide a suitable habitat for large numbers of freshwater birds.

By the time layers 10-12 were being deposited, the freshwater and terrestrial components were almost equal and the marine component had risen to 79%. This suggests that the cave, which was between five and three kilometres from the coast, had become a base for more intensive exploitation of marine resources, with layer 13 containing the first dense shell middens. Sub-unit PWB11, on the other hand, with a 55% terrestrial component, nestlings of four predatory species including black eagle and whitenecked raven, and only a 27% marine component, suggests that the cave was unoccupied by people for long periods. Moreover, the use of marine resources was variable in spite of the fact that the cave was located within about three kilometres of the coast during this period. The top of layer 11 marks the beginning of the major hiatus in human use of the cave and it is possible that the high frequency of breeding birds of prey is related to this.

The increase in numbers of freshwater species such as flamingoes and redknobbed coot (Table 5.2.H), which can tolerate relatively saline water but require fairly shallow open water or estuarine conditions (Brown *et al.* 1982; Urban *et al.* 1986), suggests that the area of open water in the vicinity of the cave was increasing. This supports the contention that the essentially riverine to deep estuarine conditions of layers 20 up to 11, which would not have supported large populations of freshwater birds, were changing into a shallow open estuary better suited to waterfowl as the rising sea level lowered the gradient, thereby causing sediments to fill the channel (Miller 1987; Rogers 1987; Yates *et al.* 1986). At about

5500 B.P., during the major hiatus when sea level had reached +2 m, an open coastal lagoon would have existed; by the time layers 3-8-9 were deposited sea level was again falling and a shallow tidal estuary was migrating nearer to the present mouth of the lake (Table 5.1).

Klein & Cruz-Uribe (1987) suggested that the smaller size of Cape dune molerats after the major hiatus reflected a biological response to drier conditions. Some support for this comes from the apparent contradiction between the evidence from the Cape dune molerats and the increase in freshwater birds. The increase in the freshwater component undoubtedly reflects the evolution of the estuary into an increasingly suitable habitat for freshwater birds. At the same time, however, a drier climatic regime would have increased the importance of the estuarine Verlorenvlei as a dry season refuge for large concentrations of waterbirds such as flamingoes and redknobbed coot, as well as people. Conditions suitable for freshwater birds appear to have peaked at the time the layer 5-7 group was being deposited when it is suggested (Deacon & Lancaster 1988) that humidity conditions were generally fluctuating around present levels. The slightly above-present sea level would have inundated currently low-lying areas and formed more extensive wetlands and open water bodies at the coast.

The absence from layer 1 and 2 sediments of eelgrass *Zostera capensis*, which requires tidal conditions, indicates that estuarine conditions at the coast existed until about 300 B.P. when the sea reached its present level. At this time the present coastal lake was formed and, while conditions further upstream in the vicinity of Tortoise Cave (Robey 1987) were undoubtedly suitable for freshwater birds as they are at present, waterfowl were no longer plentiful in the vicinity of Eland's Bay Cave.

Avery (1987a) suggested that relative proportions of seabird species might have changed in response to changing sea levels. Sea level would have dropped

sufficiently to have removed the existing breeding islands in the region during the glacial peak and at the time the layer 16-20 sequence was being deposited. By the time layers 11-13 were deposited, the sea level would have been much the same as at present and seabird breeding islands in roughly their present form. During the Holocene high sea-level stand, however, the area of islands would have been reduced which may have had a local effect on seabirds. In the light of the seasonal evidence, however, it is possible, or more likely, that the changes in proportions of seabird species evident through time were a result of changes in the timing of 'sampling' by prehistoric people.

#### SUMMARY

The results obtained from the avian samples from Eland's Bay Cave can be tied into the established palaeoenvironmental history of Verlorenvlei and the adjacent coastline. The increase in the marine component of the avian samples has been related to rising sea level and consequent shrinking of the Upper Pleistocene coastal foreland which had existed in front of the cave. The decrease in terrestrial birds from the earliest layers upwards is probably also related to this and the evolution of riverine conditions to a more open and shallow estuary and lagoon which favoured freshwater birds. Under suggested drier conditions after the major hiatus the Verlorenvlei estuary and lagoon would have assumed greater importance as a seasonal refuge for freshwater birds. After the Holocene high sea-level stand, as the sea moved to its present level, the area of open water and wetlands most suited to large numbers of waterfowl migrated upstream some 4 km and beyond.

It has been demonstrated that the source of the seabirds was most likely to have been beached birds. No conclusive evidence was found to suggest that black-backed jackals were responsible for accumulating seabirds. Black eagles were

shown to be improbable contributors of either small mammals or birds to the samples, while the evidence that Cape eagle owls were responsible remains an unlikely possibility. The increase in small mammals such as hyraxes, Cape dune molerats and steenbok/grysbok lambs can be related to the seasonality shown by the correspondence analysis, and supported by seasonal evidence from freshwater birds, and the likely availability of the Cape dune molerats and lambs themselves. In the light of the undoubted evidence (artefactual, molluscan) for human habitation of Eland's Bay Cave and the lack of evidence to suggest that another agent had contributed to the Eland's Bay Cave samples, it is concluded that people very probably accounted for the sample composition of all the layers at Eland's Bay Cave.

Most seasonal evidence indicates that Eland's Bay Cave was used between July and October. The actual timing of individual sub-units and layers varied considerably, however, while maintaining cohesion within chronological groupings. While being more representative of variability, the seasonality indicated by the seabirds is in close agreement with that derived from the aging of juvenile seals (Parkington 1972, 1976; Klein & Cruze-Urbe 1989). Parkington's (1981) contention that people visited the cave less frequently when it was located in a terrestrial environment is also supported by the avian evidence.

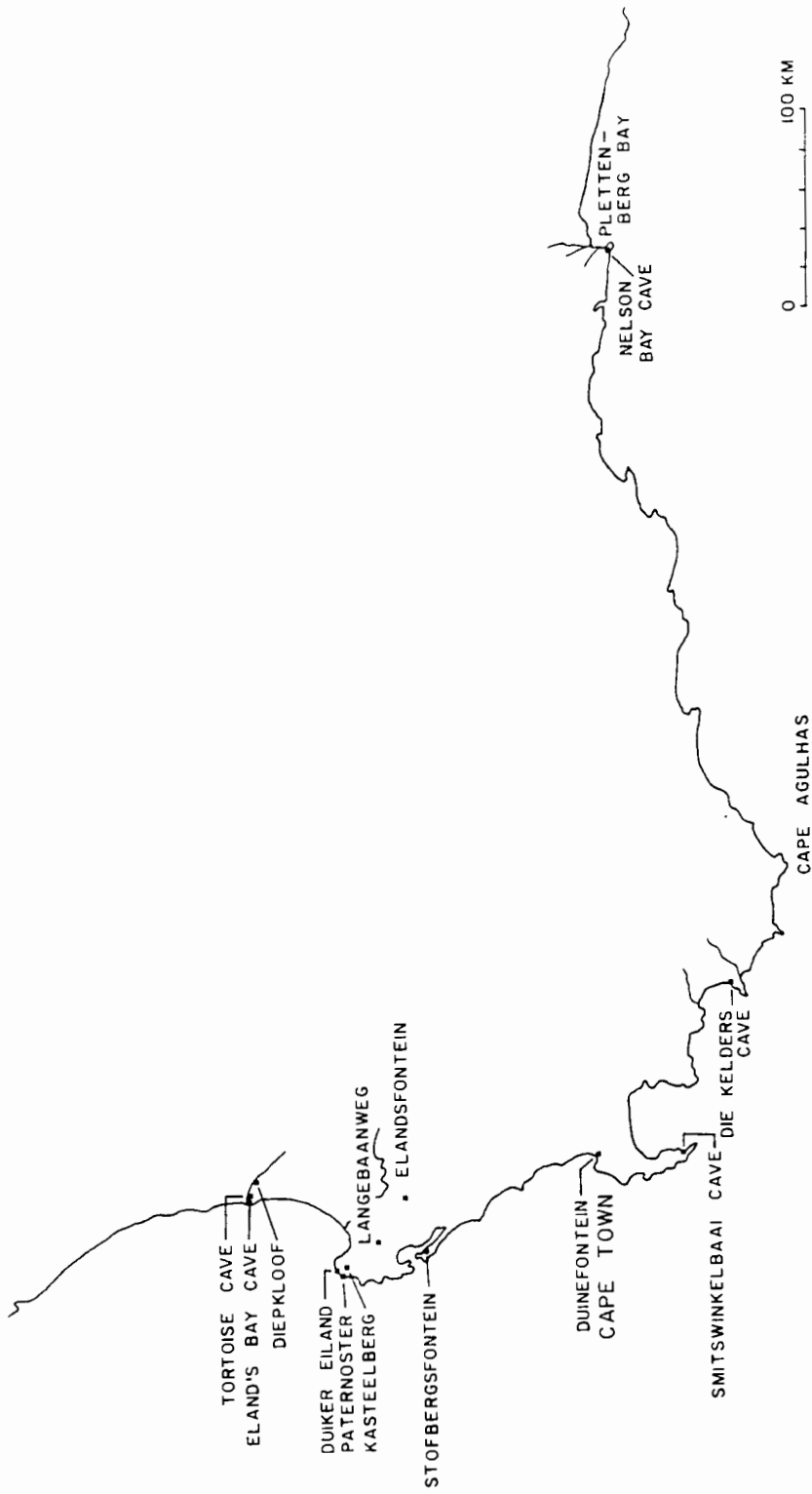


Figure 5.1. Distribution of sites mentioned in the text.

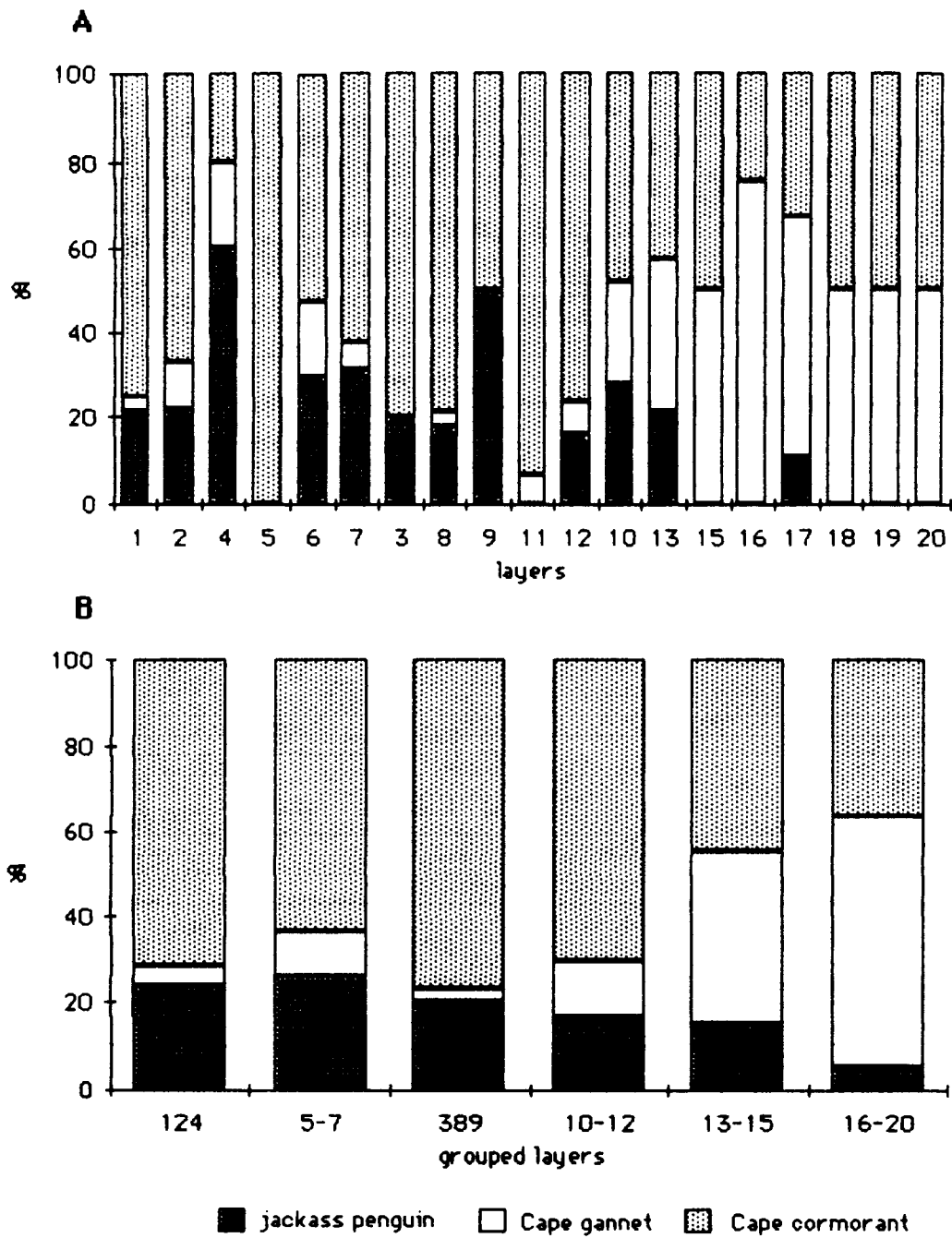


Figure 5.2. Relative proportions of jackass penguins, Cape gannets and Cape cormorants in all layers (A) and grouped layers (B).

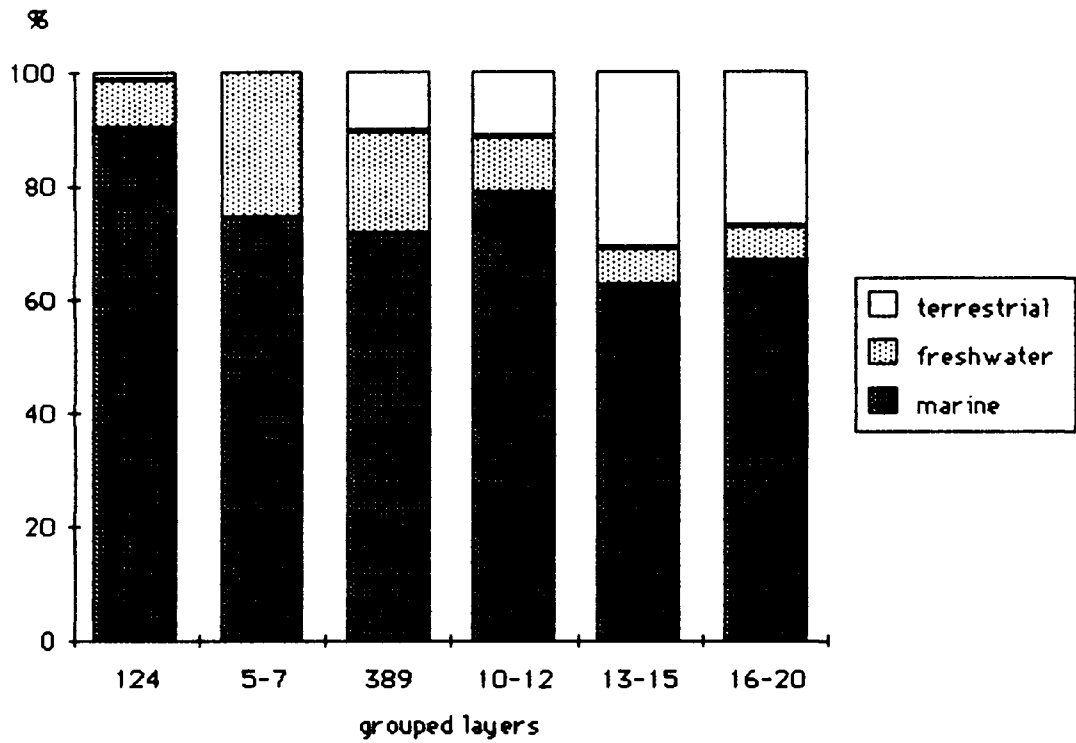


Figure 5.3. Relative proportions of marine, freshwater and terrestrial species within each group of samples at Eland's Bay Cave.

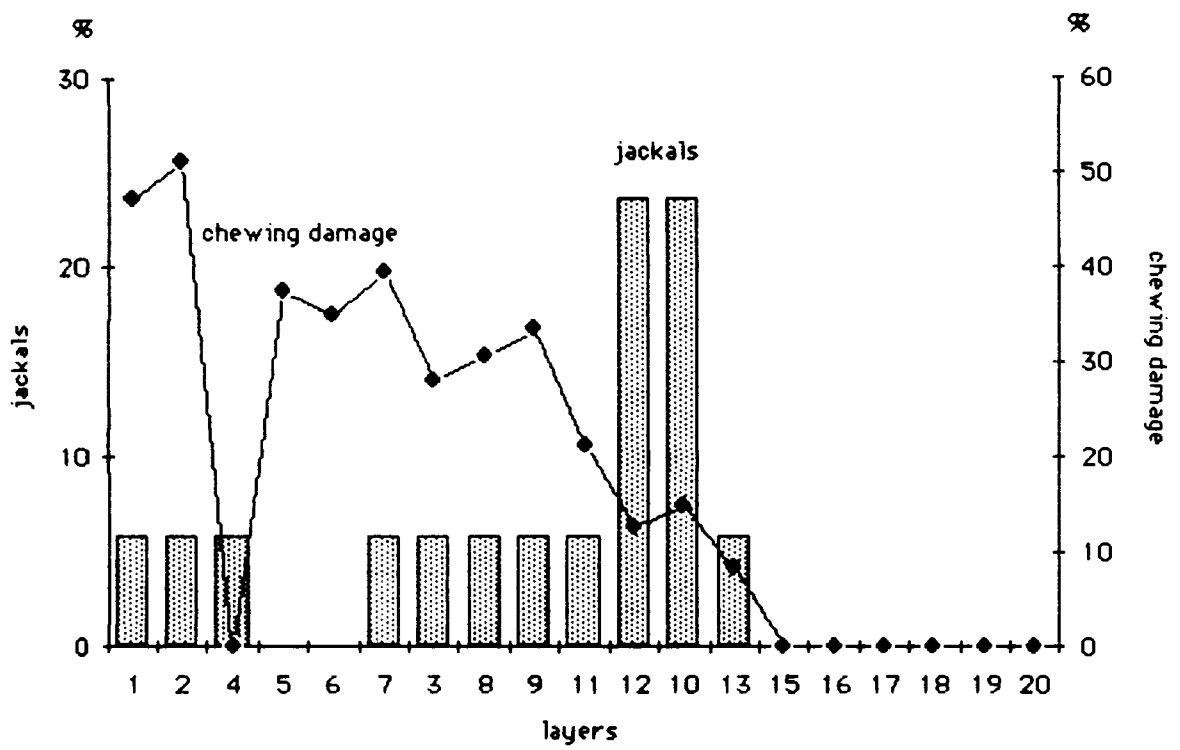


Figure 5.4. Comparison of the incidence of jackals and the relative proportion of chewing-type damage on Cape cormorant bones.

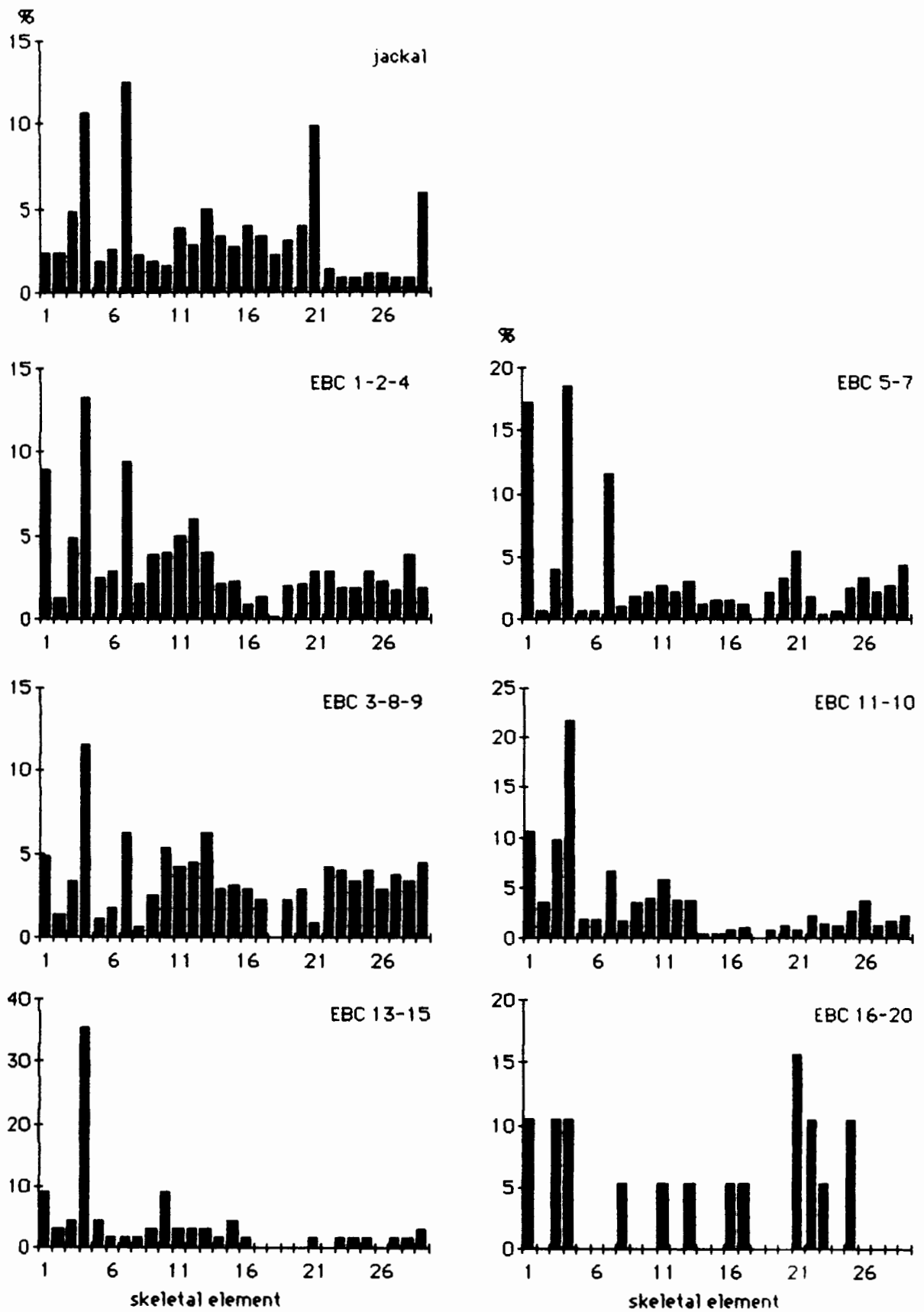
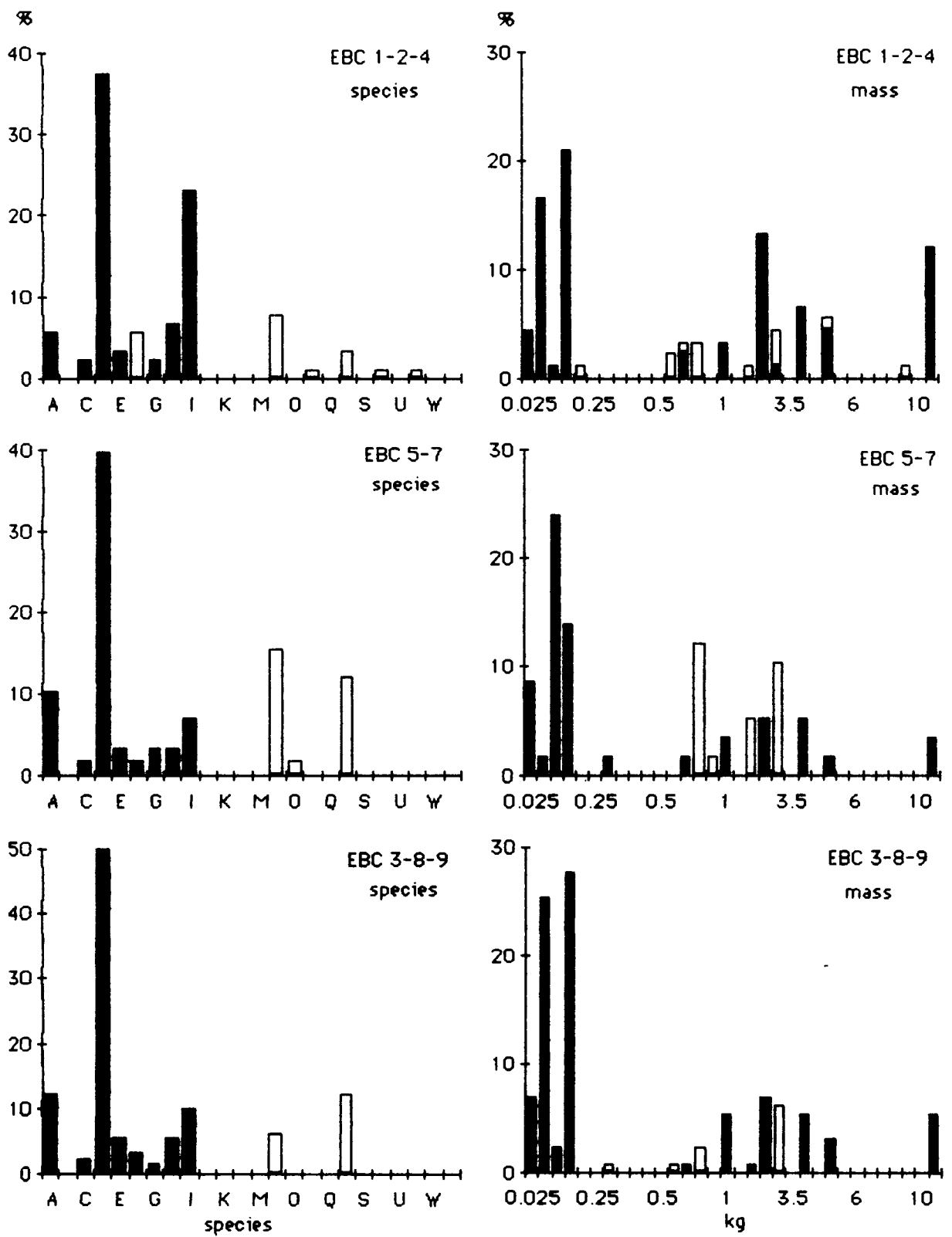
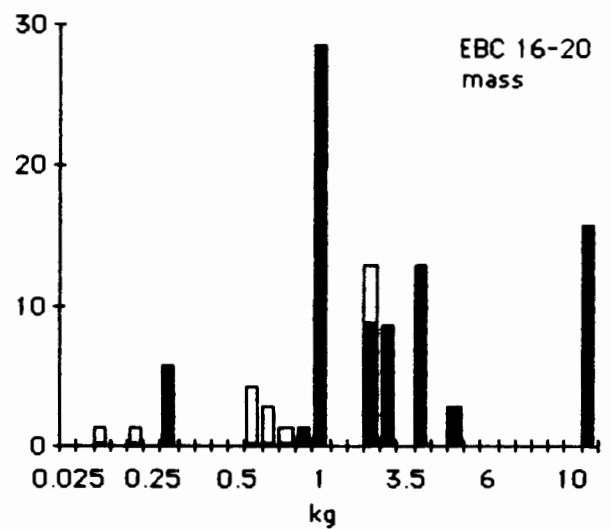
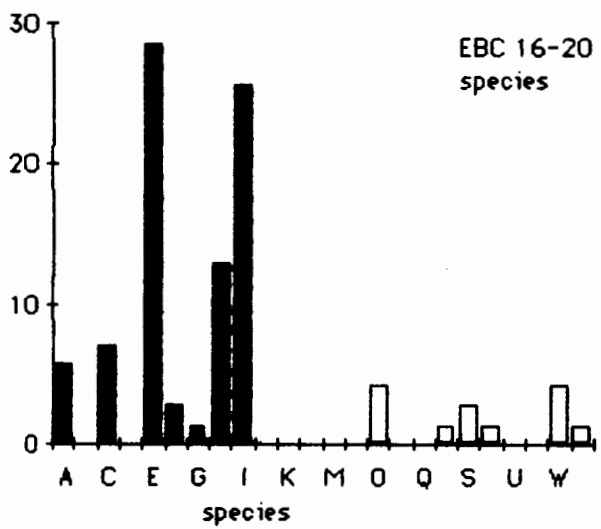
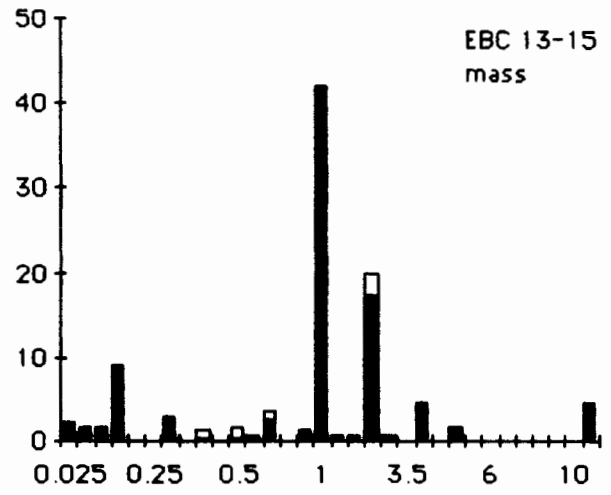
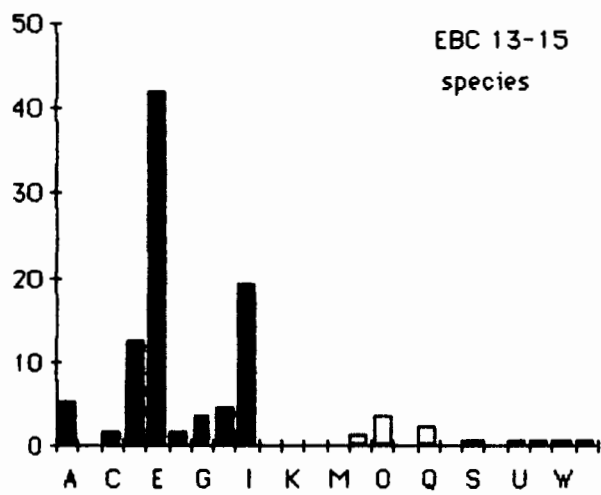
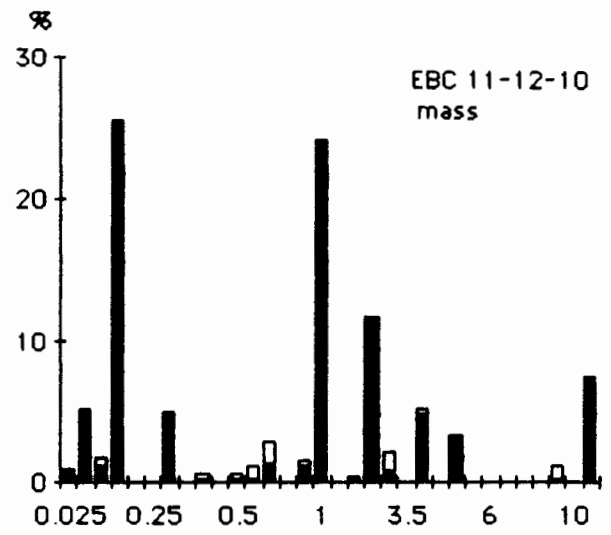
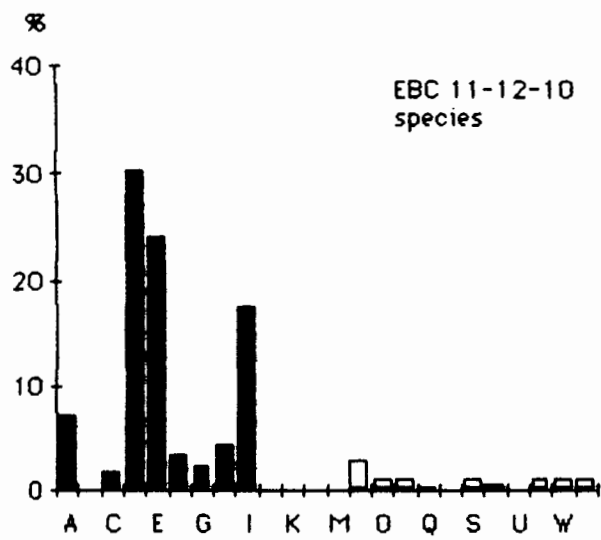


Figure 5.5. Comparison of the relative proportions of Cape cormorant skeletal elements in modern jackal accumulations with those from grouped layers at Eland's Bay Cave. Elements represented by numerical codes are listed in Table 4.2.



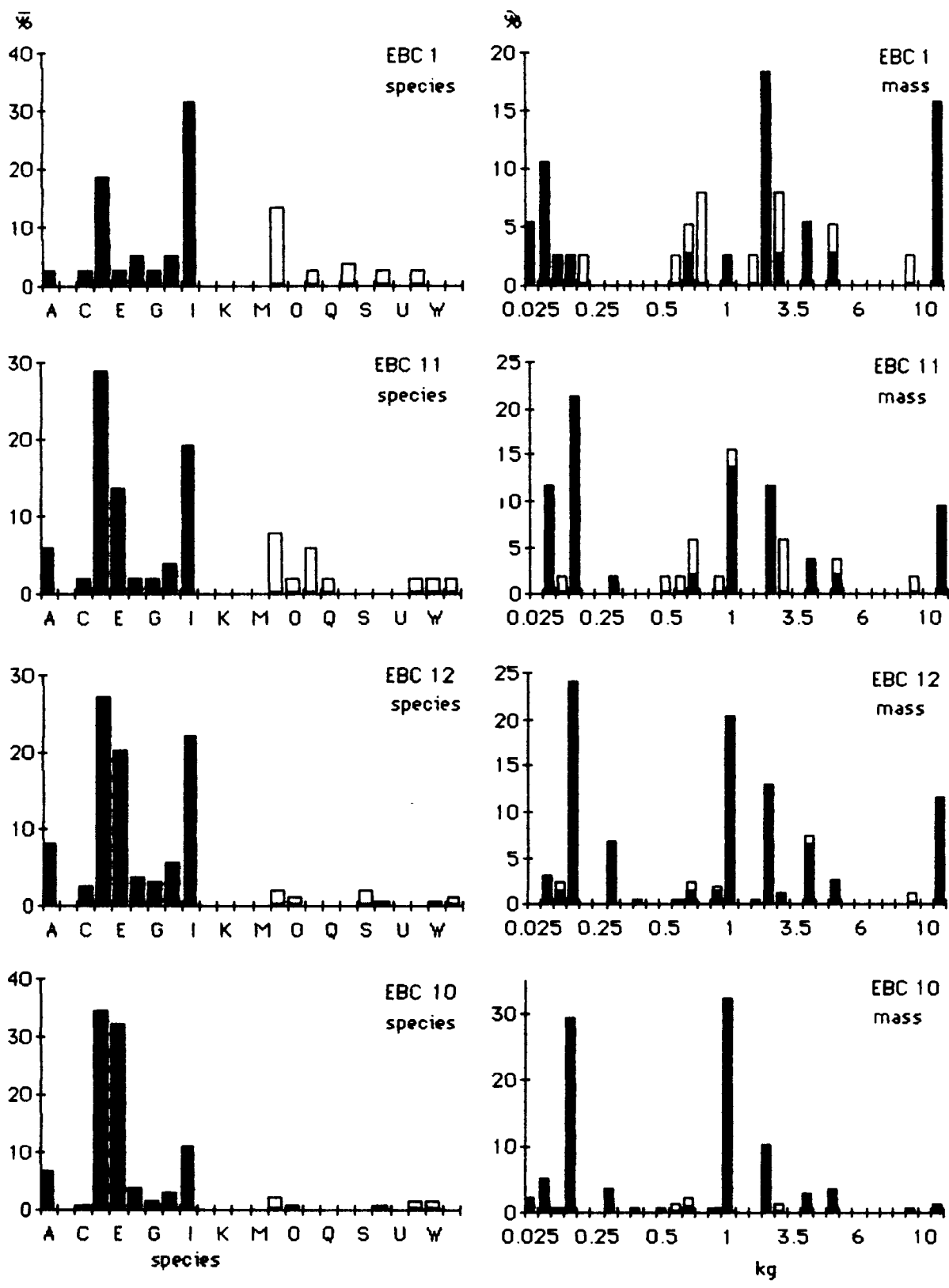
black columns - mammals; white columns - birds

Figure 5.6 (part 1). See Figure 5.6 (part 3) for caption.



black columns - mammals; white columns - birds

Figure 5.6 (part 2). See Figure 5.6 (part 3) for caption.



black columns - mammals; white columns - birds

Figure 5.6(part 3). Comparison of prey species and groups of species, and mass categories of species in grouped layers and in layers 1, 11, 12 and 10. Prey are listed in Table 4.1.

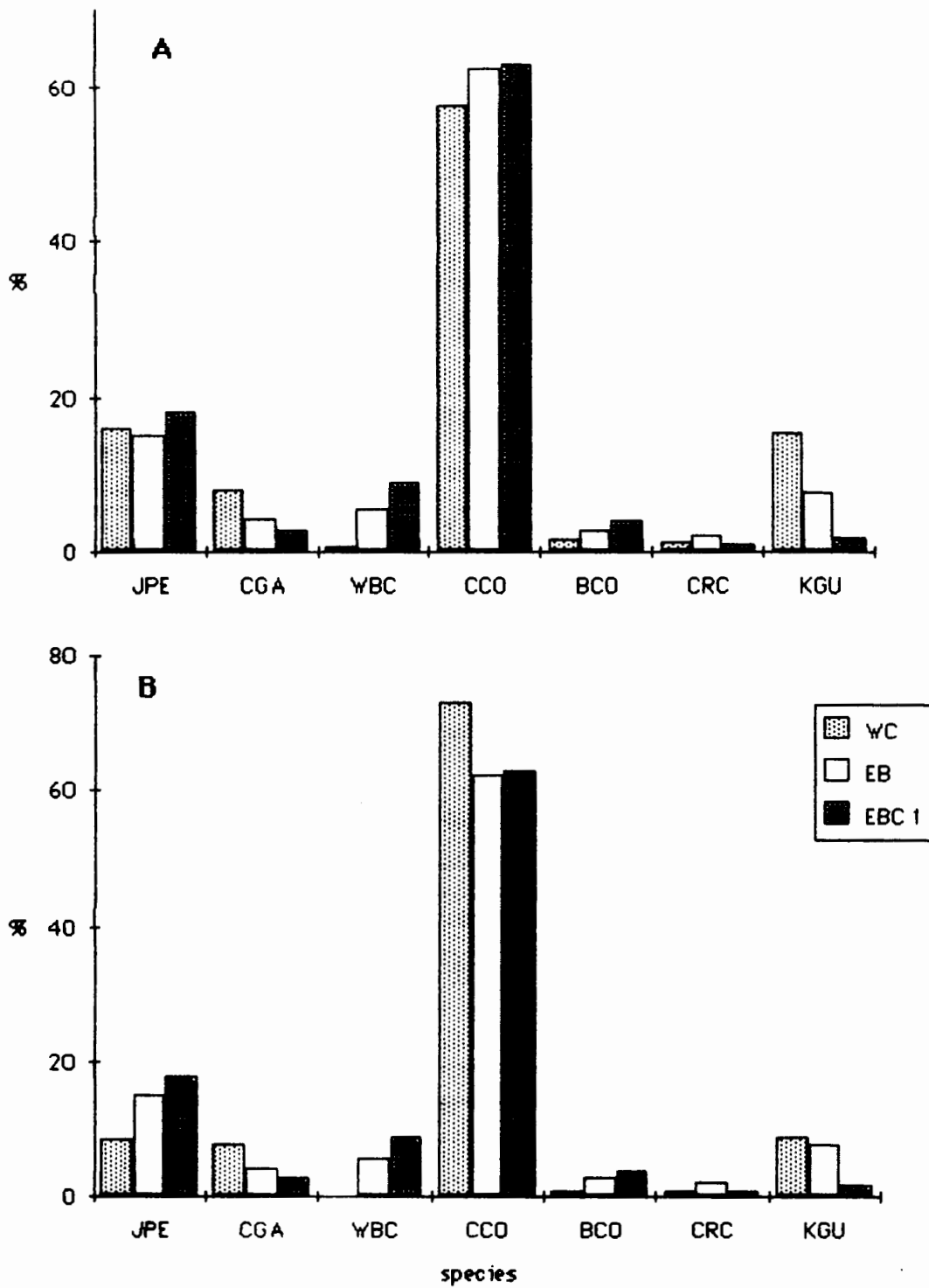


Figure 5.7. Comparison of the relative proportions of common seabirds recovered on west coast beach surveys (WC) and a two-year survey at Eland's Bay (EB) with results from Eland's Bay Cave layer 1 (EBC 1). A - WC data for 1978 to 1983; B - WC data for 1978 to 1988. JPE = jackass penguin, CGA = Cape gannet, WBC = whitebreasted cormorant, CCO = Cape cormorant, BCO = bank cormorant, CRC = crowned cormorant, KGU = kelp gull.

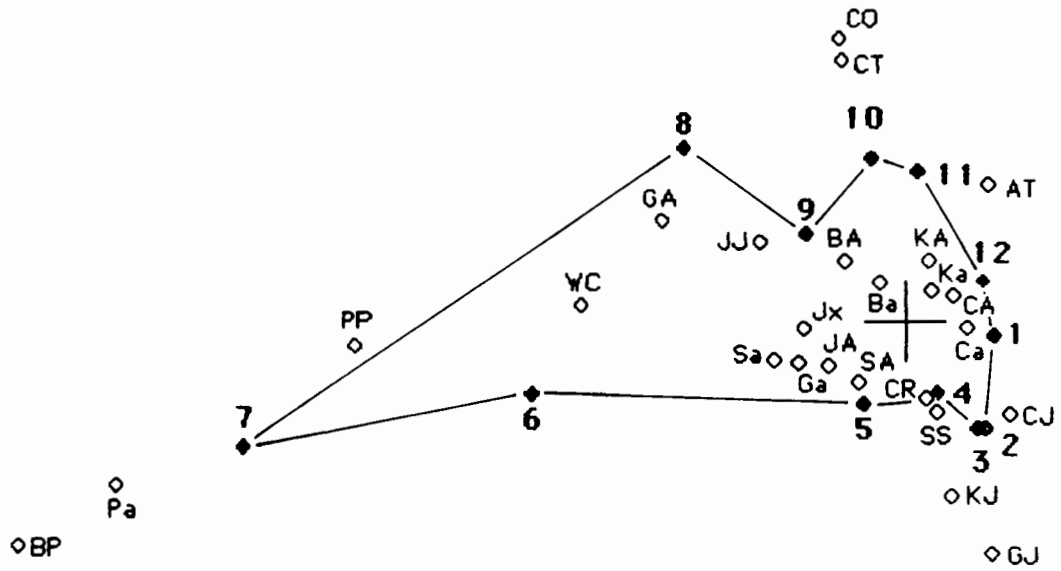


Figure 5.8. Result of correspondence analysis plot based on west coast beach surveys. Months are numbered consecutively from January to December. In the second letter of a code A = adults, J = juveniles, lower case = combined samples. Codes are given in Table 3.1.

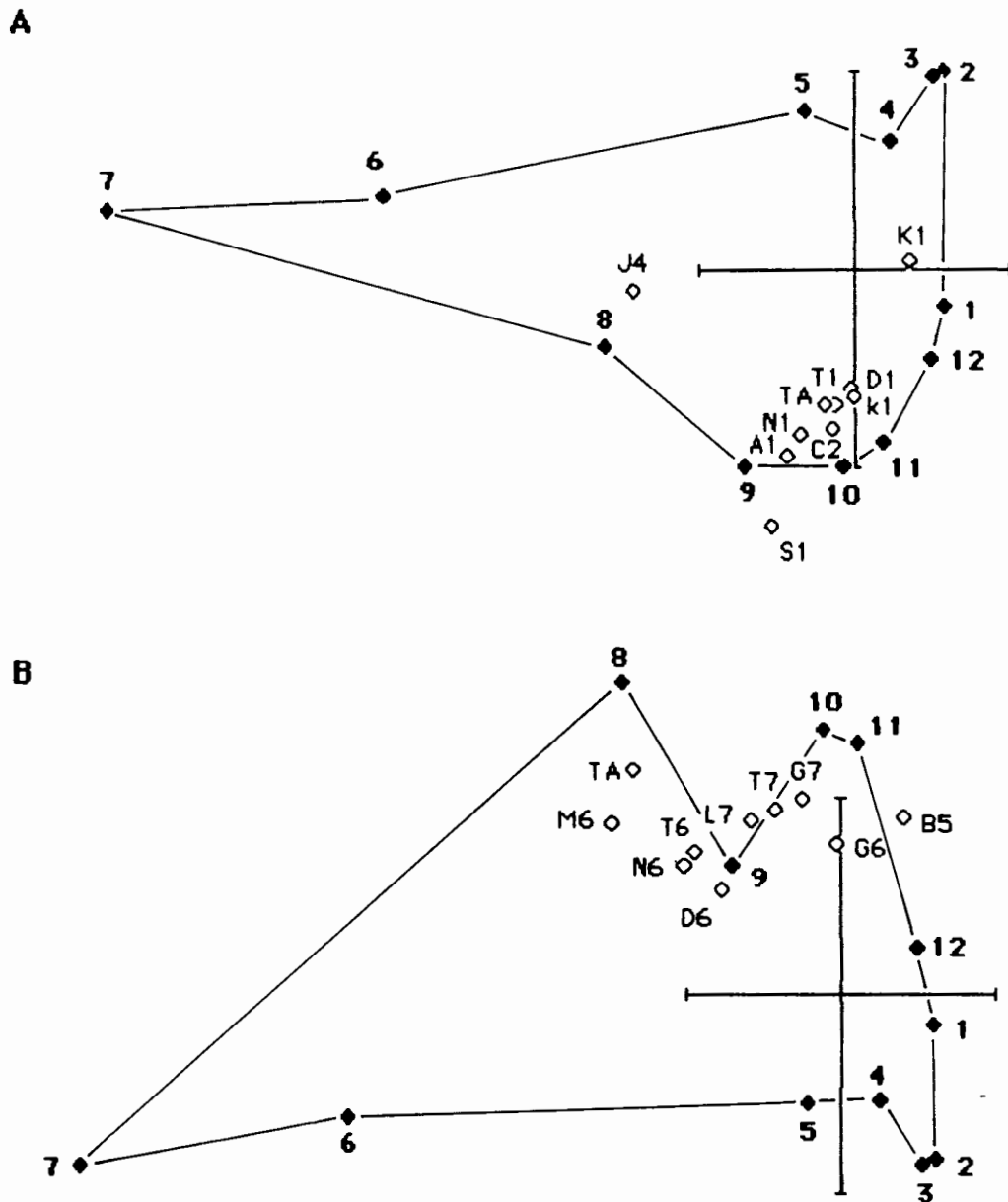


Figure 5.9. Result of correspondence analysis plot based on west coast beach surveys and layers 1-2-4 (A) and layers 5-7 (B). Months are numbered consecutively from January to December. Codes for archaeological units are given in Tables 5.2A and 5.2B. T = Layer Total; TA = Group Total.

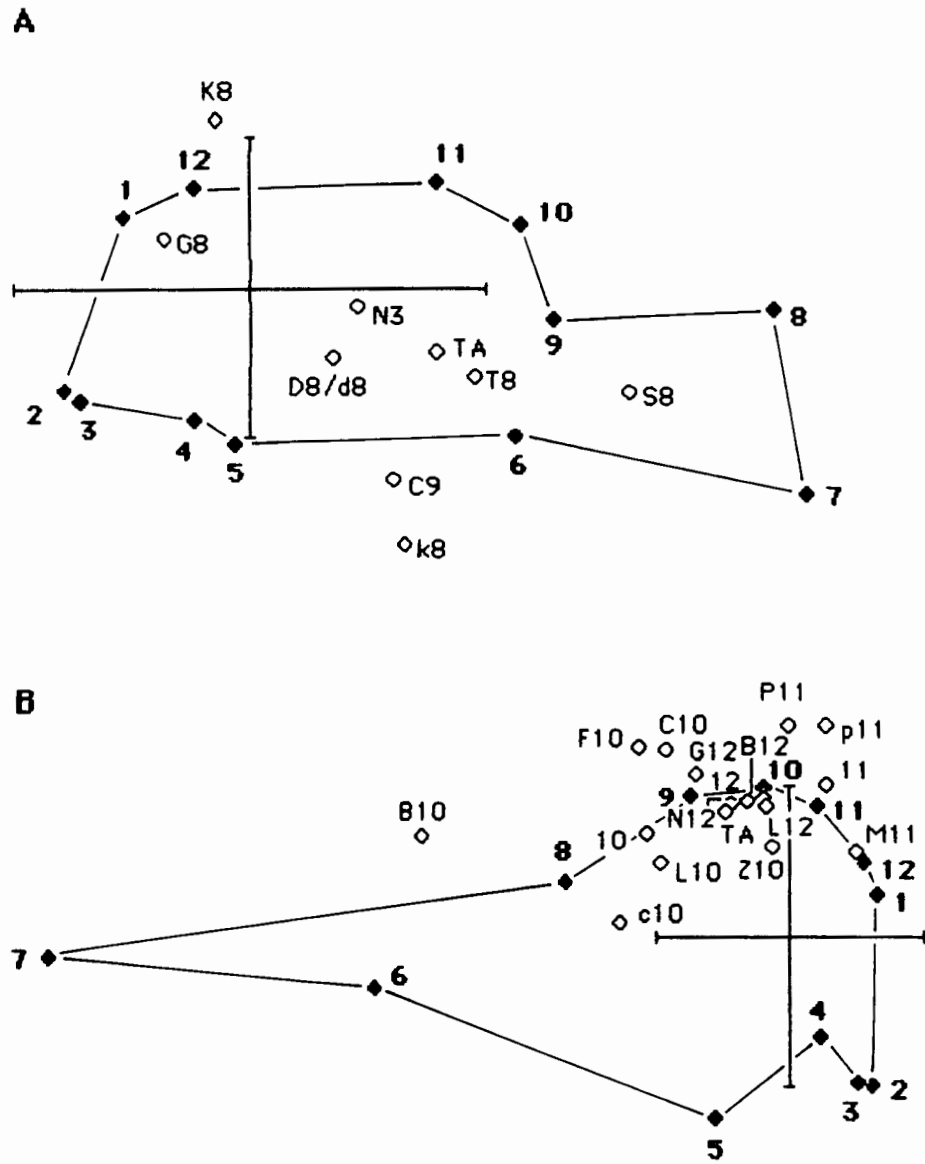


Figure 5.10. Result of correspondence analysis plot based on west coast beach surveys and layers 3-8-9 (A) and layers 11-12-10 (B). Months are numbered consecutively from January to December. Codes for archaeological units are given in Tables 5.2C, 5.2D and 5.2E. T = Layer Total; TA = Group Total.

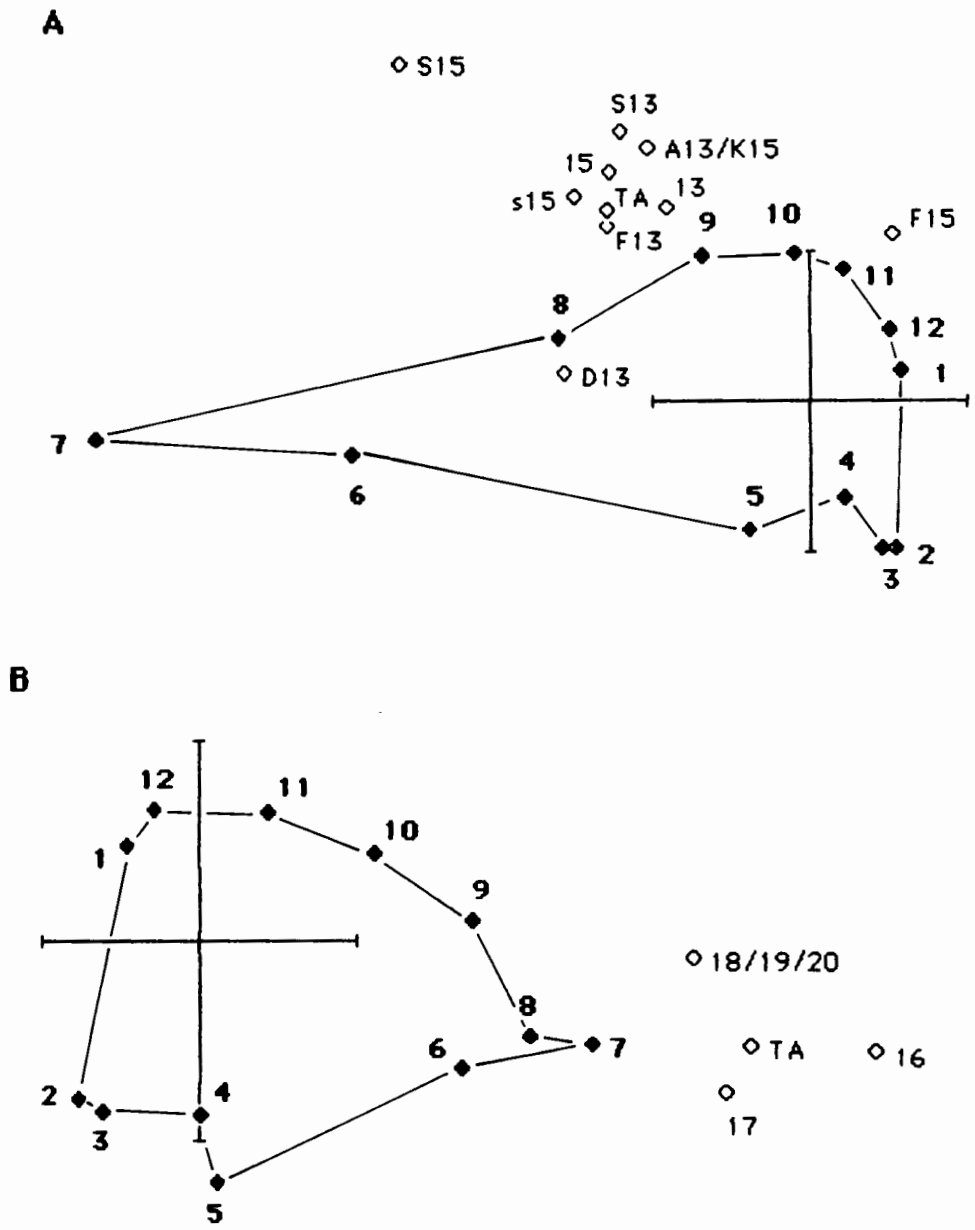


Figure 5.11. Result of correspondence analysis plot based on west coast beach surveys and layers 13-15 (A) and layers 16-20 (B). Months are numbered consecutively from January to December. Codes for archaeological units are given in Tables 5.2F and 5.2G. T = Layer Total; TA = Group Total.

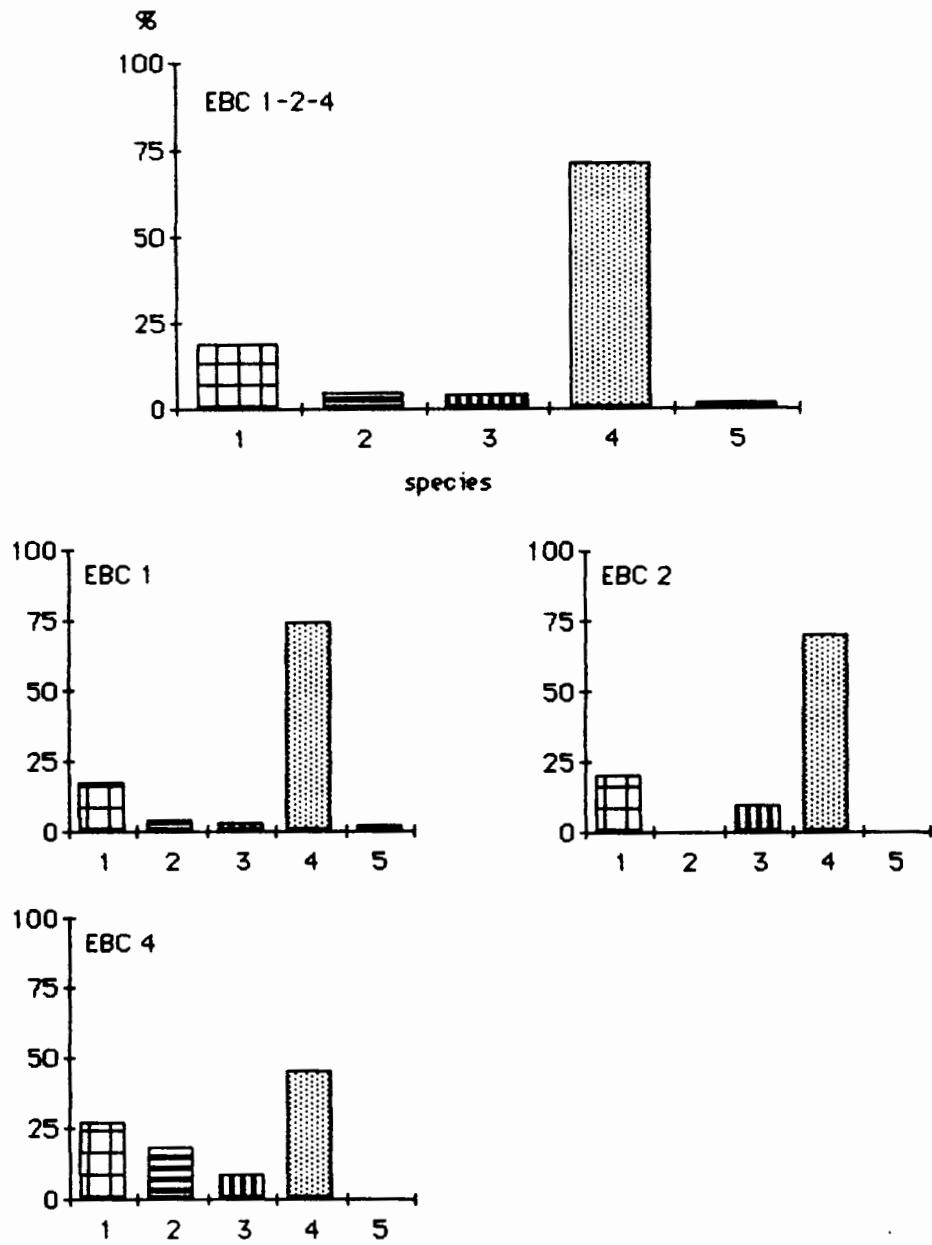


Figure 5.12 Profiles of main species or groups of species occurring in layers 1-2-4. 1 = jackass penguin, 2 = albatrosses, petrels, shearwaters, prions, 3 = Cape gannet, 4 = cormorants, 5 = kelp gull.

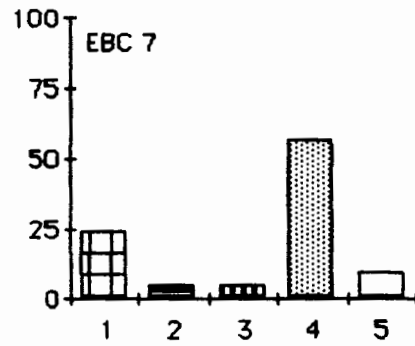
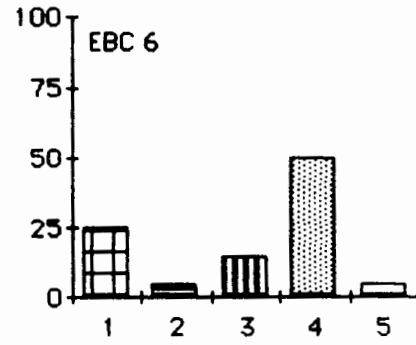
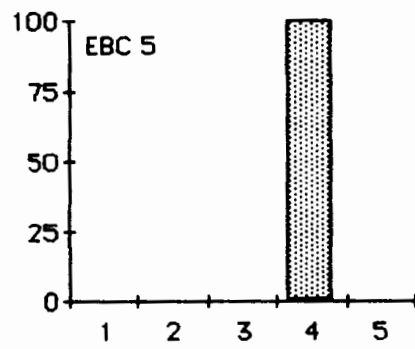
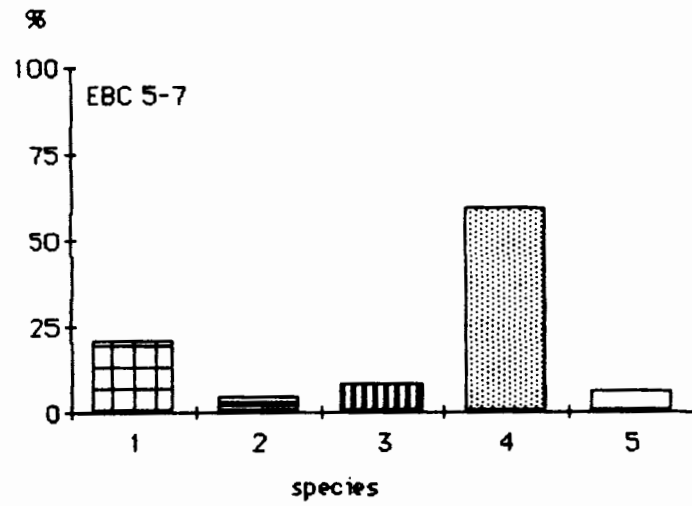


Figure 5.13. Profiles of main species or groups of species occurring in layers 5-7. Numerical codes for species are given in Figure 5.12.

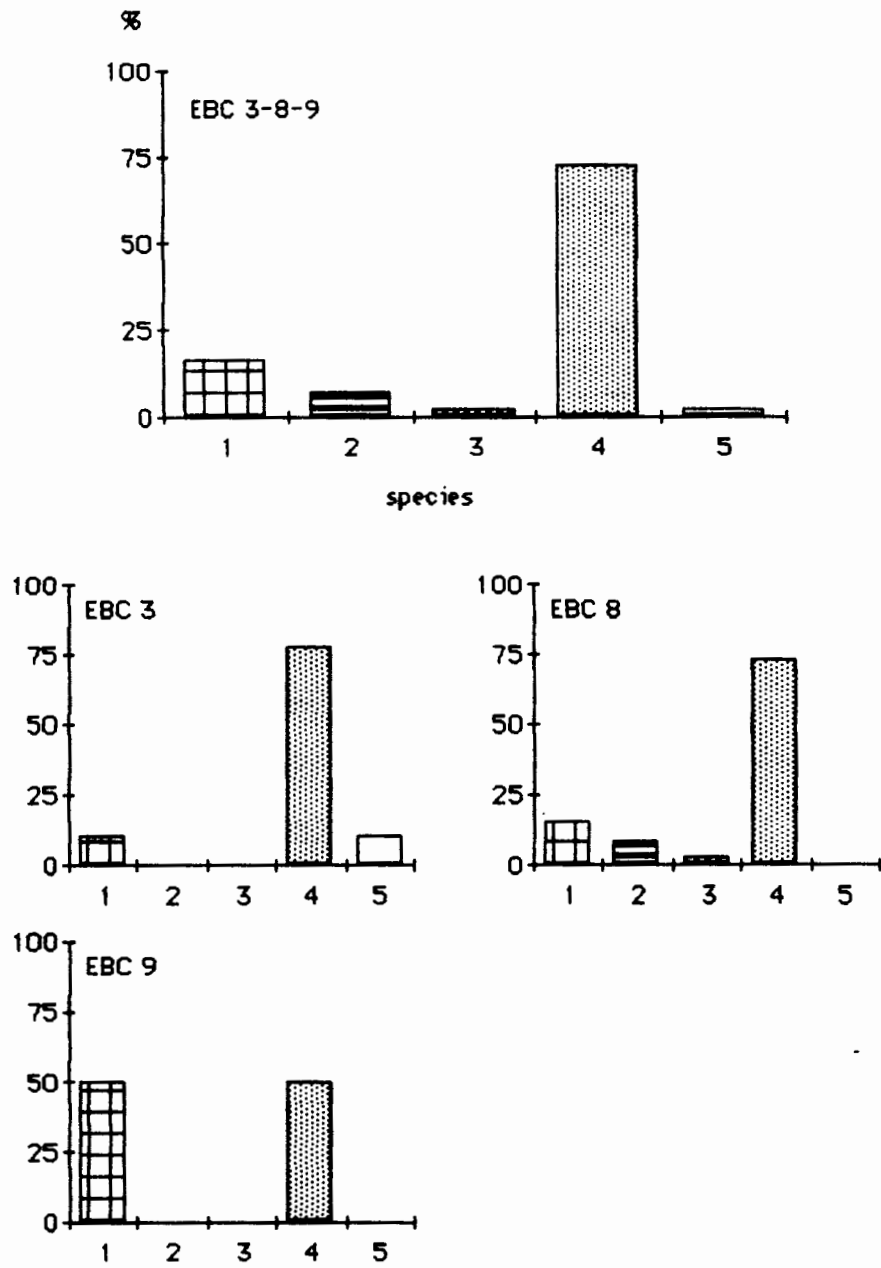


Figure 5.14. Profiles of main species or groups of species occurring in layers 3-8-9. Numerical codes for species are given in Figure 5.12.

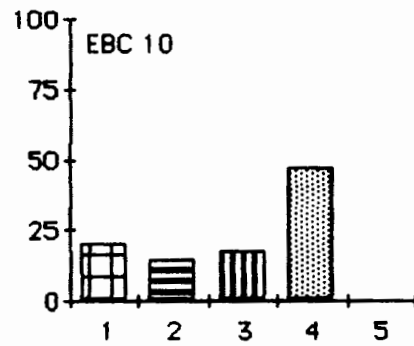
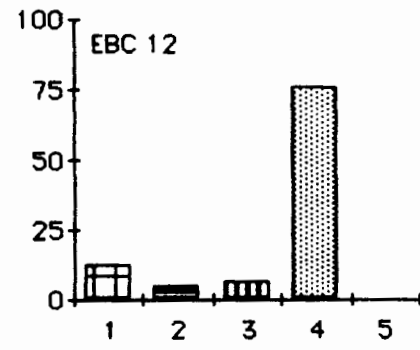
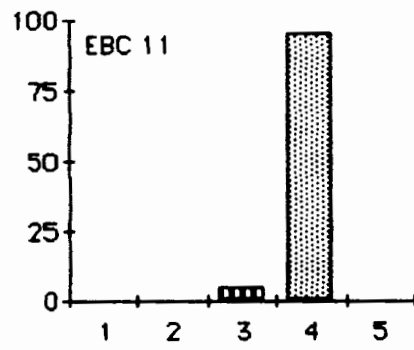
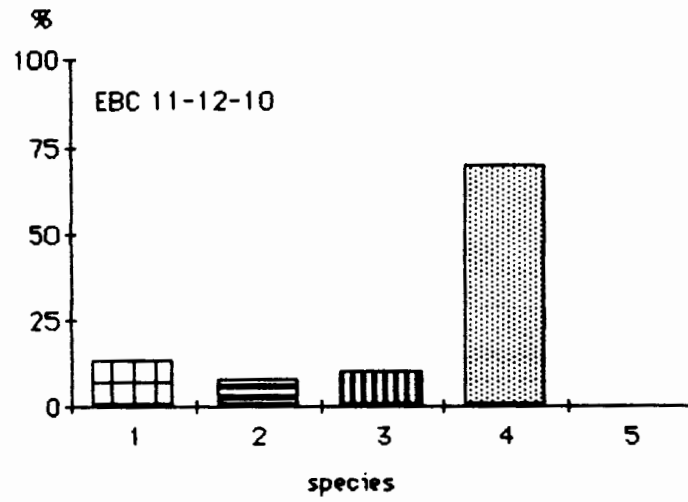


Figure 5.15. Profiles of species or groups of species occurring in layers 11-12-10. Numerical codes for species are given in Figure 5.12.

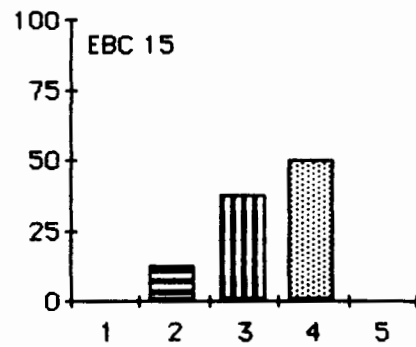
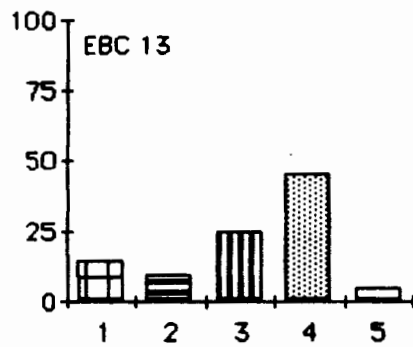
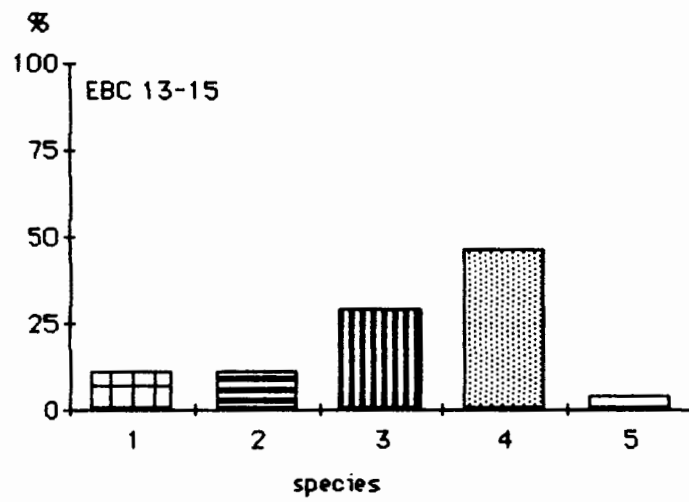


Figure 5.16. Profiles of main species or groups of species occurring in layers 13-15. Numerical codes for species are given in Figure 5.12.

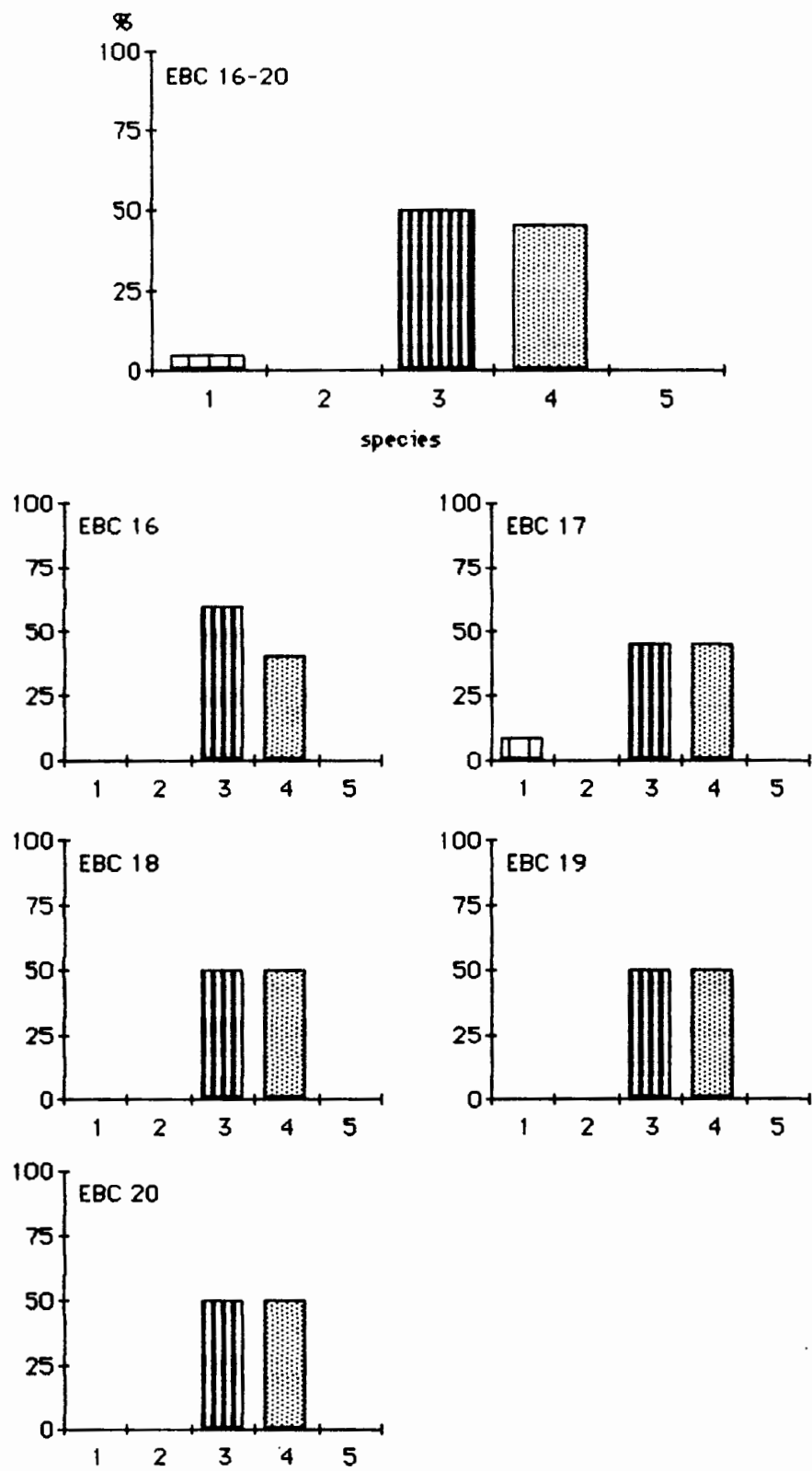


Figure 5.17 Profiles of main species or groups of species occurring in layers 16-20. Numerical codes for species are given in Figure 5.12.

**Table 5.1.** Summary of stratigraphic, chronological, cultural and environmental information available for Eland's Bay Cave (sources given in text).

LAYER	DATE	DEPOSITS	CULTURAL	LAKE	CLIMATE	TERRESTRIAL
1	315±50			coastal lake		Sea level 0 m
2			Pottery and pastoralism			
4						
5	1120±85	Dense shell midden		estuary to coastal lake	small-scale temperature and humidity fluctuations around present	slightly less grass than 3000 B.P., slightly more riverine, slightly less plain
6	1520±80					
7						
Hiatus						
		No deposition				2000 B.P. Sl +1 m
Hiatus						
3		shell middens	pre-pottery 'Wilton'	tidal estuary migrating south		sea level falling
8	3510±45					3000 B.P. as much grass as at 10000 B.P. least
9	2900					riverine, less plain than previously, most hill
	3780±85					
Hiatus						
		No Deposition		open lagoon to shallow estuary		5500 B.P. Sl +2 m 6000 B.P. Sl 0 m
Hiatus						
11	7910±80	shell middens	'Albany'	coastal but estuary still exists	Holocene temperature maximum 8-5000 B.P. ? cooler 9-8000 B.P. Wetter	8 k less grass than present, slightly more riverine than 10 k, less riverine, more hill, less plain, coast ±3 km
12	8300					
	9600±90					
10						

(cont.)

Table 5.1  
(cont.)

LAYER	DATE	DEPOSITS	CULTURAL	LAKE	CLIMATE	TERRESTRIAL
13	10700±100	shelly lenses in loamy			continued warming,	10000 B.P. slightly more
15	11070±140	sediments			humidity as at present	grass than present, limited riverine contribution, least hillside, greatest plain, coast ±5 km
16	12450±280	no shelly lenses,			warmer than glacial and	coast ±10 km
17		occasional shells only			wetter; approaching	
18					present levels or just	
19				riverine, becoming more	above	
20	13600			estuarine		
Hiatus		No deposition				
	20700		already Later Stone Age			

**Table 5.2A.** Layers 1, 2 and 4. Number of Identified Specimens / Minimum Number of Individuals recovered from selected excavated units at Eland's Bay Cave. Species are listed according to gross habitat association. ( ) = number of juveniles in total; \* = cut or worked.

SPECIES	LAYER 1										L2				L4		TOTALS	
	Dol 1	Ami 1	Ken 1	Smi 1	Kau 1	Nko 1	Cas 2	Jch 4										
Jackass penguin	*114/9(2)	7/2(1)	2/1	14/2(1)	7/2(1)	8/2(1)	4/2(1)	7/3(2)	*18(6)	4/2(1)	7/3(2)							
Blackbrowed albatross	1/1	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	
Giant petrel	1/1	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	
Pintado petrel	-	1/1	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	
Prions	-	-	-	-	-	-	-	1/1	-	-	1/1	-	-	-	-	-	-	
Sooty shearwater	1/1	-	-	-	-	-	-	1/1	1	-	1/1	-	-	-	-	-	-	
Cape gannet	11/1	1/1	-	-	-	1/1	1/1	2/1	3	1/1	2/1	-	-	-	-	-	-	
Whitebreasted cormorant	38/3	*7/1	1/1	1-1/2	2/1	5/1	1/1	1/1	*9	1/1	1/1	-	-	-	-	-	-	
Cape cormorant	921/31(3)	*171/9(1)	36/4(2)	138/11	38/4(1)	64/4	49/6(1)	4/1	*63(7)	49/6(1)	4/1	-	-	-	-	-	-	
Bank cormorant	17/2	4/1	-	2/1	-	-	-	1/1	4	-	1/1	-	-	-	-	-	-	
Crowned cormorant	-	-	-	-	-	1/1	-	2/2	1	-	2/2	-	-	-	-	-	-	
Kelp gull	6/1	1/1	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	
<b>TOTAL MARINE</b>	<b>50</b>	<b>16</b>	<b>6</b>	<b>16</b>	<b>7</b>	<b>9</b>	<b>10</b>	<b>11</b>	<b>104</b>	<b>10</b>	<b>11</b>							
Great crested grebe	*1/1	-	-	-	-	-	-	*1/1	*1	-	*1/1	-	-	-	-	-	-	
White pelican	2/1	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	
Greater flamingo	5/1	2/1	-	-	-	-	-	1/1	2	-	1/1	-	-	-	-	-	-	
Lesser flamingo	2/1	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	
Redknobbed coot	2/1	-	2/1	1/1	-	-	-	-	3	-	-	-	-	-	-	-	-	
Wader sp.	1/1	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	
<b>TOTAL FRESHWATER</b>	<b>6</b>	<b>1</b>	<b>1</b>	<b>1</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>2</b>	<b>9</b>	<b>-</b>	<b>2</b>							

(cont.)

Table 5.2A (cont.)

SPECIES	LAYER 1							L2	L4	TOTALS			
	Dol1	Ami1	Ken1	Smi1	Kau1	Nko1	Cas2						
Black eagle	-	-	-	1/1	-	-	-	-	-	1	-	-	-
Spotted eagle owl	-	-	1/1	-	-	-	-	-	-	1	-	-	-
TOTAL TERRESTRIAL	-	-	1	1	-	-	-	-	-	2	-	-	-
TOTAL	56	17	8	18	7	9	10	13	115	10	13		

**Table 5.28.** Layers 5-7. Number of Identified Specimens / Minimum Number of Individuals recovered from selected excavated units at Eland's Bay Cave. Species are listed according to gross habitat association. ( ) = number of juveniles in total; x = specimen/s with medullary bone; \* = cut or worked.

SPECIES	LAYER 5		LAYER 6		LAYER 7					TOTALS	
	Br15	Mic6	Gad6	Nkr6	Dor6	Lou7	Gre7	5	6	7	
Jackass penguin	-	2/(1)	1/(1)	2/1	14/2(1)	5/3(1)	6/2(1)	-	5(3)	5(2)	
Pintado petrel	-	-	-	-	-	1/1	-	-	-	1	
Prions	-	3/1	-	-	-	-	-	-	1	-	
Cape gannet	-	1/1	-	1/1	4/1	-	x2/1	-	3	x1	
Whitebreasted cormorant	2/1	1/1	-	-	-	3/1	3/1	2/1	1	2	
Cape cormorant	99/5	39/3	35/3	7/1	25/2	41/5(1)	68/5	99/5	9	10(1)	
Kelp gull	-	3/1	-	-	-	3/1	1/1	-	1	2	
Swift tern	-	-	-	-	1/1	-	-	-	-	1	
Tern sp.	-	-	-	-	-	*1/1	-	-	-	*1	
<b>TOTAL MARINE</b>	<b>6</b>	<b>8</b>	<b>4</b>	<b>3</b>	<b>6</b>	<b>12</b>	<b>10</b>	<b>6</b>	<b>21</b>	<b>22</b>	
Greater flamingo	-	-	4/1	7/2	-	9/2	2/1	-	3	3	
Lesser flamingo	-	-	3/1	1/1	-	-	1/1	-	2	1	
Duck sp.	-	-	-	-	1/1	-	-	-	1	-	
Redknobbed coot	-	-	x4/1	4/2	6/1	9/3	-	-	x4	3	
<b>TOTAL FRESHWATER</b>	<b>-</b>	<b>-</b>	<b>3</b>	<b>5</b>	<b>2</b>	<b>5</b>	<b>2</b>	<b>-</b>	<b>10</b>	<b>7</b>	
<b>TOTAL TERRESTRIAL</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>-</b>	
<b>TOTAL</b>	<b>6</b>	<b>8</b>	<b>7</b>	<b>8</b>	<b>8</b>	<b>17</b>	<b>12</b>	<b>6</b>	<b>31</b>	<b>29</b>	

**Table 5.2c.** Layers 3-8-9. Number of Identified Specimens / Minimum Number of Individuals recovered from selected excavated units at Eland's Bay Cave. Species are listed according to gross habitat association. ( ) = number of juveniles in total.

SPECIES	LAYER 3		LAYER 8					L9	TOTALS				
	Nye3	Sha8	Kri8	Din8	kun8	Dig8	Gar8		Cho9	3	8	9	
Jackass penguin	2/1	5/1	-	2/1	6/2	1/1	-	1/1	2/1	5	1/1		
Pintado petrel	-	1/1	-	-	-	-	-	-	-	1	-		
Blue petrel	-	1/1	-	-	-	-	-	-	-	1	-		
Sooty shearwater	-	-	1/1	-	-	-	-	-	-	1	-		
Cape gannet	-	1/1	-	-	-	-	-	-	-	1	-		
Whitebreasted cormorant	3/1	5/1	-	-	-	-	-	-	3/1	1	-		
Cape cormorant	48/4	199/11	34/3	17/2	12/2	16/2	15/2	5/1	48/4	22	5/1		
Bank cormorant	1/(1)	-	-	-	-	-	-	-	1/(1)	-	-		
Crowned cormorant	1/1	2/1	-	-	-	-	-	-	1/1	1	-		
Kelp gull	2/1	-	-	-	-	-	-	-	2/1	-	-		
Swift tern	-	1/1	-	-	2/1	-	-	-	-	2	-		
Common tern	-	1/1	-	-	-	-	-	-	-	1	-		
<b>TOTAL MARINE</b>	<b>9</b>	<b>19</b>	<b>4</b>	<b>3</b>	<b>5</b>	<b>3</b>	<b>2</b>	<b>2</b>	<b>9</b>	<b>36</b>	<b>2</b>		
Greater flamingo	9/1	12/2	3/1	4/1	1/1	-	1/1	1/1	9/1	6	1/1		
Redknobbed coot	-	3/2(1)	2/1	-	-	-	-	-	-	3(1)	-		
Water dikkop	-	-	-	-	-	?1/1	-	-	-	?1	-		
<b>TOTAL FRESHWATER</b>	<b>1</b>	<b>4</b>	<b>2</b>	<b>1</b>	<b>1</b>	<b>1</b>	<b>1</b>	<b>1</b>	<b>1</b>	<b>10</b>	<b>1</b>		

(cont.)

Table 5.2c (cont.)

SPECIES	LAYER 3		LAYER 8		L9					TOTALS		
	Nye3	Sha8	Kri8	Din8	kun8	Dig8	Gar8	Cho9	3	8	9	
Cape francolin	-	-	-	1/1	-	-	-	-	-	-	1	-
Alpine swift	-	-	-	1/1	-	-	-	-	-	-	1	-
Rock martin	-	-	-	1/1	-	-	-	-	-	-	1	-
Whitenecked raven	-	2/1	-	-	1/1	-	-	1/1	-	-	2	1/1
Other small sp.	-	1/1	-	-	-	-	-	-	-	-	1	-
TOTAL TERRESTRIAL	-	2	-	3	1	-	-	1	-	-	6	1
TOTAL	10	25	6	7	7	4	3	4	10	52	4	

**Table 5.20.** Layers 11 and 12. Number of Identified Specimens / Minimum Number of Individuals recovered from selected excavated units at Eland's Bay Cave. Species are listed according to gross habitat association. ( ) = number of juveniles in total; n = nestling/s among juveniles; \* = cut or worked.

SPECIES	LAYER 11				LAYER 12				TOTALS						
	MAR11	PEL 11	PUB11	Gon12	Nep12	Bur 12	Lim12	11	12						
Jackass penguin	-	-	-	4/2(1)	10/2(1)	16/3(2)	2/1	-	-	8(4)					
Albatross sp.	-	-	-	-	1/1	-	-	-	-	1					
P-rions	-	-	-	-	1/1	-	*2/1	-	-	*2					
Whitechinned petrel	-	-	-	-	-	-	-	-	-	-					
Sooty shearwater	-	-	-	-	-	-	-	-	-	-					
Cape gannet	-	1/1	-	1/1	5/1	5/1	4/1	-	-	1					
Whitebreasted cormorant	1/1	2/1	3/1	4/1	21/2	5/1	14/2	-	-	3					
Cape cormorant	75/7(1)	34/5	*15/2	34/2	225/14	123/7	269/15	*14(1)	-	38					
Bank cormorant	-	-	-	-	1/1	-	-	-	-	1					
Crowned cormorant	1/1	-	-	-	-	1/1	6/1	-	-	1					
<b>TOTAL MARINE</b>	<b>9</b>	<b>7</b>	<b>3</b>	<b>6</b>	<b>22</b>	<b>13</b>	<b>21</b>	<b>19</b>	<b>62</b>						
White pelican	1/1	-	-	-	2/1	-	2/1	1	2						
Grey heron	-	-	-	-	-	n1/(1)	-	-	n(1)						
Greater flamingo	1/1	2/(1)	2/1	-	-	-	-	3(1)	-						
Cape teal	-	-	-	-	1/1	-	-	-	1						
Duck sp.	-	-	n1/(1)	-	-	1/1	-	(1)	1						
Curlew	-	-	-	-	-	?1	-	-	1						
<b>TOTAL FRESHWATER</b>	<b>2</b>	<b>1</b>	<b>2</b>	<b>-</b>	<b>2</b>	<b>3</b>	<b>1</b>	<b>5</b>	<b>6</b>						

(cont.)

Table 5.20 (cont.)

SPECIES	LAYER 11			LAYER 12			TOTALS		
	MAR 11	PEL 11	PMB 11	Gon 12	Nep 12	Bur 12	Lim 12	11	12
Black eagle	-	-	n1/(1)	-	-	-	-	(1)	-
Jackal buzzard	-	-	n1/(1)	-	-	-	-	(1)	-
Lanner	-	-	2/(1)	-	-	-	-	(1)	-
Cape francolin	-	1/1	-	-	-	-	-	1	-
Ludwig's bustard	-	-	-	1/1	-	-	-	-	1
Black korhaan	-	-	-	-	-	1/1	-	-	1
Bustard sp. (large)	-	-	-	-	1/1	-	-	-	1
Spotted eagle owl	-	-	2/1	-	-	-	-	1	-
Whitenecked raven	-	-	n1/(1)	-	1/1	-	-	(1)	1
Starling	-	-	-	-	2/2	-	-	-	2
Other small sp.	-	-	1/1	-	-	-	-	1	-
TOTAL TERRESTRIAL	-	1	6	1	4	1	-	7	6
TOTAL	11	9	11	7	28	17	22	31	74

**Table 5.2E.** Layer 10. Number of Identified Specimens / Minimum Number of Individuals recovered from selected excavated units at Eland's Bay Cave. Species are listed according to gross habitat association. ( ) = number of juveniles in total; \* = cut or worked.

SPECIES	LAYER 10						TOTAL
	Lob10	Brn10	cra10	Zos10	Flt10	CrY10	
Jackass penguin	1/1	-	16/2(1)	2/1	7/2(1)	22/2(1)	8
Blackbrowed albatross	-	-	-	-	-	1/1	1
Albatross sp.	-	-	-	-	-	-	-
Giant petrel	-	-	1/1	-	1/1	1/1	3
Prions	-	1/1	-	-	-	-	1
Whitechinned petrel	-	-	-	-	-	4/1	1
Cape gannet	1/1	-	*3/1	3/1	1/1	7/3(1)	*7
Whitebreasted cormorant	-	3/1	*8/1	9/1	1/1	5/1	*5
Cape cormorant	7/1	7/1	*45/3	33/4(1)	15/2	58/3	*14
<b>TOTAL MARINE</b>	<b>3</b>	<b>3</b>	<b>8</b>	<b>7</b>	<b>7</b>	<b>12</b>	<b>4-</b>
White pelican	-	-	-	1/(1)	-	-	1
Greater flamingo	-	1/1	-	1/1	-	-	2
Cape teal	-	1/1	-	-	-	-	1
<b>TOTAL FRESHWATER</b>	<b>-</b>	<b>2</b>	<b>-</b>	<b>2</b>	<b>-</b>	<b>-</b>	<b>4</b>

(cont.)

Table 5.2E (cont.)

SPECIES	LAYER 10							TOTAL
	Lob10	Brw10	cra10	Zos10	Flit10	Cry10	10	
Spotted dickop	1/1	-	-	-	-	-	-	1
Spotted eagle owl	-	1/1	-	-	-	-	1/1	2
Whitenecked raven	-	-	-	1/1	-	-	1/1	2
TOTAL TERRESTRIAL	1	1	-	1	-	-	2	5
TOTAL	4	6	8	10	7	14	49	

**Table 5.2f.** Layers 13-15 (Layer 14 subsumed in 13). Number of Identified Specimens / Minimum Number of Individuals recovered from selected excavated units at Eland's Bay Cave. Species are listed according to gross habitat association. ( ) = number of juveniles in total; \* = cut or worked.

SPECIES	LAYER 13				LAYER 15					TOTALS	
	Foa+13	Smo13	Dus13	Ash13	Kar15	She15	1st15	Slat15	13/14		
Jackass penguin	14/2(1)	2/(1)	-	-	-	-	-	-	-	3(2)	-
Albatross sp.	-	-	1/1	-	-	-	-	-	-	1	-
Prions	1/1	-	-	-	-	-	-	-	-	1	-
Whitechinned petrel	-	-	-	-	-	-	-	-	-	1/1	1
Cape gannet	17/2	2/1	1/1	3/1	5/1	1/1	-	-	3/1	5	3
Whitebreasted cormorant	7/2(1)	-	-	-	-	-	-	-	1/1	2(1)	1
Cape cormorant	5/13	9/1	2/1	5/1	1/1	-	1/1	2/1	-	6	3
Bank cormorant	1/1	-	-	-	-	-	-	-	-	1	-
Kelp gull	1/1	-	-	-	-	-	-	-	-	1	-
<b>TOTAL MARINE</b>	<b>12</b>	<b>3</b>	<b>3</b>	<b>2</b>	<b>2</b>	<b>1</b>	<b>1</b>	<b>4</b>	<b>20</b>	<b>8</b>	<b>8</b>
Greater flamingo	-	-	-	1/1	-	-	-	-	-	1	-
Lesser flamingo	-	-	-	-	-	-	-	1/(1)	-	-	(1)
South African shelduck	-	2/1	-	-	-	-	-	-	-	1	-
<b>TOTAL FRESHWATER</b>	<b>-</b>	<b>1</b>	<b>-</b>	<b>1</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>1</b>	<b>2</b>	<b>1</b>	<b>1</b>

(cont.)

Table 5.2f (cont.)

SPECIES	LAYER 13					LAYER 15					TOTALS	
	Foa+13	Smo13	Dus13	Ash13	Kar15	She15	1st15	Slas15	13/14	15		
Egyptian goose	9/2	6/1	3\1	*9/1	-	-	-	-	-	5	-	
Greywing francolin	-	-	-	-	1/1	-	-	-	-	-	1	
Cape francolin	4/1	1/1	-	-	-	1/1	-	-	-	2	1	
Black korhaan	-	?1	-	-	-	-	-	-	-	?1	-	
Speckled rock pigeon	-	1/1	-	-	-	-	-	-	-	1	-	
Spotted eagle owl	-	-	-	1/1	-	-	-	-	-	1	-	
Whitenecked raven	-	-	-	-	-	-	-	1/(1)	-	-	(1)	
Other small sp.	-	1/1	-	-	-	-	-	-	-	1	-	
<b>TOTAL TERRESTRIAL</b>	<b>3</b>	<b>5</b>	<b>1</b>	<b>2</b>	<b>1</b>	<b>1</b>	<b>1</b>	<b>1</b>	<b>-</b>	<b>11</b>	<b>4</b>	
<b>TOTAL</b>	<b>15</b>	<b>9</b>	<b>4</b>	<b>5</b>	<b>3</b>	<b>2</b>	<b>2</b>	<b>2</b>	<b>5</b>	<b>33</b>	<b>12</b>	

**Table 5.26.** Layers 16-20. Number of Identified Specimens / Minimum Number of Individuals recovered from selected excavated units at Eland's Bay Cave. Species are listed according to gross habitat association. ( ) = number of juveniles in total; x = specimen/s with medullary bone; \* = cut or worked.

SPECIES	L 16	L 17	L 18	L 19	L 20
	GB116	GB117	OB118	OB119	SS120
Jackass penguin	-	4/1	-	-	-
Cape gannet	x*22/3	x73/5	8/1	2/1	4/1
Whitebreasted cormorant	2/1	5/2(1)	-	-	-
Cape cormorant	3/1	13/3(1)	2/1	2/1	1/1
<b>TOTAL MARINE</b>	<b>5</b>	<b>11</b>	<b>2</b>	<b>1</b>	<b>2</b>
Redknobbed coot	-	-	-	-	1/1
Wader sp.	-	1/1	-	-	-
<b>TOTAL FRESHWATER</b>	<b>-</b>	<b>1</b>	<b>-</b>	<b>-</b>	<b>1</b>

(cont.)

Table 5.26 (cont.)

SPECIES	L 16	L 17	L 18	L 19	L 20
	GB116	GB117	OB118	OB119	SS120
Egyptian goose	1/1	3/1	22/(1)	-	-
Black korhaan	-	3/1	1/1	-	-
Whitenecked raven	-	2/2(1)	-	-	1/(1)
Starling	-	1/(1)	-	-	-
TOTAL TERRESTRIAL	1	5	2	-	1
TOTAL	6	15	4	2	4

**Table 5.2H.** Layers grouped chronologically (See Table 5.1). Number of Identified Specimens/Minimum Number of Individuals recovered from selected excavated units at Eland's Bay Cave. Species are listed according to gross habitat association. ( ) = number of juveniles in total; x = specimen/s with medullary bone; \* = cut or worked.

SPECIES	LAYERS					
	1-2-4	5-7	3-8-9	10-12	13-15	16-20
Jackass penguin	23(9)	10(5)	7	16(4)	3(2)	1
Blackbrowed albatross	1	-	-	1	-	-
Albatross sp.	-	-	-	1	1	-
Giant petrel	1	-	-	3	-	-
Pintado petrel	1	1	1	-	-	-
Blue petrel	-	-	1	-	-	-
Prions	1	1	-	3	1	-
Whitechinned petrel	-	-	-	1	1	-
Sooty shearwater	2	-	1	-	-	-
Cape gannet	5	x4	1	*12	8	x*11
Whitebreasted cormorant	11	4	2	*14	3(1)	3(1)
Cape cormorant	70(8)	24(1)	27	*66(1)	9	7(1)
Bank cormorant	5	-	(1)	1	1	-
Crowned cormorant	3	-	2	3	-	-
Kelp gull	2	3	1	-	1	-
Swift tern	-	1	2	-	-	-
Common tern	-	-	1	-	-	-
Tern sp.	-	*1	-	-	-	-
<b>TOTAL MARINE</b>	<b>125</b>	<b>49</b>	<b>47</b>	<b>121</b>	<b>28</b>	<b>22</b>
Great crested grebe	*2	-	-	-	-	-
White pelican	1	-	-	4	-	-
Grey heron	-	-	-	(1)	-	-
Greater flamingo	3	6	8	5(1)	1	-
Lesser flamingo	1	3	-	-	1	-
South African shelduck	-	-	-	-	1	-
Cape teal	-	-	-	2	-	-
Duck sp.	-	1	-	2(1)	-	-
Redknobbed coot	3	x7	3(1)	-	-	1
Curlew	-	-	-	?1	-	-
Wader sp.	1	-	-	-	-	1
Water dikkop	-	-	?1	-	-	-
<b>TOTAL FRESHWATER</b>	<b>11</b>	<b>17</b>	<b>12</b>	<b>15</b>	<b>3</b>	<b>2</b>

(cont.)

Table 5.2H (cont.)

SPECIES	LAYERS					
	1-2-4	5-7	3-8-9	10-12	13-15	16-20
Egyptian goose	-	-	-	-	5	3(1)
Black eagle	1	-	-	(1)	-	-
Jackal buzzard	-	-	-	(1)	-	-
Lanner	-	-	-	(1)	-	-
Greywing francolin	-	-	-	-	1	-
Cape francolin	-	-	1	1	3	-
Ludwig's bustard	-	-	-	1	-	-
Black korhaan	-	-	-	1	?1	2
Bustard sp. (large)	-	-	-	1	-	-
Spotted dikkop	-	-	-	1	-	-
Speckled rock pigeon	-	-	-	-	1	-
Spotted eagle owl	1	-	-	3	1	-
Alpine swift	-	-	1	-	-	-
Rock martin	-	-	1	-	-	-
Whitenecked raven	-	-	3	4(1)	1	3(2)
Starling	-	-	-	2	-	(1)
Other small sp.	-	-	1	1	1	-
TOTAL TERRESTRIAL	2	-	7	18	14	9
TOTAL	138	66	66	154	45	33

**Table 5.3.** Results of Kolmogorov-Smirnov two-sample tests of whether the archaeological samples differ significantly from the modern observations. ND = no significant difference. Others are significant at the levels indicated.

ARCHAEOLOGICAL SAMPLES	E. BAY B. SURVEYS	W. COAST B. SURVEYS	W. COAST POPULATIONS
1	ND	ND	0.01
2	0.01	0.001	ND
4	0.01	0.001	0.01
1-2-4	ND	ND	0.05
5	0.10	ND	0.001
6	0.05	0.001	ND
7	ND	0.01	ND
5-7	ND	0.01	ND
3	0.05	0.05	0.001
8	ND	ND	0.01
9	-	-	-
3-8-9	ND	ND	0.01
11	ND	ND	0.001
12	ND	ND	0.01
10	0.001	0.001	ND
10-12	ND	0.05	0.01
13	0.001	0.001	ND
15	0.001	0.001	0.01
13-15	0.001	0.001	ND
16-20	0.001	0.001	0.01

## 6. SOUTHWEST COAST ARCHAEOLOGICAL SAMPLE: DIE KELDERS CAVE 1

### INTRODUCTION

One of the most important coastal archaeological sequences on the southwest coast is that in Die Kelders Cave 1, which was excavated by F.R. Schweitzer of the South African Museum (Schweitzer 1970, 1979). Die Kelders Cave 1 is located on the coast some 150 km southeast of Cape Town in Bredasdorp Formation limestone cliffs which cap basal Table Mountain Sandstone series rocks (Figure 6.1). Rocky beaches are typical of the area, although a sandy stretch extends some 18 km to the north where the Kleinriviervlei intersects the coast. Seven kilometres southeast of the cave the coast is intersected by the Uilenkraal river. The combined rocky and sandy coastline and riverine catchment provide a wide range of marine, freshwater and terrestrial resources within a 10 km radius of the site.

The base of the Die Kelders Cave 1 sequence comprises Middle Stone Age cultural remains estimated to date from 80 000 B.P. to 35 000 B.P. The Middle Stone Age sequence was terminated at the height of the Last Glacial; after a major occupational hiatus the cave was reoccupied between 2000 and 1500 B.P. when a complex of shell middens was laid down (Table 6.1; Tankard & Schweitzer 1976; Schweitzer 1979). Avian remains occur throughout the sequence.

Stratigraphic and palaeoenvironmental information is summarized in Table 6.1. Tankard & Schweitzer (1976), J. Deacon *et al.* (1984) and Deacon & Lancaster (1988) discussed evidence for environmental change and its effects on the physical characteristics of the cave and coastal region. D.M. Avery (1982) provided evidence

for vegetation change based on micromammalian remains. Major climatic trends for the western Cape region are summarized in Partridge *et al.* (submitted).

#### METHODS

The methods outlined in Chapter 5 have been followed. Avian remains were initially separated from the excavated samples by F.R. Schweitzer and his student helpers; subsequently R.G.Klein provided more remains from samples he analysed. A large volume of the available Later Stone Age deposits of Die Kelders Cave 1 was excavated and the samples are from well-defined stratigraphic and spatial units, with good bone preservation. It is believed, therefore, that the frequencies provide a reasonable reflection of remains brought to the site and preserved. In the light of the short period of the Later Stone Age accumulation, the top four layers, which are representative of the avian samples in others, are considered adequate for the scope of this study. The area of Middle Stone Age deposits excavated decreased with depth, and the sample sizes per unit reflect both this and the terrestrial character of the site at the time.

R.G. Klein kindly permitted me to use his unpublished data on the mammalian fauna for comparison with modern black eagle and Cape eagle owl assemblages. Results of beach surveys conducted in the southwestern Cape have been used in the correspondence analysis of seabirds in the archaeological samples.

## RESULTS AND DISCUSSION: THE LATER STONE AGE

## COMPOSITION OF THE SAMPLES

The species and MNIs listed in Table 6.2 have been grouped according to gross habitat preference. Results for the smaller sub-units excavated by Schweitzer (1979) are dominated by the main unit of each layer and, as numbers were minimal, have not been given separately. Sample sizes vary. The NISPs from which were calculated the MNIs presented in Table 6.2 follow a pattern similar to that at Eland's Bay Cave and many of the less common species are represented by one or very few bones. As at Eland's Bay Cave, given that whole birds are likely to have been brought to the cave for processing and that the area covered by the excavation was large, some loss of bone has clearly taken place. In spite of this, however, the composition of the marine element in the layers within which they occur is relatively consistent. With the exception of layer 1 where numbers of jackass penguin and Cape cormorant are equal, Cape gannets are the most common species overall. Compared with the Eland's Bay samples, the proportion of Cape cormorants is very low.

Species associated with the marine environment contribute a consistent 63 to 79% proportion of the overall bird sample for each layer (Table 6.2). Although the period represented is short, there is some indication that the seabird proportion was slightly less in the more recent samples. The relative proportions of jackass penguins, Cape gannets and Cape cormorants fluctuate between layers (Figure 6.2), with Cape gannets varying most. The variation is within the range observed on beach surveys and likely to reflect very specific timing of exploitation. The effect of a shorter- (annual) or longer-term fluctuation during which Cape gannet mortality was higher (Avery 1988a) cannot be ruled out since the period involved cannot be

determined. However, exactly what these small samples mean is a topic for the future.

The freshwater component contributed between 7 and 13% of the samples for each layer, with layer 1 being rather higher than layers 2 to 4 which range between 7 and 8%. The terrestrial component was 13% in layer 3 but was 22% in layers 2 and 4, and 25% in layer 1. Birds of prey, including common kestrel, jackal buzzard, spotted eagle owl, whitenecked raven, and speckled rock pigeon, which make up an important proportion of the samples, would have been using the cave as a roost and breeding site, as is the case for some of these species at present. The implication of this is that the cave was used intermittently by people.

#### AGENCY OF ACCUMULATION

The possibility that agents other than people may have contributed to the Later Stone Age accumulations at Die Kelders Cave 1 has not been considered likely (Schweitzer 1979; D.M. Avery 1982). Given that the incidence of damage on bones did not prove a useful criterion for distinguishing human from jackal accumulations at Eland's Bay Cave, and that the incidence of damage on Die Kelders Cave 1 samples was apparently low, this comparison will not be made again. However, for comparative purposes, skeletal elements of Cape cormorants and the small-mammal and non-seabird samples will be compared with modern samples.

#### Black-backed jackal

The numbers of Cape cormorant skeletal elements were not large enough to compare the relative proportions of skeletal elements in each layer with those from the modern jackal accumulations. Figure 6.3 illustrates the result for the combined

layers. A visual impression is that the samples are distinct in a number of areas. Kolmogorov-Smirnov two-sample tests, however, showed no significant difference between the archaeological sample and the comparative jackal sample. On present evidence, this should indicate that jackals were involved in the accumulation of the Die Kelders middens, although it may yet be that this statistical similarity reflects the structural properties of bird bones that control survivorship (e.g. Livingston 1989) or a more complex level of multiple agency.

Little is known of the interaction between structural properties of bird bones and the effects of damage caused by different predators, including people, or trampling and compaction. The impression gained at this stage is that the type of analysis used here is not specific enough to be totally reliable as a means of distinguishing complex multiple agencies. More sophisticated methods of analysis such as that proposed by Grayson (1988) to distinguish selective destruction and selective transport behaviour, and used by Klein & Cruz-Urbe (1989), might provide clearer answers if they were adapted and applied to avian remains from archaeological and modern comparative samples. Information would, however, first have to be gathered on the food value of different parts of the avian species (and small mammals) that would be studied.

Schweitzer (1979) recorded the possibility that canid remains in layer 2 were of domestic dog. This raises the question of what effect dogs might produce on discarded bones. It has been suggested (Klein & Cruz-Urbe 1989; Table 4.4), that on the basis of their size, pastoralists' dogs might produce damage similar to that caused by jackals, although this has not to my knowledge been tested experimentally. In spite of this the possibility that the similarity of skeletal elements at Die Kelders is due not to jackals but to dogs scavenging discarded remains of birds, must be considered. Small sample size in the Middle Stone Age layers excludes the possibility of checking this against samples accumulated prior to the introduction of

dogs. Conversely, at Kasteelberg, where extensive gnawing on bones, particularly of seals, has been ascribed to dogs (Klein & Cruz-Uribe 1989), bird bones are both scarce and fragmented. Heavy damage of this nature is not a feature of bones in the Die Kelders Later Stone Age samples. Marean (1985) cited damage to seal extremities in the Smitswinkelbaai sample that he also ascribed to canids, although this was on a smaller scale. Bird bones are relatively common at Smitswinkelbaai Cave, and do not appear to be as fragmented as those from Kasteelberg (GA pers. obs.). This suggests that the effects of canids on bones is variable and, in keeping with the observations in Namibia, that the intensity of damage caused by jackals feeding on carcasses is directly related to availability of food (Nel & Loutit 1986; Avery *et al.* 1987); if food is scarce, they (or dogs) will be more likely to chew the bones.

Although relatively few worked bones occur in the avian samples, 29% of the bone artefacts from the Later Stone Age levels came from Layers 1-4, together with a high diversity of other artefactual remains of undoubted human activity (Schweitzer 1979). People were, therefore, a major factor in the accumulation of the middens and this must be recognized in any assessment of agencies. At the same time, given the strong evidence that the middens were accumulated by people, the damage found on bones is more likely to be due to dogs than jackals. In any event, this new observation again serves to emphasise further the complexity of unravelling multiple agencies of accumulation.

### Owls and Eagles

Figure 6.4 illustrates the categories of species and of mass in Die Kelders Cave 1 layers 1-4 (see Table 4.1 for codes). Comparison of these with results from the comparative samples (Figures 4.6-4.9) shows that no similarity exists between them.

This was confirmed by Kolmogorov-Smirnov two-sample tests. The very small mammal component characteristic of barn owls and spotted and Cape eagle owls is absent, while Cape dune molerats predominate and there is a steenbok/grysbok component roughly equal to that in Eland's Bay Cave samples. The question again arises as to whether it is necessary to invoke an agency other than people. Given that people have no trouble catching Cape dune molerats, this may not be necessary, but other agencies must first be ruled out. The samples do not, however, bear the characteristics of Cape eagle owl accumulations, neither do they bear any statistical or other resemblance to those of black or martial eagles. As was found at Eland's Bay Cave, the seasonal evidence from seabirds suggests that people were using Die Kelders Cave 1 at the time of year when Cape dune molerat availability would have peaked. Unlike on the west coast, where rainfall is restricted to the winter months, the wet season in the Die Kelders region extends into September and October (Weather Bureau 1986), which would lengthen the period of Cape dune molerat availability.

### People

The catchment of Die Kelders Cave 1 provides an ideal habitat for Cape dune molerats, and it would be surprising if people did not exploit them. The samples of Cape dune molerat bones are relatively large and, if people had been dismembering carcasses or skinning them (as suggested by Klein [1975] for the Middle Stone Age), some trace of cut marks, perhaps similar in character to those described by Avery (1985b) on jackass penguin bones, should be evident.

In the discussion above it is suggested that dogs rather than jackals were likely to have modified the avian sample. The extent of this is unknown, but was not as extensive as at Kasteelberg. In view of the fact that cultural remains of

undeniably human origin (including numerous worked bones) make up the bulk of the accumulation, it seems reasonable to accept firstly that agents other than people did not add substantially to the bone samples and secondly that scavenging by dogs will not have materially affected the picture.

#### SOURCE OF SEABIRDS

In order to assess further the assumption that seabirds found in archaeological sites were mainly collected from the beach, results from the archaeological samples were compared with the modern observations. Figure 6.5 compares the relative proportions of common breeding seabirds recovered from southwest coast beach surveys and the results of a ten-year survey conducted monthly over 5 km stretches of coast at Hawston and Die Plaat with results from the combined layers from Die Kelders Cave 1. Although there are distinctions, there is a general similarity between the pattern of relative proportions in all of the samples, adding support to the contention that the archaeological remains were derived from beached birds. However, when results from the two local beach surveys and the Die Kelders Cave 1 samples are compared, the similarities are greater.

The apparent distinction between the Hawston/Die Plaat samples and southwest coast beach surveys is statistically highly significant (Kolmogorov-Smirnov  $z = 2.501376$ ). The difference can probably be explained by location, however, which is likely to have influenced local mortality and the proportions in which species were beached. The southwest coast sample is influenced strongly by the samples in False Bay where large numbers of pelagic seabirds congregate to feed and prevailing southeasterly summer winds blow onshore. The Hawston and Die Plaat samples on the other hand are from beaches in the lee of the prevailing winds and far removed from large colonies of breeding seabirds.

Kolmogorov-Smirnov two-sample tests revealed that the archaeological samples differed significantly (at the 0.001 level or below) from the southwest coast beach-survey results but that there was no significant difference when they were compared with the local Hawston and Die Plaat beach survey results, again emphasising the usefulness of backing up the more general results with local comparisons. No significant difference was found between archaeological samples. The results of the above comparisons, in addition to the regular presence of normally inaccessible species in archaeological samples, are taken to be strong evidence that seabirds in the samples were acquired by exploiting beached birds.

#### EVIDENCE FOR SEASONALITY

##### Correspondence analysis of archaeological and beach survey observations

Only those species occurring in the archaeological samples have been included in this analysis. Although species such as prions exert strong seasonal weight on the display, they affect the shape of the plot of the distribution of months but not the other aspects of the analysis. Tests showed that their effect on the display was not great and, because small numbers of prions may be beached in any month of the year, they have been included in the active rows in order to increase the variables contributing to sample profiles. The archaeological samples have been treated as inactive supplementary points. To simplify the display, only co-ordinates of months and archaeological units have been plotted. The result of the correspondence analysis plot for southwest coast beach surveys is given in Figure 6.6 for reference to the co-ordinates of species. Species in the layer 1 sample, which is relatively small (Table 6.2), may have exerted undue weight on the display, thereby giving an unsatisfactory result (Avery & Underhill 1986). This result should, thus, be viewed

together with those from the larger samples and combined layers which will be made more stable by the wider diversity of contributions to the column and row profiles.

#### *Layers 1-4*

The first two principal axes accounted for 71% of the total inertia and confirmed the seasonal grouping of species and months of the year (Figure 6.7). The distribution of samples clusters around November, although the plots of October to December cluster in a similar direction. Layers 3 and 4 and the combined total (T) tend towards September, and suggest that there is an earlier component, possibly late September and October. This would be in keeping with the fact that Cape gannet mortality tends to peak at this time. The samples indicate a relatively restricted period during which seabirds were acquired and the January to September components of the year do not appear to be represented in any of the samples.

#### Archaeological sample profiles

Profiles of the proportions of the major seabird groups (jackass penguin; albatrosses, petrels, shearwaters; Cape gannet; cormorants; kelp gull) are given for each layer (Figure 6.8). Profiles confirm some of the seasonal variability that is evident from the beach survey data (Figure 3.22A-B) and is represented in the correspondence analysis plots. Variability within the archaeological samples is apparent and no sample is directly comparable with any of the seasonal groups, although points of similarity do occur.

### Other evidence of seasonality

#### *Layer 1*

The presence of a relatively juvenile blackbrowed albatross is anomalous; newly fledged juveniles depart the Southern Ocean islands between April and June, some having been beached on the west coast as early as April (Ryan & Avery 1987). This suggests that the early part of the year might also be included in this layer. Further support for the possibility that this layer is different comes from the juvenile red-knobbed coot (breeding records [eggs] from January, April and from July to December, with a peak between August and October [Urban *et al.* 1986]), and the juvenile Cape francolin (September to December [Maclean 1985]). This would be consistent with the correspondence analysis plot which indicates that layer 1 is not being drawn as strongly towards October-November as the other samples.

The seasonal evidence for non-seabirds supports that from the correspondence analysis and adds to the body of evidence that people were the main accumulators of the Die Kelders Cave 1 Later Stone Age samples. The timing suggested by the evidence for the use of the cave for the exploitation of birds is in keeping with estimates for the exploitation of juvenile seals (Klein & Cruz-Urbe 1989, fig. 9), and was presumably aimed at making use of the predictable availability primarily of marine resources.

#### EVIDENCE FOR PALAEOENVIRONMENTS

The Later Stone Age samples from Die Kelders fall within a very narrow and recent time span during which conditions were essentially the same as at present. The variability between samples of marine species falls within the range established by the

beach surveys. The presence of redknobbed coot, probably breeding in the vicinity, suggests that open water in the form of a permanent or seasonal vlei, not necessarily large, or a river existed in the vicinity of the cave. The southern pochard is a diving duck and confirms the existence of relatively open and deep (at least in part) water (Maclean 1985). Such conditions only exist at present in the Kleinriviersvlei, some distance to the north. A suitable seasonal vlei could have existed on low ground immediately inland of the cave, and suitable conditions of deeper water may have existed in the nearby Uilenkraal River before farming and the introduction of exotic vegetation affected the flow of water (Schweitzer & Wilson 1982).

## RESULTS AND DISCUSSION: THE MIDDLE STONE AGE

### COMPOSITION OF THE SAMPLES

The species and MNIs listed in Table 6.3A-B have been grouped according to gross habitat preference. The alternate numbering of layers relates to the inter-stratification of cultural and non-cultural stratigraphic subdivisions (Tankard & Schweitzer 1976). Bird remains from non-cultural layers have been excluded from this analysis as they are primarily of very small birds which cannot as yet be identified with the limited comparative material available for these groups. D.M. Avery (1982) has studied micromammals from these samples and concluded that they represent prey of barn owls. While the majority of layers represent discrete units that were easy to subdivide, layer 3 was an extensive and amorphous unit of some depth (Schweitzer 1970, Schweitzer, pers. comm.). Subdivisions of layer 3 are given in Table 6.3B. As the actual relationships of subdivisions have yet to be established, their significance cannot be addressed here with any certainty.

Sample sizes vary, with only layers 1 and 3 yielding overall totals above 10 individual birds. Perhaps below layer 5, and certainly below layer 7, this could be due more to the diminishing area excavated than to more ephemeral occupation. Examination of the section illustrated in D.M. Avery (1982) shows that, while the area excavated may have influenced sample size, the lower units were in fact more ephemeral, thereby suggesting that sample size could reflect the level of cave usage and importance of marine elements. This possibility is also suggested by numbers of mammalian remains (Klein 1975, unpublished). It must also be borne in mind that the period the Middle Stone Age sequence is estimated to have covered and extensive breaks during which occupation was minimal and appreciable accumulations of micromammal remains from barn owl pellets were formed (Tankard & Schweitzer 1976; D.M. Avery 1982), indicate that the samples are undoubtedly temporally distinct.

The NISPs from which the MNIs presented in Tables 6.3A and 6.3B are derived follow a pattern similar to that at Eland's Bay Cave and Die Kelders Cave 1 Later Stone Age, and most of the less common species are represented by one or very few bones. Jackass penguins and Cape cormorants are almost equally represented overall, while Cape gannets only occur in layers 1 and 3.

Species associated with the marine environment contribute under 50% of the over-all bird sample for each layer (Table 6.3A). In the two largest and perhaps more reliable samples, this is 33% for layer 1 and 42% for layer 3. It does appear, however, that prior to the deposition of layer 3 the marine contribution was minimal. The freshwater component contributed 8 and 12% to the layer 1 and 3 totals, but was 43 and 33% in layers 5 and 7 respectively. The terrestrial component, as far as can be ascertained from very small samples, was consistently high: 58% in layer 1, 47% in layer 3, 43% in layer 5, and 33% in layer 7. Birds of prey, including a vulture, unidentified birds of prey, barn owl, spotted eagle owl,

whitenecked raven, speckled rock pigeon and starling, which make up an important proportion of the samples, would have used the cave as a roost and breeding site, as do some of these species at present. The implication of this is that even during the period of deposition of the denser cultural accumulations, the cave was used only intermittently by people.

#### AGENCY OF ACCUMULATION

The possibility that agents other than people may have contributed to the Middle Stone Age accumulations at Die Kelders Cave 1 has been considered by Klein (1981b) and Klein & Cruze-Urbe (1987), who believe that the Cape eagle owl was responsible for accumulating the high frequencies of Cape dune mole rat remains.

#### Black-backed Jackals

The numbers of Cape cormorant skeletal elements were not large enough to allow comparison of the relative proportions of skeletal elements in each layer with those from the modern jackal accumulations; Figure 6.9 illustrates the result for the combined layers. Examination of the sample suggests that diagenetic agencies have removed the lighter bones, as it is noticeable that only the more robust elements are present. Consequently, this sample is likely to be biased and results unreliable. Klein (1981b) also noted this in his discussion of mammalian remains. These observations are in keeping with evidence for ponding in the hiatus levels and for compaction in the Middle Stone Age levels of the Die Kelders Cave 1 sequence (Tankard & Schweitzer 1976). Klein (1981b) also demonstrated the similarity between the age and mortality profiles of steenbok/grysbok in the Eland's Bay Cave, Die Kelders Cave 1 and Byneskranskop samples. In the light of this, Klein's

(1981b) comments on the role of jackals in Eland's Bay Cave layers 11-12-10 should be considered, although he later (Klein & Cruz-Urbe 1987) believed Cape eagle owls to be the more likely contributor.

### Owls and Eagles

Although Klein (1975) originally believed that they had been hunted by people, he later (1981b) suggested that Cape eagle owls were more likely to have contributed the disproportionately large numbers of Cape dune molerats in the Middle Stone Age samples. Figure 6.10 illustrates the categories of mammalian and non-seabird species and of mass in Die Kelders Cave 1 Middle Stone Age layers 1 and 5, which are occupation horizons, and layer 6 which is non-occupational (see Table 4.1 for codes). Comparison of these with results from the comparative samples (Figures 4.6-4.9) shows that no similarity exists between them. This was confirmed by Kolmogorov-Smirnov two-sample tests. The very small mammal component characteristic of barn owls and spotted and Cape eagle owls is present in all three samples, while Cape dune molerats, surprisingly, predominate in the occupation layers only. Layer 1 includes a reasonably large proportion of hares and steenbok/grysbok, and resembles the Eland's Bay Cave samples. The number of hares in layer 1 is consistent with the environmental evidence for increased grass at this time and reduced grass when layers 5 and 6 were laid down (D.M. Avery 1982). The Cape dune molerats and very young steenbok/grysbok could have been taken by Cape eagle owls but the samples do not otherwise bear the characteristics of known Cape eagle owl prey proportions, neither do they bear any statistical or other resemblance to those of black or martial eagles. It must be accepted, as noted in Chapter 5, that the comparative sample is inadequate for direct comparisons with Cape dune molerats and in spite of the diagenetic effects, Scanning Electron

Microscope examination of bone surfaces for evidence of erosion by gastric juices may be the only solution at this stage. Cape eagle owls normally occur in rocky and mountainous regions (Maclean 1985) and this has been confirmed in the southwestern Cape folded belt mountains (R. Martin and R.A.C. Jensen, pers. comm.; ornithological collection, South African Museum). This is in keeping with observations elsewhere (Gargett 1977; Steyn 1982, Steyn, pers. comm.) and it is possible that Cape eagle owls are not likely contributors at all, in spite of the fact that they are known to occur in mountains close to the southwestern Cape coast. In these instances, however, no evidence for their taking Cape dune molerats has yet been found in prey samples (GA unpublished). As was found at Eland's Bay Cave, changing environmental conditions and the time of year when people visited the cave could account for increased numbers of Cape dune molerats. The seasonal evidence from seabirds suggests that Middle Stone Age people were indeed using Die Kelders Cave 1 at the time of year when Cape dune molerat availability would have peaked (see discussion on Later Stone Age layers).

### People

Undoubtedly people would have been able to take any of the species in the samples, and the same argument outlined in Chapter 5 and above for the Later Stone Age samples applies to animals such as Cape dune molerats and steenbok/grysbok. Careful examination of bones for signs of butchery or skinning may cast further light on the problem.

The occupation layers are characterized by high densities of stone artefacts (Schweitzer 1970; Volman 1981) as well as the bones of small and large mammals (Klein 1975). Layer 5, in which the highest concentration of Cape dune molerats occurs, is classed as an occupation layer, although large numbers of micromammal

bones in all layers (D.M. Avery 1982) indicate that there had been breaks between occupations during which barn and spotted eagle owls also used the cave.

In view of the fact that cultural remains (including bones of large mammals) of undeniably human origin make up a large proportion of the accumulation, and the argument regarding small mammals in Later Stone Age accumulations, it seems reasonable to accept that agents other than people did not add substantially to the samples of small mammals. The evidence for this proposition is not, however, entirely satisfactory in the case of Die Kelders Cave 1 Middle Stone Age samples. The analysis of skeletal elements does not appear to provide as clear a picture as was the case in the more recent larger and better preserved samples. Similarly, the problem of determining whether Cape eagle owls contributed to the assemblages cannot be fully explored as yet, although it seems highly unlikely on present evidence.

#### SOURCE OF SEABIRDS

So far, the modern samples have been compared with archaeological samples laid down during about the last 12 000 years when air and sea temperature conditions were similar to those of the present (Lorius *et al.* 1979). It is of interest, therefore, to test whether the modern samples from beach surveys will prove useful in assessing older samples laid down under possibly different conditions. Figure 6.11 compares the relative proportions of common breeding seabirds recovered from combined southwest coast beach surveys and from a ten-year survey at Hawston and Die Plaat with results for layer 3 and the combined samples. As in the comparison with the Later Stone Age samples, there are differences between the modern and archaeological samples. General similarity exists, however, and the relative proportions from beaches near the archaeological site show the greatest similarity to

the archaeological samples, thereby adding support for the contention that the archaeological remains were derived from beached birds.

The Middle Stone Age samples differ significantly from the southwest coast beach survey results (at the 0.001 level or below), but there was no significant difference between the archaeological samples and the local Hawston and Die Plaat beach survey results, again emphasizing the usefulness of backing up the more general results with local comparisons. No significant difference was found between Middle Stone Age layers or between them and the Later Stone Age samples. The results of the above comparisons, in addition to the presence of normally inaccessible species in archaeological samples, are taken to be strong evidence that seabirds in the samples were acquired by exploiting beached birds.

This finding has relevance to Klein's (1975, 1989) argument that Middle Stone Age people were not technologically equipped to hunt birds. His argument (1975, 1989) was based on the occurrence, in Middle Stone Age levels at Klasies River Mouth main site and Die Kelders Cave 1, of disproportionately high numbers of penguins versus flying species that are common in Later Stone Age samples. The degree of disproportion is not as great at Die Kelders Cave 1 as it is at Klasies River Mouth main site (Figure 6.3A, GA unpublished). Since, however, it has been established that Middle Stone Age people at Die Kelders, and undoubtedly as early 100 000 B.P. at Klasies River Mouth, were collecting beached seabirds, which requires no technological advantage, the comparison between flying and non-flying species is inappropriate. In so far as Middle Stone Age people were collecting seabirds by the same simple but effective method as Later Stone Age people, this evidence supports H.J. Deacon's (1989) contention that Middle Stone Age people were behaviourally modern. Evidence discussed below for when people acquired the seabirds provides an alternative explanation that accounts for the relative proportions of penguins and other species.

## EVIDENCE FOR SEASONALITY

Correspondence analysis of archaeological and beach survey observations

Only those species occurring in the archaeological samples have been included in this analysis. Species such as prions, which exert strong seasonal weight on the display, have been included in the active rows because tests showed that their effect on the display was not great. The archaeological samples have been treated as inactive supplementary points. Samples from sub-units of layer 3 are displayed separately, but should be interpreted in the light of the cautionary comment above regarding their interrelationships. To simplify the display, only co-ordinates of months and archaeological units have been plotted. The result of the correspondence analysis plot for southwest coast beach surveys is given in Figure 6.6 for reference to the co-ordinates of species. It should again be emphasized that species in small samples (Table 6.3A) may have exerted undue weight on the display, thereby giving an unsatisfactory result (Avery & Underhill 1986), and this result should be viewed together with those from the more stable larger samples and combined layers. The one prion individual in layer 11 provides an extreme example of this.

*Layers 1-13*

The first two principal axes accounted for 69% of the total inertia and confirmed the seasonal grouping of species and months of the year (Figure 6.12). Of the larger samples (Table 6.3A), layer 8 is displayed between September and October, layer 3 falls nearer to October, although the plots of October to December cluster in a similar direction. The plot for the combined layer total falls close to layer 3 and is

therefore consistent with the larger samples. Results from the other samples are not reliable.

### *Layer 3*

The first two principal axes accounted for 69% of the total inertia and confirmed the seasonal grouping of species and months of the year (Figure 6.13). Of the larger sub-units of layer 3 (Table 6.3B), MJA is displayed in the same position as December and October, which have the same co-ordinates, while MO and B fall between September and October. Results from the other samples are not reliable. Given the option on MJA, and the plot for the combined layer total, results for the larger samples illustrate the possibility, as at Eland's Bay Cave and Die Kelders (LSA), that the timing of visits that involved collecting seabirds varied.

### Archaeological sample profiles

Profiles of the proportions of the major seabird groups (jackass penguin; albatrosses, petrels, shearwaters; Cape gannet; cormorants; kelp gull) are given for layers 1 and 3 (Figure 6.14). Profiles confirm some of the seasonal variability that is evident from the beach survey data (Figure 3.21) and is represented in the correspondence analysis plots. Variability within the archaeological samples is apparent, but not addressed here.

### Other evidence of seasonality

Further evidence for seasonality is available from the presence of juvenile individuals. The seasonal evidence for non-seabirds supports that from the

correspondence analysis and adds to the body of evidence that people were the main accumulators of the Die Kelders Cave 1 Middle Stone Age samples.

Redknobbed coot breeding has been recorded in January, April and from July to December, with a peak between August and October (Urban *et al.* 1986), which is consistent with the September-October plot for layer 3. Sacred ibis, juveniles of which occur in a number of layers, breed in the winter months in the western Cape (Maclean 1985); ducks, a juvenile of which is in layer 7, also tend to breed during the wet season; and greywing francolin, a juvenile of which is in layer 3, breed between August and October (Maclean 1985). The occurrence of juveniles of the above species is consistent with the result of the correspondence analysis.

#### EVIDENCE FOR PALAEOENVIRONMENTS

During the period in which it is estimated that the Die Kelders Middle Stone Age occupations took place (Tankard & Schweitzer 1976; D.M. Avery 1982), Shackleton & Opdyke (1973) describe a rise in sea level from approximately -80 m below present at 75 000 B.P. to a peak of approximately -50 m at 50 000 B.P. and a subsequent drop to below -80 m during the Last Glacial Maximum by about 35 000 B.P. During this time the coastline would have moved closer to the cave, from a position about 18 km from its present position, to about 7 km from the cave at the highest sea level, and then returned to around 18 km as the sea level again dropped. The low numbers of seabirds in the layers preceding layer 3 support the point about Diepkloof (Figure 5.1) made by Avery (1987a) and Parkington & Poggenpoel (1987) that 18 km from the coast is too far inland for exploitation of the coast to have been important. The layer 3 samples, then, reflect the increased importance of marine resources when the distance between the coast and the cave had diminished. The layer 1 sample appears to represent a time when the distance to the coast had again

been increased by the lowering sea level, but at a distance less than 18 km. Basing her interpretations on the sea-level evidence in Tankard (1976) D.M. Avery (1982) estimated that the Middle Stone Age sequence ended at 35 000 B.P. at the end of the Middle Pleniglacial in oxygen isotope stage 3. Sea-level determinations vary. Although on the grounds of Shackleton & Opdyke's (1973) determination, evidence from Die Kelders Cave 1 Middle Stone Age seabirds suggests that a date in the order of 40 000 to 50 000 B.P. would be more likely, the avian evidence does, however, support other indicators that the Middle Stone Age accumulation at Die Kelders occurred during oxygen isotope stages 3 and 4.

The freshwater birds in the sample, particularly the sacred ibises which normally feed in the vicinity of water and breed in trees or reed beds (Maclean 1985), suggest that there was a vlei located nearby on the open coastal foreland in front of the cave. The presence of greywing francolin indicates the existence of grass, while the high frequency of Cape francolin, which are associated with the scrubby heath of coastal Fynbos and denser vegetation along streams and rivers (Urban *et al.* 1986), in layer 3 also confirms D.M. Avery's (1982) conclusion that previously dry and hot conditions had ameliorated by this time.

#### SUMMARY: LATER STONE AGE SAMPLES

The Later Stone Age samples from Die Kelders fall within a very narrow and recent time span between approximately 1500 and 2000 B.P. At this time conditions were essentially the same as at present, as is also evident from the species composition and relative proportions in the samples.

It has been demonstrated that the source of the seabirds was most likely to have been beached birds. Evidence from skeletal element represented suggested that black-backed jackals could have been responsible for accumulating seabirds. It

has been argued, however, that dogs, which probably damage bones in the same way as jackals and are thought to have been present in the cave, are a more likely alternative. In the light of the undoubted evidence (artefactual, molluscan) for human habitation of Die Kelders Cave 1, it is concluded that people very probably accounted for the sample composition, which was then modified by scavenging dogs.

The seasonal evidence indicates that Die Kelders Cave 1 was used between late September and December, but primarily October. The season when individual layers were accumulated varied very little, although Layer 1 may have extended to the beginning of the year.

#### SUMMARY: MIDDLE STONE AGE SAMPLES

The Middle Stone Age samples from Die Kelders have been thought to date to between 80 000 and 35 000 B.P., although this study suggests that the end of the sequence may have been slightly earlier. Evidence from the avian remains agrees with that from the micromammals that sea level rose during the period of accumulation and was then slightly lower at the end of the sequence. The avian evidence is also consistent with other evidence for changes from drier to wetter conditions during the upper part of the sequence.

It has been demonstrated that the source of the seabirds was most likely to have been beached birds, thereby extending this simple practice beyond the Later Stone Age. In the light of this, the use of relative proportions of jackass penguins (flightless) to Cape cormorants and other flying species to indicate that Middle Stone Age people were technologically unable to hunt birds that fly is not appropriate.

Evidence from skeletal elements represented suggested that diagenesis may have removed some of the more fragile skeletal elements so that it was not possible

to establish whether jackals could have been involved in accumulating the seabirds. It has also been argued that, although evidence in favour of Cape eagle owls accumulating Cape dune molerats is equivocal, response to changing environmental conditions could account for variation in the composition of the small-mammal samples. Furthermore, in the light of the undoubted evidence (artefactual, large mammals) for human habitation of Die Kelders Cave 1 during Middle Stone Age times, it is concluded that the possibility that people accounted for the small-mammal samples cannot be ruled out. Examination of the small-mammal bones for evidence of butchery, and Scanning Electron Microscopy, to establish whether bones have been eroded by gastric juices, is needed to confirm this in the Middle Stone Age as well as the Later Stone Age Samples.

The seasonal evidence indicates that during the Middle Stone Age, Die Kelders Cave 1 was used between September and October. As far as can be ascertained, the season when individual layers were accumulated, was consistent with this assessment.

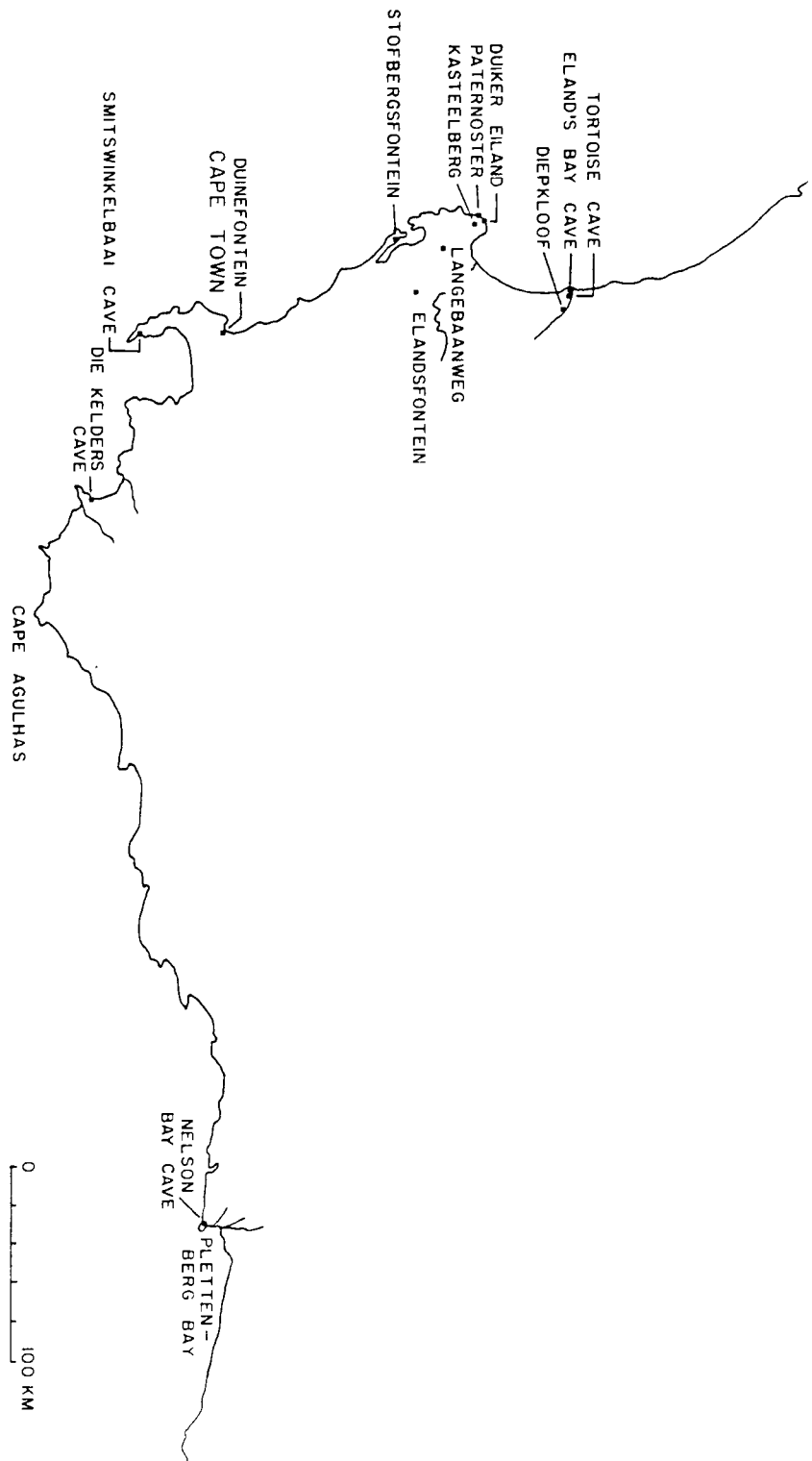


Figure 6.1. Distribution of sites mentioned in the text.

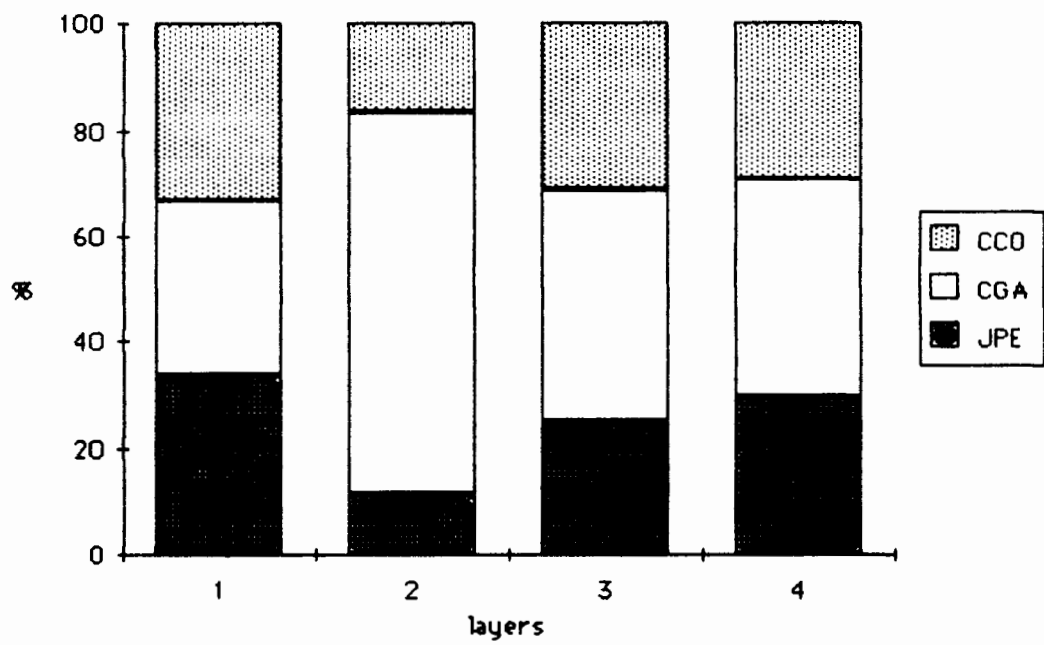


Figure 6.2. Relative proportions of jackass penguins (JPE), Cape gannets (CGA) and Cape cormorants (CCO) in Later Stone Age layers.

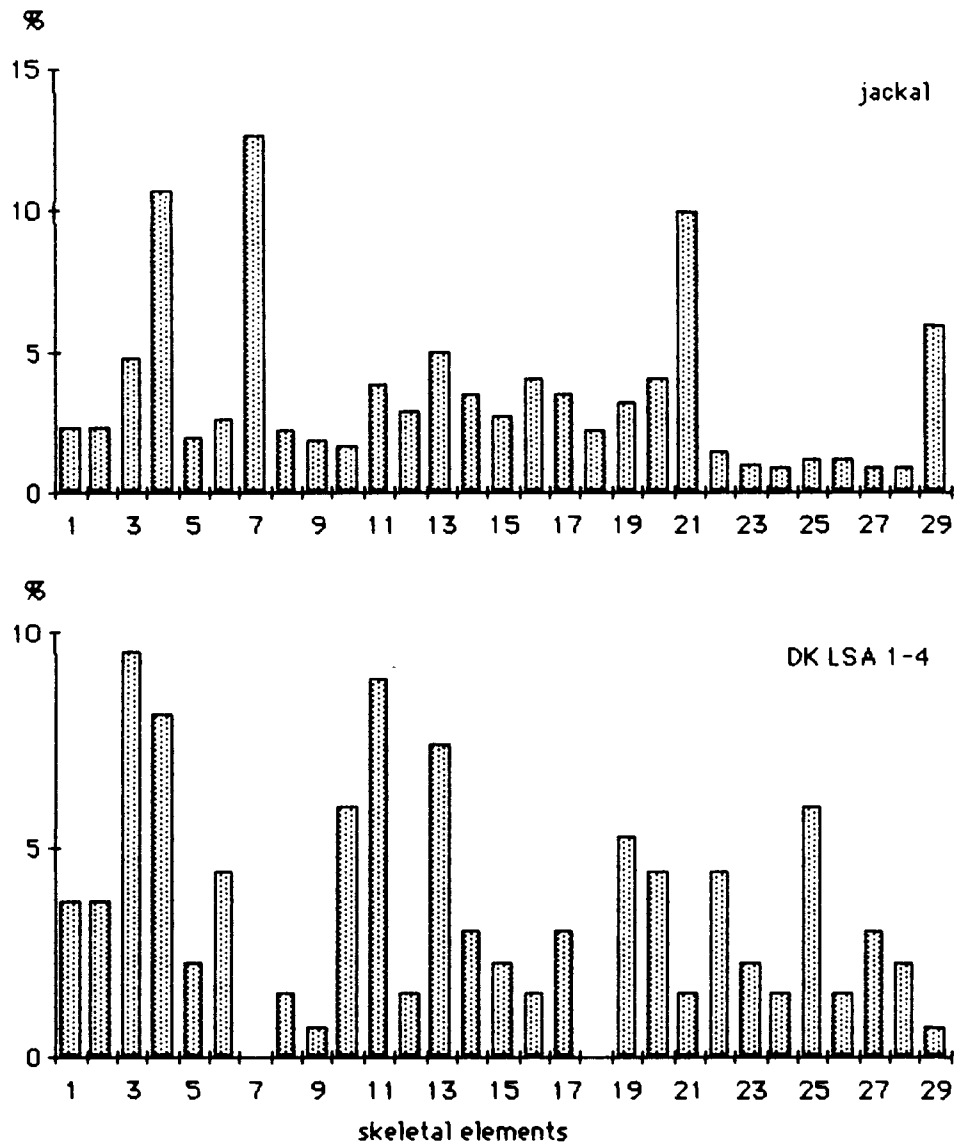
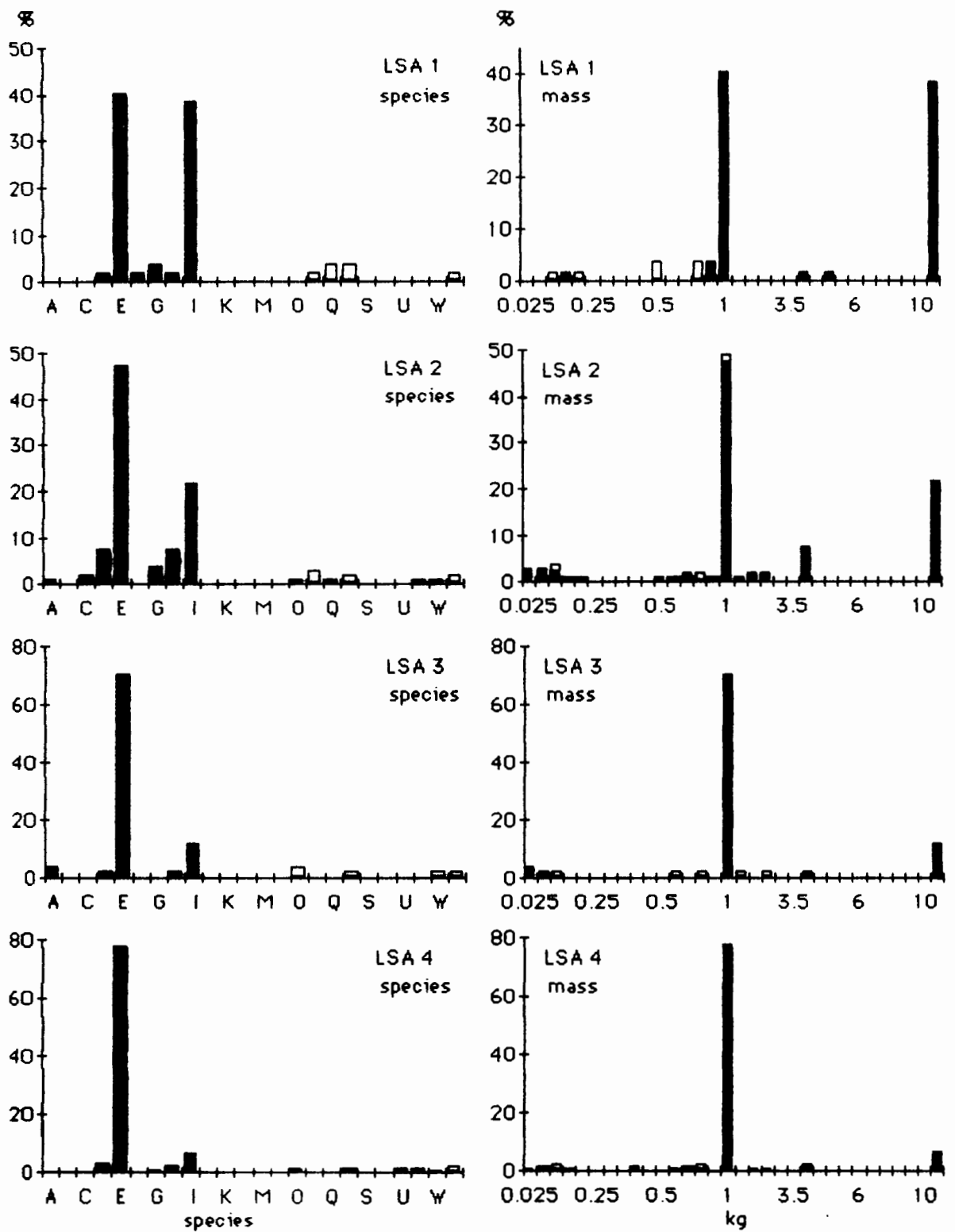


Figure 6.3. Comparison of the relative proportions of Cape cormorant skeletal elements in modern jackal accumulations with those from grouped Later Stone Age layers. Elements represented by numerical codes are listed in Table 4.2.



black columns - mammals; white columns - birds

Figure 6.4. Comparison of prey species and groups of species, and mass categories of species in Later Stone Age layers. Prey are listed in Table 4.1.

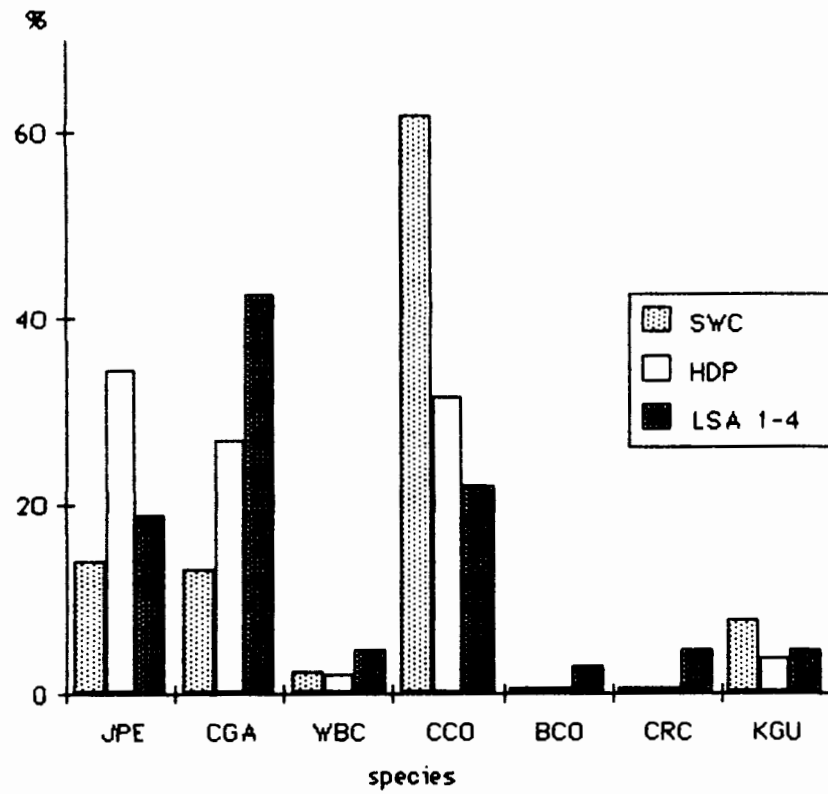


Figure 6.5. Comparison of relative proportions of common sea-birds recovered on southwest coast (SWC) beach surveys and a ten-year survey at Hawston and Die Plaat (HDP) with results from Later Stone Age layers 1-4 (LSA 1-4). JPE = jackass penguin, CGA = Cape gannet, WBC = whitebreasted cormorant, CCO = Cape cormorant, BCO = bank cormorant, CRC = crowned cormorant, KGU = kelp gull.

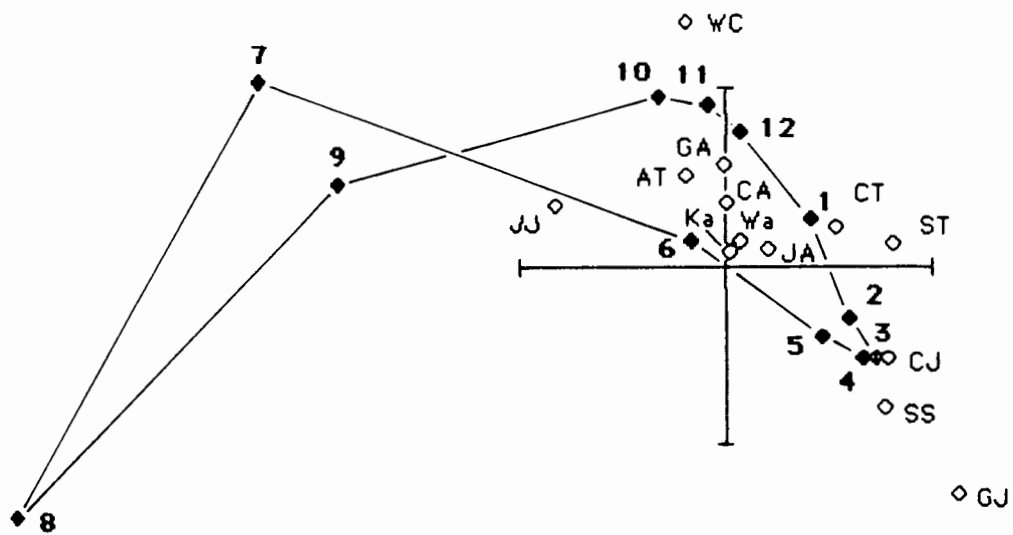


Figure 6.6. Result of correspondence analysis plot based on southwest coast beach surveys. Months are numbered consecutively from January to December. In the second letter of a code A = adults, J = juveniles, lower case = combined samples. Codes are given in Table 3.1.

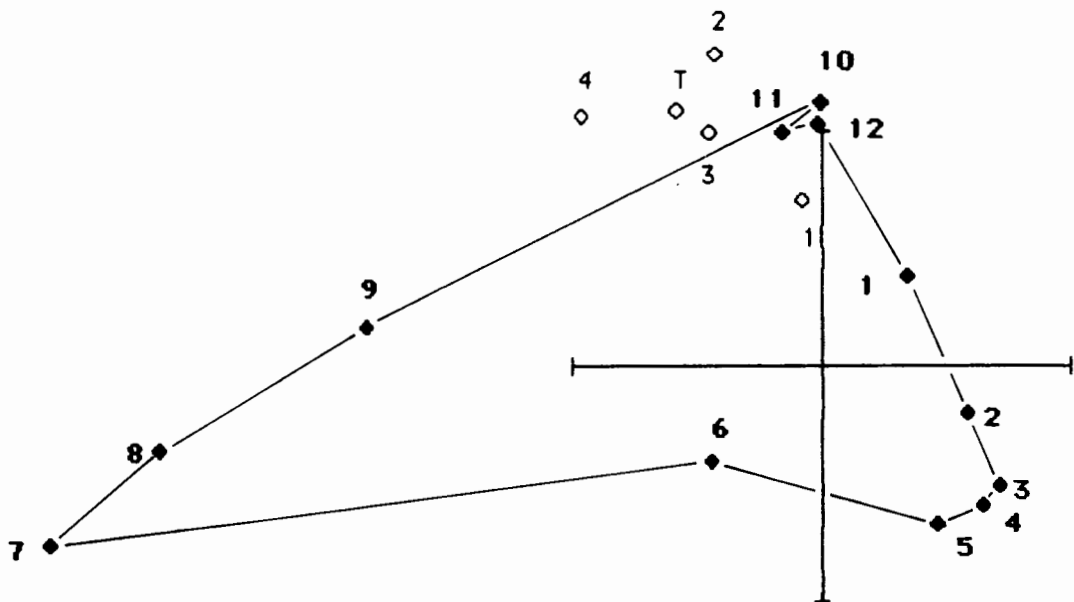


Figure 6.7. Result of correspondence analysis plot based on southwest coast beach surveys and Later Stone Age layers 1-4. Months are numbered consecutively from January to December. T = combined layers.

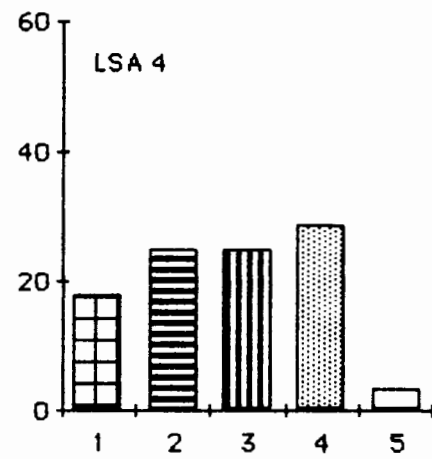
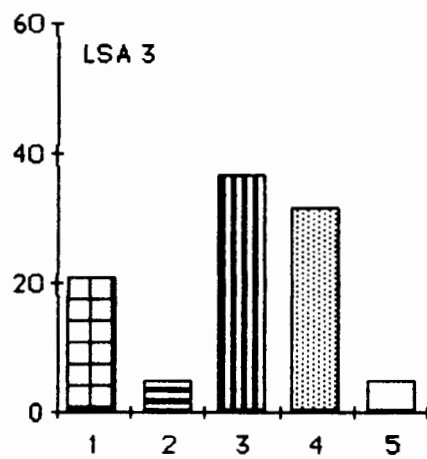
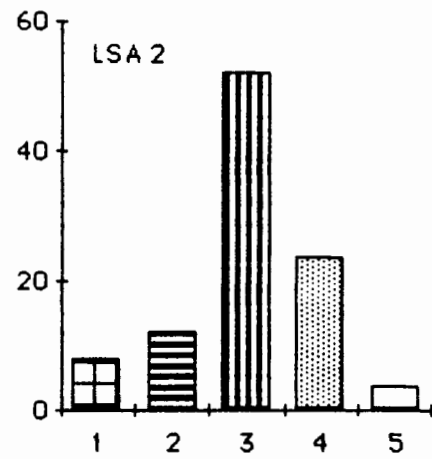
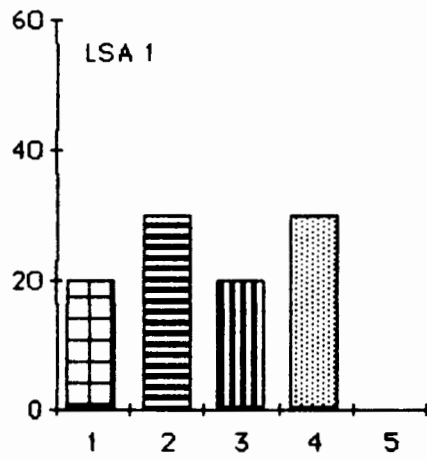
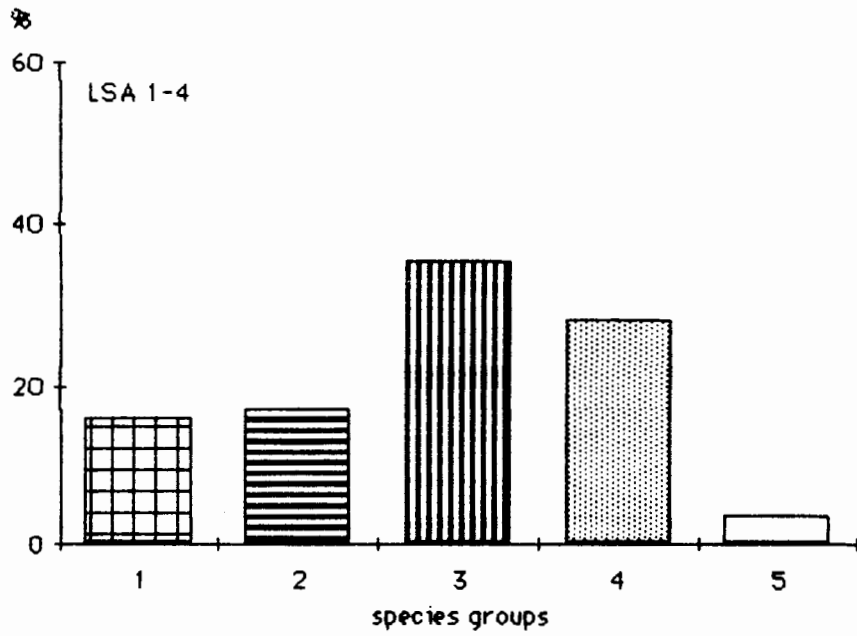


Figure 6.8. Profiles of main species or groups of species occurring in Later Stone Age layers 1-4. 1 = jackass penguins, 2 = albatrosses, petrels, shearwaters, prions, 3 = Cape gannet, 4 = cormorants, 5 = kelp gull.

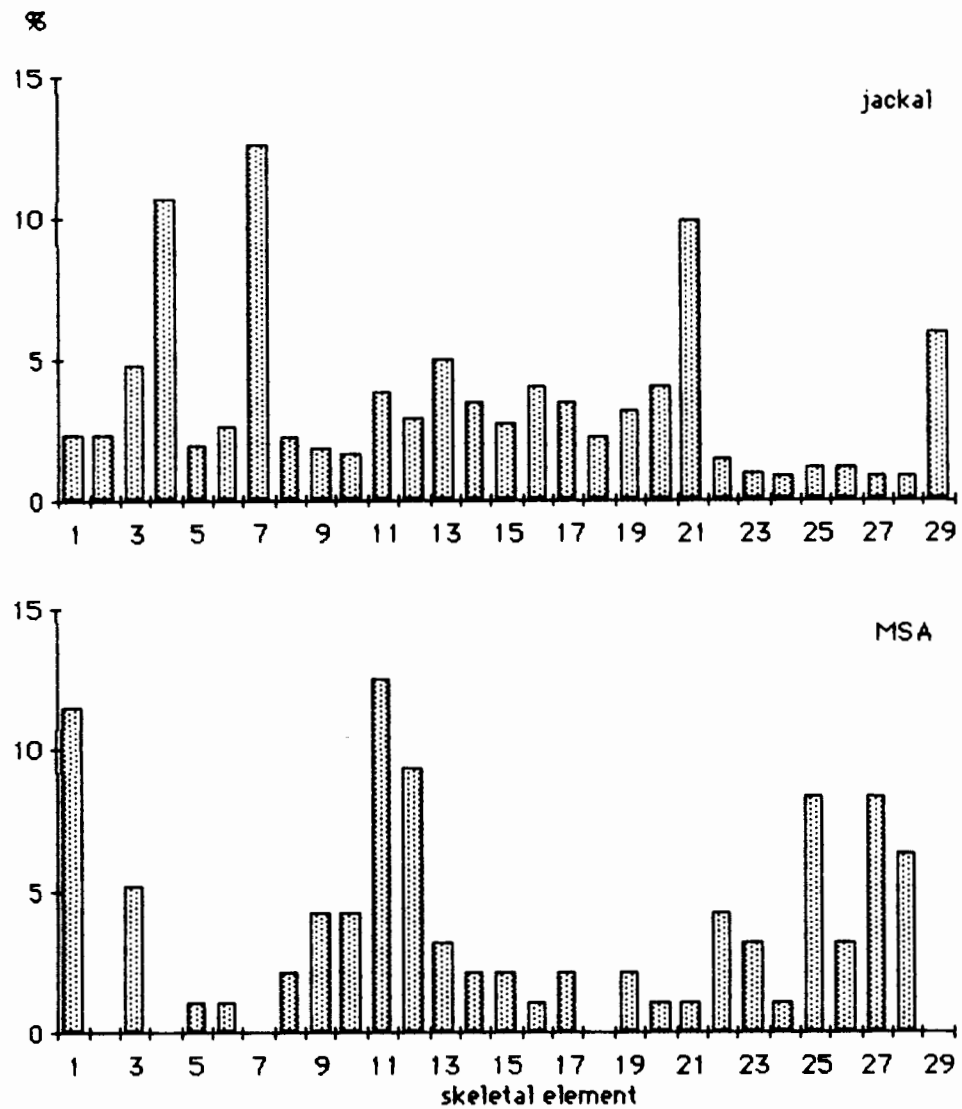
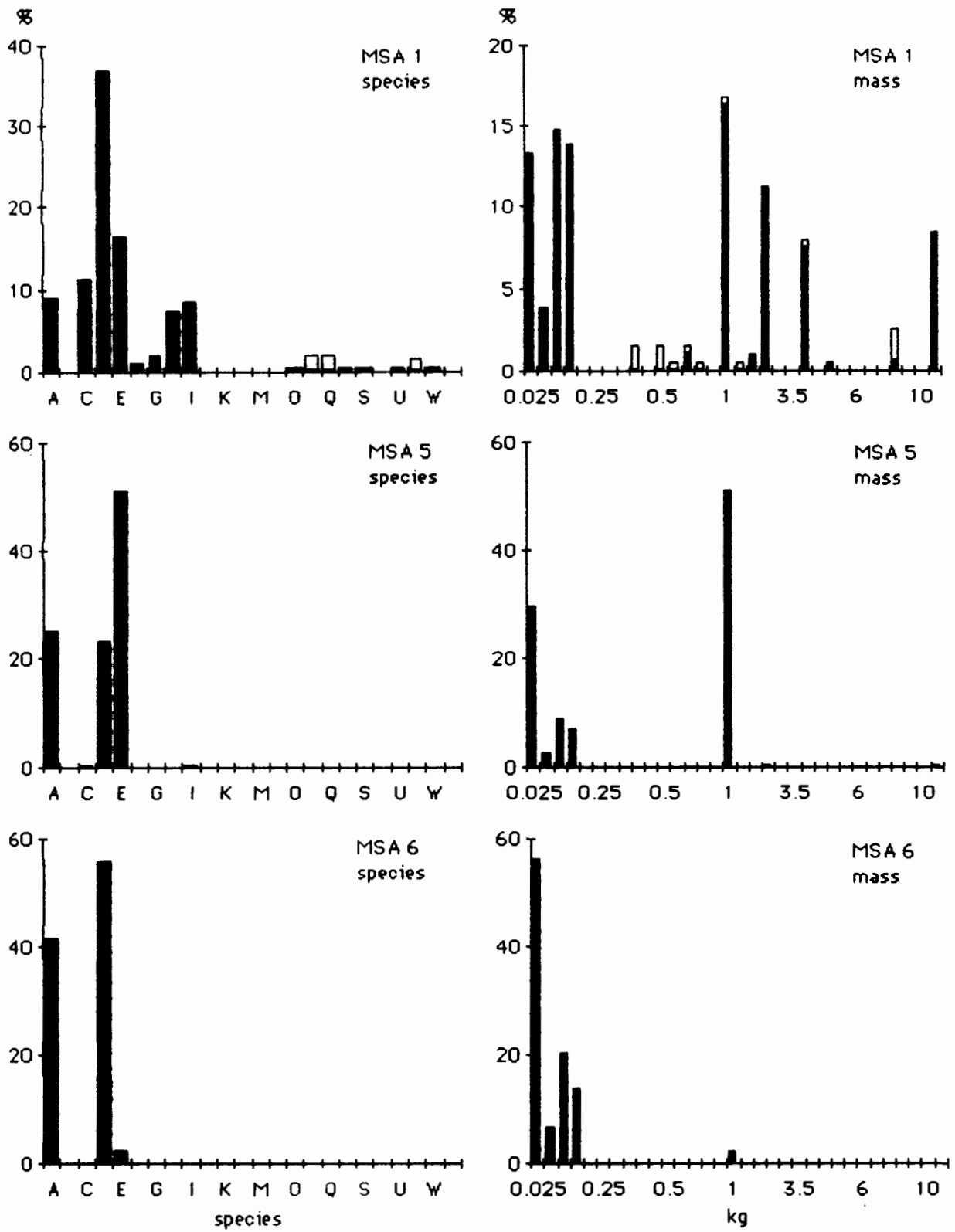


Figure 6.9. Comparison of the relative proportions of Cape cormorant skeletal elements in modern jackal accumulations with those from grouped Middle Stone Age layers. Elements represented by numerical codes are listed in Table 4.2.



black columns - mammals; white columns - birds

Figure 6.10. Comparison of prey species and groups of species, and mass categories of species in Middle Stone Age layers 1, 5 and 6. Prey are listed in Table 4.1.

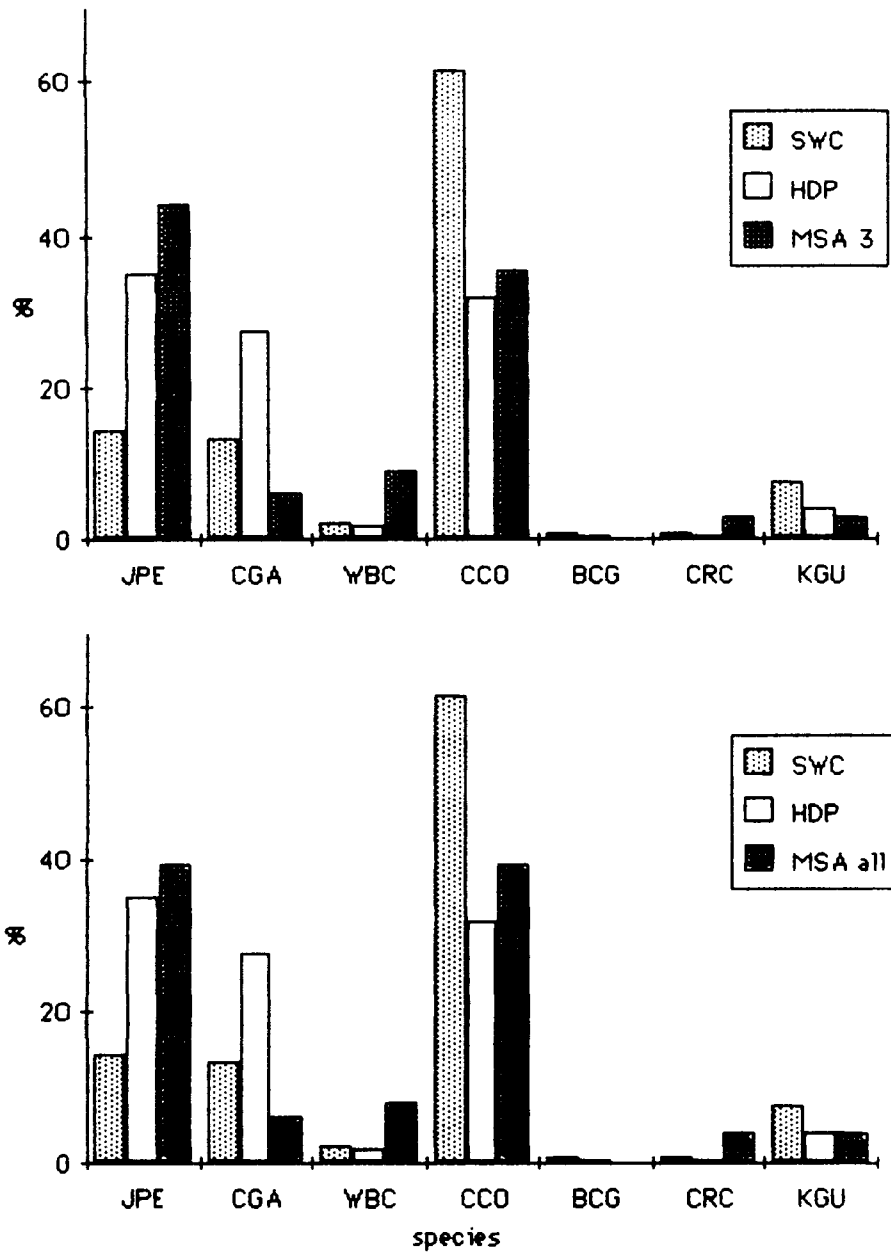


Figure 6.11. Comparison of the relative proportions of common seabirds recovered on southwest coast (SWC) beach surveys and a ten-year survey at Hawston and Die Plaat (HDP) with results from Middle Stone Age layer 3 (MSA 3) and the combined layers (MSA all). See Figure 6.5 for species codes.

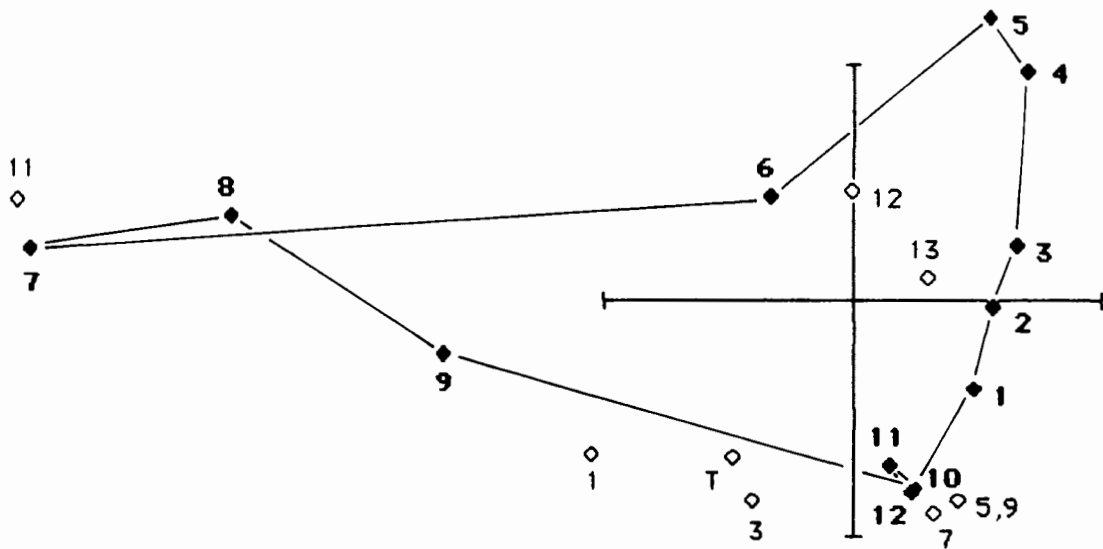


Figure 6.12. Result of correspondence analysis plot based on southwest coast beach surveys and Middle Stone Age layers. Months are numbered consecutively from January to December. T = combined layers.

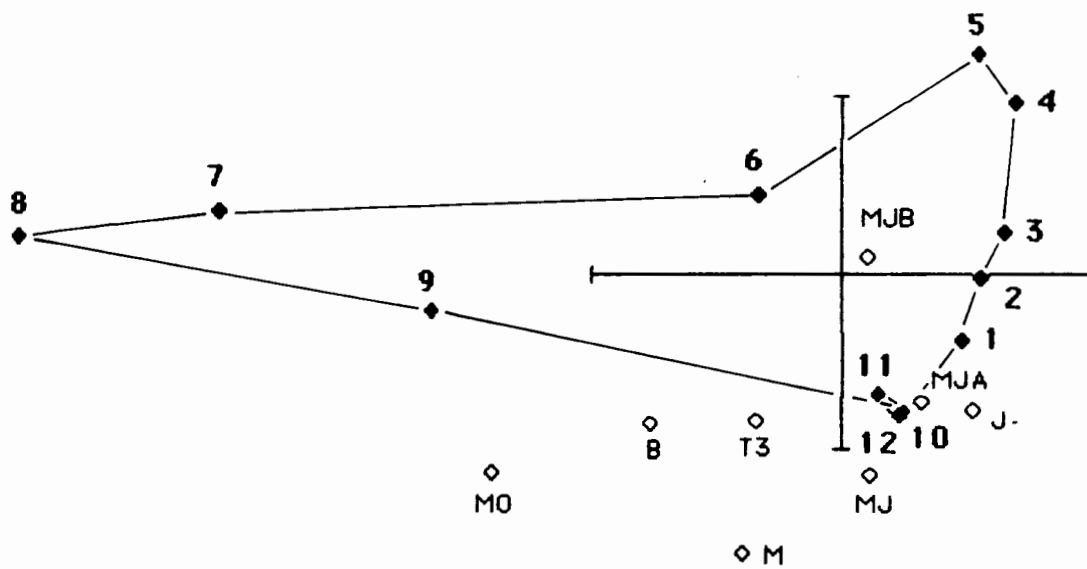


Figure 6.13. Result of correspondence analysis plot based on southwest coast beach surveys and Middle Stone Age layer 3 sub-units. Months are numbered consecutively from January to December. T3 = combined sub-units.

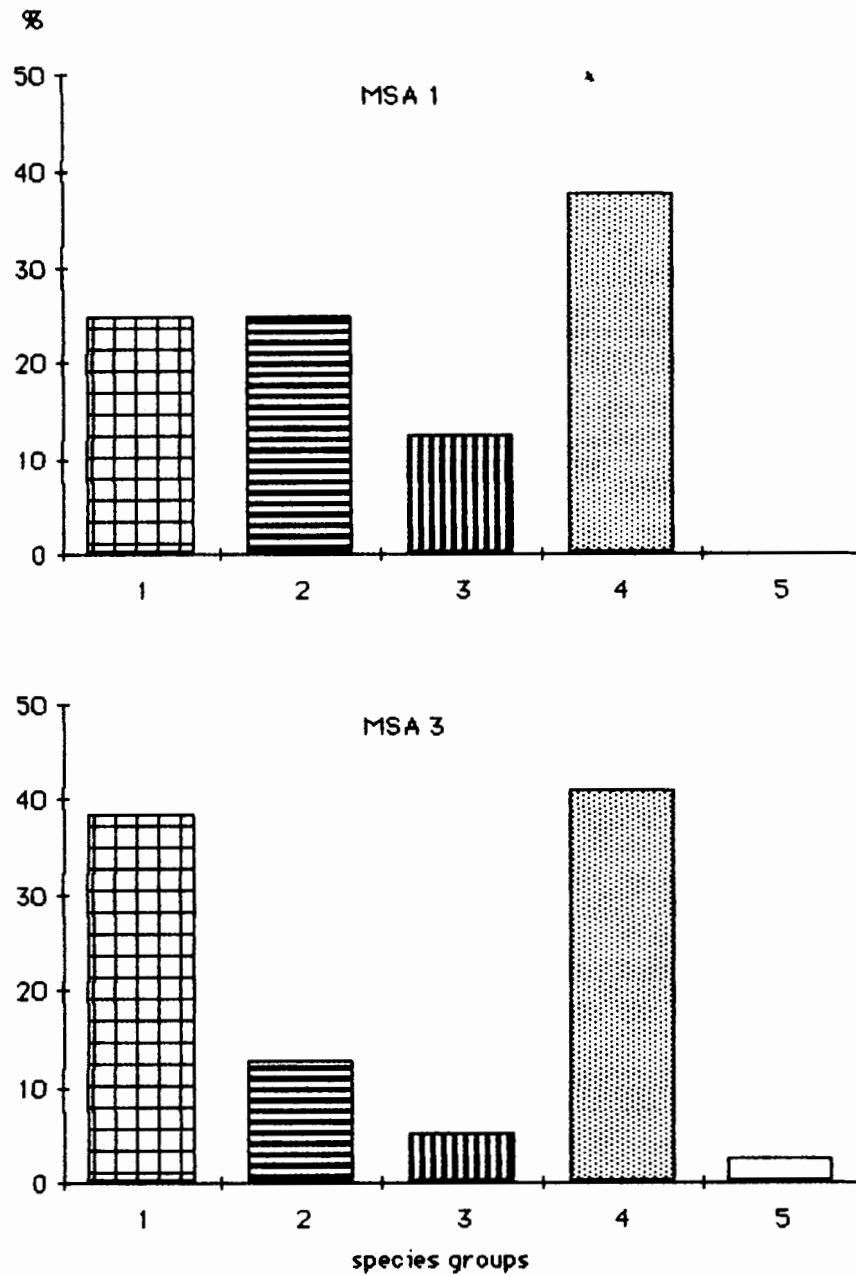


Figure 6.14. Profiles of main species or groups of species occurring in Middle Stone Age layers 1 and 3. 1 = jackass penguin, 2 = albatrosses, petrels, shearwaters, prions, 3 = Cape gannet, 4 = cormorants, 5 = kelp gull.

**Table 6.1.** Summary of stratigraphic, chronological, cultural and environmental information available for Die Kelder's Cave 1 (sources given in text).

LAYER	DATE	DEPOSITS	CULTURAL	TERRESTRIAL	SEA LEVEL
1	1509±100		pottery and pastoralism		as at present
2	1648±120				
3	1638±80	dense shell middens		small-scale temperature and humidity fluctuations around present	
4	2080±95				
	2019±85	sand/shell mix	Later Stone Age		
HIATUS					
		sandy sediments			
1	est 35 000	sandy loams & sandy non-occupational	occupation	extensive grass, dense vegetation on flats, scrub on hills; ?? wetter	generally lower than during Holocene
2			non-occupation		? lower
3		sandy loams and sandy non-occupational	occupation	intermediate	higher than 1-2
4			non-occupation	?? dry, ? general temperature increase;	
5			occupation	reduced grass, dense vegetation on flats,	
6			non-occupation	moderate restioid/'grassy' vegetation on hills	
7			occupation		
8			non-occupation	mild, possibly deteriorating gradually	
9			occupation		
10			non-occupation		
11			occupation		

(cont.)

**Table 6.2.** Later Stone Age Layers. Number of Identified Specimens/Minimum Number of Individuals recovered from selected excavated units at Die Kelders I Cave. Species are listed according to gross habitat association. ( ) = number of juveniles in total; n = nestling/s among juveniles; \* = cut or worked.

SPECIES	LAYERS			
	1	2	3	4
Jackass penguin	9/2	23/2	10/4(1)	*70/5(2)
Shy albatross	0	0	0	21/2
Blackbrowed albatross	4/2(1)	0	0	0
Yellow-nosed albatross	0	0	0	3/1
Albatross sp.	0	1/1	0	0
Pintado petrel	0	0	0	1/1
Prions	0	1/1	1/1	3/2
Cory's shearwater	0	1/1	0	0
Great shearwater	0	0	0	1/1
Sooty shearwater	2/1	0	0	0
Cape gannet	24/2	234/13	49/7	108/7(1)
Whitebreasted cormorant	5/1	19/1	0	4/1
Cape cormorant	20/2	35/3	20/5(1)	73/5(1)
Bank cormorant	0	1/1	0	1/1
Crowned cormorant	0	3/1	1/1	2/1
Kelp gull	0	5/1	1/1	3/1
Swift tern	0	0	0	1/1
<b>TOTAL MARINE</b>	<b>10</b>	<b>25</b>	<b>19</b>	<b>29</b>
South African shelduck	0	1/1	1/1	0
Southern pochard	0	0	0	3/1
Redknobbed coot	5/2(1)	9/2	1/1	16/2
<b>TOTAL FRESHWATER</b>	<b>2</b>	<b>3</b>	<b>2</b>	<b>3</b>

(cont.)

Table 6.2 (cont.)

SPECIES	LAYERS			
	1	2	3	4
Egyptian goose	0	0	1/1	1/1
Common kestrel	3/(1)	1/1	0	0
Jackal buzzard	0	4/2(1)	0	0
Cape francolin	4/2(1)	*1/1	0	0
Speckled rock pigeon	0	0	0	n4/2(1)
Spotted eagle owl	0	4/1	0	n*2/2(1)
Whitenecked raven	0	2/(1)	n1/(1)	1/1
Starling	4/1	9/2(1)	2 /1	12/3(1)
TOTAL TERRESTRIAL	4	8	3	9
TOTAL	16	36	24	41

**Table 6.3A. Middle Stone Age Layers. Number of Identified Specimens / Minimum Number of Individuals recovered from selected excavated units at Die Kelders 1 Cave. Species are listed according to gross habitat association. ( ) = number of juveniles in total.**

SPECIES	LAYERS												
	1	3	5	7	9	11	12	13					
Jackass penguin	10/2(1)	7/1(5)	-	2/1	-	-	2/1	-	-	2/1	2/1	-	
Albatross sp.	-	1/1	-	-	-	-	-	-	-	-	-	-	
Giant petrel	1/1	1/1	-	-	-	-	-	-	-	-	-	-	
Pintado petrel	-	3/1	-	-	-	-	-	-	-	-	-	-	
Blue petrel	-	1/1	-	-	-	-	-	-	-	-	-	-	
Prion sp.	1/1	-	-	-	-	1/1	-	-	-	-	-	-	
Whitechinned petrel	-	1/1	-	-	-	-	-	-	-	-	-	-	
Cape gannet	1/1	2/2	-	-	-	-	-	-	-	-	-	-	
Whitebreasted cormorant	5/1	9/3	-	-	-	-	-	-	-	-	-	-	
Cape cormorant	14/2	62/12	3/1	4/1	1/1	1/1	3/1	7/1	3/1	1/1	7/1	7/1	
Crowned cormorant	-	1/1	-	-	-	-	1/1	-	1/1	-	1/1	-	
Kelp gull	-	1/1	-	-	-	-	-	-	-	-	-	1/1	
<b>TOTAL MARINE</b>	<b>8</b>	<b>39</b>	<b>1</b>	<b>2</b>	<b>1</b>	<b>2</b>	<b>1</b>	<b>2</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	
Sacred ibis	-	8/6(2)	5/(1)	1/1	1/1	-	-	-	-	2/1	-	2/1	
South African shelduck	1/1	-	-	-	-	-	-	-	-	-	-	-	
Yellowbilled duck	-	1/1	-	-	-	1/(1)	-	-	-	-	-	-	
Duck sp.	-	-	-	-	-	-	1/1	-	-	-	-	-	
Redknobbed coot	1/1	4/2(1)	-	-	-	-	-	-	-	-	-	-	
Wader sp.	-	2/2	2/2	-	-	-	-	-	-	-	-	-	
<b>TOTAL FRESHWATER</b>	<b>2</b>	<b>11</b>	<b>3</b>	<b>2</b>	<b>1</b>	<b>1</b>	<b>1</b>	<b>1</b>	<b>-</b>	<b>1</b>	<b>1</b>	<b>1</b>	

(cont.)

Table 6.3A (cont.)

SPECIES	LAYERS									
	1	3	5	7	9	11	12	13		
Ostrich	-	1/(1)	-	-	-	-	-	-	-	-
Egyptian goose	-	5/2	-	-	-	-	-	-	-	-
Vulture sp.	4/3(1)	-	-	-	-	-	-	-	-	-
Eagles, Kites, hawks	1/1	7/4(1)	-	-	-	-	3/1	-	-	-
Common kestrel	-	1/1	-	-	-	-	-	-	-	-
Greywing francolin	6/1	3/3(1)	1/1	-	-	-	-	-	-	-
Cape francolin	11/3	94/17	2/1	-	1/1	-	-	-	-	-
Crane sp.	4/1	-	-	-	-	-	-	-	-	-
Speckled rock pigeon	2/1	5/5(1)	-	-	-	-	-	-	3/1	-
Barn owl	2/1	10/4(1)	-	2/2(1)	-	-	-	-	1/1	1/1
Spotted eagle owl	3/1	3/3	-	-	-	1/1	1/1	-	-	-
Whitenecked raven	5/1	3/3	-	-	-	-	3/2(1)	-	-	-
Starling sp.	-	4/1	4/(1)	-	-	-	-	-	-	-
TOTAL TERRESTRIAL										
	13	44	3	2	1	1	4	2		
TOTAL										
	23	94	7	6	3	4	7	6		

**Table 6.38. Middle Stone Age Layer 3. Number of Identified Specimens / Minimum Number of Individuals recovered from selected excavated subunits at Die Kelders I Cave. Species are listed according to gross habitat association. ( ) = number of juveniles in total.**

SPECIES	SUBUNITS										TOTAL	
	M	J	MJ	MJA	MJB	M/O	B					
Jackass penguin	3/(1)	2/1	17/3(1)	16/3	7/1	12/4(3)	14/2	71/15(5)				
Albatross sp.	-	-	-	-	-	-	1/1	1/1	1/1			
Giant petrel	-	-	-	-	-	1/1	-	1/1	1/1			
Pintado petrel	-	-	-	-	-	-	3/1	3/1	3/1			
Blue petrel	-	-	-	-	-	1/1	-	1/1	1/1			
Prion sp.	-	-	-	-	-	-	-	-	-			
Whitechinned petrel	-	-	-	1/1	-	-	-	-	1/1			1/1
Cape gannet	-	-	-	-	-	-	-	1/1	1/1			2/2
Whitebreasted cormorant	-	-	-	4/1	2/1	-	3/1	3/1	9/3			9/3
Cape cormorant	3/1	-	8/2	25/4	12/2	4/1	10/2	62/12	62/12			62/12
Crowned cormorant	-	-	-	-	1/1	-	-	1/1	1/1			1/1
Kelp gull	-	-	-	1/1	-	-	-	1/1	1/1			1/1
<b>TOTAL MARINE</b>	<b>2</b>	<b>1</b>	<b>5</b>	<b>10</b>	<b>5</b>	<b>8</b>	<b>8</b>	<b>39</b>	<b>39</b>			<b>39</b>
Sacred ibis	-	1/1	2/(1)	2/1	2/2(1)	1/1	-	8/6(2)	8/6(2)			8/6(2)
South African shel duck	-	-	-	-	-	-	-	-	-			-
Yellowbilled duck	-	-	1/1	-	-	-	-	1/1	1/1			1/1
Duck sp.	-	-	-	-	-	-	-	-	-			-
Redknobbed coot	-	-	-	3/1	1/(1)	-	-	4/2(1)	4/2(1)			4/2(1)
Wader sp.	-	-	1/1	-	-	1/1	-	2/2	2/2			2/2
<b>TOTAL FRESHWATER</b>	<b>-</b>	<b>1</b>	<b>3</b>	<b>2</b>	<b>3</b>	<b>2</b>	<b>-</b>	<b>11</b>	<b>11</b>			<b>11</b>

(cont..)

Table 6.38 (cont.)

SPECIES	LAYERS										
	M	J	MJ	MJA	MJB	M/O	B	S			
Ostrich	-	-	-	-	-	-	-	1/(1)	1/(1)		
Egyptian goose	-	-	-	-	-	1/1	4/1	5/2			
Vulture sp.	-	-	-	-	-	-	-	-			
Eagles, kites, hawks	-	-	-	1/1	3/2(1)	-	3/1	7/4(1)			
Common kestrel	-	-	-	-	-	-	1/1	1/1			
Greywing francolin	1/1	-	-	1/1	-	1/(1)	-	3/3(1)			
Cape francolin	1/1	3/1	10/2	24/3	10/3	6/2	40/5	94/17			
Crane	-	-	-	-	-	-	-	-			
Speckled rock pigeon	-	1/1	-	1/1	1/(1)	1/1	1/1	5/5(1)			
Barn owl	2/1	-	-	-	6/2(1)	-	2/1	10/4(1)			
Spotted eagle owl	-	1/1	-	1/1	1/1	-	-	3/3			
Whitenecked raven	-	1/1	1/1	-	-	1/1	-	3/3			
Starling	-	-	-	-	-	-	4/1	4/1			
TOTAL TERRESTRIAL	3	4	3	7	9	6	12	44			
TOTAL	5	6	11	19	17	16	20	94			

## 7. SOUTHERN CAPE COAST ARCHAEOLOGICAL SAMPLE: NELSON BAY CAVE

### INTRODUCTION

The most important terminal Pleistocene and Holocene coastal archaeological sequence on the southern Cape coast is that in Nelson Bay Cave, which was excavated by R.R. Inskeep of the University of Cape Town (upper middens at mouth of cave) and R.G. Klein, then of the University of Washington (link with Inskeep's excavation and earlier middens within cave) (Klein 1972a; Inskeep 1987). Nelson Bay Cave is located some 500 km east of Cape Town in cliffs of Enon Conglomerate on the west side of the Robberg Peninsula which forms the western boundary of Plettenberg Bay (Figure 7.1). The beaches of Plettenberg Bay are predominantly sandy within 12 km of the site, while the coast to the west of the Robberg Peninsula is rocky. 3.5 km east of the cave the bay is intersected by the Piesang River, at the mouth of which is a low island. A further 1.5 km along the beach the estuaries of the Bietou and Keurbooms Rivers form a lagoon, with extensive wetlands being a feature of the lower reaches of the Bietou at the present. The combined rocky and sandy coastline and lagoonal/wetland catchment provide a wide range of marine, freshwater and terrestrial resources within easy reach of the site.

The base of the Nelson Bay Cave sequence comprises a lag of Middle Stone Age stone artefacts, the estimated age of which is about 65 000 B.P. (Klein 1972a; Butzer 1973; Volman 1981). After a major occupational hiatus the cave was reoccupied by Later Stone Age people at 18 000 B.P. during the Last Glacial Maximum. At this time the sea level was over 100 m lower than at present and the coast approximately 80 km from Nelson Bay Cave (Klein 1972a, 1972b). By about

11 000 to 10 000 B.P. the coast would have been between about one and three kilometres from the site, well within exploitation range, and marine elements appeared in the form of a complex of dense shell middens which accumulated over the following 10 000 years. Units excavated by Inskip are numbered and a selection from between 22 and 148 have been analysed; deposits excavated by Klein are in named units (Ivan to Yellow Grey Loam) (Table 7.1 Klein 1972a, 1972b; Deacon 1984; Inskip 1987). The ages of excavated units at the base of the Inskip excavation and the top of the Klein excavation overlap at 6000 B.P. and are referred to as R6000 B.P. and K6000 B.P. respectively in discussion. Avian remains occur throughout the Later Stone Age deposits.

Stratigraphic and palaeoenvironmental information is summarized in Table 7.1. Klein (1972a), Butzer (1973), Inskip (1987) and Deacon & Lancaster (1988) discussed evidence for environmental change and its effects on the physical characteristics of the cave and coastal region. Klein (1972b, 1984c) and D.M. Avery (1982) provided evidence for vegetation change based on large and small mammalian remains respectively. Major climatic trends for the western Cape region are summarized in Partridge *et al.* (submitted).

## METHODS

The methods outlined in Chapter 5 have been followed. Avian remains were separated from the excavated sample by R.G. Klein. A large volume of the available deposit was excavated and the samples are from well-defined stratigraphic and spatial units, with generally good bone preservation in spite of the diagenetic effects of groundwater and compaction in some lower units. It is believed, therefore, that the frequencies provide a reasonable reflection of remains brought to the site and preserved. Clearer stratigraphy at the mouth of the cave enabled Inskip (1987) to

recognize and excavate very small stratigraphic sub-units, at the level of single short-term occupations. This was not possible to the same degree in the lower deposits excavated by Klein in which finer stratigraphic detail had been obliterated by the action of groundwater (Klein 1972a; Deacon 1984).

Results from beach surveys conducted in the southeast Cape have been used in the correspondence analysis of seabirds in the archaeological samples. It was, however, not possible to arrange for a local beach survey to be conducted in the vicinity of Plettenberg Bay, as it was at Eland's Bay Cave and Die Kelders Cave 1.

## RESULTS AND DISCUSSION

### COMPOSITION OF SAMPLES

The species and MNIs listed in Tables 7.2A-B and 7.3A-B have been grouped according to gross habitat preference. Results for the smaller sub-units excavated by Inskeep (1987) are given separately in Table 7.2A and B. Sample sizes vary. The NISPs from which were calculated the MNIs presented in Tables 7.2A-B and 7.3A-B follow a pattern similar to that in the Eland's Bay and Die Kelders Caves and many of the less common species are represented by one or very few bones. As was noted above, given that whole birds are likely to have been brought to the cave for processing and that the area covered by the excavation was large, some loss of bone has clearly taken place, although it is possible that some fragmentary remains of shafts were not removed from the excavated sample.

The unidentified small shearwater species is problematic. The specimens differ from the little shearwater comparative material available and appear to share similarities with the closely related Audubon's shearwater but this is only a rare visitor to the Natal and East London (500 km to the east of the site; one record)

coasts. Audubon's shearwater is a bird of tropical oceans that does not disperse widely from its nesting islands in the tropics (Maclean 1985) and it is unlikely to have occurred at Plettenberg Bay under present conditions. On the other hand, little shearwaters, which occur in sub-tropical zones and are also relatively rare, are beached on South African coasts (Sinclair *et al.* 1982). The little shearwater is by far the most likely species, therefore (R.K. Brooke, Percy FitzPatrick Institute, pers. comm.), but final confirmation must await additional comparative material. In the meantime these specimens are listed as shearwater sp. The identity of at least one species of large crane must also await confirmation. Remains are fragmentary, but some do not appear to be those of Stanley's crane. In the light of this, the wattled crane is a distinct possibility (Brooke & Vernon 1988) but remains to be confirmed. Similarly, the identity of the remains of the large eagle species must await confirmation.

In samples more recent than 10 000 B.P. the marine bird contribution is over 80%, with only one layer contributing slightly less and a number contributing over 90% and up to 100% of samples. Prior to 10 000 B.P. seabirds contributed only 57% to CS, 50% to GS and 29% to BS, while no species associated with the marine environment occurred in the two earliest samples. The basal layers (Table 7.1) are distinctive in that only a trace of marine species is present in BS and none was found in layers YS and YG. As well as being a seabird the whitebreasted cormorant occurs on freshwater at inland localities (Maclean 1985), which explains its occurrence in layer YS.

Comparison of the relative proportions of jackass penguins, Cape gannets and Cape cormorants (Figure 7.2) shows wide fluctuation through time. Jackass penguins show a tendency to increase, reaching 50% between 2000 and 3000 B.P. and then dropping to 36% by 400 B.P.; Cape gannets decreased markedly (Figure 7.2) from 60% between 10 000 and 11 000 B.P. to a low of 27% between 2000 and

3000 B.P. after which they increased to 40%. In the earlier levels, the relative proportions of jackass penguins and Cape gannets are similar to those in similar-aged layers at Eland's Bay Cave. Cape cormorants, on the other hand, increase initially but the proportion drops significantly from 34 to 14% at about 6000 B.P., after which there is a slight increase to 25% by 400 B.P. The relative proportions of jackass penguins and Cape gannets are generally higher than in the Eland's Bay Cave and Die Kelders Cave 1 archaeological and associated beach survey samples, whereas those of Cape cormorants are very low.

The proportions of all petrels, shearwaters and albatrosses, relative to the total marine bird component in each layer, also vary significantly (Figure 7.3). Petrels and shearwaters, which contribute 12% at 10 000 to 11 000 B.P., increase steeply to 25% in the K6000 B.P. group, but almost immediately drop to 19% in R6000 B.P. and 6.3% between 2000 and 3000 B.P., rising thereafter to 11% by 400 B.P. Albatrosses follow a similar pattern, reaching 16% by 8000 to 9000 B.P., after which the proportion drops to 8% by K6000 B.P., rises slightly to 10% in R6000 B.P., is at 9% by 2000 to 3000 B.P. and reaches 16% by 400 B.P. Albatrosses are more common than petrels and shearwaters after 2000 to 3000 B.P.

The relative marine, freshwater and terrestrial contributions to each unit are illustrated in Figure 7.4. Sub-units excavated by Inskeep are in sequence, although it must be borne in mind that a selection has been made. The variability between these units is only partly due to small sample size and it appears that such fluctuations within relatively short periods may represent slight variation in the timing of visits to the cave. At the same time, although the actual period covered by each unit cannot be determined, the variability may also reflect the superimposition of longer-term fluctuations on human schedules (Avery 1988a). Co-variation between freshwater and terrestrial contributions is more evident in samples prior to 8000 B.P., whereafter the marine and terrestrial contributions are more important.

The marine bird component increased through time (Figure 7.5). Between 11 000 and 10 000 B.P. the marine contribution rose from 29% in BS to 50% in GS and 57% in CS, reaching 81% in BJ, in response to the coast moving rapidly nearer to the cave as the sea level rose steeply. Thereafter the increase in marine birds was very slight until between 5000 and 6000 B.P. (HE to BE) when the proportion rose to over 90%, with a dip in IV to 86%. Thereafter, the contribution dropped slightly to 83% between 2000 and 3000 B.P. and rose again to 88% by 400 B.P.

Terrestrial elements (Figure 7.5), which contributed 18% to the basal YG layer at 18 000 B.P., reached 84% of the total in YS, which is dated to about 16 500 B.P., but had dropped to 29% by 11 000 B.P. when the coast was relatively nearby. Between 11 000 and 10 000 B.P. the terrestrial contribution rose to 50% before dropping to 15%. There was a slight increase to 18% in terrestrial elements between 8000 and 9000 B.P., dropping in the K6000 B.P. group from 14% to 4% between RA and BE before increasing briefly to 15% in IV and dropping to 5% in the R6000 B.P. group. Between 2000 and 3000 B.P. the terrestrial contribution was 17%, but had dropped to 10% by 400 B.P.

Birds of prey, including crowned eagle, spotted eagle owl, barn owl and whitenecked raven, which make up an important proportion of the samples, would have been using the cave as a roost and breeding site, although, as will be discussed below, bones of some were utilized by people and may have been obtained from elsewhere. Nevertheless, the cave could not have been the important breeding site for predatory birds that it appears to have been unless it were periodically abandoned by humans.

The proportion of species associated with fresh water (Figure 7.5), which constituted 82% in the basal YG layer at 18 000 B.P., had dropped to 16% by 16 500 B.P. but increased again to 43% by 11 000 B.P. Between 11 000 and 10 000 B.P. the freshwater contribution dropped to zero in GS before recovering slightly to 11% in

CS and dropping to 5% in BJ. The contribution continued its downward trend and dropped from 4% to zero between 9000 and 8000 B.P. when conditions are thought to have become drier. Thereafter freshwater birds constitute only very low proportions in RA, BG and IV in the K6000 B.P. group, the R6000 B.P. group and the 400 B.P. group. Some of these appear to correlate with periods when conditions are thought to have been wetter than at present (Table 7.1).

#### AGENCY OF ACCUMULATION

The possibility that agents other than people or barn owls may have contributed to the samples from Nelson Bay Cave has not been considered likely (Klein 1972a, 1972b; D.M. Avery 1982; Inskeep 1987). With the possible exception of rock hyraxes, the small-mammal contribution to the samples does not include large numbers of animals likely to have been prey of jackals, owls or eagles as was the case at Eland's Bay Cave and Die Kelders Cave 1. The absence of Cape dune molerats is expected because the present distribution of this species does not extend as far east as Plettenberg Bay (Smithers 1983).

#### Black-backed jackal

In view of the fact that Cape cormorants are not well represented in the samples, the available numbers of skeletal elements were not large enough to compare the relative proportions of elements in each unit or layer with those from the modern jackal accumulations. Figure 7.6 therefore illustrates the results for IV, RA, JA and BJ only.

A visual impression is that the samples are distinct in a number of areas, the occurrence of vertebrae being one example. Kolmogorov-Smirnov two-sample tests

showed that there were highly significant differences between the archaeological samples IV and RA and the comparative jackal sample whereas the JA and BJ samples were not different at the 0.05 level or below. On present evidence this should indicate that jackals were involved in the accumulation of the JA midden and BJ samples. However, in view of the fact that this was not indicated by observations on the bones themselves, and the problems experienced with older samples at the other sites, other factors should be examined.

The statistical similarity with jackal accumulations may in fact reflect the general structural properties and durability of bird bones that control survivorship after exposure to other destructive agencies. The bones from the lower levels have been subjected to groundwater action and appear to be more friable than bones in the more recent middens. The JA and BJ accumulations appear to be different to some of the other middens on other grounds as well. Klein (1972a) described JA as a mix of shell and silty sand, not a true midden, and BJ as being intermediate between a true shell midden and an "occupation soil" [sic]. It is possible that deposition was slower than suggested for dense shell middens, that bones were exposed to mechanical destruction on the surface for longer or that compaction, after disintegration of organic residues, and groundwater led to mechanical and chemical damage. Furthermore, bones in the BJ sample in particular appear to have been fragmented as a result of compaction and virtually no shafts of long bones have survived intact (or they were not removed from 'undiagnostic' material). This is perhaps also reflected in results of Kolmogorov-Smirnov tests between archaeological samples that distinguished between the older and more recent samples. As was the case with the older Die Kelders Cave 1 Middle Stone Age remains, it appears that direct comparisons between modern samples and older samples, which have undergone modification by mechanical and diagenetic factors, may not be appropriate. This new observation serves to emphasize again the

complexity of unravelling multiple agencies of accumulation and the need for more studies on the durability of bones such as those undertaken on mammals (Brain 1967, 1981; Binford 1978) and reviewed by Johnson (1985).

### People

Undoubtedly people would have been able to take any of the species in the Nelson Bay Cave samples, and the same argument outlined in Chapters 5 and 6 for Cape dune mole rats can be applied to the hyraxes. Furthermore, hyraxes give birth during September/October and, as will be shown below, people appear to have been using the cave at the time of year that juvenile hyraxes would have been available.

If jackals contributed to the character of the samples, it seems likely that this was secondary. In addition to the occurrence of shellfish in quantity, there is considerable evidence that bones of mammals and birds provided raw materials for artefacts. The BJ artefact sample includes the second highest frequency in the samples, while that in JA included much the same proportion as in the other samples (Deacon 1984). In this analysis bones of nine avian species recorded in the JA sample showed signs of working and there were four in BJ. A number of these were discarded ends of scraped or cut shafts.

### SOURCE OF SEABIRDS

In order to assess the assumption that seabirds found in archaeological sites were mainly scavenged from the beach, results from the archaeological samples were compared with the modern observations. Figure 7.7 compares the relative proportions of common breeding seabirds recovered from southeast Cape beach surveys

and the combined results of surveys at Rockcliffe and Port Alfred with results from the grouped layers from Nelson Bay Cave. Although there are distinctions, there is a general similarity between the pattern of relative proportions of the more recent samples and aspects of each beach survey, adding support to the contention that the archaeological remains were derived from beached birds. Had results been available from a local beach survey, the distinctions might have been less. The earlier samples appear to differ from the modern samples to a greater degree. A consistent point of difference in all of the archaeological samples is the high proportion of whitebreasted cormorants.

In spite of differences in the relative proportions of the species in the southeast Cape and Rockcliffe and Port Alfred beach surveys, a Kolmogorov-Smirnov two-sample test showed that these were not significant. Such differences as exist can probably be explained by location which is likely to have influenced local mortality and the proportions in which species were beached. The southeast Cape sample is influenced strongly by the sample from Cape Recife in Algoa Bay, where penguins and gannets breed and large numbers of pelagic seabirds congregate to feed, and where prevailing easterly summer winds blow onshore. The Rockcliffe and Port Alfred samples, on the other hand, are from open beaches far removed from large colonies of breeding seabirds in places where winds are not normally onshore.

Kolmogorov-Smirnov two-sample tests revealed that there was no significant difference between the southeast Cape surveys and the archaeological samples down to and including R6000 B.P. Earlier samples, however, differed highly significantly (at the 0.001 level). Comparisons using the Rockcliffe and Port Alfred samples revealed no difference from the 400 to 500 B.P. and 8000 to 9000 B.P. samples, whereas those from other layers were significantly different (at the 0.01 level). This again emphasizes the usefulness of backing up the more general results with additional comparisons. The results of the above comparisons, in addition to

the regular presence of normally inaccessible species in archaeological samples, are taken to be strong evidence that seabirds in the samples were acquired by exploiting beached birds. Seabirds such as albatrosses, petrels and shearwaters occur widely in the Southern Ocean and, although changing environments might have had an effect on the composition of samples, it is believed that the earlier samples are also comprised of beached birds.

#### EVIDENCE FOR SEASONALITY

##### Correspondence analysis of archaeological and beach survey observations

Only those species occurring in the archaeological samples have been included in this analysis. Prions, which exert strong seasonal weight on the display of months, have been included in the active rows because tests showed that their effect on the display was not great. Although the majority of prions are beached in winter months, individuals may be found in any month; their inclusion in the analysis increases the number of variables in the column (months) profiles and, therefore, the reliability of results. Species that have not been recorded on beach surveys cannot be analysed in this manner. The archaeological samples have been treated as inactive supplementary points. Samples were analysed according to the layers in which they occur. To simplify the display, only co-ordinates of months and archaeological units have been plotted. The result of the correspondence analysis plot for southeast Cape beach surveys is given in Figure 7.8 for reference to the co-ordinates of species. Species in small samples (Table 7.2A-B) may have exerted undue weight on the display, thereby giving an unsatisfactory result (Avery & Underhill 1986), and such results should be viewed together with those from the larger samples and

combined layers which will be made more stable by the wider diversity of contributions to the column and row profiles.

#### *Units 22-57*

The first two principal axes accounted for 59% of the total inertia and confirmed the seasonal grouping of species and months of the year (Figure 7.9A).

The distribution of samples for the 22-24 group (400-600 B.P.) falls between October and December, with 22 tending towards December and possibly January, 23 between October and November, and 24 towards October. T1 is plotted between November and December but, as samples 22 and 24 are relatively large, the variation between smaller units is likely to indicate real differences in the timing of visits to the cave. The February to September components of the year do not appear to be represented in any of the samples.

The samples from the 30-57 group (2-3000 B.P.) are widely distributed between August and December (Figure 7.9A). Units 30 and 31 are plotted in the direction of November and December respectively and 53, the largest sample in the 53-57 group, is drawn strongly towards October and November. The other samples include elements which indicate exploitation of seabirds between September and October, excluding 57 which is small. The position of T2 (combined 30-57) falls between October and November, confirming the distinction between the two groups. The February to August components of the year do not appear to be represented in any of the reliable samples.

*Units 129-148*

The first two principal axes accounted for 58% of the total inertia and confirmed the seasonal grouping of species and months of the year (Figure 7.9B). The distribution of samples is not as close as in the uppermost groups. Samples 129, 131 and 132 and 144, which are relatively large, are plotted in the direction of November to January, with November to December being the most likely period. Sample 130, which indicates a time between July and August, is very small and therefore the result is unreliable. Other samples suggest elements of between October and February, and 146 suggests March/April, but these could be ambiguous through lack of sample diversity. The result for the combined units (T1) falls between November and December. Once again the February to September components of the year do not appear to be represented in any of the more reliable samples.

*Layers IV-RA*

The first two principal axes accounted for 53% of the total inertia and confirmed the seasonal grouping of species and months of the year (Figure 7.10A). Each of the samples is relatively large and greater reliance can be placed on the individual results (as sub-units were not distinguished during excavation, they are essentially the equivalent of the combined Ts for the units analysed above). Results are plotted between October/November and April, possibly May. Most samples, including the combined total (T), appear to have been accumulated between November and December and no pattern related to stratigraphic position is apparent. Individual layers cannot be subdivided in order to establish what variability might have existed within the periods (K6000 B.P.) covered by them. Repeated occupation of the site which led to the accumulation of each layer appears, however, to have been centred

at different times of the year between summer and autumn. This pattern is similar to that evident from the analysis of the R6000 B.P. units above.

### *Layers RC-GS*

The first two principal axes accounted for 57% of the total inertia and confirmed the seasonal grouping of species and months of the year (Figure 7.10B). The distribution of samples is markedly different from any discussed so far. With the exception of GS which is small, the samples are plotted between February/March and May/June, the main distribution being between March and May. The incidence of juvenile Cape gannets in each of the samples is an important factor in the distribution of layers in the display. Totals for the 8000 to 9000 B.P. period (T1) and the 10 000 to 11 000 B.P. periods (T2) are plotted separately. Variation in the timing of seabird exploitation as far as can be ascertained from the layers, suggests that timing was more specific than in the IV-RA period (K6000 B.P.), possibly being directed at the mortality of adult and juvenile Cape gannets and whitebreasted and Cape cormorants. The June to November components of the year do not appear to be represented in any of the samples.

### Archaeological sample profiles

Profiles of the proportions of the major seabird groups (jackass penguin; albatrosses, petrels, shearwaters; Cape gannet; cormorants) are given for each group of layers (Figure 7.11). Profiles illustrate some of the seasonal variability that is evident from the beach survey data (Figure 3.21) and is represented in the correspondence analysis plots. The high proportion of albatrosses/petrels/shearwaters in

the 8000 to 9000 B.P. and K6000 B.P. samples is also evident, as is that of Cape gannets in the 10 000 to 11 000 B.P. layers.

#### Other evidence of seasonality

Further evidence for seasonality is available from the presence of juvenile individuals and of adults with medullary bone, which is only formed in females between copulation and laying and disappears rapidly thereafter (Rick 1975). The seasonal evidence for non-seabirds supports that from the correspondence analysis and adds to the body of evidence that people were the main accumulators of the Nelson Bay Cave samples.

#### *Units 22-24*

Medullary bone was noted in Cape gannet specimens in units 22 and 23. Cape gannets breed in Algoa Bay from October to March, the peak period being between October and November and the peak fledging period being February and March (Randall *et al.* 1981; Batchelor 1982). This is consistent with the correspondence analysis plot between late September and December. The presence of nestling whitebreasted and Cape cormorants is also consistent with the correspondence analysis. Whitebreasted cormorants breed on the cliffs near the end of the Robberg Peninsula (Brooke *et al.* 1982) and sick individuals or carcasses are to be found beneath the cliffs (GA pers. obs.); Cape cormorants may also have bred on the cliffs or a nearby stack. Cape cormorants breed mainly between September and March, normally peaking between September and October (Randall *et al.* 1981), and nestlings would have been available from October. The occurrence of sooty and Manx

shearwaters, which are often seen in association (Sinclair & Rose 1982), confirms a summer component (Brown *et al.* 1982; Sinclair & Rose 1982).

#### *Units 30-57*

The presence of a great shearwater confirms a summer element in the samples (Brown *et al.* 1982). A breeding colony of whitebreasted cormorants existed in the vicinity and, together with the presence of juvenile Cape cormorants, indicates November or December (possibly January) as the most likely months. Kelp gulls breed between September and March, and juveniles fledge and leave the nest from about mid November (Maclean 1985). The above are all consistent with the results obtained by correspondence analysis.

#### *Units 129-148*

The same pattern of cormorant breeding and the presence of shearwaters as described for units 30-57 occurs and is consistent with the correspondence analysis.

#### *Layers IV-RA*

The presence of recently-fledged juvenile blackbrowed albatrosses, giant petrels, a prion and sooty shearwaters in some samples confirms the existence of a February to April component (Watson 1975; Ryan & Avery 1987). Manx shearwaters also fit the correspondence analysis results, as do the breeding cormorants, including the crowned cormorant. Goliath herons breed from June to January and juveniles would be available from September or October (Maclean 1985). Lesser flamingoes

breed between June and July (Maclean 1985) and juveniles start flying from October.

#### *Layers RC-GS*

The presence of a juvenile blackbrowed albatross and a prion confirm the existence of a February to April component for the samples in which they occur. As discussed above, juvenile goliath herons would have been available from September or October through to April. South African shelduck breed from May to September, primarily between July and August (90% of eggs laid at this time); eggs hatch about 30 days later and juveniles fly at 70 days (Maclean 1985). This is consistent with results from the correspondence analysis.

#### *Layers YS-YG*

The only seasonal evidence available is from freshwater and terrestrial species. It is not known whether the water body that attracted ducks and coot was seasonal or permanent, although under wetter conditions than present (Table 7.1) permanent water would have been expected on the coastal foreland. Consequently the presence of adults is equivocal. Blackheaded herons breed from July to January in the Cape Province (Maclean 1985) and juveniles would have been available from about October to April. Greywing francolin breed between August and October (Maclean 1985) and the presence of medullary bone in the YS individual is unequivocal evidence that the bird was brought to the cave during this period. The breeding of South African shelduck has been discussed above; nestlings of the size found in YG would have been available from July to November with a peak between September and October. Curlews migrate from the Palaearctic during the

austral summer between August and March and few birds overwinter (Maclean 1985). The limited seasonal evidence for YS and YG suggests, therefore, that a period between October and November is likely, although this could span the period from August to April.

These results add considerable detail and resolution to the preliminary observations of Avery (1987c) on seasonal evidence from the Inskeep excavation (Inskeep 1987). In the layers postdating 8000 B.P. at Nelson Bay Cave seasonal evidence from birds shows a clear emphasis on the early summer period between October and December, although individual units and layers show wide variation within the range. In the earliest layers, between 8000 and 11 000 B.P., exploitation of birds appears to have taken place within a restricted period in the late summer and autumn months. There is a tendency for grouped layers to be different from each other and, within the groups, layers differ from each other and sub-units vary in position around the combined layer result. Results for JA and CS support Shackleton's (1973) conclusion that shellfish sampled from these layers had been collected in autumn or winter between May and October. In general, the evidence supports the suggested seasonal use of marine resources (e.g. Parkington 1972). More specifically the results from the upper units support the oral tradition recorded by H.J. Deacon (1970) that a Bushman group used to move from the mountains to the coast in summer to exploit marine resources.

The correspondence analysis has also demonstrated the existence of a wide range of timing of exploitation of birds, and possibly other elements such as hyraxes of which Klein (1972a) observed that two age cohorts of juveniles were to be found amongst the samples. This wide spread of seasonal evidence is also indicated by evidence from fish (Inskeep 1987) and seals (Klein 1989). As was found at Eland's Bay Cave, birding activities in the early Holocene appear to have been timed

differently to those in more recent times, probably in response to changes in the availability of beached birds and other dietary components.

#### EVIDENCE FOR PALAEOENVIRONMENTS

The Later Stone Age samples from Nelson Bay Cave include bird remains from the Last Glacial Maximum, during which conditions were colder and drier, and samples deposited subsequently under conditions essentially the same as at present.

The high proportions of freshwater and terrestrial birds in the earliest layers support Klein's (1972a) contention that during the Last Glacial Maximum the site was some 80 km from the coast and had an essentially terrestrial catchment. The terrestrial component ranges from 18 to 84% (Figure 7.5).

The high proportion of freshwater birds in YG (82%) is in apparent contradiction to evidence for dry conditions during the Last Glacial Maximum (Butzer 1973; Deacon & Lancaster 1988) and the relatively small contribution of only 16% in YS when conditions are thought to have been wetter than during YG times. However, as was suggested in the case of Eland's Bay Cave, a local permanent (or seasonal) water body in the vicinity of Nelson bay Cave would have attracted unusually large numbers of waterbirds under drier conditions, leading to their being overrepresented.

A further possibility is that the sudden switch was triggered by changing environmental conditions at the time. Hays *et al.* (1976) show a fluctuation in the oxygen isotopic composition of planktonic foraminifera in deep-sea core RC11-120 between about 16 000 and 12 000 B.P. It may be simply that terrestrial conditions were suitable for more terrestrial species in the area, rather than that fresh water conditions were worse. If so, the evidence for drier conditions in YG followed by wetter conditions in YS would be supported (Table 7.3B). It should, however, be

noted that while variation in the relative proportions of freshwater versus terrestrial species appears to coincide with changes between wetter and drier conditions, the response is not consistent. From 9000 to 8000 B.P. (JA to RC), when other evidence suggests conditions are drier, the freshwater component was low and dropped to zero whereas during K6000 (RA, BG and IV) and R6000 times and at 400 B.P., low proportions of freshwater birds coincide with wetter conditions. The occurrence of freshwater birds is clearly affected by more factors than rainfall alone. It is possible that with general amelioration of conditions after the Last Glacial Maximum, and easy access to marine resources, the use of freshwater birds became more a matter of choice than a reflection of availability; consequently, their inclusion in archaeological samples would be less predictable. Under such circumstances, fluctuations in the proportions of freshwater and terrestrial species would not provide reliable palaeoenvironmental evidence. Until the factors that affect their inclusion in archaeological samples are better understood, the use of freshwater birds as indicators of palaeoenvironments should be made with caution.

The occurrence in the lowermost levels of species such as ostrich, black-headed heron, greywing francolin, quail and crane, which favour open country and grassland, support the suggestion (Klein 1972a, 1972b; D.M. Avery 1982) that open grassland was present in some quantity. Cape francolin indicate that scrub was also present on the plain or in the vicinity of water. Blackheaded herons breed in trees or reedbeds in vleis and rivers, and cranes are often associated with water or marshy areas (Maclean 1985); this would undoubtedly have been the case for wattled cranes if present (Brooke & Vernon 1988).

If BS is older than 12 000 B.P., as indicated by Klein (1972b), the existence of open vegetation and a local water body are still indicated by the suite of species. This is in spite of the fact that conditions were not as wet as previously. The peak in terrestrial elements in GS coincides approximately with a further terminal

Pleistocene fluctuation in the oxygen isotope record from deep-sea core RC11-120 (Hays *et al.* 1976) between about 10 000 and 11 000 B.P. This may be related to a change in ocean circulation in the same way that several dramatic fluctuations in Holocene tropical lake levels, one of which coincides with a change from dry to wetter conditions at this time, have been correlated with oceanic conditions (Street-Perrott & Perrott 1990). Establishment of a link between terrestrial and oceanic palaeoenvironmental change would provide an important framework for the interpretation of avian remains.

Broecker (1987) has also drawn attention to the possibility that the Younger Dryas in the Northern Hemisphere, a cold period at this time of 700 years duration, was caused by changes in oceanic circulation which lowered sea surface temperatures, reducing their normally warming effect on air passing over the continent. The global thermohaline circulation cell transports warm, relatively fresh North Pacific thermocline water via the Indian Ocean and Agulhas Current, around the tip of South Africa to the North Atlantic Ocean. Decreases in its input to the North Atlantic have been associated with anomalously lower sea-surface temperatures (SST) north of the equator and a lowered rate of formation of North Atlantic Deep Water, higher SST to the south and prolonged droughts in the Sahel and high rainfall in Indonesia (Broecker 1987; Street-Perrott & Perrott 1990). Because the ocean circulation cell is a global feature, which influences marine and terrestrial conditions, different local effects that correlate with long-term perturbations of ocean circulation will be preserved in widely distributed localities. This is in spite of the fact that direct correlation of Southern and Northern Hemisphere palaeoenvironmental change has not generally been strong (Tyson 1986; Deacon & Lancaster 1988). Meltwater may be a complicating factor (Street-Perrott & Perrott 1990), although not perhaps over the past 6000 years when changes in ice volumes have been minimal.

The Southern Oscillation is another internal fluctuation of the Earth's circulatory system and is associated with variations in atmospheric and ocean circulation patterns. The Southern Oscillation and the thermohaline cell are therefore related in the sense that they are both fluctuations in global circulation patterns. They occur, however, on considerably different time scales; the Southern Oscillation normally occurs on a scale of between 5 to 10 years, whereas palaeoecological evidence suggests that fluctuations in the thermohaline cell normally occur on the scale of several centuries (Broecker 1987; Street-Perrott & Perrott 1990). Computer simulation has, however, suggested that thermohaline fluctuations could possibly take place on a much smaller scale (Street-Perrott & Perrott 1990). The duration of the perturbations found by Hays *et al.* (1976) is consistent with fluctuations in thermohaline circulation.

By the time layers CS and BJ were being deposited, the freshwater and terrestrial components were 11% and 31% respectively, dropping to 5% and 15% respectively, and the marine bird component had risen to 57% in CS and to 81% in BJ (Figure 7.5). This suggests that by 10 000 B.P. Nelson Bay Cave had become a base for more intensive exploitation of marine resources but that some open foreland, possibly the western corner of Plettenberg Bay which is shallow at present, was still in existence. Ponding of the Bietou and Keurbooms Rivers, or a lagoon, would have provided a habitat for waterfowl and there must have been some open country for species such as secretary birds, greywing francolin and cranes. The habitat preferences of the above species indicate the presence of low scrub and open patches of short grass, with trees in which secretary birds could roost overnight (Urban *et al.* 1986) and trees or bushes in dense cover in which rednecked francolin could roost overnight. Rednecked francolin are typical of a variety of habitats, but are commonly found in association with dense riverine scrub, grassy plains with thickets and evergreen forest edge or patches (Urban *et al.* 1986), giving support to

Klein's (1972b) suggestion that the more closed character of the present habitat may have been developing in the vicinity of the cave from this time.

The terrestrial component of samples increased from 9000 to 8000 B.P. and the freshwater component decreased (Figure 7.5). This is in agreement with suggested drier conditions at the time (Table 7.1), but should be viewed with caution in the light of the lack of information on the variable effects of environmental conditions on freshwater birds, if it can be assumed in the first place that all of these changes were responses to environmental stimuli. Similar but weaker fluctuations are indicated by the K6000 B.P. sample, although the slight freshwater increase in IV was accompanied by a 15% increase in the terrestrial contribution.

The Holocene high sea-level stand of about +2 to 3 m occurred during the period in which the RA to IV and the RR3 groups of samples (Figure 7.5) were deposited (Butzer 1973; Yates *et al.* 1986). The higher sea level would have drowned the present lagoon and large parts of the estuaries of the Bietou and Keurboom rivers, creating more extensive riverine conditions and probably thereby reducing the area of wetland habitat available to freshwater birds. The higher sea level that led to the formation of the +1.5 m mixed estuarine and marine terrace at 5800 B.P. (Reddering 1988) would have been associated with such conditions.

Increased numbers of juveniles and nestlings of whitebreasted, Cape and crowned cormorants, and possible jackass penguin nestlings, in samples RA (6000 B.P.) and above indicate that an area in addition to the cliffs was available for the establishment of breeding colonies. The 'island', which is currently linked to the Robberg Peninsula by a tombola, would have been totally separated from the mainland by the higher sea level. This would have enabled seabirds to establish breeding colonies, safe from terrestrial predators, on the island. Beacon Isle in Plettenberg Bay would probably have been similarly affected. Furthermore, if

present sea level was only reached some 300 to 400 years ago, the islands may have supported breeding colonies throughout the rest of the sequence.

It is tempting to associate the generally raised values for the marine bird component between HE and BE at about 6000 B.P. (Figure 7.5) with the effects of a further oceanic fluctuation illustrated by Hays *et al.* (1976) and correlated with higher tropical lake levels (Street-Perrott & Perrott 1990). This period is marked by considerable fluctuation in the relative proportions of jackass penguins, Cape gannets and Cape cormorants (Figure 7.2) and also of petrels and shearwaters, which appear to be independent of seasonality (Figure 7.3); the peak in albatrosses occurred earlier between 9000 and 8000 B.P. In view of the fact that the coast has been within easy exploitation distance of Nelson Bay Cave since at least 11 000 B.P., it seems likely that subsequent changes in marine bird contributions reflect a response not to rising sea level, but to changing oceanic (or associated climatic) conditions.

Essentially modern oceanographic conditions have existed throughout the southwest Indian Ocean from the early Holocene, however (Hutson 1980), and any such changes must have been within the modern range of variation. Evidence from deep-sea cores has demonstrated that circulation of the deep ocean has undergone dramatic changes during the Holocene on a timescale of about 500 years; these have been correlated with changes in oceanic and terrestrial conditions (Broecker 1987; Street-Perrott & Perrott 1990). The correspondence during the Holocene of evidence for abrupt changes in tropical lake levels and oceanic circulation (Street-Perrott & Perrott 1990) and particularly of rainfall in South Africa (Tyson 1986; Deacon & Lancaster 1988), suggests a mechanism which may have influenced marine birds over the long-term. The present effects on seabirds of shorter-term fluctuations such as local warm events and global Southern Oscillation events have been discussed in Chapter 3. If changes in past ocean and atmospheric circulation

and fluctuations in the relative proportions of marine birds could linked, archaeological samples might provide important clues to the nature and timing of long-term changes in global circulation systems.

Tyson (1986) and Muller & Tyson (1988) discussed evidence for the interaction of Walker Circulation and high and low phases of the Southern Oscillation on South African rainfall and winds. During the high phase, the interior of South Africa becomes wetter, pressure and temperature fall over the continents and rise to the south. This weakens meridional gradients and winds tend to become anomalously easterly. Thus easterly winds strengthen where they normally prevail and westerlies weaken. During the low phase winds tend to become westerly and the easterly component is weakened. This is often associated with anomalously warm coastal waters. There is some correlation between the effects of high and low phases of the Southern Oscillation in South Africa and other continents (Tyson 1986).

There is evidence that there were periods during the Holocene, when predominantly low or high phase Southern Oscillation conditions existed in southern Africa. Flohn (1984) argued that low phase conditions existed in the Southern Hemisphere between 12 000 and 6000 B.P., with drier conditions in the Transvaal, and that the frequency and intensity of warm-water episodes such as El Nino would have increased. Harrison *et al.* (1984) noted the same phenomena, and added that after 9000 B.P. temperatures again rose and that between 7000 and 3000 B.P. (and again at 2000 B.P.) the southerly wind component intensified. Further support for this may also come from the increased aeolian input at the time in samples RA to IV (Butzer & Helgren 1972; Butzer 1973) and increased dune activity in Algoa Bay which, in addition to other factors, may be related in part to increased wind activity (Illenberger 1988). Between 9000 and 8000 B.P. conditions were drier than at present, while between 6000 and 5000 B.P. conditions were warmer than at present

and rainfall in the interior higher (Tyson 1986; Deacon & Lancaster 1988). The palaeo-conditions described above would be consistent with the described changes in ocean and atmospheric circulation and the emphasis of different phases of the Southern Oscillation.

Changes in wind patterns are likely to have been reflected in the occurrence of beached seabirds. Cox (1976) demonstrated that, in Australia, onshore winds or winds blowing parallel to the coast can affect the movement of petrels and shearwaters which drift close inshore. These birds tend to fly into the wind or crosswind, but are still subject to shoreward drift. Should they encounter a part of the coastline that juts out, they are forced to fly more directly into the wind to avoid drifting onto the shore. Oceanic seabirds, are adapted to harsh wind and storm conditions and are not normally affected by onshore winds. Weaker individuals may, however, be trapped into flying repeated circles until they become exhausted. Support for this scenario in the southern Cape comes from the relative proportions of petrels and shearwaters found during the open Rockcliffe and Port Alfred coast beach surveys (16%) and the closed Algoa Bay survey at Cape Recife (28%). In addition, Powlesland (1985, 1987, 1989) cites evidence that the intensity of beaching of albatrosses and petrels is increased by protracted winds or storm conditions and that recently-fledged juveniles are particularly vulnerable.

The higher proportions of petrels and shearwaters in samples at at 6000 B.P. can be explained in terms of Cox (1976), with Plettenberg Bay acting as a trap under conditions of protracted strong winds or intensified southerly (parallel to the coast and onshore) winds postulated above. It is also relevant that numbers of juvenile albatrosses, giant petrels, prions and sooty shearwaters are associated with the archaeological samples from this time. It is suggested, then, that the peak of particularly petrels and shearwaters in the samples dated to 6000 B.P. is related to changes in the intensity of southerly winds resulting from the increased incidence of

high phase Southern Oscillation conditions at the time. The fact that albatrosses form a relatively higher proportion of the samples between 11 000 and 10 000 B.P. and reach a peak between 9000 and 8000 B.P. may also be explained in terms of ocean circulation and Southern Oscillation phenomena. At this time conditions would have been similar to the low phase of the Southern Oscillation with increased intensity of westerlies (Flohn 1984; Harrison *et al.* 1984) and some northward movement of major storm tracks (Tyson 1986). Since albatrosses, particularly juveniles, appear to be vulnerable to strong and protracted southwesterly storms (Powlesland 1987; Ryan & Avery 1987) an increase in their proportion relative to petrels and shearwaters would be expected if such conditions became more frequent. It is possible that a similar intensification of low phase Southern Oscillation conditions is reflected in the increase in albatrosses between 400 and 600 B.P., in samples 22-24 (Figure 7.3).

Fluctuations in the numbers of albatrosses, petrels and shearwaters in archaeological samples have been shown to coincide with changes in oceanic and atmospheric conditions suggested by other lines of evidence. Seabirds do, therefore, have the potential to provide important information on past environments. The present argument is heavily dependent on supporting evidence from other sources, however, and more samples must be studied in order to establish the reliability of seabirds as independent indicators of atmospheric and ocean conditions.

#### SUMMARY

The initial increase in the marine component of the avian samples can be related to rising sea level and consequent shrinking of the wide Upper Pleistocene coastal foreland, which had existed in front of the cave, as well as to changing environmental conditions. The decrease in terrestrial birds is also related to

reduction of the area covered by the coastal foreland and to a change from open vegetation with a high proportion of grass to more closed conditions typical of the present. Freshwater birds are more common in the earlier samples; this is related to the open coastal foreland and the existence of vleis or ponding of the Bictou and Keurbooms Rivers and to changing climatic conditions which, when drier, may have increased the importance of freshwater bodies as refugia. In later samples, however, no consistent pattern could be found between the incidence of freshwater birds and drier or wetter conditions. More samples will have to be examined in order to establish what other factors may affect the occurrence of freshwater birds in archaeological samples.

By 10 000 B.P. the coast was virtually in its present position and fluctuations in the marine bird contribution cannot be explained in terms of rising sea level. The high incidence of albatrosses between 9000 and 8000 B.P. and of petrels and shearwaters between 6000 and 5000 B.P., during the Holocene high sea-level stand, is thought to have resulted from a switch (? switches) between conditions of increased westerly and increased southerly winds respectively in response to changes in ocean circulation and in the emphasis of phases of the Southern Oscillation. As a result, more of these species were trapped in Plettenberg Bay and mortality was considerably higher than it was before or after. While this finding has important implications for the use of seabirds as palaeoenvironmental indicators, further observations are needed to establish whether fluctuations in the relative proportions of albatrosses, petrels and shearwaters can be interpreted with less dependence on support from other sources.

It has been demonstrated that the source of the seabirds was most likely to have been beached birds. No conclusive evidence was found to suggest that black-backed jackals were responsible for accumulating seabirds, although similarities between earlier samples and the modern jackal sample again emphasized the need

to obtain more information on the structural properties of bird bones and on the effects of factors such as decalcification, compaction and trampling that might mimic the effects of carnivore damage. In the light of the undoubted evidence (artefactual, molluscan) for human habitation of Nelson Bay Cave and the established lack of an unequivocal alternative it is concluded that people accounted for the sample composition of all the layers at Nelson Bay Cave.

Seasonal evidence from correspondence analysis and other sources indicates that after 8000 B.P. Nelson Bay Cave was used primarily in the early summer months between October and December. As was found at Eland's Bay Cave and Die Kelders Cave 1, there is wide variation between samples within the indicated range. Between 8000 and 11 000 B.P., however, people appear to have used the cave to exploit seabirds during a more restricted period in late summer and autumn, between March and May.

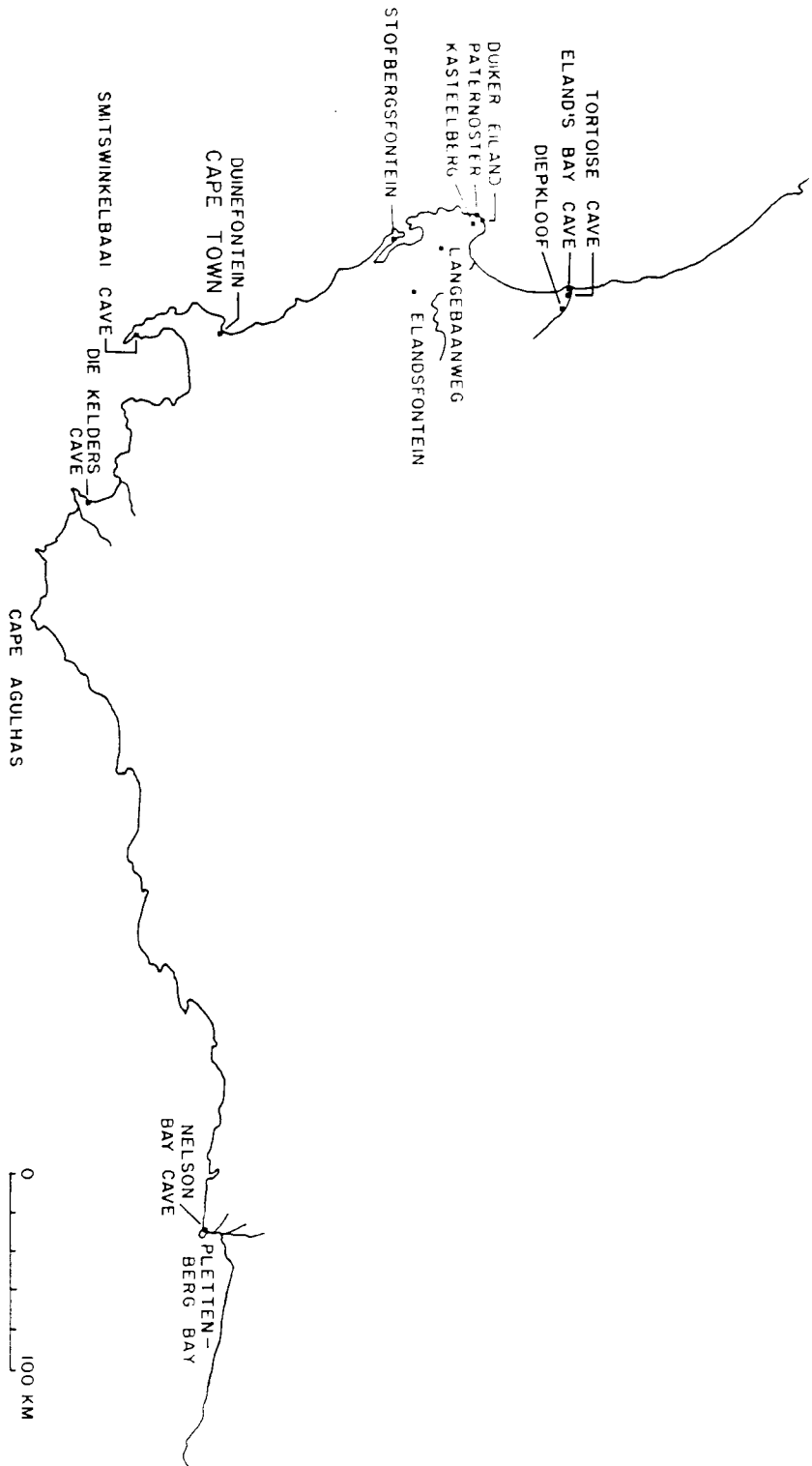


Figure 7.1. Distribution of sites mentioned in the text.

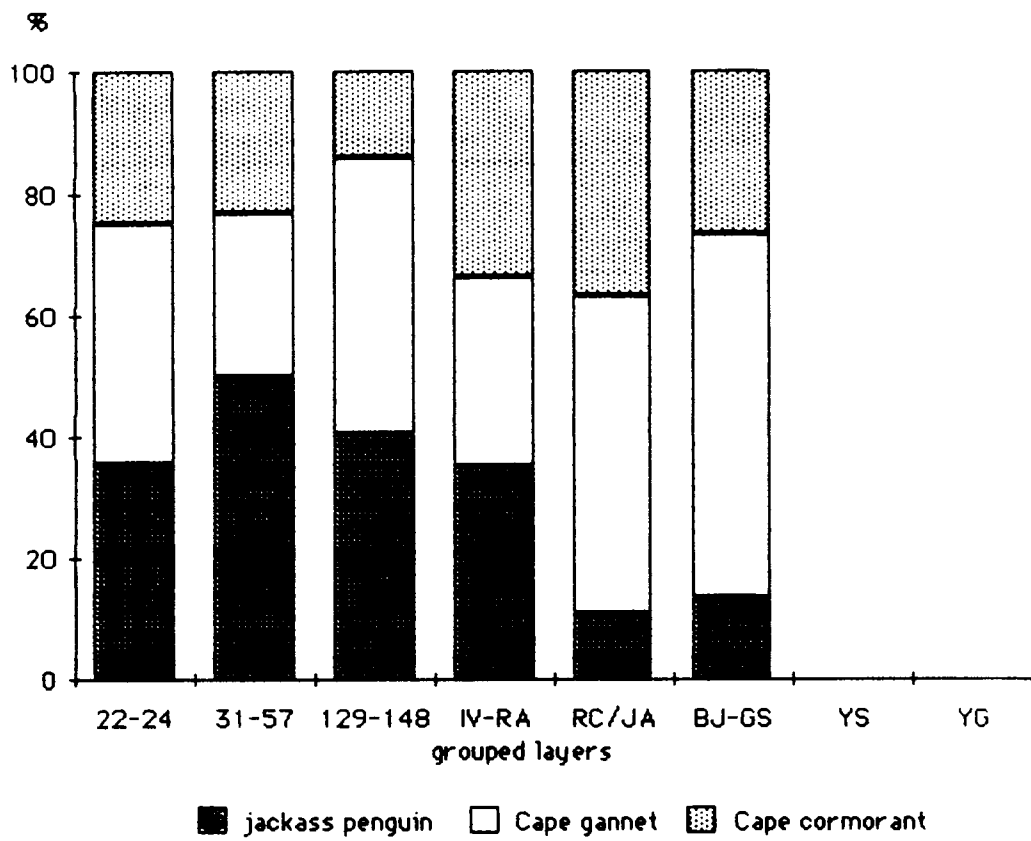


Figure 7.2. Relative proportions of jackass penguins, Cape gannets and Cape cormorants in chronologically grouped layers.

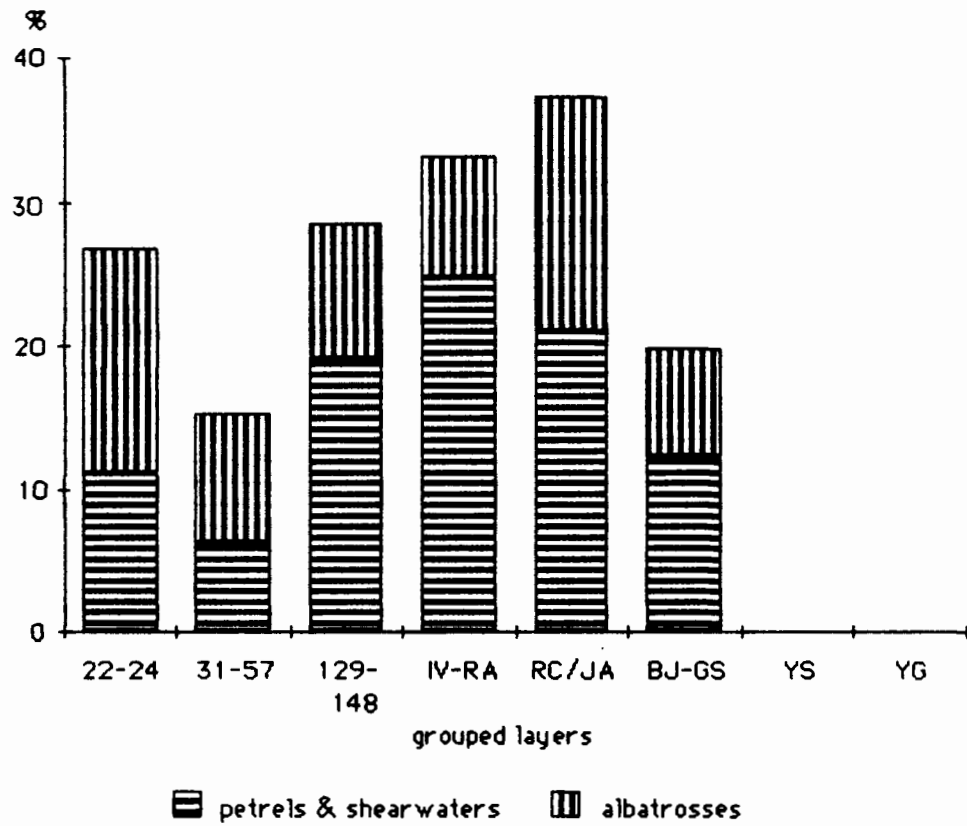


Figure 7.3. Relative proportions of petrels/shearwaters and albatrosses in chronologically grouped layers.

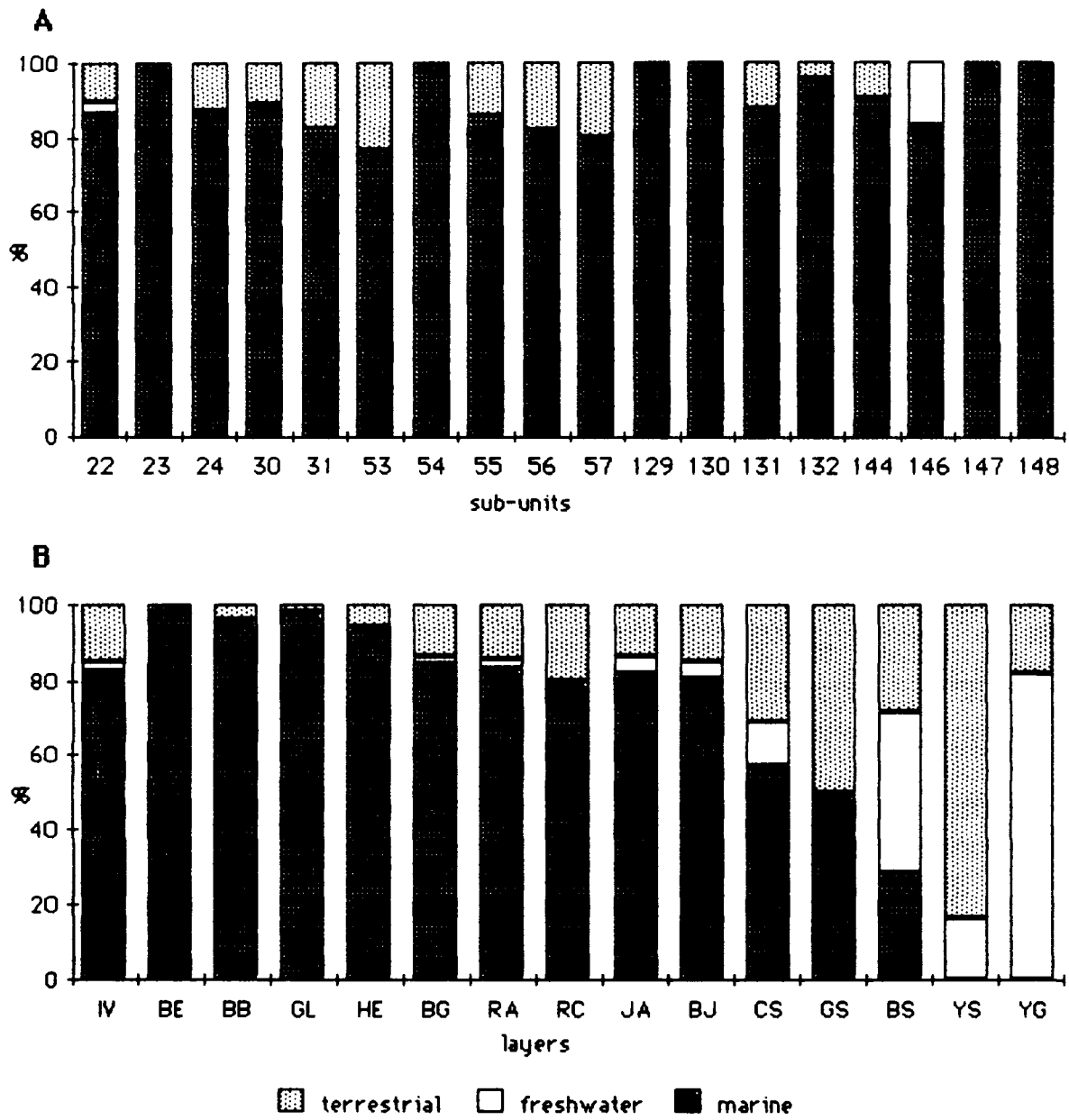


Figure 7.4. Relative proportions of marine, freshwater and terrestrial species occurring within R.R. Inskeep sub-units (A) and R.G. Klein layers (B).

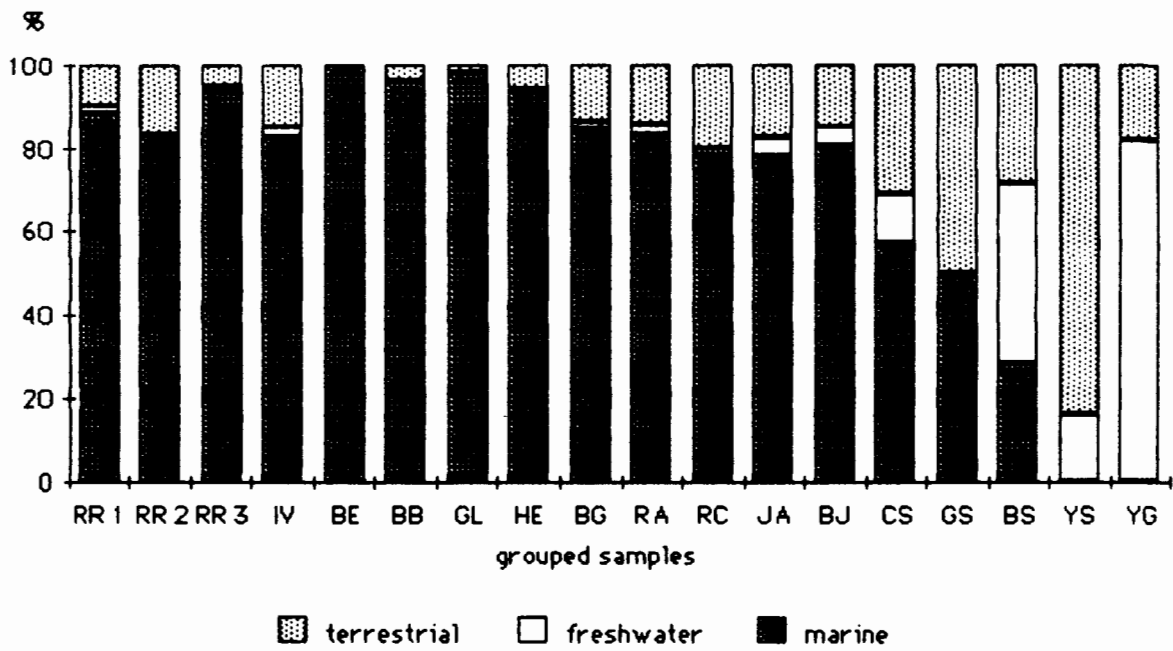


Figure 7.5. Relative proportions of marine, freshwater and terrestrial species occurring within each group of samples at Nelson Bay Cave. RR 1-3 are chronological groups of sub-units 22-148 excavated by R.R. Inskeep.

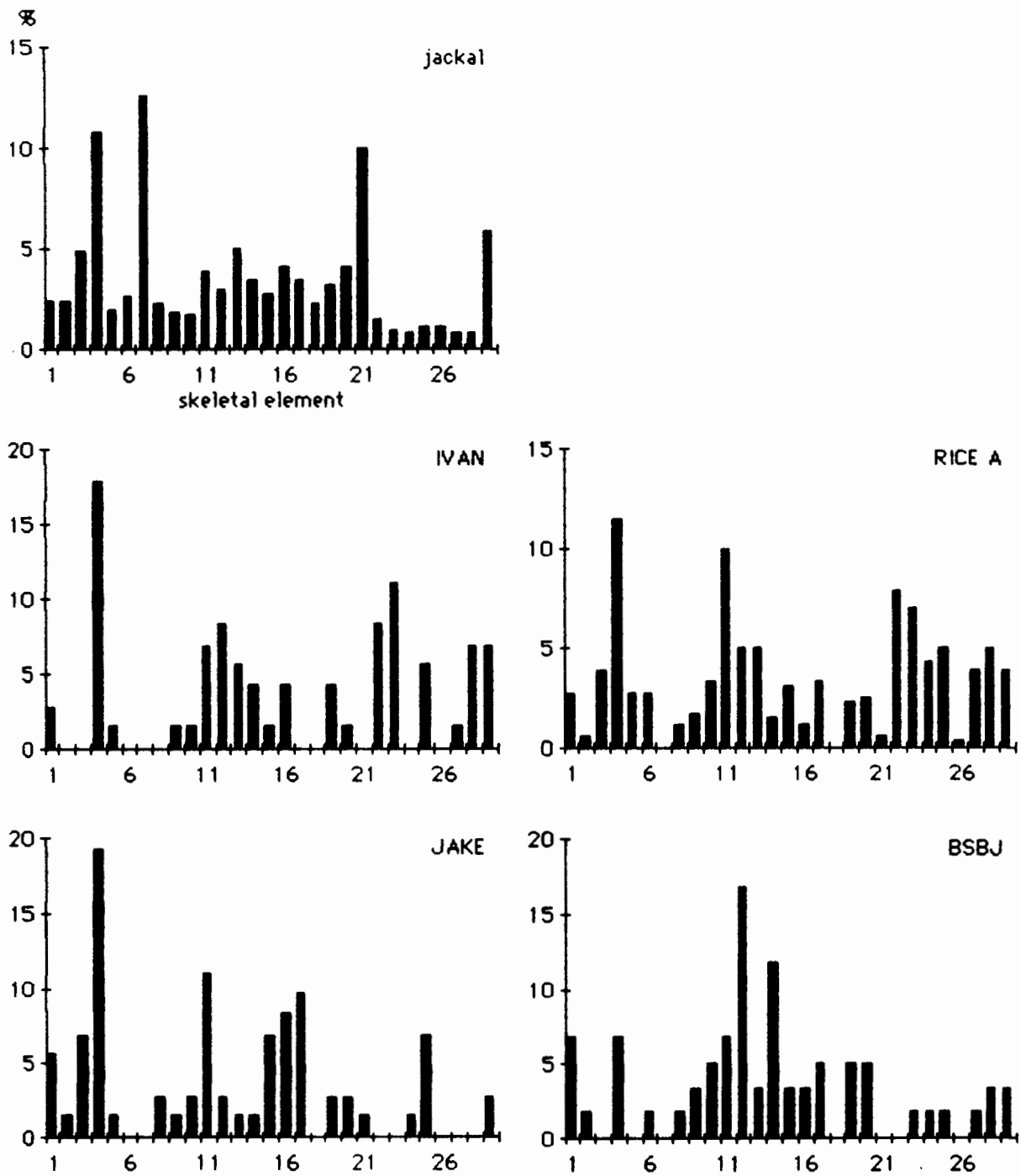


Figure 7.6. Comparison of the relative proportions of Cape cormorant skeletal elements in modern jackal accumulations with those from selected layers. Elements represented by numerical codes are listed in Table 4.2.

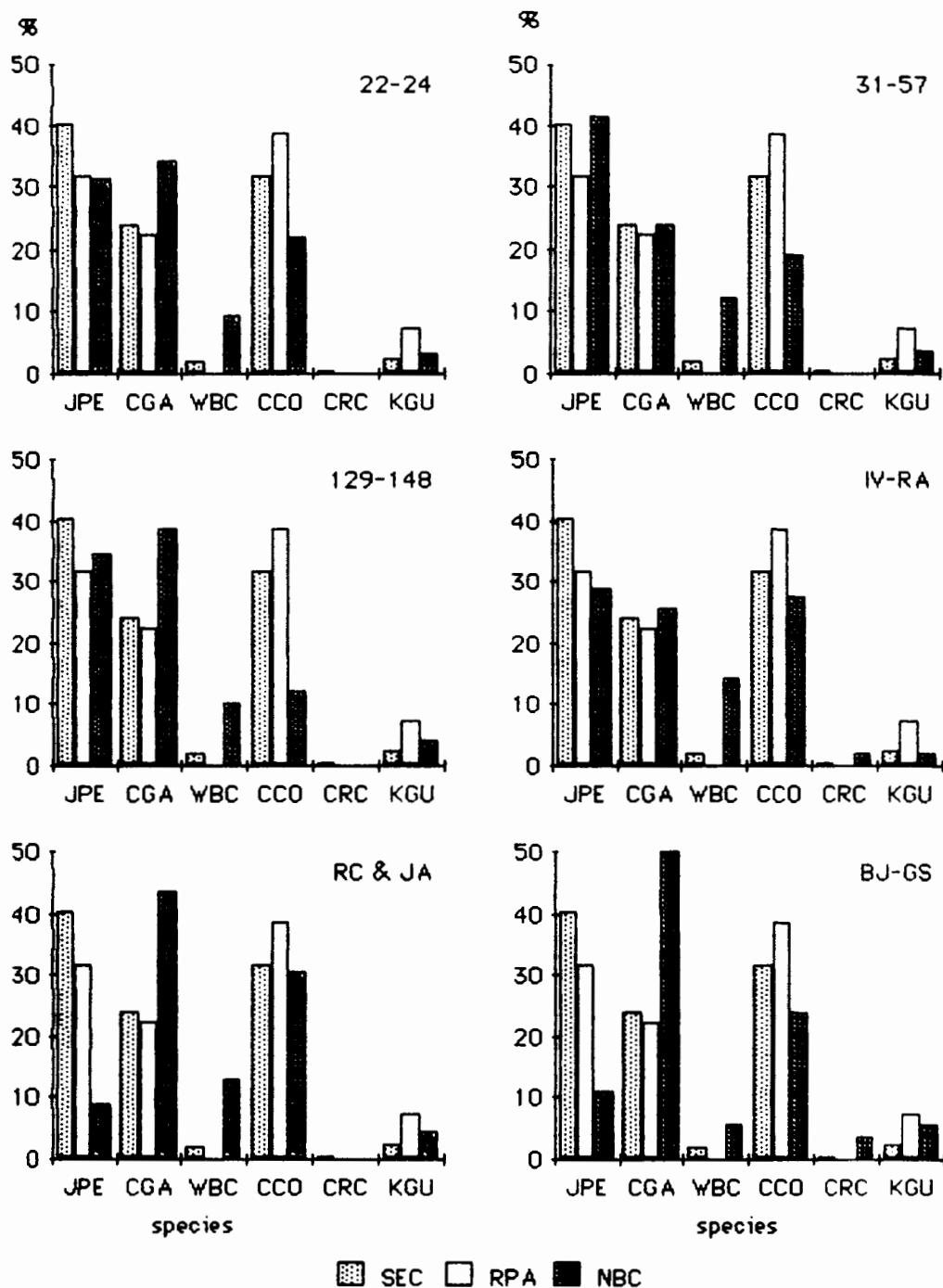


Figure 7.7. Comparison of the relative proportions of common seabirds recovered from southeast Cape beach surveys (SEC) and combined results from Rockcliffe and Port Alfred (RPA) with results from grouped layers (NBC). JPE = jackass penguin, CGA = Cape gannet, WBC = white-breasted cormorant, CCO = Cape cormorant, CRC = crowned cormorant, KGU = kelp gull.



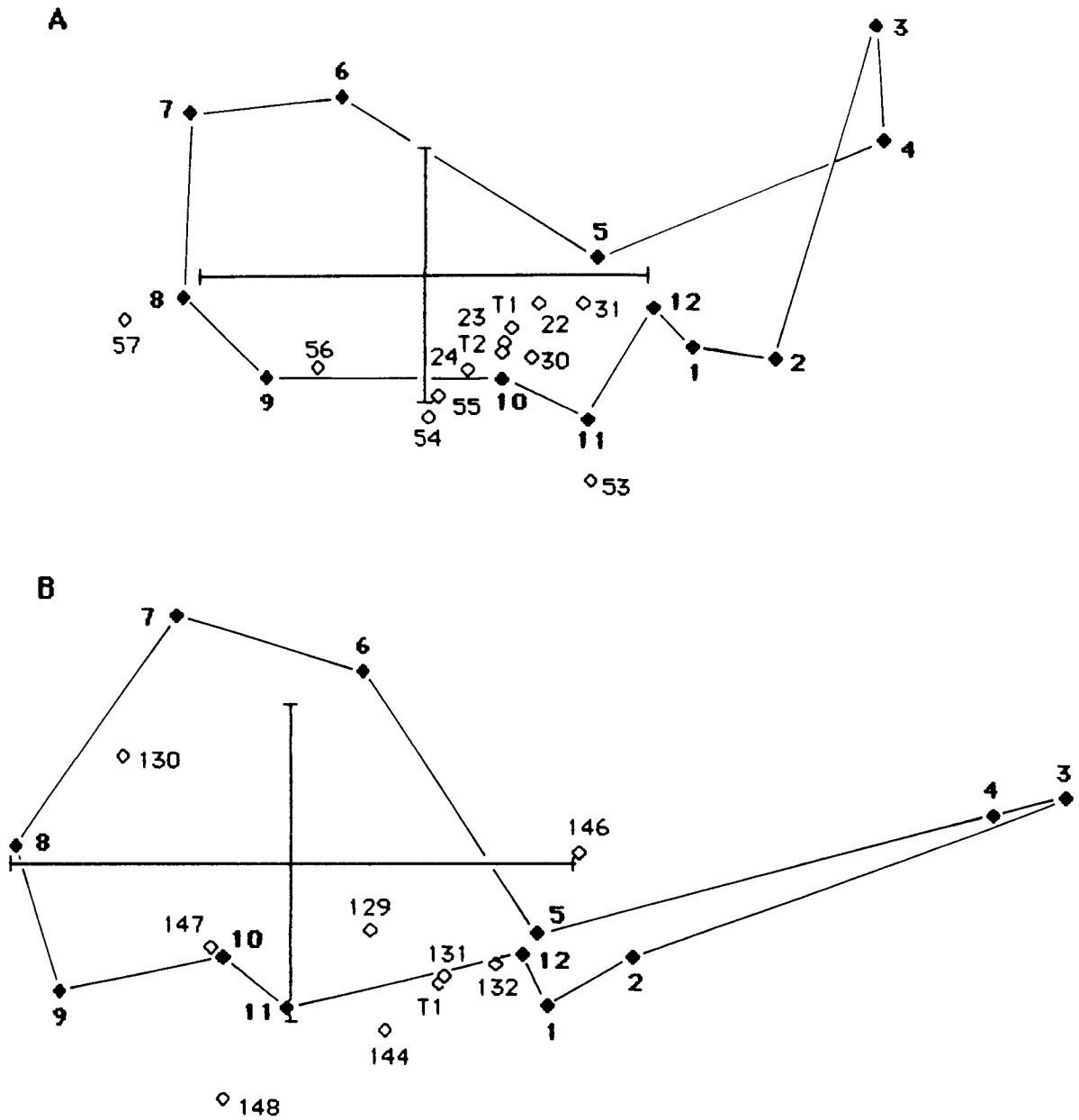


Figure 7.9. Result of correspondence analysis plot based on southeast Cape beach surveys and units 22-57 (A) and 129-148 (B). Months are numbered consecutively from January to December. T = combined layers.

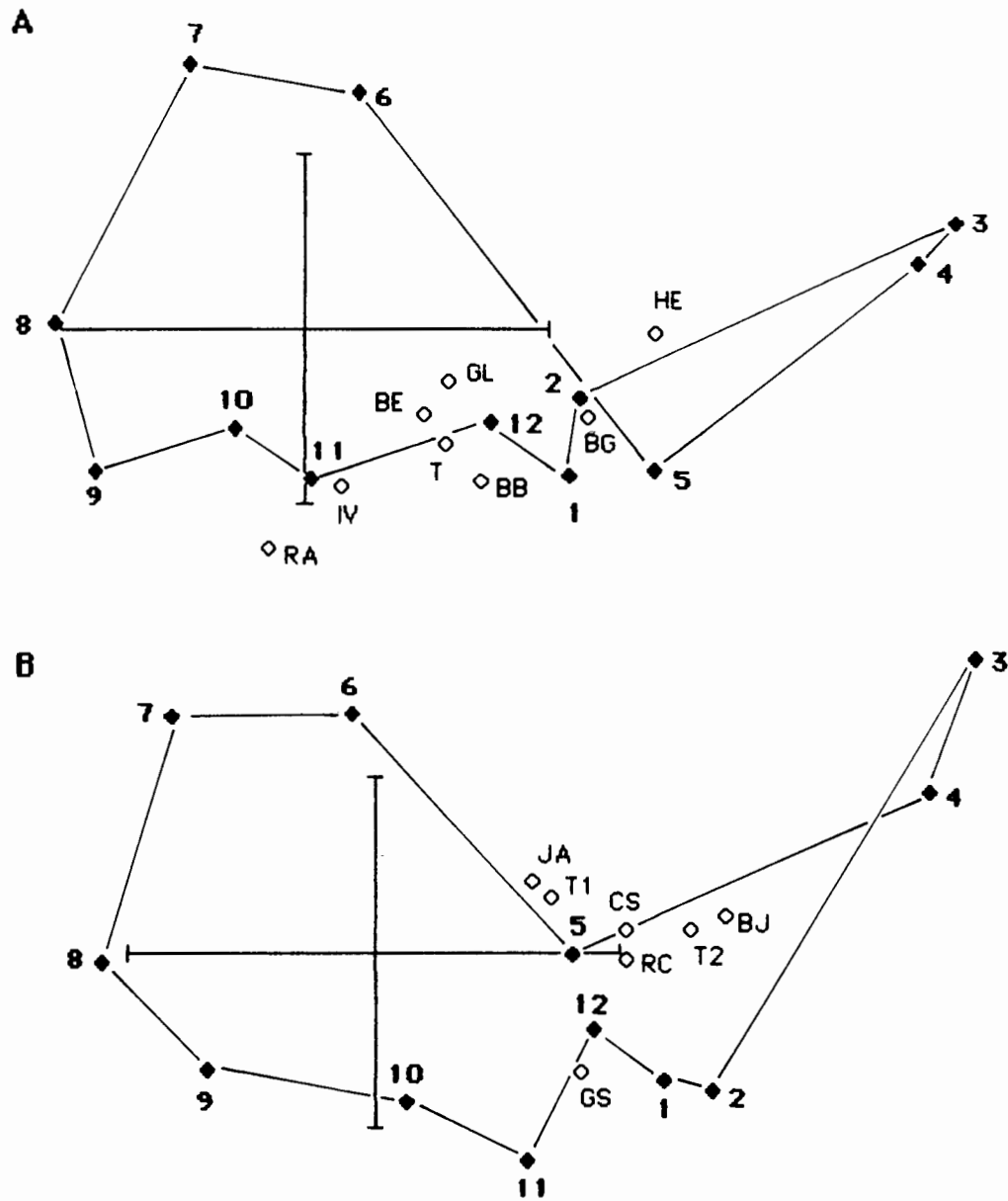


Figure 7.10. Result of correspondence analysis plot based on southeast Cape beach surveys and layers IV-RA (A) and RC-GS (B). Months are numbered consecutively from January to December. T = combined layers.

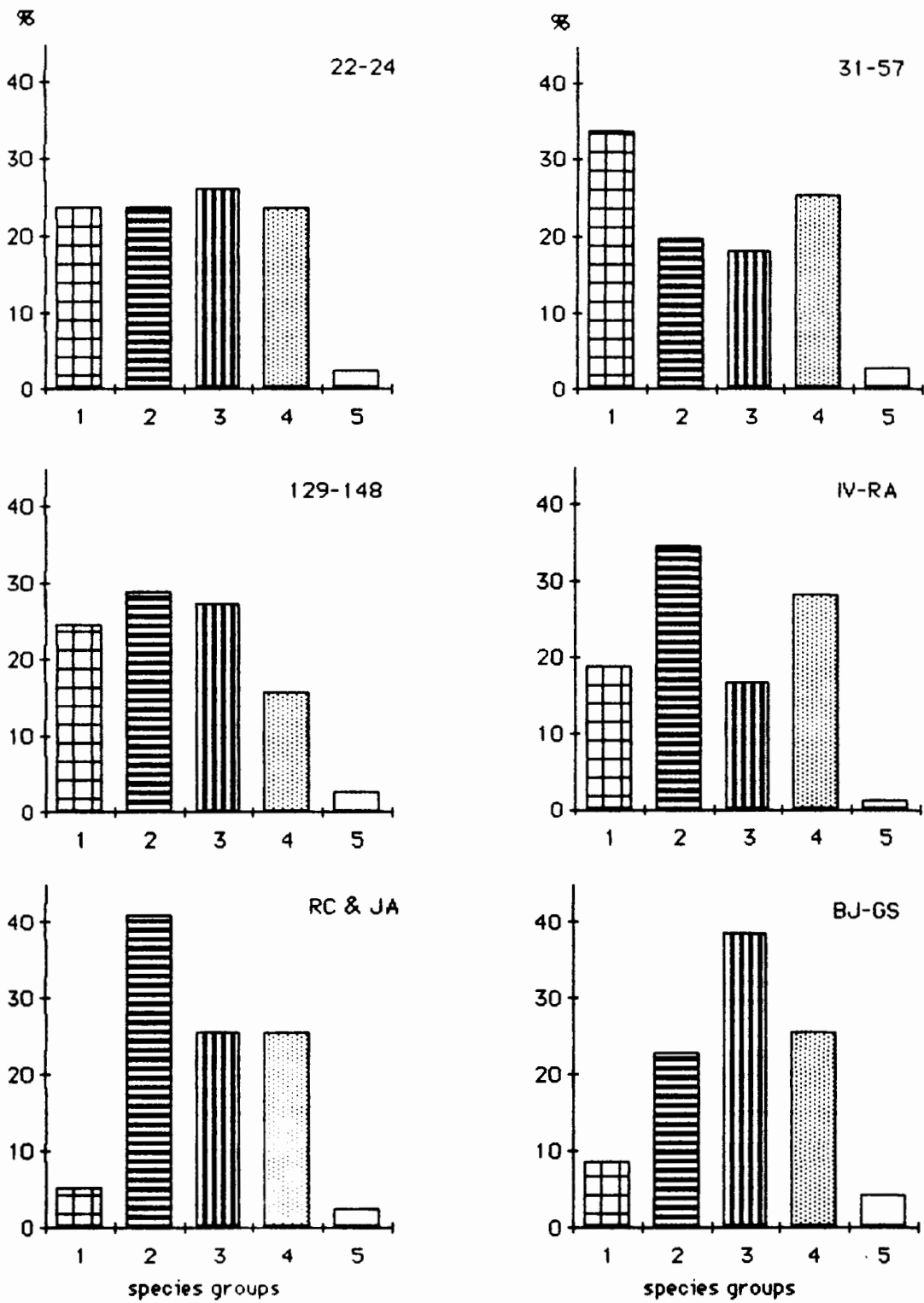


Figure 7.11. Profiles of main species or groups of species occurring in grouped units and layers 1 = jackass penguin, 2 = albatrosses, petrels, shearwaters, prions, 3 = Cape gannet, 4 = cormorants, 5 = kelp gull.

**Table 7.1.** Summary of stratigraphic, chronological, cultural and environmental information available for Nelson Bay Cave (sources given in text).

LAYER	DATE	DEPOSITS	CULTURAL	TERRESTRIAL	MARINE
22 to 24	455±30 650±50				sea level at present
30 to 31	2085±35 2950±80		pottery	slightly cooler than previously	sea level higher than present
53 to 57	±3000			wetter than present	
129 to 148	5860±70 5890±70			present faunal finally dominant	sea level + 1.5 m
Ivan (IV)					
Betsy (BE)		dense shell middens			
BSB Betsy (BB)	6050±80	brown soil	Wilton	strong input of aeolian sands	
Glen (GL)		dense shell middens		warmer than present	
Helgren (HE)		dense shell middens			
BSB G/H (BG)	5825±150 6020±160	brown soil			sea level at + 2-3 m
Rice A (RA)	6070±125	dense shell middens		wetter than present	
Rice C+D (RC)	8070±240	dense shell middens		?slightly warmer than present	
Jake (JA)	8990±80	shell middens		drier	
BSB J (BJ)	10256±210	brown soil	Albany	damp	modern shellfish composition, present coastline
Crushed shell (CS)	10150±90 11505±110	dense shell middens		Slow replacement of grazers by non-gregarious browsers	cool sea, cold-water shellfish
GSL (GS)	11950±150 11080±260	sparse shell and loam		cooler than present	coastline reaching present position

(cont.)

Table 7.1  
(cont.)

LAYER	DATE	DEPOSITS	CULTURAL	TERRESTRIAL	MARINE
BSL	10600±150 ?	loams; trace of shell		less moist in cave	cool sea
YSL	16700±240	loams	Robberg	grazers/grassland; perennially moist in cave	
YGL	18100±550	loams		cold, drier	sea level -120 m; sea temp. -5° C
HIATUS					
±65000 Middle Stone Age					

**Table 7.2a.** Layers 22 to 57. Number of Identified Specimens / Minimum Numbers of Individuals recovered from selected excavated Later Stone Age units at Nelson Bay Cave. Species are listed according to gross habitat association. ( ) = number of juveniles in total; n = nestling(s) among juveniles; x = specimen(s) with medullary bone; \* = cut or worked.

SPECIES	UNITS										
	22	23	24	30	31	53	54	55	56	57	
Jackass penguin	61/5(2)	9/2(1)	*7/3(2)	2/1	n91/6(3)	28/6(5)	n20/4(3)	20/(2)	20/4(3)	10/(1)	
Blackbrowed albatross	-	-	-	-	-	-	-	-	-	-	
Albatross sp.	41/3	2/1	3/1	4/1	43/3	-	1/1	-	*1/1	2/1	
Priou sp.	1/1	-	*2/1	-	17/2	-	-	2/1	1/1	2/1	
Whitechinned petrel	6/1	-	3/1	1/1	5/1	-	-	-	-	-	
Great shearwater	-	-	-	-	1/1	-	-	-	-	-	
Sooty shearwater	-	-	1/1	-	2/1	-	-	-	-	-	
Manx shearwater	2/1	-	-	1/1	4/1	-	-	-	-	-	
Little shearwater	-	-	-	-	-	-	-	-	-	-	
Petrel sp.	-	1/1	-	-	1/1	-	-	-	-	-	
Cape gannet	x140/7(1)	x21/2	*35/2	18/2	125/6(1)	10/2	2/1	6/1	12/1	-	
Whitebreasted cormorant	n8/2(1)	-	n2/(1)	n1/(1)	43/3(2)n	n2/2(1)	-	1/1	-	-	
Cape cormorant	n32/4(1)	1/1	n*8/2(1)	1/1	52/3(2)	6/2	6/1	7/1	2/2	2/1	
Subantarctic skua	-	-	-	-	1/1	-	-	-	-	-	
Kelp gull	4/1	-	-	-	5/2(1)	-	-	-	-	-	
Swift tern	-	-	-	-	-	-	-	-	-	-	
Common tern	-	-	-	-	-	1/1	-	-	-	-	
Arctic tern	-	-	1/1	-	-	-	-	-	-	-	
Tern sp.	-	-	-	-	2/1	-	-	-	-	-	
<b>TOTAL MARINE</b>	<b>25</b>	<b>7</b>	<b>13</b>	<b>8</b>	<b>32</b>	<b>13</b>	<b>7</b>	<b>6</b>	<b>9</b>	<b>4</b>	

(cont.)

Table 7.2 (cont.)

SPECIES	UNITS												
	22	23	24	30	31	53	54	55	56	57			
Yellowbilled duck	-	-	-	-	-	-	-	-	-	-	-	-	
Duck sp.	1/1	-	-	-	-	-	-	-	-	-	-	-	
TOTAL FRESHWATER	1	-	-	-	-	-	-	-	-	-	-	-	
Crowned eagle	1/1	-	-	-	-	-	-	-	-	-	-	-	
Jackal buzzard	-	-	1/1	-	2/1	-	-	-	-	-	-	-	
HARRIER sp.	-	-	-	-	-	-	-	-	-	-	-	-	
Greywing francolin	-	-	-	-	3/1	-	-	-	-	-	-	-	
Rednecked francolin	1/1	-	1/1	-	-	-	-	-	-	-	-	-	
Stanley's bustard	-	-	-	-	2/1	1/1	-	1/1	1/1	2/1	-	-	
Speckled rock pigeon	-	-	-	-	1/1	-	-	-	-	-	-	-	
Spotted eagle owl	-	-	-	-	1/1	1/1	-	-	1/1	1/1	-	-	
Whitenecked raven	2/1	-	-	5/1	n3/2(1)	2/2	-	-	-	-	-	-	
TOTAL TERRESTRIAL	3	-	2	1	7	4	-	1	2	1	-	-	
TOTAL	29	7	15	9	39	17	7	7	11	5	-	-	

**Table 7.2a.** Layers 129 to 148 and total. Number of Identified Specimens/Minimum Numbers of Individuals recovered from selected excavated Later Stone Age units at Nelson Bay Cave. Species are listed according to gross habitat association. ( ) = number of juveniles in total; n = nestling(s) among juveniles; \* = cut or worked.

SPECIES	UNITS										TOTAL
	129	130	131	132	144	146	147	148			
Jackass penguin	9/2(1)	-	15/4(2)	10/4(1)	23/2(1)	5/1	5/3(1)	1/(1)	51(29)		
Blackbrowed albatross	-	-	-	2/1	-	-	-	-	1		
Albatross sp.	7/1	-	10/1	-	5/1	3/1	7/1	1/1	18		
Ptarmigan sp.	1/1	*1/1	1/1	-	-	-	-	-	10		
Whitechinned petrel	-	1/1	-	-	2/1	-	4/1	*2/1	8		
Great shearwater	*1/1?	-	-	-	-	-	-	-	2		
Sooty shearwater	-	-	6/1	3/2	4/1	3/2	-	-	8		
Manx shearwater	1/1	-	-	-	-	-	-	-	4		
Little shearwater	3/1	-	-	-	-	-	-	-	4		
Petrel sp.	2/1	-	-	-	-	-	-	-	3		
Cape gannet	6/1	2/1	40/3	30/10	7/2	1/1	-	5/1	43(2)		
Whitebreasted cormorant	1/1	-	1/1	n1/(1)	1/(1)	-	-	1/(1)	15(9)		
Cape cormorant	1/1	-	2/(1)	2/2	5/1	-	-	1/1	24(5)		
Subantarctic skua	-	-	-	-	-	-	-	-	1		
Kelp gull	*1/1	-	1/1	-	-	-	-	-	5		
Swift tern	-	-	1/1	-	-	-	-	-	1		
Common tern	-	-	-	-	-	-	-	-	1		
Arctic tern	-	-	-	-	-	-	-	-	1		
Tern sp.	-	-	-	-	-	-	-	-	1		
<b>TOTAL MARINE</b>	<b>12</b>	<b>3</b>	<b>14</b>	<b>20</b>	<b>9</b>	<b>5</b>	<b>5</b>	<b>6</b>	<b>198</b>		

(cont.)

Table 7.2 (cont.)

SPECIES	UNITS										TOTAL
	129	130	131	132	144	146	147	148			
Yellowbilled duck	-	-	-	-	-	2/1	-	-	-	-	1
Duck sp.	-	-	-	-	-	-	-	-	-	-	1
TOTAL FRESHWATER	-	-	-	-	-	1	-	-	-	-	2
	(cont.)										
Crowned eagle	-	-	-	-	-	-	-	-	-	-	1
Jackal buzzard	-	-	-	1/1	-	-	-	-	-	-	3
Harrier sp.	-	-	*1/1	-	-	-	-	-	-	-	1
Greywing francolin	-	-	-	-	-	-	-	-	-	-	1
Rednecked francolin	-	-	-	-	-	-	-	-	-	-	2
Stanley's bustard	-	-	-	-	1/1	-	-	-	-	-	6
Speckled rock pigeon	-	-	-	-	-	-	-	-	-	-	1
Spotted eagle owl	-	-	-	-	-	-	-	-	-	-	3
Whitenecked raven	-	-	1/1	-	-	-	-	-	-	-	7
TOTAL TERRESTRIAL	-	-	2	1	1	-	-	-	-	-	25
TOTAL	12	3	16	21	10	6	5	6			225

**Table 7.3A.** Layers I van to Rice C/D. Number of Identified Specimens / Minimum Number of Individuals recovered from selected excavated units at Nelson Bay Cave. See Figure 7.1 for further details on the names of units. Species are listed according to gross habitat association. ( ) = number of juveniles in total; n = nestling/s among juveniles; x = specimen/s with medullary bone; \* = cut or worked.

SPECIES	UNITS									
	IV	BE	BB	GL	HE	BG	RA	RC		
Jackass penguin	n166/9(4)	27/4(1)	58/5(1)	93/7(2)	35/4(1)	*104/8(3)	*96/10(3)	1/1		
Wandering albatross	-	-	-	-	-	1/1	4/1	-		
Shy albatross	-	*11/1	7/2	-	-	-	-	-		
Blackbrowed albatross	*6/1	-	-	*47/3	*55/6(1)	*78/4(2)	*26/2	9/1		
Yellowosed albatross	-	-	*4/1	-	-	-	-	-		
Giant petrel	-	-	3/(1)	4/(1)	2/1	*5/1	3/(1)	4/1		
Antarctic fulmar	-	-	-	-	-	-	-	-		
Pintado petrel	1/1	-	-	2/2	-	-	-	-		
Softplumaged petrel	1/1	-	-	-	-	-	1/1	-		
Blue petrel	-	-	-	-	-	-	-	-		
Prion sp.	7/3	2/1	-	5/2(1)	1/1	1/1	1/1	-		
Whitechinned petrel	9/2	-	8/1	11/2	13/2	8/2	*1/1	1/1		
Great shearwater	-	-	-	-	-	-	-	-		
Sooty shearwater	17/2	22/3	*20/3	229/11(4)	151/12(4)	6/2	*35/3(1)	-		
Manx shearwater	2/1	1/1	3/1	6/1	-	2/1	-	-		
Little shearwater	-	-	-	-	-	-	-	-		
Shearwater sp.	1/1	-	-	-	4/1	1/1	-	-		
Storm petrel sp.	-	-	-	1/1	-	-	-	-		
Cape gannet	*139/5(1)	4/1/3	82/5	*164/6	*231/11(2)	x114/8(1)	*94/4(2)	*7/2(1)		
Whitebreasted cormorant	n34/4(3)	2/1	n4/3(1)	3/(1)	n6/3(2)	n8/4(2)	n54/7(4)	1/1		
Cape cormorant	n*69/8(4)	10/2(1)	1/1	54/7(2)	19/2(1)	3/1	n137/24(7)	*7/1		
Crowned cormorant	-	-	-	-	-	-	n8/3(2)	-		
Black oystercatcher	-	-	-	-	-	-	-	-		
Arctic/pomarine skua	-	-	-	-	1/1	-	-	-		
Subantarctic skua	-	-	-	-	-	-	-	-		

(cont.)

Table 7.3A (cont.)

SPECIES	UNITS									
	IV	BE	BB	GL	HE	BG	RA	RC		
South polar skua	-	-	-	3/12	-	-	-	-	-	-
Kelp gull	-	-	-	4/1	-	6/1	3/1	-	-	-
Swift tern	-	-	-	-	-	-	-	-	-	-
Common tern	-	-	-	-	-	-	-	-	-	-
Tern sp.	-	-	-	-	1/1	-	-	-	-	-
<b>TOTAL MARINE</b>	<b>38</b>	<b>16</b>	<b>23</b>	<b>46</b>	<b>45</b>	<b>37</b>	<b>58</b>	<b>8</b>		
White pelican	2/1	-	-	-	-	-	1/1	-	-	-
Whitebreasted cormorant	-	-	-	-	-	-	-	-	-	-
Grey heron	-	-	-	-	-	-	-	-	-	-
Goliath heron	-	-	-	-	-	-	6/(1)	-	-	-
Greater flamingo	-	-	-	-	-	-	-	-	-	-
Lesser flamingo	-	-	-	-	-	1/(1)	-	-	-	-
South African shelduck	-	-	-	-	-	-	-	-	-	-
Yellowbilled duck	-	-	-	-	-	-	-	-	-	-
Cape shoveler	-	-	-	-	-	-	-	-	-	-
Purple gallinule	-	-	-	-	-	-	-	-	-	-
Redknobbed coot	-	-	-	-	-	-	-	-	-	-
Curlew	-	-	-	-	-	-	-	-	-	-
<b>TOTAL FRESHWATER</b>	<b>1</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>1</b>	<b>2</b>	<b>-</b>	<b>-</b>	<b>-</b>

(cont.)

Table 7.3A (cont.)

SPECIES	UNITS									
	IV	BE	BB	GL	HE	BG	RA	RC		
Ostrich	-	-	-	-	-	-	-	-	-	-
Blackheaded heron	-	-	-	-	-	-	-	-	-	-
Egyptian goose	-	-	-	-	-	-	1/1	-	-	-
Vulture sp.	-	-	-	-	-	-	-	-	-	-
Secretary bird	-	-	-	-	-	-	-	-	-	-
Large eagle sp.	2/1	-	-	-	-	-	n1/(1)	1/1	-	-
Jackal buzzard	1/1	-	1/1	-	-	-	1/(1)	-	-	-
African goshawk	1/1	-	-	-	-	-	-	-	-	-
HARRIER cf. African marsh	-	-	-	-	-	1/1	-	-	-	-
Common kestrel	-	-	-	-	-	-	1/1	-	-	-
Large kestrel	1/1	-	-	-	-	-	-	1/1	-	-
Small/medium hawk, etc.	-	-	-	-	-	2/1	-	-	-	-
Greywing francolin	-	-	-	-	-	-	-	-	-	-
Cape francolin	-	-	-	-	-	-	-	-	-	-
Rednecked francolin	6/2	-	-	-	-	1/1	-	*1/1	-	-
Quail sp.	-	-	-	-	-	-	-	-	-	-
Crane sp.	-	-	-	-	-	-	-	-	-	-
Stanley's bustard	-	-	-	-	1/1	-	-	1/1	-	-
Speckled rock pigeon	-	-	-	-	-	-	-	2/1	-	-
Cape turtle dove	-	-	-	-	-	-	-	-	-	-
Barn owl	-	-	-	-	-	-	-	-	-	-

(cont.)

Table 7.3A (cont.)

SPECIES	UNITS									
	IV	BE	BB	GL	HE	BG	RA	RC		
Spotted eagle owl	-	-	-	4/1	1/1	-	1/1	-	1/1	-
Whitenecked raven	1/1	-	-	-	1/1	3/2(1)	1/1	1/(1)	-	-
Starling	-	-	-	-	-	-	-	-	-	-
Other small sp.	-	-	-	-	-	2/1	4/1	-	-	-
TOTAL TERRESTRIAL	7	-	1	1	3	6	10	2		
TOTAL	46	16	24	47	48	44	70	10		

**Table 7.38.** Layers Jake to YGL. Number of Identified Specimens / Minimum Number of Individuals recovered from selected excavated units at Nelson Bay Cave. See Figure 7.1 for further details on the names of units. Species are listed according to gross habitat association. ( ) = number of juveniles in total; n = nestlings among juveniles; x = specimen/s with medullary bone; \* = cut or worked. Underlined score for whitebreasted cormorant indicates this species freshwater when site inland during period of lowered sea level.

SPECIES	UNITS						
	JA	BJ	CS	GS	BS	YS	YG
Jackass penguin	6/1	16/3(2)	11/2(1)	1/1	-	-	-
Wandering albatross	-	1/1	-	-	-	-	-
Shy albatross	2/1	4/1	7/2	-	-	-	-
Blackbrowed albatross	*32/4	*2/(1)	-	-	-	-	-
Yellow nosed albatross	3/1	3/1	-	-	-	-	-
Giant petrel	5/2	3/1	-	*1/1	-	-	-
Antarctic fulmar	-	-	-	-	-	-	-
Pintado petrel	-	*1/1	-	-	-	-	-
Softplumaged petrel	-	-	-	-	-	-	-
Blue petrel	-	-	-	-	-	-	-
Prion sp.	*7/3(1)	2/1	-	-	-	-	-
Whitethinned petrel	*14/3	7/1	-	-	-	-	-
Great shearwater	-	1/1	-	-	-	-	-
Sooty shearwater	5/2	1/1	4/1	1/1	-	-	-
Manx shearwater	-	1/1	-	-	-	-	-
Little shearwater	-	1/1	-	-	-	-	-
Shearwater sp.	-	-	-	-	-	-	-
Storm petrel sp.	-	-	-	-	-	-	-
Cape gannet	*96/8(3)	*120/21(7)	*28/6(3)	-	-	-	-
Whitebreasted cormorant	7/2(1)	3/1	6/1	*1/1	-	-	-
Cape cormorant	*71/6(1)	61/6(2)	36/5(2)	3/1	2/1	-	-
Crowned cormorant	-	1/1	-	-	1/1	-	-
Black oystercatcher	2/1	-	-	-	-	-	-
Arctic/pomarine skua	-	1/1	1/1	-	-	-	-
Subantarctic skua	-	1/1	-	-	-	-	-

(cont.)

Table 7.38 (cont.)

SPECIES	UNITS							
	JA	BJ	CS	GS	BS	YS	YG	
South polar skua	-	-	-	-	-	-	-	-
Kelp gull	5/1	*6/2	1/1	-	-	-	-	-
Swift tern	-	2/1	2/1	-	-	-	-	-
Common tern	-	7/3	-	-	-	-	-	-
Tern sp.	-	-	-	-	-	-	-	-
<b>TOTAL MARINE</b>	<b>35</b>	<b>54</b>	<b>20</b>	<b>5</b>	<b>2</b>	<b>-</b>	<b>-</b>	<b>-</b>
White pelican	-	-	-	-	-	-	-	-
Whitebreasted cormorant	-	-	-	-	-	-	2/1	-
Grey heron	-	2/1	-	-	-	-	-	-
Goliath heron	-	-	1/(1)	-	-	-	-	-
Greater flamingo	2/(1)	1/1	2/2	-	-	-	-	-
Lesser flamingo	-	-	-	-	-	-	-	-
South African shelduck	-	1/(1)	-	-	-	-	-	n7/2(1)
Yellowbilled duck	*3/1	-	-	-	4/2	-	-	22/4
Cape shoveler	-	-	-	-	-	2/1	-	-
Purple gallinule	-	-	1/1	-	-	-	-	-
Redknobbed coot	-	-	-	-	4/1	3/1	25/2	-
Curlew	-	-	-	-	-	-	*1/1	-
<b>TOTAL FRESHWATER</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>-</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>9</b>

(cont.)

Table 7.38 (cont.)

SPECIES	UNITS							
	JA	BJ	CS	GS	BS	YS	YG	
Ostrich	-	-	-	-	-	10/2(1)	3/1	
Blackheaded heron	-	-	2/1	-	-	9/(2)	-	
Egyptian goose	-	-	-	-	-	-	-	
Vulture sp.	-	1/1	-	-	-	-	-	
Secretary bird	2/1	-	2/1	-	1/1	-	-	
Large eagle sp.	n*1/(1)	1/1	3/(1)	*1/1	1/1	-	-	
Jackal buzzard	-	7/1	1/1	1/1	-	1/1	-	
African goshawk	-	-	-	-	-	-	-	
HARRIER cf. African marsh	-	-	-	-	-	-	-	
Common kestrel	-	-	-	-	1/1	8/1	-	
Large kestrel	-	-	-	-	-	-	-	
Small/medium hawk, etc.	-	-	2/2	-	-	3/2(1)	-	
Greywing francolin	-	1/1	-	1/1	2/1	*8/1	-	
Cape francolin	-	1/1	-	-	1/1	1/1	-	
Rednecked francolin	*3/1	-	4/1	-	-	-	-	
Quail sp.	-	-	-	-	-	8/2	-	
Crane sp.	-	1/1	2/1	-	1/1	3/1	-	
Stanley's bustard	*3/2	-	-	1/1	-	-	-	
Speckled rock pigeon	-	1/1	-	-	-	n6/2(1)	-	
Cape turtle dove	-	-	1/1	-	-	-	-	
Dove sp.	-	-	-	-	-	3/1	-	
Barn owl	-	-	-	-	2/(1)	12/2(1)	-	

(cont.)

Table 7.3B (cont.)

SPECIES	UNITS							
	JA	BJ	CS	GS	BS	YS	YG	
Spotted eagle owl	3/1	1/1	2/1	-	-	-	-	
Whitenecked raven	1/1	-	-	-	3/1	n3/2(1)	-	
Starling	-	-	-	1/1	1/1	-	-	
Other small sp.	2/1	3/2	2/1	-	1/1	-	-	
<b>TOTAL TERRESTRIAL</b>	<b>8</b>	<b>10</b>	<b>11</b>	<b>5</b>	<b>2</b>	<b>16</b>	<b>2</b>	
<b>TOTAL</b>	<b>45</b>	<b>67</b>	<b>35</b>	<b>10</b>	<b>7</b>	<b>19</b>	<b>11</b>	

## 8. SUMMARY OF ISSUES AND RESULTS

Avian remains in faunal samples from Eland's Bay Cave, Die Kelders Cave 1 and Nelson Bay Cave have been identified and studied. The age of the samples from each site varies, but observations have been made on Upper Pleistocene occurrences between 80 000 and 40 000 B.P., on terminal Pleistocene samples between 18 000 and 10 000 B.P. and on Holocene samples between 10 000 and about 300 B.P.

An important goal of this study has been to identify the source of seabirds in the samples and to examine the possibility that agents other than people contributed to the archaeological samples. The composition of the avian samples has been examined in order to establish whether seabirds were exploited seasonally and, if so, to what extent this and other seasonal evidence might support Parkington's (1972, 1976) hypothesis of seasonal exploitation of marine resources. The nature of palaeoenvironmental evidence that could be deduced from avian remains in archaeological samples was also investigated. Finally, information contributed by this study to knowledge of avian species and populations in the past will be summarized.

To provide appropriate background information with which to compare the archaeological samples, surveys of beached seabirds were conducted over 12 years and results have been used as the basis for interpreting the archaeological samples. For the same reason samples of prey remains of coastal brown hyaenas and black-backed jackals and of Cape and giant eagle owls and black and martial eagles were assembled. The main characteristics of accumulations made by the above predators have been tabulated and compared.

Evidence from the modern beach surveys has made it possible to establish that beached seabirds would provide a predictable resource throughout the year in spite of the fact that density (no. of birds/km) varied seasonally and regionally. Assemblages drawn from beached seabirds closely resemble natural populations of resident breeding species and much of the regional variation can be explained in these terms. It has also been possible to show that the number and relative proportions of beached seabird species varies in response to physical and biological factors which are the result of short- and long-term fluctuations in oceanic and atmospheric circulation. All of the seabird species occurring in the archaeological samples could have been acquired by collecting beached birds and this would also account for the relative proportions in which they occur in the samples. Confirmation has been provided for earlier assumptions (Avery 1977; Avery & Underhill 1986) that the regular inclusion of Southern Ocean species and those resident on offshore islands in archaeological samples could not otherwise have been achieved. The composition of the Die Kelders Cave 1 Middle Stone Age samples indicates that the simple but effective practice of collecting beached seabirds has an extensive time depth, well beyond the Later Stone Age. In view of this, inferences that Middle Stone Age people were technologically ill-equipped to hunt flying birds (Klein 1975, 1989) will have to be reviewed. The occurrence of lower frequencies of Cape cormorants in Middle Stone Age samples was the primary basis for distinguishing them from those of the Later Stone Age. In the light of this study, however, the occurrence of Cape cormorants and jackass penguins at Die Kelders Cave 1 and Klasies River main site can be accounted for by seasonal and regional variation in the relative proportions in which these species are beached.

The next problem was to resolve the possibility that an agency other than people had contributed bones to the samples. Black-backed jackals take beached

seabirds (Avery *et al.* 1987) and observations on modern jackal accumulations of the remains of beached birds were compared with the archaeological samples. The incidence of damage on bones of Cape cormorants in the modern jackal samples and archaeological samples from Eland's Bay Cave was recorded. No correlation was, however, found between the numbers of jackals in the archaeological samples, the incidence of damage on bones or the relative proportions of skeletal elements in modern jackal samples. It has been suggested that the incidence of damage on the bones represents increasing secondary scavenging associated with intensification of human occupation.

Tests for differences between the relative proportions of skeletal elements of Cape cormorants preserved in archaeological and modern jackal accumulations, on the other hand, did provide a useful means of comparing the known effects of jackals on bones with samples from Eland's Bay Cave. In spite of some damage on bones, it was concluded that this was secondary and that people were the major collectors of seabirds at Eland's Bay Cave. When the same comparison was made with material from Die Kelders Cave 1 Later Stone Age shell middens, the analysis indicated that the composition of skeletal elements in the preserved samples was similar to those that had been accumulated by jackals. Further investigation highlighted the need to consider the effect that secondary scavenging by domestic dogs might have had on samples. It was concluded that jackals and similar-sized domestic dogs would produce essentially the same type of damage and that the similarity of the Die Kelders Cave 1 Later Stone Age samples to the jackal sample was the result of scavenging by dogs, bones of which are also thought to be present. In the light of this, and bearing in mind that jackals could have scavenged from middens, it is not yet known whether it will prove possible to distinguish activities of the two species since the introduction of domestic dogs at about 2000 B.P. For this

period, the preservation of skeletal parts provides an index that can only draw attention to possible activity of similar-sized canids.

It was not possible to apply this comparison with confidence to skeletal parts preserved in the Die Kelders Cave 1 Middle Stone Age samples, however, as evidence suggested that chemical and mechanical diagenesis, resulting from ground water and compaction, may have selectively removed some of the more fragile elements. The problem of diagenesis in older samples, particularly where waterlogged conditions had existed at some time, was also evident in the Nelson Bay Cave samples dated to between 9000 and 10 000 B.P. The apparent similarities between the jackal sample and samples JA and BJ could reflect either secondary jackal activity or the effects of ground water and compaction. In order to resolve such problems, experimental studies should be initiated to establish the relative durability of various avian skeletal elements. In addition, the osteological comparisons should be extended to avian species other than Cape cormorants, as well as to the mammalian components of shell midden samples.

Comparison of the proportions of mammalian and avian prey species and size (mass) categories provided no indication that black or martial eagles might have contributed to the samples as suggested by Avery (1987). The possibility that Cape eagle owls had contributed to some archaeological samples (Klein 1981; Avery 1987; Klein & Cruz-Urbe 1987) was investigated. Comparison of the Eland's Bay Cave and Die Kelders Cave 1 Middle Stone Age samples with samples of modern Cape eagle owl prey remains did not reveal any direct similarities. This may have been due to the fact that the presence of large numbers of Cape dune molerats in the archaeological samples was the main argument in favour of Cape eagle owls being contributors, whereas the absence of this species from the comparative samples made comparison difficult. Moreover, published information on skeletal part representation and damage to Cape dune molerat and steenbok/grysbok bones

is as yet insufficient to enable assessment of the possibility that an avian predator was responsible for their accumulation. On present knowledge, however, the habits of Cape eagle owls, which inhabit small caves in steep mountainous areas, argue against their being likely inhabitants of caves suitable for occupation by people. Furthermore, seasonal evidence from bird and seal remains acknowledged to have been brought to the caves by people, has indicated that people occupied Eland's Bay and Die Kelders Caves at times when Cape dune molerats and very young steenbok/grysbok were available. No question had previously been raised against the possibility that people had caught and eaten Cape dune molerats and juvenile steenbok/grysbok during more recent Later Stone Age times and, although some aspects of the Cape eagle owl argument remain equivocal, it seems on balance that there is a sound argument in favour of earlier Later Stone Age visitors to Eland's Bay Cave and Middle Stone Age people at Die Kelders Cave 1 taking these small mammals as well. Future analysis of skeletal element representation and Scanning Electron Microscope examination of Cape dune molerat and other bones for damage caused by digestive juices, may further elucidate this problem and reduce the problem of overlap in species taken by human and other predators.

The approach adopted in this study has provided new comparative observations which can be used to examine the nature of contributions that agencies other than people might have made to archaeological samples. This study also provides a clear indication that to successfully unravel the complexities of multiple agencies, comparison of as many components of a faunal assemblage as possible is essential. As others have found, attempts to elucidate one problem invariably reveal underlying complexities. The current investigation is no exception, and the need to extend the analyses to other species and to undertake experimental studies on body-part representation and on the structural properties that determine the

durability of different skeletal elements of birds and small mammals are developments that will be addressed in the future.

With possible minor exceptions, it has been found that people were the primary accumulators of the assemblages of bones in the samples, although some secondary modification by carnivores such as watermongooses or Cape foxes and jackals or dogs has been noted. The fact that it has been possible to discount the possibility that jackals and, to a large extent, Cape eagle owls contributed to the samples studied means that the role of small food items in prehistoric subsistence strategies can be addressed with greater confidence. Studies of modern San (Bushman) hunter-gatherers (Tanaka 1976; Yellen & Lee 1976) have established that small food items, which are usually more abundant and easier to acquire, form the basis of dietary strategies. This is particularly relevant to the role in coastal subsistence of birds, small mammals such as Cape dune molerats, hyraxes and steenbok/grysbok (and reptiles such as snakes and tortoises) and of larger mammals and marine resources such as shellfish.

The results of the seasonal analysis are in close support of Parkington's (1972, 1976, 1981) seasonal hypothesis for the west coast. Parkington's evidence was based on direct observations from a limited number of dietary components only, however, and much of the argument against summer occupation of the coast rested on assumed limiting factors, such as the seasonal occurrence of toxic red tides. In addition, rather than combine results of seasonal evidence derived from age classes of seals and hyraxes in small excavated units, his determinations were based on results from combined assemblages from pre- and post-hiatus samples. Although informative at this level, and supported by the avian evidence, such an approach (also adopted in Klein & Cruz-Urbe 1989) has to sacrifice resolution for large sample size. This has masked shorter-term variability that has been determined

from the avian remains. Future study of the seals in smaller units should make comparisons with the avian remains more compatible at the short-term level.

This study has provided a method for establishing how and at what time of the year seabirds with wide oceanic distributions or those that breed over protracted periods were acquired by people. Correspondence analysis of results of beach surveys has been used to determine the most likely time that seabirds will be beached in different coastal regions. Without affecting the results from the analysis of beach surveys, the profile (relative frequencies of species) of each archaeological sample determines its best position in the display derived from the profiles of beached species and the months in which they are most likely to be found. Seasonal evidence from marine, freshwater and terrestrial avian species not subjected to the correspondence analysis, and the few examples of medullary bone, did not contradict the results obtained in the correspondence analysis.

Correspondence analysis is robust and can be applied to relatively small samples. It must, however, be emphasised that a degree of reliability is lost as samples become very small. Examination of such samples in the context of results from larger sub-units associated with them, will help to reduce this problem. The study of smaller units and sub-units yielded MNIs very similar to those derived from the limited evidence for the rate that birds might be beached on a daily or weekly basis. Although the comparative evidence for this is limited, that presented in Chapter 3, and less-rigorous observations made by others on the rate of beaching, suggests that short-term occupation of sites was not unusual and, furthermore, that evidence relating to the nature and range of everyday subsistence activities can be deduced from small samples.

While regional culture-stratigraphic sequences provide useful frameworks for comparisons with other areas, it is clear that the need to combine frequencies from several excavated units to provide statistical samples obscures shorter-term details.

Although the bone and artefactual contents of very small units may be low, they are the closest we can come to observing aspects of daily life. Such small samples should provide the first level of our efforts to understand past human behaviour, even if they are quantitatively problematical, before samples are combined to obtain statistically more reliable numbers from which long-term trends may be deduced. Such an approach should indicate the levels of internal variability and could be extended to technological studies as well in order to test hypotheses such as Deacon's (1984) regarding technological development and adaptation to external factors such as season and environmental change.

In addition to variability between approximately contemporary sub-units, the timing of exploitation of birds has been demonstrated to have shifted over the longer-term (Table 8.1). It is also clear that virtually none of the reliable samples was collected during months when the highest densities of seabirds could have been expected (Table 8.1, Figure 3.3). However, with the exception of Eland's Bay Cave which includes birds collected between June and September when west coast densities are lowest, most of the samples represent collections made in months when reasonably high densities could be expected. The logical conclusion to be drawn is that, while coastal subsistence strategies included exploitation of seabirds as part of the dietary package, they were primarily directed at other resources that were available during the wet season. Exploitation of the peak availability of Cape dune molerats and juvenile steenbok/grysbok would undoubtedly have played an important role in that strategy. Annual mortality of yearling Cape fur seal pups and their exploitation also coincides with this time of the year (Parkington 1976, 1981; Klein & Cruz-Uribe 1989) and adds another highly predictable resource to the suite utilized by coastal hunter-gatherers. In the Die Kelders Cave area, the wet season extends later in the year than it does on the west coast, and a similar strategy, but slightly later in the year, is evident. At Nelson Bay Cave rainfall is more or less

evenly distributed throughout the year and may not have been as important a restricting factor on coastal strategies. This may be indicated by the variability in season evident from the birds and seals, which include juveniles of a wider age range than at Eland's Bay and Die Kelders Caves (Parkington 1976; Klein 1989).

It is worth noting that the effect of wetter conditions between 8000 and 9000 B.P. and between 1000 and 2000 B.P. may have extended the wet season period of possible occupation at Eland's Bay Cave to months which are dry under present conditions. This does not, however, appear to have affected samples between 12 000 and 14 000 B.P., which were also accumulated during a period of wetter conditions. This may not, however, be an appropriate comparison. At the time when these deposits were accumulated the coast was 10 to 16 km from the site so that people would have had an essentially terrestrial subsistence strategy and it is not yet known how coastal resources might have been integrated. The Die Kelders Cave 1 Later Stone Age samples were probably also accumulated under wetter conditions than at present. It is of further interest that higher numbers of Cape dune molerats occur at Eland's Bay Cave and at Die Kelders Cave 1 during wetter periods, adding support to the possibility that molerats were taken in the wet season when flooding forced them to the surface.

At Nelson Bay Cave, results for samples between 11 000 and 8000 B.P. are markedly different to those of more recent samples (Table 8.1). The reason for this is not immediately apparent, but may be related to the fact that climatic conditions were different. During this time there was a change from relatively restricted late summer to early autumn occupation to a longer period in K6000 which included early summer as well. This change of seasonal exploitation of seabirds coincided with the switch from relatively drier conditions typical of those during low phase Southern Oscillations prevalent between 12 000 and 10 000 B.P. to wetter conditions under the increased incidence of high phase Southern Oscillations by K6000 B.P. It

is likely that low phase conditions, with a higher incidence of westerly winds, which had led to marked seasonal variation in the southerly extent of the Agulhas Current during the Last Glacial Maximum (Hutson 1980), caused rainfall to be distributed more seasonally, possibly during summer and autumn.

The archaeological seabird samples provide a reasonably accurate picture of the composition of resident seabird communities along South African shores. There is clearly some seasonal bias in the samples but the correspondence analysis and other evidence have made it possible to account for this by determining the season of accumulation. Seasonal evidence has shown that much of the sample variability reflects differing availability at the time when birds were collected rather than the effect of environmental or other change.

Because birds are mobile and adapted to a wide range of conditions, some species provide only limited proxy evidence for environmental change. Larger samples with greater species richness enable more variables to be included in environmental assessments and are consequently likely to yield more reliable information. All three of the sites studied have yielded palaeoenvironmental information and evidence deduced from, or supported by, avian remains is summarized in Table 8.2. The Die Kelders Cave 1 samples are limited in temporal coverage, but the avian remains from Eland's Bay Cave, and Nelson Bay Cave in particular, have yielded substantial evidence for significant local environmental change, in addition to and in support of, existing information. At Eland's Bay Cave evidence essentially supports and develops that for changes in the catchment of the site in response to changing sea level. Of the three sites, the samples studied from Nelson Bay Cave have yielded the most complete sequence, with minimal breaks, from 11 000 B.P. Palaeoenvironmental information includes the effects of changing sea level and the disappearance of grassland and its replacement by scrub and bush as a significant proportion of the vegetation. Proportional changes of oceanic

seabird species are believed to reflect changes in wind patterns related to ocean and atmospheric circulation.

The evidence from freshwater birds highlighted important limitations to their use as indicators of environmental change that could lead to erroneous interpretations in the absence of other lines of evidence against which to test them. In apparent contradiction to good evidence that they were accumulated when conditions were drier than at present, high frequencies of freshwater birds were found in some samples from Eland's Bay Cave and Nelson Bay Cave. A solution undoubtedly lies in the fact that, under such conditions, permanent water bodies would have provided refugia for increased numbers of freshwater birds. The fluctuations in freshwater birds were not always consistent with wet and/or dry conditions, however, and interpretations should be made with caution; it was evident from Nelson Bay Cave samples, that rainfall was not necessarily the only factor that may have led to changes in proportions of freshwater birds, particularly when conditions after the Last Glacial had ameliorated and marine resources had become readily available.

Fluctuations in the proportion of freshwater species in the Eland's Bay Cave samples have provided supporting evidence for the development of the Verlorenvlei in response to changes in sea level. As the terminal Pleistocene and early Holocene sea level rose, riverine and deep estuarine conditions in the vicinity of the site, dominated by terrestrial species, were gradually replaced by shallower, more open estuarine conditions which suited increased numbers of freshwater birds. After the major hiatus, however, drier conditions between 4000 and 3000 B.P. caused the shallow Verlorenvlei estuary to become a refugium for freshwater species. On present evidence this appears to be a reasonable conclusion, in spite of the reservations expressed above. Subsequently, with sea level slightly higher still between 2000 and 1000 B.P., the peak in freshwater birds suggests that extensive

flooding of the low-lying coastal area had led to the formation of wetlands which supported many birds as the estuary was slowly reduced to a coastal lake by about 300 B.P. when present sea level was reached.

Freshwater conditions at Nelson Bay Cave also responded to sea-level change. The most striking effect was the reduction in habitat suitable for freshwater birds during the Holocene high sea level. The coastal topography is steep around the estuaries of the Bietou and Keurbooms Rivers, and the limited areas of low-lying floodplain wetlands, evident at the present sea level, were rapidly drowned.

Changes in the relative proportions of seabirds in the archaeological samples have been correlated with global and regional environmental fluctuations. These include the advance of the coastline as sea level rose after the Last Glacial Maximum and shifts in response to wind patterns. Perhaps one of the most significant contributions to palaeoenvironmental interpretation has been the recognition of the link between changes in the relative proportions of albatrosses, petrels and shearwaters, the mortality of which is affected by strong southerly winds and south westerly storms, with shifts in global and regional oceanic and atmospheric circulation patterns. This relationship suggests that fluctuations in the incidence of this group of seabird species in dated sequences could be used as an index of change in wind patterns, which are in turn closely related to oceanic and atmospheric conditions that have a significant effect on short- and long-term terrestrial climates and rainfall. The seabird evidence is heavily dependent on palaeoenvironmental interpretations from other sources, however, and more samples should be examined in order to establish whether this evidence can be used as an independent index of palaeoenvironmental change.

During the late Upper Pleistocene at Die Kelders Cave 1, evidence from birds indicates that previously drier conditions were ameliorating and that mixed scrub and grass and a body of fresh water existed on the coastal foreland in the

vicinity of the cave. Fluctuation in seabird numbers in the larger samples indicates that the lowered sea level rose slightly and then receded again during the period of deposition.

This study has added 86 records (Table 8.3) to the current record of 45 taxa from Upper Pleistocene and Holocene deposits cited in Clancey *et al.* (1987). While this represents a considerable advance, the list is by no means representative of the avian fauna that can be assumed to have existed in coastal regions. No major changes in the structure or composition of the avifauna were detected. This was not unexpected, however, given the short time span covered by the study and the mobility and adaptability of avian species, some of which disperse widely within and even across terrestrial and marine zoogeographic zones (Winterbottom 1972; Brooke 1981b). The observed variation in species composition and relative proportions is in keeping with what might be predicted within the range of palaeoenvironmental conditions known to have existed during the late Upper Pleistocene and Holocene.

Although this study has been aimed at avian remains, it has become increasingly clear that samples cannot be interpreted in isolation. Faunal samples are the result of complex biological and physical interactions, which cannot be resolved without reference to the processes that lead to their formation in the first place. Comparative observations on beached seabirds and on the habits of modern mammalian and avian predators that might have influenced the composition of the avian samples have provided a link between the archaeological samples and the natural systems that affect their composition. At the same time it has been necessary to integrate information on the ecology of other dietary components in the archaeological samples in order to have a better understanding of the role of birds in the structure of human palaeoecology in coastal contexts.

**Table 8.1.** Summary of seasonal information obtained from correspondence analysis of results of modern beach surveys and archaeological samples. [] indicates possible extension of range.

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DATE	ELAND'S BAY CAVE	DIE KELDERS CAVE	NELSON BAY CAVE
		1	
300-1000	Oct [Sep-Nov]		Oct-Dec
1-2000	Aug-Nov	Sep-Dec	
2-3000			Oct-Nov [Aug-Dec]
3-4000	Jul-Aug [Jun-Sep]		
R6000			Nov-Dec [Oct-Feb]
K6000			Nov-Dec [Oct-Apr]
8-9000	Aug-Dec		Mar-May
10-11000	Sep		Mar-May
12-14000	Jun-Aug		
80-40000		Sep-Oct [-Dec]	

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**Table 8.2.** Summary of palaeoenvironmental information deduced from or supported by avian evidence.

DATE	ELAND'S BAY CAVE	DIE KELDERS CAVE 1	NELSON BAY CAVE
300-1000	present conditions; few waterbirds in vicinity of cave		?islands; ?intensification of low phase Southern Oscillation
1-2000	small scale humidity fluctuations; waterbirds peak; extensive wetlands	small scale humidity fluctuations; ?Ulitenkraal R. suited to diving ducks	islands present
2-3000			
3-4000	Drier; waterbird refugium		
R6000 and K6000			sea level +1.5 m; formation of islands, reduction of freshwater habitat; intensified southerly winds, high phase Southern Oscillation
8-9000, and at Eland's Bay Cave only, to 10-11000	Coast closer; marine birds important; increased waterbirds reflects change from river to deep estuary and then more open water		terrestrial increase, waterbird decrease - ?drier; increased westerly winds, low phase Southern Oscillation
10-11000			peak in terrestrial coincided with climate fluctuations under drier conditions; low phase Southern Oscillation, increased westerly winds and ?greater seasonality open vegetation and freshwater; more scrub, ?trees
12-14000	terrestrial habitat, river; few waterbirds		open vegetation; freshwater in vicinity
16000			Drier; open with grassland; freshwater-bird refugium or ameliorating terrestrial conditions
18000			
80-40000		essentially terrestrial; lower sea level rising, conditions ameliorating; coast near to cave; vleis or river on foreland suited to breeding-waterbirds; sea level again lower	

**Table 8.3** Avian species recorded from Upper Pleistocene (80 000 to 40 000 B.P.), Terminal Pleistocene (18 000 to 10 000 B.P.) and Holocene (10 000 B.P. to present) deposits in coastal Eland's Bay Cave, Die Kelders Cave 1 and Nelson Bay Cave. x indicates taxon recorded in the southern African fossil record for this period (Clancey *et al.* 1987); \* indicates a new record.

TAXON	UPPER	TERMINAL	HOLOCENE
	PLEIST.	PLEIST.	
<b>STRUTHIONIDAE</b>			
Ostrich <i>Struthio camelus</i>	x	x	x
<b>SPHENISCIDAE</b>			
Jackass penguin <i>Spheniscus demersus</i>	x	x	x
<b>PODICIPIDIDAE</b>			
Great crested grebe <i>Podiceps cristatus</i>			*
<b>DIOMEDEIDAE</b>			
Wandering albatross <i>Diomedea exulans</i>			*
Shy albatross <i>Diomedea cauta</i>			*
Blackbrowed albatross <i>Diomedea melanophris</i>			*
Yellownosed albatross <i>Diomedea chlororhynchos</i>			*

(cont.)

Table 8 (cont.)

TAXON	UPPER	TERMINAL	HOLOCENE
	PLEIST	PLEIST	
<b>PROCELLARIIDAE</b>			
Giant petrel <i>Macronectes</i> sp. indet.	*	*	X
Antarctic fulmar <i>Fulmarus glacialisoides</i>			*
Pintado petrel <i>Daption capense</i>	*		*
Softplumaged petrel <i>Pterodroma mollis</i>			X
Blue petrel <i>Halobaena caerulea</i>	*		*
Prion spp. <i>Pachyptila</i> spp. indet.	*	*	X
Whitechinned petrel <i>Procellaria aequinoctialis</i>	*	*	X
Cory's shearwater <i>Calonectris diomedea</i>			*
Great shearwater <i>Puffinus gravis</i>			*
Sooty shearwater <i>Puffinus griseus</i>		*	X
Manx shearwater <i>Puffinus puffinus</i>			*
Little shearwater <i>Puffinus assimilis</i>			*
<b>OCEANITIDAE</b>			
Storm petrel sp. Gen. et sp. indet.			*
<b>PELECANIDAE</b>			
White pelican <i>Pelecanus onocrotalus</i>			X
<b>SULIDAE</b>			
Cape gannet <i>Morus capensis</i>	*	X	X

(cont.)

Table 8 (cont.)

TAXON	UPPER	TERMINAL	HOLOCENE
	PLEIST.	PLEIST.	
<b>PHALACROCORACIDAE</b>			
Whitebreasted cormorant <i>Phalacrocorax carbo</i>	*	X	X
Cape cormorant <i>Phalacrocorax capensis</i>	*	X	X
Bank cormorant <i>Phalacrocorax neglectus</i>		*	X
Crowned cormorant <i>Phalacrocorax coronatus</i>	*	X	X
<b>ARDEIDAE</b>			
Grey heron <i>Ardea cinerea</i>			*
Blackheaded heron <i>Ardea melanocephala</i>		*	*
Goliath heron <i>Ardea goliath</i>			*
<b>PLATALEIDAE</b>			
Sacred ibis <i>Threskiornis aethiopicus</i>	*		
<b>PHOENICOPTERIDAE</b>			
Greater flamingo <i>Phoenicopterus ruber</i>		*	X
Lesser flamingo <i>Phoeniconaias minor</i>		*	*
<b>ANATIDAE</b>			
Egyptian goose <i>Alopochen aegyptiacus</i>	*		X
South African shelduck <i>Tadorna cana</i>	*	*	*
Yellowbilled duck <i>Anas undulata</i>	*	*	*
Cape teal <i>Anas capensis</i>			*
Cape shoveler <i>Anas smithii</i>		*	
Southern pochard <i>Netta erythrophthalma</i>			*

(cont.)

Table 8 (cont.)

TAXON	UPPER	TERMINAL	HOLOCENE
	PLEIST.	PLEIST.	
<b>SAGITTARIIDAE</b>			
Secretary bird <i>Sagittarius serpentarius</i>		*	*
<b>ACCIPITRIDAE</b>			
Cape vulture <i>Gyps coprotheres</i>			
Vulture sp. Gen. et sp. indet.	*		*
Black eagle <i>Aquila verreauxi</i>			*
Crowned eagle <i>Stephanoaetus coronatus</i>			*
Jackal buzzard <i>Buteo rufofuscus</i>		*	*
African goshawk <i>Accipiter tachiro</i>			*
Harrier cf. African marsh <i>Circus cf. ranivorus</i>			*
Lanner <i>Falco biarmicus</i>			*
Common kestrel <i>Falco tinnunculus</i>	*	*	X
<b>PHASIANIDAE</b>			
Greywing francolin <i>Francolinus africanus</i>	*	*	X
Cape francolin <i>Francolinus capensis</i>	*	*	X
Rednecked francolin <i>Francolinus afer</i>			*
*Quail sp. <i>Coturnix</i> sp. indet.		*	
<b>GRUIDAE</b>			
Crane sp. Gen. et sp. indet.	*	*	*
<b>RALLIDAE</b>			
Purple gallinule <i>Porphyrio porphyrio</i>			*
Redknobbed coot <i>Fulica cristata</i>	*	*	X

(cont.)

Table 8 (cont.)

TAXON	UPPER	TERMINAL	HOLOCENE
	PLEIST.	PLEIST.	
OTIDAE			
Stanley's bustard <i>Neotis denhami</i>		*	X
Ludwig's bustard <i>Neotis ludwigii</i>			*
Black korhaan <i>Eupodotis afra</i>			X
HAEMATOPODIDAE			
Black oystercatcher <i>Haematopus moquini</i>			X
SCOLOPACIDAE			
Curlew <i>Numenius arquata</i>		*	
BURHINIDAE			
Spotted dikkop <i>Burhinus capensis</i>			X
LARIDAE			
Arctic/pomarine skua <i>Stercorarius</i> sp. indet.			*
Subantarctic skua <i>Catharacta antarctica</i>			*
Kelp gull <i>Larus dominicanus</i>	*	*	X
Swift tern <i>Sterna bergii</i>			X
Common tern <i>Sterna hirundo</i>			X
Arctic tern <i>Sterna paradisaea</i>			*
Tern sp. <i>Sterna</i> sp. indet.			X

(cont.)

Table 8 (cont.)

TAXON	UPPER	TERMINAL	HOLOCENE
	PLEIST	PLEIST	
COLUMBIDAE			
Speckled rock pigeon <i>Columba guinea</i>	*	X	X
Cape turtle dove <i>Streptopelia capicola</i>			*
Dove sp. Gen. et sp. indet.		*	
TYTONIDAE			
Barn owl <i>Tyto alba</i>	X	X	
STRIGIDAE			
Spotted eagle owl <i>Bubo africanus</i>	X	X	X
MICROPODIDAE			
Alpine swift <i>Apus melba</i>			*
HIRUNDINIDAE			
African rock martin <i>Hirundo fuligula</i>			X
CORVIDAE			
Whitenecked raven <i>Corvus albicollis</i>	*	*	X
STURNIDAE			
Starling sp. Sturnidae sp. indet.	*	*	X

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## APPENDIX 1

COMMON AND SCIENTIFIC NAMES OF SPECIES MENTIONED IN THE  
TEXT\*

## FISH

Hake

## PISCES

*Merluccius capensis*

## MAMMALS

## HEDGEHOGS

South African hedgehog

## MAMMALIA

## ERINACEIDAE

*Erinaceus frontalis*

## HARES, RABBITS

Cape hare

Smith's red rock rabbit

Natal red rock rabbit

Jameson's red rock rabbit

## LEPORIDAE

*Lepus capensis**Pronolagus rupestris**P. crassicaudatus**P. randensis*

## MOLERATS

Cape dune molerat

## BATHYERGIDAE

*Bathyergus suillus*

## ROOT-RATS

Root-rat

## RHIZOMYIDAE

*Tachyoryctes splendens*

## SPRINGHARES

Springhare

## PEDITIDAE

*Pedetes capensis*

## RATS, MICE

Vlei rats

## MURIDAE/CRICETIDAE

*Otomys laminatus**O. saundersiae**O. irroratus**O. orestes*

## HYAENAS, AARDWOLF

Brown hyaena

## HYAENIDAE

*Hyaena brunnea*

## CATS

Leopard

## FELIDAE

*Panthera pardus*

## JACKALS, DOGS, FOXES

Cape fox

Black-backed jackal

Domestic dog

## CANIDAE

*Vulpes chama**Canis mesomelas**C. familiaris*

## MONGOOSES, CIVETS, etc.

Cape (small) grey mongoose

Water mongoose

## VIVERRIDAE

*Galerella pulverulenta**Atilax paludinosus*

## FUR SEALS

Cape fur seal

## OTARIIDAE

*Arctocephalus pusillus*

**HYRAXES**

Rock hyrax/rock dassie

**PROCAVIIDAE***Procavia capensis***ANTELOPE, CATTLE, SHEEP**

Gemsbok

Springbok

Steenbok

Grysbok

Sheep

**BOVIDAE***Oryx gazella**Antidorcas marsupialis**Raphicerus campestris**R. melanotis**Ovis aries***BIRDS****AVES****OSTRICHES**

Ostrich

**STRUTHIONIDAE***Struthio camelus***PENGUINS**

Jackass penguin

**SPHENISCIDAE***Spheniscus demersus***GREBES**

Great crested grebe

**PODICIPIDIDAE***Podiceps cristatus***ALBATROSSES**

Wandering albatross

Shy albatross

Blackbrowed albatross

Yellownosed albatross

**DIOMEDEIDAE***Diomedea exulans**D. cauta**D. melanophris**D. chlororhynchus*

Albatross sp.

Gen. et sp. undetermined.

**PETRELS, SHEARWATERS**

**PROCELLARIIDAE**

Giant petrel

*Macronectes* spp. undetermined

Antarctic fulmar

*Fulmarus glacialisoides*

Pintado petrel

*Daption capense*

Softplumaged petrel

*Pterodroma mollis*

Kerguelen petrel

*Lugensa brevirostris*

Blue petrel

*Halobaena caerulea*

[Broadbilled prion

*Pachyptila vittata*]

[Antarctic prion

*P. desolata*]

[Slenderbilled prion

*P. belcheri*]

Prion spp. (3 grouped)

*Pachyptila* spp. undetermined

Whitechinned petrel

*Procellaria aequinoctialis*

Cory's shearwater

*Calonectris diomedea*

Great shearwater

*Puffinus gravis*

Sooty shearwater

*P. griseus*

Manx shearwater

*P. puffinus*

Little shearwater

*P. assimilis*

Audubon's shearwater

*P. lherminieri*

**STORM PETRELS**

**OCEANITIDAE**

Storm petrel sp.

Gen. et sp. undetermined

**PELICANS**

**PELECANIDAE**

White pelican

*Pelecanus onocrotalus*

**BOOBIES, GANNETS**

**SULIDAE**

Cape gannet	<i>Morus capensis</i>
<b>CORMORANTS</b>	<b>PHALACROCORACIDAE</b>
Whitebreasted cormorant	<i>Phalacrocorax carbo</i>
Cape cormorant	<i>P. capensis</i>
Bank cormorant	<i>P. neglectus</i>
Crowned cormorant	<i>P. coronatus</i>
Reed cormorant	<i>P. africanus</i>
<b>HERONS, BITTERNs</b>	<b>ARDEIDAE</b>
Grey heron	<i>Ardea cinerea</i>
Blackheaded heron	<i>A. melanocephala</i>
Goliath heron	<i>A. goliath</i>
<b>IBISES, SPOONBILLS</b>	<b>PLATALEIDAE</b>
Sacred ibis	<i>Threskiornis aethiopicus</i>
<b>FLAMINGOES</b>	<b>PHOENICOPTERIDAE</b>
Greater flamingo	<i>Phoenicopterus ruber</i>
Lesser flamingo	<i>Phoeniconaias minor</i>
<b>SWANS, GEESE. DUCKS</b>	<b>ANATIDAE</b>
Egyptian goose	<i>Alopochen aegyptiacus</i>
South African shelduck	<i>Tadorna cana</i>
Yellowbilled duck	<i>Anas undulata</i>
Cape teal	<i>A. capensis</i>
Cape shoveler	<i>A. smithii</i>
Southern pochard	<i>Netta erythroptalma</i>

Ducks indet.	Gen. et sp. undetermined
SECRETARY BIRD	SAGITTARIIDAE
Secretary bird	<i>Sagittarius serpentarius</i>
VULTURES, KITES, EAGLES	ACCIPITRIDAE
Cape vulture	<i>Gyps coprotheres</i>
Vulture sp.	Gen. et sp. undetermined
Black eagle	<i>Aquila verreauxi</i>
Martial eagle	<i>Polemaetus bellicosus</i>
Crowned eagle	<i>Stephanoaetus coronatus</i>
Large eagle sp.	Gen. et sp. undetermined
Jackal buzzard	<i>Buteo rufofuscus</i>
African goshawk	<i>Accipiter tachiro</i>
Harrier cf. African marsh	<i>Circus cf. ranivorus</i>
Small/medium hawk, etc.	Gen. et sp. undetermined
Lanner	<i>Falco biarmicus</i>
Common (rock) kestrel	<i>F. tinnunculus</i>
FRANCOLINS, QUAILS, etc.	PHASIANIDAE
Greywing francolin	<i>Francolinus africanus</i>
Cape francolin	<i>F. capensis</i>
Rednecked francolin	<i>F. afer</i>
Quail sp.	<i>Coturnix sp. undetermined</i>
CRANES	GRUIDAE
Wattled crane	<i>Grus Carunculatus</i>
Crane sp.	Gen. et sp. undetermined

## RAILS, GALLINULES, etc.

Purple gallinule

Redknobbed coot

## RALLIDAE

*Porphyrio porphyrio**Fulica cristata*

## BUSTARDS, KHORAANS

Stanley's bustard

Ludwig's bustard

Black korhaan

## OTIDAE

*Neotis denhami**N. ludwigii**Eupodotis afra*

## OYSTERCATCHERS

Black oystercatcher

## HAEMATOPODIDAE

*Haematopus moquini*

## PLOVERS, TURNSTONES

Wader sp.

## CHARADRIIDAE

Gen. et sp. undetermined

## SANDPIPERS, SNIPES, etc.

Curlew

## SCOLOPACEIDAE

*Numenius arquata*

## DIKKOPS

Spotted dikkop

Water dikkop

## BURHINIDAE

*Burhinus capensis**B. vermiculatus*

## SKUAS, GULLS, TERNS

Arctic skua

Pomarine skua

Subantarctic skua

## LARIDAE

*Stercorarius parasiticus**S. pomarinus**Catharacta antarctica*

South polar skua	<i>C. maccormicki</i>
Kelp gull	<i>Larus dominicanus</i>
Swift tern	<i>Sterna bergii</i>
Common tern	<i>S. hirundo</i>
Arctic tern	<i>S. paradisaea</i>
Antarctic tern	<i>S. vittata</i>
Tern sp.	<i>Sterna</i> sp. undetermined
<b>PIGEONS, DOVES</b>	<b>COLUMBIDAE</b>
Speckled rock pigeon	<i>Columba guinea</i>
Cape turtle dove	<i>Streptopelia capicola</i>
Dove sp.	Gen. et. sp. undetermined
<b>BARN &amp; GRASS OWLS</b>	<b>TYTONIDAE</b>
Barn owl	<i>Tyto alba</i>
<b>TYPICAL OWLS</b>	<b>STRIGIDAE</b>
Cape eagle owl	<i>Bubo capensis capensis</i>
Mackinder's eagle owl	<i>B. capensis mackinderi</i>
Spotted eagle owl	<i>B. africanus</i>
Giant eagle owl	<i>B. lacteus</i>
Eurasian eagle owl	<i>B. bubo</i>
<b>SWIFTS</b>	<b>APODIDAE</b>
Alpine swift	<i>Apus melba</i>
<b>SWALLOWS, MARTINS</b>	<b>HIRUNDINIDAE</b>

African rock martin	<i>Hirundo fuligula</i>
CROWS, RAVENS	CORVIDAE
Whitenecked raven	<i>Corvus albicollis</i>
STARLINGS	STURNIDAE
Redwinged starling	<i>Onychognathus morio</i>
Starling sp.	Sturnidae sp. undetermined
OTHER	Undetermined

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\* Terminology for birds after Clancey (1980), Clancey *et al.* (1987) and; mammals after Smithers (1983).