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APPLIED ANIMAL BEHAVIOUR SCIENCE

Behavioural research in zoos: academic perspectives

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Abstract

A survey of papers published in *Zoo Biology* between 1989 and 1994 showed that 40% of papers were behavioural studies, but only 35% of these reported basic research. Most papers were authored by zoo researchers (58%), either with or without an academic collaborator. A similar survey of *Animal Behaviour* in 1993–1994 revealed only three zoo-based studies, even though 160 of the 344 studies published used captive animals. Possible reasons why so few academic researchers study the behaviour of zoo animals are discussed, including the perception that zoo populations are abnormal, the current theoretical emphasis in behavioural biology on functional rather than causal explanations of behaviour, and the methodological difficulties of zoo work. Nevertheless, examples are given of published basic behavioural work undertaken in zoos, and the conclusion drawn that more structured collaboration between zoo and academic researchers is necessary to make full use of zoos' research potential. © 1997 Elsevier Science B.V.

Keywords: Basic research; Applied research

1. Introduction

The use of zoos for teaching and research in animal behaviour has been advocated by a number of people over the last 25 years (Rumbaugh, 1971, 1972; Beck, 1974; Burghardt, 1974; Maroldo, 1978; Moran and Sorensen, 1984; Greenberg, 1987). The advantages to zoos of this research are clear when the research is designed to solve particular applied problems of animal maintenance and breeding; but basic, non-applied behavioural research in zoos also gives important information which can be used to define breeding and management programmes (Eisenberg and Kleiman, 1977; Schaaf, 1984). The advantages to the academic researcher of conducting behavioural research in

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zoos are a lot less clear, and have generally been characterised as the opportunity to work on a variety of different species, most of them exotic, without incurring great field costs; the fact that the animals are confined, and hence in a relatively controlled environment; and the additional benefit that representatives of closely related taxa can be studied in zoos to answer questions about behavioural phylogeny (Moran and Sorensen, 1984; Kleiman, 1992).

At first sight it would appear that this message has been well received. There has been substantial growth in zoo-based research, and there are several journals available (such as *Zoo Biology* and *Applied Animal Behaviour Science*) which specialise in publishing results in this area. A survey of American zoos and aquaria by Finlay and Maple (1986) showed that 70% of 120 institutions that responded to their questionnaire professed to be engaged in research of some sort. Behaviour, along with reproduction, was the highest category of research (72% of 86 institutions). There is, of course, wide variation among zoos as to what actually constitutes behavioural research, ranging from unsystematic observations on particular individuals through to full scale hypothesis testing. Nevertheless, a significant proportion of this work is published. Between 1982 and 1990, for example, 28% of the papers published in *Zoo Biology* were behavioural (Kleiman, 1992), this being the largest category. Despite this, Kleiman (1992) was by no means optimistic about the future of behavioural research in zoos, and identified a number of trends which she regarded as representing challenges to be overcome. These were, briefly

1. the change in zoos' missions, and hence priorities and management practices, resulting in fewer species in more complex enclosures, as well as the establishment of non-breeding groups;
2. a shift in academic priorities from causal to functional research, the result of Behavioural Ecology being the current dominant subdiscipline within Behavioural Biology;
3. increasing managerial roles for behavioural biologists employed by zoos, leaving them with insufficient time to devote to behavioural research.

These trends were identified by Kleiman in 1992. If indeed they represent a threat to the continued growth of behavioural research in zoos, then we can make predictions from them about the subsequent state of this research, and test these predictions by analysing the recent behavioural literature. The predictions are

1. the proportion of behavioural papers in the zoo research literature will not have increased, and may have decreased, since 1990;
2. the majority of zoo behavioural research will now be applied rather than basic;
3. only a small proportion of zoo behavioural research will be undertaken by academic (i.e. university) researchers rather than zoo researchers.

2. Recent behavioural research in zoos

Kleiman (1992) analysed the distribution between different subject categories of papers published in *Zoo Biology* between 1982 and 1990. For the purpose of this paper, which asks slightly different questions, the six volumes of *Zoo Biology* between 1989

Table 1
Behavioural papers published in *Zoo Biology* between 1989 and 1994

	Total papers	Total behavioural papers	Non-applied behavioural papers	Behavioural papers authored only by University academics	Behavioural papers including zoo researchers as authors
Vol. 8 (1989)	32	11 (34%)	4 (36%)	8 (73%)	3 (27%)
Vol. 9 (1990)	43	13 (30%)	3 (23%)	8 (62%)	5 (38%)
Vol. 10 (1991)	48	17 (35%)	8 (47%)	6 (35%)	9 (53%)
Vol. 11 (1992)	39	22 (56%)	11 (50%)	6 (27%)	13 (59%)
Vol. 12 (1993)	39	13 (33%)	6 (46%)	4 (31%)	8 (62%)
Vol. 13 (1994)	55	27 (49%)	6 (22%)	4 (15%)	19 (70%)
Mean	43	17 (40%)	6 (35%)	6 (35%)	10 (58%)

and 1994 were analysed. Table 1 shows the number of behavioural papers published during this period, as well as the number that reported basic research, and how many were authored solely by academic researchers.

Papers on behavioural research constituted 40% of the total papers published during this period; the proportion rises to 43% if only 1991–1994 is considered. Thus, the evidence is that more, rather than less behavioural research of publishable quality is now being done in zoos.

The question of the proportion of basic to applied behavioural research is rather more difficult to answer. The authors of basic behavioural papers published in *Zoo Biology* often attempt to make their results relevant to the captive management and breeding of the subject species. If we take the term 'applied' to refer to those papers where the research is designed to answer a specific problem or question of captive management, then we are left with the figures shown in Table 1. These indicate that only 35% of the behavioural papers reported basic research. This supports the second prediction above.

The question of authorship is also not a simple one to answer. The trend in *Zoo Biology* is towards multiauthored papers where, very often, both zoo and university researchers are credited. If we take as a criterion the presence of only university researchers in the authorship, then we can see from Table 1 that only 35% of the behavioural papers published between 1989 and 1994 were authored solely by university researchers, whereas 58% included zoo researchers among their authors. The remaining 7% were authored by researchers from other institutions, such as Regional Primate Research Centres. Thus, the third prediction is also supported.

For comparison, Table 2 shows an analysis of the papers published in 18 issues of *Animal Behaviour* during 1993 and 1994. This journal represents the forefront of

Table 2
Papers published in 18 issues of *Animal Behaviour*, Vols. 46 (1993) to 48 (1994), using vertebrate subjects

No. of studies involving captive animals	No. of studies done in zoos	Total no. of studies
163	3	344

behavioural research, and is a journal of first choice for many academic researchers. Considering only research on vertebrate animals, of 344 papers published only three included data gained from subjects in zoos. This is not simply because testing evolutionary hypotheses about behaviour can only be done in the wild; in 160 of these 344 studies the subjects were either temporarily or permanently in captivity in the University.

We may conclude that while increasing amounts of behavioural research are being undertaken in zoos, they are primarily being done by zoo-based researchers, and are mostly designed to answer specific questions about the captive management and breeding of animals. Given what appear to be the advantages to academics of performing research in zoos (Moran and Sorensen, 1984) we may ask why so little basic behavioural research is done in zoos, and why so few university researchers are involved in zoo behavioural research.

3. The disadvantages of zoo behavioural research

The advantages of zoo behavioural research are often seen in terms of advantages to the zoo (e.g. Eisenberg and Kleiman, 1977). To an academic researcher the advantages are a lot less clear, and are usually considered to be the availability of a variety of species and the opportunity for phylogenetic comparison, all at a relatively low cost (Moran and Sorensen, 1984). While these are undoubtedly true, there are nevertheless significant disadvantages to zoo research for the academic behavioural researcher. These can be considered under three broad categories:

3.1. Zoo animals are seen as abnormal populations which bear only a superficial resemblance to their wild counterparts

Reasons for this perception include the beliefs that zoo groups have a different age/sex composition from wild groups, live in an artificial environment, develop bizarre behaviours such as stereotypies and self mutilation, and become 'domesticated' to the extent that many aspects of their behaviour become habituated to recurring variables such as food presentation and handling by people.

While these criticisms have undoubtedly been true of zoos in the past, and still are for some, there has been considerable progress both in making zoo animals more like their wild counterparts in their behavioural profile and in quantifying more precisely the effects of zoo variables on behaviour. Open plan enclosures, particularly for ungulates, have quite a long history, but modern zoos attempt to provide housing which is naturalistic in the sense that it is similar to the animal's natural habitat, rather than that it looks good to human visitors (Hancocks, 1980; Hutchins et al., 1984). An important part of creating 'naturalistic' cages and groups is the evaluation of the animals' behaviour in comparison with wild groups, but such testing of their 'naturalness' has not been widely attempted. One approach is systematically to evaluate different aspects of cage design on behaviour (Maple and Finlay, 1987); another is simply to quantify as many behaviours as possible in a captive group to see how they differ quantitatively from wild groups

(e.g. King et al., 1980; Hosey, 1989). In all of these examples the data for the wild comparison come from other studies by other authors. This makes comparisons difficult, as field workers often use different behavioural measures from those who work on captive animals. Direct comparisons of wild and captive groups using the same behavioural measures applied by the same researcher are an important way of deciding whether captive groups show a 'naturalistic' profile of behaviour, and this is an area where the academic researcher could have a major role.

Even where animals are not housed naturalistically, we are starting to accumulate data to show how variables such as the feeding regime (Wasserman and Cruikshank, 1983), the way food is prepared (Smith et al., 1989), the presence of zoo visitors (Chamove et al., 1988), the presence of other species which may be predators (Stanley and Aspey, 1984), and other features of the zoo environment may affect behaviour in systematic and predictable ways. Thus, if zoo animals are behaviourally different from those in the wild, we are at least starting to understand the ways in which they are different.

Unfortunately for the researcher, while enclosures are becoming more naturalistic, group composition is becoming more artificial as the application of population genetics has more impact on the management of breeding and, by extension, non-breeding populations of many species in captivity (Kleiman, 1992), and this will undoubtedly make many captive groups unattractive to the academic behaviour researcher.

3.2. An emphasis on functional rather than causal explanations of behaviour

The current emphasis in academic behavioural research is on functional rather than causal explanations of behaviour. Behavioural Ecology, the evolutionary approach to behaviour, is very much the dominant discipline at the moment, and it is often difficult to see how evolutionary research can be undertaken on zoo animals (Kleiman, 1992). However, testing the theories of kin selection, reciprocity, parental investment, mate choice, optimality, and so on, often require experimental manipulation of animals, which requires at least a temporary captivity. Table 2 shows that nearly a half of papers in *Animal Behaviour* using vertebrate subjects result from studies of captive animals, many of which are in long-term confinement in University laboratories. Clearly captivity per se does not make animals unsuitable for research in Behavioural Ecology.

3.3. Methodological difficulties

There are considerable methodological difficulties to be overcome in conducting well designed and statistically rigorous research on zoo animals. Sample sizes are usually rather small, and if several groups are used to boost sample size, the other variables which are thus introduced, like different housing conditions and group composition, often result in intergroup differences which prohibit data pooling. Other variables over which the researcher has no influence, such as times of feeding, animal access to other cages, or the presence of zoo visitors or other animal species, can influence behavioural data in unpredictable, or if predictable, in unwanted ways. Many academic researchers

who have used zoos will also have encountered the problem of sudden removal or addition of animals to their study group, or even complete removal of the group. Given the long time-scale of most behavioural research these are real difficulties for which there is no easy answer.

However, the most important difficulty for most researchers is the reluctance of zoos to allow experimental manipulation of either animals or cages. Empirical research depends on manipulation of variables, and the ability to do this in the zoo would help greatly to overcome many of the methodological difficulties identified above. Unfortunately, research priorities are likely to conflict with the zoos' other priorities. Alternatively, manipulation may be seen as not in the animal's interests. One solution has been to keep some animals off view in non-public areas specifically for research. Clearly, for university, rather than zoo-based researchers to reach this kind of arrangement with a zoo requires considerable negotiation, not to mention cooperation and goodwill on both sides (Burghardt, 1974). Some kind of cooperation, including joint research, between zoos and universities seems to be becoming more widespread in North America. Unfortunately, in Europe, with some notable exceptions, zoos do not solicit research from academics, and the latter largely persist in their belief that the zoo is not an appropriate place to do behavioural research.

4. Basic behavioural research in zoos

Given these difficulties it is perhaps surprising that much behavioural research is done in zoos at all. However, although applied research must be as academically stringent as basic research, it can be done more easily than basic research in the zoo, partly because the variables that impede basic research are the very ones that much applied research addresses. Furthermore, zoos are more likely to allow experimental manipulation of animals and cages if the research aims have a clearly identifiable applied outcome. Nevertheless, good basic research is possible in the zoo. Examples of basic research in zoos can be conveniently divided into four different categories that reflect different traditions in the study of behaviour.

4.1. Descriptive studies

Descriptive studies are widely perceived nowadays as a rather low priority in behavioural research. However, it is important to have descriptions of the behaviours different species show in order to evaluate behaviour in captivity against behaviour in the wild. Furthermore, theoretical papers, particularly those attempting to identify trends across taxa, can only be attempted if descriptive data on behaviour are available. Again, descriptive studies can yield catalogues of defined behavioural elements (ethograms) which can then be used by other researchers to test theories about the behaviours of the same species. Good descriptive studies include quantitative data which, again, can often be used to formulate hypotheses about behaviour, and hence precipitate further studies. A good example of this approach is the description by Hutchins et al. (1991) of the

behaviours and social interactions of Matschie's Tree Kangaroo (*Dendrolagus matschiei*) at Woodland Park Zoo, Seattle.

4.2. Research into the proximate mechanisms of behaviour

Traditionally, ethological research has been as much concerned with the causation and mechanisms of behaviour as with its evolution. Numerous studies of this sort have been successfully undertaken in zoos. Examples include the study by Ralls et al. (1987) of mother–young interactions in ungulates, and the investigation carried out by Gittleman (1988) on the energetics of lactation in red pandas.

4.3. Studies on learning and cognition

The area of study which used to be called Comparative Psychology, and deals with animal learning and cognition, also offers considerable scope for zoo-based research. In general, independent variables in this research must be tightly controlled in a way which is neither easy nor usually possible outside the laboratory. But such research has been successfully carried out in zoos, with examples ranging from early studies by Glickman and Sroges (1966) on curiosity in zoo animals to cognitive testing of elephants and sea lions (Savage et al., 1994).

4.4. Testing the theories of behavioural ecology

This is undoubtedly the least likely area of behavioural biology in which zoo-based research can make a contribution. Nevertheless, evolutionary theories of behaviour can sometimes be tested on zoo animals if relatively naturalistic groups are available. An example is the study by Witt et al. (1981), which showed that Darwinian fitness was higher in dominants than in subordinates in a group of captive barbary macaques.

5. Conclusions

It appears to be the case, perhaps more in Europe than in North America, that University researchers do not make great use of the potential that zoos offer for behavioural research. Even in North America, where zoo/university collaborations are becoming more common, the primary focus of behavioural research on zoo animals is in the solution of applied problems. However, Applied Ethology is very much built upon the theories that are formulated in basic research, and it is mistaken to believe that theory cannot be advanced or tested in the zoo environment. An example is in the area of maternal manipulation of offspring sex ratios, which originated as an interesting development of parental investment theory (Trivers and Willard, 1973), but is clearly of applied importance in the management of zoo breeding programmes (Glatston, 1996), and could, furthermore, become an area of zoo behavioural research.

At a time when zoos are increasingly required to justify their continued existence in terms of conservation, education and research, it is in the interests both of the zoo and

the academic community to promote research which is of common interest, but whose goal goes beyond just the better maintenance of animals in captivity.

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