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Introduction

The ideal program for the future study of animal behaviour would involve the coordination of field and laboratory investigation.

Schaller (1965, p. 624)

In the early days of expeditions, a naturalist's field equipment consisted of little more than a gun and the means to preserve specimens. Later on, with the shift towards collecting information on primate behaviour and ecology, rather than collecting the animal itself, field primatologists relied on pencil and paper, binoculars, a compass and, if studying nocturnal species, a torch. In 1974, Jeanne Altmann's paper on observational sampling methods, intended 'as a guide to thinking, planning and design' (Altmann, 2010, p. 48), led to systematic, quantitative studies of behaviour. More recently, a shift in emphasis towards integration of methods has led to collaboration between laboratory and field researchers working on wild primates. Technological advances have presented fieldworkers with the opportunity to collect more sophisticated data, replace check-sheets with hand-held computers, store samples for later laboratory analysis, analyse samples in the field and collect information remotely. This has led to an increase in data collected, using, for example, non-invasive techniques for DNA analyses and hormonal assays. Ecological methods and techniques available for monitoring primate habitats have also improved, with the application of remote sensing, mapping (Global Positioning Systems), and data integration (Geographic Information Systems). These methods open up possibilities to collect new information on previously studied populations, and a means to collect data on species that cannot be habituated for behavioural observations.

The technological advances described above come at a time when 48% of primate species are under threat and insufficient data are

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available to assess the status of a further 15% of species (IUCN, 2008). Knowledge of the basic behavioural ecology of a species is essential for conservation, and this makes an integrated approach combining laboratory and field techniques all the more important, particularly as some of the most endangered species are those about which least is known, such as the drill (*Mandrillus leucophaeus*) on the front cover of this second edition. Habitat destruction is rising exponentially and the effective and practical implementation of modern, state-of-the-art environmental laws appears a long way off – a paradoxical situation. The legal apparatus has evolved quickly but human culture and practices are still adapting to these modern laws. For example, in Brazil, the hunting of wild animals (including primates) is a deeply rooted practice stemming from 10 000 years of tradition in local indigenous peoples, as well as the habits of European invaders, slaves and settlers over the past 500 years. Hunting has only been illegal since 1991 and, unfortunately, continues, even for threatened primate species, at the end of the first decade of the twenty-first century.

Although fieldworkers are generally well prepared in terms of basic behavioural and ecological methodology, prior to the publication of the first edition of this volume there was no easily accessible source of information concerning the wide variety of additional data and samples that can be collected for subsequent laboratory analysis; methods usually had to be compiled from the primary literature. This was an almost impossible task for researchers and students in many habitat countries, with often very limited access to journals, and brings us to another change that has taken place relatively recently in primatological research.

We find ourselves in the midst of a shift from the traditional 'power bases' of primate research to research that is increasingly initiated and conducted by nationals of the countries where non-human primates occur. This is nicely demonstrated by research in the Neotropics, where some field studies have now been running for over 25 years. These studies were generally initiated, conducted, coordinated and funded by non-Latin-American researchers and institutions. Over the past two decades, a growing number of Latin-American researchers have completed their academic training either in their country of origin or abroad. Most of these latter scientists have returned home, bringing with them the knowledge and techniques they have learned and, most importantly, contributing significantly towards developing primatology in habitat countries. As a result of this development, a new trend has arisen in Neotropical

primate research: studies are now led by local researchers and researchers from abroad are looking to collaborate with them. However, regular capacity-building programmes and field training courses are required for the continuation of this trend.

The second edition of this volume attempts to build on what has been achieved since the publication of the first edition in 2003. Although many of the chapters have simply been brought up to date, we (DJC and JMS) have done our best to address criticisms levelled at the first edition, for example, by including a new chapter on behavioural methods and field experiments, trying to ensure that complex terminology and jargon is explained within the individual chapters and that all chapters provide references appropriate to primatological applications, and ensuring that the 'tone' of the chapters is inclusive and addresses all primatologists. That said, this second edition adheres to the guiding principles of the first edition, as the feedback has been very positive. We have also retained the individual approach taken by the authors to each topic as we believe that the imposition of too much structure would be counter-productive, given the diverse nature of the research methods covered in this book. It will become clear to the reader that primatology has moved on, but we wonder whether primatologists have moved with the changes. There remains so much to be done, with little time left to do it in the case of many species. The first edition clearly served to broaden horizons with reference to some methods, but other topics seem to have remained side-lined, as is outlined in the preface to this second edition. For example, we know little more about food mechanics than we did prior to the first edition, and the role of ultrasound in primate communication has yet to be investigated. We hope that this will change over the coming years and that this second edition will serve not only as a guide for students and researchers wishing to enter new fields, but also encourage people to 'think outside the box'. The world is becoming more and more competitive – you might just get your hands on the funds that have eluded you for so long by trying something novel or trying a new combination in your pursuit of further knowledge of primates.

In this introductory chapter, we briefly illustrate the methodological paradigm shifts that have occurred in the history of primate field studies with a case study (the aye aye). We then give our own advice to those preparing for the field, with a general overview of how to plan and conduct a field study, before detailing the aims of this volume and presenting an overview of the chapters.

METHODOLOGICAL PARADIGM SHIFTS IN FIELD PRIMATOLOGY: THE AYE AYE

Several methodological paradigm shifts have occurred in the history of primate field studies (Strum & Fedigan, 2000; see also the preface to this volume). Until the early twentieth century, the driving force behind field studies was classification, through the collection and dissection of specimens, and comparative anatomy. Knowledge of behaviour in the wild increased much more slowly and, until the 1920s, comprised incidental observations by adventurers, seafarers, hunters, explorers and missionaries, some of whom were naturalists. This interest in behaviour, albeit anecdotal, constituted the first paradigm shift leading towards modern day behavioural and ecological studies. This and subsequent changes in methodological approach are well illustrated by studies of the aye aye (*Daubentonia madagascariensis*; family Daubentoniidae).

The aye aye was discovered by Sonnerat (1782, cited in Owen, 1863) in Madagascar during a voyage to the East Indies and China. Sonnerat described it as bearing resemblance to a squirrel, but also having characters that allied it to lemurs and monkeys. Cuvier (1798, cited in Owen, 1863) classified the aye aye as a rodent, and although Schreber (cited in Peters, 1865) placed it within the lemurs as early as 1803, it was not definitively recognized as such until 60 years later, with the publication of Owen's monograph on aye aye anatomy in 1863.

Expeditions aimed almost uniquely at the collection of aye aye specimens for anatomical study continued into the early twentieth Century (reviewed by Lavauden, 1933). Pollen (1863) neatly summed up the reason for the lack of information on the natural history of the Malagasy vertebrates, and his explanation remains generally applicable today:

> *It remains incomprehensible for those who do not know the obstacles faced by scientific explorations, that one knows so little of the natural history of this large country, even though a number of travellers have visited different parts of it. But, if one notes the numerous difficulties that these enterprising travellers have taken in their stride, . . . one is no longer surprised. On the contrary, one is obliged to pay homage to these zealous travellers who have risked their lives for science and sacrificed their health for the collection of the limited number of specimens they managed to obtain* (translated from the original French).

Early descriptions of aye aye behaviour stem from animals kept in captivity in La Réunion (Vinson, 1855) and Mauritius (Sandwith, 1859

in Owen, 1863). Sandwith (1859 in Owen, 1863) provides an excellent description, stating:

> *I . . . was much struck with the marvellous adaptation of the creature to its habits, shown by his acute hearing, which enables him to aptly distinguish different tones emitted from the wood by his gentle tapping; his evidently acute sense of smell, aiding him in his search; his secure footsteps on the slender branches, to which he firmly clung by his quadrumanous members; his strong rodent teeth, enabling him to tear through wood; and lastly, by the curious slender finger, unlike that of any other animal, and which he used alternately as a pleximeter, a probe, and a scoop.*

Lamberton (1911) carried out the longest such study, observing a captive individual in Madagascar for over a year. Given its nocturnal habits, Lamberton concluded that the only way to study the aye aye's natural behaviour was in captivity, and was ahead of his time in remarking that:

> *. . . individuals taken to Europe are certainly in bad condition. Made feeble by the voyage, embittered by suffering, sick due to the change in climate and food, how to distinguish between what is natural and what is a consequence of the conditions in which the animal finds itself? Observations made on aye ayes held in captivity in their country of origin certainly approach reality far more . . .* (translated from the original French).

The earliest descriptions of aye aye behaviour in the wild come from missionaries in Madagascar, who compiled information by interviewing the Malagasy (see, for example, Baron, 1882). Lavauden (1933) made the earliest qualitative behavioural observations of wild aye ayes, including photographs of wild individuals, a nest and a larval tunnel exposed by an aye aye. The first comprehensive description of aye aye behaviour and ecology was published by Petter in 1962, but no quantitative studies were conducted in the wild until the late 1980s (Ancrenaz *et al.*, 1994; Sterling, 1993). In terms of the integration of laboratory and field techniques, only diet and nutrition have been investigated for the aye aye, by combining field data with chemical analyses of food items (Sterling *et al.*, 1994). Our knowledge of aye aye biology could be greatly expanded by the application of more of the methods detailed in this volume.

PLANNING AND CONDUCTING A FIELD STUDY

Field trips are expensive, and may well be once-in-a-lifetime opportunities for both the researcher and, unfortunately, the study population.

For example, DJC's study population of mongoose lemurs (*Eulemur mongoz*) at Anjamena, Madagascar, has declined by 85% over a 13-year period from 1995 (16 groups/km^2) to 2008 (3 groups/km^2) (Shrum, 2008). Even more worrying is that of all the areas surveyed by Shrum (2008), Anjamena exhibited the highest population density. It is therefore imperative to prepare well and to maximize the information collected. In this section we provide some guidance on how to deal with some of the non-scientific aspects of fieldwork. However, this is by no means to be regarded as covering all eventualities, as it is mainly based on our personal experience and on conversations with colleagues. Many of the following chapters give specific advice on various problems.

Preparation

Before you leave for the field, ensure that you know what your objectives are. The stated aims of your project must be fulfilled by your planned data collection. It is likely that these aims will change over time, usually because you have been too ambitious at the outset, but you need to start somewhere. Think about how you will analyse your data before you go into the field. Make sure that you are familiar with your study species by referring to previous work, contacting others who have worked on the same animals, and, if possible, spending time at a zoo observing them to give you a feel for their behaviour and general characteristics. You can also try out behavioural sampling methods at the zoo, although you might need to change things once you are in the field if, for example, your contact time with the animals is low or visibility is poor. If possible, test your ecological methods before you go; if your study requires particular techniques (e.g. collection and preparation of botanical samples, blood sampling), take expert advice, get the necessary training and practise the techniques you will be using in a laboratory. Make sure that you are familiar with all your equipment before you leave. If your study will involve capturing your study animals, training and preparation are essential and you should take the opportunity to collect as much information as you can about each captured individual (e.g. morphometrics, health status and biological samples). Even if these data, or other samples collected, are not directly related to your current research questions, they may constitute a future research project, or provide opportunities for collaboration.

Gather as much information on potential study sites as you can, read up on previous studies carried out at the same or similar study

sites and contact colleagues who have worked in these areas. Bear in mind that those running a study site have invested a great deal of time in energy in it, and respect this. Inform yourself of particular problems that may pertain to the study area(s) (e.g. difficult terrain; climate; health hazards; antagonism from local people; political stability) and don't hesitate to ask for advice from those with more experience. Inoculations, applying for ethical permission, permits, dealing with travel arrangements and setting up collaborations all take time. You may also need to sort out travel arrangements some time in advance if you will be travelling during busy periods. Insurance, at the very least medical cover, is expensive but essential in case something goes wrong.

Terrain and climate

Ensure that you are fit enough to cope with difficult terrain, and that you can be evacuated within a reasonable time scale, should you injure yourself and need hospital treatment. This will apply generally, but particularly in remote areas, and being sensible will greatly reduce the probability of an accident. For example, employ local assistants to climb trees, should this be necessary, as they will usually be much better at it than you are. Make sure that you have adequate protection from the elements, such as warm clothing, clothing to protect you from the sun, and rainwear.

Health hazards

Assess the health hazards that you may face and take the necessary precautions. Get a medical check-up before you leave for the field, have all the recommended vaccinations, take the necessary medication with you, and remember to take it. If you are travelling from abroad, it is also advisable to seek the advice of a medic once you reach your destination (especially if you will be carrying out a long-term study), as a local doctor will know more about local diseases and the precautions or prophylaxes that may be necessary. For example, consider using locally produced malarial prophylaxes, which are perfectly adequate in most cases, but always consult a doctor first. Furthermore, you are less likely to contribute to the growing resistance of the parasite to drugs that are too expensive for local people to afford. As is the case the world over, see a medic before you take

antibiotics (if possible), and finish the course – again, to avoid contributing to the ever-increasing problem of antibiotic-resistant bacteria.

If you will be handling animals and/or working at some distance from medical services, then rabies vaccinations are a good idea. However, if you are bitten by an animal that may be rabid, then you must seek medical attention immediately, as the vaccination does not give you full protection. It is also a good idea to have a selection of syringes and needles with you, as well as the necessary equipment for perfusions, to be used if you are admitted to an under-equipped hospital. You will have been inoculated against Hepatitis A and B as a standard procedure, but HIV is rife the world over and if you don't have your own equipment with you, then you may run the risk of infection from recycled syringes.

Take large amounts of standard first aid kit items with you (e.g. plasters, bandages, painkillers). This is not just for your own use; people may come to you for help before they go to the nearest medic, particularly if you are working in a remote area. In Madagascar, DJC was asked to help in cases of serious ear and eye infections, septic wounds, sexually transmitted diseases, malaria, minor cuts and bruises and headaches, as well as sick zebu cattle. In most cases, all you can do is send your 'patients' to the local doctor, in others, a painkiller or plaster will do the world of good and you will have made a friend. Think about taking a first aid course before you leave, and finally, if you are employing local assistants, think about acting as their health insurance (we think this is only reasonable) and pay for any medical and dental treatment. In addition to moral considerations, it is to your own advantage to do so, as healthy employees are more inclined to work.

Precautions against dangerous animals require common sense, vigilance and, for example, thick leather garters as a protection against venomous snakes, and long trousers and long-sleeved shirts as protection against insects. In remote places we recommend that you keep snake anti-venin at your field camp (and know how to use it if required), because this needs to be taken within a few hours after a snake bite occurs, and you won't have time to get to a medical centre.

Look after your mental health, ensure you take regular breaks from the field and don't push yourself beyond your limits. Remember, you will be working hard, but you are not supposed to return from the field a mental and physical wreck – again, use your common sense. Take advantage of being in a new place: meet people and learn about the culture and traditions of the country and region you are working

in. Little things can help you get through bad times – DJC found the shortwave radio useful, as well as the luxury of an inexpensive reading lamp in the tent, powered by a car battery charged using solar panels; JMS kept a diary; MT made good friends in the local village for weekly meals and monthly Sunday barbecues.

Political stability

If you will be working abroad, check your government's website for detailed information on the political stability of the country and area you intend to work in, and follow their advice. If you will be working in a highly volatile area, then ensure you have your escape route planned in advance, should you need to leave in a hurry. Even if a country is stable, it is always a good idea to register your presence with your local embassy or consulate of your country of origin (if you are a foreigner), and let them know your itinerary. Whether you are a foreigner or a national of the country you are working in, always inform the local authorities of your presence and what you are doing. This is common courtesy and will also help guarantee your safety.

The pilot phase

If you can afford it, then a pilot phase is invaluable for finding a study site, setting up collaborations, arranging permits and testing your methodology. If you are travelling around to find an appropriate study site, then make contacts with people working and living in the area to get to know the advantages and disadvantages of working there. Spend some time at the site to assess the logistics of provisioning. If you will be working in the forest, assess the visibility, and density of the forest and, above all, try to find and follow your study animals to test your methods. DJC visited three potential study sites during her pilot phase to study the cathemeral mongoose lemur. One location was out of the question as the density of the study animals was low and the forest highly degraded. The second had the advantage that it was at a field station, and transport and provisioning would have been relatively easy to deal with. However, the density of mongoose lemurs was again low. In one area of forest near the field station where visibility was good, the flora was mostly introduced. In a second area the forest was dense, visibility low and the canopy very high. A third area where visibility was good contained no study animals. The study was eventually carried out in the third location, because the

density of study animals was extraordinarily high, the forest was open enough that no transects needed to be cut, the canopy was not too high and visibility was good. The downside was that the site was fairly remote, making provisioning complicated, and transport and access difficult, particularly during the rainy season.

Use your pilot phase to test your sample collection and storage methods. For example, the practicalities of collecting faeces, or food specimens, from small canopy primates may only become apparent when sitting below subject animals in a 30-m canopy (keep your mouth shut). A few representative samples taken back to the lab at this stage will allow you to test preservation methods and will save a lot of trouble at a later stage. Check out the possibilities for getting access to power, and adapt your methods accordingly, including a 'plan B'. Bear in mind that logistical arrangements, agreements, etc., can all change between your pilot study and your next major field season. Finally, look into how you will communicate with home, colleagues, advisors and/or collaborators. Establish this before returning to the field, so that everyone knows what's happening.

Working with other people

Studying primates inevitably involves interactions with other people, be they other researchers (in the field and the lab), field assistants, local populations or government officials. When working with other researchers and with field assistants, make sure that everyone (including you!) has a clear picture of what to expect from the project and the roles different people play. If you are in a situation where you need to employ assistants personally (e.g. you are not working on a pre-existing field station), then we recommend drawing up some kind of contract. This can prevent a lot of problems and also makes it clear who is the boss. You and your assistants and employees are not a team (this observation stems from bitter experience!), and any working situation usually needs some kind of hierarchy in order to function efficiently. Field biologists are often passionate and prepared to live on very little, in challenging conditions, but you can't assume that your employees will want to do the same.

Respect the culture of the area you are in. Good relations with people from top officials down to workers and villagers are very important, both for your study and for researchers coming after you. Bureaucracy can be a pain, but rules are there for a reason, and you wouldn't break the law at home. Whether you are a foreigner or from