

TROPICAL FOREST EXPEDITIONS

By Clive Jermy and Roger Chapman

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CONTENTS

INTRODUCTION

1.	TROPICAL RAIN FOREST: ITS POTENTIAL FOR RESEARCH	
1.1	Introduction	5
1.2	Types of tropical forest and where they are found	11
1.3	Some lines of research for rain forest expeditions: Life Sciences	14
1.4	Some general points about collecting biological specimens	19
1.5	Some lines of research for rain forest expeditions: Earth Sciences	24
2.	IN THE FIELD	
2.1	Contact with local people	30
2.2	Movement and navigation on land	37
2.3	River crossings	41
2.4	Moving an expedition on a river	52
2.5	Moving people and supplies by air	56
2.6	Communication and supply	61
2.7	Training, risk factors & casualty evacuation	62
3.	CAMPING IN THE FOREST	
3.1	The camp site	68
3.2	Sleeping in the forest	72
3.3	Camp hygiene and well-being	79
3.4	Latrines and refuse	82
3.5	Routine clothing and equipment	84
4.	COOKING AND CATERING	
4.1	Water, its supply storage and purification	94
4.2	Fire lighting and stoves	97
4.3	Food: imported rations and local food	101
4.4	Food from the forest: plants	104
4.5	Food from the forest: animals	108
5.	HEALTH AND SAFETY IN THE FOREST	
5.1	General aspects	115
5.2	Setting up a base camp medical service	118
5.3	Malaria and other tropical diseases	124
5.4	Venemous and poisonous animals	133
6.	THE TREE CANOPY	
6.1	Introduction	141
6.2	Climbing the trunk	144

6.3	Climbing free of the trunk	147
6.4	Long term work in the canopy	155
6.5	Some safety tips	157
7.	PHOTOGRAPHY	
7.1	Introduction	160
7.2	Care of photographic equipment	162
7.3	Storage of photographic materials	163
7.4	Processing films	165
7.5	Preservation of negatives	167
APPENDIX 1:	Code of Ethics for Foreign Collectors of Biological Samples	169
APPENDIX 2:	Useful organisations based in the UK	171
BIBLIOGRAPHY		179

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Roger Chapman & Clive Jermy

*“Do you know the pile-built village where the sago dealers trade?
Do you know the reek of fish and wet bamboo?
Do you know the steaming stillness of the orchid-scented glade?
When the blazoned, bird-winged butterflies flap through?
It is there that I am going...to my palms and flying foxes...
For the Red Gods call me out and I must go...!”*

Rudyard Kipling – “Feet of the Young Men”



Figure 1.0. Upper mountain forest with Pandanus and Podocarpus, Finisterre Range, East Papua New Guinea

INTRODUCTION

This book is designed to give advice to people of limited expedition experience who are about to carry out research and travel in relatively remote tropical rain forest regions. It is assumed that most expeditions will be of about 2-3 months in length and most, it is expected, will be operating when the humidity, temperature and rainfall are lowest, and when the rivers - the main line of communication in the jungle - are still navigable.

The principles of gathering information, choosing a team, making a plan, conducting a thorough reconnaissance of the area of operation and carrying out the necessary liaison visits to Embassies, High Commissions, government and scientific departments, is the same on any expedition so they will not be mentioned here. Details can be found in the *Expedition Planners' Handbook and Directory* published by the Expedition Advisory Centre at the Royal Geographical Society (RGS-IBG). Practical advice given in this booklet will be relevant to the tropical rain forests of South and Central America, West Africa and South East Asia. The advice given is based on the many expeditioners who have contributed to this book but they may not have covered every eventuality or area. There is no substitute for a well-planned reconnaissance or advice from those that know your proposed area well.

Unfortunately, certain travel books tend to give an entirely erroneous impression of the tropical forest. How often have you read phrases such as: "We hacked our way through impenetrable jungle", "eaten alive by mosquitoes", "one bite by the deadly *Fer de Lance* and you are as good as dead", or "it was like climbing a treadmill in a steaming Turkish Bath"? These are the sort of phrases, all quoted by the "Green Hell School", which hold in your mind, sell books and newspapers but do not give an entirely accurate description of the tropical rain forest. Chapter one gives a brief outline of where tropical forests are to be found and something about their ecological nature. It is not however an introduction to the structure and biology of tropical rain forests but does lead the reader to the appropriate references.

If you can control your imagination, then the tropical rain forest can prove to be a fascinating and beautiful place; it is a world so utterly unlike anything else.

If you are physically fit and healthy; if you have an open and receptive mind coupled with an inquisitive eye; if you are prepared to face a number of irritants such as flies, mosquitoes or ants; if you are not worried about getting soaking wet or receiving a few stings and tropical sores, then you will relish this new environment. Many are the compensations. Finally, if you heed these few words of advice you will lessen the discomfort that most Europeans suffer in the tropical rain forest and perhaps, in the end, grow to love it. Remember, the jungle is neutral; it is up to you to decide how to approach it.

Chapter 1: TROPICAL RAIN FOREST: THE POTENTIAL FOR RESEARCH

1.1 Introduction

Forest environments in tropical areas fall into four major types depending basically on the amount of rainfall. Two types have considerable and regular rain for most of the year and are termed moist or rain forests. The other two, namely savanna and thorn forests, are in progressively drier areas. This book discusses expeditions to tropical rain forests only, although much of what is said here may be useful in some forest areas of the drier tropics.

Any expedition intending to work in a tropical rain forest should obtain and study Tim Whitmore's *An Introduction to Tropical Rain Forests* (1990), and for those going to Asia or the Pacific, *Tropical Rain Forests of the Far East* (1984). The references included in those books are not cited here specifically. Books of a general nature which are good background reading are marked with an asterisk in the bibliography at the end of this book.

1.1.1 Climate of rain forest areas

Tropical areas have a constant high temperature usually defined as having monthly mean temperatures of 18 °C or over, or where the difference between the warmest and coldest months is less than 5 °C.

In areas where every month is wet, with 100mm of rainfall or more, with only occasional usually unpredictable dry spells of a few days or weeks, rain forest will occur. In areas where there are several dry months (seasonal dry spells), semi-evergreen rain forest or monsoon (in Asia, a term not used for the seasonal but similar forests of Africa or Americas) will be found.

Expeditions will want to be aware of rainfall patterns and a useful pictorial device for illustrating climate in various areas was devised by Walter and Leith (1967) and elaborated for biological purposes by Walter *et al* (1975). A few examples are given in Fig. 1.1. For plants and animals, extremes of weather are often more important than the average (mean) conditions and weather observations throughout your stay may be significant and should be reported on. Unusually prolonged dry periods in rain forests may trigger flowering, or even kill some organisms. Forests, by their very nature, have internal microclimates that differ from the more general climate outside. Different plant and animals have adapted to these niches in various ways. See Whitmore (1990) for further information.

1.1.2 General characteristics

Rain forests are structured in layers. The main canopy is between 30-40m high. Above, a few taller trees irregularly protrude. These are the giants of the forest, often 60m tall, with huge crowns of branches spreading out over the others. Below are shorter trees between 15-25m high; some are young emergents which will eventually reach the main canopy or beyond. The upper levels receive much more rain, wind and sun; the lower are stiller, shadowed and humid. In effect, the various canopies act like filters or giant umbrellas, allowing just 2% of the sunlight to reach the forest floor and breaking the force of even the fiercest tropical storm to a fine spray by the time it reaches the ground.

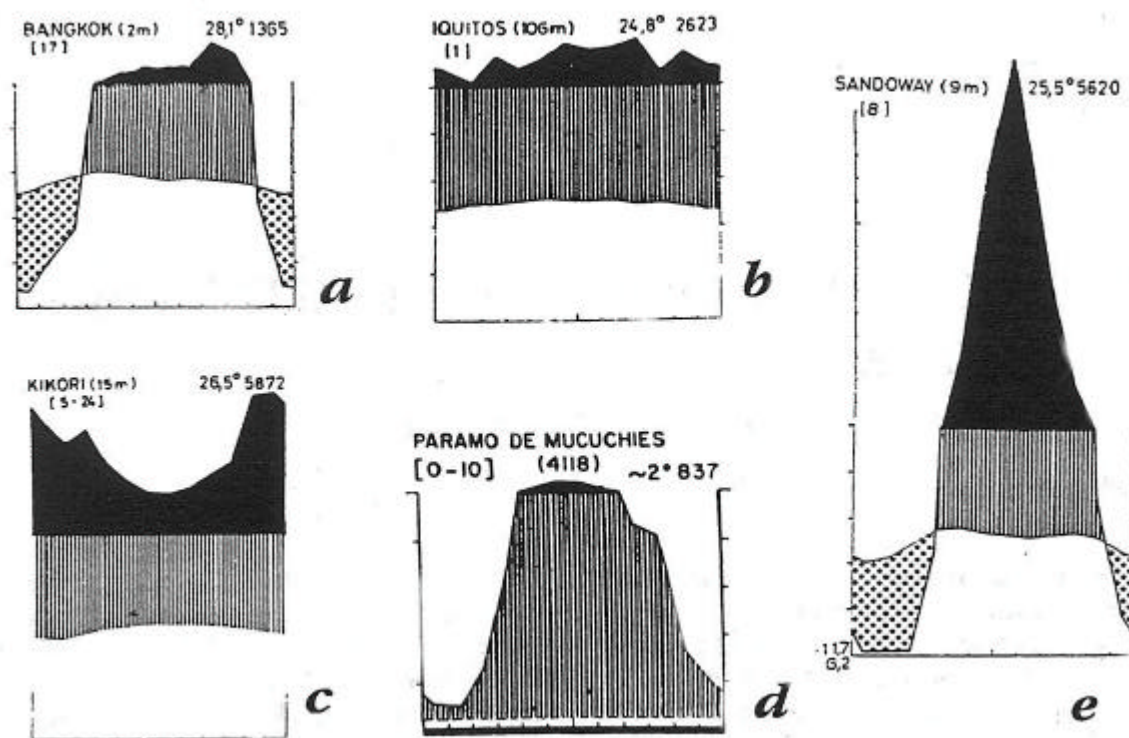


Figure 1.1: Sample climate-diagrams. The dotted areas are periods of aridity; vertical lines humid periods; and the black areas, periods when the monthly rainfall exceeds 100mm. For a full interpretation and explanation as to how these graphics are calculated see Walter et al. (1975). a. Monsoon forest near Bangkok; b. Amazonian rain forest; c. Everwet rain forest in New Guinea; d. Montane forest in the Andes; e. Monsoon forest with very high rainfall, Bangladesh - Myanoma border.

While the forest floor is often free from plant litter, save for a thick mat of interconnecting roots, lianas (climbing vines) and epiphytes (most commonly plants like orchids) grow on, up, around and through the main tree growths, binding every thing together. The leaves of tropical trees are often thick (to store nutrients from rain water), tough and glossy (to reduce leaching of valuable minerals and evaporation of water,

both needed for growth). The bases of many tree species are surrounded by buttresses; sheets of wood which flare out from the trunk acting as extra supports.

Each layer of the forest is a world of its own, with distinctive populations of mammals, birds and insects. These adapt to take advantage of the special conditions characterising each "zone", and rarely pass between. Ornithologists estimate that perhaps as many as 95% of birds used to the darkness of the inner forest will not cross clearings, even to breed or feed. More animals live in the canopies than any other parts of the forest - up to half of all mammals in the Malay Peninsula, for instance. (In temperate forests the average is 15%).

Generally rain forest soils are poor and barren; in part because they are so old. Almost two-thirds are acidic and low in nutrients, and unsuitable for conventional agricultural systems. Because they often contain high concentrations of iron and aluminium, valuable nutrients are either immobilised (phosphorous) or simply pass through before they can be absorbed (calcium, magnesium and potassium).

The humid tropics of Latin America have the worst soils: 82% are acidic and barren (African humid tropics 56%, Asia 38%). 40% of humid tropical Asia has somewhat fertile soil, 24% of Africa and 13% of Latin America. In the Amazon Basin only 6% of the soils can be considered suitable for agriculture, and they are scattered along the river's flood plains.

The volcanic regions of countries like the Philippines, Indonesia, Papua New Guinea, Cameroon, and along the flood plains of the Amazon and Congo river systems, have more fertile soils. Accounting for perhaps 18% of the total rain forest, these areas already support tens of millions of people.

One of the great biological ironies of tropical moist ecosystems is that they support such tremendous concentrations of plants, birds, insects and other animals on such barren ground. The secret lies in the fact that these forests are virtual closed systems in which nutrients are perpetually recycled. They are highly efficient - studies have revealed that less than 1% of nutrients are lost through leaching.

Whereas in temperate forests the great bulk of nutrient matter is found in the soil, the reverse is true in the rain forests. Here, as soon as any organism dies, it begins to break down and is absorbed by living organisms. Leaves, roots, trunks, insects, birds, and other animals all benefit. As Woody Allen once said about nature – "it's one giant restaurant, everything eating everything else".

Rain forests are not, strictly speaking, the green lungs of the Earth as is popularly supposed. Their contribution to atmospheric oxygen levels through photosynthesis is balanced by the release of carbons from organic decay (although when cleared and burnt, considerable amounts of carbon are released into the atmosphere adding to our

overall carbon budget). Critical to the success of the system is the presence of specialised fungi, mycorrhiza, in the roots of many plants. Highly efficient absorbers of water and nutrients, their presence in the root mat is essential for growth. When the forest is cleared or burnt, and the fungi destroyed, recolonisation is often impossible.

These absorptive qualities are equally important for "downstream" communities dependent on the integrity of the forests. Rain forests are appropriately named - they are literally bombarded with water every day. 200mm of rain falls in a typical thunderstorm in Ghana - four times London's monthly average. But the forest canopies break the water's impact, preventing erosion and landslides, and the root mat becomes a giant sponge maintaining regular flows of water into river systems. Deforestation brings massive soil erosion, landslides, flooding in the wet season and crippling drought in the dry months.

1.1.3 Species diversity

The biological richness of these forests is legendary. Up to 50% of all living things - at least 5 million species - are estimated to live in tropical forests. New methods of collecting insects in the rain forest canopy suggests figures of 25 million or more! The main reason for such diversity is their great age coupled with a hot, moist climate. According to the US National Academy of Sciences (NAS), a "typical" 1,000 hectare patch of rain forest contains up to 1,500 species of flowering plants, 750 species of trees, 125 of mammals, 400 of birds, 100 of reptiles, 60 of amphibians and 150 of butterfly species. Insects are so abundant and yet so scarcely studied that only vague guesstimates can be hazarded - perhaps 42,000 per hectare according to the NAS. And recent surveys indicate even higher amounts!

1.1.4 Some facts about plants

- Tropical forests contain up to 86 species of trees per 0.5ha, whereas a temperate forest has on average 4 tree species per acre.
- The United Kingdom has c.2,000 different plant species; Costa Rica which is five times smaller, has at least 8,000.
- Panama has as many plant species as continental Europe.
- Madagascar, an island smaller than Texas, has at least 12,000 plant species, over 60% of which are endemic.
- In Brunei and the Malaysian state of Sarawak there are at least 2,500 native tree species, whereas the UK boasts only 35 in an area almost twice as large.

1.1.5 Some facts about animals

- 16% of all the world's known species of birds are found in Indonesia, and one-quarter of them are endemic.

- The Sunda Shelf sector of South-east Asia (the western half) contains at least 297 mammals and 732 birds, whereas Western Europe, an area almost four times as large, has only 134 and 398 respectively.
- Amazonia contains one in five of all bird species on Earth, and at least 2,000 species of fish (ten times as many as in all of Europe).
- The Victorian explorer Henry Walter Bates collected more than 700 species of butterfly within a distance of an hour's walk of his home in eastern Amazonia in Brazil.
- Recent surveys have uncovered as many as 41,000 different species of arthropods (centipedes, millipedes, spiders etc.) per hectare of rain forest in Panama.

Because so many of these species are endemic (i.e. peculiar to a particular area), clear-felling or otherwise degrading the rain forest, results in notoriously high levels of extinction. Islands like Madagascar have suffered especially badly in this respect. Perhaps as much as four-fifths of Madagascar's rain forests have already been destroyed. The unparalleled diversity of species within rain forests means relatively few individuals of each. Most plant species occur less than once an acre. A study of 24 hectares of Malaysian rain forest revealed 381 species of tree, of which 157 occurred only once. And some of the larger mammals like Javan tigers or mountain gorillas are naturally rare because they need large hunting territories or deep cover. Any forest clearance disrupts their life cycles and slows their breeding.

While their rarity makes them vulnerable to development, our ignorance grossly compounds our carelessness in extinguishing them. A mere 1.6 million species world-wide have been named; only a small fraction of these actually studied. The US National Science Foundation estimates that there are only 4,000 scientists in the world who specialise in tropical biology; and all tropical biological research, of which rain forests are only a part, receives a mere \$40 million annually. There is both scope for and need of expeditions to tropical forest.

1.2 Types of tropical forest and where they are found

1.2.1 Main types of rain forest formation

Three main areas of tropical rain forest exist (Fig. 1.2): the largest area is in the New World from Veracruz in Mexico, in the Caribbean, south to the Orinocco and Amazon basin with an outlier on the Atlantic coast of Brazil, extending just beyond the tropics (to c.23°S.) on the one side and on the Pacific side of the Andes to Colombia, Ecuador and Peru. The next largest is in S.E. Asia: Indochina and Burma to Papua New Guinea, with outliers in S.W. India and Queensland. The third is in Africa centred on the Zaire basin, with outliers west of Dahomey to Sierra Leone and on eastern Madagascar. Some of the larger island archipelagos in both the Indian and Pacific Oceans also contain small but important areas of rain forest.

1.2.2 Lowland evergreen rain forest

This forest ranges from sea-level to 1200m. It has the richest plant community both in species number and biomass and is usually seen to have three tree layers, those reaching 45m in height (emergent trees), the main layer (24-36m) and a layer of smaller trees beneath. It includes the **dipterocarp** rain forests of the Malaysian/Indonesian archipelago and complex forests over limestone where this occurs as a country rock. (See Whitmore, (1984): chaps. 12.1, 12.4, 17).

1.2.3 Semi-evergreen rain forest

Similar to the above but it exists in areas where a seasonal water stress (i.e. a dry period) is seen. Up to one third of the trees may be deciduous although not all necessarily losing their leaves at the same time. This is a common formation in the Amazon basin and in S.E. Asia forms a belt between the monsoon and evergreen forests. (See Whitmore, 1984: chap. 12.2).

1.2.4 Heath forest

Known in Malaysia as 'kerangas' and in South America as 'campina', this is a type of forest on nutrient-poor, highly acidic, siliceous (usually white sand) soils, which although occurring in everwet climate areas, show all the morphological features of plants undergoing drought stress. Many of the trees have thick sclerophyllous leaves, which are often very small. Myrmecophytes (ant-plants) are common and the forest canopy is low, even, and open, with many bryophytes on the floor and epiphytes on the pole-like slender trunks.

1.2.5 Mangrove swamp forest

This is a fascinating coastal environment affected by tidal saline water, with a number of curious features associated with the plants that live there: flying buttresses, stilt-roots,

pneumatophores, viviparous reproduction. The ecology presents many interesting problems. (See Whitmore, 1984: chap.13.1).

1.2.6 Peat swamp forest

This forest is on highly organic soils, usually on alluvial or coastal plains. The surface is often domed and the water table is higher than that of the surrounding land. The water source is from precipitation rather than from run-off (cf. raised bogs in temperate lands). It can provide good agricultural land for pineapple and rubber plantation with clearance and drainage. (See Whitmore, 1984: chap. 13.3)

1.2.7 Fresh water swamp forest

These forests get their water from streams and are thus periodically inundated with mineral-rich water. The species diversity is still rich but there is a tendency to gregariousness not usually seen in TRF. (See Whitmore, 1984: chap. 13.4).

1.2.8 Monsoon forests

These are forests where water is periodically seriously limiting to plants and rainfall is only 275mm annually, i.e. one tenth of that usually seen in other tropical forest discussed here. Because of the dry period, fire, usually man-made, is a dominant ecological factor. (See Whitmore, 1984: chap. 14).

1.2.9 Mountain rain forests

As one climbs a tropical mountain, obvious changes take place in the structure, composition and physiognomy of the forest. Variation varies as to where in the world one explores, but basically one goes through a lower montane formation between 800 and 1250-1500m altitude and above that into what is generally known as upper montane forest, the upper facies of which merge into scrub in which heathers, cranberries (*Vaccinium*) and *Rhododendron* species predominate.

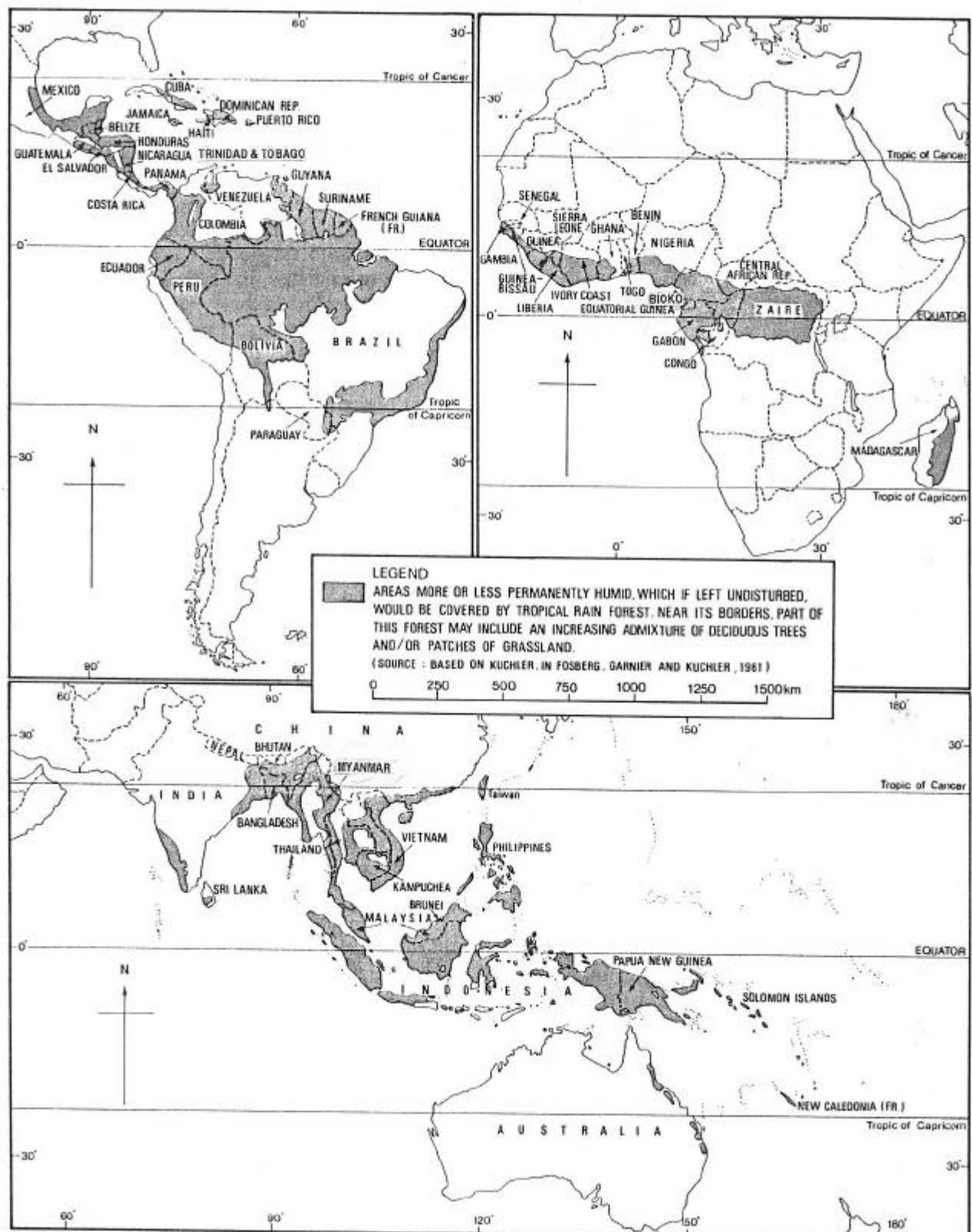


Figure 1.2 The tropical rain forest and rain forest countries

1.3 Some lines of research for rain forest expeditions: Life sciences

The ecology of tropical rain forests and their biota presents an enormous opportunity for expedition fieldwork. Any biological project carried out in tropical rain forest is going to bring the expedition members close to a wide range of plants, and to a lesser extent, animals, all of which will be completely new. There will rarely be a simple, straightforward textbook which will aid identification, even of the common species. A local scientist who knows his or her flora is indispensable to the success of any expedition that wants to work on the ecology of the rain forest. There is another good reason for having members from the host country in your team: it helps with communications with local people, gives local administrators the confidence that you have made the right contacts at central government level, and, through them, allows that government to monitor your programme and see that the host country benefits from your visit.

1.3.1 Studies on forest ecology

Although forest microclimates are stable, they can vary enormously from place to place. Studies of these environmental factors can often give stimulating results if well thought out beforehand. Raich (1989) found light an important factor in dipterocarp forest and in gaps, where he showed substantial seasonal and spatial variation. Studies as to what plant species establish themselves in gaps left by fallen trees can be attempted but problems may be encountered with the identification of seedling trees. Biomass variation in different forest formations usually needs longer periods than is available on short-term expeditions but restricted comparisons of interest can be made.

Forest inventories measuring all trees with a DBH (diameter at breast height) of 10cm or more in a 1-ha linear transect (10 x 1000m) to show diversity, frequency, density and dominance can be a worthy objective (Boom, 1986). It must be linked with collecting good herbarium specimens of each species (which can be from 90 to more than 200 species per hectare) for later determination. This is another project which would benefit by having a local forester or botanist join the team, or at least have someone in the local forest herbarium identify the species. It is also a good opportunity to collect information on local names and uses of the plants. Invariably only a number of the trees will be flowering, and then very difficult to even see, let alone collect. Good herbarium material will always be welcomed by the local national herbarium, which should always be offered the first set of any collected material. Herbaria here in the UK (Natural History Museum, and Royal Botanic Gardens, Kew and Edinburgh) will be always pleased to have duplicates of any named material, but may not be in a position to identify these plants for you.

Studies in leaf morphology in relation to forest type and altitude zonation, especially if a field microscope can be taken in, can show how plants adapt themselves to different environmental extremes. Other projects could compare structure and even physiology (e.g. photorespiration rates) of plants in sun and shade (see also Medina et

al., 1977). These physiological investigations can use simple apparatus which should be tried out before leaving the UK. For a wider approach see Hubbell (1990) and Hubbell & Foster (1992)

1.3.2 Projects involving studies of epiphytes

The tropical forest abounds in epiphytes, e.g. orchids, many ferns, the screw-pine family (Pandanaeae), the pineapple family (Bromeliaceae), and aroids of all forms (from climbers like *Philodendron* to single but often enormous plants of the genus *Anthurium*) and many others, but the diversity is not that great and, given good herbarium material collected in the field, the species can usually be identified. Lichens and bryophytes are other epiphytes more abundant in the canopy and on the more stunted trees of the upper montane forest (elfin forest). There are also specialised lichens and bryophytes, mainly liverworts, which grow specifically on leaves of young trees and larger herbs in the lower montane and lowland rain forest. These folicolous species can be difficult to identify but are easy to collect and with specialist help can be tackled on one's return. Specific studies on the distribution of mosses and lichens in relation to host specificity and position on the trunks of those host species could add substantial knowledge to an underworked field.

Vascular plant epiphytes often have complex structures to catch or retain leaf litter, e.g. special leaves as in some ferns like the stagshorn (*Platycerium*) and basket ferns (*Drynaria*). Both the roots of the fern and other epiphytes get nutrients from these aerial peat pockets. Ants and termites play a significant role in establishing these aerial gardens (Huxley, 1980) carrying up sand grains and other detritus. In a large mature crown a very wide spectrum of plants from woody rhododendrons to small sedges can live undisturbed for many years. Roots also have complex structures which help in water absorption/retention and interesting anatomical studies can also be instigated. In the rain forest the majority of epiphytes are found in the forest canopy. Methods of how to get into the tree canopy are given in Appendix 3.

1.3.3 Projects that study the inter-relationships of plants and animals

The interdependence of plants and animals presents interesting problems, e.g. flower pollination and seed dispersal. Studies on nectar production and its relation to microclimate in bird-pollinated species, e.g. *Heliconia* spp., can elucidate the role the plant itself plays on the feeding rate of pollinators. The study of ant-plants (see Huxley, 1978; 1980) and the role of ants in preventing herbivory opens a wide field for observation when one is camping 'onsite'.

Such projects must be backed up by well-prepared specimens to identify the components of these relationships, so familiarity with collection and preservation techniques is needed.

1.3.4 Ecological projects on vertebrates

Any programme involving larger vertebrate populations usually requires more time in the field than is available to the average expedition. Exceptions to this rule will be found when naturalists or zoologists of considerable experience are attached to the expedition (cf. Medway, 1972; Medway and Wells, 1971). Studies on range, feeding habits and breeding behaviour of birds are frequent objectives for expeditions and ornithological teams should contact specialists at BirdLife. (See Appendix 2). Baiting, capture and recapture of various animals (fish, amphibians and other trappable vertebrates) can give useful information on population size or location patterns.

Work on plotting and describing amphibian breeding sites together with sound recordings of their mating calls opens up a number of avenues for projects, especially where a range of altitude can be covered. In most cases the animals have to be collected and preserved for later identification

(see pp7-10).

1.3.5 Projects on the ecology and behaviour of invertebrates

Many projects on smaller animals, especially invertebrates, e.g. insects, can be carried out. Studies on activity patterns or reproduction rates, for instance, in relation to temperature and other microclimate states can be carried out in the few months available (e.g. Larsson, 1990), as can studies in feeding habits of invertebrates (e.g. Monk and Samuels, 1990). Territory ranges of certain flying insects can also be studied. Investigations into the faunal composition of forest water bodies, e.g. tree holes, water caught or secreted in leaf bases, specialised organs such as flower bracts in gingers and related plants, and insectivorous pitchers of the genus *Nepenthes*, stimulates one to think of the use of such water bodies to the plants themselves, and the interrelationships between the animals that live there. Life cycles are often extremely short where the water bodies are ephemeral and animals can often be bred through to the adult stage in the few weeks available on the expedition. Interesting short-term studies were made on *Heliconia*, a banana-like plant of the American tropics, which has hard horny persistent floral bracts. These hold liquid, most of which is secreted by the plant (Bronstein, 1986; and see Vandermeer *et al.* 1972). Identification of species is not always necessary to understand their adaption to their microhabitats.

1.3.6 Projects studying diversity

The tropical forest is one of the richest habitats for plant and animal diversity (see Prance, 1982) and some simple but informative work can be undertaken comparing animal and/or plant diversity between different habitats, altitudes, vegetation formations, regions or countries. This kind of project lends itself to longer term recording and can be the aim of successive expeditions from the same institute/university. Nadkarni and Longino (1990) compared invertebrates in the canopy and in the forest floor litter in montane forests in Costa Rica. Samples of the litter were

sifted for the following groups and the numerical dominance was counted: mites, adult beetles, holometabolous insect larvae, ants, collembola, amphipods and isopods. All were easy to identify by the non-specialist. Similar work was carried out by Mark Collins and his team in Gunung Mulu National Park (Collins, 1979a). Foraging activity of insects such as termites can be intensively studied for short periods and can result in data worthy of publication (e.g. Collins, 1979b).

Getting into the canopy of forest trees has long been both a physical challenge and scientifically rewarding. Several accounts and techniques have been documented, best summarised by Mitchell (1986); (see chapter 6) for further discussion. Assessment of arthropod diversity in the canopy has been a subject of much debate over the past ten years (Stork, 1988), but comparative quantitative studies of tropical insects especially in relation to plant host-specificities are projects worthy of consideration. The technique using knock-down insecticide fogging, which can be set up in the forest canopy by a competent expedition, can collect large numbers of insects on sheets laid out on the forest floor. Such projects should be linked in with a programme of a professional entomologist in order to maximise the data achieved as there will be many species new to science in an exercise of this nature.

1.3.7 Biological projects involving man

In most tropical forests there will be opportunities to study the way in which man has lived as an integral part of this ecosystem, in harmony with it, and often dependent on it. Such studies are usually long-term, and can also be politically sensitive as they often relate to minority tribes and nomadic peoples. However, with the cooperation of the host countries some interesting lines can be pursued by the small expedition (see Kedit, 1982). The more strictly anthropological projects are discussed elsewhere in this book, but the effect that man has had, and is having with increasing effect on the structure and components (plants and animals) of such forests, when exploiting their valuable timber resources, does present ample scope for research and is addressed in part above.

One very important area where small expeditions can collect useful information is in the area of ethnobiology - collecting information on what plants (and animals) local peoples use for medicine, food, folk-lore, textiles, etc. This is not the kind of project to be carried out by men alone, as much of medicinal and folk-lore use is known to the indigenous women only and is unlikely to be divulged to a man. Collecting such data needs a specialist approach and the reader should refer to Bellamy 1992. Tribal cultures are fragile and may take a long time to reach, both physically and mentally. In some cases it may be better not to try to do so. Furthermore, host countries may not encourage contact with more remote peoples. Nevertheless, many people now living on the edge of tropical forests or in secondary bush mosaic amongst valleys of primary jungle will have an extensive cultural knowledge of useful plants, and will be more easily contacted. Linked to any ethnobiological project must be a collection programme whereby substantial herbarium material is pressed and dried for later determination.

Another area which relates to the uses man makes of wild plant species is the study and possible collection of wild stocks of domesticated plants, e.g. sago, taro, sweet potato, yams. A living collection, again with good herbarium specimens, of varieties of these species grown in different villages or valleys can be invaluable to those building up a gene bank of living material; e.g. the International Board for Plant Genetic Resources, and this organisation should be contacted if an expedition has facilities (and permission) to collect living plants

1.3.8 Management plans for protected areas

If the expedition is visiting a national park or other 'protected' area you may be asked to prepare, or otherwise contribute to, a Management Plan for the area. The preparation of such a Plan requires a detailed knowledge of the ecology of the forest, and of the administration of the authority responsible for the park, and should only be attempted if somebody from that Department (usually the Forest Department; see Appendix 1) can be attached to your team.

Under direction, however, you can contribute useful information, e.g. towards an inventory of plants and animals there, the detailed distribution of a rare species, pressure on hunting or other uses the local inhabitants make of the park, etc., which can add to any management plans the pertinent authority might have.

Information on national parks and other protected areas for all tropical forest countries can be obtained from the Protected Areas Data Unit, at the World Conservation Monitoring Centre.

1.4 Some general points about collecting biological specimens

1.4.1 Before the expedition: the purpose and ultimate depository of specimens to be collected

After the initial outline of an expedition has been formulated, the first, and most vital, step is that of consultation. Most life-science projects will provide an opportunity for collecting plant and animal material useful to other researchers, and, other things being equal, this should not be missed. The members should talk over their proposals with people having a personal experience of working in the particular environment and with appropriate specialists able to advise on what to collect and how to collect it. These discussions with taxonomists should be directed towards resolving a number of key issues, particularly which habitats the expedition should study, and which plant and animal groups they should collect, and, most important, for what purpose. It is not sufficient to collect material for a national institution unless that institution want the material to fill a gap in its collections or to incorporate into an ongoing taxonomic survey.

It is always advisable to specialise and to collect or study only a small and manageable group or habitat, even though this often appears inadequate or undemanding in the early planning stages. It has the advantage that it can reduce the logistic problems which may arise from the transport of unnecessary collecting equipment and freight. If the programme is restricted to manageable proportions, the appropriate collecting techniques and most suitable method of data recording can be agreed. With biological collecting, preservation is also important, but fortunately, for most material required for taxonomic study, the procedures are quite simple although the techniques are necessarily involved for larger animals. For material required for histological or cytological study, special fixative solutions will be needed. Whilst discussing collecting methods with specialists, it is strongly recommended that the expedition members familiarise themselves with museum material of the groups on which they will be working and, before leaving for the field, ascertain who is going to identify the specimens.

One further issue which must be considered during the planning is that of environmental conservation, a matter which is increasingly significant as more and more habitats, and plant and animal groups, are becoming scarce or over exploited and subject to legal restrictions. An expedition must always be aware of the conservation status of the land which is being studied or traversed, especially of any laws governing the collection and removal of plants and animals from parks and reserves where permission must be obtained in advance. The fact that an expedition may be collecting for a recognised institute, or funded by an organisation with an international reputation, is no protection against the law, and transgression can only cause embarrassment to all concerned, possibly jeopardising the prospects of future groups applying to work in that country. General information on conserved areas and related legislation, and guidance as to whom to apply to in a particular country can be obtained from the Protected Areas

Data Unit of the World Conservation Monitoring Centre. In addition to conservation regulations, many countries have laws which govern the exportation of particular plants and animals, whether dead or alive, notably those countries which have ratified the Convention of International Trade in Endangered Species of Wild Fauna and Flora (CITES), in which, for example, all orchids and cacti are considered as endangered species. Information on this is obtainable from the Wildlife Trade Monitoring Unit of the WCMC mentioned above.

For a full discussion on the ethics of collecting biological materials see Cunningham (1993) and Appendix 2 for an example.

1.4.2 A note on the danger of chemicals used in collecting

We want to stress at the outset that a number of chemicals used as killing or fixing agents or as preservatives, in various institutes, both at home and abroad are hazardous and harmful to the health of those who come into direct contact with them. They may be flammable, simply irritant, and highly toxic or have recently been shown to have carcinogenic or mutagenic properties. This applies to a number of substances that have been used for many years by museums, in research laboratories and in the field. A good example is formalin, used in great quantities as a fixative and preservative since the early 1900's. For long regarded as just an irritant, it is now recognised that this substance represents a chronic health hazard and should be handled with extreme caution. This statement can be applied to many of the substances mentioned below and in the various papers included in the reference section of this paper. Please read those papers in the light of what is said here.

Some substances such as carbon tetrachloride, benzene and benzinene have been banned and their use severely restricted in biological studies, whilst others such as ether and chloroform require the strictest control in transit and in the field. Linked with this review of the risk of exposure to hazardous chemicals used on expeditions is the problem of firstly obtaining them in the country visited (i.e. you may well have difficulty in locating suppliers, and secondly, transporting them on public transport (airlines, ships and trains, where strict regulations now govern what may be carried), or by local porters in the field (for whom you have both a moral, and often legal, obligation to protect). Foremost examples of how to assess and control hazardous substances and processes are to be found in *The Control of Substances Hazardous to Health Regulations (UK)*, 1989, HMSO, London.

1.4.3 Collecting equipment used in biological specimens

The equipment needed for collecting biological specimens in the rain forest is similar to that used for collecting any particular group in other parts of the world. Due to the ever humid atmosphere, special attention must be given to effectively drying those specimens that are to be taken back in a dry state, e.g. insects and plants. The use of special kerosene (paraffin) heaters for plant drying is described in Hollis *et al.* 1977 as

is an alternative "wet" method which requires sealing pressed plants between newspaper into plastic bags with dilute alcohol and drying them on return to base or home institute.

A useful general guide to collecting those groups of plants and animals most likely to be tackled by the small expedition is given in Jermy *et al.* 1992 and Forman and Bridson 1988. That account has been confined to the collection of plants and invertebrate animals only. Techniques for collecting and especially for preserving and preparing vertebrates are often complex, hazardous, or subject to legal restrictions, and generally less suitable for an inexperienced expedition team. The subject is dealt fully in the EAC Field Techniques guides ('Mammals'-Barnett & Dutton 1995; 'Reptiles & Amphibians'-Bennett 1999; 'Fishes'-Coad 1998) and in the British Museum (Natural History) Series Instructions for Collectors: No. 1 Non Marine Mammals (Anon., 1968); No. 2A Birds (Harrison and Coles, 1970); and Fishes (Anon. 1965). Similarly, methods for collecting ecto and endo-parasites are not discussed and for reference see Anon. (1954), Lincoln and Sheals (1979) and Instructions for Collectors No. 12 Worms (Anon., 1932). Further elaboration of techniques may be found in Anon. (1954, 1957), Cogan and Smith (1974) and Lincoln and Sheals (1979).

One aspect that refers to any specimen collected, whether animal or plant, is that it cannot be over-emphasised that full details of where and when the material was collected should be taken, if possible in duplicate in case of mishap to baggage.

1.4.4 Labelling of collections

All too often, valuable material arrives back from a field trip with insufficient data or with the specimen data in confusion. It is difficult to give direct advice on methods of labelling and recording since each situation presents its own problems, but certain general principles should be followed. Every expedition party must have an adequate supply of suitable labels, notebooks and writing materials. As far as possible, each specimen or separate collection should be securely labelled at the time of collection; on no account should the data be committed to memory with the intention of making notes or labels at a latter date. It is often convenient simply to give the material a numbered label in the field and to enter relevant additional information in a notebook against that reference number. As a precaution against loss of valuable field notes, it is wise to make one or more carbon copies of the notes and to keep these copies in a separate store, or even to dispatch them home by post if the expedition is a long one. In many countries, photocopying is far cheaper than it is in Britain, so it might be feasible to copy all field notes before leaving for home.

Only good quality rag paper should be used for labelling dry-preserved specimens; for labels that have to be immersed in fixative or preservative solutions, a high wet strength paper, e.g. "goat-skin" parchment, is recommended. A cheap pulp-paper should never be used, since it will fragment easily when wet or stored in damp conditions. For this reason, all notebooks should also have a high wet-strength paper

and those used by surveyors for field records can be recommended. Labels can be written with a soft lead or wax pencil or in Indian ink, provided the ink is allowed to dry thoroughly before immersion in preservative solution. Ordinary ink and ballpoint pens must not be used.

The minimum information which is required for each specimen is the date of collection, the collector's name, the number of the specimen, and the locality in as much detail as possible; avoid place names used by local inhabitants unless they are found on printed maps. With increasing use of computer mapping of species distributions, latitude and longitude co-ordinates should be given whenever possible. It is of great importance to make notes on the habitat, type of substrate, pH, salinity, temperature (of water, in aquatic habitats), frequency of occurrence, behaviour, colouration, associated animals and plants, and name of the host (or phorophyte) if a parasite (or epiphyte). Colour notes can be referred to commercial paint colour guides (e.g. paint merchants' pamphlets), many of which are linked to British Standards coding. In the case of pressed plants, it is also useful to make notes on the characters of the specimen which may be lost in pressing (three-dimensional form, odour, etc.). However, the exact information required will obviously depend on the purpose for which the animal or plant groups are being collected and should always be discussed with the appropriate specialist during the planning of the expedition. The value of colour photographs should not be underestimated, as a quick but permanent habitat or other record; they are also very useful for recording the host of a parasite when the host is not retained as part of the collection, or early stages of insects (e.g. caterpillars) when it is essential to rear it out in the field in order to identify the species.

1.4.5 Packaging specimens for return to home base

The safe packaging of specimens and collections for transit is largely a matter for common sense, although the following hints may prove useful. Dry specimens are brittle and susceptible to damage from vibration or pressure and, in hot, humid climates, are liable to fungal attack. For dried plants, 250 gauge polythene bags sealed with sticky tape or self-sealing bags provide good protection but the sealed bags should be periodically checked for 'sweating' which will occur if the specimens are not completely dry before finally being packed for shipment. The plastic bags can be packed in small cardboard cartons before being crated in larger boxes, to minimise movement and crushing during transit. A few balls of naphthalene (moth balls) placed in each bag will protect the specimens from insect attack.

Dry-preserved insects present particular problems and for general advice see Cogan and Smith (1974). Some larger insects can be pinned in the field into store boxes; the boxes are then sealed with tape and protected by a thick layer of wadding or expanded polystyrene to give protection during shipment. Smaller insects on the other hand may be packed in small cardboard boxes with deep-sided lids, conveniently about 130 x 100 x 50 mm in size. The box can then be filled with successive layers of

cellulose wadding with the labelled samples of dried insects spread out on each level. The layers of insects and wadding can be built up as the collections are made. Cotton-wool must not be used as the fibres snag the bristles and spines of the insect appendages, which then break off when the insect is removed. Each box is finally sealed in a plastic bag to prevent pests attacking the specimens. Collections from humid rain forest should be dispatched to the specialist, well protected and by the fastest possible route. Air freight is always preferable to surface freight where funds allow.

With wet-preserved material, the aim is to ensure that the packaged specimens do not dry out. Specimen tubes are best placed in wide-mouthed plastic jars with fluid-tight screw-tops, and protected at the top and bottom of the jar with a thick layer of cotton-wool, soaked with a small quantity of the preservative used in the tubes. The jars are then best packed in heavy duty plastic drums with screw or clipped lids. Cotton-wool and other fibrous packing material must always be kept out of direct contact with delicate specimens, especially small arthropods, as they tend to become inextricably tangled during transit.

1.5 Some lines of research for rain forest expeditions: Earth sciences ¹

The complex environments of tropical rain forests provide great opportunities for short duration studies of local variations in microclimate and soil characteristics and of hydrologic and geomorphic processes. In thinking about the types of project which may be feasible in any particular forest area, the variety of forest types and terrain present must be considered. In most localities contrasts exist between ridge crest, slope, valley floor and floodplain sites. In many localities, patches of disturbed forest are close to natural forest, providing opportunities for comparative studies of people's impacts on the forest. Inevitably, many forest study sites are remote and conditions for setting up instruments for field monitoring are difficult. The high humidity often makes electronic instruments inoperable and battery life short. Experience suggests that only instruments which have proven reliability under rain forest conditions are worth using by expeditions and that rechargeable batteries, replaced every few days, are the only way of guaranteeing continued operation of battery-powered recording instruments.

The choice of field study must take account of two groups of factors, the available logistic support at the study site and the likelihood of variation in weather during the study period. Some expeditions may be closely associated with long-term projects with field laboratories and local power supplies capable of providing considerable technical and practical support. Others will be in remote areas, entirely dependent on supplies they can carry with them. As things tend to go wrong, projects must not be too ambitious and must be within the bounds of the logistic support available.

Even though tropical rain forests are wet environments, long periods without rain can occur. At the Danum Valley Field Studies Centre in Sabah, for example, annual rainfall averages some 2800mm, or more than 230mm per month. However, in April 1991, the rainfall was only 24.2mm, nearly all the days that month being dry. Projects relying on measuring rainfall and water flows may be frustrated and expedition planners should have alternative projects in case the weather is unusually dry!

1.5.1 Climatic, microclimatic and meteorological observations

The difference in microclimate between the interior of the forest and the open provides many opportunities for comparative investigations. Temperature and humidity show diurnal fluctuations, with open areas warming up far more than the forest interior during the daytime, while humidity within the forest is much more constant. Simple thermometers and hand-held whirling hygrometers read at thirty minute or hourly intervals could provide basic information. Chart-recording wet and dry bulb thermometers, or more sophisticated data loggers, would be preferable. Some higher education institutions may be able to lend the chart-recording instruments.

¹ Account written by Ian Douglas and Tony Greer (1992) in *Expedition Planners' Handbook & Directory* pp.28-34

The vertical zonation of temperature and humidity in the forest is of great interest. One simple way of obtaining a vertical temperature profile is to use a catapult to send a line across a high bough of a tree and then to haul up a rope on to which are fixed maximum and minimum thermometers at intervals of say 5 or 10m. The rope can be hauled down as frequently as required for the instruments to be read.

Rainfall in tropical regions is extremely variable over short distances. Networks of gauges could be established in an open area to assess that variability. Simple gauges can be made of plastic funnels and plastic jerry cans, but make sure the containers hold at least 4 litres if the funnel diameter is over 15cm. Gauges should be placed in a grid, perhaps 1 to 5m apart, or be laid out in transects 10 to 50m apart with gauges 1 to 10m apart along the transect lines.

Within the forest the spatial variability of throughfall, (the rain penetrating through the vegetation canopy), is even greater and the value of observations of both throughflow and stemflow, (the rain running down tree trunks, is high). To be useful, such measurement schemes have to be carefully designed. Many gauges to catch throughfall are required and they have to be relocated frequently. As the forest foliage is so varied in character, one gauge may be beneath an opening in the canopy, so that rain falls directly into it, while another may be deprived of rain by a particularly dense patch of leaves above it. Plastic funnel gauges may be used, but at least 20 would be required in a 500m² area of forest. Alternatively, lengths of plastic guttering may be used to give a larger, more representative catch area, but they require larger collecting vessels, perhaps of 10 litre capacity. Whatever type of gauge is used for throughfall, random relocation perhaps to another point on a grid selected using random number tables, is essential. The average of the catch of all the gauges, randomly relocated, can be compared with the catch in the open, to give an indication of the percent of the rainfall intercepted, i.e. not arriving at the throughfall collectors.

A small part of the rain falling on the forest runs down the tree trunks as stemflow. This is measured by fitting collars around trees to divert the stemflow into collectors. Such collectors are easily made from epoxy resin which can be moulded into the required shape before it hardens. Care must be taken to ensure there are no gaps between the collar and the bark. Again collectors should be up to 10 litres in capacity. Stemflow should be measured on at least 15 trees of varying size and species as great differences occur. The volume of water collected in a stemflow collar can be converted into a depth of rainfall by dividing it by the area of ground occupied by the base of the tree. To obtain the total depth of water reaching the ground, the average throughfall depth has to be multiplied by the proportion of the area of ground occupied by the throughfall gauge network that is not occupied by the bases of trees, and the stemflow depth by the proportion that is. The sum of the net throughfall and stemflow depths so calculated is then the net depth of water from rain reaching the ground.

Meteorological observations of the types described above could be used to establish differences between conditions in primary forest, secondary forest, grassland and open areas, or within an undisturbed forest between natural gaps, closed forest, slopes and river banks. Soil temperatures are poorly known, and soil thermometers could be used to assess thermal conditions at sites along a soil catena. Temperature and humidity observations are safe topics, while with rainfall there is always a risk that the expedition may coincide with an unusually dry period.

1.5.2 Studies of soils and forest floor conditions

The forest floor is a key part of the forest ecosystem. The plant debris that falls to the floor is attacked by decomposing organisms releasing nutrients to be added to soil, taken up by plants or lost to drainage waters. Litterfall rates can be assessed by establishing simple traps under various types of forest canopy. Essentially a litter trap is a fine gauze mesh suspended between four posts about 50cm above the forest floor. Usually about 1m², the traps should be emptied every day, or at frequent intervals, otherwise insects will have already destroyed part of the material. The litter may be dried, in the sun if an oven is not available, and weighed, to obtain an estimate of the litterfall per m². A simple classification into leaf, twig, other plant fragments, insects and other debris may be attempted. As litterfall varies seasonally and depends on wind and rainfall, time is a constraint on the value of results from short term studies, but comparisons of litterfall in different types of forest, and particularly between natural forest and secondary regrowth would be most useful.

A wide range of assessments of the physical properties of soil may be made in the field, including measurements of infiltration, bulk density and permeability. Infiltration can be measured using a double ring infiltrometer, made of two rings, possibly of strong plastic of the types used for gas mains, or of metal, 20cm deep and one about 30cm diameter and the other 36cm. The two rings are driven into the ground. A known quantity of water is applied to the ground surface inside the inner ring, and the time taken for that water to infiltrate is calculated. The result is converted into the depth of water infiltrating in one hour. Infiltration rates vary greatly with soil types, from 10 to 27cm h⁻¹ over a range of soils in Puerto Rico.

Bulk density measurements require access to a balance, but are easily accomplished if one is available. Permeability may be measured using a field permeameter which is easily constructed in a workshop but would have to be thoroughly tested before being taken on an expedition. Details of these techniques are readily available in texts such as those edited by Goudie (1989) and Landon (1984). If a field test requires a ready water supply or needs basic laboratory facilities, their accessibility must be ascertained in advance.

Soil description in the field, by excavating soil pits and examining soil profiles, a major activity on many expeditions, is particularly valuable on a downslope catena if

linked to studies of litter and slope hydrology. The percent silt-clay content of a soil, a good indicator of water holding capacity, can be obtained by sieving if a 63 micron mesh sieve, lid and collecting pan are taken in the field, and water and a good balance are available.

1.5.3 Soil erosion and nutrient loss investigations

Concern about the impacts of forest disturbance leads to many proposals to measure erosion and the removal of chemical elements in solution. In planning to undertake such studies, the episodic nature of erosion must be recognised. A few heavy rainstorms may carry away nearly all the soil eroded in a year. An expedition may be lucky to sample such a major event, but probably it will not do so. Comparative studies are therefore more appropriate for short-term projects. The second factor is the level of logistic support for such investigations. Chemical analyses are only possible if portable field analytical kits are available, or if local laboratories are able to assist, or if an adequate number of samples can be taken back to the home country base for analysis. Concentrations of most dissolved substances in tropical rain and river waters are extremely dilute, usually less than 10mg l⁻¹ for most elements. If field analysis is planned, the field kit must be able to give reproducible results for such low concentrations. As samples deteriorate with storage without refrigeration, transport back to home base for additional analyses may be unwise. Analytical specialists or geochemists should be consulted before finalising the programme.

Notwithstanding the necessary cautionary approach to erosion studies, highly valuable projects can be carried out, particularly when disturbed areas subject to large amounts of erosion are compared with one another. A typical project might be to investigate erosion on abandoned logging tracks, one of which has uninterrupted flow of surface water downslope, the other having barriers to trap sediment and impede water flow. Small runoff plots, 5m long and 1m wide, can be installed with a collector trough made of guttering at the lower end and walls of waterproof canvas or wooden boards. The trough will have an outlet leading to a collector, usually at least two plastic dustbins linked by plastic hoses so that the overspill from one goes into the other. Usually such materials can be obtained in towns close to the field area. Volumes of water collected and the concentration of sediment in the water need to be determined. The latter can be done by filtration in a laboratory, or in the field using pre-washed and weighed filter papers fitted in a filter holder through which water can be pushed using the air pressure created by a bicycle pump. The filters retaining the sediment can then be dried and taken back to the home base to determine the weight of the sediment. Samples of the collected water could be analysed.

Water can be tested for temperature, pH and conductivity using small field meters, but many such instruments are unreliable under humid tropical conditions. pH cells must be kept in standard solutions except when in use. Conductivity reflects the chemical composition of water and thus is useful for reconnaissance studies to test

whether tributary streams have similar solute contents or to identify where major changes in water quality occur. A field check using pH and conductivity meters is advisable before selecting sites for water sampling in a study designed to highlight environmental contrasts. Levels of dissolved oxygen indicate the potential of streams for aquatic life, but dissolved oxygen meters must be calibrated with standard solutions. Before buying or borrowing such field instruments, advice should be sought on their suitability and robustness under rain forest conditions.

Stream water quality is an excellent environmental indicator. In the Amazon basin, rivers are described as black water, white water and clear water rivers. The acidic, dilute, black waters are found in many sandy podzolic areas of the tropics, including large areas of coastal peats and freshwater swamp forests. Classifying rain forest aquatic environments in this way, by water testing over a wide area, is an ideal expedition project.

1.5.4 Investigations of river morphology and fluvial processes

Rivers draining rain forests differ enormously according to the geologic history of their catchment areas and the climatic regime of their part of the tropics. Detailed observations of river channel form and process in the tropics are needed to improve flood prediction and sediment load forecasts. Simple surveys of channel cross-sections and the mapping of channel bed materials and vegetation provide useful information. Mapping of the distribution of sediments of different sizes in the channel and on gravel bars helps to establish the material available for transport during high flows. Measurements of sizes and lithology of pebbles, preferably using the 4 to 6cm long axis class, help to establish the way rock fragments change shape and lithologies are eliminated with downstream transport. Tropical vegetation grows rapidly, but on river channel margins it shows a zonation related to flood frequency. Mapping this riverine vegetation with simple descriptions in terms of life-forms, gives a good indicator of annual and extreme flood heights.

Small streams are often encumbered with large amounts of broken tree trunks and branches, some of which form debris dams which trap sediment being transported downstream. Such debris dams are washed out during the biggest storm events or exist until they rot away. Although they have been well studied in the wet temperate forests of the west coast of North America, they have seldom been investigated in the tropics. Simple surveys of the amounts of coarse woody debris and numbers of debris dams in streams of different size, lithology, gradient and disturbance by people would add to understanding of how biological and hydraulic factors work together in rain forest streams. If a major storm occurs during an expedition period, the opportunity should be seized to resurvey any stream for which debris data had already been collected.

Many have hypothesised that tropical streams exhibit minor fluctuations during calm weather as a result of the daily evapotranspiration cycle. If a simple river level

gauge, in the form of a graduated board or staff, can be erected on a stream bank, hourly observations, day and night, could enable any such fluctuation to be tested. This work could be coupled to air, soil and water temperature measurements, pH and dissolved oxygen determinations to reveal whether significant diurnal variations occur. Ideally such observations could be repeated on streams of differing characteristics.

Many of these projects involving aspects of the hydrological cycle and fluvial processes could be combined together in a team study, with individuals having responsibility for different components, such as rainfall and interception, slope processes, channel form, and river water quality. Detailed studies of soil properties and hillslope hydrology have been integrated in this way.

1.5.5 The impact of varying degrees of forest disturbance

Although much remains to be learnt about the undisturbed natural rain forest, even more information is required about what happens in areas that have been logged, cleared, replanted or abandoned to secondary regrowth. Usually patches of such modified forest are readily accessible and provide good opportunities for short term comparative investigations. In particular, areas of soil compaction, such as logging roads, places where logs were assembled, abandoned construction sites and tracks along which logs were dragged, may be investigated to determine how dense the vegetation is a certain time after disturbance has ceased, the proportion of water still running over the surface, the amount of organic matter on the soil surface, the size and length of any rills and gullies and any other evidence of the rate of recovery from disturbance. All the projects relevant to natural forest are relevant to disturbed or secondary forest.

1.5.6 The importance of preparation

Work in tropical forests is hot and uncomfortable, despite the splendid ecological variety and complexity of the environment. Everything possible must be done before departure to ensure that projects will work and instruments will function. All equipment and techniques should be thoroughly tested in a forest environment near the home base before departure. Try constructing a runoff plot at home if one is to be built in the rain forest. Many of the problems of ensuring all the water runs into the collector will be discovered and precious expedition time will not be lost. This applies to any planned field construction or installation. The tools needed in the field will be identified and any missing information can be sought before departure. Check carefully the assistance available in the field and find out what restrictions or regulations there may be on taking samples out of the field area or the country, or on importing them to the home country.

Additional information on techniques may be found in Goudie (1989), Haynes (1982), Landon (1984) and Anderson & Spencer (1991)

¹ This chapter is based on Jermy (1992) and Secrett (1985) *Rain Forest: protecting the planet's richest resource*. Friends of the Earth, London.

Chapter 2: THE EXPEDITION IN THE FIELD

2.1 Contact with local people

2.1.1 The importance of reconnaissance

As with all expeditions, a reconnaissance trip to the country and area of the proposed expedition is important and well worth the cost and effort. Not only will the usual contacts be made (diplomatic, civil, police, scientists and possibly military), but the recce team should also endeavour to contact those with local knowledge of the tropical forest to be explored. It is important to speak to forest dwellers, whether they are hunter-gatherers, peasants clearing land, loggers or prospectors.

These people will almost certainly be an indispensable source of help and advice, as well as provide a rich cultural experience. In return for this advice, the least the expedition can offer in return is complete respect, generosity and consideration. Good relations established on a recce can help put the future expedition into the field with confidence. The recce team should also discuss and plan the effects of the expedition on the often delicate economy of the area. It can decide whether locally grown food can be purchased for the expedition, without being detrimental to the community's own needs.

2.1.2 Local protocol

As you will have already made the major diplomatic contacts, on arrival in the host country it is important to double-check the protocol for visiting your specific area. There may well be local police or provincial/district regional officers to be seen and specific permits to be obtained. Those permits you have been given already may have to be over stamped and ratified. More protocol may be needed "up country" than is apparent (or even understood!) by federal or regional departments.

You may have to make courtesy calls on regional and village headmen of those villages through which you are to travel. There may also be a hierarchy to be visited in a strict order of precedence.

2.1.3 Interpreters and carriers

To be able to communicate with the local people is paramount. If wise you will have a member from the host country in your team. In rural areas, especially those remote, you may well need further interpreters - those that speak the lingua franca of the region and local dialects/languages used along your expedition route. Therefore you may have to employ such a person for the whole expedition.

Your carriers (known as porters, woodsmen, workmen etc. in different countries) should be selected with the assistance of your interpreter at the beginning of the expedition, close to your point of departure. Arrangements may well have to be made to change your carriers en route, pay off the earlier ones and take on new ones as you enter a new tribal or linguistic area. In some cases, carriers may not wish to be away from their fields too long so will only take you to the next village. This will help to spread the cash you are bringing into the local economy.



Figure 2.0. Carriers arriving at a village in the Finisterre mountains, Papua New Guinea. Photo: Clive Jermy



Figure 2.1. Carriers waiting for payment, Papua New Guinea. Photo: Clive Jermy

The carriers and interpreters must fully understand their terms of employment during the trek. This should include:

1. *The length of their contract including their hours of employment and payment per day.* Payment should be made in small cash at the termination of employment (there are usually local government rates to guide you) and they should be made aware of any bonuses for extra work. Payment in South East Asia often includes cigarettes. Do not inflate local government rates to bring them in line with your own values as this brings problems to the local economic structure as well as to later expeditions.
2. *Whether food is to be provided for the carriers by the expedition.* You must decide when and what will be given out daily. (See below). Special food may need to be purchased, as well as cooking and eating implements.
3. *If they will be provided with a rucksack or not.* If not they may need time to make or collect their own. The reconnaissance should ascertain if they carry individually or in pairs using poles and 'bush rope' (lianas from the forest).

4. *What equipment you are providing for their accommodation e.g. tents, plastic sheeting, tarpaulin etc.*
5. *If the carriers are expected to set up your camp when required.*

Usually the hired interpreter will be in charge of the carriers; he may be the leader of the carrier team. Sometimes it may be politic to take a government official but they seldom carry equipment. It is through him that you can give your instructions for movement, daily routine, pitching and striking camp. He can act as an intermediary for any problems which may arise with the carriers and as a means of ensuring that the carriers feel that all their needs are understood and acted on.

A good foreman carrier/interpreter will act as a supervisor on the trek to ensure that the carriers keep up a good pace, but it is sensible to place a good member of the team at the rear of the column to ensure that they do not straggle behind.

Carriers usually prefer to stay together once a camp site is chosen. They will erect their "lean-to", drape their tarpaulin and make a fire in its entrance. They are always efficient in making themselves comfortable whatever the weather, and will soon have their meal on the boil.

It must be remembered that local people prefer their own type of food - corn, cassava, beans, manioc, and rice in South America, rice and tinned fish in S.E. Asia, posho in Africa. Most do not like the tinned or dehydrated British rations which are designed for the European palate. It is most important that the carriers' rations are distributed daily before they pack and load their equipment for the trek. If you issue them food for a week, you can guarantee they will have eaten it in two or three days and will clamour for more. It is an old ploy. Carriers do like to have an issue of tea and/or coffee, biscuits and/or stick tobacco and newspaper to supplement their rations. The occasional extra as a bonus for good work is also an incentive to maintain an harmonious team.

After the evening meal, do not be surprised if the carriers chat away around the fire late into the night, before they finally curl up and fall asleep around the dying embers. However late they go to sleep, they will always be first up and will have a fire going just as dawn breaks.

If you are travelling to high altitudes on a mountain you may need to supply extra shirts, woollen jumpers etc. and blankets for warmth at night. Picking up garments at jumble sales before you leave the UK can be useful.

At the end of the expedition, when you decide to pay off your carriers and interpreters, you should work out all their payments in advance, get piles of cash prepared and conduct the "pay parade" formally. It is sensible to take small gifts for

each carrier as a memento of their time on the expedition, such as expedition T-shirts, hats or brochures, which they can show with pride to their family when they return home. Ideal presents are machetes or simple expedition implements which you no longer require when the expedition is over. Knives, mess tins, rope or even biscuit tins will be invaluable to them. In some places, a bonus may be expected upon completion of the expedition – sometimes as much as 10%.

Depart as friends, for your relationship with your carriers may well help other expeditions which come into the area at a later date.

2.1.4 Contact with indigenous tribes

Isolated ethnic groups tend to be extremely conservative and traditional - much more so than most groups you may have met previously. Many of the customs that we consider normal may be taboo, so try and learn as much as possible about their habits from your guides. For example, in South-east Asia it is usually considered impolite to enter a longhouse wearing boots or shoes. Do not rush things, but slowly gain their confidence. In some places men and women do not sleep in the same hut, even if they are married.

Some tips on first contact:

- Allow your interpreter and a couple of local people to approach first and explain why you as "whitemen" are coming into their territory. A small group approaching will allay any fear of aggression.
- When your interpreter waves you forward, do so slowly and in friendship, smiling, but make it obvious that you are the person in charge of the group. Keep any weapons hidden or leave them behind.
- Shaking or holding hands is a universal way of showing friendship. Do so with as many of the people as possible.
- Do not take pictures or start bartering until you have become friends and the tribe shows that it does not object.
- Ask for the Headman and when he arrives show respect for his position in the community and offer your gifts (salt, tobacco, knife or machete, beads, mirrors, coloured cloth, combs or needle and thread are always acceptable). Be as generous as possible. Tribal people do not appreciate possessiveness or stinginess.
- Express interest in his village and accept with gratitude any drinks or food given to you (whatever it looks or tastes like) - keep smiling.
- Treat all women with respect and do not show interest in them - however attractive they may be.



Figure 2.2. Roger Chapman (with pipe) making first contact with members of the Tigiri tribe in the Western Highlands of Papua New Guinea. Photo: Bill Neumeister

2.1.5 Staying overnight in a village

Once you have gained the peoples' confidence, ask permission to make your camp close to the village. Make payment in cash or kind for all food purchased. There may be an "official" Government house in the village for use of visitors of your standing. It would be impolite to refuse such hospitality on your first night in the community.

You may want to pay off your carriers and recruit new ones the following day from this new village, but do not release your first carriers unless you are sure of obtaining new ones.

If you are entering a new tribal area, it is a suitable time to pay off a couple of your carriers and employ two men from this village, who may well speak the language of the next tribe and have knowledge of trails en route which are not marked on your map. Conduct this arrangement through the Headman and your interpreter. Use every opportunity to gain as much knowledge from the tribe about the route ahead, obstacles, problems and details of the neighbouring tribes. The Ministry responsible for remote areas or tribal people may not have had much information about this remote part of the rain forest. Check, before going in, what information could be useful, and make notes about the village - which may prove useful for your report.

Ask permission to photograph e.g. huts, gardens, implements which can support your report (make a note of the film shots to correlate them after they have been developed). Instant Polaroid photographs can help break down peoples' reserve.

Some expeditions' medical teams open a surgery for those people in the village who require treatment for tropical sores, cuts, abrasions, etc. Even if you do not have a trained medic, you can help the community by dressing sores etc. However, it is often illegal to do so in some countries and you should check before you allow your medics to carry out any medical aid (without a licence for the country in question) on behalf of the local communities – remember, even if you are experienced enough to give other members of the expedition a shot of antibiotic the local people may be allergic to the serum and react violently, and even tragically.

Make sure that your camp site in no way hinders the general life of the village. Keep everything neat and tidy and beware of "light fingers". Empty tins, cardboard boxes and plastic bags may all be useful to the people of the villages. On one recent expedition to the Far east, only smart training shoes, and nothing else, were taken from the base camp by some fashionable thief!

If you have any doubt about the friendship of the people, keep a guard by the fire throughout the night.

Do not be surprised if your every action is watched by a large crowd of villagers throughout the daylight hours. Your team will be a novelty and a constant source of wonderment. If you have scientists who want to sort specimens, you may have to cordon a "lab" area.

Express your gratitude to the Headman for his hospitality with a small gift before you depart (fish-hooks, hammer, saw, bush knife, nails or a machete). He may well arrange for the young men to travel with you until approaching darkness forces them back. They prove invaluable as guides and extra carriers.

Shake hands with as many people as possible and try and maintain that feeling of good will and fellowship.

If you are discourteous, aggressive or unappreciative, bad words about your behaviour will travel to the neighbouring villages much faster than you do, as drums are often used to warn other villages of your approach. In Zaire, West Africa, I heard messages pass by drum up to 50kms in the stillness of the night.

The simple rules for a pleasant association with the local people you encounter are: "Act naturally, with common sense and good behaviour, display good manners, show respect, generosity and meticulous honesty"

2.2 Movement and navigation on land

2.2.1 Trekking routine

It is hot and humid in the rain forest. Even in the dry season, it rains a great deal, particularly in the late afternoon and during the night. For much of the globe where rain forest exists, daylight and nightfall arrive very quickly and in the forest it can get dark within ten minutes. Within 5° either side of the equator, daybreak and nightfall will be around 6am and 6pm respectively: if you are in dense forest this can be somewhat later/earlier. Thus, it is important to travel early in the day and to pitch camp by mid afternoon whilst there is plenty of daylight. However, your daily routine may depend on rainfall patterns if you are to achieve your aims.

A steady pace can be maintained during the day by the line of the trekkers, with the weakest or slowest member of the party close to the leader. A possible order is as follows:

Guide/cutters - line leader - interpreter - slowest members of the team - team - carriers - "tail-end Charlie".

On the trek, you must ensure that you have members of your team interspersed with local carriers and that your best team member takes up the "tail-end Charlie" position; otherwise, the group will get out of control. Everyone should be able to see the person in front. Go at the pace of your weakest person; always keep the person in front in sight and ensure that the guide does not move too far ahead - load him down with a heavy pack if he does. The "tail-end Charlie" should warn the line leader by whistle if there is a straggler, if the line of march is too extended or if there is too much bunching (which leads to people continually bumping into each other and being hit by springing branches caught on the rucksack in front).

It is advisable to know where the medic and medical pack is, in relation to the team. The leader may well decide to move up and down the column, in order to keep an eye on the whole party. Messages should be passed clearly by voice whenever required, although they tend to become garbled in larger groups ! As a general rule, it is a good idea to stick to the 50/10 rule. That is, to trek for fifty minutes and halt for ten minutes each hour. This may well have to be adjusted but will allow the team to settle into a good rhythm and maintain a steady pace. Resting, re-filling water bottles, treating blisters, de-leeching and discussing the route can all be carried out during the halts, although these activities should be ongoing throughout the course of the day.

The trekkers should maintain a comfortable pace that allows them to remain relaxed yet aware of their immediate environment. Everyone should keep an eye on the people around them, looking for signs of fatigue and heat-related problems. It is important to look ahead at the trail and the foliage, to ensure that there are no snakes or protruding roots and vines waiting to surprise the team. Hazards should be pointed out

and relevant information passed down the line to keep everyone aware of salient points.

2.2.2 Following local trails

When travelling through rain forest, maps will be of limited help. Trails, even if well established (e.g. between villages), cannot be located under the forest canopy by air photography and transferred onto a map, although government officers may sketch in their routine patrols. Without exception always use local guides, who not only know the route but will also know its condition, whether bridges are intact or ladders up steep rocky climbs are safe etc. No map, written instruction or graphic can replace the local guide. It is far easier to take the advice of local guides who use these local trails than to cut your way through the forest on a compass bearing.

If you use local guides on long treks and change them at every new village, ensure that they fully understand what you want. Never ask local people any important question to which the answer could be yes or no. They will say "yes" to anything just to please you. Double check and spend time with them discussing the route through an interpreter, before you place them in the lead.

As far as possible you must check and recognise on the map every stream and river you cross as these are more likely to be marked accurately on the map. Compare the magnetic bearing with the grid bearing (do not forget the mean variation) of the flow of the river or stream, and, if possible, check its height with an altimeter. Take care that your machete is not affecting your compass reading; it may become magnetised during sharpening.

You may also want to traverse a route again, without guides, so remember to blaze or mark both sides of trees for the return journey. Regularly used routes can be marked with orange plastic tape which can be bought in rolls. This is also useful for marking courses through island complexes on rivers. Look out for previously slashed saplings or broken twigs, which are the signs of a regular route. A local guide will recognise the route immediately.

Most trekkers tend to imagine they have travelled further than they really have. It is wise to check out your average speed at the start of any long journey by pacing over a selected known distance. If you have to count paces for increased accuracy, count every 100 paces then notch a stick, transfer a stone from left to right hand or use a 'worry bead' as an abacus. Simple, thumb-operated pace counters are often available locally and are excellent for use on the trail.

Ensure that a couple of cutters are widening and marking out the trail with machetes, so that the freshly cut foliage can be seen easily. If you come to a track junction, mark trees with a notch or clearly indicate the route that you have taken with orange tape for those that follow.

Use your common sense and do not have too high an opinion of your ability to cover great distances – remember that the heat will affect your speed and the endurance of the team.

It is also wise to keep a record of your route in a notebook so that you can fill in details on your map once you have returned to camp and complete your diary with all this information.

2.2.3 Cutting a trail

If part of your aim is, for example, to reach the summit of a mountain, or to take altitudinal samples through different forest formations, then you may well have to cut your own trail.

There are no hard and fast rules for cutting trails. One way is for the main cutter in front to tackle major obstacles, followed (at a safe distance) by a second cutter to clear more vegetation and push aside felled branches. The leader takes frequent compass bearings to keep a route.

A more elaborate way is to have two cutters with machetes in front, followed by one person with a pole or marker. They, in turn, are followed by the line leader with a compass and another person counting paces. The line leader calculates the magnetic bearing by converting his grid bearing (by adding the magnetic variation), then directs the man with the marker pole onto the line of the magnetic bearing on his compass. The line leader can then mark his map every 1,000 paces (approx. 1km). The trail can be widened with machetes or marked with orange tape if the trail is to be used continuously in the future.

Obviously, the speed of movement varies as a result of the rate of cutting, thickness of vegetation, and topography. For greater speed, use a prismatic compass to find a tree on the correct bearing and push towards it cutting the minimum amount of vegetation; then repeat. Cutters working behind you open the trail to the required degree. Cutting can be very tiring, so the line leader should change his lead cutter every half hour or so. Pause frequently to sharpen machete blades; keep them razor sharp. This will ensure that a good speed will be maintained. However, it is important to remember that the line leader can only tell the distance travelled from paces and his exact position only when the line reaches a recognisable pre-determined location. It is also useful for him to maintain a running log of all the information gained on streams, obstacles, land falls etc. if the new trail is going to be used by other parties who may need a full briefing on the new route.

GPS units are extremely useful navigational aids in the jungle, although sometimes the canopy can slow down the reception with the satellites. If GPS units are

issued, all team members should be taught how to use them, but on no account should electronic devices totally replace a map, compass, pacing – or your local guide.

One point to remember is that although local guides might well know the area and can guide you and your team through the forest they often tend to take very direct routes from A to B. If the trails that you are cutting are going to be used regularly by expedition members, scientists and the like, it is worth spending some time to plan and cut an easier route that involves contouring around and ridge-lining along features. This is not always possible but it will make gathering your forest data from remote locations somewhat more comfortable if you do not have to climb a jungle-covered, vertical hillside for an hour, first thing every morning!

2.3 River Crossings

“More tragedies occur from river crossings than from any other cause on forest expeditions. People continually underestimate the power of water”.

In 1986, when I made my first expedition forage into the rainforest, the primary thing that struck me was just how wet everything was. This water, part of the continual climatic cycle, has to go somewhere and as the forest floor is invariably poor in absorbing much moisture, it is usually drained away through rivers and streams.

As anyone who has travelled on foot through rainforests will tell you, river crossings are frequent and often present problems.

2.3.1 Streams

Streams and tributaries are the most frequent found obstacles and on face value present the trekker with little difficulty. However, they are often associated with very steep banks and are occasionally hidden by foliage.

The local remedy for these obstacles is to cut two or three short, sturdy poles and to lay them side by side to form a bridge. This works well when the poles are new and strong but can double the problems as they deteriorate. Lichens and fungus grow on these poles and they become wet and slippery. Termites and rot invade the structure and they become weak.

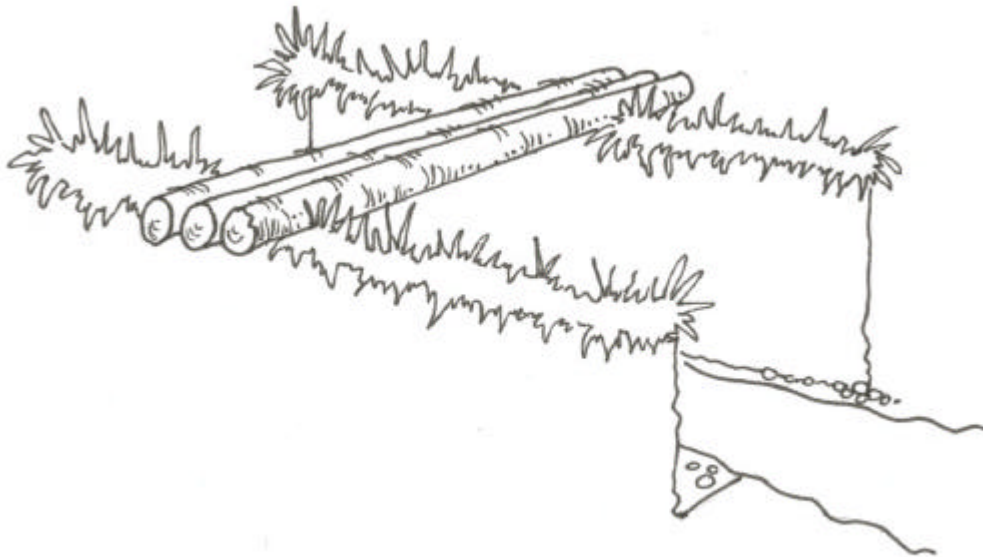


Figure 2.3 Log crossing- Bob HartleyÓ

Great care should be taken before committing a fully laden westerner to one of these 'bridges' and, if necessary, they should be replaced. This is a relatively simple task and, with careful selection, need not be invasive to the surrounding forest. Stakes can be used to stop the logs rolling sideways on the banks.

2.3.2 Rivers

Many rivers are often shallow and 'fordable' without slowing the trekkers' progress too much. Therein lies another frequently experienced problem. The submerged rocks and boulders found on the river bed are often concealed by dirty or tannin filled water.



Figure 2.4. River crossing using submerged tree trunk, cut logs, balance poles, and stepping stones. Photo: Bob HartleyÓ

Care needs to be shown and side stepping with the support of a walking pole is advisable. This also eliminates that ‘sudden shock’ when holes or pockets are found on the river bed. A safety recce should be conducted prior to every river crossing even if it is only a cursory glance from the more experienced leader.

Concern should be shown for what is up and down stream, what is likely to be inhabiting the river, what is happening to the river ie: washing chemicals from mines or latrines for local villages, and how fast the river is flowing.

There are obviously many other concerns depending on the groups’ capabilities, rainfall and the condition of the individuals.

2.3.3 Deep Rivers

Deeper rivers are often accompanied by a local solution for crossing; a felled tree or improvised suspended bridge to name but a few.

The felled tree solution has all the limitations of the short poles mentioned earlier and they need to be surveyed to check their suitability. The implications of a fall into a deeper river are obviously more serious. They are no less likely to collapse if they are rotten and I have seen some fairly large tree trunks crash into rivers under the weight of an unsuspecting trekker.



Figure 2.5. Local guide crossing bamboo bridge in Sarawak. Photo: Bob Hartley

The improvised suspension bridge is usually built to support the lightweight frame of the indigenous population and not the beefy, rucksack-laden westerner.



Figure 2.6. Crossing a bamboo bridge with handrails in Sabah. Photo: Bob Hartley

Great care needs to be taken on these bridges that tend to creak and wobble during crossing. Bamboo is often used in the construction of bridges and this, like most products used, has a limited life span. It can become brittle as it ages and collapses in dramatic style. The sharp edges and tendency to splinter increases the risks associated with the use of bamboo. It is also smooth and offers little grip.

2.3.4 River Crossing Approaches

All river crossings should be approached with caution and a suitable crossing point established. A safe entry and exit point should be found as well as the consideration of what to do if someone takes an unexpected swim.

I would advise all visitors to the rainforest (who intend covering some distance on foot) to take a safety rope. The use of ropes will be covered later but as a throw line or handrail it justifies the extra weight involved in carrying one.

Steep descents to enter a river should be avoided as retreat is difficult and an air of trepidation exists even before entering the water. Equally the exit may be difficult once the river has been crossed if it is too steep and too many people have found

slippery, crumbling banks barring their way as they try to get out of the river. Foliage, lianas and thorn bushes only add to the difficulties of river crossings and should be avoided if possible.

2.3.5 Roped River Crossings

The use of the rope in the United Kingdom is considered a last resort. I believe that its use should be contemplated earlier in a rainforest as it can be instrumental in preventing disasters with some very simple procedures. The aforementioned log river crossing can be made safe with the use of a rope handrail.



Figure 2.7. Crossing a river in Sarawak. Tree trunk is submerged and a tensioned rope hand rail is in use. Falls are likely as the wood is slippery and hard to see. Photo: Bob HartleyÓ

There are several methods of securing these but ideally two trees in line with the log should be found. A rope tensioned at just above waist height will afford sufficient support to prevent falls. Tension can be obtained by improvising a pulley system using a carabiner, or even a bight in the rope, and then doubling it around a tree. .

Dynamic rope will need quite a bit of this as the stretch will be significant. The rope can also be used as a 'life-line' for less confident team members in much the same fashion as 'short roping' techniques are used in mountain craft. It is often referred to as 'dog leading', which is probably the most appropriate expression and in itself is self

explanatory. The ideal knot to use for this would be the 'bowline' as it is easily tied and, more importantly, easily undone.

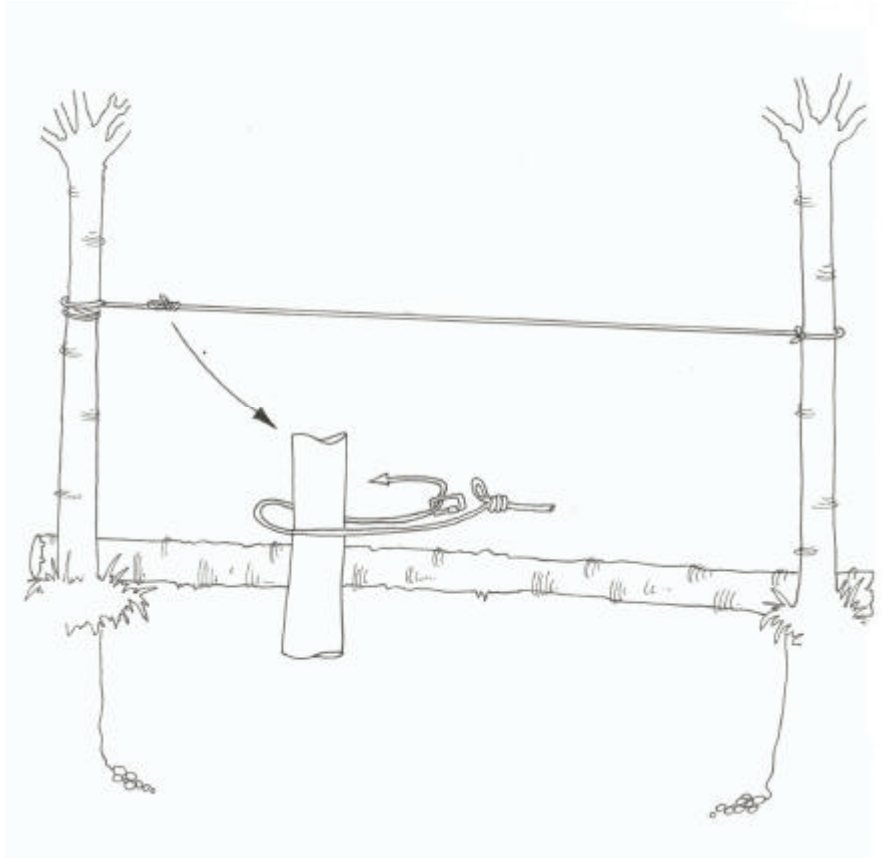


Figure 2.8 Tensioned handrail - Bob Hartley

More sophisticated systems exist but need to be learnt and practised if they are to be used to good effect. The 'pendulum system' or 'continuous loop' are the two favoured by the Mountain Leader Training Board and both offer excellent security if used correctly. The limitations of both of these systems are that the rainforest floor is a mass of branches, vines and foliage. Add this to the coils of a rope and you have a recipe for confusion. Tangles are commonplace and unless strict discipline is in place, the time lost through employing one of these systems could become detrimental to the group's progress.



Figure 2.9. Crossing a wide river whilst balancing on a slippery tree trunk. Note the tensioned rope handrail overhead and rucksack carried on one shoulder in case of a fall. Photo: Bob HartleyÓ

In conclusion it would be advisable to instruct all visitors to the rainforests of the world to prepare themselves for the inevitability of river crossings. I once experienced twenty-seven serious crossings in a nine-day trek and although practise does prepare the individual, it is rare to find two river crossings that are the same. Each has a complication that needs to be catered for and that is, in itself, half the fun of it. Rivers should be treated with respect and the ‘gung ho’ approach of wading chest deep through fast flowing rivers avoided at all costs. Equally, over confident prancing across logged river crossings will lead to disaster. As sure as buttered toast will always land spread side down, the cocky log crosser will fall, usually with a leg either side of the log, resulting in a groin wrenching injury.

As with many aspects of rainforest travel the local people will usually know the best approach when crossing rivers. Seemingly impossible rivers may necessitate the summoning of a boat or a drastic change in direction. The individual needs to remain flexible and adaptable. Rivers can often suddenly swell and become impassable as a result of prolonged rainfall and just as quickly recede. It may need a little patience but waiting on the bank may prove to be the safest option.

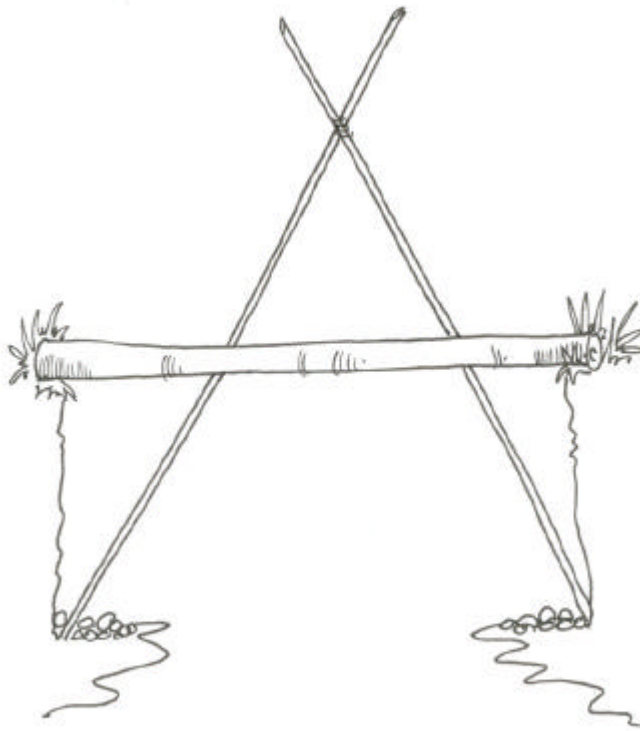


Figure 2.10. Log crossing with balance sticks - Bob HartleyÓ

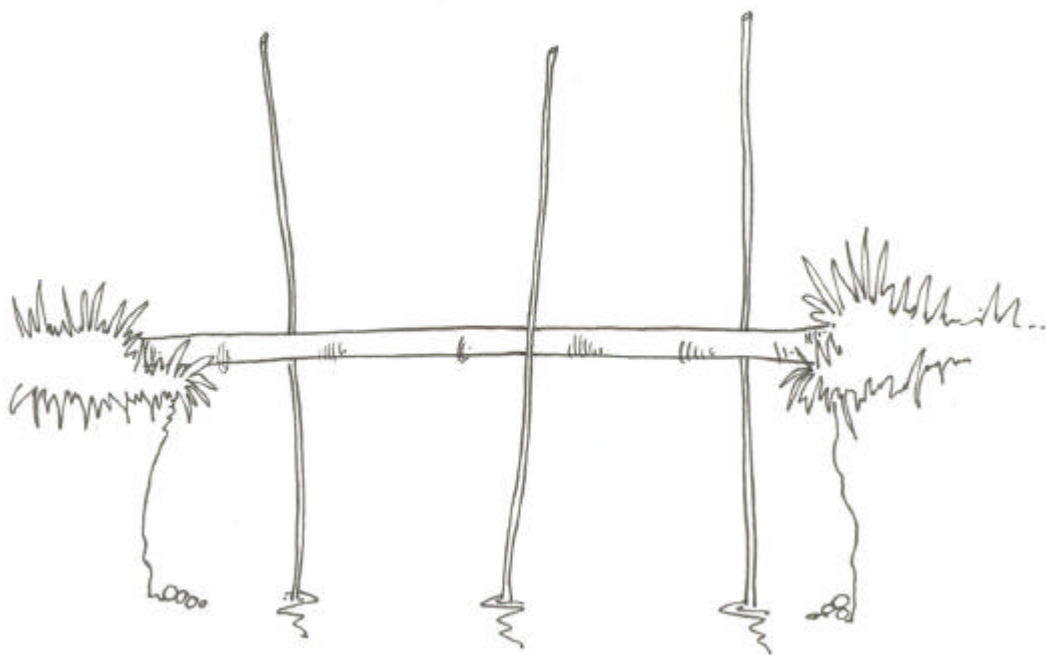


Figure 2.11. Log crossing with multiple balance sticks - Bob HartleyÓ

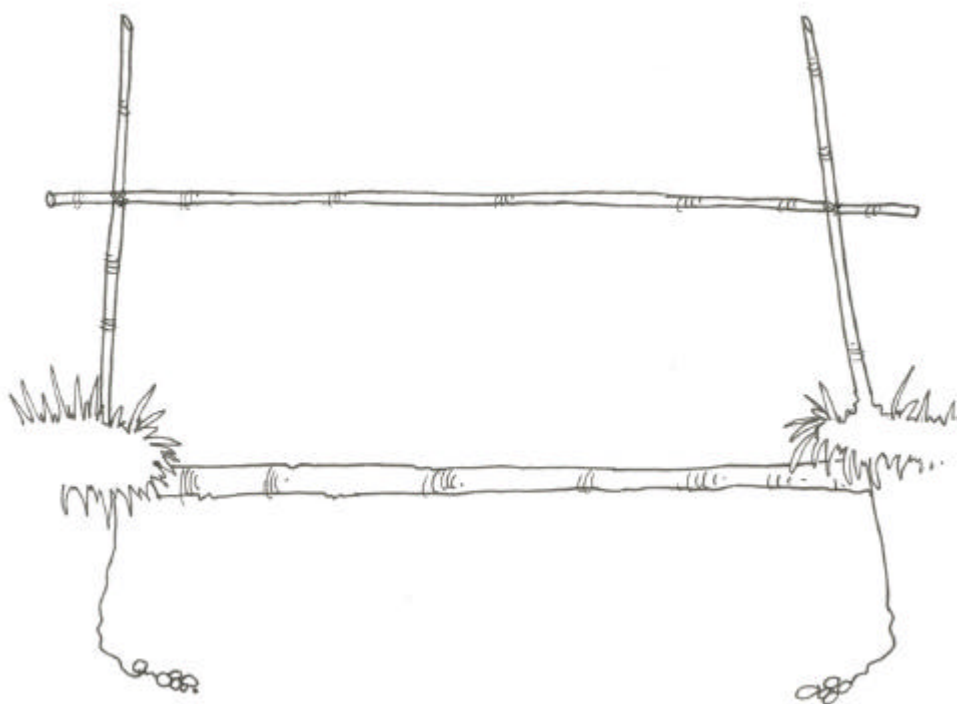


Figure 2.12. Bamboo log bridge with bamboo handrail - Bob HartleyÓ



Figure 2.13. The rucksacks are clipped onto the running-carabiner, then pulled across with the thin nylon rope Photo: Roger Chapman

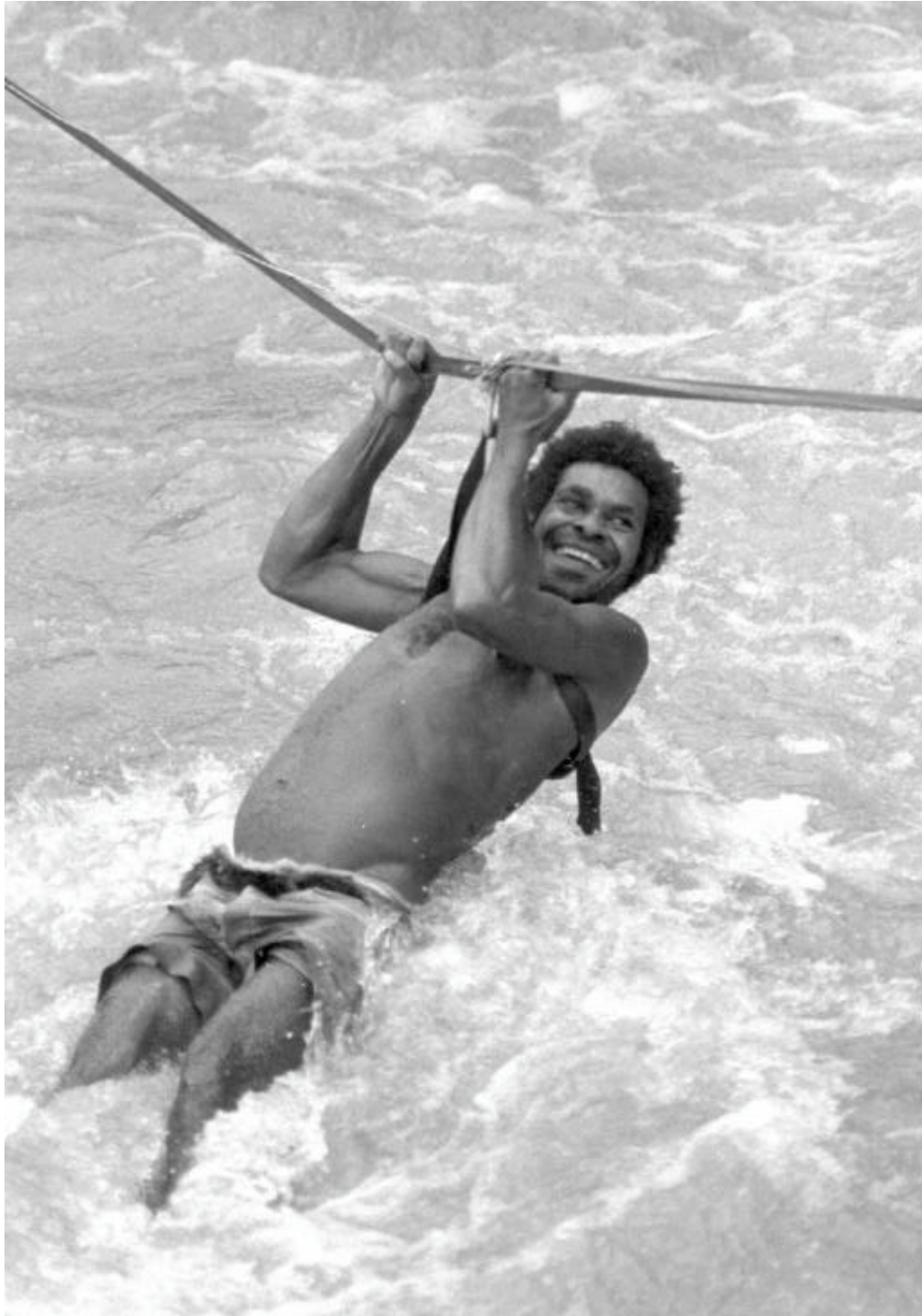


Figure 2.14. Ensure that the crossing is organised safely and carefully for both team member and carriers. Photo: Roger Chapman

2.4 Moving an expedition on a river

There may be stages in almost every rain forest expedition where boat travel is necessary. Many groups, particularly small ones on low budgets, will have to hire local boats which are likely to be dugouts or aluminium equivalents. Others may prefer to use inflatable boats. Inexperienced river travellers would be well advised to hire two boatmen for each boat if they are going to encounter rapids; one for the bow and one for the motor. These men may also be willing to cut trails, fish, cook, erect camps, etc., when their boating skills are not required. Ascertain this prior to setting out. If you are hiring men and their boats, you may want to release them as soon as the journey is finished or the exercise will become more expensive. Invariably the guidelines given below for travel in inflatables will be overridden by circumstances if dugouts and local craft are being used. These boats may be overloaded at the last minute by an influx of more local travellers etc. Be prepared for capsizing and **always wear life-jackets.**

2.4.1 Inflatable boats

If the expedition is dependent on many miles of river travel and local hire is out of the question, inflatable boats could be the answer. They are easy to transport to the site and the popular sizes, 14ft and 16ft long, are robust and ideal on white water but slow on flat water (Knowles, 1992).

2.4.2 Equipment required for inflatable boats:

- 4 oars (2 in reserve)
- 6 paddles (3 in reserve)
- 1 rowing frame
- 4 life jackets
- bailers (attached)
- Canvas bucket
- Large piece of foam rubber (good for bailing and as cushion)
- 15-25 HP outboard motor (attached) and spares
- Oil and petrol mix in plastic container or metal jerry can (25 litre cans)
- Fuel funnel. Supply of 9.5 HP sheer pins. Tool kit
- Nylon cord (Painters) on bow and stern (8m long)
- Large net (2 metres by 2 metres double)
- 30 metre nylon tape
- carabiners (light alloy) ideal for securing rope loops
- Air pump
- 1 Patching and repair kit
- waterproof "Pelican" type (expensive but watertight) or ammunition boxes (cover sharp corners with tape and padding)
- 2 water jerry cans. Millbank bag (large) for water purification
- 1 stove for cooking and paraffin
- 2 large cooking containers

- Fishing gear - hooks, lines
- Food in plastic bags by meals for 7 days (4 men)

2.4.3 A few important points:

- Motors and tanks must be securely lashed to the boat.
- Motors with special propellers that do not need sheer pins should always be used in preference to the pin type when available, if rapids have to be navigated.
- A 25 HP engine is ideal for any passable rapids; anything larger would make a portage very arduous.
- Descending rapids is more dangerous than ascending.

Hauling through rapids is a leap-frog operation. Part of the team move to a secure position upstream with the point of the painter (on safety ropes if necessary), while the others secure the boat. The boat is hauled to the new position and the system repeated.



Figure 2.15. Manoeuvring up the Uraricoera River on the Royal Geographical Society's expedition in the Brazilian Amazon, the Maraca Rain Forest Project.



Figure 2.16. Loading the inflatables and a 14m dugout. Note how everything is secured by line or nets in case of capsizing. Photo: Rupert Grey

2.4.4 Navigating on rivers

Although rivers are usually clearly and accurately marked on most maps in forest environments, it helps considerably to obtain recent air photographs. Meandering rivers can often alter their course. Rivers flowing under dense tree canopies will not, however, be seen on air photographs but large emergent trees found along lowland rain forest may be recognisable. Any map between 1:100,000 and 1:250,000 will give sufficient information to make a running comparison between features such as the angle and width of the river, vegetation clearings and tributaries seen during the course of the journey. However, the running comparison method should be used in conjunction with the *time/distance/speed* method of navigation.

Assuming you know the accurate map position of your campsite (A) (see Fig.2.17) and you have an obvious river junction (B) about 12 kilometres ahead, you can accurately work out your speed on the river, if you travel the distance in one smooth journey.



Figure 2.17

The *distance* between A and B can be measured accurately using a piece of string aligned with the river on the map. Follow every bend, meander and wiggle of the river with the string. Straighten the string and get an accurate distance measurement from the kilometre scale or grid lines (1km apart). Time the journey from A to B, and then simply divide to obtain your speed.

On the journey you should pin-prick the map - or use chinagraph pencil on the plastic coating of the map, marking your estimated time of arrival (ETA) point on each 15 minutes and compare it with the actual arrival point. By checking in this way you will know where you are on the whole journey.

2.5 Moving people and supplies by air

In many remote areas, especially in mountainous country, travel by small, light, fix-wing planes, or helicopters, may be the most time-effective (and therefore cost-effective) option. If you do have aircraft at your disposal, or plan to incorporate them into a medical evacuation plan, you should obey the pilot's briefings and loading instructions as he is responsible for your safety and the security of your equipment.

Discuss your destination with the pilot before take-off. He will know which landing strips are operable. Sometimes villagers are responsible for maintaining the landing strip and may not cut the grass as regularly as they should! This could prevent a small plane landing so you may have to divert to another strip or wait for the grass to be cut. In some cases you will find cattle grazing on the strip – or sometimes even rice paddies ! This problem is not so crucial with a helicopter but there are other factors that require attention when employing helicopters.

2.5.1 Travelling by helicopter

When boarding the helicopter, the pilot will hand you a headpiece and mouthpiece, so that you can communicate above the noise of the engine. Strap yourself in with the safety strap, close the door and have your map and notebook at hand to give directions to the pilot. Ensure that you know which door-handle to use. The emergency door-handles in military aircraft are normally coloured black and yellow and if these are operated, the whole door is designed to drop off – apart from being a little embarrassing, the aircraft will be normally be grounded until the door is re-attached !

If you have to travel as a group in a military helicopter then obey the instructions of the load master. He will be in permanent signal communications with the pilot. To enter the helicopter:

- (a) Line up the patrol at the edge of the landing zone at 10 o'clock and 2 o'clock positions, where 12 o'clock is the front of the aircraft.
- (b) Each member should remove head-dress and scarves.
- (c) Carry packs in left hand.
- (d) Remain crouched.
- (e) When loadmaster descends and gives "thumbs up" sign, then the group leader only runs forward to make contact with the loadmaster.
- (f) Group leader remains alongside loadmaster by the door and signals each man in turn to approach and enter.
- (g) The leader helps each man into the helicopter and is the last member of the patrol to be seated.
- (h) The load master will give the group leader a headset and mouthpiece so that he can communicate with the pilot.

2.5.2 Helicopter landing zones

Increasingly, helicopters are being used for transportation and re-supply in the rain forest. They are very expensive to hire and are often beyond the budget of most expeditions but with good liaison coupled with the generosity of local "exploration" companies there may be times that an expedition will need to clear helicopter landing zones (LZ) in the rain forest.

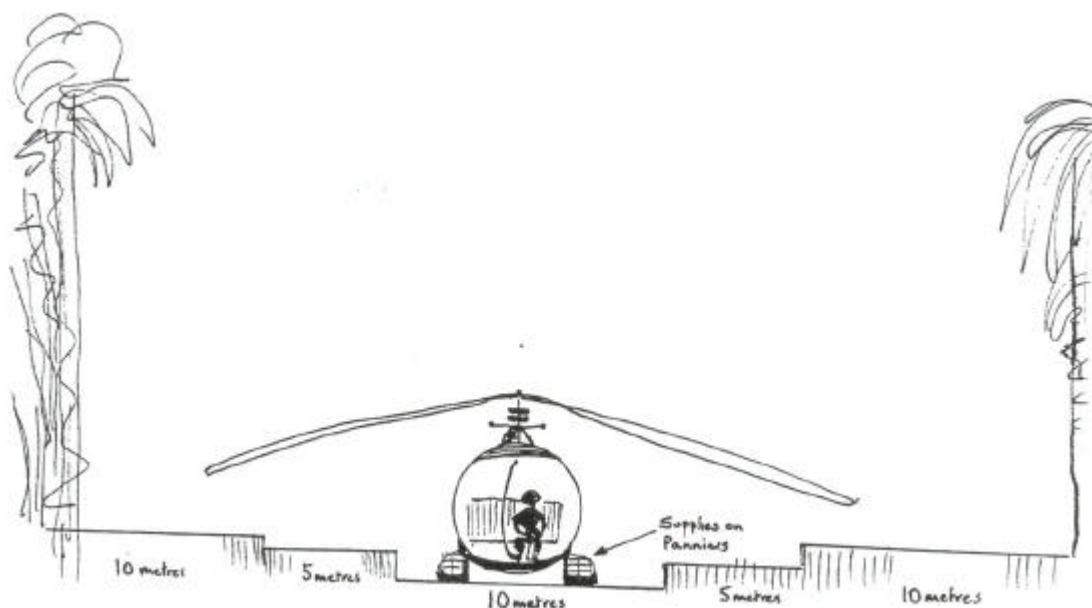


Figure 2.18

With the forest canopy at 30-40 metres above the ground, stretching for hundreds of kilometres, it is virtually impossible for any pilot of either a fixed-wing or helicopter to locate a small clearing in the forest. Even if helicopter supplying/communications are not envisaged, you may need to bring in an emergency medical team or air ambulance. In many cases, helicopters are used for evacuating casualties quickly from the jungle. This means of evacuation is obviously preferable to a protracted stretcher-carry, but by no means guaranteed. Helicopters should never be relied upon to extract an injured party but if the luxury exists you will need to consider the tree canopy, weather, daylight hours remaining etc. in relation to a helicopter airlift. Not all helicopters are equipped with winches and so a large area of jungle will normally need to be cleared to accommodate an aircraft. It is worth having an orange marker balloon which can be inflated with helium. Once filled with the gas, the balloon will ascend on a 50-60m line well above the forest canopy. Once the pilot has located you, the balloon can be drawn in and signalling can begin. These balloons are not normally air-portable in cargo but if you can obtain them in advance of the expedition, they should be sent out by overland freight as they are excellent items for forest-based teams.

Size of landing zones (LZ) for the average two-seater helicopter (Bell, Gazelle, Sioux) is a circular "pad" 10 metres in diameter which must be cleared to ground level. Around the helipad, the trees and foliage must be levelled to 0.3 metres (knee level) for 20 metres diameter, and to 0.6 metres (waist level) beyond that for 40 metres (Fig.2.11). Find out what type of helicopters are available so that if it comes to selecting or constructing a LZ you will know how big it has to be.

If you have day-glow panels, make a large H in the centre of the helipad. Ensure that it is skewered well into the ground, as the suction from the whirling helicopter propeller will drag it upwards or blow it away. For most large helicopters, which can transport people, animals and supplies in the rear of the helicopter (Huey, Puma, Wessex, Chinook) the size of the LZ has to be doubled.

On one occasion the author was told to clear a site to the "size of a basketball pitch" in the rain forest. It took 1 1/2 days of cutting to get it to the required size. Even when the hard work was done it still looked remarkably small. With a great deal of skill on the part of the Australian pilot, coupled with good hand signals, an enormous Chinook helicopter (which can hold over 24 men) was gently hovered and then manoeuvred down to the landing zones.

A rocky promontory sticking out into a river makes an excellent LZ. There is no pre-cutting and it is an easy entrance and exit for the helicopter. River beds, sandbanks and rock ledges make ideal LZs.

2.5.3 Hand signals

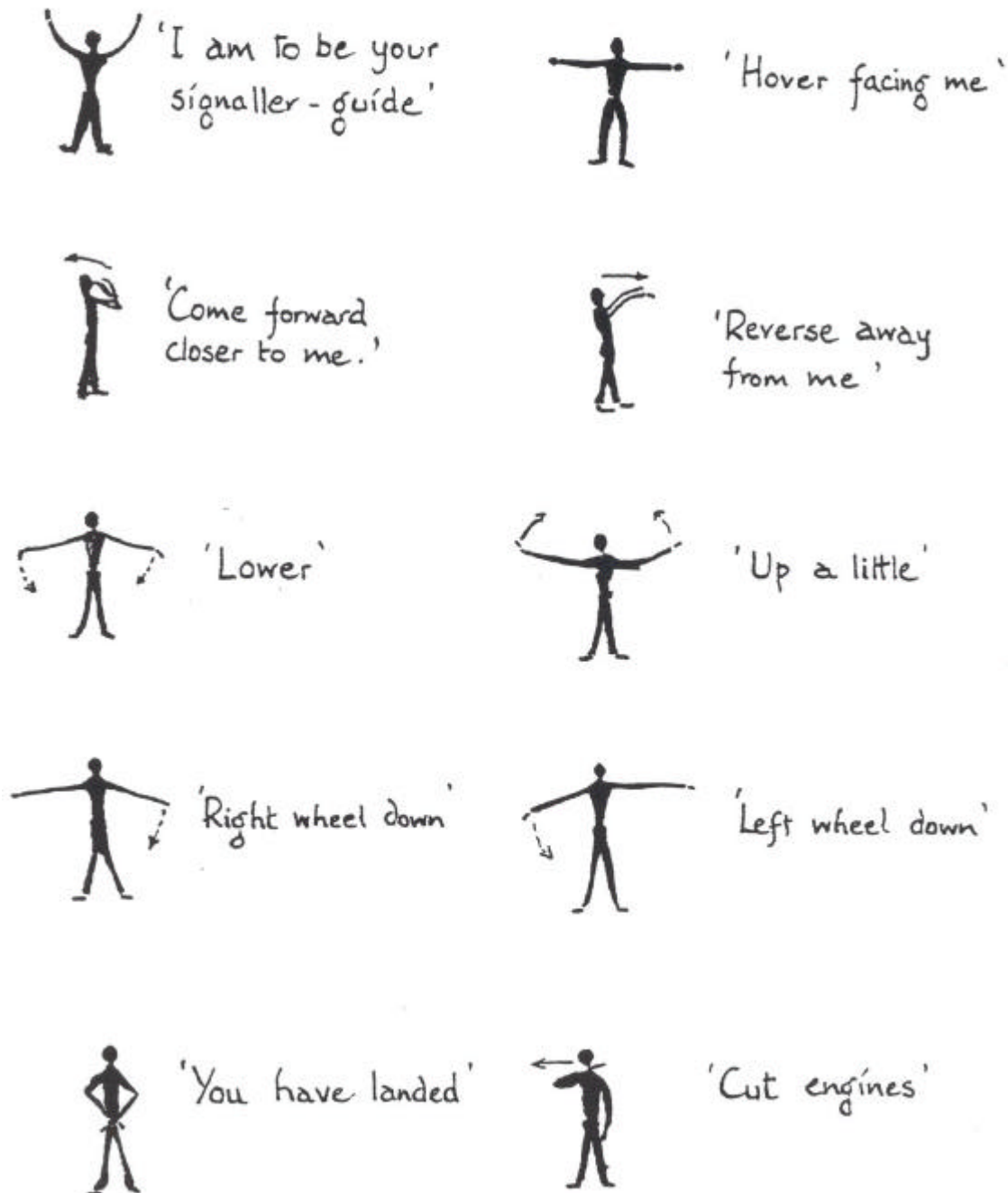


Figure 2.19

In a small helicopter, the pilot will have no co-pilot or load master to guide him onto the LZ in the rain forest, so it is as well that you learn the simple hand-signals to assist him. Stand up-wind of the pad, wearing a bright garment or day-glow panel

around your waist to attract the pilot's attention. Remove your head-dress, because it will blow away with the force of the wind from the propeller, then signal the pilot to land.

2.5.4 Safety with helicopters

The propeller blade has a radius of approximately 6 metres from the axis. When the helicopter is on the ground, propeller blades will whirl above head level, if the engine is at full pitch, but as the engine slows down the blades sag downwards and could easily decapitate someone who approaches the helicopter inadvertently or without obeying the simple safety rules:

1. KEEP OFF the LZ unless you are on duty as a signaller
2. Wait until the blades stop revolving before you approach the pilot
3. NEVER APPROACH FROM THE REAR
4. If you have to approach the pilot, when the blades are revolving, WAIT for the PILOT'S instructions to advance (thumbs up) then do so obliquely (so that he can see you all the time) and bend double.

2.6 Communications and supply

All tropical forest expeditions need to set up a communications line. Larger expeditions may decide to use radio communications but, as Purvis (1992) points out, this presents leaders with the greatest number of bureaucratic obstacles. His article should be consulted. If you are working in a National Park you may be able to use the radio frequency used by Park Rangers and keep in contact with Park HQ. In other areas a cooperative logging company may let you use their base as a contact point, and link with a government's public utility communication line. In some countries, e.g. Sarawak and Belize, you may be able to radio direct into an international telephone circuit if radio beacon/repeater and control points are suitably placed. Satellite phones are excellent and becoming more popular.

2.6.1 Visual distress signals

Helicopter rescue (e.g. Medevac) can only take place in daylight. Even if the aircrew are equipped with night vision equipment, it is very unlikely that a helicopter will attempt to land in a jungle clearing at night and allowances should be made for this. Coloured smoke signals can be carried in case a temporary brushwood fire cannot generate sufficient smoke to indicate your position but remember that the smoke might not reach to the top of the canopy and will hang in the air inside the clearing. Again read Purvis (1992). Miniflares and similar rocket-flare pyrotechnics are excellent for reaching over the treetops and are sometimes available at stockists in large ports overseas. Check this on your reconnaissance. Otherwise, consider freighting them out to your country destination in advance. A set of three coloured nylon signalling panels measuring at least 8 feet in length and 2 feet wide should be part of the safety equipment.



Figure 2.20. If you can afford the services of a helicopter resupply, it will save you both time and effort. Photo: Roger Chapman

2.7 Training, risk factors and casualty evacuation

During the planning phases of your expedition you will have looked at various general safety-related aspects. The jungle environment, however, offers several specific problems and obstacles that need to be addressed if the safety net and the well-being of the team is to be of a high standard.

This chapter briefly covers the following topics:

- Training and local knowledge / awareness
- Risk assessment factors
- Casualty evacuation from the jungle

2.7.1 Training

Before the expedition heads into the field it is worth carrying out a basic training course to ensure that all members feel confident of living and operating in the jungle. It is a unique environment and has many surprises all of its own, yet if the training is positive and enjoyable it will help to dispel some of the myths that are heard about the jungle and will make the trekkers more confident in their ability to spend protracted periods in that environment.

Jungle training can initially be a series of lectures and slide shows before the expedition even departs from the country of origin. This will be an introductory stage beneficial to those who have never been to the forest environment before, covering topics such as geographical location, local areas, flora and fauna and also some health related issues. It is also an excellent opportunity to ensure that everyone has the correct jungle equipment and it is worth arranging a day in a local wood to run through some basic skills needed to set up and run a jungle camp.

Once you arrive in the jungle for real, it is then a case of spending a few days in the hands of the local forest rangers, guides and porters in order to start the acclimatisation process and to become familiar with the jungle. All of the sights, sounds and smells will be new to most team members, as will the daily routine of living in the forest. Start the course gently, taking jet-lag, dehydration and fatigue into account. Try to resist the temptation to trek into the jungle immediately. Allow for two or three nights in a village or a base-camp location to plan and prepare for a short trek and to let the team catch up on sleep!

For the first couple of days, it is advisable to cover topics such as jungle hazards, plants and wildlife - most of which will be unique to that region. Also take time to learn what to wear in the jungle and how to pack your equipment to avoid the constant overhanging branches and vines as well as the damp. Heat-related injuries and first-aid are vital and each trekker should know exactly how to spot the signs of heat

exhaustion and heat stroke and should rehearse the actions to be carried out in the event of such a casualty. Encourage trekkers to drink water and to maintain a healthy balanced diet, including mineral replacement and salt intake. It is a good idea to prepare a small, concise aide-memoire for each trekker. Keep it small, like a credit card and laminate it for durability. It should be carried everywhere by the trekkers. This small flash-card can be a life saver and a constant reminder to the team of what to keep an eye open for. The buddy-buddy system is important in the jungle with everybody watching out for each other.

Other topics to be covered during jungle familiarisation training could include:

- First aid training, including heat-related problems
- Basic emergency navigation and use of compass
- Actions on becoming lost / separated
- River crossings
- Helicopter handling drills
- LZ and winch-hole dimensions
- Cooking
- Fire lighting
- Water sources
- Radio communications
- Jungle craft (using local materials – lectures on “survival” topics such as natural shelters, traps etc. can highlight the versatility of the jungle environment)
- Using machetes safely and how to maintain them
- How to improvise a stretcher
- How to treat insect and snake bite
- Which plants should be avoided & which plants are useful (e.g.: burning old termite mounds on the fire to keep mosquitoes at bay)
- Signalling techniques
- Local language (basic phrases to communicate with the guides etc.)
- Movement in the jungle and what to look out for on the trail
- Daily routine from dawn to dusk
- Health and hygiene (equipment, body, clothing)
- Base-camp management
- Latrines

2.7.2 Risk Assessment

Some factors to consider in your overall planning and risk assessment, in addition to the more general subjects, are as follows:

- Climate / health – Typhoon season, tropical storms, humidity levels, extreme temperatures, heat exhaustion, heat stroke, sunburn, dehydration, traveller’s diarrhoea, infected insect bites, rashes, tropical diseases, snake bite, malaria, tropical

virus, fungal infections, waterborne disease, insect borne disease (eg: Typhus), local clinics and hospitals (do they have a helicopter landing site?)

- Geographical areas – swamps, jungle rivers, hidden cliffs and escarpments, gullies susceptible to flash-flooding, coastal tidal waves and subsidence due to deforestation.
- Cultural factors - tribal issues (friendlies and not-so-friendlies), environmental issues (eg: logging - dividing communities), religious/ethnic problems and hotspots, traditional remedies / tattooing / local alcohol and narcotics habits.
- Flora and fauna – dangerous plants with sharp leaves, spikes, dangling thorns, roots, poisonous trees and plants, flying insects, snakes, animal hazards, bees, wasps, hornets, crocodiles, bats, big cats, rat infestations, wild pig attacks, crawling insects, hazardous marine life, leeches and ticks
- Deadfall - falling branches or entire trees especially during rainstorms, wind and helicopter use
- Machetes - cuts and secondary infection
- Disorientation - trekkers becoming separated/lost in jungle
- Communications – effects of jungle environment and climate on radio/satellite phone communications and schedules
- Helicopters/Fixed Wing Aircraft – civil or military liaison, location of airstrips, landing sites, night-flying capability, winch facility, flying range, radio frequencies, medical evacuation facility, number of passengers, payment up front, handling drills whether it is equipped with homing beacon receiver?

The effects of heat must never be underestimated and all medical staff should be aware of any pre-existing health problems within the team that could be aggravated by even mild dehydration and salt loss. Acclimatisation will take several weeks and this should be borne in mind when planning moves through the jungle. See chapter 5 for details on Health and Safety in the forest.

It is also worth issuing trekkers with a safety/contact details card. This can cover basic first aid/ABCs and also what to do and who to contact in an emergency. A list of useful telephone numbers, callsigns, radio frequencies etc. and the details of the insurance policy will assist a trekker to make contact with the relevant authorities/support bases if they are ever separated or find themselves in difficulties. It is designed more for use in urban areas and transit phases but can be adapted to the different stages of the expedition. If it is kept small and laminated it will last a long time

and the trekkers can be encouraged to carry it on their person everywhere.

2.7.3 Casualty evacuation from the jungle

A casualty evacuation from the jungle may occur at any time and without warning. A simple accident, heat-stroke or snake bite could result in a team member having to receive more advanced medical attention than the expedition medics can administer and therefore each member of the team should be aware of the evacuation plan. Leaders are not exempt from needing evacuation!

Ideally, in an emergency, a helicopter would be called in on a clear radio link, arriving at a pre-cut landing site or winch-hole within thirty minutes and whisking the casualty to a high quality hospital to make a full recovery.

In reality however, a medical evacuation from the jungle will tend to become a protracted, exhausting and frustrating business almost always resulting in a long stretcher carry over rough terrain and against the clock. Plan for the slow scenario, and if you have vehicles and boats at your disposal, so much the better.

As an example, on an expedition to Seram, Indonesia in recent years, the assistant leader of a small team contracted Dengue fever three days into a five day trek across the island and had to be carried by eighteen porters (in teams) over the central highlands. The evacuation took five days before the team arrived at a medical facility back at the start point. The porters thought that the casualty would die anyway and so they didn't initially want to carry him - and only a lengthy and determined series of tactful negotiations managed to convince them that the evacuation should continue! The medical kit consisted of limited supplies of vital I.V fluids and the doctor with the team did a fantastic job in making the supplies last.

The leader survived the ordeal as a result of the medical treatment he received during the evacuation and the plan formulated by the overall expedition leader. After a lengthy and slow recovery, he continues to lead treks in the jungle.

In formulating the evacuation plan, the leader deliberately chose to discount the use of a helicopter located at a point somewhere ahead of the team – the decision being based on the uncertain weather conditions, unknown availability of the helicopter and the severe terrain ahead. It later transpired that the helicopter was grounded for mechanical reasons and the weather deteriorated anyway.

Among the numerous lessons learned from this case, it highlights the need to have a good interpreter who understands local customs and cultural sensitivities and who can therefore negotiate deals under duress. It also shows that it is sometimes worth issuing each member of the trekking team with a single unit of IV fluid to carry in case the nature of the illness requires IV treatment. The heat and humidity in the jungle

causes dehydration and mineral loss quickly and stretcher carrying will be slow and physically draining for patient and rescue team alike.

If you are planning methods of evacuation for your team, start with planning on doing it yourself, whilst your outside support group start to attempts to raise aircraft and prepare the secondary evacuation steps. Strong team leadership and an ability to brief the team sensitively and clearly are important as the leader will have a number of issues to deal with when the evacuation call is made. It helps tremendously to have a dedicated medical person/team on the expedition so that the leader can be free to concentrate on the other issues.

Communications are extremely important and it is advisable to carry an EPIRB (Emergency Position Indicating Radio Beacon) as a minimum. Radios and satellite telephones are all very well, but an EPIRB will send a signal that can be picked up inside an hour and that will alert the support agencies (your organisation and local authorities, rescue agencies etc) that there is a problem, most probably life-threatening. It will NOT guarantee a helicopter arriving overhead to assist you, but the word will be out and you can then carry on with your stretcher carry or chosen course of action at least reassured that you have some form of alerting the outside world.

If in any uncertainty, casualties can usually be placed into one of the following categories, although speedy evacuation is better for all cases:

- Priority One (P1): Urgent life threatening cases needing evacuation within 2 hours. Major bleeding and fractures, major burns, serious stomach wounds and chest injuries, Heat stroke, snakebite, head injuries and multiple wounds.
- Priority Two (P2): Evacuate within 4 hours. Spinal injuries, face and eye injuries, fresh wounds for cleaning/dressing
- Priority Three (P3): Cases that are not responding to treatment. Lesser fractures, dislocations. Evacuate within 24 hours if possible.

If you are requesting a casevac by voice communications, the following details should be sent:

- Number of casualties (casualty details)
- Nature of injuries/illness
- Current location
- Local Landing Zones (and location co-ordinates & description where possible)
- Your plan of action
- Relevant timings
- Local weather situation

- Special conditions (blood types, equipment needed – intubation kit ?)

Remember Medical Confidence – some expeditions have pre-arranged “Nick Numbers” (alongside the nominal roll) for trekkers in case of evacuation. These are authenticated by both ends of the communication link so that there is no doubt about who the casualty is. It also helps prevent sensitive details leaking to people eaves-dropping on the radio net.

Helicopters can either **land on** the ground (easiest means but has to be flat and totally clear), carry out a **low hover** above it (where the ground is wet or unsuitable) or in some cases they can lower a winch and stretcher inside a **winch hole**. When using a winch, NEVER touch the cable until it has earthed itself on the ground or you will receive a dangerous static shock. Bring the casualty to the winch and not vice-versa. Natural clearings such as river beds, cultivated jungle, deforested areas or logging roads can be turned into landing sites after some further clearance with machetes. Identify the Landing Zone with marker panels (well-attached to the ground) and have someone control the LZ. Keep all other parties away from the LZ to reduce the risk of deadfall injury. A winch hole should really be an absolute minimum of 2 square meters at the canopy but in actual fact, the bigger it is the better not only to assist the pilot to lower the winch / stretcher to you but also for him to find you in the first place.

Lastly, be careful with rocket pyrotechnic signals – the aircraft won’t come near you if the pilot thinks he is being shot down !

Chapter 3: CAMPING IN THE FOREST

3.1 The camp site

Jungle campsites can have a varying degree of permanence depending on their function in the expedition's objectives.

3.1.1 Base camp

If an expedition is going to work in an area of forest (e.g. a national park) for several months, it will need a major site which will act as: (a) a reception area to receive (and acclimatise, possibly train) expedition members that arrive on a staggered schedule; (b) the main administrative centre of the expedition and store for food, equipment and members' personal belongings/clothes that they will not want until their return home; (c) a rest, recuperation and medical centre where members on long-term projects can rest and reform between sorties into the jungle; (d) a general liaison centre between the expedition and local peoples (if there are local inhabitants living in the forest area) thereby becoming a meeting place for different local communities of the host country itself.

When these functions are taken into account the base camp tentage will need to be substantial and if funds, and proximity to river or road transport allow, you may wish to build more solid huts using locally sawn timber and/or corrugated iron or local palm thatch. Remember, if the base camp is at mid mountain altitude (1200-1500m) the nights will be cold so walled enclosures will be more cosy. In warmer climes, a tarpaulin or plastic sheet, 5 x 7m, stretched over locally grown sapling-timber will sleep 6 - 10 people, although more space per person is recommended for long-term residents.

Where a substantial base camp is needed, advance parties should go out to the area 2-3 weeks before the main party and recruit local helpers to build living accommodation, eating huts and science 'laboratories' for the expedition. Local government officials will give you the standard rates for such labour. Local advice should be taken about the actual site, and clear indication made on when and where you wish the huts to be made with local materials. The style of the long house or hut on stilts varies throughout the tropical world, so it is important that a member of the expedition supervises the construction and siting of each hut to suit the needs of the expedition. Do not fall into the trap of imagining that everything will get done in your absence. Reconnaissance parties are often promised the earth, but it is only when expedition members are personally present that action commences - out of sight is out of mind. Once work commences, and the local people see the colour of your money, it is amazing how quickly a base camp can be constructed.

If the base camp is going to act as a medical centre, the medic will need a tent of his/her own, where the medical supplies can also be stored in locked cases. It may also double up as a surgery or sick-bay if a sick expedition member needs constant care. If

you can camp near an open stretch of river bank or where braidings widen a stream, this may prove useful if you need to evacuate members in an emergency by helicopter. Some organisations adopt a policy of clearing a helicopter landing site at their base-camps. If you are lucky enough to have helicopter support, try to have the pilots check the landing site in advance and agree on its exact location.

If a base camp is correctly sited it will be close to local communication lines (rivers, roadhead, airstrip) and there will be villages (or possibly nomadic groups) within reach. It is not advisable to have your base camp in a village or you may be inundated with inquisitive guests. But, wherever you are 'in the bush', you will get visitors, those hoping for medical attention, for work as labourers or guides, and those coming to trade food or just learn from this new experience. Base camp may therefore need a covered area where locals can sleep overnight and make a fire to cook food or to keep warm. Remember to place plank walkways between huts to avoid a mud-bath. It is important to think of fire control and to have buckets of water, sand etc. at strategic points. Remember that dry palm leaf roofing materials are extremely flammable and yet are normally used for cooking areas with open fires. They are also home to scorpions which tend to drop onto people when the cooking fires are smoking. Store any flammable liquids in a safe area away from the camp.



Figure 3.0. The RGS base camp at Long Pala, Mulu N.P. This structure close to the river housed facilities for 30 people, including porters and guides, and was built in 14 days with local labour and dismantled at the end of the expedition.

Photo: Nigel Winsor.



Figure 3.1 Hammock with fly sheet

3.1.2 Scientific camps

There is often little difference between a base camp or a large transit camp and a camp where scientists of various disciplines work through the day or night. Nightfall is early (c.1800hrs) and some may want to continue preparing specimens, pressing plants or simply writing notes, activities which will need good lighting. Paraffin (kerosene) pressure lamps or butane lamps with incandescent mantles are the best but neither are easy to move from camp to camp without breaking the mantle - so have a good supply of mantles - and fuel. Butane canisters (for the Bluett-type lamp) are the easiest to transport and are becoming increasingly common in bazaars in the 'outback' but it may be wise to have a few kerosene lamps in camp just in case you run out of butane. Kerosene storm lanterns are useful for background lighting and for the guide's use or you may find all your fuel goes in all-night burning! Empty tins with replaceable lids can be filled with kerosene and a wick placed through a hole in the lid to act as basic lanterns. These are useful for marking areas of the camp at night.

Lighting will attract insects especially in mid-mountain altitudes and if mosquito netting can be purchased in bulk you may consider putting net side walls around your shelter.

For those working in jungle camps during the day it is worth using 500 gauge clear polythene sheeting for protection against rain instead of a coloured canvas or plastic sheet, as the latter may not give you enough light to work with in small forest clearings. Even in lighter areas, the green or gold colour emitted by the commoner

plastic sheets can affect your assessment of, for instance, flower colour.

3.1.3 Transit camps

After an eight-hour trek through the rain forest, you ought to start looking for a stream with a small clearing which is free from high concentrations of ants or termites, animal runs or swampy patches where mosquitoes breed. Ensure that it is high enough to be above a flash flood. It is an added advantage to choose a site where you can dry your clothes, feet and body in the sun's rays, not too far from your direction of travel for the next day. Around the clearing there should be a selection of smaller trees about 10-12 feet apart, from which hammocks can be strung with ease. If some members of the party are using A-frame hammock beds, there should be plenty of thin saplings in the vicinity. Do remember that 'A' frame hammocks require a lot of tree felling and result in destruction of large areas of young trees, in large quantities. When deciding on a camp location, not all of these requisites may be found, but the priority should be:

- a. Water – but avoiding flash-flood sites (river beds, flood plains)
- b. Hammock-hanging trees (remember deadfall hazards)
- c. Clearing

The site should be chosen in plenty of time to pitch camp, light a wood fire and prepare a meal before it is dark and the rains come down.

If an expedition is surveying an area in detail, transit camps may need to be maintained throughout the expedition. In this case a cooking/eating/sleeping area may be constructed under a permanent plastic sheet (or even suitably thatched if material is available). If pole-bed sheets are used instead of hammocks the frames can be left for later visits.

3.1.4 Camping alongside rivers

One phenomenon of rivers in tropical rain forest areas, is that they rise and fall dramatically as a result of torrential rain. Thus great care must be taken when choosing the camp site, lest all the tents, belongings and boats are swept away by a sudden increase in the speed and volume of the river. After a four hour torrential downpour, it may take up to eight hours before there is an obvious physical change to the river, swelled by the thousands of gallons of rain water flowing down many rivulets, streams or run-off on the sides of the mountains leading into the river valley. Rivers can rise 8 feet or more and increase their speed from 2 to 4-6 knots in 4 hours after a rain storm. Always choose a campsite on top of a bank, well clear of the surface of the water. Ensure that the boats are pulled up the side of the bank, and tightly secured onto branches with a good length of rope or cord, in case of a rise in the river. Fortunately, rivers will fall quickly once they have reached their optimum height, but this is of no help if the raging waters have carried away boats and equipment during the night. To be forewarned of such eventualities is no bad thing.

3.2 Sleeping in the forest

If an expedition is spending several weeks in the forest, sleeping arrangements must be taken seriously and developed into a fine art. It is inadvisable to sleep on the ground and two main methods to raise your bed are generally used: hammocks or bed sheets (canvas or tough plastic) mounted on frames about 2ft above the ground. When camping up to 1200m altitude it is wise to use a mosquito net; above that mosquitoes are absent but nets are useful to keep out various 'creepy crawlies'. Hammocks are excellent when on a long journey, sleeping in a different location each night.

3.2.1 Setting up a single hammock and fly-sheet

There are a number of considerations in setting up a hammock and fly sheet.

a) Choosing a site

Choose your two trees about 30cms (1ft) in diameter, erect and strong and 3-4m (10-12ft) apart.

Clear the foliage between the trees with a machete and ensure that there are no sharp cut-off saplings directly below your hammock. It is worth sweeping away leaf litter in the vicinity of camp with branches, not your hands.

Important: Avoid very large trees which may shed branches and fall on you in the night. Strong winds preceding thunderstorms can dislodge dead branches. Sometimes it is unavoidable and you will hear dead-fall crashing down around you in the forest. Carry out checks of the branches and trees in the immediate area and ask your guide if you have any doubts about what is alive and what poses a threat. Avoid trees with termite tunnels on the trunk and trees protected by biting ants: in Amazonia the eucalyptus-like *Triplaris gardneriana* is known as the "novice's tree" because any novice who fixes a hammock to it gets attacked by ants!

b) Erecting a fly-sheet ("Jungle Basha")

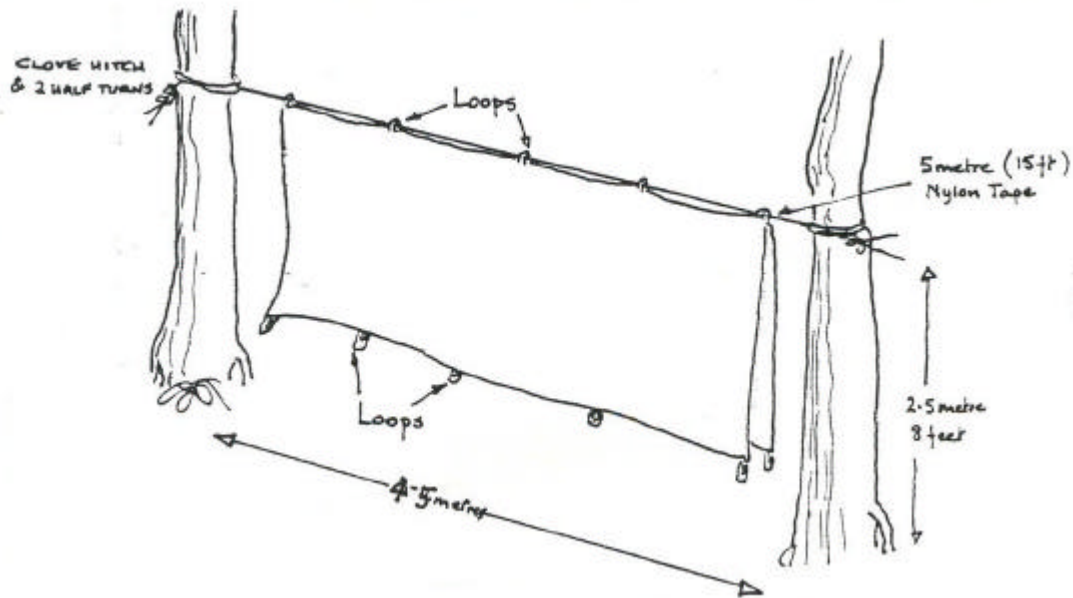


Figure 3.2

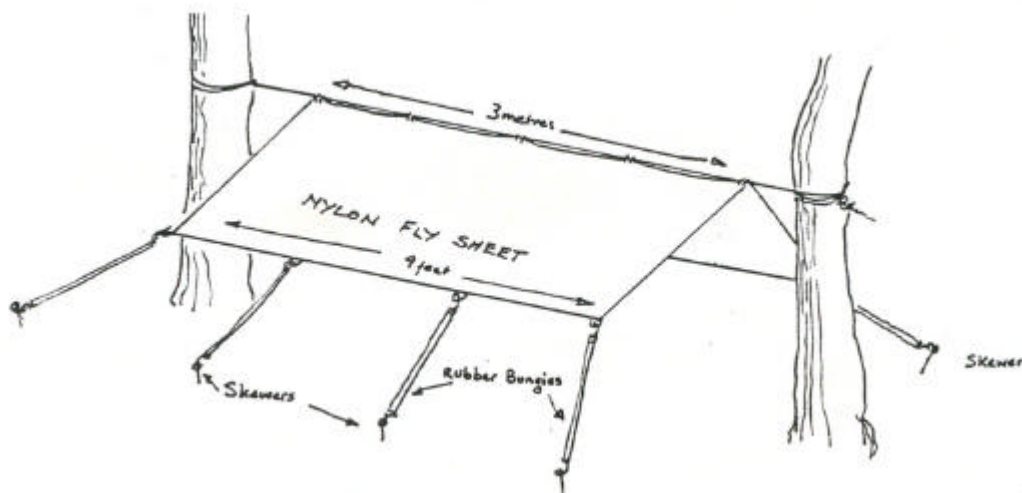


Figure 3.3

If you are using a nylon fly-sheet ("basha sheet") tie 2 meter lengths of nylon "parachute" cord to the loops around the edge of the fly-sheet. Spread the basha-sheet by stretching it out and secure it to saplings and branches near the site by these lengths of cord, or to skewers or saplings in the ground. Alternatively, you can use thin 1 meter bungee cords to attach the basha. These are useful items of equipment, but it is still worth carrying a supply of nylon cord for contingencies, washing lines etc.



Figure 3.4 A typical jungle basha with camp fire and clothes drying. Note height of hammock, mosquito net tucked in and kit packed in rucksack under shelter. Photo: Bob Hartley

c) Erecting the hammock

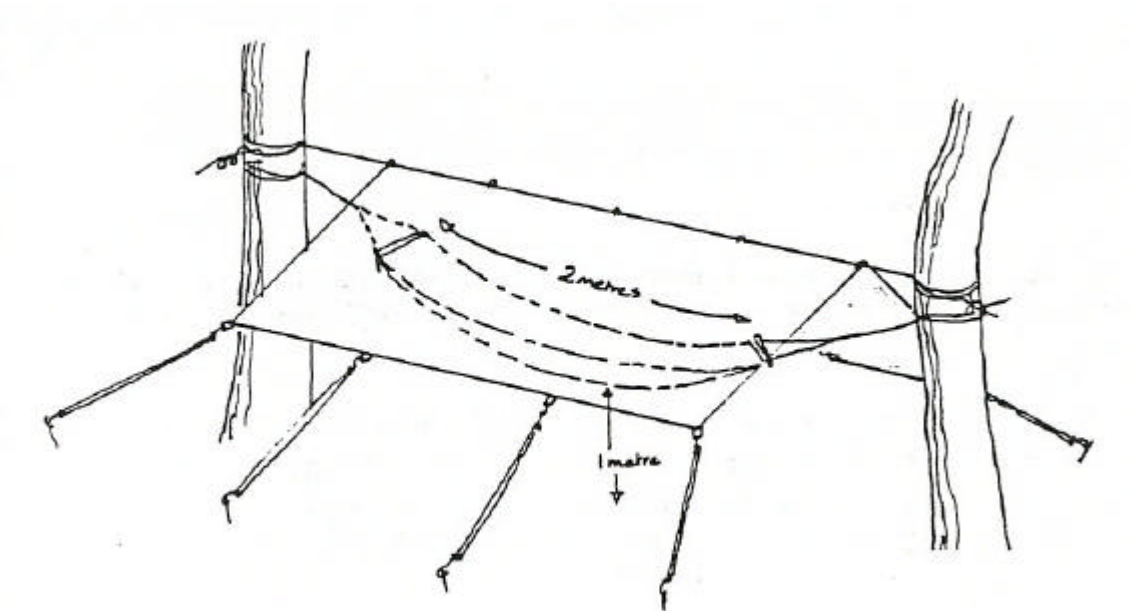


Figure 3.5

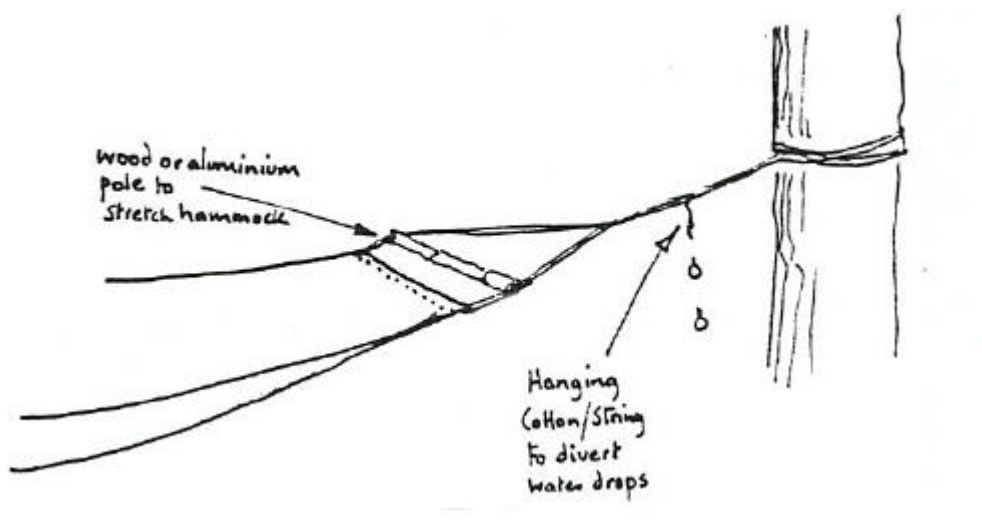


Figure 3.6.

Erect your hammock under the basha sheet. Ensure that it is high enough above the ground. Set it about waist high to start with - it will sag, and you will get soaked if it rains during the night and the hammock touches the ground vegetation. Depending on the design of the hammock, you might need to stretch the hammock laterally by placing a short wooden (or aluminium) pole between the corner ropes at each end.

d) Erecting a mosquito net and final adjustments

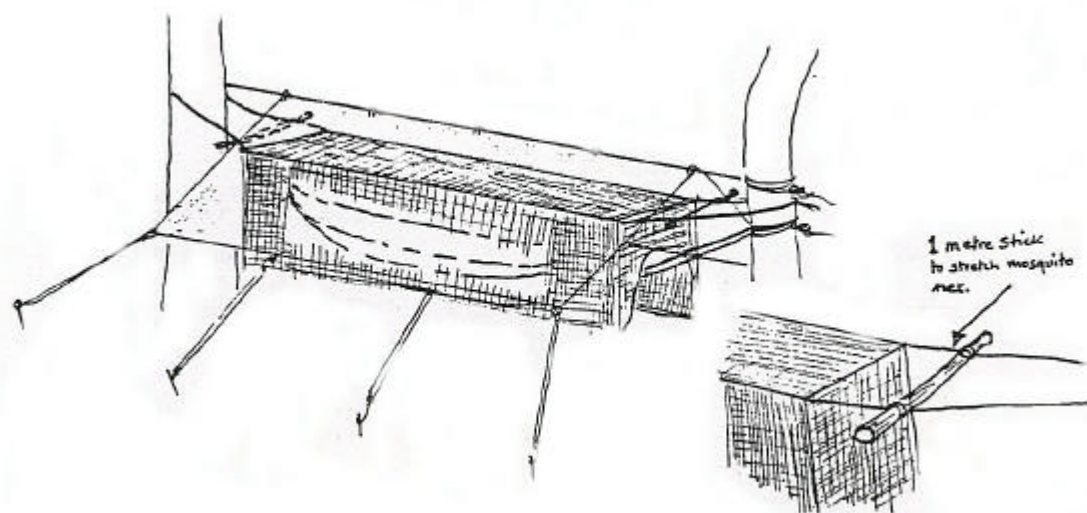


Figure 3.7

Erect the mosquito net above the hammock. Some mosquito nets fit over the hammock ropes and can be tied below the hammock. Others are designed to be tucked into the hammock – a sleep-sheet or sleeping bag will then cover the spare material. Fit a thin 1m (3ft) stick to keep the net stretched at the ends, if you have a “box” shaped net. These are preferable to the nets shaped like a tunnel or a wedge as they can be fitted underneath a basha sheet very easily and allow more room to move comfortably. Carefully check your mosquito net and put tape over any tear or hole as a short term measure. It is better to sew the hole as soon as possible.

Prior to your expedition, it is a good idea to treat your net with Permethrin as this will deter insects from walking on the net and has been proven to reduce Malaria. Remember that insects can still bite you if you are touching the net during your sleep. Permethrin will help in deterring persistent insects from landing on the material. It also kills them.

When you finally retreat to the inside of your mosquito net, turn off your head torch as you open the net and climb into the hammock. This will reduce the number of midges and tiny insects that will possibly try to join you inside.

Ensure the basha sheet covers the hammock and mosquito net, and that the mosquito net is large enough for the hammock. Test the hammock in daylight, by carefully sitting in the centre of it. Once the weight has been taken up, swing your legs onto the hammock. Try not to fall out of the other side ! It proves embarrassing.

Some South American hammocks are wide enough to let you sleep diagonally or horizontally across them. Unroll your sleeping bag and place it in your hammock, then tuck the mosquito net flaps under the sleeping bag. It can be very cold in a hammock at higher altitudes as the weight of your body will decrease the insulation effect of your sleeping bag. In such sites spare clothes, newspaper (or botanical drying paper!) will help to give you that "bottom" warmth.(Two layer hammocks are available enabling you to place a sleeping mat and tuck in one side of the mosquito net between the layers)

3.2.2 Frame for several hammocks

In some countries it is common to build a frame of trees that carries a line of hammocks and is covered by a large tarpaulin or palm-thatched roof. If your expedition does use hammocks and involves a number of camps through which personnel will move, a semi-permanent structure like this saves a lot of time.

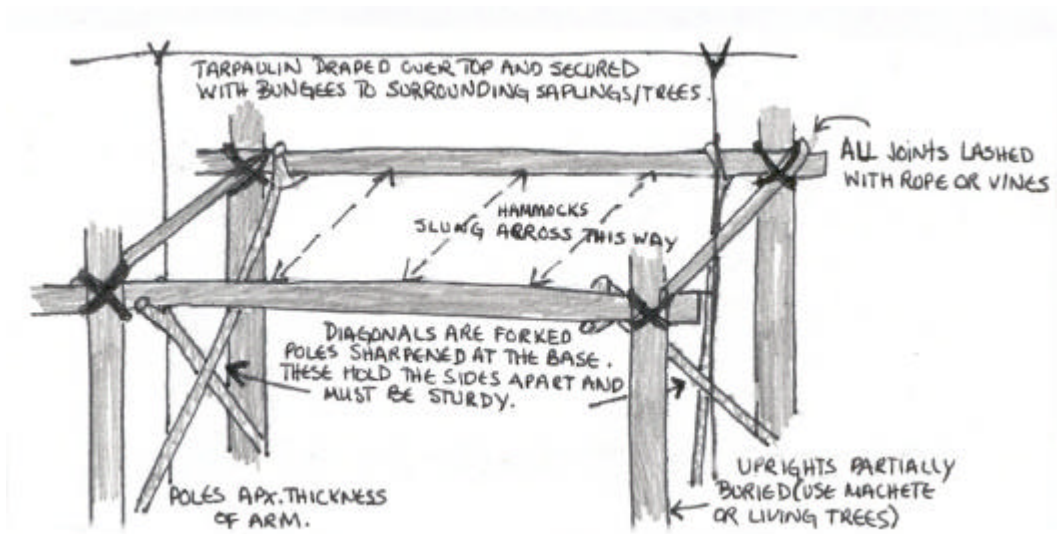


Figure 3.8 Frame for several hammocks

3.2.3 Erecting a pole-bed sheet frame

Hammocks may be alien to your guides or porters, and they will build a frame (similar to that described for several hammocks, but only two feet high) across which they will lash saplings to make a bed. For those expeditioners not used to such hard beds a canvas (or tough plastic) sleeve (or pole-bed sheet) may be stretched between two poles and lashed to the main bed frame. These bed sheets may be made up, or purchased from ex-army or expedition suppliers. The frames and sleeve poles can be left in the camp when you move on, for a later visit either by you or others of the team.



Figure 3.9. A typical jungle basha. Photo: Bob Hartley

3.2.4 A few extras

Make a small table with sticks under the hammock on which to place your rucksack. Put two sticks, each about 2 feet in length, vertically in the ground on which to place each upturned boot. A welcome luxury on long-term projects is a lightweight folding chair or stool, to save squatting or sitting in your hammock. Candles can be held in sticks cross-split at one end and secured in the ground. Site them a little distance away from the mosquito net and hammock.

Suspend a taut length of nylon parachute cord along the length of your basha, under one side. This can act as a washing line for all your damp and grimy day-time clothing, thereby keeping it away from the hammock, and off the ground, yet letting it remain within easy reach.

Try to store your equipment off the ground and keep your rucksack closed. When it rains in the jungle, you will find everything covered in a fine spray of water and debris. Puddles form quickly, even under bashas and it does not take long for items to become soaked if they are left out. Avoid the temptation to lay out all of your equipment on a ground sheet – this is asking for a disaster !

3.3 Camp hygiene and well-being

3.3.1 Keeping Dry

Many parts of the tropical rain forest have an average rainfall of 3,000-5,500mm a year in comparison to 1,500mm in Britain. It is always wet and often very difficult to keep your equipment and yourself dry unless you take specific precautions. At low altitudes the high temperatures make being wet more bearable but even there, there can be sudden drops in temperatures which can chill you when wet. Wet clothes at higher altitudes are something to be avoided where temperatures at night can drop considerably.

You should take a good supply of large and small plastic bags including several heavy-duty ones. Zipped plastic folders are often useful. The re-sealable “Ziploc” freezer bags are sometimes available and help to keep food and equipment dry (canoe bags are totally water tight and can even take submersion in water with a simple but effective quick release buckle closure system. Up until recently these have been fairly heavy and expensive but now light weight, good quality, inexpensive ones are available [made by Totonka] and are perfect for night time kit.

When leaving camp during the day be sure that all bedding is protected by plastic. Clothes used to give extra warmth at night should also be protected. A lightweight waterproof jacket or poncho-cape and even a small, folding umbrella will make life more comfortable, especially during transit in open-topped vehicles or just while you are in camp. Breathable materials such as Goretex do not work so effectively in humid, warm climates, so a nylon cagoule should suffice. You should place a large plastic bag (or preferably a neoprene rucksack liner) inside your rucksack before you place in separate items wrapped in small waterproof bags. Each should be sealed and made airtight. With sensitive or delicate equipment such as film or cameras, you should add silica gel sachets to maintain complete dryness. (See chapter 7 for more details).

You must be particularly careful during the night to ensure that you do not touch textile fly-sheets otherwise the rain will drip through. After some months in the rain forest, the waterproofing on such fly-sheets loses its effectiveness; therefore it is wise to take some aerosol waterproofing liquid to re-spray the damaged areas. Fly-sheets made of 500 gauge (or thicker) polythene sheet do not lose their impervious nature but prolonged exposure to UV rays, especially prevalent in higher altitudes, will cause the plastic to become brittle and eventually disintegrate. Continually check that you do not get holes in the fly-sheet. If you get one, then mend the tear or hole with waterproof tape on both the outside and inside. Do not use the fly-sheet as a groundsheet as it will wear out quickly.

Small cotton run-off lines attached to the cords at each end of your hammock may help prevent rain from running down the cords from the tree trunk straight into your sleeping area. Sometimes however, you just can’t win and end up becoming damp

whatever you do ! If you decide to wash your spare, dry clothing, do it only if you can guarantee to have a set of dry clothes for changing into later. In reality, your spare “dry” kit will become your spare “clammy and smelly” kit – but will certainly be dry in comparison to your daytime work clothes and something to actively look forward to at the end of a long day.

3.3.2 Kitchen

One person must be responsible for the kitchen area, so that there is no doubt whose responsibility it is to cook each day, and who is to keep the kitchen area tidy and clean.

You will need to consider how to store your food. Rodents quickly appear in camp and can severely damage stores as well as transmit disease to humans, e.g. the multimammate rats (*Mastomys natalensis*) will urinate on your food supplies and transmit Lassa fever in West Africa.

There will need to be firm rules about the cleaning and preparation of food, including the preparation of fresh fruit and salads - you may wish to ban lettuce and other broad-leaf vegetables completely. If the expedition has the good fortune to have a local cook, the medics must keep a constant watch on standards of hygiene. Aprons must be washed, cloths and utensils boiled daily, finger nails short, wounds kept covered etc. Table tops and food preparation areas need to be scrubbed daily. Always bear in mind the possibility that the cook may be a carrier of disease. It is a good idea not to let any ill members of the expedition carry out kitchen duties until they have recovered from their illness.

The cooks work long hard hours, getting up before the rest of the team and working late into the night. They are the heart of the expedition and it is a thankless task. They are moaned at, if not often actually abused, but the expedition cannot function without food. A show of thanks from other members of the team goes a long way.

Food should ideally be stored off the ground. In longer term camps, a system of shelves and hooks should be used and a “quartermaster” be allocated to control and resupply the food stocks. Plastic, resealable boxes (“Tupperware” type containers) are excellent for food storage and for keeping perishable items dry. These are also available in larger towns and can be sent into the expedition area with the other stores.

Routine in camp life pays great dividends. It is advisable to have individuals do their own washing up and to look after their cutlery etc.. This should be stored in personal kit, away from flies, animals and dirt. Refrigerators in the field (whether gas, paraffin or electrically operated) are seldom 100% reliable. They must not be over-filled and the door must not be opened and closed too often. Scientists try to compete with the food, beer and even the medical officer's drugs for space in the fridge. This must be

resisted at all costs. Scientific specimens must be kept in a separate fridge if they need to be kept at low temperature.

3.4 Latrines and refuse

3.4.1 Latrines

When a camp is to be used for more than a few days it is worth building a pit-latrine, suitably screened and covered against rain. It is often the most comfortable building in camp - rightly so as it is a place of contemplation. When in alluvial forest make sure the pit is above the flood-plain. In mountainous areas you may be able to use the natural topography (e.g. a gully), but remember the natural drainage and the source of your own water supply. For overnight stops, a simple latrine can consist of a 2ft deep hole dug next to a tree. The tree offers some support whilst squatting. Mud from the hole is used to cover the waste and the entire hole is re-filled before the team moves off from the camp site. Latrines should be sited downstream from the water supply, and away from the water source altogether. Burning a mosquito coil near the latrine will help to reduce the amount of flies at the site.

Mark the path to the latrine with lamps and strong cord at shoulder height. This helps when answering a call of nature in total darkness. The path should be free of all obstacles, roots etc. as it will be in use for 24 hours a day. Keep the toilet paper in a waterproof bag.

Whenever possible keep a box or plastic bag full of sand (river sand is good) or light soil for sprinkling into the pit after use. A strong disinfectant liberally sprinkled is the best way to kill germs and discourage flies. If practical, establish hand-washing facilities (with a bucket of water treated with “Dettol” type antiseptic, changed daily) near the loo. Use the ash from the camp-fire to cover the waste. Lime may be available for long term base camps.

If your expedition has built the loos for your camps you must have a plan for dealing with the area after the expedition is over, leaving it safe and hygienic.

3.4.2 Refuse and drains

Rubbish disposal should be tackled as a daily chore to prevent smells and breeding flies. Rubbish will also attract vermin and scavengers if not disposed of completely. It is advisable to burn everything before burying it in a deep pit or taking it away for disposal. It can be useful to dig a rubbish pit on a slight gradient to promote drainage in the rainy season. We strongly recommend that all non-biodegradable, non-combustible refuse should be brought out of the forest when the expedition finally withdraws. Only in cases where it is impossible to take the refuse with you, burn what you can and deeply bury the non-combustibles. This includes tins and glass as even starving expedition members leave scraps in the corners of sardine tins. Make sure that natural erosion and animals will not uncover your refuse tip.

Even small mobile camps will need to dispose of dirty water. Without adequate

drains, your static camp will soon become very smelly, and stagnant water is a breeding ground for mosquitoes. Constructing drains is a time-consuming process. By their very nature they have a tendency to be regularly washed away or become clogged up. For camps which will be used for any length of time, building good kitchen drains and grease-traps will pay great dividends in the long term provided they are used and maintained properly.

Grease-traps tend to get clogged up very quickly by a surface layer of food particles, causing the whole system to break down. A good filter which is small enough to hold back rice etc., and which can easily be cleaned is a great asset. Making one of plastic netting or mosquito screen over chicken wire is one possibility. Washing suds and tooth-paste spit can cause problems as they tend to form a slimy surface over soakaways which then require regular maintenance to clear.

3.4.3 Camp-training guides and labourers

The personal hygiene of local peoples will vary so when possible get them to follow your example. If they are using western-style loos, make sure they use them properly. Remember Moslem people need water when defecating so make sure their toilet area is downstream. If you are supplying them with tinned food, make sure the empty tins are disposed of correctly. Watch out for plastic bags and plastic string used in camping, and do not leave the vegetation adorned when breaking camp.

3.5 Routine clothing and equipment for the jungle environment

3.5.1 General

Routine daytime clothing for general jungle wear need not be expensive but some thought should be given to its characteristics - the main items are listed below. Whatever clothing and equipment you decide upon, the trick is to become familiar with it all before you embark to the jungle. Try out the hammocks and basha-sheets, break in the boots, learn how to pack it all and get used to carrying the equipment. Some items will need a “servicing” after the initial use, buttons come off, seams need sealing etc. It is better to sort out your equipment at home rather than in a tropical downpour on a jungle-covered mountainside, miles from anywhere. Operate on the basis that you have two sets of clothing in general – your daytime clothing and your spare, dry night-time clothing. Anything else is usually superfluous and ends up being stored somewhere.

The golden rule is that you **will** get wet during the day so you must be dry at night. At all costs protect your night time clothing even to the extent of taking off your dry clothing, or throwing on a waterproof poncho, if a visit to the latrine is called for in the middle of the night.

The jungle has a wonderful system of rotting down to create new growth, unfortunately this will have the same effect on your equipment and you, in the longer term. For any expedition longer than a couple of weeks expect a 30% failure rate of equipment and the addition of fungal growths to your body!

3.5.2. Footwear

a) Jungle boots

These are lightweight, calf-high, canvas boots with rubber serrated soles and nylon laces (non-rot) over the sewn-in tongue of the boot. Holes above the rubber sole let out water and the walking action of the foot squeezes the water out like a hose. US Army jungle boots are superior quality to the British Army jungle boots (BE AWARE- there are many copies of U.S jungle boots. At best they are American made but down graded. At worst they are Far-east imports that will have a life expectancy of about two weeks). A good check is to lift the inner sole of the boot, underneath should be a leather inner sole held in with heavy stitching. In addition the original boot will have a steel shank but of course this will not be seen. Nylon (mesh) inner-soles are useful (they can be removed, cleaned and dried within an evening). Jungle boot soles are notoriously hard and an insole will make the boot more comfortable on roads and hard-packed mud surfaces.

Some travellers are happy with hockey boots, but they are not resilient enough nor do they give a suitable grip if you wish to go on extended treks through the jungle. It is advisable to have a spare pair of boots in case the first pair disintegrate.

Canvas shoes or boots can usually be bought locally, but larger sizes (i.e. 11 and over) may be difficult to find. They will also wear out faster. Try to avoid buying waterproof “breathable” fabric boots for jungle environments as these tend not to work as well in humid, wet conditions and will become punctured by thorns. The fabric will often trap water inside and that leads to problems later. If anything, it is worth investing in a pair of liner socks made from Goretex or similar breathable fabric. These can be worn inside damp jungle boots in the evenings, when you want to wear dry socks and allow your feet to dry out. When you are breaking in your jungle boots, make them damp and rub some boot polish into the leather uppers. Then walk around in the boots until they dry out. Then repeat the process. This will help the leather shape to your feet. Jungle boots are more comfortable when slightly damp – as they will tend to remain whilst you are in the forest.

There are more and more good tough non-waterproof, quick drying boots becoming available but, because all our feet are different, always go for fit and comfort at the expense of technical excellence if necessary.

If you are based at a static camp and weight and bulk are not an issue remember the good old Wellington boot. These can be upgraded considerably by placing a plastic mesh jungle inner sole inside to aid air circulation.

b) Leech socks

In some areas (e.g. S.E.Asia) leeches can be bad and mostly (not always as they may drop from leaves in wet shrubbery) become attached by way of the feet. They will penetrate through boot-lace holes and through open weave socks. Leech socks are simple-styled socks made from fine-weave cotton, with a double seam tightly sewn, so that leeches cannot squeeze through. They are worn over the sock and draw over the trousers, with a draw-cord to tighten just below the knee. N.B. If leeches have evaded your defences they can be persuaded to leave with a dab of insect repellent (or ash, salt, tobacco or iodine tincture).

3.5.3 Over view to clothing

There are great differences of opinion even amongst experts on the pros and cons of cotton against man made fabric for clothing. Cotton breathes better and has a nicer feel but is subject to rotting if not constantly aired and will also remain wet longer. Man made fabric (polyamide) will dry quickly and will not rot, but feels clammy for many people. The choice is yours.

- **Trousers:** Loose fitting cotton “ripstop” or quick drying polycotton (polyamide is the modern alternative being completely man made) trousers with a map pocket on the thigh and double material on the knees is worthwhile. They should not be tight in the groin or be tight around the waist, but do allow for loss of weight in waistline. Many styles have a built-in belt. Allow for the bottoms of the trousers to tuck into

your socks/boots or into an elastic band over the upper part of the boot. Do not stuff your pockets or map pocket with objects unless they are waterproofed, as they are likely to get wet if you wade a river and can cause chafing.

- **Socks:** There are plenty of good quality socks on the market. Loopstitch wool/nylon mixes are hard-wearing and offer padding for the feet (the modern alternative is wool/coolmax). Take three pairs. Calf length will suffice.
- **Underwear:** Avoid nylon garments with tight elastic. Unpadded Lycra shorts are excellent to reduce chafing by trousers and also very effective protection against persistent leeches. Lycra sports bras for women are available. Wash garments daily – they are quick-drying and hard wearing. Cotton underwear absorbs sweat but does not dry quickly and can chafe.
- **Shirts:** Shirts should be predominantly cotton or (polyamide) poly-cotton, long-sleeved, with 2 pockets and should be tucked in so ticks and leeches cannot enter easily. Ensure that the sleeves are rolled down when walking through the forest to ward off scratches and biting insects. T-shirts are useful and low bulk but do not offer the same protection from sun and insects as long-sleeved shirts in the forest.
- **Towel:** A small one dries quickly. For light weight, a square of muslin is adequate. Modern “Travellers Towels” are now generally available but are expensive (the chamois type are best as these work well when wet and take up no room). A Sarong is a versatile, quick-drying item of clothing that can double as a towel. Be sure to have a couple of them as it is not good etiquette to wear the same Sarong you use for a towel to a meal with locals.
- **Sweat-rag/Bandana:** This is very useful on an arduous walk to wrap around your neck or forehead. You will sweat a great deal for the first three weeks until your body becomes acclimatised. Choose a lightweight, pure cotton cloth 4ft x 1ft 4ins for a bandana that can also be used as a head and back of the neck cover.
- **Hat:** The cotton, floppy jungle hat is ideal for keeping your head out of the sun, stopping ants, ticks and twigs getting into your hair, and lethal rattan 'tendrils' (the extended midribs of pinnate leaves armed with fish-hook spines) off your face, keeping the sun out of your eyes, as well as swatting flies, picking up hot cooking pots, water carrying, wiping a sweaty face, sitting on, and a hundred and one other useful tasks. It or a similar wide-brimmed hat is essential for long river journeys in open craft. It might be worth investing in a midge head net. This should be worn over the hat, not underneath it, and tucked into the shirt collar. It will stop you being savaged by biting insects if you are working in wet environments.
- **Rain wear:** When in lowland and mid-mountain rain forest, one may find shelter for the occasional storm. If on a trek and you need to continue walking/working, then

the poncho-type of rain cape is more comfortable to wear than a closed anorak however light. Consider taking a small, folding umbrella too.

The above clothing is for long travel treks. For shorter walks on established trails, local people often dress in only shorts, T-shirt and sometimes shoes (or wellies). Wearing more clothing may be unnecessary, hot and heavy.

3.5.4 Other items

- **Eating equipment:** A regular clipped knife, fork and spoon set is desirable. Avoid the cheaper sets as these will rust even though they say they are made from stainless steel [modern Lexan plastic is both durable and lighter than steel]. A tea spoon is often worth its weight for measuring as well as stirring. Deep plastic bowls and mugs are recommended. Mess tins are still popular with some. Hygiene demands that individuals mark their own mugs.
- **Tin opener:** The small military tin opener is invaluable. Try to attach it to your spoon but avoid hanging it around your sweaty neck.
- **Map:** Ensure that both sides are completely waterproofed with a plastic coating. You can then keep it in the trouser map-pocket and continually use it without fear of disintegration.
- **Compass:** (e.g. Silva Type 4) attached to the breast pocket flap. Avoid letting it come into too much contact with DEET insect repellent as this will remove the markings and scar the plastic.
- **Whistle:** Wear this around your neck for easy reach. Everybody working in the jungle should have a whistle in case they become lost or separated.
- **Torch:** A small torch is usually adequate. Try to use one that takes AA batteries as these are generally available throughout the world. There is an advantage of having a torch that can be used without hands e.g. clipped to clothing or strapped to the head (the only disadvantage with head torches is that flying insects tend to zoom in straight to your eyes). Carry them with the batteries reversed or separate to avoid unintentional switching on and take spare batteries, bulbs and in some cases, springs (for Maglite torches). Mini Maglites are excellent and head-straps are available for use with them. As a rule of thumb, bulbs will last for two changes of batteries. It is easy to underestimate the amount of bulbs needed for a long expedition. In addition try to choose a torch that can be completely stripped down [Maglite or Petzel] so that running repairs and cleaning can be carried out. Consider carrying a mini back up torch or snap light stick for emergencies.
- **Watch:** Choose a luminous, waterproof watch. Some prefer to attach it to a cord and

not wear it on the wrist as it can cause sores and may drop off if the strap rots. Note that cheap plastic watches make the wearer less of a target for thieves in towns.

- **Sunglasses:** It is worth investing in a good pair of polarised sunglasses with U.V. filter for river trips, secured behind the neck with string.
- **Sunscreen:** The highest factor available is recommended for river travel. Use Uvistat or similar sun screen for lips. Remember, you can get sun burn from reflected light/heat when travelling by canoe.
- **Insect repellent:** There are several types of repellent on the market these days, some containing chemicals (such as DEET) and others containing natural ingredients. Try them out and see what you are happiest with. DEET is certainly a reliable repellent and can be bought in different strengths, however it does tend to scar plastic surfaces. Whatever you decide to buy, ensure that you take enough with you as it is a vital part of your jungle inventory. (A 100ml bottle of insect repellent will last approx. one week if applied properly). In addition a new Permethrin based clothing treatment [BUGPROOF] is now available. Each treatment lasts two weeks no matter how wet you become and works extremely well). If you use a repellent on the skin and also a sun screen, the repellent will halve the protection value of the sun screen.
- **Penknife:** A good, lockable penknife attached to a lanyard around your waist and kept in a trouser pocket is preferential. A Swiss army pen knife is extremely useful and compact, combining tin opener, scissors and blades.
- **Machete:** This is an important tool for the jungle environment and should be handled and treated with respect. Anyone using a machete should be taught how to hold it, cut with it and handle it without causing any damage. Carry it in a sheath suspended on a nylon tape slung around the shoulder or from the waist. Attend to the blade: ensure it is oiled and razor sharp every night. Keep it in its sheath when walking in the forest: it can be a lethal tool but only if mishandled.
- **File:** Carry a file (or whetstone) and oil for the machete. Wrap metal files in a sheet of paper and then inside a plastic bag.
- **Gloves:** Tough canvas gardening gloves can protect your hands from blisters if wielding a machete or from cuts and scratches if clearing foliage. They are also useful if climbing in limestone country where rocks can be razor-sharp.
- **Camera:** See chapter 7 for care of photographic equipment. A small camera can fit into a shirt pocket.
- **Waterbottles:** Plastic or metal water-bottles (1 litre) fit neatly into the side pocket of a good rucksack. Ensure that the tops can be secured with cord to prevent losing

them. Carry one of them on a belt so you can drink regularly. Have another full bottle in the pack, ready to swap over when the first is empty. In this way you can then keep one bottle purifying and the other ready to use. Have Purification tablets (or Iodine liquid) close at hand. On long walks take a 4 litre flexible waterbag but carry it inside the top of the rucksack where it will not be pierced by thorns. The new flexible water bags, with drinking tubes attached, are very useful for prolonged treks where constant small intakes of water are preferred. Ensure the tubes are kept clean.

- **Notebook and pencil:** Place them in a waterproof wallet in your breast pocket. Use a waterproof notebook such as those manufactured by Aquascribe. Use B & HB pencils and cut them in half as they are easier to carry. They should be brightly coloured yellow/red in case they are dropped onto the forest floor.
- **Basha sheet, Hammock, Mosquito net:** These are available from commercial suppliers (Nomad Travellers Store, Kathmandu trekking, Arktis of Exeter) and are designed to be used either as a unit or as individual sections to allow more flexibility. Try to avoid army surplus 3-in-1 jungle hammocks as they tend to be heavy and do not allow you to split the unit up. For example, it is better to have a mosquito net that can be set up in a village hut without a hammock. The basha sheet can be used for sheltering in vehicles, waterproofing equipment and catching rainwater etc.

Attach 2 meter lengths of parachute cord to the loops on the basha sheet and put thin elastic cord onto the mosquito net corners. It reduces stress on the material when it is tucked into the hammock and you are lying on top of it all. Some hammocks are very lightweight and incorporate a length of cloth that can be pulled over the top when the temperature drops a bit. Stretcher hammocks are useful and comfortable but a little heavier and bulkier than cloth Thai-style hammocks. Try to find one made of quick drying cotton-polyester rather than canvas. Hammocks will become damp, however hard you try to prevent it from happening.

- **Sleeping bags:** What weight of sleeping bag you should take depends on how high you are planning on climbing. The jungle can become chilly at night even at sea level and so it pays to have a synthetic bag that will keep you comfortable. For general use, a small “Snugpak Softy” 3 or 6 sleeping bag is a good option. Covered in Pertex material, the bag dries out quickly if it becomes damp and packs away to a small size. Avoid down fillings. Alternatives include, quilted “poncho liners” (Tropical quilts like a synthetic blanket) and lightweight woollen blankets. Cheap blankets can be purchased in street markets and left behind with friends and villagers after the expedition. A short length of Karrimat will complete the sleeping kit that allows a little flexibility. Check all your sleeping equipment as it is a vital part of your jungle kit. You will be a lot happier if you can guarantee yourself a decent night’s sleep in a basha that you know how to set up.

The best combination is a tropical quilt for general use [less restricting when in a hammock than a sleeping bag and quicker drying] with the addition of a one to two season sleeping bag to use in combination for colder nights.

- **Waist bag:** It is certainly worth taking a waist pouch that can accommodate a waterbottle and some essential items of equipment. This should be carried everywhere, without fail, and will mean that you always have some emergency items with you if you become lost or separated from your pack. Several designs are available and even ex-army belt pouches will do. Typical contents of this pouch would include: *Waterbottle, iodine purifier, penknife, insect repellent, small first aid kit, Maglite torch and 2 spare batteries, lighter, small candle for firelighting, compass (if not worn on shirt), high energy snacks, waterproof matches, your passport and wallet in waterproof bags, location device – whistle should be around your neck.*
- **Rucksack:** Buy a strong, well-made rucksack which is balanced and comfortable when fully packed. Gifford (1992) gives a detailed description of rucksack features. Some packs have several compartments but a single one will suffice. Side pockets are very useful, but if they are attachable, place them to the rear of the pack, where they will not catch on undergrowth. Keep the profile of the pack low – certainly try not to pack it any higher than the back of your neck as this will allow you to move more freely through the forest. It is advisable to know where everything is to alleviate the frustration of finding a needed item at short notice. Take care to pack everything into strong, waterproof rucksack liners and plastic bags (or waterproof boat bags), and take spare bags.

3.5.5. Rucksack contents

Below is a list of the basic equipment that you will require in the jungle. The list of optional items consists of additional kit that is certainly worth taking with you, but you might choose not to carry it all the time. Some of the equipment will not need to be kept

dry but it is still worth carrying it all wrapped in plastic bags. This will prevent damp from spreading from soaking wet basha sheets, water bags and the like.

If you carry a rolled up sleeping mat, strap it vertically to the rear of the pack so that it will not snag on branches above your head as you walk along. The following example is a quick guideline as to how you might pack your rucksack:

In the main compartment of the rucksack, lined with a neoprene bag: Stuffsack containing your spare shirt, trousers, socks, goretex liner socks, foot / body powder, spare torch batteries, sarong / towel

Then pack: your hammock and mosquito net, medical pack (with personal medication) and any group items that need to be kept dry.

Then pack: Your food bag, fuel blocks (eg: hexamine), cooking pot, lid, brew kit (tea, sugar, milk, coffee) and your spare food (for emergencies).

Close the liner and pack: your basha sheet (probably wet) and the full waterbag (also wet) behind the shoulder area of the pack. Also ropes and other group items.

In the top pocket: candles, lighters, toilet paper, metal file, wash kit, sunscreen, sewing / repair kit, 10m nylon cord, spare maps and GPS unit

In the sidepockets: Waterbottle, purifying kit (filter, tablets), mug, spoon, snacks

Machete is worn on the waist. Notebook and pencils, map, watch, whistle carried in pockets or worn on the person.

Other items could include: Tent pegs, sleeping bag, sleeping mat, fleece jacket, waterproof jacket (or poncho – but not for use as a shelter), training shoes, flip-flops, shorts, T-shirt, camera and film, journals, lightweight daypack, sunglasses, walkman and tapes, mosquito coils and spare wash kit items.

Larger items for distribution within a trekking team could include the following:

Radio/communications equipment, medical packs and IV fluids, ropes, air marker panels, pyrotechnics, EPIRB satellite beacons, scientific equipment, tarpaulins, cookers and fuel etc.

3.5.6. Equipment for river expeditions

Clothing for river travel can be lighter and fewer items need to be at hand or round the neck. You can wear T-shirt, shorts and gym shoes if you are not liable to sun-burn. Do not wear heavy boots in boats. Rucksacks should be carried in a net container at the stern of the craft. Cameras, notebooks and maps should be kept in small waterproof

boxes attached to the safety line which runs along the inside of the boat. All personal and boat kit must be secure in case of capsize.

3.5.7. Some points about personal equipment

It is strongly recommended that all personal items should be clearly marked with the owners' name and it is suggested that separate articles are packed in separate plastic bags. A colour patch can often be useful for marking, particularly on such things as the handles of cutlery and mugs which should never be used by anyone else. This is especially important in areas where diseases such as stomach upsets or hepatitis can be transmitted by personal contact. On expeditions each person should be responsible for their own washing-up.

Each member of the team should be issued with a small personal survival pack, which should be carried on the person at all times. It can be tied to a trouser pocket by a length of cord or kept in the waist bag along with the other items. Survival Packs contain:

- razor blade/disposable scalpel blade
- miniature compass
- fish hooks and weights
- fishing line
- waterproof matches /gas lighter / small candle stub
- anti-malarial tablets
- steritabs for purifying water
- survival instructions card
- whistle
- nylon cord
- wire saw

The contents should be enclosed in a plastic bag and a small tin which can act as a cooking container.

Female members would be well advised to bring a sufficient quantity of tampons, as these are difficult to purchase in many countries.

3.5.8. Camp and night attire

Once the camp is built, by about 4.00pm, it is wise to get out of the wet day-clothes and change into shorts (if sandflies, mosquitoes, etc. allow), T-shirt and flip-flops. This is the time to take care of your feet and to dry, powder and tend to any abrasions or blisters. Flip-flops allow the feet to dry well but always wear your boots when walking around. It is inadvisable to walk bare-foot in the forest for fear of thorns, insect bites and stings, hookworm or jiggers (where there has been recent habitation- which can cause extreme discomfort if they burrow beneath the toenails). In Amazonia, black flies (piums and borrachudos) are particularly bad near running water where they breed.

In most areas, mosquitoes and biting flies will increase at dusk. Put on a sweater or change into your dry clothing to protect arms and legs from bites. Apply insect repellent to the exposed hands, neck and face (beware of eyes and lips). By this time, your feet should be thoroughly dried out, so you can change into dry socks and boots.

If you have sweated a great deal in the daytime or become muddy, wash your shirt and trousers in a nearby stream; wring them out and hang them in front of the fire. Once the clothes have dried out take them into your hammock, to use as a pillow. This will mean that the shirt and trousers will, hopefully, be warm and dry and ready at hand to put on early in the morning when you may not be feeling at your best. Boots should be placed upside down on sticks beneath your hammock so that they can be kept dry and do not become the home of insects or creepy crawlies at night. Be sure to check in all the corners of your mosquito net before clambering into bed. Do not leave night attire unpacked during the day whilst away from camp as it risks becoming damp. Proper care of boots and clothes is essential. Ensure that the camp attire and night attire are well wrapped in plastic bags and completely waterproof before you put them into your rucksack.

Chapter 4: COOKING AND CATERING IN THE FOREST

Food and feeding is an important aspect of all expeditions and those to tropical forests are no exception. Most people associate living in a hot climate with a decrease in food intake, mainly because your activity and your need for energy tends to be less. If you are active however you may well have a strong appetite, and you will certainly generate a lot of extra body heat in addition to that produced by the higher environmental temperature. In this case you will need to drink enough fluid to prevent your body overheating.

When considering catering and cooking in the forest you must address the supply of water, the heat sources available for cooking, the equipment needed and the foods available both locally and at home. These subjects will now be discussed in more detail.

4.1 Water, its supply storage and purification

4.1.1 Need

In the tropics your basic requirements for water may be up to 10 pints (5 litres) per person per 24 hours, plus an extra pint per person for each hour's work. In extreme heat and high humidity as much as 25 pints (15 litres) per person per 24 hours may be needed. You should try to aim at drinking sufficient water to ensure an output of urine of at least two pints per 24 hours. Again, thirst is not an indication of water requirement. Every member of the expedition should have his own personal water bottle. This should preferably be of heavy polythene or metal covered with felt or some other cloth which can be wetted and so help keep the contents cool by evaporation. Make sure that all water containers are scalded with boiling water before you set out so that you start with a clean container.

4.1.2 Supply

In evergreen tropical forest where rain falls almost every day, rivers and streams will abound. Topographical maps will show a dendritic drainage pattern in hill areas but these may not be as dense on the ground. Towards the ridge, water in the form of a streamlet may be very difficult to find, especially in limestone country. For anything other than a temporary camp it may be worth spreading a plastic sheet for rain catchment, whenever possible in an open glade on the ridge top: catchment under trees will pick up leaves which will at the least taint the water, and at the worst may introduce poisons if they remain in the water container. A small hair-net or similar nylon net over the container will prevent this.

If drinking water is obtained from the river/stream, make sure there is no settlement or porter camps upstream. But in all cases water should be boiled or purified (see below) before drinking.

In large camps servicing more than ten people, substantial water catchment using corrugated iron (usually easily available and the cheapest) or plastic will be worth the investment if transport to the campsite is possible. Similarly 250 gallon (1250 litres) or larger galvanised tanks can be transported by boat.

4.1.3 Purification

All water that passes your lips, (e.g. for drinking, for cleaning teeth or for cooking), should be purified. This can be done by either boiling or chemical treatment. To purify water by boiling, the water must be brought to the boil and must boil hard for at least five minutes. This is unreliable at high altitude where water boils at a temperature lower than 100°C. In that situation one should use a chemical method of purification.

There are a number of chemical water purifiers available. (See Juel-Jensen, 1992). These include iodine (10-20 drops of a 2% solution per gallon, or Potable Aqua iodine tablets), silver, and quick-acting effervescent chlorine water purifying tablets such as Puritabs and Steritabs which can be obtained from most large pharmacists and camping shops. When you use these tablets follow the instructions every time and do not try to skimp. Tablets are usually available in two sizes (one or twenty-five litres) and may be individually wrapped or available in tubs. You should plan to take those which are the best size and most suitably packaged for your needs and environment.

Chemical treatment of the water may give it an unpleasant taste, and although members will quickly become accustomed to this, you may like to use fruit juice crystals (**vitamin c powder**) to disguise the taste. Tablets to take away the taste of chlorine are available but are not recommended except under controlled conditions.

In water heavily contaminated by suspended sediment, the active component of the sterilising agent will be mopped up by foreign proteins and will not work. Solids and other foreign bodies must therefore be removed by filtering before using chemical purifiers. There are a number of methods for this which include filtering through fine gauze, or if this is not available, through a handkerchief. Some people use a canvas bag called a Millbank bag (from Nomad Travellers' Store and Pharmacy, Turnpike Lane, London) which is useful for small scale filtration. (see Fig. 4.1) In the tropics pottery candle filters are popular, especially in static locations, and these can be obtained from a number of suppliers (listed in Appendix 5). If you use pottery candles for filtering water, make sure the candles are scrubbed regularly and before they become clogged and brown with filtered foreign matter. Remember that filtration does not purify the water (although the Swiss manufacturer Katadyn has combined a silver purifying agent, a candle filter and pump into one unit). If water has to be obtained which is heavily silted, a large tank where the sediment can settle before the water is filtered and purified, is desirable. See Juel-Jensen (1992) in Winsor and McWilliam for more detailed discussion.

A note about salt

For the first week or two after arrival in a hot climate one or two teaspoonfuls of salt per day extra-to-home-needs are required until you are properly acclimatized. In hot countries always take some salt at all meals. Use ordinary table salt rather than salt tablets, which are costly and usually pass through the gut without being absorbed. You will need more salt if you are feeling exhausted, sweating, vomiting or have diarrhoea. The salt should be foregone if there is not sufficient water to match it. Do not use salt tablets or emplets. Electrolyte replacements (e.g. Dioralyte and Rehidrat) are now available commercially as effervescent pills or powders. These are highly recommended as they replace other vital salts such as potassium and are easy to carry.



Fig 4.0 The Millbank bag in use. Photo: Roger Chapman

4.2 Fire lighting and stoves

In some tropical National Parks, wood fires may not be permitted at some camp sites. This is sometimes because you may start a forest fire but mainly because the natural forest community must be conserved. So check with local wardens or rangers.

If the weather is wet, take dry sticks from the old camp site fire in your rucksacks when moving on, so that you have good dry kindling wood for the fire at your new campsite. When you have local guides, they will be able to organise the camp fire. Local inhabitants of the forest will be able to show you particular trees which will readily burn even when wet and sappy. In some countries you need to avoid burning poisonous woods (Belize has several varieties that will burn with an acrid, blinding smoke resulting in skin rashes and painful lungs).

Fire lighters are most useful, but make sure they do not crumble into your rucksack (these are very difficult to find locally). Take several gas lighters (cheap models can be found in the local markets) to maintain a steady flame. A piece of rubber from an inner tube is a good substitute fire lighter for wet conditions. Carry a couple of normal household candles in your pack so that you can save on matches. A piece of candle standing in the middle of the tinder is an excellent aid to lighting a fire, leaving your hands free to stack the kindling and to build the fire as it starts to take off.

There are many ways of lighting a fire - wigwam, trench, lean-to methods - but by taking these precautions you can soon get a roaring fire going in the worst of weathers. Remember to strip away all the wet bark from the logs that you have cut and collected. There will usually be dry wood underneath the wet outer skin so it is worth the time taken to do this.

Once the fire is alight, erect a pole over the fire with Y stick support(s) and hang your cooking pots to boil water for that first life-giving cup of tea or coffee! Gone are the days when you rub two sticks together or attempt to light a sodden match, but those that live in the bush will often have the knowledge of how to start fires using friction and bush tinder and which is the best green timber to use. If you get a chance, do try to learn as it is a useful skill and satisfying when you get the desired results !

In most tropical areas tin mugs (1 and 1/2 pint sizes) and plates can be bought easily. Try to avoid enamel mugs because they are prone to rusting where the enamel chips off. A compact knife, fork and spoon set is a good investment and can bring dignity to a meal. Bamboo is a useful wood from which to make eating utensils. If you use bamboo to burn you MUST remember to split each section because otherwise it will explode in the fire, resulting in sharp splinters flying through the air ! Old, yellow bamboo is better for fuel, although it burns quickly. Green bamboo sections can be used for cooking rice, boiling water and carrying food in the jungle. Ask your guides to show you how they use it as it is an incredibly versatile plant.

On long journeys, cooking equipment has to be small enough to fit into a rucksack. The Army surplus mess tins - rectangular in form and usually available in

pairs - are ideal to fit into a rucksack side pocket. However, a large biscuit or jam tin with a wire handle can make a good brew-kit. Remember to keep one of your pans for brewing tea or boiling water and the other for cooking food to avoid finding rice in your tea. Not good news (for an Englishman)!

4.2.1 Stoves

Considerations which will have a bearing on the choice of stove for a particular expedition are likely to be:

- availability of fuel
- efficiency
- expense
- safety
- dependability
- weight
- velocity of wind
- altitude
- temperature variation
- type of pans being used
- ease of operation
- cleanliness

Stoves are often named after the types of fuel on which they run: only paraffin (often called kerosene) and bottled gas are discussed here. Refer to Gifford 1992 for other types of stove.

For short term expeditions it will probably be practical to take all necessary fuel for the full period either in small containers with each cooking unit, or in bulk. If this is intended, check beforehand on any regulations that may be in force, both in this country and overseas - gas cylinders, for instance, cannot be taken on aircraft. Indeed very few fuels, if any, can be taken on IATA aircraft which are banned by international convention, from the transport of dangerous articles. Experiment beforehand with the consumption of the stoves to be taken, allow for some wastage and for adverse conditions. If it is intended to obtain fuel in the expedition area, check thoroughly that it is available and that it is of the type suitable for your stoves. Find out also the word for the particular fuel in the language and dialect of the area. Check too, if any regulations apply to the use of specific fuels in the area. Fire precautions can be very strict in some regions. Do not assume that forested areas will necessarily provide cheap wood for fuel; as burning of such wood even if available may be prohibited.

a) Paraffin may be used in either pressurised or un-pressurised stoves. Except for possibly on occasions in base camps, the unpressurised variety have little application to expedition use. In pressure stoves such as the Primus, Optimus, etc., paraffin has much to offer. It satisfies almost all the above criteria and in particular it is efficient, cheap,

little affected by cold and almost universally available. Its only disadvantages are that it requires a second fuel for priming (though solid Meta fuel, Jelly meths, or similar, are the easy answer) and that it is pretty penetrating if it gets anywhere it shouldn't be, such as inside a rucksack or on to food. Paraffin pressure stoves are deservedly the most usual choice for all types of expeditions. Models are available in three capacities, from half-pint to about three pints. Two one-pint stoves are recommended for a unit of six people.

Paraffin stoves are not dissimilar to their petrol counterparts, except that pumps are necessary with paraffin or kerosene, due to the low volatility of the fuel. The control valve and safety valve are replaced by a simple air bleed valve, and the pump and valve control the tank pressure, fuel flow and heat output. Once started, cold temperatures have little effect on performance, but the stove must be primed to start, either by using a methane block, methylated spirits or alcohol.

b) Bottled Gas is clean and convenient; it is also expensive and not always available. Valved gas cookers with large butane or Calor Gas cylinders may well be worth considering for standing or base camp use, but much depends on local supplies.

c) Gas stoves are very simple. There is a connecting device to secure the cartridge, a valve to release fuel and control its flow, and a burner to shape the flame. No pumping, priming or handling of fuel is necessary, and although this type of stove is exceptionally popular, there are misconceptions concerning gas and its performance. This type of burner is not always easy to protect from wind but in everyday situations, or limited period trips at low altitudes, the performance of gas stoves is usually adequate, as long as the flame is protected without reducing the airflow around the burner head or mushroom. A normal size cartridge in average conditions burns for approximately 1¹/₂ hours and this figure should obviously be borne in mind.

Some expeditioners are fearful of gas canisters. However, the cartridges are extremely robust and great care is taken in their manufacture. They are constructed to withstand pressure many times that experienced in normal use, but in the event of a hazardous situation, the base is designed to expand outwards, from a concave to a convex shape. This increases the volume of the cartridge by 30% and allows some of the liquid gas to expand into vapour, thus relieving the pressure. If the pressure in the cartridge becomes too great, the base is designed to be forced off by the expanding gas vapour, avoiding dangerous fragmentation of the cartridge.

Of course, success with any cooking system comes with practice and experience, and no camping stove is designed to cook sophisticated meals. Always bear in mind that an efficient heating and cooking unit that is reliable to use, simple to operate, requiring the minimum amount of maintenance for maximum efficiency and minimum weight is what you require. Lastly, for safety and reliability, always ensure that spare parts are of the same make as the stove - not "universal or multi-part" fittings.

Remember too, that with both types of stoves, transportation of fuel is unavoidable, creating bulk and weight, but these problems can be put in perspective and allowed for, when the thermal properties of stove fuels are

compared and examined. As shown below, the figures for propane and butane look extremely good. However, these figures become unreliable in varying weather conditions, temperatures and altitude. Because of this, some people feel that white spirit, petrol, and paraffin are the fuels worth carrying. Certainly paraffin is usually available, even in remote areas, and no problems are created with supply or movement. Also, by comparison of weight to heat, both petrol and paraffin are acceptably efficient.

Fuel	Advantages	Disadvantages
Paraffin	• Good availability of fuel • Spilt fuel doesn't easily ignite • Fuel sold throughout world • High heat output	• Priming required • Spilled fuel does not evaporate easily
Butane	• No fuel to spill • No priming required • Immediate max. heat output	• Poor local availability • Transport by air restricted • Higher cost of fuel • Cartridge disposal is a problem • Cannot change Gaz cartridges until empty

Figure 4.1.: Fuel comparisons between paraffin and butane stoves

As Nick Lewis and Paul Deegan say in their superb chapter in the 2002 edition of the Expedition Planner's Handbook on environmental aspects of expeditions, "combining a couple of fresh ideas with a common sense approach.....will significantly help to reduce the environmental impacts generated by expeditions." With this in mind, you may want to consider taking a liquid fuel (such as gasoline or paraffin) for cooking, as a pressurised stove that uses a liquid fuel burns hotter than bottled gas with no resulting empty cartridges for disposal. Take comprehensive repair kits and learn how to use them rather than carrying a number of expensive spare stove and tents. Remember that poorly maintained or damaged products can result in damaged equipment being abandoned in-country. Also, less equipment results in less weight with less to go wrong.

4.3 Food: imported rations and local food

4.3.1 Long journeys through the forest

Where possible it is always best to eat local food, but for long journeys on foot, you may have to use dehydrated rations. It is possible to carry about one week's rations in your rucksack if you limit yourself to carefully balanced dehydrated food. It is important to supplement these rations with greens and fresh fruit - purchased from local villages - at least once a week. This type of ration pack demands individual cooking, but for peace of mind and stomach, individuals should take their own extras or "goodies" to supplement the rations.

For example:

British Army Pack (1 day; 4 oz)

Breakfast: 2 x oatmeal blocks, tea, milk/sugar

Lunch: tin of sardines, raisins/nuts, biscuits/margarine, tea/milk/sugar

Supper: curry and rice (pre-cooked dehydrated), biscuits and margarine, tea/milk/sugar, chocolate, cocoa/milk/sugar

4.3.2 Group rations in larger camps

For larger expedition catering one should refer to Gifford (1990,1992). Where base camp facilities are being maintained to service smaller patrols/surveys, cooking can be central. Prior to the expedition moving into the field, rations can be pre-packed in plastic waterproof bags with each meal labelled by date (e.g. B'FAST 2 NOV, LUNCH 2 NOV, etc.) This ensures that meals are varied each day for a week. It can bring comments such as "sardines - it must be Monday!" but at least the meals are different and varied.

	Day one	Day Two
<i>Breakfast</i>	2 pkts porridge oats 2 pkts dried egg (scrambled) 5 tins bacon 5 tins 20 tea bags 6 tins condensed milk 2 lbs sugar 2 bread loaves 10 pkts Army biscuits	1box cornflakes 1 box museli 10 tins spam 5 tins baked beans 1 coffee pot 6 tins condensed milk 2 lbs sugar 2 bread loaves 10 pkts Army biscuits
<i>Lunch</i>	10 tins sardines 10 tins herring	10 tins corned beef 10 tins spam

	20 pkts biscuits	20 pkts biscuits
	5 tins jam, varied	5 tins jam, varied
	5 tins butter/margarine	5 tins margarine
<i>Supper</i>	1 pkt mince meat (dried)	5 tins Irish stew
	1 tin curry powder	2 lrge pkts mixed veg
	2 lrge pkts dried peas	4 pkts mashed potatoes
	1 lrge pkts runner beans	1 pkt dried fruit
	1 pkt apple flakes	

Figure 4.2. . An example of two days menu from a 10-man expedition

When travelling it is sensible to make contact with local villages, wherever possible, in order to purchase fresh food to supplement your rations, but such food may not always be available.

One or two designated people should be the quartermasters and thus be totally responsible for provision, packing, loading and distribution of food. You should plan your provisioning and buy tinned/dried food in the local bazaar or market town before entering the remoter areas. The quartermasters play an important role in the morale of the whole party and if wise, should keep a large supply of goodies to bring out at moments when the team get a little depressed by the monotony of other food.

When travelling with local people they will require their own food: rice in Asia; manioc, blackbeans and rice, and coffee and sugar in Amazonia.

4.3.3 Food sources in an emergency

Hopefully, the techniques of foraging, trapping and fishing for survival while undertaking projects in the remoter regions will never be necessary; but of course, occasionally things do go wrong, and it is then that some of these simple suggestions and ideas may be useful. None of the methods, traps or techniques described are based on vague theories, probabilities or possibilities. All of them have been used by people in practical survival situations for varying periods of time.

Perhaps the biggest problem is realizing, and getting to grips with the fact that things have gone badly wrong, and you are out on a limb, either alone or in a small group. The overriding fear of not being noticed as overdue, or of searchers giving up, will be ever present. Firstly, you must overcome the shock of the situation, "it" has happened to you, and there are no alternatives but to take stock, and try to improve your position. Those people who have survived successfully have nearly all reported, on returning to civilisation, that they asked themselves, "How can I improve my situation?" on a daily or hourly basis, and then found their own answers both productive, absorbing and time-consuming, thus occupying their minds, and consequently maintaining a

reasonable level of morale throughout.

When considering available foods, it is never necessary to go very far to find roots, fungi, wildlife or even parts of trees that are edible. When you are working or travelling with locals find out from them what is edible and what is not. And keep notes: such information is worth recording and publishing on your return.

Some tips for emergency situations are given in the next two sections.

4.4 Food from the forest: plants

4.4.1 General points and precautions

The jungle contains a wide variety of edible wild plants and some cultivated ones which frequently grow wild. Unfortunately many of the former are difficult to distinguish from poisonous or unpalatable species. Because birds and animals eat them it does not mean that they are safe for human consumption. Some birds, animals and even aborigines can eat quantities of strychnine and other poisons which would be lethal to Europeans. There are also a number of violently irritant plants which should be avoided. Again check with your guides which plants should be avoided.

As a general rule red fruit and plants with white sap should be avoided, and the taste test should be applied to any plant which is being considered as food unless it is definitely identified as edible. The taste test consists of the following stages:

1. Smell the proposed food – if it smells of almonds then discard.
2. Crush a bit and apply to soft skin i.e. inside wrist. If a rash / irritations occurs then discard
3. Touch a piece on the corner of your mouth. If tingling or a reaction occurs then discard.

If it tastes very bitter or causes any unpleasant reaction at any stage of the test, it should be discarded and the mouth washed out, or if it has been swallowed it should be regurgitated.

This test can be repeated after cooking, as some parts of plants which are poisonous when raw are edible when cooked or after boiling a number of times in changes of water. Samples of plants which have been tested should be kept for future reference.

In primary jungle the height of most of the trees makes it extremely difficult to collect fruit and leaves, while the lack of sunlight on the ground does not encourage the growth of smaller plants. The majority of edible plants are more likely to be found in clearings and alongside tracks or streams and rivers, where the sun has been able to penetrate the canopy. Descriptions of the more common and easily identified plants fit for food follow.

4.4.2 Edible wild plant foods

- **Palms:** The young shoots and apical buds of all palms and bamboos can be eaten raw, though the more bitter varieties taste better cooked. The outer layers must be peeled off, until the crisp and edible interior is reached. Care must be taken to avoid the fine irritant hairs or sharp needle spikes which are often present.

Larger palms such as the Nibong, Sago and Coconut will usually have to be felled to obtain the apical bud, which is often about three feet long and will yield several pounds of good food, whereas the smaller palms may only produce a few ounces. Apart from the coconut, the fruit are not usually edible, but sago can be extracted from the pith of the sago palm by crushing it under water. It can be cooked as a porridge or dried to use as flour.

- **Ferns:** The characteristic curly or fiddle shaped young fronds of ferns can be eaten raw, though they are much more palatable cooked, and delicious fried. Any fine hairs should be rubbed or singed off. They are edible as far down the stem as it can be snapped cleanly between finger and thumb, or in the case of Bleecham, which is a more open leafed fern, as far down the stem as is red.
- **Pit:** Resembling thin, reedy, sugar cane, pit grows to a height of ten feet and has a reddish green stem covered in green leaves, three to four feet long and about four inches wide. The leaves turn yellow on older plants. It is found on the banks of creeks and rivers, and the tender young shoots can be baked in hot coals or boiled, after which the leaves should be removed to reveal what is sometimes described as 'jungle asparagus'.
- **Wild ginger:** Broad bamboo shaped leaves grow in pairs out of smooth finger thick stems, which are found in clumps up to ten feet high. Except for the young leaves and shoots, which are red and can be eaten raw or cooked, the plant is a very deep green.
- **Pandanus:** Found near water, frequently on the coastline but also up to 10,000 feet, the pandanus has long narrow leaves with a saw edge and midrib. The trunk is covered with sharp spikes and the fruit grows in large red segmented ovals with a rough surface. When ripe they break open revealing closely packed, small, oval grey, seed containers. The oily juice which can be sucked from the ripe seed is nutritious and has a rich 'winey' smell. A machete or stone may be necessary to extract the seed after the grey containers have been dried in the sun.
- **Coco yam or taro:** Growing up to four feet high the flower is like a greenish arum lily and is surrounded by a cluster of light green stems, each of which terminates in one large dark green heart shaped leaf. There is often a blue or purple spot where the stem joins the middle of the leaf. The root should be well cooked, peeled, and taste tested before being eaten as some similar plants are poisonous. The young leaves can also be boiled as "greens".
- **Lilies:** The fleshy roots, seeds and stems of water lilies are edible raw or cooked. Stems-should be peeled and eaten like celery, whereas the seeds can be pounded into a dough and roasted. When burnt the leaves produce an ash which can be used as seasoning.
- **Fungi:** Most of the softer fungi, found growing on wood, are edible raw, but they are difficult to identify and their food value is small. As some may be poisonous, use

only those eaten by locals e.g. the young "egg" stage of the stinkhorn, Venus Veil (*Dictyoxiphium*).

4.4.3 Cultivated plants

Those that are most commonly found growing wild are:

1. Banana and plantain.
2. Pawpaw or papaya.
3. Jackfruit and bread fruit.
4. Mango, guava, passion fruit, durian and wild raspberry.
5. Sugar cane and maize.
6. Yam, sweet potato and tapioca.
7. Coconut palms and rubber trees.

They are best identified by visiting local fruit and vegetable markets and cultivated areas. Those which are normally eaten raw may be more palatable cooked if they are not ripe.

In some instances, parts which are not normally eaten may also be edible, such as the trunk and bud of the banana, apical bud of the coconut, calyx of passion fruit, nuts from rubber trees and leaves of tapioca.

Tapioca bears special mention as it grows wild readily and is also often planted by indigenous tribes. Also known as cassava or manioc, it grows to a height of ten feet and has leaves like a lupin. The large tuberous roots are edible and grow up to two feet long. There are two basic types, sweet and bitter. The sweet have red veins on the leaves and stems. They should be well cooked in a similar manner to potatoes. Before being cooked the bitter varieties, which can be distinguished by their white veins, should be grated into a cloth and squeezed under water to wash out the high acid content.

4.4.4 Poisonous wild plants

The following in particular should be avoided:

- **The milky mangrove:** A small shrub which only grows in mangrove swamps and is distinguished by its white milky sap. Everything about it is an irritant, even the smoke if it is burnt. The milky juice which easily spurts out, causes violent blistering and blindness if it gets into the eyes.
- **The nettle tree:** These small trees have large velvety leaves which are heart shaped and saw edged. The many small flowers are green or green and white and the clusters of berries look like black berries. They are especially common near water and produce a burning sensation when touched. If a large area of skin is affected, a high fever and intense pain can last for several days. A solution of carbonate of soda

or wood ash will help reduce the irritation.

- **Cowhape or cowitch:** A climbing plant with oval leaves found in scrub but generally absent from true forest. The flowers and pods are covered with stiff hairs which readily break off and penetrate the skin, causing considerable irritation. They are very dangerous if they get into the eyes. The flowers vary from greenish white to red or dark purple.
- **Rengas:** There are several kinds of tall forest trees known jointly as Rengas. The sap which oozes from slashed trunks etc. or even water off the leaves and twigs can cause a rash. The sap is usually blackish. They have long spear leaves and clusters of small five pointed starlike flowers. Treat all plant exudants cautiously and avoid all with dark or blackish sap.

4.5 Food from the forest: animals

The easiest forms of animal food to obtain in the jungle are insects, reptiles and fish, as most other animals have learnt to fear man and use their acute senses to maintain a safe distance. They are rarely seen and extremely difficult to catch or trap.

Normally, an expedition would respect the wildlife and kill larger animals for food only on a sustainable basis. You should be aware of the protected species and not encourage porters and guides to kill indiscriminately. The purpose of this section is to alert you to methods of survival in emergency situations only.

- **Slugs and snails:** Although easy to obtain in the jungle, perhaps the least palatable to many humans are slugs and snails. They can be found in small hollows and in colonies on edible plants and should be boiled in several changes of water until no scum occurs.
- **Insects:** Large grubs are easy to find in rotten logs. They should be split and broiled over a fire, as should caterpillars, after singeing to remove irritant hairs. Grasshoppers and similar insects can also be roasted after their wings and legs have been removed.
- **Reptiles:** Tortoises and turtles are particularly easy to catch, while all reptiles are good eating. Frogs can be caught with a net or by hand and can be dazzled by using a torch at night, they will also take a baited hook. Snakes are frequently found in water and under logs and rocks. The only safe way to kill a snake that maybe venomous is by decapitation. The head is still capable of spitting or biting long after it has been severed from the body.

Large monitor lizards provide a lot of meat but are capable of inflicting savage bites. You can try and noose them, or grab them by the neck and tail. The position of tree lizards low down on tree trunks should be carefully noted and the tree approached from the opposite side, when the lizard can be grabbed unawares. None of the Asian lizards are poisonous.

- **Birds and terrestrial mammals:** The most likely to be met are wild pig, monkeys, squirrel, deer, civet cats, bats and birds. Despite their natural instinct for survival, the traps illustrated at Figs 4.3,4.4,4.5 can be set to catch some of them or attempts can be made to shoot them with bows and arrows made from bamboo, if the use of fire-arms is likely to attract unwelcome attention.

To have the best chance of trapping it is necessary to identify spoor, which can be learnt by a visit to a local zoo, so that the right type and size of trap can be placed in runs or on the approaches to water holes, feeding grounds or salt licks. Several traps should be connected by fences of sticks and leaves to channel the quarry into them. Some birds and animals can be caught in a baited trap, if their feeding habits are

known. All traps should be checked at least once a day to reduce the chance of the catch escaping or being carried off by a predator.

- **Bats:** Many caves or hollow trees are quite often inhabited by colonies of bats which can be flushed into a net by lighting smoky fires in the other inlets or they can be knocked out with a stick. The larger fruit bats or flying foxes are excellent food.
- **Fish:** Jungle streams normally abound with edible fish, eels, fresh water prawns, crayfish and crabs. The only poisonous fish are some of the highly coloured or spiney salt water varieties, which should be avoided. Fish may be caught by any of the following methods.

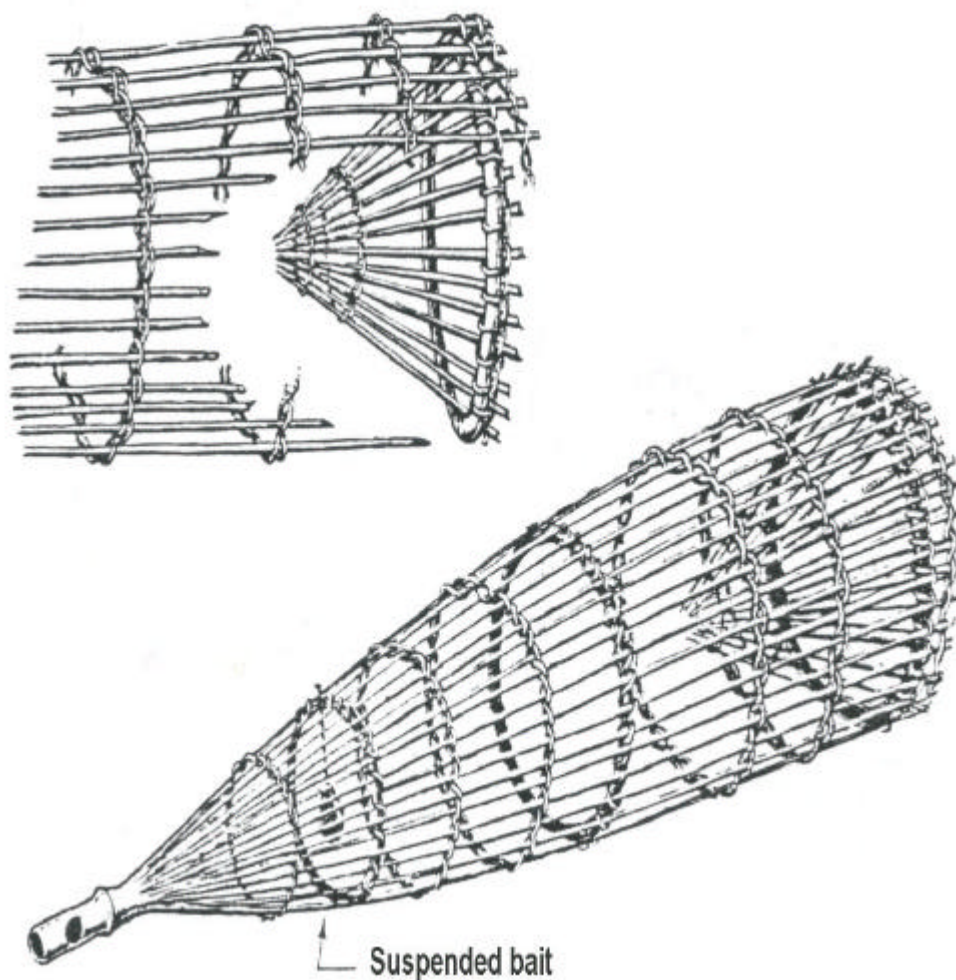
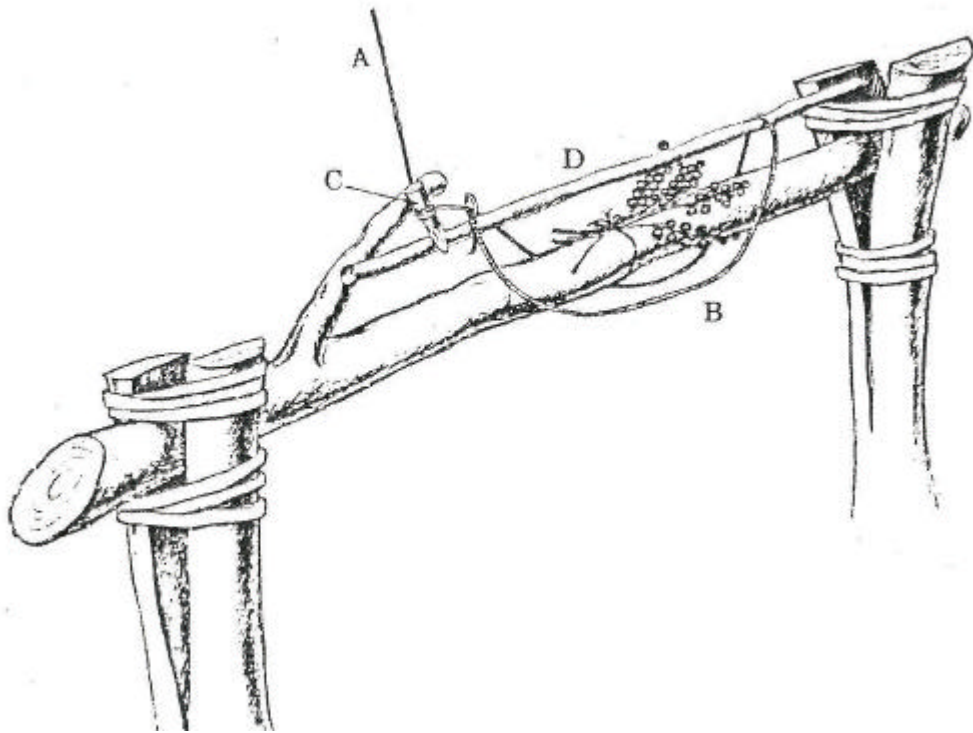
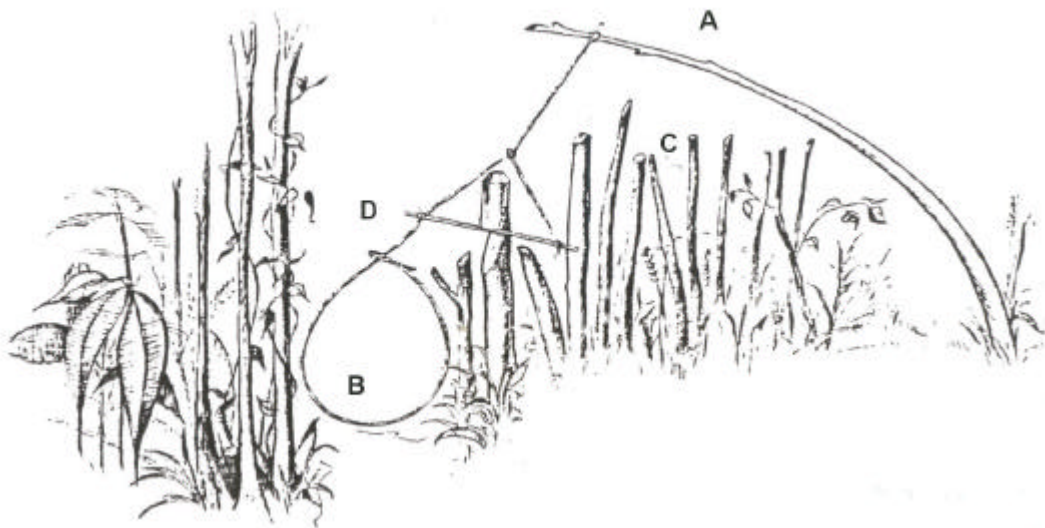


Figure 4.3 Fish Trap



Explanation: The cord (A) is under tension: it is an extension of the loop (B) and is wrapped around a peg (C) which holds the perch (D) in place. When a bird that is attracted by a bait of fruit or berries, lands on the perch which is dislodged, the tension of (A) draws the noose tight around the legs of the quarry.

Figure 4.4 Bird Trap



Explanation: The sapling (A) is under tension and the noose (B) is set in an animal run, the rest of the run being blocked with sticks (C). The noose is made to a size and set at a height suitable for the quarry. Where an animal is caught in the noose it will pull away the stick (D) from the notch in which it rests, and the sapling will spring up and draw the noose tight.

Figure 4.5 Small animal trap



Explanation: Figure 4.5 shows details of the platform which is set level with the ground and camouflaged in the main illustration. When a pig or other animal treads on the platform, the peg is dislodged and the noose tightens around the animal's leg and suspends it in the air as the sapling (C) springs upright.

Figure 4.6. Pig trap

4.5.1 Trapping / Poisoning

- **Nets:** can be woven from string, vines and creepers or improvised from face veils, mosquito nets or hammocks. They should be threaded onto a suitably bent stick or fixed over a gap in a dam made of stones, leaves and twigs, and the fish driven into it.
- **Scoops:** can be made of thin twigs woven together and mounted on a frame or from thick bamboo stem which is split finely down to one segment, to use as a handle, and splayed out, with creeper or vine woven in and out of the ribs.
- **Traps:** made as shown in Fig.4.3 should be baited so that the fish cannot get at it from the outside, and securely anchored in a gap left in a dam, where the water flows slowest. Traps should be inspected at least once a day.
- **Hook and line:** both can be improvised, hooks being made from pins and pieces of metal or carved from bamboo. Lines can be made from rattan, vine or threads drawn from clothing and plaited for strength. Food, insects or berries can be used as bait or a lure made from cloth, paper or metal. Crabs, frogs, eels turtles and even snakes will also take a suitably baited hook.

Failing all other methods fish can be chased into the shallows and caught by hand, or left high and dry in tidal waters.

- **Spears or gaffs:** can be made from bamboo. The points of the prongs should be barbed and hardened in a fire.
- **Poisoning:** the bark and twigs of the matchbox bean, a vine producing flat woody pods up to four feet long, or the roots of the tuba, which spread over wide areas on and just below ground level, should be pounded with a stone to release the sap and dipped frequently into a slow running stream. Small fish die within about ten minutes, while larger ones become stupefied and can be scooped out with ease. Traps or nets should be set fifty metres or so downstream to collect the dead and stunned fish, which are perfectly safe to eat. Tuba can be recognised by the fact that its oval leaves grow close together on green shoots, growing at an angle to the brown creeping stem.

4.5.2 Preparation, cooking and preservation of animal foods

- **Preparation of animal foods:** Although the flesh of all animals, birds, reptiles, fish or insects and their eggs are edible, the following steps should be taken to avoid any possible contamination. Ensure everything is kept as clean as possible and protected from flies or other insects.

Clean out the contents of the crop, stomach and intestine to avoid being poisoned or infected by something it has eaten but do not discard, as they are good food when cleaned. Small fish can however be eaten whole and a few days starvation will clear the stomachs of most insects.

Remove the poison glands and apparatus of poisonous snakes, fish and insects. In the case of snakes this only amounts to removing the head plus a couple of inches of the neck, and is not strictly necessary as their venom does no harm when taken orally, unless there is a break in the tissues of the mouth or alimentary canal. On the other hand some marine fish and insects with complicated poison mechanisms will have to be discarded altogether.

Skin or singe off fur or feathers and cook thoroughly to destroy any bacteria or parasites.

- **Cooking:** Basically jungle cooking amounts to boiling, baking in a fire or spitroasting, though when fat is obtainable, frying will often improve the flavour and present a pleasant way of eating fat, which has a very high calorie content. Boiling is the least wasteful method of cooking, as the majority of the juices are retained and the water can be made into a broth, unless it has been used to reduce the acidity of some of the bitter plants. Utensils for boiling can be improvised out of sections of bamboo or large folded leaves which will not burn below the water level.
- **Baking:** Baking in the fire may be done in recognisably safe leaves or clay. A hole in the ground should be lined with stones before the fire is built and when a deep pile of embers have built up, they should be raked out and the food wrapped in clay or leaves placed on the hot stones and covered with embers. Skinning or singeing is not necessary with clay cooking as any fur or feathers come off with the baked clay. This is a slow method of cooking and one and a half hours should be allowed for each pound of meat.
- **Spit roasting:** Quite the easiest but the most wasteful method of cooking is spit roasting, which nevertheless often enhances the flavour of the food. Care must be taken to ensure that the wood used for spits has no sap or resin.
- **Salt:** is lacking in jungle foods and not easy to get from plants. Small quantities may be collected by burning the fronds of the nipah palm (a trunkless palm similar to attap or bertram, without the celery like base), and mixing the ash with water to dissolve the salt, then straining it, through a cloth to remove the ash before evaporating it. The fruit of this palm is also edible. The birds' nest fern (*Asplenium*

nidus) can also be ashed.

- **Preservation:** Meat or fish can be preserved by cutting it into thin strips and:
 1. Drying in the sun.
 2. Smoking.
 3. Salting or pickling in brine, if near the sea. Smallfish can be treated whole.

Chapter 5: HEALTH AND SAFETY IN THE FOREST

5.1 General Aspects

5.1.1 Before the expedition: vaccinations, injections and drugs.

As Richard Dawood (2002) says in his excellent chapter in Expedition Medicine on vaccinations, it is important to seek good advice on what protection you need.

Embassies and travel agents unfortunately often are not the best sources of information, although things have changed in recent years in the case of the latter. You will always be able to obtain good advice from the Oxford University Centre for Tropical Medicine, John Radcliffe Hospital, (Headington, Oxford OX3 9DU, tel. 01865 220968, 220970, 225430); the Liverpool School of Tropical Medicine (Pembroke Place, Liverpool L3 5QA, tel. 0151-708 9393, website www.liv.ac.uk/lstm/lstm.html); the London School of Hygiene and Tropical Medicine (Gower Street, London WC1E 7HT, tel. 0207-636 8636, website www.lshtm.ac.uk); and the Birmingham Hospital (Bordesley Green East, Birmingham B9 5ST, tel. 0121-424 2000, website www.heartsol.wmids.nhs.uk).

For the physician to give you optimum advice on the diseases against which you should receive protective immunization, it is essential that you should give a full account of not only where you are going, but how you are going to get there, and what you are going to do when you finally get there. The businessman who is going to a conference in Nairobi is exposed to fewer hazards than the zoologist who is seeking small rodents in their burrows in the wild countryside. Both are going to Kenya but the former is unlikely to get rabies and the latter might contract that lethal disease.

There are up to date disease maps as well as lots of other useful information on the World Health Organisation's International Travel and Health webpage. The address is www.who.int/ith.

All expeditions are advised to read Expedition Medicine and to discuss your vaccination requirements with your own (or university) doctor. If your expedition involves a scientific project in which the potential of handling animals exists, then all members (not just the zoologists) should be vaccinated against rabies.

5.1.2 Remoteness of the expedition from medical aid

The time needed to get help is much more important than the distance to a doctor or hospital, and in a remote area the nearest hospital may be small and poorly equipped. If it is easy to get good medical attention you need take only basic medical equipment. If help is available, but difficult and expensive to reach, you should take more equipment and plan to deal with more of the possible accidents and illnesses without outside help, but also have available a communication system to summon help if needed. However,

on some expeditions there is simply no help available and so the party must be completely self-sufficient, and also aware of the likely risks and consequences of any serious injury or illness.

5.1.3 The organisation of the expedition

If camps are a long way apart each one must have a separate medical kit, since drugs and equipment for an emergency are useless if they are more than one day, or at the most two days, from where they are needed. However for non-emergency drugs and dressings it may be convenient to have small stocks at out-lying camps with a larger reserve stock at base camp to replenish the other medical kits if necessary. Every group of people going away from camp should carry a small first aid kit, so that some basic first aid equipment is always available.

5.1.4 The medical skills of the party and training

There is no point in taking drugs and equipment if you do not know how to use them, since they may be ineffective or even dangerous. A small amount of pre-expedition medical training for the nominated medical officer (MO) in specific procedures such as suturing, insertion of IV lines, local anaesthetic and intramuscular injections, can greatly increase the care offered by non medical members of the expedition. Everyone should have some first aid training and be able to use basic resuscitation equipment. For every drug in the medical kit there should be specific instructions about when, and when not, to use it, the dose and the possible side-effects. A proper record must be kept when drugs are used. Many expeditions carry drugs which are normally available only on a doctor's prescription; this is reasonable if the drugs are carefully chosen and full instructions are provided, since the potential benefits outweigh the possible dangers. Sometimes medical advice may be obtained by telephone or radio, even from a remote area, and evacuation of the patient to a doctor or hospital may not be necessary if the necessary drugs are available.

Cost of medical equipment

If possible the cost of medical equipment should not determine how much is taken in the kit. Some drugs and equipment are expensive, but the cost is small compared with the cost and inconvenience of getting outside help for a condition that could have been treated adequately in camp.

The mode of travel

More equipment can be carried if yaks or lorries are available than if everything has to be carried in rucksacks. Weight is usually the most important factor, but the size and shape of the containers may also be significant. On some expeditions the party walks to base camp while the equipment is taken by lorry or helicopter. If this occurs the party

must carry some medical equipment. There is no point in having a medical kit if it is not available when it is needed.

Those forest expeditions which are supported by a trained medical officer/nurse will need more information than given here and should obtain and read the Expedition Advisory Centre's book 'Expedition Medicine'. Substantial material is quoted from Illingworth (2002) and Warrell (2002) in this book.

5.2 Setting up a base camp medical service¹

5.2.1 Camp health and hygiene in the field

Unstinting efforts to maintain a high standard of hygiene will contribute to a lower incidence of gastric problems and the consequent loss of working man hours.

Sources of water are discussed in Chapter 3 but you must be unremitting in your efforts to keep a high standard of clean water. Discuss with the medical officer and/or leader before departure what sort of safe water regime (rules) needs to be established. Someone will need to be responsible for the water every day. This can be one person's responsibility throughout the project, or be organized on a rotation basis, but everyone must be aware of how the system operates. Every member of the expedition must know the difference between safe and unpurified water containers: consider using a simple system of markers.

It is often necessary, on a long expedition, to identify one day of the week (say a Sunday) which is slightly different from the rest in some way, perhaps with breakfast half an hour later. This Sabbath is also useful for those taking weekly antimalarial prophylaxis: "Sunday is anti-malarial day". The expedition nurse can be responsible for putting out the appropriate pills and seeing to it that everyone takes them.

If there is an accident write down as soon as you can what happened in great detail. If you have planned how to cope when things do go wrong and you stick to the rules you will not make things worse. No one will blame you for the accident, but they will do if you mishandle the situation afterwards, especially communicating with those at home. Clear and truthful information is vital. Make sure that the insurance companies are informed promptly. Never destroy your records.

Before the expedition sets out, make sure each member has stated what he/she wishes to happen in case of an accident, fatal or otherwise. Do they want next of kin to be informed?

5.2.2 Camp safety

Spend time in camp removing hazards - marking guy ropes, fixing hand rails or holds and tying back branches where people regularly work or pass. The MO must be aware of anyone using or storing dangerous chemicals. Anaesthetic agents for small mammals and formaldehyde are commonly used on expeditions. If firearms are to be used safe storage must be foolproof. Be especially aware of any scientist working with dangerous specimens (alive or dead). No one should handle venomous animals without previous

¹ Acknowledgement is given to Hokey Bennett-Jones (2002) and Robin Illingworth (2002) from which much of this section has been lifted.

training. If, for example, a venomous creature like a snake is to be handled, advise that it is done early in the day. If anything untoward happens, communications and, if necessary, evacuation, are far easier in daylight. Everyone should know where the camp First Aid kit is kept but make sure all medical equipment and drugs are stored safely - everything should be packed and labelled clearly with the name and batch numbers.

Think about fire risks and what fire-fighting methods are open to you. Store fuel safely away from the main camping area. Fuel should not be kept in people's tents (i.e. lamp fuel) nor in plastic containers. Money spent on sound metal and clearly labelled jerry cans is never wasted.

Keep a book in the dining area for people to record daily where they are going, with whom and expected time of return. Everyone should know the policy and procedure for a late or lost person. Try and make sure people have adequate clothing and kit for the conditions. A whistle is useful, especially if alone in the field.

In the event of your having a spell away from camp for whatever reason, appoint a second in command. He/she should know first aid and ideally, be familiar with evacuation procedure and be a calm sort! Finally, you should be aware of any local security risks. Is it safe to leave anyone (especially a girl) alone in camp?

5.2.3 Expedition medical kits

There may be some explorers who buy a bottle of aspirin and a tin of Elastoplast while waiting for their plane and bring them back unopened three months later. Most expeditions take rather more medical equipment but fortunately need very little of it. However, a few expeditions have major medical problems.

Organising the medical kits for an expedition takes a lot of time and effort if it is done properly. It is particularly difficult to know what to take on a small, light-weight expedition travelling in a remote area and carrying all its equipment. A large expedition can take more medical equipment, but however much is taken one could not possibly deal with every conceivable accident and illness which might occur. Inevitably you have to compromise between taking so little equipment that you cannot deal with even the common medical problems, and taking so much that you are weighed down with an enormous medical kit which is never used. It is pointless to have a medical kit, which is so big and heavy that it is left behind because no one can be bothered to carry it, or so comprehensive that items cannot be found when they are needed. However, with careful planning most of the common medical problems can be treated without outside help and first-aid treatment for more serious conditions can be given if necessary.

The commonest injuries on expeditions are blisters, minor wounds and small burns. If cleaned and dressed properly these should heal without any problem, but if treated badly they may cause considerable difficulties, especially if the person becomes

unable to walk. Some sprains and minor fractures can also be treated quite adequately on an expedition. More serious injuries are fortunately rare; first aid treatment will be required before evacuation to hospital.

The common ailments are aches and pains, sunburn, insect bites and bowel disturbances. These usually get better without treatment but simple drugs provide symptomatic relief. These common conditions are the same wherever you go and so the same basic medical kits can serve for many different expeditions. However, some expeditions will encounter particular medical problems, depending on their area and objectives, and so need extra drugs and medical equipment.

Road travel can be one of the most dangerous parts of an expedition. A road accident might cause serious injuries to several people, completely overwhelming any local medical facilities. Minimising risks while travelling and avoiding injuries and illness during the expedition are far more important than trying to plan medical kits to cover every possible eventuality.

The amount of medical equipment which should be taken on an expedition will depend on a number of factors, including the remoteness from medical aid, the size and duration of the expedition, the mode of travel, the organisation of the expedition (in particular the number of camps and the travelling time between them) and the medical skills of the party.

5.2.4 Personal medical kit

Each expedition member should take some personal medical equipment, including Elastoplast or similar dressings, sun cream, lip salve, insect repellent, foot powder, simple painkillers and rehydration sachets (eg. Dioralyte). For people who need to take a drug regularly it is best if they carry the main supply and someone else looks after a reserve stock. People who are allergic to Elastoplast should take a roll of Micropore tape which does not cause irritation.

While travelling to the expedition area the main medical kits may be packed and inaccessible. It is useful to have readily available a small kit containing a few plasters, tablets for headaches, diarrhoea and travel sickness, and water purifying tablets.

5.2.5 Communal medical kits

Recommendations for expedition medical kits are based on the kits that have been used on many Brathay expeditions. There are three standard kits: the field kit, the mobile camp kit and the base camp kit. A typical expedition of 20 people to south-east Iceland might have one base camp kit, one or two mobile camp kits and four field kits. Extra drugs can be added and special medical kits made if required for particular expeditions. For example, a Brathay expedition to Sabah (Borneo) involving 18 people as well as local guides and porters, took two base camp kits, one mobile camp kit, four field kits

and four extra boxes of drugs, intravenous fluids and other items, a total of 27kg weight of medical kits.

Detailed list of kit and drugs for field, mobile camp and base camp are given in Warrell and Anderson (2002), chapter 3.

5.2.6 Medical problems specific to tropical expeditions¹

Common problems are blisters, diarrhoea, insect bites and skin infections.

Skin

Stop as soon as practical and treat any 'hot spots' before they become blisters. Damp and encased in shoes, feet become waterlogged, smelly and infected with fungi, so take every opportunity to air dry them and avoid sleeping in wet socks. Bacteria can gain entry through soggy broken skin giving secondary infections. Fungal infections are also common in the groins. Wash and dry the skin daily where possible and apply prophylactic antifungal powder to the feet and skin folds. Using a combination antifungal/ weak steroid cream (hydrocortisone) economises on weight, speeds relief of inflammation and can double up as anti-irritant on non-infected bites.

Wound infections

In this humid environment, even small scratches can quickly become infected. Minor infection may progress to spreading skin infection (cellulitis) requiring antibiotics, or abscesses, or at worst, become a life threatening generalised sepsis (septicaemia). It is prudent therefore, to examine the skin particularly legs and arms each evening. Using carefully cleaned hands, wounds should be washed with soap and water as soon as possible, dried with clean gauze or similar, antiseptic applied, and covered if open. Iodine tincture 2% for water sterilisation is an effective antiseptic but traditional cream stings less. Spray-on Iodine (Savlon Dry) avoids the need to touch the cleaned wound. Healing is more likely if the wound is kept dry.

Prickly Heat (Miliaria rubra)

This is an intensely irritating prickly rash, which arises in skin waterlogged from continual perspiration. The sweat pores become blocked and inflamed giving a rash of tiny blisters on a background of red skin. Common sites are the waist, armpits, neck, upper back and chest, scalp and flexures. Treatment is to bathe in cool water, gently pat dry and apply talcum powder or calamine lotion.

Insects

Insects are often tiresome nuisances but their importance lies in the large range of diseases they can transmit (see section 5.3). Malaria is probably the most significant disease numerically. Fortunately, the same methods of bite avoidance work for all. Some people hardly seem to respond to bites while others suffer intensely irritating reactions. Topical or oral antihistamines or Eurax all help with itching, although there is

¹ This section is taken from P Richards in Expedition Medicine (2002).

a small risk of skin sensitisation with topical antihistamines. The breach of skin integrity or subsequent scratching can produce secondary bacterial infection, treated with antibiotics as above.

Insect Avoidance

- Cover Up: Long sleeves, trousers, and hat. Especially dusk to dawn.
- Insect Repellent: DEET, Eucalyptus, Citronella. Cover all exposed skin.
Spray or liquid better than solid stick which may leave gaps
- Mosquito Net: Especially for sleeping. Avoid gaps; tape tears.
More effective if permethrin impregnated.
If touches skin, insects may reach skin through the net pores.

Gastro-enteritis and Hygiene

Personal and camp hygiene are particularly important in the tropical environment. Acceptable contact lens hygiene may not be practicable in an expedition setting due to the risk of eye infection. Antibiotic eye drops and back up spectacles must be carried. Diarrhoea and vomiting can spread quickly through the expedition team and hands should be washed with antiseptic soap after use of the latrine and before handling or eating food. I take personal responsibility for cleaning and storing of my own spoon and mess kit and avoid sharing of personal water bottles. As daily fluid requirement is already high due to perspiration, added loss from gastroenteritis can quickly lead to dehydration, particularly where vomiting makes extra intake difficult.

Treatment to replace lost fluid and body salts should begin at the onset of the illness before dehydration becomes apparent. Losses should be minimised by ceasing exercise and remaining in the shade as cool as possible. Glucose is rapidly absorbed across the bowel wall, taking water and sodium with it and is more effective mixed with water in rehydrating than water alone. It is the basis for oral rehydration solution (ORS) which also contains important salts such as sodium and potassium. A rough guide is 200-300ml with each bout of loose stool in addition to normal daily fluid requirement. If no commercial preparation is available, it can be made by:

**8 Level Teaspoons of Sugar + 2 Level Teaspoons of Salt
in
1 Litre of Sterilised Water**

A quick and easy way of measuring out these measurements is by using a special plastic spoon obtainable from TALC, Teaching-aids At Low Cost, PO Box 49, St Albans, Herts AL1 5TX, Tel 01727 853869, Website www.talcuk.org.

A surprising amount of fluid can be taken by frequent sipping, although some may vomit back, some will stay down. Severe dehydration may require rectal (controversial) or intravenous fluids and evacuation.

In contrast to Britain where gastro-enteritis is usually viral, in this environment it is often bacterial. This is associated with acute onset, fever and general toxicity and responds rapidly to antibiotics such as ciprofloxacin. Other useful drugs are loperamide, which slows the diarrhoea and antiemetic drugs to reduce vomiting such as prochlorperazine, which is available as suppositories or special tablets dissolvable under the upper lip (Buccastem).

Psychological aspects on tropical forest expeditions

Unfamiliar sounds, smells, fear of animals, disease, the intense darkness of night or the isolation of sleeping exposed in a hammock in a strange place may contribute to anxiety. The best tip is to be interested in the jungle around you, learn about the environment, listen to local guides; become informed. Fear arises from uncertainty and unfamiliarity and knowledge makes the forest accommodating rather than intimidating. Prolonged exposure to wet discomfort saps morale so regular return to a comfortable environment, which might be a well-constructed base camp, is important. 'Social time' particularly for sharing of the evening meal and general relaxed chat is important for team integrity and morale.

Extra drugs should be taken if special medical problems are likely.

5.2.7 Treating the local people

Local people may seek medical attention from a visiting expedition. Plans for this situation should be made in advance. People with chronic conditions should be referred to local medical services but those with acute illness or injury may need emergency treatment or evacuation for medical care. Paediatric doses of some drugs may be required. Local people employed as expedition guides or porters should receive the same medical treatment as other expedition members and additional supplies of dressings, analgesics and antibiotics may be needed to allow for this.

5.3 Malaria and other tropical diseases¹

Malaria is endemic in almost all parts of the tropical world as far north as southern Turkey, as far south as north-eastern South Africa, as far west as Mexico and as far east as Vanuatu in the western Pacific. The females of certain species of mosquito (genus *Anopheles*), which nearly always bite between dusk and dawn, transmit malaria. Four different species of malarial parasites commonly infect humans: life-threatening *Plasmodium falciparum* and the three so-called benign malarias, *P. vivax*, *P. ovale* and *P. malariae*. Falciparum malaria kills 1–2 million people each year and is particularly dangerous to those who have not acquired immunity to it by growing up in a malarious part of the world. About 2,000 cases of imported malaria are reported in the UK each year, but over the last few years the proportion of dangerous *P. falciparum* cases has increased to over 60%. Each year, a few people die of imported malaria in the UK and an unknown number die abroad. Most of these deaths could have been prevented by better education of the travellers, use of approved methods of prevention and prompt medical attention when a person falls ill.

5.3.1 Principles of personal protection against malaria

1. Awareness of risk: vulnerable individuals, such as pregnant women, infants or immunocompromised people, should avoid entering a malarious area.
2. Anti-mosquito measures: kill, exclude, repel and avoid mosquitoes.
Sensible clothing (long sleeves, long trousers) between dusk and dawn.
Diethyltoluamide (DEET) – containing insect repellent applied to exposed skin.
Insecticide (pyrethroid) – impregnated mosquito bed net or screened accommodation sprayed with insecticide each evening.
Vaporising insecticide in the sleeping quarters (electrical, mosquito coil, knock-down insecticide).
3. Chemoprophylaxis: mefloquine (Lariam) or other drugs, depending on the particular geographical area
4. Standby treatment: Fansidar, mefloquine, quinine, Malarone
5. In case of feverish illness within a few months of return: see a doctor and mention malaria specifically!

5.3.2 Assessing the risk

Within malarious countries, the areas of malaria transmission may be patchy, depending on environmental factors such as temperature, altitude and vegetation as well as the season. Thus there is no malarial transmission in some African capital cities that are at a comparatively high altitude, such as Addis Ababa and Nairobi, and in other areas malaria transmission occurs only during a brief rainy season. If possible, reliable local advice should be obtained about the status of malaria transmission in the area where,

¹ This section is taken, with permission, from Warrell (2002)

and at the time when, the expedition is to take place. Even within a transmission area, the risk of being bitten by an infected mosquito can vary from less than once per year to more than once per night. The chances of catching malaria during a two-week visit, while taking no protection at all, has been estimated at about 0.2% in Kenya and 1% in West Africa.

5.3.3 Anti-mosquito measures

Since most malaria-transmitting mosquitoes bite in or near human dwellings during the hours of darkness, the risk of infection can be reduced by insect-proofing sleeping quarters or by sleeping under a mosquito net. Individual, lightweight, self-supporting mosquito nets are available. Protection against mosquitoes and other biting invertebrates (sandflies, lice, fleas, bed bugs, and so on) is greatly enhanced by soaking the net in a pyrethroid insecticide such as permethrin (0.2g per sq metre of material every six months). Screens and curtains can also be impregnated with insecticide. In addition, bedrooms should be sprayed in the evening with a knock-down insecticide to kill any mosquitoes that may have entered the room during the day. Mosquitoes may also be killed or repelled by vaporising synthetic pyrethroids (Bioallethrin 4.2% w/w) on electrical heating devices (such as No Bite and Buzz Off) where electricity is available or over a methylated spirit burner (Travel Accessories UK Ltd, PO Box 10, Lutterworth, Leicester LE17 4FB). Burning cones or coils of mosquito repellent “incense” may also be effective. To avoid bites by any flying insect, light-coloured long-sleeved shirts and long trousers are preferable to vests and shorts. To avoid malaria-transmitting mosquito bites, this sensible clothing should be worn particularly after dark. Exposed areas of skin should be rubbed or sprayed with repellents containing N-N-diethyl-m-toluamide (DEET). Insecticide-containing soaps and suntan oil are available and clothes can be soaked in repellent solution.

5.3.4 Anti-malarial chemoprophylaxis

At one time comparatively harmless drugs, such as chloroquine (Nivaquine), pyrimethamine (Daraprim) and proguanil (Paludrine), gave a high degree of protection against malaria parasites. However, the rapid emergence of resistant strains of *P. falciparum* has made chemoprophylaxis much more difficult. In particular, chloroquine resistant strains of *P. falciparum* now predominate in most parts of the tropics except in Mexico and Central America, north-west of the Panama Canal, Haiti, parts of West Africa and the Middle East. The failure of travellers to take their antimalarial tablets regularly, and in particular to continue taking them for four weeks after leaving the malarious area, also reduces the effectiveness of chemoprophylaxis. During bouts of vomiting and diarrhoea (traveller’s diarrhoea), these drugs may not be adequately absorbed. In choosing chemoprophylaxis, the risk of contracting malaria should be balanced against the risk of side-effects from the drug. This is illustrated by the case of mefloquine (Lariam) which has recently excited a heated debate. Although mefloquine is probably twice as effective as the chloroquine plus proguanil combination in

preventing malaria in Africa, the incidence and severity of side-effects, especially in young women, is greater with mefloquine.

5.3.5 Chemoprophylactic drugs and combinations

1. Mefloquine (Lariam)

This drug is effective against most multiresistant *P. falciparum* strains. It has some unpleasant side-effects: nausea, stomach ache and diarrhoea in 10–15% of people who take it; insomnia and nightmares; giddiness and ataxia (unsteadiness and inco-ordination) in some; and, much more serious, a rare “acute brain syndrome” consisting of psychological changes and in very rare cases generalised convulsions (epileptic attacks). For these reasons it is recommended for use only in areas with a high risk of resistant malaria (such as Africa, the Amazon region and South-east Asia). The dose is 1 tablet (of 250mg) a week.

2. Proguanil (Paludrine) and chloroquine (Nivaquine)

The combination of proguanil – 2 tablets (each of 100mg) every day – and chloroquine – 2 tablets (each of 150mg base) once a week – was the standard recommended and most widely used prophylactic regimen in areas where *P. falciparum* is chloroquine resistant. Unfortunately, its efficacy has now declined, so that it is no longer recommended for Africa, the Amazon region or SE Asia and Oceania. It is safe in pregnancy and (in a lower dose) in children. The only side-effects are rare mouth ulcers, mild indigestion and hair loss. Since this combination is no longer effective, it should be pointed out to travellers that despite taking antimalarials they may still develop malaria. However, if they are on antimalarials they are unlikely to become seriously ill with malaria, but they must seek medical treatment if they get a fever, especially during the first few months after returning from the malarious area.

There is no evidence that chloroquine, taken in the doses recommended for prophylaxis against malaria, ever causes damage to the eyes in people who take the drug continuously for 5–6 years. Checks after chloroquine prophylaxis are therefore unnecessary, unless the individual has taken the drug for a very long time (more than 6 years continuously) and the total cumulative dose approaches 100g.

3. Atovaquone-proguanil (Malarone)

This safe, effective but expensive drug needs be continued for only 7 days after leaving the malarious area. The dose is one tablet each day for adults.

4. Doxycycline (Vibramycin)

This tetracycline antibiotic has proved useful for prophylaxis in areas where mefloquine resistance is prevalent, such as the Thai-Cambodian border region. It gives some protection against other travellers’ diseases such as typhus, leptospirosis and some types of traveller’s diarrhoea. One 100mg tablet a day should be taken. Side-effects include

photosensitive rashes, skin irritation, diarrhoea and oral/oesophageal or vaginal thrush. It should not be used by pregnant women and young children.

5. Maloprim, Deltaprim

This is a combination of dapson 100mg and pyrimethamine 12.5mg, which, unlike mefloquine and chloroquine, is safe for sufferers from epilepsy. Its manufacture may soon be stopped. When used, 1 tablet a week (for example, every Sunday), no more, no less, should be taken.

5.3.6 Choice of prophylactic drug/combination in different geographical areas

- (a) Middle East, West Asia, Indian subcontinent, parts of South America (except Amazon region of Brazil), China: use **proguanil plus chloroquine**.
- (b) Mexico, Central America, Haiti, Dominican Republic, parts of South America (except Amazon region of Brazil): use **chloroquine**.
- (c) Africa, Amazon region of Brazil, South East Asia (except Thai-Cambodian border region): use **mefloquine, doxycycline or Malarone**.
- (d) West Pacific, New Guinea: use **mefloquine or doxycycline**.
- (e) Thai-Cambodian border region: use **doxycycline or Malarone**
- (f) Turkey, Egypt, Mauritius (rural, seasonal only): use **chloroquine or proguanil**.
(Malarone is an alternative to mefloquine or doxycycline in all areas, for those who can afford it!)

During pregnancy it is vital for the expectant mother to take antimalarials or, preferably, to avoid entering a malarious area. The hazards of getting malaria, particularly falciparum malaria, during pregnancy are great. The remote hazard of adverse effects on the baby of the antimalarial drugs is far outweighed by the advantages. Chloroquine plus proguanil as outlined above should be used. Maloprim and other pyrimethamine-containing drugs, mefloquine, doxycycline and Malarone, should be avoided during pregnancy.

It is wise to start weekly mefloquine three weeks before leaving for the malarious area in case side effects develop and you have to switch to another drug. All antimalarial drugs except Malarone must be continued for 4 weeks after return. Remember that no antimalarial drug is perfect. Much depends on whether it is taken regularly. If you are ill at all after your return you should consult your doctor and mention the possibility of malaria. If there is any doubt you should be referred to an infectious disease unit for exclusion of malaria. If you have been taking an antimalarial it may be difficult to find the parasites and yet you may be quite ill.

5.3.7 Standby treatment for malaria in high-risk areas

If you are going to a remote malarious area you would be wise to take a supply of quinine, 600mg to be taken 8 hourly for 7 days if you get a fever. Mefloquine, 2 tablets

(each of 250mg) repeated after 8 hours (1,000mg total for an adult, 20mg/kg for children), is an alternative unless that is the drug you have been taking for prophylaxis. Fansidar and Malarone are also useful standby treatments. A new combination drug, artemether plus lumefantrine (Riamet or Co-artemether) will also be suitable for standby treatment.

5.3.8 Prevention of the “benign” malarias (*vivax*, *ovale* and *malariae*)

Weekly chloroquine or mefloquine will usually prevent *vivax*, *ovale* and *malariae* malarias. However, *P. vivax* and *P. ovale* can establish themselves in the liver despite chloroquine prophylaxis and may re-emerge to cause relapsing infections months or years later. Primaquine, 15mg a day for 2 weeks, will usually eradicate the liver cycle and should be given to travellers who have spent more than a few months in areas where these species are endemic. In parts of Indonesia, particularly Irian Jaya, and in Papua New Guinea, Thailand, the Philippines and Solomon Islands, *vivax* malaria may not be eradicated by the usual 2-week course of primaquine. In these cases a 4-week course of primaquine should be given after the person returns home.

In New Guinea and adjacent areas of Indonesia (for example, Lombok), *vivax* malaria has become resistant to chloroquine. A double dose of chloroquine or the standard dose of mefloquine followed by a 4-week course of primaquine can be used to treat such resistant infections. Advice on malarial prophylaxis can be obtained from the following Tropical Medicine Units.

Malaria Reference Laboratory

Tel +44 207 636 3924

Tel (24hr) +44 9065 508 908

Website www.lshtm.ac.uk/centres/malaria

Hospital for Tropical Diseases

Tel +44 207 387 9300/4411

Healthline +44 9061 337733

Fax Number +44 207 388 7645

Website www.thehtd.org

London School of Tropical Medicine

Tel +44 (0)207 636 8636

Website www.lshtm.ac.uk

Liverpool School of Tropical Medicine

Tel +44 151 7089393

Fax +44 151 708 8733

Website www.liv.ac.uk/lstm/lstm.html

Oxford University Centre for Tropical Medicine

Tel +44-1865-220968

Fax +44-1865-220984

5.3.8 Bilharzia (schistosomiasis)

This fluke infection occurs in Africa, the Middle East, eastern South America, China and South-east Asia. Infection is acquired through contact with fresh water from lakes and sluggish rivers, usually by bathing or washing with water taken from these sources. Infected humans contaminate the lake by defecating or urinating into it and infect, in turn, the intermediate snail hosts. Snails release tiny cercariae into the water which

burrow through the skin of bathers. The earliest symptom of possible infection is “swimmer’s itch”, experienced soon after contact with infected water. Some people develop an acute feverish illness associated with an urticarial rash and blood eosinophilia a few weeks after infection. Later symptoms include passage of cloudy or frankly bloodstained urine or dysentery and, rarely, ascending paralysis and loss of sensation in the lower limbs.

Travellers usually get worried about bilharzia when they get back from their trip and remember bathing in forbidden lakes or hear that another member of the party has been diagnosed as having schistosomiasis. Diagnosis is confirmed by finding ova in stool, urine or rectal biopsies, or by a blood test. Treatment is fairly simple with 1–2 doses of praziquantel (Biltricide).

Prevent bilharzia by not bathing in sluggish fresh water sources in endemic areas. Local advice may be misleading. Lake Malawi, officially declared free of bilharzia, has been the source of many imported cases of bilharzia in the UK over the last few years.

5.3.9 River blindness (onchocerciasis)

In parts of East, West, Central and Southern Africa, Mexico and Central America and north-eastern South America, pernicious little black flies (for example, *Simulium damnosum*) transmit this infection from human to human in the vicinity of fast-flowing rivers and streams. The adult filarial worms live in subcutaneous nodules, especially around the waist. They produce enormous numbers of microfilariae which cause irritation and changes in the pigmentation and texture of the skin and damage the eyes, eventually causing river blindness. Foreign travellers have contracted onchocerciasis after only brief stops in the transmission zone.

Diagnosis is supported by finding blood eosinophilia and is confirmed by microscopical detection of wriggling microfilariae in skin snips taken in affected areas. There is also a blood test of moderate specificity.

Treatment with ivermectin is effective, but may cause a temporary but damaging exacerbation of lesions in the eye and skin and should therefore be supervised in a hospital.

Prevent infection by wearing light-coloured clothing (long sleeves and long trousers) and applying DEET-containing repellents to exposed areas of skin.

5.3.10 Sleeping sickness (African trypanosomiasis)

Tsetse flies (*Glossina*) transmit trypanosomes (*Trypanosoma brucei gambiense*) between humans and *T.b. rhodesiense* between humans and animal reservoir hosts in a number of smallish areas scattered throughout West, Central, East and Southern Africa.

A small ulcer with a scab may appear at the site of the infected tsetse fly bite and, within the next few days, intermittent fever begins associated with headache, loss of appetite and enlargement of lymph glands, especially in the posterior triangle of the neck. Eventually, there is invasion of the central nervous system and patients become apathetic, sleepy and eventually comatose.

The diagnosis is confirmed by finding motile trypanosomes in lymph node aspirates, blood or cerebrospinal fluid. Treatment is difficult, especially after invasion of the central nervous system. Foreign travellers, especially to the game parks of Eastern and Southern Africa, have been infected and there is currently a massive resurgence of sleeping sickness in Central/East Africa.

5.3.11 Dengue fever (Break bone fever)

Mosquitoes such as *Aedes aegypti* and *A. albopictus* transmit dengue viruses from human to human in almost every part of the tropics, notably in South-east Asia and the Caribbean, and increasingly in urban areas. In most foreign travellers, dengue causes an acute fever associated with headache, backache and pains in the muscles and joints ("break bone" fever). The most obvious reddish blotchy rash often appears after a temporary lull in the fever. Petechial haemorrhages may be found in the skin and conjunctivae. The blood count usually shows leucopenia with relative lymphocytosis and thrombocytopenia. The diagnosis can be confirmed by testing two blood samples, one taken immediately and the other 2 weeks after the acute illness.

Severe, life-threatening forms of dengue (dengue haemorrhagic fever and dengue shock syndrome) occur almost exclusively in children who have been brought up in endemic areas and are suffering their second dengue infection.

Treatment of dengue fever is symptomatic (bed rest, control of fever and paracetamol).

Prevention is by wearing sensible clothing (see above) during the daytime biting period and applying DEET-containing repellents to exposed skin surfaces.

5.3.12 Rabies

Rabies or hydrophobia (literally fear of water) is a virus disease of mammals, which is usually transmitted to man by a dog bite. Although dogs are the most important source of human rabies worldwide, some countries have other vector species, such as cats, wolves, foxes, jackals, skunks, mongooses, racoons, vampire bats (Caribbean and Latin America only), flying foxes and insectivorous bats. Rabies occurs in almost every country; the fortunate exceptions include Antarctica, Scandinavian countries (except Greenland and Svalbard), Malaysia, New Guinea, New Zealand, Japan, the UK and some smaller islands. It is especially common in parts of Latin America, the Indian

subcontinent, Vietnam, Thailand and the Philippines. The disease probably causes at least 60,000 human deaths each year.

Rabies virus can enter the body in a number of ways. Virus in an animal's saliva can penetrate skin that has been broken by a bite or graze; and can invade unbroken mucous membranes, such as those covering the eye and lining the mouth and nose. Very rarely, the virus has been inhaled, for example, from the atmosphere of caves infested with insectivorous bats. Transmission of rabies from human to human must be excessively rare, but at least eight patients are known to have developed rabies after receiving infected corneal grafts. After the virus has entered the body, one of two things may happen. The virus may be killed by antiseptics or immune mechanisms before it does any harm; or it may spread along the nerves to reach the brain where it multiplies and causes inflammation (encephalitis) which is almost invariably fatal. The incubation period (the interval between the bite and the first symptoms of encephalitis) is usually about 2 months but can vary from 4 days to many years. The earliest symptom is itching or tingling at the site of the healed bite. Later the patient may develop headache, fever, confusion, hallucinations and hydrophobia. Attempts to drink water induce spasm of the muscles of breathing and swallowing associated with an indescribable terror. Death supervenes after a few days of these terrible symptoms. In a form of rabies which is less common, there is spreading paralysis without excitement or hydrophobia. There have been only six known survivors from rabies encephalitis: they were treated with intensive care.

Prevention

Stroking stray dogs and apparently tame wild animals, keeping carnivores as pets and other unnecessary contact with mammals should be avoided in areas where rabies is endemic. Irrespective of the risk of rabies, mammal (including human) bites and scratches and licks on mucous membranes or broken skin should be cleaned immediately.

First, scrub with soap and water under a running tap if possible, or else immerse in water, for at least 5 minutes. The best virucidal agents are 40–70% alcohol (gin and whisky contain more than 40% alcohol) and povidone iodine. Mammal bites are frequently contaminated by a variety of micro-organisms other than rabies virus, so a doctor or the expedition nurse should be consulted. Immediate thorough cleaning of the wound is of the utmost importance in preventing infection.

Second, rabies should be considered if it is known to occur in the area. The decision whether or not to give post-exposure vaccination and rabies immune serum is made by a doctor. Ideally, it is based on examination of the biting animal; but usually this is not possible. The species of animal, its behaviour, the circumstances of the bite and, in the case of a domestic animal, when it was last vaccinated, are useful pieces of information. The decision must be made as soon as possible by a doctor working in the area where the bite occurred. On no account should it be delayed until patients return to

their own country. If in doubt, vaccinate. Modern vaccines such as HDCV, PVRV, PCEC and PDEV are potent and safe. They require fewer injections than the older type of nervous tissue vaccine which was given on at least 21 consecutive days under the skin of the abdomen. The old Semple vaccine deserved its reputation for being dangerous; the tissue culture vaccines are safe. Timely cleaning of the bite wound combined with vaccination and use of immune serum has proved very effective in preventing rabies. If a suspected rabid animal later bites someone who has received pre-exposure immunization, immunity must be boosted with 2 injections of vaccine on days 0 and 7.

If the bitten person has not previously been immunized, a full course of post-exposure vaccination is required. The conventional course, using modern vaccines (detailed above), involves intramuscular injections of 1 whole vial (0.5ml or 1ml of reconstituted vaccine) intramuscularly on days 0, 3, 7, 14 and 30. These individuals should also receive a dose of rabies immune globulin. Half is infiltrated around the bite wound and the rest given intramuscularly into the front of the thigh. The dose of equine rabies immune globulin is 40iu/kg body weight; the dose of human rabies immune globulin is 20iu/kg body weight.

If rapid induction of active immunity is required and there is a shortage of vaccine, modern vaccines can be used effectively and economically by employing an alternative multiple site intradermal regimen. On day 0, 1 ampoule of vaccine is divided between eight different sites (both deltoids, both thighs, both sides of the umbilicus and above both shoulder blades at the back). At each site 0.1ml (in the case of 1ml ampoules of vaccine) or 0.05ml (in the case of 0.5ml ampoules of vaccine) is injected intradermally (so that it raises a small peau d'orange papule). On day 7, 4 intradermal injections are given (both deltoids and both thighs) and single intradermal injections are given on days 30 and 90.

It is essential to take rabies seriously and minimize the risk of infection by avoiding potentially rabid animals. If bitten by a suspected rabid animal and no suitable vaccine is available, the individual should be repatriated without delay so as to start post-exposure prophylaxis as soon as possible.

For dog bite/rabies queries contact Public Health Laboratory Health Centre, Virus Reference Laboratory, Tel. +44 208 200 4400 ext. 3204.

5.4 Venemous and poisonous animals ¹

Travellers in tropical countries usually have an exaggerated fear of snakes, scorpions and other venomous animals. Most parts of the world, especially the tropical regions, do harbour animals with potentially lethal venoms, but local farmers and children, rather than travellers, suffer. Thus, snake bite is a major cause of death among some tribes of the Ecuadorian and Brazilian jungles, and among the inhabitants of some parts of Burma, Nigeria and Sri Lanka; and many children die of scorpion stings in parts of Mexico and North Africa. Yet the author knows of no recent case of a European traveller being killed by a venomous bite or sting.

Before travelling to a tropical country it is worth finding out about local venomous species and trying to discover if there is a national centre for antivenom production, supply and treatment. The use of antivenom (also called antivenin, antivenene or anti-snake-bite serum) requires medical training. If an expedition is going to an extremely remote and snake infested area it might be wise to collect some antivenom from the regional centre and to ensure that there is someone in the party who has been trained to use it safely. Otherwise rely on local medical services; but enquire about them in advance. Before buying antivenoms manufactured in Europe, seek expert advice about their effectiveness against tropical species which are important causes of bites or stings in the area of your expedition.

5.4.1. Snake bite

Snakes never attack humans without provocation and so the risk of snake bite can be reduced as follows. Avoid snakes and snake charmers. Do not disturb, corner or attack snakes and never handle them, even if they are said to be harmless or appear to be dead. Even a severed head can bite! If you corner a snake by mistake, keep absolutely still until it has slithered away: snakes strike at moving objects. Never walk in undergrowth or deep sand without boots, socks and long trousers; and at night always carry a light. Never collect firewood or dislodge logs and boulders with your bare hands and never put your hand or push sticks into burrows or holes. Avoid climbing trees or rocks which are covered with dense foliage and do not put your hands on sunbaked ledges you cannot see when climbing. Never swim in rivers matted with vegetation nor in muddy estuaries where there are likely to be sea snakes.

5.4.2 Treatment of snake bite

First aid - to be given by the man-on-the-spot

1. Reassure the patient who may be terrified by the thought of sudden death. The grounds for reassurance are that only a small minority of snake species are dangerously venomous to man and even the most notorious species, such as

¹ This section has been taken from Warrell (2002) to whom full acknowledgement is given.

cobras, often bite without injecting enough venom to be harmful. The risk and rapidity of death from snake bite has been greatly exaggerated. Lethal doses of venom usually take hours (cobras, mambas, sea snakes etc.) or days (vipers, rattlesnakes and other pit vipers etc.) to kill a man - not seconds or minutes as is commonly believed. Correct treatment is very effective.

2. Immobilize the bitten limb with a splint and arrange immediate transport to hospital, dispensary or to the expedition medical officer. The patient must avoid exercising the bitten limb.
3. Do not attempt to catch or kill the snake *but if it has been killed already take it with you; it is useful clinical evidence, but must not be handled with bare hands even if it appears to be dead.*
4. Treat pain (and anxiety) with paracetamol tablets, 0.5-1.0g for adults.
5. Avoid traditional remedies (incisions, suction, tourniquets etc.) which do more harm than good. For example:

DO NOT apply a tourniquet (ligature or tight band) unless the snake is large and you are absolutely certain that it is one whose venom contains a dangerous neurotoxin (for example cobra, krait, mamba, Australian tiger snake, taipan etc.). If a tourniquet is used it must be tightly applied above the bite - around the upper arm or thigh. To avoid gangrene it must be released after 30 minutes. A better method of reducing absorption of the injected venom is to bind the bitten limb firmly, but not too tightly, starting over the site of the bite, using a long stretchy crepe bandage and incorporating a splint. These methods should not be used after bites by snakes whose venoms cause a lot of local swelling and gangrene (e.g. most vipers and some cobras).

DO NOT suck at the wound, cut it with a razor blade, introduce potassium permanganate crystals, apply ice, electric shocks or interfere in any other way.

DO NOT give aspirin which may cause bleeding.

DO NOT give antivenom which can be dangerous and should be administered only by a doctor, nurse or dispenser who has emergency drugs (adrenaline, antihistamine and corticosteroid) to deal with serum reactions should they occur.

If you have your own supply of antivenom take it with you to hospital where the doctor or other trained staff can give it.

5.4.3. Advice for the expedition medical officer

Absence of local swelling four hours after a bite by a viper, rattlesnake or other pit viper suggests that no venom was injected and that no further treatment is necessary; but bites by some snakes with neurotoxic venoms (mambas, kraits, cobras etc.) may not cause any local swelling.

5.4.4 Indications for antivenom treatment

1. Bleeding from gums, nose, gastrointestinal tract or any other site distant from the bite itself, which started spontaneously after the bite, and persistent bleeding from wounds (such as venepuncture sites).
2. Failure of the patient's blood to clot if placed in a new, clean, dry glass tube and left undisturbed for 20 minutes.
3. Signs of nervous system involvement such as extreme drowsiness or unconsciousness, drooping eyelids, difficulty in swallowing and breathing, and pain, stiffness and paralysis of skeletal muscles.
4. Passage of dark red, brown or black urine (haemoglobinuria or myoglobinuria).
5. Signs of heart involvement such as low or falling blood pressure, unusually slow pulse rate or irregular rhythm.
6. Swelling of more than half the bitten limb, swelling after bites on the fingers and toes, or swelling after bites by snakes whose venom is known to cause gangrene (e.g. most vipers and rattlesnakes, some cobras).

NB: antivenom should never be given unless at least one of these six signs is definitely present.

Slight local swelling alone is not an indication for antivenom. Never give antivenom unless you have adrenaline (1 in 1000 solution, that is 0.1%, dose 0.5ml by subcutaneous injection) available to treat severe reactions to the antivenom.

5.4.5 Choice of appropriate antivenom

Before giving antivenom make sure that its range of specificity includes the snake that has bitten your patient. Some knowledge of Latin scientific names is useful, e.g. *Naja* - cobra, *Dendroaspis* - mamba, *Bungarus* - krait, *Micrurus* - coral snake, *Bitis* - giant African vipers, *Echis* - carpet viper, *Bothrops* - fer de lance, *Trimeresurus* - pit vipers, *Crotalus* rattlesnake. It may have been possible to identify the biting snake; or its venom may have produced a diagnostic clinical sign, such as incoagulable blood caused

by the carpet viper in the northern half of Africa. Otherwise, a polyspecific antivenom with activity against the principal venomous species of the region is used.

Caution: Do not give antivenom which is opaque: the change from a clear to cloudy solution indicates loss of activity and increased danger of reactions. Expiry dates can be ignored provided that the solution is crystal clear. Manufacturer's instructions included in packs of antivenom may be misleading!

5.4.6 How to give antivenom

For maximum effect, antivenom should be given directly into a vein, by slow intravenous injection (2ml per minute) or slow intravenous infusion of antivenom diluted approximately 50/50 in sterile isotonic saline. The initial dose depends on the type of antivenom, species of snake involved and severity of symptoms, but a typical starting dose is four or five 10ml ampoules. This is repeated after a few hours if the life-threatening condition such as bleeding or weakness of the breathing muscles is not cured, or if the blood remains incoagulable after six hours.

The patient should be watched for signs of an antivenom reaction: namely, fever, itching, rash, vomiting, breathlessness and wheezing, increase in pulse rate and fall in blood pressure. If this happens, give 0.5ml of 0.1% adrenaline by subcutaneous injection: this can be repeated after about 10 minutes if it is not effective. Reactions are likely to be particularly severe in those who suffer from asthma, eczema and other allergic disorders.

Only in extreme circumstances should medically unqualified people give antivenom. Intramuscular injection into the anterior (front of) thigh can then be used. Firm pressure should be applied to the site of injection to prevent bleeding.

5.4.7 Treatment of complications

1. Massive external bleeding or leakage of blood and tissue fluid into a swollen limb may leave the patient with an inadequate circulating volume. Transfusion with blood products or plasma expanders may be needed.
2. Respiratory paralysis may require mouth-to-mouth or more sophisticated forms of artificial ventilation.
3. Secondary infection may be introduced by the snake's fangs or local surgery at the bite site. Patients with infected wounds and those with local gangrene should be treated with antimicrobials and a tetanus toxoid booster. Gangrenous tissue should be excised surgically and the skin defect covered immediately with split skin grafts.

Note on spitting cobras

In Africa and parts of South East Asia there are populations of cobras which can spray their venom forward from the fang tips for a distance of several metres. This is a defensive reaction. Venom entering the eyes or landing on other mucous membranes causes severe local pain and watering and can result in ulceration of the cornea. Treatment is the same as for any chemical injury to the eye. The eye should be irrigated with generous volumes of any bland fluid available (water, milk or even urine!). Pain-killing drugs such as paracetamol can be given by mouth. Ideally, the eye should be examined by a doctor, antibiotics such as chloramphenicol or tetracycline eye ointment instilled for several days and the eye closed with a dressing pad. If you suddenly see a spitting cobra, duck or put your hand in front of your eyes.

5.4.8 Stings by bees, wasps and hornets (Hymenoptera)

In normal people many stings, probably hundreds, would be required to introduce enough venom to kill. A man in Rhodesia survived more than 2,000 stings. But a few percent of the population are hypersensitive and could be killed by a single sting. The development of hypersensitivity is suggested if there are progressively severe local reactions to successive stings; or systemic symptoms such as generalised tingling with rashes (urticaria, "nettle rash" or hives), swelling of the lips, tongue and throat, flushing, dizziness, collapse, wheezing and unconsciousness within half an hour of the sting.

Prevention and treatment

It is possible to confirm hypersensitivity and desensitize the patients using purified venom, but this takes a long time. People who know or suspect that they are hypersensitive should be taught how to give themselves a subcutaneous injection of 0.5ml of 0.1% adrenaline and should carry this with them on the expedition ("Min-i-Jet" self injectable adrenaline kits with a 1/4 inch long 25 gauge needle). They should wear a Medic-Alert tag in case they are found unconscious (Medic-Alert Foundation International, 12 Bridge Wharf, 156 Caledonian Road, London. N1 9UU. Tel. 0207-833-3034, Website www.medicalert.org.uk).

In tropical countries, especially Africa and Middle and Southern America, rock climbers and other travellers have occasionally been attacked by large swarms of angry bees, and some fatal falls have resulted. Some of these accidents could have been prevented if local advice had been sought. Thundery weather is known to upset bees. In the face of an attack, the best tried methods of evasion seem to be to run very fast or to immerse yourself in water. The climber should appreciate that a fall is probably the greatest danger. After securing himself he will have to rely on protection afforded by anorak, haversack or tent. In South America about 100 people die each year after being attacked by furious swarms of "Africanised" honey bees. The principal effects of multiple stings in the non-hypersensitive subject are haemolysis, rhabdomyolysis (breakdown of skeletal muscle), bronchospasm, pneumonitis and kidney failure. No antivenom is available.

5.4.9 Ants, beetles, moths and caterpillars

(Especially the brightly coloured, hairy ones) can cause several problems: local pain, inflammation, nettlerash, blistering and arthritis on contact and, in Venezuela and Brazil, systemic bleeding and incoagulable blood.

5.4.10 Spider bites

Dangerous spiders occur mainly in the Americas, southern Africa, the Mediterranean region and Australia. The most notorious genera are *Latrodectus* (black widow spiders), *Phoneutria* (Brazilian Walking spider), *Atrax* (Sydney funnel web spider) and *Loxosceles* (brown recluse spiders). All tend to be associated with human dwellings (i.e. village huts) rather than forest environments. *Latrodectus*, *Phoneutria* and *Atrax* venoms affect nerves, muscles and heart, producing cramping pains, muscle spasms, weakness, sweating, salivation, "gooseflesh", fever, nausea, vomiting, alterations in pulse rate and blood pressure and convulsions. *Loxosceles* bites cause severe local necrosis, a generalized red rash, fever, dark urine (haemoglobinuria), blood clotting disturbances and kidney failure. Deaths are unusual except among children. Bites usually occur when the victim brushes against a spider which has crept into the clothes or bedding. Antivenoms are manufactured in countries such as South Africa, Australia and Brazil, where spider bite is an important medical problem.

5.4.11 Scorpion stings

Dangerous scorpions occur less in the everwet forest but more in seasonally dry areas, particularly in North Africa, the Middle East, USA, Mexico, South America and India. The fatal cases are usually children. Most stings are not life-threatening but cause excruciating local pain with little swelling. Powerful neurotoxins in the venoms of dangerous species have an action on the autonomic nervous system and muscles including the heart. Symptoms reflect initial release of acetylcholine neuro-transmitter (causing vomiting, abdominal pain, tachy/bradycardia, "gooseflesh", salivation etc.) followed by release of catecholamines (causing hypertension, pulmonary oedema, ECG abnormalities).

The severe local pain is treated by injecting 1-2% lignocaine, but a powerful analgesic such as pethidine injection may be required. Severe systemic symptoms should be treated with appropriate pharmacological agents (e.g. vasodilator drugs) and antivenom. Atropine, betablockers and digoxin are not generally recommended.

Prevention is better than cure. When establishing a base camp in a scorpion-infested area, first dig out the scorpions. Their entry holes are usually easily recognizable, oval in shape. A thin twig should be used to guide the digging as the tunnel often changes direction. Always suspect there may be a scorpion under cases, logs etc. Always shake your boots and shoes out before putting them on. Always look where you put your bare feet. The Editor omitted to do just that in Ethiopia in 1978 and

regretted it. The RGS Kora 1983 expedition dug out 180 scorpions in the base camp site. The exoskeleton of scorpions fluoresces in ultra-violet light, so use a UV lamp to search your chosen camp-site.

5.4.12 Other venomous invertebrates

Bites by some tropical centipedes can be dangerous as well as painful. They frequent the bark crevices on timber used in camp building and may well get into the folds of damp clothes, towels, etc. Millipedes, often amongst dead leaves on the forest floor, can squirt irritating defensive secretions, so take care when examining them closely. There is no specific treatment for either of these menaces. Many species of ticks can inject a paralysing toxin while they suck your blood. If a member of your party becomes progressively weak, it is important to search for the tick in hairy areas and to detach it as soon as possible: the symptoms should then subside.

5.4.13 Invasive arthropods

Various tropical arthropods have larvae which invade human tissue or are merely blood sucking.

Congo floor maggot (*Auchmeronyia luteola*)

The larvae live in the floors of huts. They attack humans who sleep on the ground and suck their blood, causing local swelling and itching. Fumigate the hut and treat the bites symptomatically, making sure that no secondary infection is introduced (wipe the skin with tincture of iodine, give systemic antimicrobials if there are signs of infection).

Tumbu fly, putsi fly, ver du cayor (*Cordylobia anthropophaga*)

This fly is common in sub-Saharan Africa. It lays its eggs on damp clothes laid out to dry and, if they are not ironed, the eggs will hatch and burrow into your skin. Do not spread your clothing on the ground to dry. A small boil develops with something moving in the middle; this is the posterior segment with the respiratory spiracles. There is a sensation of movement in these lesions.

Treatment

Cover with paraffin (Vaseline) and grasp the maggot, which will stick out its “head” to get air, or do a proper surgical excision.

Ver macaque, human botfly, Berne, El Torsalo, beefworm (*Dermatobia hominis*)

This fly is widely distributed in Central and South America from Mexico to Argentina and Chile. It lays its eggs on other insects. They hitchhike to the human skin and penetrate quickly. To begin with the maggot is bottle-shaped and, although paraffin may cause the creature breathing difficulties, in the early stages you are likely to pull off the “neck” (actually the posterior segment with the spiracles) if you attempt to extract it. Wait until it is further developed, and you may succeed as with the tumbu fly.

Otherwise make a cross incision to pull the maggot out, taking care not to cut it. An alternative is to cover the lesion with candle wax. The maggot will burrow its way into the candle wax, and you have got it.

Creeping eruptions (*larvae migrans*)

The track made under the skin is caused by the larvae of animal nematodes, such as *Ancylostoma braziliense*, *Uncinaria stenocephala* and *Ancylostoma caninum*, the hookworms of cats and dogs. The larva moves day by day. The best treatment is thiabendazole applied topically in paraffin ointment.

Jigger fleas (*Tunga penetrans*)

After fertilisation the female of this little flea jumps (feebly) and burrows alongside the nailfold or into the skin of the groin, loses her legs and produces eggs each night. These must be curetted out and iodine applied. Jiggers and other unpleasant creatures can be avoided if you do not walk around barefoot.

Chapter 6: THE TREE CANOPY¹

Recent studies involving climbing into the tree canopy has stimulated some expeditions to look at this relatively unknown area of the tropical forest. The techniques described here are specialised and those using them should be fully aware of the dangers involved.

6.1 Introduction

The tropical forest canopy harbours a greater diversity of life than any habitat on the planet. As much as half of all life on earth may exist there, yet it remains nature's last biological frontier. Man has never created a vehicle capable of travelling easily across the rain forest roof, this is why this environment is still largely unexplored. The first scientific attempts to get into it were made with the help of local Indian climbers and even specially trained monkeys, but the latter often ate the samples they were supposed to collect before returning to ground. Improvements were made using rope firing cannons during an Oxford University Expedition in 1929 led by Major R W G Hingston, which were then used to haul observers on a bosun's chair into the canopy.

In 1960 a Dutchman, Adrian Kortlandt, constructed primitive walkways with the help of pygmies in Zaire obtaining some of the first systematic observations of undisturbed chimpanzees. Elliot McClure (1977) an American biologist, pioneered observations of the Malaysian hill dipterocarp forest by erecting Swedish aluminium tree climbing ladders (in c. 10ft lengths) almost 50 metres up a meranti tree. Its erection was an engineering feat, and McClure spent the following three years studying the canopy from this height. The tree, and the forest around it, were finally felled in 1977 to make way for the Trans-Malaysian Highway.

A variety of walkways and scaffolding towers, even rope webs, were built through the 1970's culminating in the lightweight portable aerial walkways designed by Andrew Mitchell and built by Army engineers on expeditions organised by the Scientific Exploration Society, notably Operations Drake and Raleigh. These were constructed of lightweight man-made nylon fiber tape and aluminium alloy strips of factory flooring, tensioned between trees like a suspension bridge. Equipment was hauled up with block and tackle to large wooden sleeping platforms in tree crowns. Cross-bows enabled mono-filament lines to be fired between crowns enabling the main suspending cables of 4500kg breaking strain to be pulled and tensioned between them using Tirfor jacks. The flooring, suspended beneath them was pulled out between the trees covering distances of up to 75 metres per section. From these walkways, teams of botanists and zoologists made some of the first comparisons of the plants, insects and

¹ This account is taken with permission from Mitchell, A.W (1982) REACHING THE RAIN FOREST ROOF (a handbook on techniques of access and study in the canopy), with substantial additional material from Robbins, A.M.J. (1933a,b).

birds of the rain forest canopies of Panama, Papua New Guinea, and Sulawesi in Indonesia. Such canopy walkways have now been built in a number of countries.

For most expeditions, techniques such as these are beyond fieldwork budgets. There are two approaches that expeditions can take to canopy access: they can climb the trunk; or they can climb without touching the trunk. Both will be described in some detail here. It should be emphasised again that climbing and working in the tree canopy is a dangerous occupation and those who do it should be fully trained in its techniques. It is essential that various aerial rescue scenarios are rehearsed and practised so as to give all participants some idea of the great difficulties involved in getting an incapacitated climber to the ground (Barrell, 2002). Industry best practise states that whenever climbing work is undertaken, at least one member of the ground staff must be able to perform an aerial rescue (FASTCo, 1999). Although expeditions are not exactly industry-related, this is still a prudent precaution to take.



Figure 6.0 Telescopic clipper pole in use from Drake walkway, Panama. Rope main cables were later replaced with polyester tape. Photo: C. Sainsbury



*Figure 6.1 Tensioned webbing tape ladder for ascent to platform. Note safety line.
Photo: A. Mitchell.*

6.2. Climbing the trunk

The best people to climb the trunks of large forest trees are the local inhabitants who are usually well versed in the art of climbing tropical trees. Once into the crown, equipment or apparatus can be pulled up if local help is not available. Two methods may be used.

6.2.1. Tree surgeon's spikes and belt

This method involves using strong boots with sharp metal spikes pointing inwards at the instep attached to them on a metal plate which supports the climber. A leather belt attached to a harness holds the climber into the tree. The ascent is made by alternately jabbing the spikes into each side of the trunk. This method has been extensively used in temperate regions for trimming trees. It is fraught with hazards and should only be undertaken by experienced tree-care professionals.

Niel Rettig, a wildlife photographer with 'Films and Research for an Endangered Environment' (FREE Ltd) utilized standard linesman and tree-trimmers safety equipment with some modifications to scale trees in the Philippines whilst making a highly successful film about the Philippine eagle.

6.2.2. Driving bolts or spikes into the trunk

Denison *et al.* (1972) first described this method of climbing to study canopy ecosystems of coniferous forests in the H. J. Andrews Experimental Forest of Western Oregon, Canada. In 1977 and 1979 D. W. and J. M. Thomas of the Missouri Botanical Garden used the same techniques to scale trees in two wet evergreen forests in the Republic of Cameroon, one being in the Douala-Edea Reserve. The objective was to establish observation points in large hardwood trees and to study epiphyte ecology. A tree with a clean straight bole is selected.

The climber carries a hammer and lag screws which hold better in bark and trunk than pitons or spikes that are used in rock climbing. A team-mate remains on the ground to belay the climber with a safety rope, occasionally taking his weight as he ascends the tree. The lag screws are first hammered gently through the bark and sap wood, taking care not to deform the head, and are then screwed down with a socket wrench. During the process the bolt head sometimes shears off and any which appear damaged or weakened must be replaced. 'Etriers' or stirrup loop ladders made of tape are clipped to the hangers along with the belay rope, enabling the climber to step upwards to install the next bolt and hanger, proceeding in this way to the top of the tree (Fig. 6.3). The initial climb takes several hours and is arduous.

The equipment needed for the Bolt and Hanger method is as follows:

1. 20 carabiners. A few should be locking.

2. 40 bolt-hangers. Angled metal plates with two holes, one for a carabiner, one for the bolt. Ensure bolt hole will accommodate substitute lag screw below
3. 50 carriage bolts (lag screws). Climbing bolts often sold with the hangers should not be used. Instead lag screws with hexagonal heads and 5/16in. shafts are substituted. These should be 2in. or 2 1/2 in. long for hard-wooded trees. A few 4in. or 6in. bolts may be useful for platform construction
4. Hammer, ratchet and socket to fit the bolts
5. 1 fixed rope, 38m of 10mm (7/16in.) laid for a 30m climb
6. 1 safety-rope, at least 70m of 7/16in. laid for a 30m climb
7. 70m of 6mm (1/4in.) rope and a small pulley for hauling gear
8. 15m of 25mm (1in.) tubular nylon tape, for slings
9. 2 pairs of jumars, 2 willans 'sit' harnesses, two 3-step etriers, 1 figure-8 descender,
10. 1 helmet
11. 1 heavy-duty pulley for the safety rope

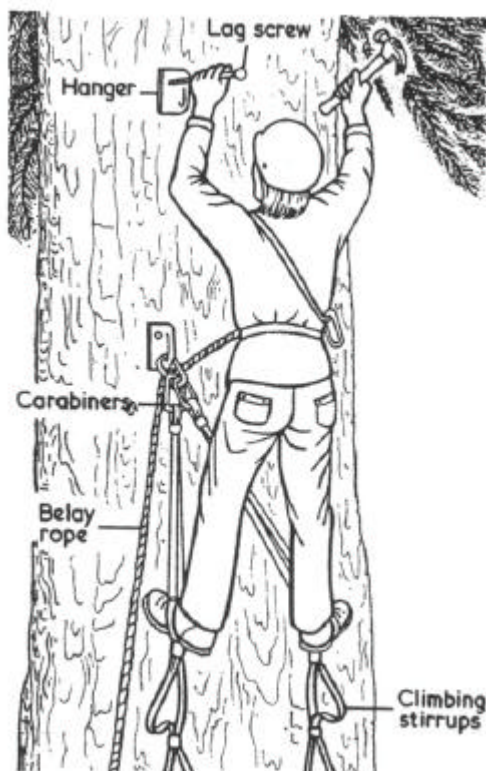


Figure 6.3

When the climber reaches a point above the proposed platform, the belay rope and a fixed rope for future ascents are attached to the tree. The belay rope passes through a pulley whilst the fixed rope is secured to bolt hangers and is tied around the trunk or branches. It also passes through carabiners in bolt hangers at 10m intervals so that it lies against the trunk for future jumar ascents. Experienced climbers can rig a tree

in a day. In hard-wooded, thin-barked trees, short lag screws are used to secure bolt hangers to the trunk.

When used by the author, it was found that the ropes and other climbing equipment were still in good condition after two years use but one tree was expelling bolts after two and a half years. This can be a real danger in some species and regular checks should be made. In two years, six platforms were constructed and many hours of canopy observation were made involving almost daily ascents in some months. It is strongly advised that the ropes should not be left *in situ* for any longer than absolutely necessary, definitely no longer than one week – climbing ropes used on oil rigs are discarded after 50 hours use. If ropes are left *in situ* then the entire length should be given a thorough visual and tactile inspection before every use. The individual and combined effects of such things as UV radiation, continual wetting and drying, animal urine/saliva/blood on rope strength are poorly understood and therefore great care should be taken before trusting one's life to a rope (Barrell, 2002).

Rock climbing pitons have been used to ascend trees for walkway construction with climbers stepping up on the pitons themselves and clipped to them in a harness by carabiners. It takes 3-4 hours of arduous work to reach the top. Dr David J. Chivers (pers. comm.) used 18cm nails to make a series of 'steps' up several Malaysian trees to about 30 m. Again, current techniques and equipment provide much more suitable access methods. It should also be mentioned that approved industrial rope access procedures require the climber to be attached to two independent points of suspension at all times. This is not always practicable in tree climbing but is a sound procedure to follow whenever possible.

The main disadvantage of these methods are that they carry unacceptable safety risks, there are more suitable methods available, they require heavy equipment, are very arduous and cause injury to the tree.

6.2.3. Tree bicycle (Baum-velo)

The tree bicycle, or Swiss tree gripper, is an expensive item of equipment and not discussed further here. It could be used where the bole is free of lower branches (see Barner & Olesen, 1983).

6.3. Climbing free of the trunk

This section describes a method used to ascend trees without touching the trunk, that is, directly into the branches from the ground or a neighbouring tree (see Fig 6.4). This has many advantages over the methods previously described in that it is simple, inexpensive, rapidly deployed, causes no injury to the tree and avoids contact with the trunk where irritating and potentially dangerous hazards may exist. First a climbing rope must be rigged over a suitable branch, using the advanced line system in which a lighter line is placed over a canopy bough by one of the under-mentioned techniques (see Fig 6.5). The climber then ascends the climbing rope using standard equipment available from caving or mountaineering equipment suppliers.



*Figure 6.4: Man in harness adopting the single rope technique into the tree crown.
Photo: H.DeForesta*

There are two main constraints that apply to any projection device developed for the advanced line technique:

a) Projectile:

The projectile must have a certain minimum weight that will allow it to pull the line over the branches, overcoming surface friction of the bark, and also the weight of and wind drag on the line between branches and catapult. Certain trees may have bark types and/or numerous twigs which produce so much friction that heavier projectiles must be used. The maximum weight usable is determined by the height range required and the power needed to achieve this. The shape of the projectile must be suitable for firing, capable of penetrating foliage with a minimum of resistance, and should minimise snagging if the projectile has to be pulled back over branches for repositioning. The Honduran catapult uses a compact cylindrical lead weight with a conical end, cast from a simple mold.

b) Line:

The line has to be sufficiently strong to resist the drag and weight of the intermediate cord when this is pulled back over the branches, and also the forces resulting from checking the projectile if a line brake is used, or when pulling the projectile free of minor snags. The line must be as light and as slippery as possible to minimise the weight of the projectile required to overcome line weight and frictional forces. The storage drum must allow the line to pay off with the minimum of resistance, as this will cause the greatest drag during firing.

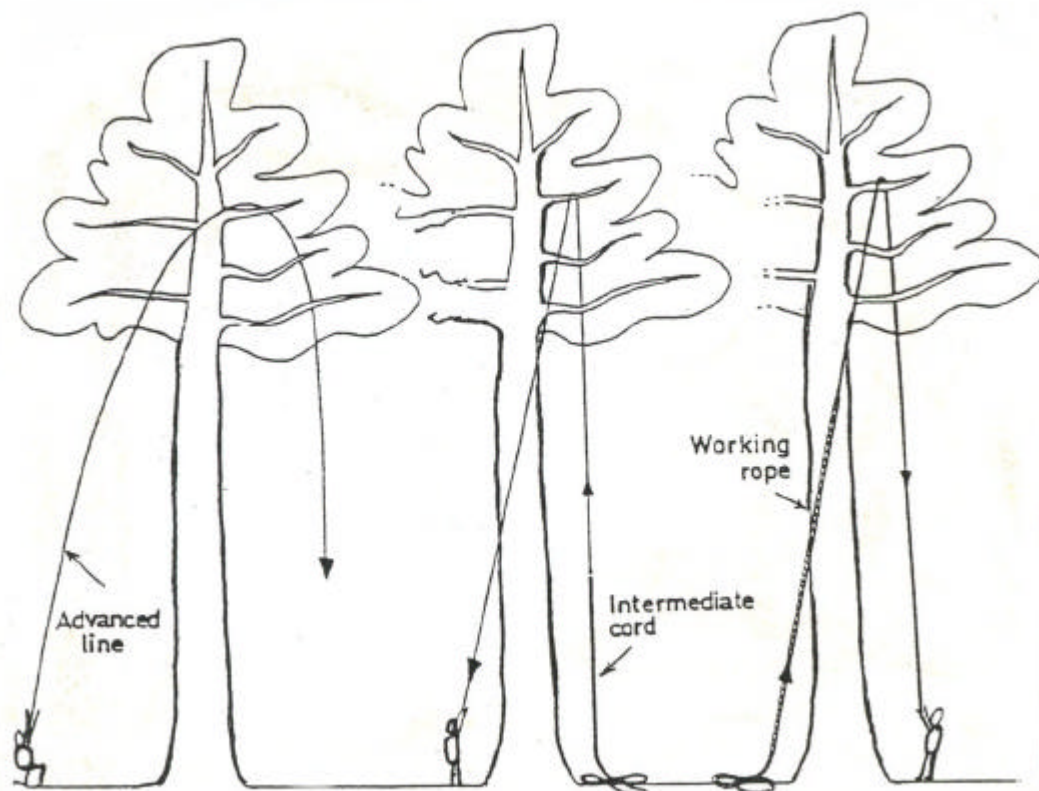


Figure 6.5

The basic technique was described by Perry (1978), Perry & Williams (1981); and Whitacre (1981) published a detailed account with numerous diagrams. A growing number of researchers now use this method with minor modifications and a variety of techniques exist for rigging the advanced line.

6.3.1. Rigging the advanced line

Six methods may be used:

1. Crossbow

Perry (1978) used a 36kg pull crossbow to fire a weighted arrow trailing a 14kg test monofilament fishing line over the tree's crown or a high limb. The weighting of the arrow ensures its return to the ground. The line pays out from a spool which prevents tangling. A stronger (54kg to 110kg test) braided nylon line is then attached to the monofilament line and pulled over, followed by the climbing rope. The 110kg line is needed when the rope touches several limbs as abrasion will cause a weaker line to break. Be aware that some countries are very cautious about allowing people in who have powerful hunting weapons (e.g. crossbows), especially those countries where poaching is a major problem (Barrell, 2002).

A crossbow was used in a similar way to erect the Drake walkways in Panama, Papua New Guinea, and Sulawesi (Indonesia). At that time arrow bolts often failed to return to earth if the canopy was thick. The bolts should have blunted ends to prevent them sticking into branches and a small hole drilled in the rear end enables the monofilament line to be attached easily. We used a drum attached to the crossbow from which to pay out the monofilament line but a spinning fishing reel has been found to work better, and aids rapid recovery of the line. Crossbows are particularly useful for shooting horizontally when placing lines between tree crowns in the canopy.

Hubert de Foresta (pers. comm.) and his colleagues used the crossbow technique in French Guiana in 1980 and in Gabon in 1981 using a 54kg pull crossbow and a 45/100 monofilament line in a study of flowering and fruiting in canopy species.

2. Slingshot or Shanghai

Nalini Nadkarni (pers. comm.) currently uses a powerful 'Wrist Rocket' slingshot to propel a 40g lead sinker over a selected limb of the target tree. The slingshot's strong elastic bands and wrist brace give a range of 50m with good accuracy. The sinker is attached to 7.5kg test monofilament fishing line paid out from a fishing reel mounted on a short rod allowing tangle-free deployment and recovery. Attaching a piece of brightly coloured flagging tape to the sinker helps in locating it if it should get caught in the foliage. If the sinker fails to reach the ground it can be 'plucked' by pulling and releasing the weight until it does. Nadkarni attaches nylon parachute cords to the fishing line and rapidly reels it in followed by the climbing rope, thus gaining access to the canopy at La

Selva, Costa Rica, to study epiphytic biomass and mechanisms of nutrient transfer in a wide range of individuals and species. Margaret Lowman (pers. comm.) has used the same method to study leaf growth and herbivory in Australian rain forests.

Kortlandt, in 1963, used a crossbow catapult equipped with a bicycle tube sling to propel a 50g lead ball from the ground over a forked branch 15-20m high in Zaire. The monofilament line paid out from a fishing reel attached to the catapult. A 2mm line was then pulled over followed by an 8mm climbing rope and next a rope ladder. With accurate aim the procedure took only minutes. This system was developed by the Forestry Department at the Agricultural University of Wageningen, Netherlands.

3. Catapults

A light-weight catapult has been designed by the Danida Forest Seed Centre and discussed by Stubgaard (1987). The handle is made of 8mm shafting steel, with a Y-fork and a brace vent to fit the arm (for either right or left-handed person). The propulsion unit is surgical latex tube 23cm long, 4.5mm inside diam., 8.55mm outside diam. with a 28 x 120mm leather pouch to take the projectile.

A fixed-spool spinning reel for fishing is used as line holder sufficient to have 60mm external diameter when the spool is fully loaded. The line of 0.40mm monofilament fishing line should have a length of 200m. The projectile should be 30 - 40g lead weight. This line could draw over an intermediate line, which in turn can be attached to the climbing rope.

A more robust catapult was designed for seed collection in rain forests in Honduras (Robbins et al, 1981). The details have been published in English and would be worth reading if work in the canopy is anticipated.

4. Rifle

Gene Montgomery of the Smithsonian Tropical Research Unit used a modified rifle which fired a brightly coloured weight of medium density and roughly 100mm diameter, to which was attached a fishing line. The cartridge power had to be limited. The rifle was used to raise lines to allow fogging of the upper canopy for insect studies. The same technique has subsequently been used by Terry Erwin of the Smithsonian Institution, Washington, D.C., by Edward Broadhead of Leeds University and Nigel Franks of Harvard University.

5. Fishing rod

John Innes and Chris Ecroyd (pers. comm.) currently use a 1.6m fishing rod to cast an 80g lead weight attached to a fishing line up to 25m with accuracy in Pureora Forest in central North Island, New Zealand. The work was begun in 1980 to study epiphyte distribution and predation of the blue wattled crow *Callaeus cinera* by introduced mammalian predators.

6. Throwbag and throwline

Andrew Barrell currently uses a 'Big Shot' (see Jepson, 2000) to launch a specially made throw bag (made of stitched plastic or canvas, filled with fine lead shot and weighing between 100 and 400 grams) attached to a 2mm polypropylene line, into the canopy. Heights in excess of 60 metres are achievable by this method. For anything below 25m, he throws the bag by hand and maintains that fairly consistent results are achievable up to this height with practise. This equipment is available through arborist equipment suppliers such as Honey Brothers and Fujikura but expert advice should be sought before spending large chunks of budget on possibly inappropriate equipment.

6.3.2. Ascending the climbing rope

Any standard climbing rope will do at a pinch but too much stretch makes the initial few metres difficult. Lowman uses 11mm Bluewater II. A tight weave is advisable. The length of rope required depends upon the height of the tree but 100m is a rough guide. SRT (Single Rope Technique) rope, with a very low stretch factor, as used in caving, is recommended. It is also recommended that an extra climbing rope be used as a safety backup in conjunction with the main climbing line. This rope remains attached to the climber by means of a short stop and a device such as a Petzl shunt or Troll rocker. These devices slide freely up and down but will lock onto the rope if a sudden fall occurs, e.g. the main climbing line breaking.

The climber uses a webbing sit-harness, for example Willans harness or the Petzl Speleo harness and three 'jumar' type self-locking ascenders, plus a pair of foot stirrups attached to the lower of two jumars locked on to the climbing rope. Climbing harnesses are not designed for comfort when in suspension therefore it is advisable to look for harnesses with wide and padded back straps and leg loops. The NARC 'Treehopper' fulfils these criteria and also has a lower front attachment point which allows greater freedom of movement. Ascenders operate by way of a spring-loaded grip which allows free passage of the climbing rope in one direction but clasps and locks it tightly in the other. The first jumar is connected to the harness as shown (in Figs 6.6 & 6.7). The climber then puts all his weight on the harness, moving the stirrups plus legs up the rope with the lower jumar. Now taking the weight with his feet he stands up in the stirrups, holding himself into the rope above the upper ascender, whilst raising this ascender as high as possible with the other hand. By repeating the process he can 'inch-worm' his way up the rope. A third jumar is kept free on a belt in case of failure in either of the other two. De Foresta recommends the use of a 'Croll' chest ascender attached to a chest harness with the stirrups strung from the upper ascender as this improves progression up the rope. Carabiners, preferably screw-gate locking for safety, can be used for attaching stirrups and harness to jumars.

The climber can rest or take samples on the journey up by letting the harness take his weight. The method thus provides a vertical transect through the forest. On reaching the limb the climbing rope may be moved to a preferred position. At the top it

is important to be tied into the tree at all times. Barrell recommends the use of an adjustable lanyard attached to a side 'D' ring. This is useful for stabilising the climber in a certain position, e.g. for taking a photograph, and also as a secondary safety attachment when necessary, e.g. if main climbing line needs to be moved to another limb. The return to the ground is made using a single, security 'stop', self locking descender or by abseiling (rapelling). New methods and items of equipment are continually being developed by cavers and climbers and the reader should look out for these new approaches.

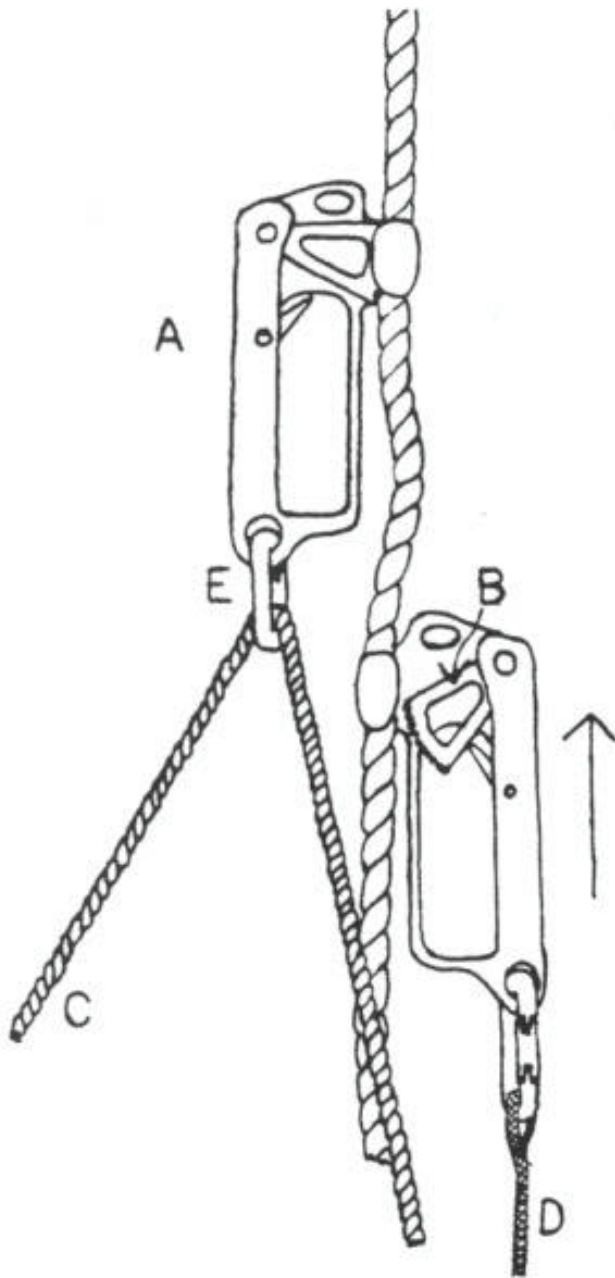


Figure 6.6

Upper rope ascender (A) is connected by a carabiner (E) to rope loop (C) from harness. Footslings (D) are attached to lower ascender. Toothed cam (B) is positioned away from the rope, and this procedure allows for ascender to be moved up or down. After Perry (1978).

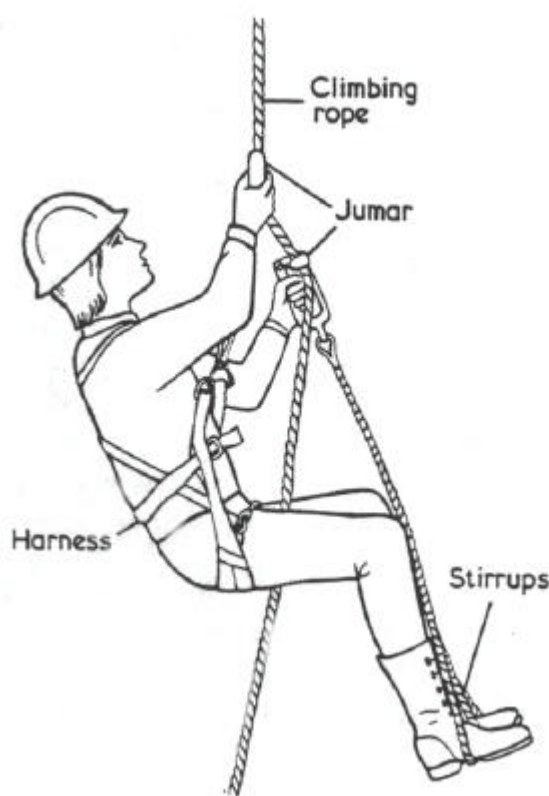


Figure 6.7

Position of equipment during climbing procedure. The lower ascendor is being lifted to the upper ascendor. Note the strap-type harness which provides cool, comfortable support. After Perry (1978).

6.3.3. Abseiling

This is the method by which a climber may slide down a climbing rope using friction to slow the rate of descent. There are a variety of devices which can do this including carabiners (not recommended), brake bars (racks), whale-tails 'stop' descenders and a figure-of-eight. The device is attached to the harness and the climbing rope passes through it. There are two sizes of figure-of-eight; heavy people should use the larger size.

Abseiling should not be attempted without careful instruction first from an experienced climber as it is easy to make mistakes. Also, do not attempt to abseil too fast as the friction can cause the rope to melt! Heavy gloves are necessary with figure-of-eights in some circumstances. Separate safety ropes should be employed at all times in case the abseil rope breaks though this is extremely unlikely but some descending devices will 'creep' on their own if untended and some are difficult to operate if the rope is wet. Each person in the canopy should possess his or her own descending device so that a return to the ground is always possible in times of emergency. Also there should be a ground-based system in place whereby a member of the ground crew should be able to retrieve an incapacitated climber without having to climb the tree. Such systems exist and expert advice and training should be sought before undertaking any climbing-related work as it can have potentially fatal consequences if carried out in an inexperienced manner. Before you begin climbing, check that you have all the

necessary equipment for your work and your descent. A rope should be used only a limited number of times for abseiling. You should enquire about the limit for your own rope.

Single rope technique is the most flexible and widely applicable access method for climbing trees (Barrell, 1994). The equipment costs about £600.00, 30% of which is for the climbing rope. It can be carried in a back-pack by one person and is easily available at outdoor equipment stores. Trees can be rigged in half-an-hour and climbed to a height of 30m in 5-10 minutes. Should you wish to stop, hands are free for taking notes or photographs. The method can be taught easily within an hour, although more time should be spent on training regarding rescue situations. The intermediate rope may be left up in the tree if the climbing rope is needed elsewhere, enabling the system to be quickly re-rigged as required.

6.4. Long term work in the canopy

The purpose of getting into the canopy, and indeed to select the right canopy at that, will be dictated by the scientific programme. Invariably there will be a need to come and go easily and to be able to move, manoeuvre and explore in a limited way the new ecosystem now opened up to the scientists. More adventurous methods of moving more widely in the canopy on rope webs have been described by Perry (1981) and for larger teams along aerial walkways by Mitchell (1982).

6.4.1. Building platforms

Once the arboreal naturalist has arrived in the fork of a tree by whatever means he chooses, it is advisable to consolidate his position there by constructing a tree platform, if a long stay is desired.

Pulling materials up directly into the canopy unaided is arduous. For the Drake walkways a triple block pulley system was used for heavy items, though this was time consuming to use. The top pulley block should be fixed c. 3m above the proposed platform level to enable materials to be swung in easily. Barrell recommends the use of a belay device, such as a gri-gri, on hauling rope. This acts as a safety backup for material being lifted and also as a control for material coming down. The block can be fixed on a cross beam between branches. Pulley blocks should be hauled up already riven as this saves time. Arborist suppliers have pulleys that are very strong, light, compact and simple to use – a swing-side 4-ton working load pulley will fit in your trouser pocket and weigh no more than 1 pound. During construction, two-way radios can be a great help in communications between platform and ground, and are essential in rain.

6.4.2. Construction of platforms in the crotch of the tree

The configurations and number of limbs growing from the crotch will dictate the design of the platform. Stout saplings or imported timber spars are hauled up and fixed to the main branches to form the base of the platform first. It is important that this is not rigid as the branches of the crotch move and could break a rigid platform. McClure used 'U'-shaped metal straps to secure heavy beams forming the base of his triangular platform in Malaysia. Nylon ropes tend to stretch and sisal may be better but expands and shrinks in sun and rain. Abrasion between ropes and tree should be minimised with padding. Bolts or nails are not ideal as they injure the tree and can work loose in time. Sisal or padded metal straps are probably best.

The flooring can be made of smaller saplings cut to lengths ordered from above and bound with rope to the main supports. To save time those in the centre of the floor need not be individually lashed but held down with cross poles at each end lashed parallel to the main supports. This is not advisable for a long-term platform. Large numbers of saplings can be used up in this process and thought should be given to the

effect this may have on projects or regeneration in the immediate vicinity of the target tree. A short-term platform can be completed in 3-5 hours.

It is essential that platforms have safety railings around them but further sophistication depends upon the purpose to which they will be put. A roof affords useful protection against rain and sun, a canvas tarpaulin being cooler than plastic. Donald Perry spent several days at a time in his tree platform in Costa Rica. Others have found sleeping in tree platforms uncomfortable due to large numbers of mosquitoes at night. Never sleep without being tied in. Hides can easily be built using palm fronds. All lashings and spars should be regularly checked for wear and breakages.

6.4.3. Long-term access to tree platforms

Ladders are likely to be easier for most users for long-term access rather than rope climbing methods. Ideally, fixed metal ladders are best but in the absence of these, rope or webbing tape ladders can be used hanging free or fixed to the trunk, though these wear in time. If the ladder is tensioned with rope guys and placed at an angle to the tree rather than vertically it is easier to climb. They do, however, occasionally and rather disconcertingly, flip over leaving the climber suspended upside down half-way up! A safety rope is therefore vital to which the climber may be attached in a sit-harness connected to an ascender on the safety rope which rises up the rope as he climbs the ladder. It is advisable to assess how far from the ladder the climber will dangle if he/she falls and whether or not they can regain the ladder or let themselves down to the ground if a fall occurs.

6.5. Some safety tips

The following safety hints should be known by all members of the climbing crew:

- Communication between the anchor man and the climber should continue from the time the climber begins his ascent until he again reaches the ground. Simple standard words and phrases need to be established to avoid any possibility of misunderstanding. The anchor man must know the status of the climber at all times.
- The safety rope should be coiled on the ground before the climber ascends to avoid tangling or snagging the rope in the underbush. Rope bags are even more effective for tangle-free deployment of lines and they keep the rope cleaner and drier.
- The anchor man should hold the safety line under one arm and over the other shoulder. It is wise to make a half turn around a neighbouring tree. This gives control and prevents the safety line from being pulled from his hands. Pull in and pay out the safety rope by alternate hand grips. A sliding rope is difficult to control and can cause painful friction burns. It is advisable to use, instead of a human body, a device such as a gri-gri for belaying. It is very simple to use, it is much more secure than body-belaying (what happens if the body-belayer suddenly gets attacked by hornets and drops the rope? A gri-gri will hold if suddenly left untended) and can be used by even the smallest person to support a climber.
- Know the knots and when to use them, and be sure to tie them securely. The safety line must be tied to the climbing belt properly and carabiners should be locked when in use.
- Never climb with anything tied or looped around the neck.
- Safety helmets and goggles should be worn to prevent injury to the head and eyes in climbing rough, densely branched trees. Often the climber will be exposed to direct sunlight once in the canopy, and the sun is deceptively fierce. A sun hat is a good item to have whilst aloft.
- Stand and grip branches close to the point of attachment to the main stem.
- The climber should have three points of support at all times (one hand and two feet or two hands and one foot), moving one limb at a time, except when attached to the tree by a safety strap or when suspended on a safety line. There should always be at least one rope connection to the tree.
- Do not carry tools while climbing the crown. If there is need for a pole pruner or cone rake etc., use a light haul line to hoist the equipment to the working level. Leave the haul line attached to large tools as a lanyard while working. Return tools to the ground on the line; do not drop them or throw them down.
- Beware of sharp branch stubs: they can snag clothing and may cause painful cuts and bruises especially if the climber swings into them. An adjustable lanyard should be employed whenever there is a risk of a swing.
- Climb spirally or in a zigzag manner, or fasten carabiners to the stem so that you cannot fall more than 5ft (1.5m) before your weight comes onto the safety rope.
- The diameter of the main stem should not be less than 3in (8cm) at waist level during climbing. If in doubt concerning security, do not hesitate to tie a carabiner to

the stem at a safe level before climbing within reach of the seed-bearing crown. If there is a likelihood of a fall of 1m or more then dynamic (stretchy) climbing line should be used to lessen the shock loading to the body.

- In attaching the safety strap, a firm grip should be kept by one arm around the stem until the strap is clipped to the ring of the belt. At smaller diameters the strap may have to be wrapped around the stem two or three times. Be sure the strap is not twisted.
- Before letting go of the tree with your hands, test your weight against the safety strap and foot holds.
- The safety strap should always be attached around the tree stem except while you are climbing or changing position or are suspended on the safety line.
- Before dropping bags of specimens or other material, be sure that the personnel on the ground are notified and are well clear.
- Have a well-stocked first aid kit handy at the climbing site at all times. It is also advisable for the climber to have a basic first aid kit on their person when aloft. A military First Field Dressing is ideal.

It is imperative that, prior to the trip, suitable advice and/or training is sought regarding tree climbing. If in any doubt whatsoever regarding the nature of the work to be undertaken and its associated hazards it may be an option to allocate a portion of the expedition budget to employ an experienced climber to accompany the team and carry out and /or supervise the work. **The Global Canopy Handbook: *Techniques of Access and Study in the Forest Roof*** is essential reading for all expeditions considering work in this field. The book is edited by Andrew Mitchell, Katherine Secoy and Tabias Jackson and available from the Global Canopy Programme, Halifax House, University of Oxford, South Parks Road, Oxford. Website: www.globalcanopy.org.

References

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Figure 6.8

A walkway in the forest canopy in the Darien region of Panama. Photo: Scientific Exploration Society/Operation Drake

Chapter 7: PHOTOGRAPHY¹

7.1 Introduction

In the rain forest, you will find yourself fighting a tandem of photographic foes. One permanent member of the tandem is heat; the second member is high humidity. You need therefore to undertake basic precautions to protect your optical or electronic equipment and photographic materials against heat, humidity, dust, and fungal and mildew growths if you are staying in the forest for a prolonged period of time.

Although moderately high temperatures have little effect on equipment, they do hasten the natural deterioration of films and papers. However, high temperatures and high relative humidity together promote corrosion of metal, growth of fungus, and moisture damage to packaging materials. Moreover high temperatures and high relative humidity greatly accelerate deterioration of the sensitometric characteristics of films and photographic papers. Abrasive dust is a serious threat to the glass surface of lenses and other optical equipment, as well as being a nuisance in processing.

To protect them against moisture, most films are sold in heat-sealed foil pouches, snap-cover plastic cans, and taped metal or plastic cans. The foil pouches containing sheet film are vapour-tight but not necessarily 100 percent light-tight and, therefore, should not be subjected to normal room-light.

Water vapour, ever present in the air in the tropical forest, and water that condenses on the cooler area parts of optical and other equipment is something that must be avoided. Whenever possible, a good "bake" in direct sunlight is one way of ensuring dry apparatus (but do not place cameras with film in them, in hot sun!).

The usual way of maintaining dryness in airtight cans/boxes or thick polythene bags is to use silica gel. The kind impregnated with cobalt chloride is good: it will be blue when dry and pink when it has absorbed moisture. It must then be heated (in a pan over the fire/stove) until it is blue again. Small crystals and 'dust' can break off and get into equipment and physically prevent a mechanical movement so it is a good idea to put the gel in an old nylon stocking (but take it out before heating it).

The high humidity in spite of the use of a desiccant mentioned above often makes electronic instruments inoperable and battery life short. It is recommended that only instruments which have proven reliability under rain forest conditions are worth using by expeditions and that rechargeable batteries replaced every few days, are the only way of guaranteeing continued operation of battery-powered recording instruments.

¹ Adapted from Kodak publication Tropical Photography reproduced by kind permission of Kodak Ltd.

7.1.1. Some elementary precautions

Elementary precautions to undertake during a short visit to a tropical rain forest are:

1. Do not leave cameras or film in hot sunshine for longer than is necessary nor leave them in an enclosure which may become very hot, such as the glove compartment or the trunk of a car standing in the sun; or in expedition boxes which may be carried (or left) by porters for a long period in the open. Remember that a white surface reflects heat as well as light. For this reason, a white-painted enclosure remains cooler in sunshine than a dark-colored one.
2. In a dusty place, keep the camera in its case and the lens capped when not in use. Cap auxiliary lenses at both ends.
3. Keep all films as cold as possible - in a refrigerator if available. Do not break the seals until you are ready to use the films and they have warmed up.
4. Avoid leaving film in the camera and have exposed film processed as soon as possible.
5. To avoid moisture condensing on film and lens surfaces when they have been kept in an air conditioned room for some time, allow the camera to warm up before using it outside.

7.2. Care of photographic equipment

Abrasive dust is a major problem in many tropical climates and may well be encountered when travelling to the forest. There are few enclosures that can exclude it altogether. Enclosing the camera and auxiliary lenses in plastic bags is helpful, but in a humid atmosphere the stagnant air in the bag promotes the rapid growth of fungus. Equipment should not be kept enclosed this way longer than a few hours.

Constant cleaning of the camera parts before and after use is a necessary procedure. Special care must be taken with lenses: the abrasive action of gritty dust is a serious threat to the glass surfaces and to the photographic image. Clean lenses by gently blowing any dirt away from the exposed surfaces of the picture-taking and viewfinder lenses. Breathe a mist onto the lens; or moisten a cotton swab or soft, clean, lintless cloth with just a drop of lens cleaner. Then lightly wipe the lens.

CAUTION: Never wipe or rub a dry lens or it may cause abrasions. Do not use solvents or solutions not made for cleaning camera lenses. Chemically treated tissue or solutions intended for eye-glasses can damage the coating on your camera lenses. Any wiping or cleaning with fluid or tissue must be done with the greatest care and only when necessary. Keep both ends of lenses capped when not in use.

Some photographers mount a haze filter or a piece of optical glass permanently on the lens as a protection against abrasion by dust. It is less expensive and easier to replace a scratched filter than to replace the lens itself and a haze filter has no appreciable effect on exposures.

7.3. Storage of photographic materials

Sensitized photographic materials are perishable products under practically any conditions. Proper storage is therefore important at all times. In tropical climates, storage is especially important because deterioration is rapid in a hot and humid atmosphere.

Most black-and-white materials will withstand moderate heat for a few weeks without serious changes in their characteristics. Store colour films intended for amateur use (consumer films) where the temperature will not rise above 75°F (24°C) for more than a few days.

Always store colour films intended for professional use (e.g. with 'Professional' in the film name) in a refrigerator at 55°F (13°C) or lower.

Extremes of relative humidity are a serious threat to all photographic materials, even at moderate temperatures. At high temperatures, the effects of humidity are greatly accelerated. Not only can the sensitometric characteristics of the material become impaired, but physical damage can occur as well. Sheets of film may stick together or become glazed in patches where they touch one another. Rolls of film may stick so that they cannot be unwound, or the outside edges of the roll may be affected more than the inside so that the film buckles. Moreover, cardboard cartons may swell and break open, labels may drop off, and cans may rust. These effects can be expected if the relative humidity remains above 60 percent.

Extremely low relative humidity is not quite so serious, but if it falls below 15 percent for a considerable time, set up an electric humidifier to maintain a relative humidity of 40 to 50 percent in the storage area.

7.3.1. Warm-up times

When films are taken from cold storage or from an air-conditioned room into a warmer atmosphere, allow sufficient warm-up time before opening the heat-sealed envelopes or other moisture barriers. Otherwise, moisture condensation forms on the surfaces if the film temperature is below the dew point of the surrounding air.

The table below gives warm-up times for a number of package sizes of Kodak films. The times apply to sheet-film boxes standing upright with an airspace between them and to long rolls without exterior cartons or wrappers on the cans.

Film Packages	For 20°F (11°C) rise in temp.	For 75°F (42°C) rise in temp.
Roll film	0.5	1
35 mm long rolls	3	5
16 mm rolls	1	15
70 mm long rolls	5	10

Figure 7.0 Table of Warm-Up Times (Hours)

7.3.2. Care of exposed films

When a film has been removed from the moisture-resistant package, it is immediately subject to deterioration in a hot and humid climate. When the film has been exposed, the latent image also will deteriorate. Colour films are particularly susceptible in this respect. Process all films as soon as possible after exposure. If processing facilities are not available in your vicinity, mail the film to the most convenient processing station immediately. If you are unable to do this for some reason, enclose the films in an airtight jar or can together with a dessicant and place them in a refrigerator if at all possible.

7.3.3. Tips on exposure

Measurements made in various parts of the world have shown that when atmospheric conditions are similar and when the sun is at the same elevation in the sky, the intensity of illumination is practically the same, regardless of geographical location. Since the sun reaches a higher elevation in the tropics than elsewhere, the light intensity is extremely high when the sun is at its zenith. Exposure can be adjusted easily for the higher light intensity. However, when the atmosphere is clear and the sky cloudless, the lighting contrast is also extremely high. In these conditions, shadows tend to lack detail even though the highlights are correctly exposed or perhaps over-exposed.

With nearby subjects, fill-in flash is helpful when lighting conditions are not favourable. In black-and-white work, you can give extra exposure to get more shadow detail and then reduce the development of the film to lower the highlight density. Another effect of taking photographs when the sun is directly overhead occurs in landscapes without high trees or buildings. The absence of shadows yields a flat, uninteresting picture. The only way to avoid this result is to photograph the subject earlier or later in the day when shadows are longer.

7.4. Processing films

Some expeditions in the field for a long period may want to process their black and white films on the spot, especially if the results want to be checked. If you are forced to process black-and-white films when temperature control is impossible, Kodak recommends this procedure:

1. Use Kodak Pre-hardener SH-5 before development. This hardens the emulsion enough to permit processing at temperatures up to 100°F (38°C).
2. To avoid reticulation of gelatin coatings on the negatives, keep the temperatures of all solutions, including the wash water, within 5°F (3°C) of each other.
3. Fix the film in a fresh hardening fixer such as Kodak Rapid Fixer with hardener, or KODAK Fixer.
4. Rinse the negatives for 30 seconds in fresh water and then bathe them in Kodak Hypo Clearing Agent for 2 minutes with agitation. Wash for 5 minutes in running water or in several complete changes of fresh water. Avoid washing for longer than 10 to 15 minutes at high temperatures, as it softens the gelatin.
5. In a dusty atmosphere, grit and sand find their way into processing solutions and wash water. To avoid scratching the films, rinse them well but do not wipe them before drying. To help drain off surplus water, use fresh Kodak PHOTO-FLO Solution and hang the films to dry in a place as free from dust as you can find. Instructions for processing black-and-white films at high temperature are given in Black-and-White Processing Using Kodak Chemicals (J-1). The Developing Dial in the Kodak Complete Darkroom Dataguide (R-18) indicates developing times up to 80°F (27°C) for a number of Kodak films.

7.4.1. Processing black-and-white papers

If darkroom facilities are set up in basecamp, black-and-white printing is not troublesome in tropical climates unless the temperature in the darkroom is extremely high. Unless prints are properly fixed and thoroughly washed they discolour and fade when conditions are hot and humid all the time. The following hints will be helpful if you must make prints when conditions are difficult:

1. At high temperatures, development will be very much shorter than the normal recommended time. Do not force development beyond the point where the print does not appear to be getting darker. Over-development results in fog and yellow stain, and softens the paper.
2. Change the developer as soon as it becomes discoloured. Oxidation takes place rapidly at high temperature.
3. Use a less energetic developer, such as KODAK SELECTOL Developer instead of KODAK DEKTOL Developer. This permits a slightly longer developing time.
4. Add Kodak Anti-Fog No. 1 to the developer to prevent stain and fog on papers that have been improperly stored.

5. To prevent stain and swelling of the gelatin, use a fresh stop bath and agitate the prints thoroughly, particularly during the first few seconds of immersion.
6. Use the two-bath fixing system and keep the baths fresh to provide the best hardening and the most permanent prints. Improperly fixed prints stain and fade rapidly in a hot, moist atmosphere.
7. Reduce washing time to the minimum by using Kodak Hypo Clearing Agent.

7.5. Preservation of negatives

Because deterioration caused by residual chemicals in the emulsion takes place rapidly in a hot and humid atmosphere, always fix and wash films thoroughly. In handling negatives, wear cotton gloves to avoid finger marks. When the negatives are not in use, keep them in clean envelopes, because any greasy residue deposited on the surfaces by indoor atmosphere promotes the rapid growth of fungus, which destroys the gelatin coatings on the film.

The most important consideration in storing negatives in a humid climate is to keep them dry between 40 and 50 percent relative humidity in the storage area. If a building is properly air conditioned, the relative humidity will not be higher than this. However, if it exceeds 55 percent for any considerable period, use an electric dehumidifier. If other means of keeping negatives dry are not available, they can be stored in a heated cabinet often closed in a metal box with a dessicant.

In a tropical climate, do not store negatives for a long time. Inspect negatives at regular intervals so that any deterioration can be remedied and more suitable storage conditions arranged.

7.5.1. Preservation of prints

The same recommendations apply to preserving prints as to preserving negatives. Careful processing and storage in a dry place are the principal requirements. When black and white prints are used for display (e.g. in an local interpretive centre), hypo-alum toning has been found helpful in preserving the prints from atmospheric effects and from attack by fungus. Colour prints should be lacquered so that they can be wiped clean occasionally.

Prints always should be dry-mounted. Pastes and gums that absorb moisture can attract insects and fungus. Use archival-quality mounting board, paper, and album leaves. Impurities in ordinary materials may discolour the prints in a short time. At relative humidities below 60 percent, prints keep well in an album if the pages are large enough to allow a 3.5-inch border on all four sides of the prints. The closed album then gives a measure of protection against atmospheric effects and attack by insects or fungus, particularly when the prints have been treated with a fungicide such as HYAMINE 1622 (see below). Note that fungicides cannot be used with colour prints.

If the relative humidity is above 60 percent, pack the prints or the album in a sealed container together with a dessicant. Inter-leave single prints, whether mounted or un-mounted, with good quality paper. To be sure that deterioration is not taking place, inspect valuable prints periodically and renew the interleaving paper or any other packing material at these times.

7.5.2. Fungus

Fungus spores and bacteria are in the air regardless of temperature and humidity. Moisture is important to their growth even when the temperature is as low as 40°F (4.5°C) as is often the case in damp basements. They thrive in darkness, in stagnant air, and they spread to other materials. They feed on dead organic matter such as leather, cloth, wood, paper and gelatin. Take particular care to avoid finger prints on films and prints because the oil from the skin will nurture these fungus spores.

If fungus can gain access to packaged film or paper, it will damage unexposed film. It readily attacks processed materials and may eventually destroy the gelatin coatings. A blue coloration on the back of the processed films indicates the presence of fungus - the acid generated by fungus regenerates the blue anti-halation dye from a colourless form which was not destroyed during processing. Fungus growth may also etch or distort images. Damage to the image is usually not immediate. If the growth is discovered in time you can take steps to remove it and to prevent recurrence. Continued growth causes permanent damage and destruction of the gelatin. The effect on colour materials is more serious because the growth may liberate substances which affect the dyes.

Uncontrolled fungus growth will also attack the enclosures in which processed negatives and prints may be stored and cause some disintegration. This includes envelopes, file folders, boxes with interleaving sheets, albums, and mounting board used for storage and display. In the case of mounted prints, pastes and gums that absorb water can accelerate possible fungus attack because of the moisture.

The best preventive against fungus attack is to keep negatives, transparencies, and prints dry; that is, at a relative humidity between 30-50 percent. Air conditioning with controlled relative humidity, an electric de-humidifier, heated cabinets or metal boxes with the use of a dessicant such as silica gel will protect photographic materials. Silica gel or other dessicants provide only a temporary solution to the control of relative humidity. There is also evidence that hypo-alum toning makes prints less susceptible to attack by fungus. For more information, see Kodak Publication J-1, Black-and White Processing Using Kodak Chemicals.

If controlled storage is not possible then inspect the materials regularly to make certain fungus growth is not in progress. When there is evidence of fungus, remove it, if possible, and replace all enclosures. You may detect infected areas more readily during examination by use of an ultraviolet light. The growths fluoresce as bright blue-white areas. Do not look into the light source: direct exposure can affect the eyes. This test may not be useful when testing photographic papers containing "brighteners". The brightener compounds fluoresce in ultraviolet light making it difficult to detect fungus.

APPENDIX 1: Code of ethics for foreign collectors of biological samples

This *Code of Ethics for Foreign Plant Collectors* was developed at the Botany 2000 Herbarium Curation Workshop held in Perth, Western Australia, in October 1990. It was modified in April 1992 to cover other biological material and formed Appendix 1 to the Manila Declaration (Anon. 1992).

The foreign collector should:

1. Arrange to work with a local scientist(s) and institute(s).
2. Respect regulations of the host country; for example, by entering on a research/collecting visitor visa, not a tourist visa, and observe regulations for export of biological specimens, quarantine, CITES, etc.
3. Obtain official permission for all collecting in National Parks or protected areas.
4. Ascertain whether items used in scientific work and which are difficult to obtain can be contributed.
5. When applying for a travel study grant, include equal travel expenses for local counterpart(s) and an amount to cover the cost of processing museum specimens or other costs of the visit to the host institute.
6. Leave a complete set of adequately labelled duplicates with the institute before departing the country. [Editor's note: when material has to be left unidentified (e.g. a possible new species) send determinations to the host institute as soon as possible].
7. Ensure that types of species described as a result of the research are deposited in the National Museum or Herbarium of the country of origin.
8. Inform the institute in the country of origin where duplicate specimens are to be deposited.
9. Not exploit the natural resources of the host country by removing high-value biological products; for example, collecting without prior permission plants with potential horticultural, medicinal, cultural, or other economic value.
10. Obtain a list of rare and endangered species of the country visited and not collect these species without permission.
11. Collect no more material than is strictly necessary; collect cuttings or seeds for live plant specimens, rather than uprooting whole plants; collect subsections rather than whole organisms, wherever possible, for marine specimens.
12. Leave photographs/slides for the host institute(s).
13. Inform the host institute or appropriate organisation of the whereabouts of any rare or endangered species that are found.
14. Send copies of research reports and publications to collaborator(s) and host institute(s).
15. Acknowledge collaborator(s) and host institutes(s) in research reports and publications.

16. Collect identified reference voucher specimens for all biological products to be exported.

APPENDIX 2: Useful organisations based in the UK ¹

ACTIONAID DEVELOPMENT EDUCATION,

3 Church Street, Frome, Somerset BA11 1PW. Many excellent education materials on development issues including 'Development in Brazil'. Five briefing packs giving a country profile, brief history, and information on indigenous people and Amazonian development, The Greater Carajas programme, and population and migration flows.

BIRDLIFE INTERNATIONAL,

(formerly the International Council For Bird Preservation, Wellbrook Court, Girton Road, Cambridge CB3 0NA (01223-277 318; fax: 01223-277 200) is a worldwide partnership of organisations working for the diversity of all life through the conservation of birds and their habitats. Website: www.birdlife.net. Email: birdlife@birdlife.org.uk

BRITISH ECOLOGICAL SOCIETY,

26 Blades Court, Deodar Road, Putney, London SW15 2NU (0208-871-9797) Promotes the science of ecology, and tropical ecology through the work of its Tropical Ecology Group.

CHILDREN'S TROPICAL FOREST UK,

8 Midgate, Peterborough PE1 1TN (01733 639 66) Promotes tropical forest conservation issues amongst school-age children.

CONSERVATION FOUNDATION,

1 Kensington Gore, London SW7 2AR (020 7591 3111; fax: 020 7591 3110). Launched to create and manage sponsorship schemes involving all environmental interests. Amongst these projects is a grants scheme, Young Scientists for Tropical Rain Forests scheme and the Madagascar Environment Research Group. Website: www.newsnet-21.org.uk

COUNCIL FOR ENVIRONMENTAL EDUCATION,

94 London Street, Reading, Berkshire, RG1 4SJ (0118 950 2550; fax: 0118 959 1955). The national body co-ordinating and promoting environmental education. Maintains a database of teaching resources. Email: info@cce.org.uk

DURRELL INSTITUTE OF CONSERVATION ECOLOGY,

University of Canterbury at Kent, Canterbury CT2 7NJ (01227 475 480 or 01227 764 000; Fax 01227 475 481) is a research and post graduate training institute centred on conservation biology to assist peoples to maintain their own

¹ For a fuller list of specialised libraries and institutes see *Expedition Planners' Handbook & Directory* (Winser and McWilliam, 1993).

ecosystems through education, training, research and field implementation.
Website: www.ukc.ac.uk/anthropology/dice

EARTHWATCH EUROPE,

Belsyre Court, 57 Woodstock Road, Oxford OX2 6HJ (01865 318 838; fax: 01865 311 383). A membership organisation, funding which recruits fee-paying members of the public who can help share the costs and labour of field research.
Website: www.earthwatch.org.uk Email: info@earthwatch.org.uk

EDINBURGH CENTRE FOR TROPICAL FORESTS,

Pentlands Science Park, Bush Lane, Penicuik, Edinburgh, EH26 OPH (0131 440 0400; fax: 0131 440 0440). An association between the University of Edinburgh's School of Forestry, the International Forest Science Consultancy, the Institute of Terrestrial Ecology and the Royal Botanic Gardens Edinburgh for research, training, education and consultancy in the sustainable management of tropical forests. Maintains a database of consultants. Website: www.nmw.ac.uk/ectf Email: mail@ectf-ed.org.uk

EXPEDITION ADVISORY CENTRE,

Royal Geographical Society, 1 Kensington Gore, London SW7 2AR (020 7591 3030; fax: 020 7591 3031). Provides advice, information and training to those carrying out scientific fieldwork overseas. Website: www.rgs.org/eac Email: eac@rgs.org

FAUNA & FLORA INTERNATIONAL,

Great Eastern House, Tenison Road, Cambridge CB1 2DU (01223 571 000; fax: 01223 461 481). The world's oldest international conservation charity publishes the much-respected journal *Oryx*. Through its own resources and the Oryx 100% Fund gives financial assistance to conservation projects. Website: www.fauna-flora.org. Email: info@fauna-flora.org

FOUNDATION FOR ETHNOBIOLOGY,

61 Greenridges, Oxford, OX3 8PL (01992 448 007; fax: 01992 447 945). Involved in promoting the importance of indigenous knowledge about the uses of natural resources, regularly carrying out fieldwork projects overseas.

FRIENDS OF THE EARTH,

26-28 Underwood St, London, NI 7JQ (020 7490 0881; fax: 020 7490 1555). Campaigns on a wide range of environmental issues including tropical forest destruction.

GAIA FOUNDATION,

18 Well Walk, Hampstead, London, NW3 ILD (020 7435 5000; fax: 020 7431 0551). Works to highlight the importance of cultural and ecological diversity.

Through its Forest People's Fund works with indigenous people in rain forest countries. Email: gaiafund@gn.apc.org

ICAN,

The International Canopy Network's Global Canopy Program, Oxford Forestry Institute, Department of Plant Sciences, University of Oxford, 6-8 South Parks Road, Oxford OX1 3UB (01865 271 036; fax: 01865 275074). Website: www.globalcanopy.org Email: amitchell@globalcanopy.org

INSTITUTE OF TROPICAL BIOLOGY,

Department of Plant and Soil Science, University of Aberdeen, Cruckshank Building, Aberdeen AB24 3UU (01224 272 257; fax: 01224 272 703).

INTERNATIONAL CENTRE FOR CONSERVATION EDUCATION,

Brocklebank, Butts Lane, Woodmancote, Cheltanham, Gloucestershire GL52 9QH (01242 674 839; fax: 01242 674 839). Provides training and audio-visual materials on the environment and sustainable development including tropical forest biodiversity. Website: www.icce.org.uk. Email: info@icce.org.uk

INTERNATIONAL INSTITUTE FOR ENVIRONMENT AND DEVELOPMENT (IIED) 3

Endsleigh Street, London, WC1H 0DD (020 7388 2117; fax: 020 7388 2826). Strives to explain the links between environment and the needs of the poor. IIED advocates the sustainable use of natural resources because they are linked to economic growth and human need. Website: www.iied.org. Email: mailbox@iied.org

IUCN - THE WORLD CONSERVATION UNION,

(UK Office) Publications Unit, 219c Huntingdon Road, Cambridge CB3 0DL (01223 277 894; fax: 01223 277 175). Can supply reports on the many research projects it has funded throughout the world. Website: www.iucn.org. Email: info@books.iucn.org

JERSEY WILDLIFE PRESERVATION TRUST,

Les Augres Manor, Trinity, Jersey, Channel Islands JE3 5BF (020 7434 4479; fax: 020 7287 9364). Manages a network of preservation programmes for endangered species including fieldwork and re-introduction programmes in Madagascar, Brazil, and Mauritius.

LINNEAN SOCIETY OF LONDON,

Burlington House, Piccadilly, London W1J 0BF (020 7434 4479) Concerned with the science of natural history, and the preservation of biodiversity. Organises scientific meetings, publishes several specialist journals, and provides funding. Website: www.linnean.org. Email: john@linnean.org

LIVERPOOL SCHOOL OF TROPICAL MEDICINE,

Pembroke Place, Liverpool L3 5QA (0151 708 9393; fax: 0151 708 8733).

Website: www.liv.ac.uk/lstm/lstm.html

LIVING EARTH,

4 Great James Street, London, WC1N 3DB (020 7440 9750; fax: 020 7242 3817). An environmental education charity working both in the UK and overseas, providing training programmes and teacher resources. Website: www.livingearth.org.uk. Email: info@livingearth.org.uk

LONDON SCHOOL OF HYGIENE AND TROPICAL MEDICINE,

Keppel Street, London WC1E 7HT (020 7636 8636).

Website: www.lsthtm.ac.uk

NATIONAL REMOTE SENSING CENTRE,

Delta House, Southwood Crescent, Southwood, Farnborough, Hampshire, GU14 0NL (01252 362 000; fax: 01252 375 061). Supplies remotely sensed data for conducting resource surveys, and monitoring and mapping the natural environment. Website: www.nrsc.co.uk. Email: nvec@nrsc.co.uk

NATURAL HISTORY BOOK SERVICE LTD.,

2-3 Wills Road, Totnes, Devon TQ9 5XN (01803 865 913; fax: 01803 865 280). Mail order book retailer specialising in field guides. Website: www.nhbs.co.uk. Email: nhbs@nhbs.co.uk

NATURAL HISTORY MUSEUM,

Cromwell Road, London SW7 5BD (Switchboard: 020 7942 5000). Has research programmes in biodiversity and conservation of tropical forests, especially Central America, in the life science departments of Botany, Entomology and Zoology. Website: www.nhm.ac.uk

NATURAL RESOURCES INSTITUTE,

Central Avenue, Chatham Marine, Kent ME4 4TB (01634 880 088; fax: 01634 880 077). The scientific arm of Britain's Overseas Development Administration. NRI collaborates with developing countries to increase sustainable productivity of their renewable natural resources through the application of science and technology. Website: www.nri.org. Email: postmaster@nri.org

OXFORD FORESTRY INSTITUTE,

Department of Plant Sciences, University of Oxford, South Parks Road, Oxford OX1 3RB (01865. 275 000; fax: 01865 275 074). Has two main elements; for the University of Oxford's Department of Plant Sciences it provides academic and technical staff together with laboratories and library services, and for outside

institutions it provides research, training and information services. OFI is also responsible for the entire forestry and agroforestry research programme of the British Overseas Development Administration. Website: www.plants.ox.ac.uk. Email: ofi@plants.ox.ac.uk

OXFORD TROPICAL MEDICAL UNIT,

The Nuffield Department of Clinical Medicine, John Radcliffe Hospital, Headington, Oxford OX3 9DU (01865 220 968; fax: 01865 220 984).
Email: david.warrell@ndm.ox.ac.uk

PROGRAMME FOR BELIZE,

1 Eyre Street, PO Box 749, Belize City, BELIZE (+501 275 616). A consortium of UK and USA organisations who have purchased and are now responsible for the development of over 160,000 acres of tropical forest in an area known as the Rio Bravo Conservation Area, for the future benefit of the people of Belize. A draft management plan has been compiled, and the intention is to encourage carefully monitored and controlled eco-tourism. Research and archaeological expeditions are encouraged. An education programme for local and national communities is already underway. Website: www.pfbelize.org. Email: pfbel@btl.net

RAINFOREST CONCERN,

27 Lansdowne Crescent, London W11 2NS (020 7229 2093; fax: 0207 221 4094). Works with the Ecuadorean Maquipucuna Foundation.
Website: www.rainforestconcern.org. Email: rfconcern@gn.apc.org

RIO MAZAN PROJECT,

The Greenhouse, 48 Bethnel Street, Norwich, Norfolk NR2 1NR (01603 611 953; fax: 01603 666 879). A small independent charity working for the conservation of Andean forests. Has programmes on ecological research, environmental education, and practical conservation work with Ecuadorean counterparts and volunteers. Fieldwork began 1986, and ongoing.

ROYAL BOTANIC GARDENS EDINBURGH,

Inverleith Row, Edinburgh EH3 5LR (0131 552 7171; fax: 0131 552 0382). Dedicated to the pursuit of high quality research on the systematics and biology of plants. This includes a strong commitment to understanding tropical biodiversity with current projects in Central Brazil, on the economically important tree flora of Kalimantan, and the floras of Bhutan, China, Nepal and Burma. Website: www.rbge.org.uk. Email: press@rbge.org.uk

ROYAL BOTANIC GARDENS, KEW,

Richmond, Surrey TW9 3AB (020 8332 5000; fax: 020 8332 5197). Has biodiversity research programmes targetted on tropical and west Asia, tropical

Africa, South America and Madagascar. Website: www.rbgkew.org.uk.
Email: info@rbgkew.org.uk

ROYAL ENTOMOLOGICAL SOCIETY,

41 Queen's Gate, London SW7 5HR (020 7584 8361; fax: 020 7581 8505). Promotes entomological research and fieldwork. Past expeditions supported by the Society include Project Wallace to Northern Sulawesi during 1985 which involved over 100 scientists from 17 different countries studying the insect diversity and conservation, agricultural and medical entomology and forest regeneration in the Dumoga-Bone National Park.

Website: www.royensoc.demon.co.uk. Email: reg@royensoc.demon.co.uk

ROYAL GEOGRAPHICAL SOCIETY (with the Institute of British Geographers)

1 Kensington Gore, London SW7 2AR (020 7591 3030; fax: 020 7591 3031). Carries out multi-disciplinary research in many environments including the tropical forest of Brunei, Brazil, and Malaysia, funds overseas fieldwork by other groups through its Expeditions Grants Scheme, and acts a forum for the discussion of tropical forest issues through its programme of popular and academic lectures. Website: www.rgs.org. Email: eac@rgs.org

SURVIVAL INTERNATIONAL,

6 Charterhouse Buildings, London EC1M 7ET (020 7687 8700; fax: 020 7687 8701). Campaigns for the rights of all indigenous peoples, but especially those in South America. Website: www.survival-international.org. Email: info@survival-international.org

TAMBOPATA RESERVE SOCIETY (TreeS - UK),

c/o John Forrest, 64 Belsize Park, London NW3 4EH (020 7722 8095). The support group for the Tambopota Reserve, Madre de Dios, southeast Peru where there is an on-going research programme into the area's flora and fauna which includes an ethno-botanical research programme based at the Explorer's Inn.

Website: www.geocities.com/treesweb/index. Email: john.manytrees@virgin.net

TELEVISION TRUST FOR THE ENVIRONMENT (TVE),

Prince Albert Road, London NW1 4RZ (020 7586 5526; fax: 020 7586 4866). Promotes environment and development issues through broadcast television, the *Moving Picture Bulletin* which provides information on new environmental programmes, and a free cassette distribution service for developing countries.

Website: www.oneworld.org/tve. Email: tve-uk@geo2.poptel.org.uk

TIMBER TRADES FEDERATION,

Clareville House, 26-27 Oxendon Street, London SW1Y 4EL (020 7839 1891).

Website: www.ttf.co.uk. Email: ttf@ttf.co.uk

TROPICAL BIOLOGY ASSOCIATION,

Department of Zoology, University of Cambridge, Downing Street, Cambridge CB2 3EJ (01223 336 619; fax: 01223 336 619). Runs research and conservation training courses for graduate biologists. Also has an office in East Africa.

Website: www.zoo.cam.ac.uk/tba. Email: tba@zoo.cam.ac.uk

TREKFORCE EXPEDITIONS,

34 Buckingham Palace Road, London SW1W 0RE (020 7828 2275, Fax 020 7828 2276). Organises adventurous and conservation expeditions in several areas of Indonesia, Malaysia and Belize and is currently involved in organising a series of scientific expeditions in Belize and Sarawak which recruit fee-paying volunteers. Website: www.trekforce.org.uk. Email: info@trekforce.org.uk

UK TROPICAL FOREST FORUM,

Jane Thornback c/o Natural Resources Institute, Central Avenue, Chatham, Kent ME4 4TB (020 8332 5717; fax: 020 8332 5278). An independent association of UK organisations which helps to define effective action to conserve tropical forests. Website: www.forestforum.org.uk.

Email: j.thornback@btinternet.com

WORLD CONSERVATION MONITORING CENTRE,

219 Huntingdon Road, Cambridge CB3 0DL (01223 277 314; fax: 01223 277 316). A joint venture between the three partners who developed the World Conservation Strategy: IUCN - the World Conservation Union, UNEP and WWF. It supports conservation and sustainable development through the provision of information on the world's biological diversity.

Website: www.unep-wcmc.org. Email: info@wcmc.org.uk

WORLD RAINFOREST MOVEMENT,

Unit 1c, Fosseyway Business Centre, Stratford Road, Moreton in Marsh, Glos GL56 9NQ (01608 652 893; fax: 01608 652 878). A grouping of organisations and individuals concerned about the destruction of the rainforests worldwide and involved in activities attempting to reverse this process. The World Rainforest Movement is based in the Third World Network (TWN) and Asia Pacific Peoples Environment Network (APPEN) in Penang.

Website: www.wrm.org.uk. Email: wrm@gn.apc.org

WORLD WIDE FUND FOR NATURE (WWF-UK),

Panda House, Weyside Park, Catteshall Lane, Godalming, Surrey GU7 1XR (01483 426 444; fax: 01482 426 409). Has 23 national offices. WWF-UK has a special Forestry Unit which has published a number of major reports on the biodiversity and conservation of tropical forest. WWF's largest projects is in the

Korup National Park, Cameroon where studies of the social, economic, physical and biological aspects of the Park and its surrounding are being carried out.

Website: www.wwf-uk.org

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