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FALLOW FARMING:

EXPLORING SUBSISTENCE IN KRISA, FAR NORTHWEST PAPUA NEW GUINEA, AND BEYOND

Thesis submitted in partial fulfilment of the requirements for the degree of
Doctor of Philosophy in Environmental Anthropology

by

Stefanie Klappa

Department of Anthropology
University of Kent
2005

ABSTRACT

In Krisa, far northwest Papua New Guinea, people appear to farm fallows. This oxymoronic condition challenges prevailing notions of human-environment interaction and thereby conventional models of rainforest subsistence, as in turn their use in conservation and development interventions. I follow these associations in a reflexive and circular project, moving from portraying subsistence, to problematising subsistence concepts, to the impact in turn of such concepts on real-world subsistence situations. My central thesis is that agriculturally-minded outsiders succumb invariably to misconceptions about subsistence in Krisa and the region, revealing both their ethnocentric bias and leading to potentially fatal consequences for local livelihoods and environments. My analysis proceeds therefore on two levels, as I evaluate both field data and the terms in which they would conventionally be described. It revolves centrally around the foraging–farming duality, whose incongruity with empirical evidence has long perplexed students of tropical subsistence. Despite countless imaginative attempts to resolve the impasse, studies have typically embraced the duality's categorical opposition, however obliquely. I argue that this is precisely the root of the dilemma, as it reflects less any principles of human–environment interaction than an ideology informed by agriculture. I develop this argument by blending a natural scientific approach for conceptualising human-environment interaction with an anthropological approach for generating, integrating and presenting data, thus outlining a framework for exploring the ecological dimension of subsistence holistically and historically, in the tropics and beyond. This allows me to expose ethnocentric bias; generate a dynamic and multi-dimensional ethnography; relate this to apparently disparate concepts of tropical subsistence worldwide; reveal their common foundation in the generation of clearings; and draw up an evolutionary model of rainforest subsistence. I thereby demonstrate at once the value of natural science to an anthropological exploration of subsistence and its use as an instrument of reflexive anthropology.

ACKNOWLEDGMENTS

First and foremost, I express my deepest gratitude to the people of Krisa, who have not only been welcoming and hospitable, but shared freely of their time, stories, wisdom, companionship, and good humour. Living in Krisa between 1997-99 was very special for me and proved one of the most rewarding experiences in my life; it has profoundly changed the way I view the world and myself. Numerous individuals supported my work; instructed me and helped me understand a way of life so different from the one I knew; confided personal and collective histories, insights and ideas; and accompanied me, took me around their land, invited me to their homes, ate and laughed with me. Yet, as I express my gratitude, I must at once ask forgiveness. My stay was widely attributed significance beyond the research situation, and although I have tried my best to explain the purpose of my presence, dispel unwarranted expectations and assuage fears, I have not always been successful in this endeavour, not least due to my own ignorance. I hope that I will be forgiven any upset or disillusionment that have arisen from this failure. I must also apologize for the delay in returning research results and repatriating documentation drawn up collectively. I am hoping to remedy this situation eventually, so that the generosity of Krisa people will at once have been an investment into their own community.

Three community members with whom I had worked closely sadly passed away during or shortly after my stay in Krisa: Arum Ukong, of whose death I learnt when returning to the village in 1999; Anai Apio, who died at the eve of my final departure the same year; and Clara-Maephu Wep, of whose death I learnt by mail. I will remember them fondly. If I am profoundly indebted to them as to numerous others, my special thanks must go to three people in particular. Bewa Tou, my mentor and adoptive father, not only consented to, facilitated and oversaw my stay; accommodated me in his residential camp; and added me to his family. He also shared his rich store of knowledge, both profane and esoteric, and captured my imagination with his inspired accounts. Not least, he was a powerful father figure, at once charismatic and caring. I may not share his convictions and view of the world, but I greatly admire his wisdom and his political, intellectual and spiritual achievements, much as I cherish his kindness. Daniel Waki, who became like a brother to me, contributed immensely to the research, in functions conventionally termed 'field assistant' and 'key informant'. However, his actual role went far beyond these tasks. He took care of logistics while astutely figuring out the kind of information I was after; he willingly went along with my often absurd wishes at collecting herbarium specimens, and it was mostly him who carried out the frequently arduous task of harvesting them; he taught me about plants and animals, about gardening and hunting, about bush spirits and sorcerers, about land and history; he kept me up-to-date about events and enlightened me about the political landscape of the village; he organised appointments, facilitated interviews, and carried out surveys. And, he kept me excellent company. Gertrud Bewa, my immediate neighbour and adoptive sister-in-law, was a reassuring English-speaking and female point of contact early on, and became a close companion with whom I shared many happy hours and countless jokes. Her perspective as an in-married outsider also provided a useful counterweight to my daily experience of Krisa life. Besides, she relieved me of the chores of carrying water over a steep and slippery slope and washing my laundry at a mosquito-infested well. — Thank you all for your help and hospitality, for your input to the research, and for contributing to one of the happiest times in my life!

In Vanimo, I thank above all the small but big-hearted expatriate volunteer community at the time for their excellent company; insightful comments and sharing of complementary information; and the scent of home when I was homesick. In particular, I am deeply grateful to Joan and Graeme Findlay for their caring attention in 1997-98, including nursing services during a bout of malaria, and to Alan McNeil for several weeks of free accommodation in 1999, invaluable help with all tasks connected with my final departure, and the provision of relevant maps, documents and photographs. I am also indebted to members of the Diocese of Vanimo for offering rented accommodation in 1997-98 and to various members of the Sandaun Provincial Government for issuing my research permit, providing office space and facilities, supplying transport, and furnishing me with valuable complementary information.

My colleagues within the APFT research programme provided at once supreme intellectual stimulation, invaluable practical support, and outstanding companionship. In particular, I shared innumerable highly inspiring and fruitful discussions with David Ellis, both in Kent and during mutual visits at our respective field sites in Papua New Guinea; enjoyed the fieldwork support of Vakaloloma Siuta Sam during her visit to Krisa and her superb company whenever we met; received logistical support from Felix Topni Niofiarl in Vanimo; and benefited from the hospitality of Berit Gustafsson in Port Moresby, who on my last stay witnessed patiently the conversion of her house into a temporary artefact storage unit, as did Alan McNeil earlier in Vanimo—both deserve special thanks for putting up with this. Colin Filer kindly provided accommodation in Port Moresby when I first arrived in Papua New Guinea, while Paul Sillitoe chased up the processing of my research application, thus enabling timely commencement of my field research.

My doctoral scholarship, including research funding, was paid through the DG8 budget line of the European Commission, within its multidisciplinary research initiative APFT (L'Avenir des Peuples des Forêts Tropicales/ The Future of Rainforest Peoples). Small grants towards completion of this study were subsequently contributed by the Royal Anthropological Institute; the British Federation of Women Graduates Charitable Foundation; the Allcorn-Box-Memorial Fund at Kent; and the Newby Trust Ltd. Funding for the acquisition and shipping of the artefact collection from Krisa was provided mainly by the South Australian Museum in Adelaide, where I am most grateful to Barry Craig for his interest, facilitation, useful advice, and eventually accommodation of my expanding budgetary needs as the collection grew exponentially. A smaller contribution was made by the Economic Botany Collection at the Royal Botanic Gardens at Kew, where I thank Hew Prendergast and Naomi Rumball for their support. Thanks to Naomi Rumball also for preliminary identification of some of the plant materials used in the artefacts, as to Bob Johns and David Floyd at the Herbarium for preliminary identification of some of the plant specimens deposited there. In Port Moresby, thanks are due to John Dop of the National Museum and Art Gallery for putting up with my hurried and shifting schedule and for kindly forwarding the part of the collection destined for the South Australian Museum; also to staff of the National Mapping Bureau for their friendliness and helpfulness and for free printouts of their latest production.

In the Department of Anthropology at Kent, my first thanks must go to erstwhile staff member Laura Rival, whose inspiration was instrumental for my career choice. Her infectious enthusiasm instilled in me, a newcomer to the discipline, the fascination with anthropology, and her encouragement propelled me to apply for the APFT scholarship. My subsequent thanks are due to Christin Kocher Schmid, who accompanied this study from its inception and has influenced it to a major extent, as I have developed many of my arguments through discussions with her. She has always offered freely and generously of her time, research results and insights and has been a constant source of inspiration and support. This continued even during lengthy absences due to her own field research, and after her departure from Kent upon conclusion of the APFT research programme at the end of the year 2000. Her input contributed not only immeasurably to my academic progress, but was also instrumental in making the research experience thoroughly enjoyable and satisfying, as she skilfully managed the close and synergistic collaboration of co-researchers within the Pacific section of the APFT programme. She has also provided an exceptional level of personal support, most obviously through meeting me upon my first arrival in Papua New Guinea, accompanying me to Krisa, and returning later for an extended visit, but more generally through her unfailing loyalty and caring attitude. Besides, she saved me much work by sharing her extensive electronic excerpts of Australian patrol reports from the region. Roy Ellen has officially been my principal academic supervisor and has in particular accompanied the writing-up of this study. His work has been fundamental for me to develop and hone my arguments through critical engagement with his views. David Zeitlyn has commented most helpfully on an early and much longer version of the section on kinship.

Outside Kent, Kyle Latinis bears considerable responsibility for the course this study has taken. His enthusiastic response to my ideas on tree cultivation in Krisa, prompted by an email sent before my second spell of field research and continued upon its conclusion, provided the final push for me to concentrate on this topic. I am most grateful for the stimulation, for the choice has proved very rewarding. Similarly, I thank Tim Ingold, Miguel Alexiades and Diane Russell, who have at various times responded encouragingly to ideas presented at conferences, which I have subsequently incorporated here. In regard to written works, the ideas of Tim Ingold, David Rindos, and Peter Dwyer have provided me with great inspiration, as will become obvious from the study.

Following conclusion of the study, Eric Hirsch and Patricia Howard in their function as examiners conducting the viva voce examination made very helpful comments for focusing the argument and for possible future directions of my research. I am particularly grateful for the stimulating discussions with Patricia Howard and her concise recommendations for corrections.

Last, but not least, I am deeply grateful to the many friends, in Papua New Guinea, Kent and elsewhere, who have at various times supported and encouraged my career choice; shown enthusiasm for my work; challenged my arguments and contributed their ideas; and provided understanding, affection, and good judgment when necessary. In addition to those mentioned earlier, and those that remain unmentioned, particular thanks are due to Rose Singadan, for the many fascinating and enlightening discussions about her native Papua New Guinea during her year at Kent, besides her help while in Port Moresby; to Cristina Adams, Tamar Baijgielman and Sarah Keeler, for variously alerting me to original aspects of my study; to Sonia Vougioukalou, for sharing her knowledge about state of the art methodology in ethnobotany; to Patty Baker for useful suggestions on presentation and some vital last-minute help with the scanning of maps; to all of them and to Amy Warren, Mary Adams and Daniela Peluso, for their keen interest and support, not to mention their wonderful friendship; and to my sister, for believing in me.

Above all, I offer a prayer of thanks to the power that has seen me through the last six years of an atrocious personal struggle, which was nothing to do with this study but which inevitably got bound up with and unduly delayed it. Eventual conclusion of the one has only permitted conclusion of the other, which is therefore at once testimony to the fact.

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CONVENTIONS

Text Formats

I apply *italics* to Latin scientific binomials, as is established practice, but leave in normal font any other foreign words and phrases commonly used in English texts, such as versus, vice versa or vis-à-vis. I also apply *italics* to indicate emphases, to which I occasionally add ***boldface*** for ideas which I consider particularly important. In contrast, I use underline to highlight sequences of important concepts or places, and **boldface** to ease reference where groups of similar or related terms or names occur. In addition, I use SMALL CAPS for terms in Tok Pisin, and SMALL CAPS WITH DOTTED UNDERLINE for terms in the Krisa vernacular (and occasionally in the vernacular of neighbouring communities). This choice of font reflects the usual style in which Tok Pisin is written throughout the country, and the typical style in which this and the Krisa vernacular are written by the many semi-literate people in the community.*

Choice of Language

I refer to both Tok Pisin and Krisa vernacular terms and phrases in ethnographic contexts, which reflects partly local reality, partly the research situation. Tok Pisin, or Neo-Melanesian Pidgin English, serves as lingua franca in large parts of Papua New Guinea, and is one of the three national languages (besides Motu and English). In Krisa, it nowadays rivals the vernacular in everyday conversations as well as in formal speeches, and has become the first language for most community members born after the mid-1970s. It was therefore the obvious language in which to conduct research, although I also kept extensive records of vernacular terms. I preferentially refer to these. Their exclusive use is, however, neither possible nor desirable, since in parallel with the language shift and other socio-cultural changes some concepts have become locally important which carry a label in Tok Pisin but have no vernacular equivalent; others are used so frequently in Tok Pisin that I never recorded the vernacular equivalent if there was one. It is particularly in these two cases that I refer to Tok Pisin terms.

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* Note, however, that due to software limitations I could apply the format of SMALL CAPS WITH DOTTED UNDERLINE only in the textual parts of this study. In figures, I have substituted with CAPS WITH UNDERLINE, while in the spreadsheets of Appendices 15-17 I had to substitute with CAPS only. It will however be clear from the respective context whether reference is to vernacular or Tok Pisin terms.

Orthography

The spelling of Tok Pisin is phonetic, varies across the country, and is in constant flux. While 'The Jacaranda Dictionary and Grammar of Melanesian Pidgin' (Mihalic 1971) may be considered the ultimate reference in questions of orthography, I have therefore occasionally strayed from its norms. For writing Krisa vernacular terms, I follow my own, unstandardised, orthography. Linguists Mark Donohue and Lila San Roque have recently developed a formal orthography for the Krisa vernacular (San Roque 2000a, 2000b, 2001; Donohue & San Roque 2004:34-37), but this is still in its trial stage. Furthermore, though, their Krisa dictionary includes only some of the terms I need to write out, and I do not feel competent applying their orthographic conventions to the remaining terms myself. Hopefully, we can combine our dictionaries in the future and harmonize the spelling of terms. In the meantime, I rely on my own phonemic notations in the characters of the international phonetic alphabet. For the present study, I have transcribed my records into Latin characters, which I use phonetically with the following qualifications:

- Y is to represent /j/, in keeping with English pronunciation
  → example: /jιj/ ("bow") transcribes as YIY.
- Ö is to represent /O/, which seems to have [y], [↵] and occasionally [Θ] (otherwise transcribed as E) as allophones, depending largely on the speaker
  → example: /τOvι/ ("old") transcribes as TÖNI.
- P is to represent /÷/ with the allophones [π], [ϕ], and occasionally [β] (otherwise transcribed as B); pronunciation depends on the speaker and the vowel context: while in front of /ι/, /π/ is a clear plosive, in front of the other vowels it tends towards the fricative
  → example: /÷A/ ("uterus", "pouch", "bag") transcribes as PA.
- R is to represent the flap (/P/) with the allophones [ρ] (otherwise transcribed as RR), [λ] and sometimes [δ] or [ν] (otherwise transcribed as L, D and N, respectively); pronunciation depends much on the speaker
  → example: /κυβιαPυ/ (a kind of yam) transcribes as KUBIARU.[†]
- X is to represent /≠/, with allophones apparently ranging through [ℵ], [®], [Ξ] and [κ]; pronunciation depends typically on the speaker's degree of literacy, with increasing literacy shifting pronunciation from the epiglottal/ pharyngeal to the uvular sound
  → example: /φα≠αυ/ (the most salient bamboo) transcribes as YAXAU (transcription of /φ/ see above).[‡]

[†] The alternation between [ρ] and [λ] is typical for New Guinean languages, with the attendant confusion for speakers of European languages and difficulty for transcription with Latin characters. A classical case is the cultural group that became known as Etoro in the ethnographic literature, but was 'renamed' as Etolo by Peter Dwyer (1990:218, also xiii). Like Dwyer's rendering, informal transcriptions in Krisa typically employ the character "L" rather than "R" for the flap. Since, however, to my European ears the flap sounds more like "R" most of the time, while /λ/ occurs also otherwise, I have decided to reserve the character "L" for these latter cases. I have, however, been not wholly consistent in my transcriptions, representing e.g. the personal name /δYκ PA/ as DUKALA, to respect local spelling, and the name of the fertility ritual, which I recorded both as /APι/ and /Aδι/, as ADI, since I recorded the latter pronunciation more frequently.

- ‘ is to represent the glottal stop (/ʔ/) within a word
  - → example: /κʊβʔιPαμ/ a kind of yam) transcribes as KUB’IRAM.[§]
- doubling of S indicates shortening of the preceding vowel
  - → example: PASSA and KISSI (two kinds of palm), or Ossima (a village neighbouring Krisa).
- nasalisation and tonal variation are omitted.

Kin Type Notation

I follow the system most commonly employed for kin type notation (e.g. Barnard & Good 1984:3f.), linking the following abbreviations and kin positions:

F	father
M	mother
B	brother
Z	sister
S	son
D	daughter
P	parent
C	child
G	sibling
m.s.	male speaker
f.s.	female speaker

Plant Identification

I supplement my sporadic mentions of plant resources in chapters 2-4 with Latin binomial identifications, as is common practice. In chapter 5, however, where I refer extensively to Krisa plant resources, I employ a different approach, in the interest of clarity and in line with the methodological and pragmatic considerations which I advance in detail in chapter 4. Thus, I refer in the main text principally to a plant's vernacular name, or where this exists its common English/ Tok Pisin name, besides indicating its life-form. I do, however, identify it with a unique reference number, under which any further identification can be found in Appendix 15, and which remains consistent across all other Appendices to enable quick and easy cross-reference.

[‡] The shift of pronunciation with increasing literacy is reflected in informal transcriptions with “K”, and may in fact be promoted by it. Since, however, /κ/ occurs also otherwise, I have decided to reserve the character “K” for these latter cases.

[§] Note that in contrast to this designation, Donohue & San Roque (2004) use the inverted comma to represent one of four tones, the ‘pitch contour’ (op.cit.:36-tbl.17).

Thus, I refer for example to sago palm and the most common vegetable tree in the main text as

sago palm (SU, 1)

TULIP tree (WISIA, 51)

which can be identified in Appendix 15 as

ref.no.	vernacular name	English name/ description	Tok Pisin name	scientific name
TREE PALMS				
1	SU	sago	SAKSAK	*Metroxylon sagu*
...	...	...	...	...
TREES				
51	WISIA	—	TULIP	*Gnetum gnemon*

Bibliography

For ease of reference, I list serial sources separately at the end of the bibliography and use a coding system to cite them in the text. There are three series:

Agricultural Systems of Papua New Guinea Working Papers (ASWP)
A series of numbered publications which comprise a database describing and cataloguing the entirety of agricultural systems in Papua New Guinea. The series shares explanations on background and contents of the database (chapter 1), and on its format (chapter 2, comprising descriptions of data fields 1-109). Individual publications cover one national province each, inventorising in turn all agricultural systems identified within it. My coding for citations correspondingly employs the format

ASWP [Working Paper no.]:[Agricultural System identification code].

Hence, citation (ASWP:chpt.2) denotes shared text of the series; (ASWP 3) Working Paper no.3; (ASWP 3:1511) Working Paper no.3 describing agricultural system no.1511. I describe the database in more detail in chapter 2.

District Office Reports (DOR) and Patrol Reports (PR)
A series of regular reports by government officials from stationed work at the district office or walking patrols during Australian administration of the then Territory of Papua and New Guinea. Depending on the changing location of the district office in charge of the region at various times, reports were dispatched from either Vanimo or Aitape, but are nevertheless described unambiguously by chronological information alone. Thus, district office reports are identified by year and quarter, patrol reports by year and running number. My coding correspondingly employs the format

DOR [year]/[quarter]

PR [year]/[running no.].

Hence, citation (DOR 57-58/2nd) denotes District Office Report 1957-58 2nd quarter; (PR 48-49/6) Patrol Report 1948-49 no.6.

West Sepik Data Sheets (WSDS)

A series of numbered maps issued by the Sandaun (West Sepik) Provincial Government. My coding employs the format

WSDS [Map no.].

Hence, citation (WSDS 9) denotes Map 9 of the series.

CHAPTER 1

INTRODUCTION

Mention the name Papua New Guinea, and your audience is likely to conjure up visions of vast green wildernesses, pristine forests, nature untouched. Unless they are anthropologists. Then, they might rather envisage busy root crop cultivation and pig husbandry, sweet potato mounds and yam store houses. Two strikingly contradictory images. And each of them rather impervious in turn to the converse notions of either the forests as populated, even transformed, by humans, or else New Guinean gardeners as hunting and gathering, roaming these forests and subtly manipulating them to suit their needs. And yet, with this altered perspective the two contrasting images begin to blend into one: of forests with humans and by humans; of clearings disrupting yet generating them; of gardens untamed and forests tended; of resources at once cultivated and wild, planted and gathered, produced and procured. A single image begins to take shape, but it is one of inconsistencies and contradictions: the closer we draw, the more it slips out of focus. Apparently, our lenses can but capture one dimension at a time. Accommodating the full picture may require a change of lenses. This operation, and the resulting image of fallow farming, will be my concern in the following study. A brief elaboration of the above vignette shall set the scene for this task.[1]

1.1. Wilderness and Cultivation in Papua New Guinea—A Sketch

A Contrast of Perspective

The contrasting images just sketched out stand most obviously for the contrasting associations typically made by non-Papua New Guineans about Papua New Guinea (PNG). According to these views, the country is either cloaked in vast expanses of untouched forests, or populated by busy cultivators who have dramatically transformed the landscape in the quest for status and altitudinal expansion, leaving extensive grasslands in place of tree cover. Naturalists and the public at large tend to subscribe to the former view; anyone with even a slight ethnographic background to the latter. Neither view is particularly hard to account for. Both are illuminated when consulting distributional maps: of vegetation cover (Map 1) on the one hand and of ethnographic research sites (Map 2) on the other.

Corresponding to Map 1, vegetation assessments indicate that roughly 60 % of PNG's surface are presently covered with forest (Filer 1998:18). Previous estimates even put the figure at 70-80 % (loc.cit.-n.4). Certainly, much aerial photography of the country suggests nothing but lush, green infinity. Hence, there are obvious statistical reasons for this image to take hold in the minds of the naturalistically inclined and the general public alike. Beyond documented fact, though, the image of vast forests is typically embellished with the fantasy of pristineness. The conviction results that the forests represent vegetation in its primordial state and hence pure wilderness.[2]

This notion resonates with another one widely held, of PNG as one of the last wild places on earth. That view owes much to the country's late exposure to European exploration, which in turn prompted sensational news of stone-age economies and lost tribes until recently, and to its present reputation as one of the roughest destinations for tourists and professionals, due to its tribal wars, law-and-order problems, and lack of urban amenities alike. Although relating to disparate domains, these various aspects tend to blend into an overall perception of remoteness from a modern way of life, equated in turn again with a primordial state, or wildness.

The underlying fantasy, or fallacy, is the belief in a single evolutionary continuum of cultures culminating in modernity; a belief which has happily survived outside anthropology. It is necessarily coupled with the belief in a similarly straightforward continuum of environmental impact resulting in the highly transformed landscapes of modern societies. In this doubly unilinear scenario, the more a condition in either trajectory differs from the modern present, the closer it automatically appears to the presumable point of departure in the past. PNG as the dramatic counterpart of modern life and environment conforms therefore ideally to the image of the primordial for either. As both trajectories additionally reinforce each other, PNG's wildness becomes a token of its wilderness and vice versa, the etymological proximity of both conditions symbolizing their apparently causal connection.

Anthropologists, of course, have learnt to scorn the belief in unilinear evolution—and to cope with PNG's excess of violence and lack of urban amenities—and so have remained outwardly impassive to PNG-related wild(er)ness fantasies. They have rather followed the call of another kind of pristine condition, namely the absence of longstanding culture contact with Europeans. Barely 125 years ago, Captain John Moresby completed the outline of New Guinea; by the 1920s, administrative control in present PNG was yet limited to coastal areas and offshore islands; exploration of the central highlands only commenced in the 1930s (Nelson 1970:4-6).

If anthropologists therefore flocked to the island lured by the prospect of unspoilt cultures, distribution of research sites typically reflected the regional level of administrative penetration. Besides, it manifested the relative densities of local populations and the extravagance of their material and socio-cultural artefacts. The attendant clustering of research sites is illustrated in Map 2. In keeping with early administrative presence, ethnographic interest converged initially on offshore islands and coastal areas, subsequently also on the Sepik-Ramu river basin. A selection of legendary names and sites underscores the point: Miclouho-Maclay on the Rai Coast in the 1870s; Malinowski in the Trobriand Islands in 1915-18; Bateson among the Iatmul in the 1930s; Mead and Fortune at the Yuat river and the Chambri lakes in the 1930s, and on Manus Island in the 1930s and '50s (Bulmer 1970; Gordon et al. c1980). In the wake of explorations in the central highlands, anthropologists additionally began to invade this region from the middle of the 20th century onwards, taking advantage of an agreeable climate without malaria, and of substantial but residentially scattered populations which offered ideal conditions for studies in the emerging field of human ecology.

As a consequence of variously motivated research preferences, anthropologists have therefore largely bypassed the country's dominant environment: forest. Ironically, this has meant a neglect of precisely the regions which inspire the popular imagination of vast untouched wildernesses. If it has afforded some protection from the respective sentiments, it has, though, engendered at once a skewed reflection of the country's ecological and cultural reality. Hence, the contrast between popular-naturalistic and ethnographically informed conceptions of PNG, ostensibly a product of academic sophistication, is as much an artefact of a geographically biased perspective, illustrated by a comparison between Maps 1 and 2.

A Contrast of Place

The underlying geographical contrast, in turn, is the second level at which my imagery applies. More specifically, it is the contrast between *lowland rainforest* environments and subsistence forms on the one hand, and highland and non-forest lowland environments and subsistence forms on the other.

This contrast, though, remains typically hidden due to the entrenched ethnographic bias which focuses on a narrow selection of regions. Indeed, geographic assessments of the country regularly reflect and thereby cement the prejudice. For example, Peter Bellwood (1978:92), in providing an overview of the cultures of Southeast Asia and Oceania, felt that Melanesia was sufficiently described, on geographical grounds, "in two sections—the New Guinea Highlands, and Island Melanesia (which also includes coastal New Guinea)". Paul Sillitoe (1998:1-4) has been slightly more differentiating in his recent textbook on the anthropology of Melanesia, without though overcoming the existing bias. Thus, he explained:

> "The natural environment of Melanesia repeats the theme of variation... A useful initial distinction to make is between small and large islands... Three gross regions are identifiable on these larger islands:

> 1. the coast (or, rarely, the lowlands);
> 2. the lowland plains of the great rivers; and
> 3. the highlands (particularly in New Guinea) or the interior mountains."

His further descriptions confirm his parenthesised notion of the lowlands, and in particular of lowland forest—even though this constitutes the dominant environment on the largest island, New Guinea:

> "The *coast* varies from inviting beaches to impenetrable mangrove, from steep cliffs where mountains plunge into the sea to raised coral reefs and from equally inaccessible swamps to grasslands and bushy regrowth... The great *river plains* are less varied, characterised by large, meandering rivers, sometimes with islands of floating vegetation, enormous areas of swampland with isolated backwaters, and some savannah, grassland and forest... The *highlands* are stupendous, with ranges of precipitous mountains clothed in majestic rainforest, the highest topped with alpine grassland and sometimes snow ..." (original emphases)

Certainly, such assessments reflect not only a skewed distribution of research sites, but thereby at once a correspondingly skewed distribution of the local population (cf. Filer 1998:26-fig.2.6). For, ethnographic attention has typically concentrated on the most populous regions, presumably as much a function of prior administrative attention as of the desire for representative group sizes. In this respect, the prevailing image does illustrate the country's overall geography to some extent. However, it virtually eliminates the better part of the country's surface, which is by no means uninhabited, and thereby eliminates at once not only any contrasting environments but also the respective cultures and subsistence forms.

The extent of the exclusion emerges with a review of PNG environments, which divide into roughly seven vegetation forms (after King & Ranck c1980:93; Ward & Lea 1970:47-map26):

(1) grassland
(2) freshwater swamp (herbaceous and wooded)
(3) mangrove
(4) savannah
(5) lowland forest (tropical rainforest, <1,000 metres)
(6) upland forest (lower and upper montane forest, >1,000 metres)
(7) alpine vegetation (minor)

Map 1 explicitly represents forms (5) and (6); the remainder of forms correspond to the respective white patches. Of these, only part corresponds in turn to the regions favoured ethnographically.

These are in particular the grasslands, which concentrate along parts of the north and islands coasts, and in the highlands. They typically indicate areas of intensive root crop cultivation—principally of taro and/ or yam near coastal areas and in hill country, and of sweet potato combined with intensive pig husbandry in the highlands (ASWP 1-17). The concomitant occurrence of spectacular exchange systems—from the kula in the islands (Malinowski 1922) to the moka in the highlands (Strathern 1971)—has enhanced factors like administrative presence, population densities, and agreeable climate to capture anthropological attention. The resulting ethnographic coverage of these regions has rendered the respective cultures and subsistence forms emblematic for the country at large. Indeed, the prominence of highlands subsistence has been heightened by several explicit studies on this topic (cf. e.g. Rappaport 1967, Waddell 1972); more generally, high and mid-altitude areas have been heavily favoured by studies on human–environment interaction (Kocher Schmid 1991:12,13).

Next prominent in PNG ethnography are some of the riverine habitats. Large expanses of freshwater swamp occur on either side of the central cordillera. Those in the south, lining the Gulf of Papua and the Fly river, are sparsely populated and have received little ethnographic attention. Those in the north, though, filling the basin of Sepik, Ramu, and tributary rivers have attracted generations of anthropologists, who flocked to the region lured by its high population densities and extraordinary material and socio-cultural artefacts. The respective ethnographic representations (cf. e.g. Bateson 1958[1936]) have contributed the second major image of PNG cultures, while leaving little room for subsistence studies (Kocher Schmid 2005; Obrist 1990:462). Available information indicates that economies are by and large oriented towards aquatic environments: sago palm starch typically serves as the staple, but much of it is traded in for fish, while seasonal flooding of gardens provides fertilisation from silt (ASWP 2:1413,1418; 7:1307).

Mangrove and savannah habitats are found only south of the central cordillera. They are sparsely populated and have attracted little ethnographic attention, although the studies which have been conducted have reinforced the association between PNG subsistence and sago.[3] Mangrove occurs off the swampland in the Gulf region, especially in the river deltas. Economies are again oriented towards aquatic environments, with the added need to accommodate high ground water levels; diets tend to rely on sago palm starch, garden crops, and marine resources; gardens are often drained with channels (ASWP 4:0113-0115; 5:0201). Savannah lines the flanks of the Gulf and is most extensive on the Oriomo Plateau in the far south of the country. By definition, forest cover is reduced, while cultivation is comparatively pronounced despite extensive use of sago (ASWP 4:0112).

Collectively, ethnographies from the above mentioned regions have rendered an overall image of the country as populated by industrious root crop cultivators engaging in spectacular ceremonies; and by sago eaters typically creating dramatic art, ritual, and myth. The slowly growing number of nonconforming accounts from forest areas (e.g. Dwyer & Minnegal 1990, 1991; Guddemi 1992; Huber 1977; Kelm & Kelm 1980; Townsend 1974, 1990) has been insufficient to shift standard anthropological perceptions.[4] Besides remaining numerically inferior, they are further marginalized in the process of academic reproduction, as students raised on classical texts adopt and perpetuate the received images as universal. Consequently, they discount situations which differ, considering them either abnormal or indeed not worthy of attention. Such prejudices are common even among Melanesianists. Indicative of the prevalent tenor, Peter Dwyer (pers.comm. 2003) has reported regular scepticism towards his accounts of Kubo subsistence, while my collecting of artefacts in Krisa provoked the question, "is there anything interesting there?"

Academics outside the regional club tend to maintain yet more essentialised notions of PNG subsistence, and hence to project the hidden geographical contrast within the country onto a global plane. Emilio Moran (2000:287f.), for example, asserted sweepingly:

> "In the Amazon, where land has traditionally not been in limited supply, populations shifted in response to decreased farm yields, lower returns to labor in hunting, and fear of sorcery and raids. In New Guinea, where populations have been much denser, there has been a tendency to have continuous cultivation in prime areas. This can lead to environmental degradation, and some populations have, in fact, turned their montane rain forest into low-quality grassland."

The distinction between PNG and Amazonia, though, is less the absence of vast and sparsely populated forest with the former, than of densely settled highlands with the latter. In fact, PNG is set within the world's second largest block of tropical rainforest, which is centred on Malesia (Whitmore 1990:10,11-fig.2.1.)—the botanical region comprising Indonesia, Malaysia, the Philippines, Timor and New Guinea (van Balgooy 1976:1). Tropical rainforest, in turn, covers the better part of the country's surface (cf. Map 1).

Subsistence across these extensive areas obviously varies. Yet, there is a combination of common features which not only set (lowland)[5] forest apart from all other PNG environments, but indeed reveal similarities with the situation in Amazonia. In particular, cultivation is by definition moderate enough to retain forest cover. Conversely, hunting/ fishing/ collecting contribute substantially to local diets; besides, tree crops are common, while the staple is typically sago palm starch and/ or banana (esp. ASWP 2-5, also 7, 11, 12, 19). Indeed, there is considerable evidence across New Guinea at large of groups surviving mainly or completely without any cultivation at all—enabled in particular through spontaneous and abundant growth of sago palm—which has prompted a notion of hunter-gatherer societies in PNG (Roscoe 2002). Yet, a residual level of cultivation in most cases, however minor, renders such reconceptualizations slightly contrived, akin to comparable endeavours by Amazonianists (cf. Rival 1999).

The bewilderment caused by either condition—PNG lowland subsistence and its academic representation—is once more replicated by my imagery on two further levels. For, the side-by-side of forest cover and cultivated areas not only reproduces locally the larger geographical contrast within the country. It thereby at once juxtaposes hunting-gathering and cultivation, subsistence forms classically considered distinct. This situation is doubly irritating. Firstly, it confounds established concepts of subsistence which stipulate definite conditions. Secondly, though, it does so by introducing notions of wild(er)ness thought to have been left behind in the lay domain. After all, the void left in the subsistence equation by limited cultivation activities must presumably be filled with the additional variable of wild resources. If the need for such conceptual supplementation is confusing in any context, it is the more so in regard to PNG, which classically ranks as the country of cultivators par excellence.

The challenge which PNG lowland subsistence poses to the prevailing view of PNG subsistence therefore but highlights its challenge to the prevailing view of subsistence at large, as it exposes the persistence of lay perceptions in academic schemes. I believe the dilemma to be resolved less by a reconceptualization of subsistence forms, than of subsistence itself—or, to keep with my imagery, less by changing the angle of observation than by changing the approach. As essentialist notions of PNG subsistence meet essentialist notions of subsistence, a change of lenses may be due...

1.2. Introduction to the Study

Field Site, Institutional Context, and Prior Research

I undertook empirical research for this study in PNG's Sandaun (West Sepik) Province, in an area of lowland rainforest close to the north coast and near the international border with Indonesian West Papua at 141° EL (see Map 3). In the Vanimo District, I conducted overall 16 months of field research, divided into two spells between September 1997 and August 1999. My base was Krisa main village in the Kilimeri Census Division, but I also spent between one day and several weeks in various Krisa hamlets, in a number of the neighbouring Mbo-speaking communities, and in the nearby provincial capital Vanimo (see Map 4)

My field research was part of a larger research programme, which in turn motivated the choice of field location.[6] Thus, funding and research guidelines were provided by APFT (L'Avenir des Peuples des Forêts Tropicales/ The Future of Rainforest Peoples), a five-year multidisciplinary research initiative based at various academic institutions throughout Europe and sponsored by the European Commission, under its DG8 budget line which is devoted to conservation and development issues. The purpose of APFT was to generate information on the livelihoods of populations in rainforest areas in ACP (Africa–Caribbean–Pacific) countries, with special considerations to subsistence, demography, urban-rural links and diachronic perspectives. Methodologically, it relied heavily on the model of 'Sites Intensif Pluridisciplinaires/ Sites of Intensive Pluridisciplinary Research', which entailed the targeting of selected areas with multidisciplinary investigations combining long-term field studies with short-term surveys and following a common protocol across sites, to render assessments at once holistic and comparative. Institutionally, it operated through collaboration with national organisations and researchers in the target countries. In Papua New Guinea, it was implemented through the National Research Institute (NRI), where it was integrated into the existing research focus 'Conservation of Renewable Resources', which aimed at understanding the social context and impact of commercial timber extraction.

Against this background, Vanimo and its hinterland were selected as 'Site of Intensive Pluridisciplinary Research Vanimo–Kilimeri', representing one of two such sites in the country, besides four additional sites of complementary long-term research (cf. Kocher Schmid 2000c; Kocher Schmid & Ellen 2000:29-164). This choice followed a number of considerations. Thus, within PNG the area

- had not been subject to any in-depth social scientific research;
- is part of the generally under-researched forested lowlands (cf. pp.3ff.), and was itself the sole lowland site targeted by APFT research;
- has a sizeable population compared to other sparsely populated regions (cf. p.4);
- is part of one of the largest logging concessions in the country (cf. Filer 1998:44-fig.3.5), with operations both longstanding and ongoing, thus enabling comparative assessment of pre- and post-logging attitudes among the local population, and of local experiences with variously extensive operations;

- is remote from the capital, thus rendering transport of researchers costly and hence dependent on external donor support;
- is inaccessible by road from the rest of the country, thus minimizing security concerns for researchers.

Following this designation, Christin Kocher Schmid in her function as Pacific co-ordinator of APFT paid a reconnaissance visit to the area in 1996, during which she also selected Krisa for long-term field study. Between then and 2000 followed

- my own resident research in Krisa;
- several research visits by Christin herself and by associated researchers from Europe;
- several surveys in collaboration with NRI and the National Museum and Art Gallery.

Appendix 2 provides an overview of these assignments, while Appendix 3a lists a selection of texts generated which are also used in this study. Besides APFT-sponsored research in the area, a fortuitous encounter between myself and linguist Mark Donohue in Vanimo in 1999 led to an additional collaboration; to the residence of research student Lila San Roque in Krisa in 2000; and to the first literacy work in the community. Appendix 3b lists documents generated so far from linguistic research in the area.

Prior to the accounts based on these in-depth investigations, only sketchy reports from sporadic attention by explorers, missionaries, government officials and various researchers had been available from the area. Appendix 4 provides an overview and brief descriptions of the most relevant texts. The very first mentions of the area date from the foiled landing in Vanimo Bay in 1827 by French navigator Dumont d'Urville; a brief visit to the same location in 1885 by German explorer Otto Finsch; and a joint German-Dutch expedition along the common border at 141° EL in 1910, which though bypassed Vanimo, Krisa and the Kilimeri area (Finsch 1888:334-341; Schultze-Jena 1914:1-43; Tiesler 1970:111-122). Pamela Swadling (1990:204-262) has compiled information from numerous sources on prehistoric and historical trading connections in general, and the plume trade in particular, of the wider region with Southeast Asia and Europe.

Between 1930 and the mid-1970s, several generations of government officials produced regular reports from stationed work and walking patrols along the Vanimo coast and through its hinterland, which contain ethnographic information about the local populations, including details on topics such as religion, marriage practices, land tenure and subsistence. Erstwhile patrol officer K.H. Thomas, first officer-in-charge to be stationed at Vanimo in 1930, subsequently published his observations in the journal Oceania (Thomas 1941-42:163-186). It is not documented, though, whether he ever visited Krisa. Accounts corresponding to the official reports, if less comprehensive, were also produced by missionaries, and have been included in the local history of the Passionist order by Fr. Ignatius Willy (1996).

In early 1940, entomologist Evelyn Cheesman encamped in Krisa for probably several weeks. Besides pursuing her specific research interests, she also made interesting ethnographic observations, which she presented in various publications (Cheesman 1941:170-188, 1949:207-221, 1958:253-258). Her stay is well remembered by surviving community members and is recorded in oral accounts. Hence, there can be no doubt that Krisa village was the place she visited, although her maps and geographic descriptions are confusing, a puzzle which I discuss in Appendix 5. In 1970, linguist Donald Laycock must have passed through Krisa coastal hamlets, if not Krisa village itself, since his notebook of that year contains detailed entries on the Krisa vernacular (Donohue & San Roque 2004:10f.).[7] Some time in the early 1980s, ornithologist Bruce Beehler set up camp "south of Waterstone village [then the largest Krisa coastal hamlet], on the walking track to Krisa" (Beehler 1991:213), as part of his research in the region (op.cit.:193,206-220).[8]

In November 1992, NRI anthropologists Jacob Simet and Joseph Ketan undertook baseline research on local group structures and territorial claims in numerous coastal and inland communities between Vanimo and Bewani, including in Krisa (Simet & Ketan 1992). Their investigations were part of a larger study on the potential for smallholder cash cropping in the region, in turn part of the West Sepik Provincial Development Project (op.cit.:3), neither of which, though, was ever implemented to any major extent. The area has also been subject to cursory surveys in the context of the National Nutrition Survey of 1982-83; the generation of the Agricultural Systems of PNG database in 1991; and its predecessor in 1982 (ASWP 3:1506,1511). Finally, locations on the Vanimo coast have been sporadically represented in terms of their geology and archaeology (Gorecki et al. 1991); ethnohistory (Deklin 1979); urban geography (Allen 1976); and material culture in its relation to inter-community networks (Welsch, Terrell & Nadolski 1992; Welsch & Terrell 1994).

Hence, I have been able to draw on data generated in the course of my own research; on published and unpublished material generated by APFT-sponsored research in the Vanimo–Kilimeri area at large; on the results of recent linguistic research; and on earlier texts, which if sparse have provided valuable supplementary information. In particular, they have enabled the balancing of oral accounts by local people with written records by outsiders, and thus served to corroborate at once indications of diverging perceptions and of diachronic developments, both of which constitute fundamental concerns of my study.

Argument and Aims of the Study

Integration of my field data, supplemented with the additionally available information, yielded an image of subsistence which sits uneasily with prevalent notions of human–environment interaction. In Krisa, environmental manipulation intricately assimilates ecological processes; human activity promotes extensive ranges of enhanced vegetation, their diversity stimulated by human design; long-term schemes, spanning time-frames beyond human life, encourage a multitude of milieus, while short-term approaches take advantage of habitats changing through sequences of successional stages; and dynamic mosaics of waxing and waning anthropogenic landscapes overlap in time and space. Such conditions of intimate human–environment interplay, long haul and immediacy, flux and fuzzy boundaries confound established schemes. They render absurd the all-embracing opposites by which we habitually organise the biological world into wild and cultivated, and human activities within it into foraging and farming. They even challenge the deeply engrained view of the garden as the epitome of human interference with the forest, and as the centre of land use and livelihoods.

Similar perplexities are nothing new in the study of human subsistence. As I will detail in subsequent chapters, they pervade ethnographic and archaeological[9] accounts from tropical rainforest areas around the world. In particular, they have manifested in debates about human survival in tropical rainforest (e.g. Headland 1987; Bailey et al. 1989); in changing perspectives on swiddening (e.g. Beckerman 1983a; Sponsel 1986; Denevan & Padoch 1987; Dounias 2000); in various attempts to conceptualise systems centring on trees and other perennial resources (e.g. Clarke & Thaman 1993; Foresta & Michon 1993; Hviding & Bayliss-Smith 2000; Michon 2005); in the separate treatment of systems relying on sago palm (e.g. Ellen 1988; Dwyer & Minnegal 1991); and in an overall inflation of subsistence categories (e.g. Dornstreich 1977; Guddemi 1992). In one way or another, explicitly or implicitly, the respective studies all share a concern with human-disturbed vegetation; with regrowth and perennial resources; and with dynamic processes. Hence, they converge on the fuzzy intermediate zone between foraging and farming, forest and garden, natural and artificial. If they have thereby eroded the exclusive duality of these concepts, they have typically retained the definition of subsistence forms via precisely this duality. They have thus confirmed rather than contested the basic assertion that there are essentially two contrasting ways of making a living. They have left intact the corresponding nature–culture divide, and with it the conventional binary approach towards describing and analysing subsistence and patterns of human–environment interaction more generally.

In contrast, I propose to problematise the binary approach itself, by inverting its common relationship with empirical evidence. Instead of applying the former to interpret the latter, I use the latter as the yardstick against which to measure the former. This assessment reveals the foraging–farming duality as less universal than commonly assumed. Indeed, it indicates its origins in the experience of a particular human–environment relationship, namely fixed-field agriculture. This experience, in turn, engenders not only a hierarchical view of the world which is little suited to the objective description of human–environment interaction. It also produces amalgamated concepts which carry a number of implicit, but unwarranted, assumptions resulting in preconceived categories of environmental forms and subsistence practices. These, in turn, can only partially describe the spectrum of subsistence forms, leaving some as paradoxical or altogether unidentifiable. The resulting conceptual vacuum contrasts with a scientifically motivated methodological overemphasis on botanical and zoological identification of resource species, on plot surveys, and on quantitative ecological assessments, which though evade their potential utility for want of a comprehensive framework in which the data could be interpreted.

Against this background, I develop an alternative approach, which employs natural scientific concepts for exploring the ecological dimension of subsistence, while relying on social anthropological methods to generate, integrate, and present data. In particular, this approach emphasises:

- ecologically elemental forms of human–environment interaction, thus allowing for objective descriptions of resource management;
- functional connections between resource management and use, thus apprehending subsistence as process and highlighting its diachronic dimension;
- human material needs in their entirety, thus allowing for a comprehensive assessment of resource use, and of resource management in turn;

- functional connections between subsistence and elements of the socio-cultural matrix in which it is embedded, thus permitting correlation of changes in either and to trace the attendant diachronic trajectories, both retrospectively and prospectively.

Hence, I disaggregate both the monolithic concepts of foraging and farming, and the more nuanced but similarly amalgamated concepts identified as 'subsistence techniques'. This opens the way to model subsistence systems from the bottom up (Hviding & Bayliss-Smith 2000:10); and represent them at different levels of complexity (Moran 2000:77,311-318) and from different analytical domains (Johnson 1982). It also permits elemental comparisons across cases, thus providing avenues for a widened perspective, regional or global. Combined with the emphasis on process, it enables us to describe the reproduction of systems over time, which in turn constitutes the prerequisite for a number of further analyses. On the one hand, it offers immediate correlations between past management and present landscapes, which matches the principal concern of historical ecology (Crumley 1993; Balée 1998). Combining this, in turn, with an equal emphasis on the wider cultural context entails by definition an attention to the local meanings of environments, themselves often historically defined. It thus coincides with the interests of the anthropology of landscape (Bender 1993; Hirsch & O'Hanlon 1995). On the other hand, the systemic perspective is essential for more wide-ranging diachronic analyses (Thomas 1996[1989]:chpt.7). Its integration with archival and archaeological evidence not only permits the tracing of historical developments in specific cases, but also their abstraction for modelling the long-term evolution of these systems in various timeframes (op.cit.:chpts.5-7). Finally, the projection of these dynamics can indicate future change within various scenarios and thus provide assessments suited to inform policies and applications.

Through its elemental, multi-dimensional, and dynamic character, the approach I propose for exploring the ecological dimension of subsistence is therefore at once universally applicable and highly versatile. I demonstrate its use in practice by applying it to the Krisa case, which first inspired its conception. The resulting ethnography forms the empirical core of this study, augmenting the evidence gleaned from the literature and complementing the theoretical core established through development of the alternative investigative approach. It generates and illustrates my central thesis that subsistence in Krisa, and indeed the region, is a prime example of "fallow farming", a phrase I use provisionally and with some irony to describe a form of land use and livelihood strategy that relies on a spectrum of plant management practices ("farming") to encourage a range of secondary floral communities ("fallows") and the vegetal and faunal resources integral to them. Within the existing lexical framework, therefore, people in Krisa appear to *farm* in order to generate *fallows*.

This designation for the phenomenon I describe is my own; I have earlier used it with slightly different syntax (Klappa 1999a). As far as I am aware, there are no identical or related designations in the literature which likewise entail the meaning of 'farming to generate fallows'. In fact, I believe that the very *concept*, of a dynamic system geared towards variously immature environments, has not been proposed in a comprehensive way, although a few authors have interpreted data in a like fashion, usually within a broader argument (e.g. Huber 1977, 1978; Kennedy & Clarke 2004). I will refer to these especially in the final chapter. Apart from these studies, there are examples in the literature which seem to resonate with the *term* I use, but which differ in their underlying concepts and arguments, as I set out in detail in Appendix 1.

My choice of terms is deliberate and intended to apply on several levels, like the introductory metaphor of wilderness and cultivation which it seeks to transcend. It indicates that the environments generated are transitional, thus alluding to the similarly dynamic and long-term character of the described subsistence form. It also defines these environments as the manifestation of prior human action, thus describing a functional relationship between both. Furthermore, it expresses the tension which this correlation generates in the conventional classification of subsistence forms, by oxymoronically juxtaposing two mutually exclusive terms. For, 'farming' is understood as the antithesis of 'fallow', which refers precisely to the former's absence.[10] Combining both in a single phrase results in a semantic absurdity, much as Krisa subsistence seems, in a conventional framework, a conceptual impossibility. After all, conventional concepts may allow us to represent farming and non-farming activities and environments alongside one another, but cannot accommodate their interpenetration within a functional relationship. In fact, neither can the chosen phrase, remaining ultimately bound by the lexical conventions of its conceptual substrate, whose limitations though it thereby exposes. Hence, it encapsulates at once a representation of Krisa subsistence; a critique of conventional concepts; and the need for their parallel use in a conventional framework.

The latter, in turn, manifests in outsiders' depictions of Krisa subsistence as a combination of low intensity gardening (farming) and extensive hunting-gathering (foraging—for example in fallows), exemplifying the unfocused approach portrayed in the introductory metaphor and substituting for numerous similar cases around the world. Besides reflecting the confusion prevalent in academia, they may at once have real-world repercussions, when they provide the basis for interventions in the interest of environmental conservation or economic development. For, the misjudgement of systems as composite rather than functionally integrated entails a misjudgement of their dynamics, which may render actions less counteractive than counterproductive, resulting in the erosion of local environments and economies. Subsistence concepts are therefore never mere academic devices for apprehending empirical scenarios, but at once instruments in their transformation. My ethnographic representation of Krisa subsistence reflects this ambivalence, as it illustrates both the conflict between binary conceptions and a functionally integrated system, and the diachronic change engendered by the resulting tension.

My project is therefore doubly reflexive and eventually circular, and these aspects are embodied by three major aims. Firstly, I want to portray subsistence in Krisa; discover its principles; and trace parallels with contemporary and continua with past systems. Secondly, I want to problematise conventional concepts of subsistence and the binary approach on which these rely. Thirdly, I want to illustrate the real-life impact of these concepts on subsistence in Krisa in turn. The first task constitutes basically a representation of empirical evidence. The second task supplies both the theoretical framework for this and is inspired by it, thus manifesting the first level of reflexivity. The third task relates the results of the second back to those of the first, thus manifesting the second level of reflexivity and closing the circle of empirical evidence. Through this countermovement, my project becomes at once an exercise in indirect, or academic, advocacy, as it sets out to support the position of local communities by means of contesting discourse which distorts their situation and consequently undermines their existence.

Arrangement of Material

In the arrangement of my chapters, I partly inverse the sequence of these aims, while following largely the sequence of arguments outlined. My thesis accordingly proceeds along three strands, which are represented by three core chapters:

- chapter 3: evaluation of evidence gleaned from the literature;
- chapter 4: development of an alternative investigative approach;
- chapter 5: presentation of the Krisa case.

Thus, my study emphasises empirical evidence and its relationship with theory, and relies heavily on scientific concepts and reasoning. It is only partly ethnographic, the case study serving more for illustration and the contribution of pertinent data than the development of the argument, which though it originally inspired. The supplementary role of the ethnography, combined with the need to cover numerous aspects of local life and history and to gear these in turn to a discussion of subsistence, has unfortunately limited the potential to give room to individual voices and situations and maintain their coherence. Instead, it has favoured abstractions from statistical sets of data and has frequently led to a scattering of otherwise connected information among disparate parts of the chapter. This approach matches, though, the principal aim of my study, which is less the representation of local subsistence from an academic perspective (or, indeed, from a local one), than an examination of this same academic perspective against local subsistence data.

More specifically:

Chapter 2 provides an impressionistic introduction to the study, as I establish some facts and fictions about subsistence in Krisa and the region. After bounding the region, I present a selection of outsiders' notions about local environments, life styles, and forms of land use. Also, I extract relevant information from the Agricultural Systems of PNG Working Papers database (ASWP), while discussing the conflict between its methodological approach and local forms of plant management, indicating in turn difficulties more generally with empirical research into the respective forms of subsistence.

Chapter 3 constitutes a critical review of existing models for subsistence in tropical rainforest. I begin by introducing the paradox of nonclassifiable subsistence forms with reference to Phillip Guddemi's (1992) article "When Horticulturalists are like Hunter-Gatherers". I then examine the relevant models and debates, moving from the question of human nutritional demands and the possibility of tropical rainforest foraging; through the concepts of swiddening, arboriculture and agroforestry; to the role of sago palm as a resource. In the process, I point out conceptual inconsistencies and contradictions inherent in the respective models, while drawing out the correspondences among them. The material presented in this chapter therefore serves at once as the basis for the theoretical considerations advanced in chapter 4; sets out principles of rainforest subsistence elaborated further in chapter 5; and provides evidence recalled in chapter 6.

Chapter 4 traces the confusions noted in chapter 3 to the foraging–faming duality and its implicit ethnocentrism, which it seeks to transcend through reconceptualizing subsistence as fundamentally biological interaction between humans and their environment. I develop this alternative view of subsistence based in particular on the evolutionary-ecological approach of David Rindos (1984); the phenomenological-ontological approach of Tim Ingold (esp. 1992, 1994, 2000); and a critical engagement with Roy Ellen's (esp. 1982, 1994, 1996a, 1996c) perspective on human ecology and reflections on associated cognitive processes. I proceed by progressively disentangling the fraught relationship between natural science and anthropology, thus clarifying their respective remits of inquiry and enabling their constructive blending in a comprehensive theoretical framework universally applicable to the study of subsistence within human ecology. I conclude by presenting a methodology which translates the insights gained into practice, and which involves the innovative use of material culture collections.

Chapter 5 consists in a fine-grained and multidimensional portrait of Krisa subsistence in its cultural and historical context, with a fundamentally human-ecological perspective. I analyse and interpret my field data on the basis of the theoretical and methodological approach developed in chapter 4; with reference to the principles of tropical rainforest subsistence identified in chapter 3; and integrating the evidence presented in chapter 2. I develop this ethnography through a changing focus on more or less encompassing and intersecting social units—cultural-linguistic groups and communities; landholding corporations; economic, domestic and co-residential units; relatives; families; individuals—and their physical mobility, which manifests socio-political fluidity in turn. Within the resulting spatio-temporal framework, I address various aspects pertaining to subsistence, tracing at once their historical trajectories: diet and material culture; resource use and management; subsistence activities and division of labour; technical expertise, ethnobotanical classifications and concepts of knowledge; appropriation, consumption and distribution; land use, territorial control and the meaning of landscape; legal codes and political regimes; and myth, ritual, metaphysics and notions of time. In the process, I trace the principles of Krisa subsistence, both in ecological and socio-cultural terms, while demonstrating at once their transformation under the influence of modernity. I finish with an hypothetical evolutionary sequence, suggesting how the present system of Krisa subsistence may have developed from antecedent forms, and indicating its possible future.

Chapter 6 concludes the study in twofold respect. On the one hand, I relate the evolutionary sequence traced in chapter 5 to general evidence presented in chapter 3, as well as to particular examples of nonclassifiable forms of subsistence worldwide, thereby distilling its universal aspects and indicating its pan-tropical relevance. On the other hand, I relate the erosive trend described in chapter 5 to the theoretical considerations of chapter 4, thus identifying the agenda of development and conservation practitioners as a reflection of the same ethnocentric bias that underlies paradoxical subsistence classification in academia. I thereby return to the starting point of both the text and the argument, documenting the real-world effect of conceptual bias by means of the ethnographic evidence which helped to reveal it.

CHAPTER 2

FACTS, FICTIONS AND FANTASIES ABOUT SUBSISTENCE IN THE FAR NORTHWEST OF PAPUA NEW GUINEA

> "If you go to Wasengla, they're still nomads, they don't make gardens; that's why there is so much malnutrition."

Thus lamented a Catholic Sister of Indian extraction to me in 1998, condemning the subsistence situation at the Wasengla mission station—located beyond the crest of the Bewani mountains, 55 kilometres south-southwest of Krisa and at comparable altitude, and some further 20 kilometres from the provincial capital Vanimo where she was based. In one brief sentence, she managed to express a range of sentiments about local subsistence: her perception of local land use ('no gardens') and its social context ('nomads'); her perception of local health and frustration at it ('so much malnutrition'); the causal link she perceived between both ('that's why') and thereby her disapproval of the former; and her sense that improvement in both respects was desirable and had already been achieved in other cases ('still'). Indeed, her statement at the time was coupled with a favourable assessment of the situation in Krisa.[11] Her sentiments resonate variously with those expressed by numerous other visitors to the far northwest of Papua New Guinea. Collectively, they convey a perception of local subsistence, and conception of subsistence more generally, which matches the two contrasting images portrayed at the outset of chapter 1. In the following, I will provide a sample of such sentiments, summarize the beliefs they betray, and draw out their factual basis. First, though, I will delineate the geographical region to which they apply.

2.1. The Far Northwest of Papua New Guinea

The region which I define as 'the far northwest of Papua New Guinea ' stretches about 200 kilometres along the international border at 141° EL, from the north coast to the foothills of the central cordillera, in a strip variously between about 100-200 kilometres wide. As indicated in Map 5 (cf. also Map 4), it encompasses:

- the coast between the border and the Piore river—with Vanimo town as the largest residential centre of the region;
- the coastal hinterland—including the Oenake range on which Krisa is situated; the Pual river basin in which the neighbouring communities of Mbo-speakers concentrate; and the Serra hills;
- the Bewani and Border mountains;
- the upper Sepik river valley.

Elevation remains mostly below 1,000 metres; the predominant vegetation is therefore lowland rainforest, with some areas of swampland along rivers (cf. pp.3ff.). Population densities are low away from the more densely settled coast, ranging between 8 persons/ km^2 in the northern parts of the region and 2 persons/ km^2 in the upper Sepik valley (ASWP 3). Existing ethnographic accounts from the region are sparse and are limited to areas south of the Bewani mountains, a situation which contributed to the selection of the Vanimo coast and its hinterland for APFT-sponsored research (cf. pp.7ff., Map 4). Appendix 6 lists a selection of publications most of which are at once used in this study, most with explicit reference to subsistence; Map 6 indicates the respective locations and authors.

The two principal criteria which suggest to bound the region as proposed are socio-economic and historical; a third may be artefactual, although the evidence, presented in Appendix 7, is patchy and inconclusive. Most important for my purposes, subsistence seems largely uniform throughout, as I will indicate under pp.25ff., and discuss in more detail in chapters 5 and 6. By implication, this also entails correspondences regarding social organisation and cosmology, to which I will refer briefly in section 3.1., and again in more detail in chapters 5 and 6. The respective features extend presumably across the international border into Indonesian West Papua, although evidence is sketchy. Trans-border extension of the land use system has been documented for the coastal portion of the region (ASWP 3:1506); trans-border extension of social structure and ritual have been indicated for the region between Bewani and Border mountains (Gell 1975:1,73-75). Either may be much more widespread, considering continuous land and vegetation forms.

Evidence of shared historical processes supports both the described bounding of the region towards the north, east and south, and the suggestion of trans-border extension to the west. Thus, linguists Mark Donohue and Melissa Crowther (n.d.:2f.) have defined a greater region of north-central New Guinea (NCNG), whose eastern portion coincides with the region I have delimited as far northwest PNG, and which they describe and justify as follows:

> 'NCNG... is bounded on the south by the rise of the main cordillera in New Guinea and the Sepik basin with its easy riverine transport, on the west by the Lakes Plains[12] and those areas that have trade or other relations with the Lakes Plains, and to the east by those parts of the Torricelli range that show extensive contact with Sepik

> societies or with coastal Austronesian communities. To the north, the Pacific Ocean... serves as a border. NCNG is an area with the highest concentrations of different language families in a small area anywhere in the world... Additionally, it is an area of great uninhabited bush, with stark mountains and endless swamp alike serving to separate different people groups from each other. NCNG is a delimitable area not because of its internal homogeneity, but mainly because of external factors. The following factors coincide to define this area.
>
> NCNG:
>
> - is bounded by areas of high-intensity and far-ranging contact, such as the Lakes Plains/ Mamberamo river basin, various Highlands areas, and the Sepik river basin;...
> - has no large valleys or riverine systems which would allow easy access to different areas;...
> - has no Austronesian settlements extending inland;...
>
> There is one criterion that is internally motivated, and which serves to provide some additional justification for the delimitations that we use: In addition to the empirical points mentioned above, it appears, from oral histories, that NCNG:
>
> - is the area affected (directly or indirectly) by the hypothesised Bewani expansion: Evidence suggests that a movement of peoples or cultures took place at some point about a century before contact, centred on the western Bewani mountains. The influence of this movement can be seen in the modern distribution of peoples in the whole NCNG area. Beyond this area the influence is muted or absent."

In chapter 5, I will refer in more detail to this hypothesised event, which I can further support with my own field data. In summary, it seems reasonable to designate a region 'far northwest PNG' on geographical, ecological and cultural grounds, which in turn coincides with the eastern portion of a greater region 'north-central New Guinea'.

2.2. Subsistence in the Region

The Environment: 'Wilderness'?

The setting in the far northwest of PNG—extensive lowland rainforest and low population densities—seems ideal to inspire sentiments of wilderness. Certainly, Papua New Guineans themselves tend to be rather immune to such fantasies. Indicative of the national tenor, biologist Rose Singadan, from Chimbu Province in the highlands but with field experience both in Krisa and similar environments across the border, laughed at the obvious absurdity of the notion, exclaiming:

> "There is nothing wild in Papua New Guinea!"

European visitors to the region, though, are easily tempted by the wilderness fantasy. The first among them must have been the members of the joint German-Dutch border expedition (Schultze-Jena 1914). Their accounts convey an image of vast forests which all but eclipse the humans living in them:

> "People without knowledge of iron are a poor match for the kind of forest we have encountered above; with stone axe, fire, and lethal ringbarking they wrest the most modest measure of space from the jungle, to satisfy the requirements for hut construction and garden preparation. An unbroken thicket closely adjoins the settlement, since we can hardly speak of a path where the Papua have left only the traces of wear like wild animals do, curving around every little obstacle; only here and there a snapped branch shows the seeker the way." (op.cit.:33, my translation)

> "A few low trees, whose leaves are cooked as vegetables, are the remnants of the forest which rises immediately behind the huts." (op.cit.:40, my translation)

The mentioned vegetable trees are most certainly *Gnetum gnemon*—TULIP ("two leaves") in Tok Pisin, on account of their opposite leaves—one of the principal food sources in the region. Ironically, this species is indicative of secondary vegetation and is in fact often planted, hence nothing less than the imagined forest remnants but rather their precise opposite.

The early explorers' description resonates with that of naturalist Bruce Beehler, who encamped at the Puwani river, a southern tributary of the Pual, in the early 1980s (Beehler 1991:193,210-213). Similarly struck by the inconspicuousness of human activities and likewise perceiving an antagonism with the forest, he though saw the latter less as threatening than as threatened:

> "What appeared to be pristine forest, without discernible hunting tracks, was, in fact, regularly visited by hunters in search of game and by children in search of edible nuts... the children simply took off into the forest and followed barely discernible traces that I had not even noticed. They moved easily through the habitat, acting as if it was their backyard, as I suppose it was. Often, the villagers' activities in the forest leave little visible evidence, but their influence is probably considerable. Removing many of the important dispersers of seeds, as well as many of the larger, edible, seeds themselves, may influence the dynamics of forest regeneration, especially over the long run.
>
> The most important influence that lowland villagers have on the forest is their slash-and-burn agriculture... in a large lowland village, much of the land within a half-hour walk... has been disturbed in the not-so-distant past, assuming the village has been stationed in this vicinity for that period of time.

> It is not uncommon for villages to be resituated every decade or so... Much of the habitable lowland areas have been colonized at one time or another during the last millennium. Much of what looks like 'virgin' rainforest is probably old secondary growth.
>
> The actual level of long-term interaction between humans and lowland rainforest in New Guinea is still a matter of speculation... Subsistence agriculture, supplemented by hunting and gathering, can place considerable stresses on forest ecosystems... The nature of these stresses, and the manner in which the forest adapts (or fails to adapt) to them, would be an interesting research problem for future tropical ecologists." (op.cit.:211f.)

Hence Beehler acknowledges the historically anthropogenic nature of much lowland rainforest, but simultaneously suggests that the very activity which has over millennia created today's landscape could now threaten it. This results not only in a logical paradox, but betrays his allegiance to the notion of pristineness. More specifically, his otherwise very realistic account and insightful ecological reflections fail to note that lowland villagers not only *remove* plants from the forest, either through eating seeds or clearing vegetation, but also *add* plants, such as the TULIP trees.

The People: 'Nomads'?

The perception in some quarters of pristine forests is complemented in others with disdain at diet and lifestyle of their human inhabitants. Thus, patrol officers regularly expressed their frustration upon expeditions into the Vanimo hinterland:

> "The people visited are of a semi-nomadic type...." (PR 48-49/6)
>
> "The predominance of hunting and sago-processing activities results in only minor attention being devoted to agriculture. Most villages have gardens, but these are not large." (PR 53-54/2)
>
> "The administration is attempting to encourage more thorough agriculture, and this tends to encourage, in turn, a more settled mode of life. The bush people spend much time away from their villages on extensive hunting trips." (Thomas 1941-42:165)
>
> "Persistent talk must be given to these people at all times to keep up their gardens. If this is not done the Kilimeri natives will not build and replant new gardens. Their line of thought is as follows. 'Why should we sweat and slave in gardens when our bush is filled with sago palms. We men can sit down and our wives and womenfolk can prepare the sago, so why should we build gardens.' This unfortunately is the attitude of these people in connection with gardens." (PR 48-49/6)
>
> "Inland the diet is extremely poor. [There are] many attempts to encourage the people to go in for more extensive gardens but as yet the people do not take to the idea willingly... the work entailed bringing about [garden] produce tends to frighten the average native. With the abundance of sago palm it is obvious to all that the simplest way of obtaining food is to chop down an occasional sago palm and allow the women to do the hard work, that is if they can manage to find the time to cut down the said tree." (PR 46-47/9)[13]
>
> "...they must be taught to realise... that a diet of sago and coconuts, with the addition of the few vegetables grown in their gardens is insufficient." (PR 48-49/6)
>
> "Attempts are now being made to change the dietary habits of the people to allow for the consumption of more nutritious food (vegetables, poultry, pig and fruit)." (PR 62-63/8)

Besides anything else, the penultimate statement betrays the officer's ignorance of vegetables other than garden crops. In fact, local diets are exceedingly rich in vegetables, with TULIP leaves not only highly typical but also highly nutritious, as I will detail in subsequent chapters.

Missionaries have largely shared these images of local people and views of local subsistence, and have after the exodus of expatriate officers following PNG's independence in 1975 continued to preach cultivation, dietary change and sedentism as the principal ingredients of socio-economic development—as exemplified by the Catholic Sister's quote which introduced this section.

Cultivation—or not?

Academics have subtly echoed these stereotypes by disregarding local practices of land use and plant management in various ways. Illustrative is the obvious disdain expressed by NRI research officer Felix Topni Niofiarl, who reported on a garden survey in Mbo-speaking communities:

> "...people did not make new garden[s] so... we could not make proper observation and records of this. Only 2 % of the gardens measured were newly cleared and planted with crops... Even though, during our earlier base study on demography, each household postulated that they had more gardens. However, when actually going out into the field, all we found were old garden sites overgrown with bushes." (Niofiarl 1998:4)

A more subtle, but nonetheless characteristic form of prejudice occurs in the Agricultural Systems of Papua New Guinea Working Papers (in the following "Working Papers" for short, cited as ASWP—cf. Conventions). The Working Papers constitute a database describing the entirety of agricultural systems in PNG. Systems are identified with the two-digit National Census Code, e.g. 15 for West Sepik Province, followed by a two-digit system code relevant for that province, e.g. 11 for the system identified in the Vanimo hinterland, which thus becomes system 1511 overall. The database represents a remarkable mapping project and an invaluable source of information on numerous aspects of PNG land use. In regard to low-intensity systems, though, its utility is compromised by a methodological bias towards the garden and its crops, and a corresponding neglect of other environments, resources, and forms of plant management. The extent and significance of this bias shall be outlined in the following.

To begin with, a set of six criteria distinguishes one system from another (ASWP:chpt.1):

1. fallow type
2. fallow period
3. cultivation intensity
4. staple crop
5. garden and crop segregation
6. soil fertility maintenance techniques.

Half of these are explicitly or implicitly geared towards the garden as the antithesis of the fallow. Thus, the specification for item 3. reads: "number of consecutive crops before fallow", that for item 6.: "other than natural regrowth fallow"; item 5. refers unambiguously to the garden anyway. 'Garden', in turn, is more specifically defined as:

> "a contiguous area of land planted with crops under the management of a social unit such as a family or a household" (data field 28).

Of course, the term 'crops' allows various interpretations. In fact, the preceding crop inventories (data fields 21-27) include numerous tree crops and other perennials. Yet, the context in which the term 'garden' occurs throughout leaves no doubt that it refers only to an area planted with what are conventionally understood to be 'garden crops': herbaceous annuals. This reading is supported by the specification "a contiguous area of land", which contrasts with the often fuzzy spatial arrangement of managed perennials. It is reinforced by the approach taken to quantification, with "Intensity of Land Use" (data field 109) defined as the R value suggested by Ruthenberg (1971:3)[14], namely ratio of cropping period to cultivation cycle (= cropping period + fallow period). This implies that cropping alone determines land use, supporting the specification of item 3. In summary, land use and garden are narrowly defined as limited to the cropped plot, which though contrasts with local concepts encompassing various fallow stages—a divergence which likely confused researchers conducting the garden survey among Mbo-speakers, as quoted above.[15]

The respective bias in the Working Papers becomes yet more pronounced through the level of detail recorded in regard to garden treatment. Thus, data fields refer for example to

- various forms of fertilization (33-39)
- various forms of mounding and bedding (53-58)
- staking of crops (52)
- soil management: tillage (42, 59), soil retention (51), etc.
- water control: irrigation (46), drainage (50).

In contrast, there is no consideration of practices relating to the management of fallows and perennial crops such as the TULIP tree, which may not only be planted in gardens, but promoted through the initial clearing, protected during weeding, specially nurtured in fallows, and retained with renewed clearing. Indeed, such practices are explicitly disregarded, and the focus on the cropping period is affirmed, in data field 34. Though labelled as "Planted Tree Fallow", it is placed under the larger heading of "Soil Fertility Maintenance Techniques" and reads:

> "A presence and significance measure of whether tree species... are planted into gardens or fallows *for the stated purpose of improving soil quality during subsequent cultivations.* This measure *excludes the practice of planting fruit tree species* into gardens and fallows, but does not exclude the planted trees being used for timber or firewood." (my emphases)

Individual tree (and other perennial) crops are similarly neglected. Firstly, they occur only as food sources, upon transfer of a notion adhering to garden crops. Thus, the sago palm (*Metroxylon sagu*) enters the records only on account of its food use—its pith provides starch—but not on account of its other essential uses, in particular for house construction.[16] The LIMBUM palm (?*Gulubia costata*), essential for house construction and the manufacture of containers but without food uses, is altogether absent.[17] Other crops without food uses are similarly omitted, such as bamboos used only for artefactual purposes. Yet, non-food narcotic crops, in particular betelnut

(*Areca catechu*) and tobacco (*Nicotiana tabacum*), are included, maybe indicating the conceptual proximity between food and drugs (cf. e.g. Hugh-Jones 1993).

Secondly, perennial crops with food uses are organised together with garden crops and/ or in arbitrary categories, which takes them and their management out of focus. The following list reproduces the principal crops grouped together, with an indication of plant part used:

- "Staple Crops" (data fields 21-23):
  - sago (*Metroxylon sagu*)—pith
  - breadfruit (*Artocarpus* spp.)—fruit
  - banana (*Musa* spp.)—fruit
  - a variety of root crops
- "Other Vegetable Crops" (data field 24):
  - TULIP (*Gnetum gnemon*)—leaves
  - BALBAL (*Erythrina variegata*)—leaves
  - lowland PITPIT (*Saccharum edule*)—inflorescence
  - a variety of herbaceous leaf- and fruit vegetables
- "Fruit Crops" (data field 25):
  - numerous trees—fruit
  - banana (*Musa* spp.)—fruit
  - sugarcane (*Saccharum officinarum*)—stem
  - a variety of herbaceous fruit crops
- "Nut Crops" (data field 26):
  - numerous trees—nuts
- "Narcotic Crops" (data field 27):
  - betelnut (*Areca catechu*)—nut
  - betel pepper (*Piper betle*)—infructescence
  - tobacco (*Nicotiana tabacum*)—leaves.

The classification by function ("staple", "vegetable", "fruit", "nut", "narcotic") generates not only potentially overlapping classes of crops, but cross-cuts ecologically more meaningful classifications which differentiate crops morphologically (by organ used, such as fruit, seed, leaves, stem, etc.) or anatomically (by life-form, such as tree, palm, vine, herb, etc.). If its heuristic value for organising garden crops has led to its widespread use (cf. Table 24), its application to perennial crops inappropriately subsumes these with their annual counterparts and the respective forms of management; breaks them up as a group and thereby diffuses their significance; and deflects attention from common, or divergent, patterns of management among them.

Thirdly, treatment of perennial crops is limited through the ecological limitations imposed by an emphasis on gardens, entailing in turn an emphasis on both arable land and cultivation activities. This limitation is particularly consequential in regard to the sago palm, which is occasionally planted in gardens, but otherwise occurs largely outside them, in swampy habitat, where it may or may not be planted in turn. The authors explicitly acknowledge the former complication, suspending the six criteria listed earlier, by pointing out that:

> "Sago is a widespread staple food in lowland Papua New Guinea. Sago is produced from palms which are not grown in gardens. Most of the criteria above cannot be

> applied. In this case, systems are differentiated on the basis of the staple crops only." (ASWP:chpt.1)

In this general context, they remain vague about the additional complication regarding plant management. In some of their systems descriptions, though, they do distinguish between "planted sago" (e.g. ASWP 5:0203), "managed, naturally occurring stands" (e.g. ASWP 3:1511), or indeed "wild palms" (e.g. ASWP 5:0201). They are more explicit in regard to "Nut Crops" (data field 26), defined as including "important nuts grown *or collected*" (my emphasis). Yet, these qualifications remain exceptions. Their equal applicability especially to TULIP, but also to several other tree species listed, of which both planted and spontaneous individuals are harvested, remains unacknowledged. Indeed, it remains unacknowledged that some of the listed crops are never planted, while conversely important noncultivated food crops may be omitted altogether. Thus, ferns are mentioned as vegetables for system 1511, but not bamboo shoots, which according to Alfred Gell (1975:17) "are more important in the diet than garden crops" in Umeda, indeed ahead of TULIP leaves, which constitute the principal accompaniment of meals in Krisa.[18]

Hence, the fundamental agricultural bias of the Working Papers—manifested, indeed, in their full title—limits the range of investigated perennials through a focus on food; blurs relevant categories through a merging with garden crops; and renders systems which centre on perennial species and fallow environments at once marginal and amorphous through the need to suspend the fine grain of description and analysis ("systems are differentiated on the basis of the staple crops only"; "nuts grown or collected"). If qualifications become necessary to accommodate some obviously important species, they reinforce the notion of anomaly, able at best to highlight rather than remedy the bias.

Problems of Method and Representation

The complications highlighted by the Working Papers are indicative of wider problems of method and representation with land use systems centred on fallows and perennial resources, as in the far northwest of PNG.

The first problem relates to the investigative focus. In principle, this needs defining prior to the generation of data to ensure their relevance. Thus, a concern with garden crops and the respective cultivation techniques is meaningful in regions where gardens assume a prominent subsistence role, but comparatively unimportant where this falls to environments beyond the garden. A misplaced focus on gardens then distracts from more important resources and the respective management techniques, and can produce misleading classifications which cement the biased perspective. A case in point is the overestimation of cropping patterns as a classificatory parameter in the Working Papers, against an underestimation of gardening intensity, illustrated by the descriptions for system 1511 and the inter-provincial system 1507/ 1402[19]:

> "[System 1511] is very similar to System 1506 [should read 1507]/ 1402 but is distinguished on the basis of minor differences in the importance of crops." (ASWP 3:1511)

> "[In System 1507/ 1402, t]he importance of agriculture differs considerably from place to place, in the size of plots cultivated and in the labour invested in cultivating them." (ASWP 2:1402, 3:1507)

With an altered perspective, though, which encompasses both the garden and environments beyond, "minor differences in the importance of crops" become comparatively insignificant, while "importance of agriculture" becomes a significant parameter defining the degree of reliance on garden crops vs. non-garden crops. With this perspective, System 1511 appears as partly homogeneous with System 1507/ 1402, which though turns out as heterogeneous in itself. Yet, judgements about the relative relevance of data require prior acquaintance with the respective form of land use, which renders the problem largely circular and its solution dependent on in-depth research preceding any surveys.

Once the investigative focus has been appropriately trained, though, the second problem arises, namely how to generate the data in practice. Even garden surveys are time-consuming and back-breaking. The more gardens transform into fallows, with species abundance, biomass and plant size surging, the more surveys become protracted and exhausting. With environments beyond a recognizable erstwhile garden, they become totally unmanageable for sheer size of the involved area. Of course, application of transects can counter the problem, but this option is itself fraught with difficulties. Firstly, the data obtained through transects are not necessarily representative of the surveyed vegetation form, due to the statistical effects of species distribution and subjective observer bias during sampling (cf. Ellen [in press] and references cited). Secondly, devising meaningful transects necessitates prior acquaintance with local environmental categories, which again produces a circular problem. Besides, such categories may themselves be conceptually fuzzy, as is the case in Krisa (see chapter 5), or as reported for example by Roy Ellen (op.cit.) for Seram, Maluku, thus replicating the original dilemma. Thirdly, the high species diversity in tropical rainforest, and the large distances covered by its itinerant inhabitants ("nomads") in the course of their subsistence activities would demand substantial transect sizes anyway.

The one environment which is ecologically well defined, typically recognised as a separate vegetation form locally, and generates a staple food, and which would therefore lend itself to surveys, is so unattractive that few researchers have felt drawn towards the activity: sago patches or swamps are by definition boggy and typically infested with malaria-transmitting mosquitoes, the palms themselves frequently armed with vicious spines. Christin Kocher Schmid (pers.comm. 2003) has for example reported that researchers participating in the APFT programme flatly refused to survey sago swamps in the Pual basin. A rare and notable exception has been research by James Rhoads (e.g. 1982), to which I will refer extensively in chapter 3.

Finally, extending investigations beyond the temporally and spatially well defined area of the garden raises not only the question of how to bound surveys appropriately in time and space, but similarly of how to integrate the generated data. This dilemma has manifested in the Working Papers most obviously as the need to suspend established parameters in order to accommodate important crops. This move indicates that conventional frameworks are overtaxed by crops occurring outside gardens in time or space. The attendant conceptual confusion recurs almost universally with the description of land use systems which combine low-intensity gardening with extensive harvesting of resources beyond gardens, as illustrated by the metaphor which introduced chapter 1.

I shall demonstrate the extent of this confusion in chapter 3. In chapter 4, I shall develop an alternative framework more suited to the integration and presentation of the respective data. There, I shall also describe an alternative, primarily ethnographic approach for exploring subsistence, via resource uses and management activities. This has allowed me to focus my investigations on the most important crops and subsistence practices and to circumvent the problems associated with extensive vegetation surveys.

Conclusions

However biased existing accounts from the far northwest of PNG may be, they do allow certain conclusions, not only about the authors' fantasies, but also about subsistence facts. Of all the sources reviewed under the foregoing headings, the Working Papers provide the most concise information. Three of the systems listed describe the entirety of land use forms in the region; individually, they correspond to the geographical subdivisions identified in section 2.1. Their characteristics are encapsulated in the following summaries (underline added):

> System 1506 (ASWP 3):
> "Located along the coast from Vanimo west to Wutung village and extending into Irian Jaya [now West Papua]. Tall woody regrowth, generally more than 20 years old, is cleared, cut and burnt. Large gardens, made by a number of households, and smaller individual gardens are made. Sago is an important food; banana, sweet potato, coconut and taro are important crops; other crops are cassava, Chinese taro and yam (*D. esculenta*). Only one planting is made before fallowing. Taro, sweet potato and Chinese taro are generally grown in separate parts of the garden."
>
> System 1511 (ASWP 3):
> "Located in the Bewani and Border Mountains and along the north coast [i.e. in the coastal hinterland, as indicated on the respective map and considering that system 1506 refers to the actual coast]. The primary source of food everywhere is sago, some of which is planted and some of which is managed, naturally occurring stands. Gardens are cleared in fallows of tall woody regrowth, 15-30 years old. Fallow vegetation is cut, dried and burnt. Only one planting is made before fallowing. Banana and taro are important crops; other crops are yam (*D. alata*), sweet potato and Chinese taro. Game and fish are important sources of food. Food gardens are planted at the end of the drier season."
>
> System 1417/ 1504 (ASWP 2/ 3—cf. n.19):
> "Located in areas of swamp and frequent flooding north and south of the Sepik River and west of Ambunti. Sago is the most important food. Hunting, fishing and the collection of wild vegetable foods are important activities. Agriculture is not an important source of food. Small food gardens are made by a minority of households (less than 30 per cent). Tall woody regrowth, greater than 20 years old, is cleared and burnt. Crops grown are banana, taro and sweet potato. Only one planting is made before fallow."

The summaries clearly describe a north-south gradient along which gardening decreases, in terms of garden size, frequency, and importance, with an attendant increase in the contribution of sago and the harvesting of wild animals and plants.

I believe that this gradient is a comparatively recent product of gradual administrative and missionary penetration and the attendant indoctrination, and of the resulting intensification of gardening, as suggested in chapter 5. I therefore regard the region as an in principle (if no longer entirely in practice) homogeneous subsistence area which is differentiated less by the approach to subsistence than by its (modern) manifestations, besides minor variations due to altitude and hydrological conditions. Furthermore, I believe that a similar approach to subsistence is found west across the border in Indonesian West Papua, as indicated for system 1506; is found with slightly different manifestations towards the east in many lowland parts of northern PNG (recall that "[System 1511] is very similar to System 150[7]/ 1402", which in turn stretches along the Sepik river valley away from the river—cf. p.23); and is found with possibly greater differences but fundamental similarities on the other side of the central cordillera, in southern New Guinea. I will return to these wider perspectives in chapter 6.

For the moment it is sufficient to note that in the far northwest of PNG

- gardens are made, though not necessarily often or of large size;
- harvesting of wild animals and plants can be important;
- sago is the staple.

Besides the sago palm, trees and other perennials contribute substantially to local crop inventories, as illustrated in Table 1 (p.28), which collates and compares data from ASWP 3, with columns on perenniality and woodiness added. That the trend is evident despite the Working Papers' bias against non-food crops, non-garden vegetation, and unorthodox forms of plant management underlines its pervasiveness.

If the Working Papers thereby sketch out a general image of subsistence in the far northwest of PNG, this is supplemented by factual information contained in the more general accounts quoted under the foregoing headings. Collectively, they suggest that:

- people and their activities blend into the forest (Schultze-Jena, Beehler).
- people are mobile, conceptualised as 'nomadism' (Catholic Sister) or 'semi-nomadism' (PR), which manifests both as extensive excursions into the forest (PRs) and as frequent village relocations (Beehler).
- in the forest, people hunt game and collect nuts (Beehler); hunting and sago processing are the principal subsistence activities (PRs)
- there are vegetable trees (Schultze-Jena).
- gardening is a minor, if not marginal activity (PRs, Niofiarl).
- nevertheless, this 'slash-and-burn agriculture' probably has an extensive and long-term environmental impact, hence much of the forest is not 'virgin' (Beehler).

The ethnography I develop in chapter 5 confirms these characteristics and demonstrates that they are all facets of a functionally integrated whole. Without a systemic view, though, they appear disparate, generating a fractured image of local subsistence which is often laced with developmental notions or indeed moral overtones. In the crudest case, the framework for interpreting the facts is built on two complementary illusions: that tree cover equalled naturalness and its absence alone cultivation. In an evolutionist scheme, these illusions appear as successive stages, typically equated with incremental human achievement and benefit. Missionary zeal then urges its proponents to hasten the transition towards the supposedly superior condition. Even a more detached interpretation of the facts typically retains the basic opposition of forest versus garden, as the contrast between a natural environment on the one side, and an environment transformed by humans on the other. In the conventional conceptual grid, the corresponding subsistence forms get labelled, respectively, as hunting-gathering and cultivating. Forms combining both aspects often engender the perception that the hunting-gathering element was residual, and the cultivation element as yet incomplete, and that the situation represented a step on the evolutionary path towards full agriculture. A closer view reveals that this developmental interpretation is problematic, as is more generally the blending of existing conceptual models which individually can accommodate but part of the empirical data. By exploring these models in the following chapter, I will at once trace the fault lines with contradictory situations as found in the far northwest of PNG.

Table 1: Crops in the Far Northwest of Papua New Guinea (after ASWP 3)

data field	crops (spelling according to ASWP)	botanical identification (according to ASWP)	crop present in system			perennial	woody
			1506	1511	1504		
21-23: staples	sago	*Metroxylon sagu*	░	▓	▓	▨	■
	banana	*Musa* cvs	░	░		▨	
	taro	*Colocasia esculenta*	░	░		▨	
	Chinese taro	*Xanthosoma sagittifolium*				▨	
	yam	*Dioscorea esculenta/ alata*	*D.esc.*	*D.al.*		▨	
	cassava	*Manihot esculenta*		*		▨	
	sweet potato	*Ipomoea batatas*	░				
24: other vegetables	aibika	*Abelmoschus [Hibiscus] manihot*				▨	
	amaranthus	*Amaranthus* spp.					
	Chinese cabbage	*Brassica chinensis*		†			
	ferns	N/A	‡			▨	
	kangkong	*Ipomoea aquatica*		§		▨	
	nasturtium	*Nasturtium* spp.				▨	
	tulip	*Gnetum gnemon*				▨	■
	kumu musong	*Ficus copiosa*				▨	■
	balbal	*Erythrina variegata*		**		▨	■
	lowland pitpit	*Saccharum edule*				▨	
	highland pitpit	*Setaria palmifolia*		††		▨	
	pumpkin	*Cucurbita moschata*	‡‡	‡‡		▨	
	cucumber	*Cucumis sativus*		§§			
	corn	*Zea mays*					
	other	N/A		***			
25: fruits	sugarcane	*Saccharum officinarum*				▨	
	pawpaw	*Carica papaya*				▨	
	ton	*Pometia pinnata*				▨	■
	marita pandanus	*Pandanus conoideus*				▨	■
26: nuts	coconut	*Cocos nucifera*	░			▨	■
	breadfruit	*Artocarpus altilis*				▨	■
	galip	*Canarium indicum*[†††]	‡‡‡			▨	■
	pangium edule	*Pangium edule*				▨	■
27: narcotics	betel nut	*Areca catechu*				▨	■
	betel pepper	*Piper betle*				▨	
	tobacco	*Nicotiana tabacum*					

(data from ASWP 3, columns on perenniality and woodiness added)

legend:

	mentioned as present
░	mentioned as subdominant staple
▓	mentioned as dominant staple

(notes see next page)

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[*] Cassava is also grown to some extent in Krisa.

[†] The role of Chinese cabbage is taken by ?Indian mustard (*?Brassica juncea*) in Krisa.

[‡] Fern fronds are also on sale at Vanimo market (pers.comm. Kocher Schmid 2004), hence either collected in coastal communities, or imported from Mbo-speaking communities or from Krisa.

[§] Kangkong and watercress are also grown to some extent in Krisa, although they are probably more prominent in areas with more ponds and streams, respectively.

[**] Balbal is also grown in Mbo-speaking communities (pers.comm. Kocher Schmid, 2004) and in Krisa.

[††] I have never noted highland pitpit grown, consumed, or sold in Krisa.

[‡‡] Pumpkin tips are also on sale at Vanimo market, hence either grown on the coast or imported from Mbo-speaking communities or from Krisa; pumpkin tips and fruits are grown to considerable extent in Krisa.

[§§] Cucumber is also grown to some extent in Krisa.

[***] According to Alfred Gell (1975:17), bamboo shoots constitute the most important accompaniment of meals in Umeda.

[†††] For the problems with identifying galip, cf. Case Study 1.

[‡‡‡] Galip nuts are also on sale at Vanimo market, hence either collected in coastal communities or imported from Mbo-speaking communities or from Krisa.

CHAPTER 3

CONFUSING CONCEPTS IN THE STUDY OF TROPICAL SUBSISTENCE

3.1. "When Horticulturalists Are Like Hunter-Gatherers"

Under this title, Phillip Guddemi (1992) published an article exploring the paradoxical situation he found while working among the Sawiyanö in the far northwest of PNG (cf. Map 6, Appendix 6). His title flags a wide-ranging puzzle in the study of tropical subsistence, arising from the juxtaposition of subsistence forms which otherwise tend to be considered mutually exclusive. I have so far emphasised in particular the technical aspects of this puzzle: the unorthodox side-by-side of limited cultivation activities and extensive hunting-gathering. For Guddemi, though, the contrast runs deeper, encompassing at once the incompatibility between technical and social aspects.

He noted that classical hunter-gatherer studies used to postulate a close correspondence between the subsistence practices of hunting and gathering, and distinct social features such as small group size, fluid group composition, conflict avoidance through mobility, immediate return and demand sharing (op.cit.:303). He also observed that this postulate had been undermined by increasing evidence to the contrary: that often those designated as hunter-gatherers did in fact not just hunt and gather, but engaged also in limited gardening, herding, wage labour or trade (op.cit.:303f.)—reminiscent of the situation he subsequently described for his own field site. He then referred to Nurit Bird-David (1988, 1992)[20] as the principal scholar who had argued for the validity of the hunter-gatherer concept on social grounds: that the concept referred not primarily to techniques, but to the approach towards them and the attendant social parameters.

It is mainly in this social sense that he defined the Sawiyanö as "Hunter-Gatherers", as opposed to the "Horticulturalists" which they appear to be in a technical sense. As Guddemi observed somewhat analogous to my introduction to chapter 1, this contrast is replicated by the contrast of Sawiyanö subsistence with the classical image of PNG subsistence:

> "New Guinea societies in particular have been famous for anything but a forager-like style of subsistence or social organization. The ethnographic record has been dominated, instead, by very productive horticultural societies which are often preoccupied with the production, distribution, and circulation of pigs and/ or shell valuables and/ or long yams. In fact, this type of concern has been taken by many specialists as well as generalists to define Melanesianness. However, there exist several small-scale New Guinea societies, such as many of those of the Sepik hinterlands, in which features of the hunter-gatherer social configuration are found." (op.cit.:304)

More specifically, Guddemi's data, as well as my own data from Krisa and the data presented in other accounts from the region (cf. Appendix 6) render an image of societies in which people typically

- maintain rather low group sizes and population densities;
- employ considerable individual and group mobility, which tends to draw on flexible kin relationships and inter-group alliances;
- appear casual in their appropriation of resources and immediate in their consumption, in a hand-to-mouth fashion;
- display a large degree of egalitarianism, value individualism, rely on nucleated work groups and emphasize sharing, often expressed as demand-sharing;
- define their way of life less in regard to cultivation than to a seemingly more hazy and intricate concept of human–environment interaction;
- follow a legal code which not only bases land-use on land-rights, but also vice versa, thus rendering non-use a forfeiture of rights and familiarity with land an entitlement to it, and attaching legal significance to environmental manipulation which in cognitive respect remains inconsequential;
- recount myths, apply magic, and perform rituals which centre, not on gardens, gardening and its products, but on locales, practices and resources beyond: the various forest environments; the hunting, gathering and collecting activities within them; and the organisms which populate this vague sphere outside close human control, often similarly ambivalent in status as the subsistence activities, neither completely cultivated nor completely wild.

Hence, the confusion in technical respect is compounded by a confusion in social-cosmological respect. The one involves the problem, on which I will expand further in the remainder of this chapter, of how to classify forms of subsistence which rely on the juxtaposition of contrasting subsistence practices. This is not merely a taxonomic challenge. It impinges on our conceptions of human–environment relations more generally, as I will detail in chapter 4. The other confusion concerns our ideas of how the ecological and the cultural aspects of subsistence relate. In this regard, Guddemi concluded:

> "Technology, in the sense of knowledge, is not destiny. Knowledge of planting in and of itself does not mandate a social transformation from a so-called hunter-gatherer social formation to a sedentary one." (op.cit.:312)

This declaration seems addressed at scholars who postulate that historically the 'discovery' of planting triggered increasing sedentism and consequently social change. Unfortunately, it introduces an unfounded assumption, if only for it to be debunked. After all, the relationship between sedentism, subsistence and social forms, and much less so a causal one, is far from clear.[21] In fact, the described subsistence system is necessarily predicated on mobility, as I will demonstrate in chapter 5. Still, Guddemi's basic argument remains that subsistence involves (at least) two variables, namely technical patterns on the one hand, and social patterns on the other, which are to be kept separate analytically. Whether these are independent in practice, as he implies, or mutually dependent, as I will show, any such conclusion must rely on the prior distinction of both domains.

Guddemi sketched out the profound implications of this recognition by speculating about the possible extent of the described condition in space and time:

> "[The Sawiyanö] are certainly not the only group showing this; more populous and prominent groups may be reanalyzed in this way; e.g., the Yanoama (Yanomami) of South America (Colchester 1984)[22]. Whatever their particular histories, these groups show that the knowledge of plant propagation does not necessarily lead to sedentism and its associated social transformations. Therefore, what is there to have prevented such a type of exploitation in the tropics, if not of root crops then of tree crops such as bananas, at a very deep time horizon indeed, far earlier than that which is usually discussed for the origins of that complex of technological and social adaptations called agriculture?" (op.cit.:312f.)

I will return to this idea in chapter 6, where I apply precisely the widened focus which Guddemi suggested. In the remainder of the present chapter, I will lay the foundations for this, by examining existing models for subsistence in tropical rainforest.

3.2. Human Survival in Tropical Rainforest—Proteins and Diets

In the last several decades, numerous authors have concerned themselves with the question of human survival and its limitations in tropical rainforest. The respective debates, which I will review in this and the next section, touch on several of my concerns: on the one hand, they provide some answers to the question whether present-day diets in the far northwest of PNG are nutritionally adequate; on the other hand, they offer an important background for comparative analyses and for speculations on subsistence system prehistory.

At first, the debate revolved around the question of protein availability. It was apparently triggered by Donald Lathrap's (1968)[23] contribution to the seminal volume 'Man the Hunter' (Moran 1996:535). Subsequently, Daniel Gross (1975) published a synthesis article, in which he surveyed relevant literature for "evidence that dietary protein was limiting on aboriginal settlements throughout most of Amazonia" (op.cit.:527), and that "small and frequently shifting villages, warfare, and population control were adaptations to this limitation" (loc.cit.). He concluded that "the size, form, and permanence of settlements, social complexity, and warfare patterns may vary in the Amazon basin with differences in the availability of animal protein in the diet" (op.cit.:538). Gross based his argument on the assumption that "[p]rotein is provided primarily by meat and fish" (op.cit.:527), in keeping with the general tendency of the debate, which was largely framed in terms of game scarcity (but cf. e.g. Milton 1984:14). Such scarcity was variously affirmed or dismissed as a fact, and as a factor in settlement patterns and social organization (for reviews see e.g. Keesing 1981:161; Milton 1984:7; Moran 2000:271f.,303).

The protein debate focused almost exclusively on Amazonia, which differs substantially from New Guinea in its faunal resources. Overall, the island's (mammalian) fauna is impoverished (e.g. Dwyer & Minnegal 1991:192; Gressit 1982:899; Menzies 1991:13f.); large game animals are limited to pig (introduced in the process of human colonization [e.g. Menzies 1991:13]), cassowary, crocodile, monitor lizard, and python, with the first the most prevalent; other game animals are in particular marsupials, the largest weighing up to 20 kilograms (Menzies 1991:115), but most others much smaller, besides rodents, bats and birds.[24] For assessing protein availability in New Guinea, therefore, challenges to the notion of protein limitation are of particular interest if they refer either specifically to the island, or involve arguments other than game abundance or scarcity.

Two authors have respectively made relevant contributions in this regard. Peter Dwyer (1983:esp.161,166f.) suggested that in New Guinea hunting is nutritionally effective only in altitudes below about 1,000 metres, the altitudinal limit for abundance of feral pigs—and incidentally the altitudinal limit of lowland rainforest. In a publication co-authored with Monica Minnegal (1991), he examined in detail the mechanisms accounting for success in securing and distributing comparatively large amounts of hunted meat in a lowland rainforest community (op.cit.:192-204). If these publications did not explicitly contribute to the protein debate, an earlier article by Stephen Beckerman (1979) was openly designed as a "Reply to Gross". Although Beckerman referred, again, to Amazonia, his arguments translate in principle to New Guinea. Thus, he challenged the protein scarcity hypothesis in particular on the grounds that Gross and others had neglected alternative protein sources: invertebrates (op.cit.:538-540); vegetable matter, including palm fruits and palm heart (op.cit.:540-547), nuts and fruits from dicotyledonous trees (op.cit.:547f.), and various cultivated foodstuffs, including cultivates of the previous (op.cit.:548-552); and the 'single-cell protein' of micro-organisms in fermented foods (op.cit.:552f.).

Even Beckerman paid only limited attention to non-mammalian vertebrate fauna. Thus, he mentioned reptile eggs but in passing (op.cit.:537), and omitted birds' eggs altogether, as indeed birds as game animals. This may reflect the dietary situation in Amazonia; in the PNG lowlands, birds in particular provide an important source of game meat and eggs, the cassowary exemplifying the former, the megapode the latter. The same applies to a lesser extent for reptiles.

Beckerman's attention to invertebrates highlighted another pervasive bias in assessments. Apart from the authors quoted in his review, there are number of others who have explicitly concerned themselves with entomophagy, without though reversing the trend. In particular, there are two publications which explore the subject in an Amazonian context: Dufour (1987) and Ruddle (1973); two monographic works: Bodenheimer (1951[25]—quoted in Ruddle [1973:94] as the only comparative work at the time) and Taylor (1975[26]—quoted in Sponsel [1986:77] among further references on the subject); and a recent article reviewing insect use more generally, with reference to numerous further publications: Motte-Florac and Ramos-Elorduy (2002). If they have all documented the dietary importance of insects, they have also regularly pointed out the neglect of the subject. In particular, the latter authors observed that "the nutritional value of insects is not well known" (op.cit.:216), an unfortunate situation in view of their multiple nutritional advantages:

> "Edible insects have a very high dietary value... Many species are valuable sources of proteins; with a 30 % to 72 % content they are richer than most meats... The quality of these proteins is generally good, and most edible insects are richer in several essential amino acids than the FAO/ WHO standards defining protein quality demand... Moreover, high lipid levels (30 %-36 %) are... particularly interesting for rural areas where fat resources are frequently lacking; moreover these fats enable an efficient use of protein. Insects are also rich in Vitamin B which is often scarce in tropical areas..." (loc.cit.)

Besides their superior nutritional values, insects are highly productive, "needing less feed to produce more meat than any other kind of animal" (Wilkinson & Elevitch 2004:97); they are typically procured with less effort than game animals (cf. Ruddle 1973:99); and their harvesting may at once reduce pest populations which could otherwise cause havoc to crops (cf. Ruddle 1973:96; also Flach 1983:30). The topic of entomophagy is highly relevant in a PNG context, in particular in lowland and mid-altitude areas, where the pith of the sago palm serves not only as the source of the starchy staple, but also as the substrate to incubate 'sago grubs'—the thumb-sized larvae of the sago weevil (*Rhynchophorus* spp. and others).[27] These are rich in both protein and fat, those of a South American species of *Rhynchophorus* comparable in their proximate composition to pork sausage (Dufour 1987:389,390-tbl.2). In Krisa, sago grubs are consumed frequently and in large quantities; other invertebrate foods are the larvae of wood-boring beetles which infest decaying tree stumps; moth larvae; various kinds of caterpillars; and crayfish.

The neglect of vegetable protein in dietary assessments is almost standard.[28] Beckerman countered this tendency partly, while admitting to potential gaps in his list (op.cit.:540). Indeed he omitted not only the fruiting bodies of mushrooms (cf. Treide 1967:102f.), but most importantly also leafy greens. These play a prominent role in PNG diets; typically contain considerable amounts of protein (see Table 2 below); but are as typically forgotten in dietary assessments.[29]

Lastly, Beckerman's reference to micro-organisms puts a widespread phenomenon of sago use in a new perspective: the wet storage and ensuing fermentation of sago starch. They are widely known and reported, explanations ranging from reduced perishability through enhanced flavour to cooking purpose (see section 3.6. for more detail). Increased protein content as a function of storage, though, for a staple which is otherwise nearly devoid of this nutrient (see Table 2 [p.36]) is not usually considered.[30]

Of course, protein content needs to be matched by a balanced amino acid composition in order to be nutritionally effective. In this respect meat, fish and egg ('proto-meat') are superior to other foodstuffs, as Beckerman (op.cit.:553,547-550,esp.fig.1) and Gross (1975:527-tbl.1) have reiterated (see also Dufour 1987:393). Yet, insects, too, may contain high amounts of essential amino acids (cf. p.34), while a varied diet is likely to level imbalances overall. In that sense, Table 2 represents only the tip of the iceberg. It lists with their protein content foodstuffs which are relevant in the far northwest of PNG, but emphasises plant resources overall and cultivated species among these, due to its correspondence with Table 1. Even so, the variety of protein sources, and their often high protein content, is evident.

Against this background, the notorious lack of protein in New Guinea diets (e.g. Garine 1994:229) appears as a potential artefact of incomplete assessments.[31] In fact, it seems that New Guineans have ingeniously countered the intrinsic paucity of their faunal resources with a diversification of their diets and the reliance on a wide range of comparatively protein-rich invertebrate and vegetal foodstuffs, and, in the forested lowlands, the abundant availability of feral pigs.

Table 2: Protein Content of Foodstuffs in the Far Northwest of Papua New Guinea
(notes see next page)

category	common name of plant/ organism	botanical identification	plant organ/ food item	water content per 100g edible portion	protein content per 100g edible portion
staples (starchy)	sago	*Metroxylon sagu*	starch (processed pith)	20-45 %	0.2 g
			fermented	(no data)	(no data)
	banana	*Musa* sp.	fruit	68 %	0.8 g
	taro	*Colocasia esculenta*	corm	75.4 %	2.2 g
	Chinese taro	*Xanthosoma sagittifolium*	cormels	70-77 %	1.3-3.7 g
	greater yam	*Dioscorea alata*	tuber	76.4 %	1.9 g
	lesser yam	*Dioscorea esculenta*	tuber	73.6 %	1.5 g
	cassava	*Manihot esculenta*	tuber	65.6 %	1 g
	sweet potato	*Ipomoea batatas*	tuber	72 %	1-1.2 g
	breadfruit	*Artocarpus altilis*	flesh	80 %	0.8 g
other vegetables	aibika	*Hibiscus manihot*	leaves	[*]83 %	[*]5.6-5.7 g
	amaranthus	*Amaranthus* spp.	leaves	85 %	5 g
	Indian mustard	*Brassica juncea*	leaves	91.8 %	2.4 g
	ferns	N/A	fronds, shoots	(no data)	(no data)
	kangkong	*Ipomoea aquatica*	leaves	89 %	2.7-4 g
	tulip	*Gnetum gnemon*	leaves	[*]76 %	[*]6.4 g
	kumu musong	*Ficus copiosa*	leaves	(no data)	(no data)
	balbal	*Erythrina variegata*	leaves	81.5 %	4.6 g
	lowland pitpit	*Saccharum edule*	inflorescence	92.4 %	4.1-4.6 g
	pumpkin	*Cucurbita moschata*	leaves	92.6 %	3 g
			fruit	91.9 %	0.7 g
	cucumber	*Cucumis sativus*	fruit	96 %	0.3-0.7 g
	corn	*Zea mays*	seeds	62.5 %	4.2 g
fruits	sugarcane	*Saccharum officinarum*	stem	81.4 %	0.2 g
	pawpaw	*Carica papaya*	fruit	87.1 %	0.5 g
	ton	*Pometia pinnata*	fruit	(no data)	(no data)
	marita pandanus	*Pandanus conoideus*	fruit	75.8 %	1.4 g
nuts	coconut	*Cocos nucifera*	flesh—mature	36-50 %	4-4.7 g
			milk (= watery extract)	59 %	2.5-4.3 g
			flesh—immature	70-90 %	0.7-4.8 g
			liquid	95.4 %	0.1 g
	breadfruit	*Artocarpus altilis*	seeds	52 %	6 g
	galip	*Canarium indicum*[†]	kernels	9 %	14.2 g
	pangium edule	*Pangium edule*	seed, pulp	(no data)	(no data)
mushrooms		N/A	fruiting body	(no data)	(no data)
insects		family *Cerambyidea*	sago grubs, uncooked	[‡]70.5 %	[‡]6.1 g + fat: 13.1 g
		Rhynchophorus sp. (South America)	palm grubs, smoke dried	[§]13.7 %	[§]24.3 g + fat: 55.0 g
		various spp. (South America)	caterpillars, smoke dried	[§]11.6 %	[§]52.6 g + fat: 15.4 g
fresh hen's egg		[*Gallus* sp.]	egg	(no data)	[**]11.3 g
whole cow's milk		[*Bos* sp.]	milk	[††]87 %	3.7 g

Notes to Table 2:

Listing of items corresponds largely to extent and format of Table 1. Data are taken from French (1986) unless otherwise specified. Data on South American insect larvae, hen's egg and cow's milk are added for analogy and/ or comparison. Highlighting indicates food items with comparatively high protein content.

[*] Data from Powell (1976:116-tbl.3.3).

[†] For the problems with identifying galip, cf. Case Study 1.

[‡] Data from Ruddle et al. (1978:58f.).

[§] Data (South American origin) from Dufour (1987:390-tbl.2).

[**] Data from Gross (1975:tbl.1).

[††] Data from Beckerman (1979:543).

3.3. Human Survival in Tropical Rainforest—Calories and Environments

The Debate

As the protein scarcity debate died down in the 1980s, a new debate was emerging, with the focus now on the scarcity of calories in tropical rainforest (esp. Hart & Hart 1986; Headland 1987; Bailey et al. 1989; Piperno 1989:540-543; Townsend 1990; Bailey 1990; Dentan 1991; also Milton 1984, who fused both debates by postulating an asymmetrical scarcity, and resulting exchange relationship, between Tukanoan and Maku Indians). It culminated in a special issue of the journal Human Ecology in 1991 (Headland & Bailey 1991; Brosius 1991; Endicott & Bellwood 1991; Dwyer & Minnegal 1991; Bahuchet et al. 1991; Stearman 1991; Bailey & Headland 1991).[32] In the following, I will refer to these sources only by author and page number, to simplify citations.

In the protein debate, the main concern had been the effect of protein availability on settlement patterns and social organization; its relevance for the present study is less in terms of this discourse than of its implications for dietary assessments. The calorie debate, in contrast, revolved around the more fundamental(ist) question, through which it impinges directly on my study, whether low calorie availability limited human presence altogether. More specifically, whether human presence became possible only upon 'environmental improvement' through cultivation and was therefore a "post-agricultural phenomenon" (Dwyer & Minnegal 188): whether rainforest dwellers were either cultivators themselves or depended on cultivators, for the trade of foodstuffs or for past or present environmental transformations. The original debate-promoting articles by Headland and by Bailey et al. had affirmed this proposition, rejecting the notion of independent foraging in tropical rainforest.[33]

Arguments were based on various forms of evidence: data on rainforest ecology and resource biology (Bahuchet et al.; Bailey & Headland; Dentan; Endicott & Bellwood; Hart & Hart; Headland; Milton; Piperno; Stearman); ethnographic and ethnohistorical data (Bahuchet et al.; Bailey et al.; Brosius; Dentan; Dwyer & Minnegal; Endicott & Bellwood; Hart & Hart; Headland; Milton; Stearman; Townsend); and archaeological data (Bailey et al.; Bailey & Headland; Endicott & Bellwood; Headland; Piperno). On the one hand, the massed contributions on a single topic provided a wealth of evidence in concentrated form. On the other hand, interpretation of such evidence depended on the various authors' conceptual outlook, the role of assumptions heightened by "political-philosophical overtones" (Dentan 139). For, the debate continued an earlier challenge to ahistorical and isolationist views of hunter-gatherers (cf. Bahuchet et al. 214, Dwyer & Minnegal 188), while engaging notions of purity and essence in respect to environment and subsistence form. This threatened its deterioration into a pointless classification exercise with protagonists talking at cross purposes, and obscured intriguing commonalities among them.

This situation, though, offers an opportunity to explore implicit assumptions about rainforest environments and subsistence alongside the evidence, and via this detour bring us closer to an understanding of present, past, and potential land and resource use in tropical rain forest. In the following, I will attempt such a dual exploration, with three aims in mind: 1) to distil insights relevant to my argument;

2) to identify some limitations of the debate, again as they pertain to my argument; and 3) to trace a pattern of environmental manipulation which is conspicuous in many accounts but has been made little explicit.

Rainforest Instability

To begin with, the debate highlighted the contrast between essentialist notions of rainforest habitat and evidence for its complex and dynamic character. The former has typically manifested in concepts of a stable climax state and of "homogeneous complexity" (Stearman 246; also Brosius 127f.), which have tended to render an image of rainforest as both permanent and uniformly mature and diverse. Consequently, rainforest was considered entirely inhospitable to humans, due e.g. to plant anatomy (edible parts out of reach in the canopy because of competition for light), physiology (much ligneous substance because of the need for structural support), and distribution (low resource density) (e.g. Bailey et al. 60). This was contrasted with the observation that light-dependent secondary vegetation exhibits opposite characteristics and consequently tends to be richer in food plants (Bailey et al. 62; Bailey & Headland 264; Hart & Hart 38f.; Piperno 541-543,549). The contrast was taken as evidence that only large-scale forest clearing in the course of agricultural activities could promote sufficient secondary vegetation to support human populations (Bailey et al. 62; Bailey & Headland 264) and/ or allow for the cultivation of food crops to which these populations would gain access directly or indirectly (e.g. Headland 464; also cf. Dwyer & Minnegal 188). The assumptions which support these inferences, though, are unrepresentative of ecological reality. They are qualified by an examination of the underlying ecological concepts, and by ecological research that indicates instability, immaturity and patchiness of tropical rainforest environments.

Firstly, the established Clementsian model of an ordered vegetational succession towards a mature and persistent climax state is based on temperate zone evidence and hence little suited to tropical regions (Johns 1990:esp.135); is fraught with ideological baggage (Blumler 1996:31-33); and is challenged by recent insights which indicate "that succession is not always linear or progressive" and "that most plant species are adapted to and even require some form of disturbance" (op.cit.:33). In fact, biological thinking more generally has moved towards a nonequilibrium model of ecological communities, regarding them as in constant flux upon sporadic disturbances (e.g. Campbell & Reece 2002:1186-1188). Secondly, the long-held tenet has been reversed by which diversity has been uncritically equated with a climax state, and hence taken as its indicator. On the one hand, theoretical considerations suggest that the comparatively broad resource requirements of numerous rainforest species would through competition lead to the elimination of diversity in the process of succession (Connell 1978:esp.1306f.,1309). On the other hand, factual evidence indicates that indeed single species dominance tends to mark mature forests (op.cit.:passim), while conversely high species diversity occurs particularly in unstable areas (ibid.; Johns 1990:135,136,137). Contrary to the widely established view, therefore, rainforest is to be regarded as "a dynamic and unstable ecosystem" (Johns 1990:133).

Indeed, there is ample evidence for extensive oscillations in the extent of rainforest in Africa, Amazonia, Southeast Asia and New Guinea upon long-term climatic change—the maximum contractions during periods of glaciation with their cooler and drier climate reducing rainforest worldwide to patches of 'Pleistocene refugia' (Johns 1990:135f.; Whitmore 1990:87-96; also, relying on various sources: Bahuchet et al. 221; Bailey et al. 67-70; Endicott & Bellwood 175).[34] Besides such drawn-out fluctuations, intrinsic rainforest instability is suggested by the extremely long timespans—several centuries—which the development of mature vegetation requires, demanding the unlikely absence of any disturbance in the meantime (Johns 1990:137). Thus, sporadic and localised causes for rainforest instability are volcanism and earthquakes; cyclones and wind storms; and drought, which in particular in Malesia (cf. p.6) is heavily influenced by the El Niño phenomenon (Johns 1990:138f.). On a smaller spatial scale, infections, tree deaths, lightning strikes, wind falls, landslides, and localized variations in moisture and river activity constantly cause disturbance (Johns, 1990:138; Endicott and Bellwood 158 [relying on Whitmore 1975][35]; Stearman 246; also Bailey & Headland 265). Distinct floral and geological features may further amplify instability (Johns 1990:133; Stearman 247f.; Whitmore 1990:116 [relying on Johns 1986][36]). Hence, "even 'mature' tropical forest is a dynamic mosaic of vegetation in various phases of succession, and... was that way long before human intervention" (Bahuchet et al. 219; see also op.cit.:224, Dentan 424 and references quoted).

Even in the absence of disturbance, vegetational character varies due to the need for drainage which creates ecotones[37] along stream- and riverbanks (Brosius 134; Dentan 424) and due to topographic, edaphic and microclimatic differences which create microhabitats (Endicott and Bellwood 158 [relying on Whitmore 1975][35]; Stearman 246). Furthermore, some soil conditions produce naturally open canopy (Endicott & Bellwood 168). The resulting "spatial and temporal texture of tropical forests" (Stearman 246) coincides with the tendency of humans

- to rely on immature vegetation (cf. p.39);
- to utilize various biomes simultaneously (e.g. Dentan 424 [relying on several sources]);
- to favour ecotones, which offer both high biological productivity and high species diversity (e.g. Harris 1969:9).

Besides, environmental patchiness can facilitate harvests through concentrating rather than diffusing resources, as manifested most strikingly in monospecific stands (Stearman 247 [relying on a survey of various sources]). Rainforest must therefore always have offered some degree of hospitability to humans, even though human activities have substantially increased the overall proportion of favoured rainforest habitats since.

Calorie Sources

The recognition of rainforest instability has at once shed new light on the principal calorie source investigated in the debate: yams. Originally, it was assumed that their seasonal shortage was limiting to human survival in rainforest (esp. Headland 468). Yet, forest yams seem adapted less to seasonal drought—in contrast to savannah yams—than to rainforest dynamics, rendering their availability less subject to climatic cycles than to vegetational disturbance (Bahuchet et al. 223f.). Piperno's (541) observation that tuberous perennials "are scarce in undisturbed contexts [but] common in secondary growth" supports this suggestion, as does information I have recorded in Krisa that wild yams begin to sprout in abandoned gardens (cf. also Watson 1965:297).[38]

Besides the presumably misplaced emphasis on yam seasonality, the emphasis on yams per se tended to obscure other calorie sources in variously mature rainforest—analogous to the focus on game and fish which obscured other protein sources (cf. section 3.2.). Firstly, dietary starch as a source of calories is not limited to tubers. The range of alternatives encompasses large starchy tree fruits, such as from *Artocarpus* species (Endicott & Bellwood 164); Job's tears (*Coix lachryma-jobi*) (Dentan 426);[39] the Melanesian 'croton complex', comprising *Cordyline terminalis*, cycads, and true crotons (loc.cit.);[40] and starch-storing palms such as *Metroxylon sagu* (op.cit.:427—see section 3.6.). The relevance of sago palms was also highlighted by Brosius, Dwyer & Minnegal, and Townsend (all:passim), a lead, though, which the proponents of the starch scarcity hypothesis showed little enthusiasm in exploring. The conceptual ambivalence of sago palms as resources (see section 3.6.) and the neglect of Melanesia in the debate (see below) may have contributed to this indifference. Secondly, carbohydrates as a source of calories are not limited to starch, but are also contributed by the sugars in honey (Dentan 423; Bahuchet et al. 229; Endicott & Bellwood 164; Stearman 255) and in tree fruits (Dentan 423; Endicott & Bellwood 163f.), which for some Malaysian groups surpass starchy foods in terms of preference (Dentan 423). Thirdly, calories are also contributed by non-carbohydrate nutrients, in particular the fats of nuts and seeds and of animals (Bahuchet et al. 229f. and Brosius 145 [qualifying an earlier assessment by Hart & Hart 34,46]). Protein may be an inefficient and potentially harmful source of calories (Bailey et al. 61, and references quoted; also Milton 19f.). Nevertheless, meat can figure prominently as a foodstuff (Stearman 254), or can function to tide people over otherwise lean periods (Bahuchet et al. 230f.).

On the other hand, nutritional sufficiency depends not only on calories, but importantly also on functional nutrients, in particular protein (Dwyer & Minnegal 189-n.4; see also e.g. Ellen 1982:152f., Morren 1977, and section 3.2.). The importance of essential fats and micronutrients has rather been omitted in the debate. The aspect of functional nutrients of whichever kind (proteins, lipids, vitamins, minerals) is especially important when sago starch is the dominant staple, since it consists of almost pure carbohydrate. As indicated in section 3.2., sago starch may be successfully complemented with protein and fat from nuts, insects, eggs, and game; and the protein from leafy greens and fermentation processes.

Human–Environment Interaction

The debate exposed and contested not only essentialist notions of rainforest, but thereby at once essentialist notions of human–environment interaction according to which foraging constitutes an unmediated exploitation of resources and agriculture the sole form of environmental manipulation.

The conception of unmediated exploitation entails the idea of a one-way relationship between resource availability and use. Its corollaries are, on the one hand, that resource availability is seen to determine and hence manifest in use (Bahuchet et al. 221f.; Endicott & Bellwood and Dwyer & Minnegal make the same point less explicitly), on the other hand, that resource use is perceived to inevitably cause resource depletion. Empirical evidence, though, contradicts both notions. Of course, only available resources *can be* used, but not all available resources *are* used.

Assuming the latter disregards the role of nutritional and cultural choice and easily results in unrepresentative assessments (Bahuchet et al. 222; Brosius 132; Endicott & Bellwood 156f.,163f.; Dentan 427; Townsend 746). Conversely, use of resources does not necessarily diminish their availability, but may within limits increase it. Depending on a resource's reproductive strategy, moderate harvesting may enhance its productivity within a window of initial depression and long-term depletion through overharvesting (Brosius 132 [relying on numerous sources]). Non-use, rather than use, then leads to resource deterioration (op.cit.:133). This phenomenon has been documented in particular for sago palms with clumping habit (op.cit.:143; see also section 3.6.), and indicates a symbiotic relationship between humans and their resource (see section 4.5.).[41]

If therefore the concept of foraging turned out as artificially limited, that of agriculture emerged as artificially inflated (following quotes with underline added). Thus, Headland & Bailey spoke in their review article interchangeably of a life "independently of agriculture" (title), a life "independently of domesticated plants and animals" (117), and survival "in a rain forest without access to at least some cultivated foods" (118); in their response article, Bailey & Headland refined their hypothesis to state that "in the absence of purposeful forest clearing for the purposes of cultivation of domesticated or semi-domesticated plants, humans have never subsisted for sustained periods in tropical forest environments" (266f.). In regard to subsistence prehistory, Bailey et al. had thought rainforest occupation unlikely "until the development of ways to alter [i.e. enhance] the density and distribution of edible resources through domestication of plants and clearing of climax forest" (73), whereas Headland & Bailey were concerned about "human subsistence in tropical forest prior to the introduction [i.e. from the outside!] of domesticated plants and animals" (121).

As I will demonstrate in detail in chapter 4, these phenomena are principally distinct from one another. Conflating and subsuming them as agriculture is indeed "naive", as Brosius (129) was provoked to comment. In fact, forest clearance is only one factor which may enhance resource density and distribution; others are less invasive forms of resource management, such as the removal of juvenile competitors, or harvesting alone, as described above. Introduction of (ex-situ) domesticat*ed* resources is not a necessary precondition for such alteration, although (in-situ) domesticat*ion* may be its long-term consequence; clearly, both processes are distinct. Conversely, domesticated resources do not necessarily require cultivation; cultivation, in turn, does not equal agriculture; and agriculture does not constitute the sole form of environmental manipulation which would make it the necessary opposite of foraging.

Hence, the proponents of the calorie deficiency hypothesis relied on an at once aggregate and monolithic concept of resource management and subsistence development, manifested in their facile equation of forest clearance, enhanced resource density and distribution, (external) introduction and (autochthonous) evolution of domesticates, cultivation, and agriculture. Not only was this inevitably at odds with empirical data and therefore demanded regular qualifications. It also obscured that the apparent opposites of 'foraging' and 'agriculture' converge in fact on precisely the unorthodox forms of resource management whose nuanced exploration could shed more light on human survival in tropical rainforest, past and present.

Forager Behaviour

The debate has also drawn attention to the characteristics of forager behaviour, again via the critical examination of some facile assumptions. Thus, the proponents of the calorie scarcity hypothesis relied on a rigidly defined concept of foraging not only in ecological respect but also regarding various other dimensions of human life. In fact, Brosius (129) complained that "they continually shift the focus of their arguments from agriculture, to technology, to management effects, to ecotones, to previous human disturbance, and it is not at all clear where they have established bounds". In particular, they variously demanded the absence of both cultivated and domesticated food resources; of iron tools; and of trade irrespective of content (Brosius 129f.).

Clearly, such criteria are unrepresentative of ethnographic reality. Indeed, they conflict with current thinking in hunter-gatherer studies. Thus, it is now widely accepted that "subsistence based on hunting of wild animals, gathering of wild plant foods, and fishing, with no domestication of plants, and no domesticated animals except the dog" provides only a "minimal definition" of foraging (Lee & Daly 1999a:3). Rather, it has been recognised that on the one hand "contemporary foragers practice a mixed subsistence" including gardening, herding and trade (loc.cit.), while on the other hand the respective societies share characteristic traits in regard to social life, ethos and world view (op.cit.:3-5; cf. also section 3.1.). This has produced a more encompassing definition, which acknowledges that

> "...subsistence is one part of a multi-faceted definition of hunter-gatherers: social organization forms a second major area of convergence, and cosmology and world-view a third. All three sets of criteria have to be taken into account in understanding hunting and gathering people today." (op.cit.:3)

Much as hunter-gatherer existence is multidimensional, so is forager behaviour multiform and complex. This manifests not only in a combination of subsistence activities, but more specifically in the pursuit of opportunistic strategies, by which foragers take advantage of multiple resources encountered (Dentan 424; Endicott & Bellwood 154,181). Particular instances are the adoption of agricultural foodstuffs when the opportunity arises (Bahuchet et al. 222; Endicott & Bellwood 181), and "snacking behaviour", which contributes both to overall food consumption and to dietary variety (Stearman 253). This combines with the tendency to use immature vegetation, a combination of biomes, and ecotones (cf. p.40). The attempt by Headland and Bailey, in their various contributions, to limit the debate to mature rainforest habitats without ecotones, and to exclusively non-agricultural foodstuffs therefore "means that... a people must behave in ways uncharacteristic of both their species and their economic adaptation" (Dentan 424).

The authors' stubborn adherence to an extremely rigid concept of foraging, both in ecological and behavioural terms, was particularly ironic in view of Headland's initial reference to a "Rousseauian notion of natural purity and cultural pollution [that] permeates the field of hunter-gatherer studies" (464 [quoting Barnard 1983:194][42]), which apparently he aspired to demolish, and of the original assertion by Bailey et al. that "studies of these contemporary peoples can add to our understanding of universal processes that have shaped the behavior and morphology[!] of our species and accounted for differences among us" (59).

An Implicit Theme: The Status of Forest and Trees

In fact, a detailed examination of the data presented in the debate may contribute precisely such an "understanding of universal processes", which though the fixation on essential categories obscured. Thus, most contributions carried a common, if partly implicit theme relating to the recognition that the distinction between agriculture and foraging is blurry, "either conceptually or with respect to the biological and demographic processes of the resources being exploited" (Brosius 130f.) This blurriness occurred, more specifically, with the status of both the forest at large and of individual resources, in particular trees and palms. Indeed, Townsend (746) observed that "the line between gathering and cultivation seems particularly wobbly" for the latter, and warned appropriately: "Perhaps because of this ambiguity, palms are being left out of an argument to which they are likely to be crucial" (cf. Ingold 2000:86; also sections 3.5. and 3.6.). In fact, many contributions documented, if largely in passing, a central subsistence role of trees and palms. I will detail this evidence in the following, before moving on to the ambiguous status of the forest at large.

Townsend herself (746) mentioned primarily *Metroxylon* sago palms, but in passing also other palms, as well as fruit and nut trees, as suitable resources for rainforest subsistence. She described the Saniyo-Hiyowe in the far northwest of PNG as comparatively self-sufficient users of feral and wild sago, who draw only a minor proportion (<10 %) of their calorie foodstuffs from cultivation, and suggested that they "provide a more useful model of prehistoric tropical forest foraging than the ethnographic cases of foraging" which rather refer to "commercial hunter-gatherers". In passing, she indicated how exotic tree domesticates can be slotted into an existing system of resource use without any structural changes (746).

Dwyer & Minnegal followed a similar line of argument, proposing Kubo subsistence in the southern PNG lowlands as the basis for a model of non-agricultural subsistence in tropical rainforest (187,210). They demonstrated elegantly how cultivation, which provides a minor proportion (2-14 %) of calories (207), is structurally independent of hunting, which in turn is ecologically and socially integrated with the use of mostly wild sago. They emphasised, however, that current sago distribution and densities manifest long-term human manipulation, conscious or unconscious (210 [referring to Rhoads 1982]).

Dentan detected a "centrality of trees in the thinking of foragers in both parts of Malaysia" (427). This "ubiquitous arboricentricity" (423) becomes evident in the importance of tree fruits for the diet; in "husbanded collecting" (following Ellen 1988:127), which involves the tending of wild trees, opportunistic weeding of adventitious seedlings, and individual ownership; and in the integrality of tree ownership to land tenure (422f.). Dentan inferred that it may reflect an ancient approach to resource use (423), and speculated on this basis about the suitability of various genera of sago palms for Semang (west Malaysian forager) subsistence, presently based on yams and trade (427ff.).

Brosius (143f.) traced a similar attention to trees with the Penan of Borneo, who hold a concept of 'molong', entailing access rights as well as ecological stewardship towards various fruit trees and *Eugeissonia* sago palms, many of which occur outside agriculturally affected areas (144). Penan support *Eugeissonia* abundance through moderate harvesting, which enhances productivity (cf. p.42); through additional thinning en passant (144); and through observing recovery periods for stands (143). The centrality of *Eugeissonia* in Penan subsistence is evident in its integration with mobility patterns (142).

Bahuchet et al. (235f.) likewise mentioned tree crops, when speculating how early Bantu cultivation in African rainforest may have evolved symbiotically with existing Pygmy forager subsistence. Thus, ecological considerations (223-228), linguistic evidence (234,235), and archaeological data (236) suggest that early farmers may have relied on Pygmy knowledge of rainforest resources, in particular yams, to develop "an agricultural system centered on root crops and trees" (236).

Piperno pointed out that wild palms are extensively used by contemporary Panamanian indigenous populations, but that their abundance is low in mature and late secondary forest (542f.). As she generally found wild resources in greater abundance in disturbed contexts (esp.541,549), she speculated that forest clearance for the purpose of planting fields may have incidentally enhanced their densities (549).

In sum, numerous contributors to the calorie debate documented how trees are centrally important for rainforest foraging, while variously acknowledging their reliance on human impact. This latter aspect has been especially highlighted by Piperno. Her evolutionary perspective, and her acknowledgment that the variability of economic strategies during the early millennia of agricultural development made a distinction into agricultural and hunting-gathering economies meaningless (548) may distinguish her position from that taken by Bailey and Headland in their various contributions. Yet, she, too, regarded secondary vegetation and its utility as essentially a by-product of agriculture, and this in turn as the necessary precondition for and/ or concomitant of human occupation of rainforest habitats. Considering the intrinsic instability of rainforest, though, and its implications for resource availability, causality may well be the other way round. Thus, ***cultivation plots may be a by-product of the desire to generate useful secondary vegetation, diverse biomes, and ecotones*** in order to enhance existing characteristics of rainforest which make it habitable for humans (cf. p.40).

In any case, the notion that humans could occupy rainforest, or any environment, without leaving traces, is as misleading as that of unmediated exploitation of resources which it entails (cf. p.41). Accordingly, Brosius (131f.) referred to the dilemma of how to define 'pure foraging' and 'undisturbed forest' in view of "the unconscious effects of exploitation or the conscious management of resources", and reflected:

> "We may be forced to conclude that foragers have not ever existed on[sic] any biome."

Therefore: "It may indeed be true, as Bailey et al. contend, that humans did not occupy tropical forests 'until the development of ways to alter the density and distribution of edible resources' (1989:73). But there are certainly other ways to do this than 'through domestication of plants and clearing of climax forest.'" In a similar vein, Bahuchet et al. (231) pointed out that Pygmies, "like other foraging peoples,... sometimes manipulate wild plants in ways that must be classified as 'protoagriculture'", in particular by replanting yam heads. Like Brosius, they then expanded their perspective to suggest: "'Foraging' peoples may also interfere with wild plants on a much larger scale, by manipulation or even virtual management of the environment" (ibid. [referring to Groube 1989]) and concluded that

> "massive interference with the forest to promote food plants is probably much older than shifting cultivation, and 'foragers' in rain forest may have enjoyed the benefits of such interference long before true agriculture and domesticated plants evolved in situ in these forests (Groube, 1989), or arrived from elsewhere". (ibid.)

These considerations also throw new light on another intriguing limitation of the debate, namely the virtual exclusion of New Guinea (cf. e.g. the omission in Bailey et al. 62-67, paralleled by that in Lee & Daly 1999b). This region has typically received little consideration in the debate (exceptions are Townsend and Dwyer & Minnegal), which is maybe unsurprising in view of its common, if unwarranted, equation with cultivation practices. Indications that these reach back to the expansion of rainforests and the creation of large swamplands at the end of the Pleistocene have been taken as evidence that humans in New Guinea have only ever lived in substantially transformed rainforest environments (Bailey et al. 70; Bailey 747; Headland & Bailey 120). This interpretation not only disregards the time-lag which widespread environmental transformation would have required; it also naively assumes a homogeneous approach to subsistence throughout the island. In particular, it is inconceivable how "evidence for *minor localized* deforestation", which "*might* relate to the development of early agriculture" (Bailey et al. 70, emphases added) and which coincided temporally, but not necessarily spatially, with the creation of large swamplands can disqualify the sago palms in these swamplands as potential resources for prehistoric foragers (Bailey 747).

Such slips highlight the dangers of applying a blanket approach to geographical regions and archaeologically documented phenomena (cf. Brosius 128; Endicott & Bellwood 181). Contrary to superficial inferences of this kind, just the two contributions by Townsend and Dwyer & Minnegal demonstrate through in-depth analysis how in two distant locations in New Guinea, situated on opposite sides of the central cordillera, subsistence independent of 'agriculture' is possible in principle and largely in practice. The fact that the sago palms harvested must be considered managed corresponds both to the observations of Dentan, Brosius and Bahuchet et al. of practices focused on trees, and to the two latter's considerations regarding "massive interference with the forest" through non-agricultural resource management.

Conclusion

To conclude, there was a tendency in the calorie debate to rely on rigid definitions, which were suited to polarise the discussion and to obstruct rather than promote further investigation (cf. Dwyer & Minnegal 190-n.5; Townsend 747). Such polarization then produced a lack of attention to the fuzzy intermediate zone, sometimes by outright dismissal of borderline cases (cf. Brosius 129; Dwyer & Minnegal 210-n.14). This led to a paradoxical argument, in which the proponents of the starch scarcity hypothesis consistently eliminated an ill-defined condition of disturbed forest from their category of forager subsistence, but then stopped short of explicitly including this condition in their category of agriculture. Thereby, they rendered invisible the respective subsistence forms, which though at once represent the most likely candidates for survival "independent of agriculture". Likewise, their dismissal "[i]f tropical rain forests presently seem able to sustain human foragers, it may be because long human occupation in most areas has created widespread disturbance of what were once climax habitats" (Bailey et al. 62) implied that form of vegetation and hence subsistence were dependent on length of occupation. Taken to the extreme, this means that by entering the rainforest humans ceased to be foragers by definition, if there had ever been any foragers before. While this is not what the authors intended to convey, it conforms precisely to the conjectures by Brosius and Bahuchet et al. quoted above. Before I provide more theoretical support for this stance in chapter 4, I will in the remainder of the present chapter continue to evaluate available evidence for tropical rainforest subsistence. I will thereby follow the approach of Dwyer & Minnegal, who, rather than focusing "on ways in which people do not live in rain forest;... argue for careful examination of the ways in which they do" (189).

3.4. Swiddening

Perspectives on Swiddening

In contrast to the confusion regarding subtle environmental management in the calorie debate, there is little doubt that swiddening, an age-old form of land use in the tropics, constitutes a genuine form of cultivation, conforming to the definition by Ruthenberg (1971:2-n.1), of cultivation as "the preparation and use of land for growing crops". What distinguishes swiddening from other forms of cultivation is that the cropping period alternates with an often substantially longer fallow period (e.g. Ellen 1994:218). The fallow period separates the recurrence of two phases which Conklin (1957:31) identified as essential with this form of land-use: (I) removal of old vegetation and (II) control of new vegetation.

These characteristics have led to three complementary perspectives on swiddening, represented by three different terms. Firstly, the focus on Conklin's phase I has led to the identification of swiddening as '<u>slash-and-burn agriculture</u>', describing the technical sequence by which the removal of old vegetation is typically accomplished. Secondly, the focus on Conklin's phase II, and its likeness in many respects to temperate zone gardening, has led to the identification of swiddening as '<u>gardening</u>' (or 'horticulture').[43] Thirdly, the focus on the alternation between cropping and fallow phase, and the concomitant recognition that each new cropping phase needs to occupy a new portion of land, has led to the identification of swiddening as '<u>shifting cultivation</u>', entailing a "rotation of fields rather than crops" (Grigg 1974:57)[44].[45]

None of these terms is wholly satisfactory:

- 'slash-and-burn agriculture' disregards regimes without slashing and/ or burning, such as those employing 'slash only', 'slash-and-mulch', or 'burn-and-mulch' regimes; furthermore, it directs attention away from the cycle 'cultivation–fallow', which incorporates multiple components besides the cropped plot, an aspect on which I will expand below (cf. Dounias 2000:80,82,84);
- 'swiddening' itself suffers from the same limitations: according to Conklin (1957:1), it is the "recently revived English dialect word for 'burned clearing'"; according to Rappaport (1971:117), it "comes from the Old Norse word for 'singe'";
- 'gardening' is likewise biased, emphasising the cultivated plot and its characteristics at the expense of the aspect of fallowing or any cyclical land use patterns;
- 'shifting cultivation' tends to imply not merely a shifting of cultivation plots, but also a consequent shifting of settlement sites (e.g. Grigg 1974:60; Ruthenberg 1971:3); this confuses the issue, does not necessarily reflect ethnographic reality, and may even entail a negative value judgment, distortions which were summed up by Conklin (1957:1) in the image of "an aimless, unplanned, nomadic movement or an abrupt change in location, either of which may refer to the cropping area, the agriculturalists, or both";

- besides, both 'slash-and-burn agriculture' and 'shifting cultivation' are easily associated with the destructive ('slash-and-burn') pioneer ('shifting') agriculture of migrants, which constitute forms of subsistence wholly different from swiddening, involving 20-50 times more forest clearance (Dounias 2000:102).

More appropriate terms would be 'rotational bush fallowing' (Grigg 1974:60), or 'fallow farming' sensu Ruthenberg (1971:3, cf. Appendix 1). Yet, 'swiddening', first proposed in 1951 (Conklin 1957:1f.; Harris 1972:246), has come to assume these meanings and has become the standard term. In contrast, both 'slash-and-burn agriculture' and 'shifting cultivation'—which had long been authoritative (e.g. Grigg 1974; Ruthenberg 1971) and is still used, for example, by Sillitoe (1996)—should be avoided for their unfortunate connotations. 'Gardening', finally, which in particular non-anthropologists, whether academics or laypersons, frequently use, and which I have used in the text so far, might be considered inappropriate for its biased perspective and its conceptual reliance on a temperate-zone template. However, the cultivated plot is indeed the most conspicuous aspect of the system, and many of its characteristics do correspond to those of temperate-zone gardening (cf. n.43). I will therefore employ both the terms 'swiddening' and 'gardening', if in different meanings. With 'swiddening', I will denote the cyclical phenomenon, in theoretical contexts which serve the exploration of systemic properties and functional connections. With 'gardening', I will in ethnographic contexts denote the manifestation of this phenomenon in the cultivated plot and the activities associated with it.

Principles of Swiddening—Plot Preparation

Swiddening comes in numerous variations (cf. Conklin 1957:2-5; Dounias 2000:79-99; Ruthenberg 1971:16-24), but some aspects occur consistently throughout the spectrum, including plot size and the sequence of plot preparation.

The size of the plot—or 'swidden'—rarely exceeds 1 ha, and more commonly covers about 0.5 ha/ 1 acre (Dounias 2000:75; Harris 1972:246). It is interesting to note that this size approximates the extent of a natural disturbance (Dounias 2000:75). In view of the dynamic nature of rainforest and the role of this for human survival, which I have explored in the previous section, this correlation has implications both for forest regeneration and hence sustainability, and for inferences about the evolution of (certain forms of) swiddening, considerations to which I will return in chapter 6.

Plot preparation is considered the step that launches the cycle of land rotation. It commences with the removal of vegetation which has over some period of time remained largely unaffected by human interference, the type of vegetational community present depending on the length of this interval in conjunction with local ecological parameters. The following vegetation types are commonly distinguished: 'forest', with no indication of previous use; 'fallow' or 'regrowth', which in advanced stages may be classed as 'secondary forest'; and, without the establishment of major woody perennials after repeated clearing, 'grassland' (cf. e.g. ASWP:chpt.2-data field 17). Woody cover is preferable because it provides more biomass and hence more nutrients in the ash generated by subsequent burning, which constitutes the prime fertilizing agent in view of the fact that

> "tropical nutrient inventories are mainly in the plant cover rather than in the soil" (Clarke 1976:249; also Dounias 2000:81, Geertz 1963:22f. and Harris 1972:252f.).

Besides, woody cover fulfils a number of functions which enhance the recuperation of the soil before clearing and burning, and limit initial weed growth in the planted plot (after Ruthenberg 1971:33f. and Vasey 1981:18f.; cf. also Geertz 1963:19-22 for a vivid description of some of the processes involved):

- it lowers soil temperatures and thus facilitates the recuperation process
- it offers protection from erosion
- it limits the leaching process due to rapid evaporation
- it brings up nutrients from the subsoil owing to deep roots
- it enhances nitrogen and other nutrient levels
- it adds nutrients through leaf litter
- it enhances the restoration of soil structure
- it shades out weeds.

The beneficial effects of woody cover are sufficiently achieved through vegetation which is between 5-15 years old (Clarke 1976:253; Vasey 1981:19; Whitmore 1990:135), hence the same plot may be recultivated after that period. Indeed, it is predominantly secondary vegetation, rather than oldgrowth forest, which gets cleared for swidden plots (Clarke 1976:253; Dounias 2000:88; also Harris 1972:249).

The process of clearing typically follows a sequence in which first undergrowth is slashed and then large woody perennials are felled without being removed from the plot. This creates an opening in the canopy which will admit light necessary for the subsequent growth of crops and provides nutrient-rich combustible material (Dounias 2000:82). Next, the dead vegetal matter is either left to dry and then burnt, or, rarely, left to rot. This applies in particular to non-ligneous material, which is at once that part of the vegetation containing most of the mineral nutrients (Whitmore 1990:135). Ligneous material rather withstands either fire or decomposition and later on tends to fulfil such purposes as erosion control, the creation of micro-climates, or, once removed, firewood. The process of burning (and, partly, of rotting) is understood to prepare the plot for planting in multiple ways (after Conklin 1957:71, Dounias 2000:83f. [relying on Nye & Greenland 1960][46], and Ruthenberg 1971:35):

- it unclutters the plot, enabling unobstructed work and plant growth
- it releases nutrients from the plant material, thereby fertilising the soil
- it provides a soft and friable substrate
- it reduces soil acidity and limits aluminium toxicity
- it temporarily sterilises the soil, exterminating microbial fauna, insect pests and the seeds of competing flora ('weeds')
- it produces heat, which promotes crop growth.

Principles of Swiddening—Cropping Patterns

Once the plot has been prepared in this way, crops are introduced. Assemblages vary from rather uniform ('monocropping', 'monoculture') to highly diverse ('intercropping', 'polyculture' [Flowers et al. 1982; Hames 1983], 'mixed cropping'

[Ruthenberg 1971:27-30]), although the latter arrangement represents the typical crop arrangement in swiddens, as indeed with cultivation in the tropics at large (Vandermeer 1989:1,106). Diversity—"the simultaneous growth of two or more useful plants on the same plot" (Ruthenberg 1971:27f.)—can be manifested in various spatial and temporal patterns: continuous planting of different crops; interplanting of fast and slow maturing crops, or indeed annuals and perennials; ordered row arrangements or other layouts. Some of these may be distinguished as separate forms (e.g. Ruthenberg 1971:28-n.1) or subsumed as one (e.g. Hames 1983:17), but in line with common usage I will label them all as intercropping (cf. Vandermeer 1989:6-8). After all, much as Hanunóo plots are "intercropped in complex, overlapping associations" (Conklin 1957:147), so are most others, rendering any distinction of patterns largely analytical.

Intercropping reflects the diversity of crops used (cf. Conklin 1957:73; Dounias 2000:89); interacts synergistically with other characteristics of swiddening (see below); and constitutes in many regards the most advantageous form of cultivation. Its benefits vis-à-vis monocropping derive from basically three sets of characteristics (after Beckerman 1983a:3, Clarke 1976:249f., Dounias 2000:93, Ruthenberg 1971:28,30, and Vandermeer 1989:4,32,33-45,46f.,68-85,86-105,127, all relying also on other sources):

1. maximisation of yields per area, through
    - making more efficient use of space, by filling interstices.
    - making more efficient use of light, moisture and nutrient resources, by allowing the cultivation of crops in locations most suitable to their individual requirements.
    - reducing intraspecific competition (as long as it remains above interspecific competition) and enabling more efficient niche utilisation.
    - reducing susceptibility to disease organisms and species-specific pests, due to spacing of like species and promotion of predators.
    - permitting facilitation (in which one species provides benefits to another), in the form of structural support, shelter, provision of microclimates, reduction of evaporation, nitrogen fixation, improved nutrient availability, effect of mycorrhizal fungi, disruption of herbivore attacks, provision of pest traps.
    - suppressing weed growth, due to improved soil cover and competition from crop plants.
    - reducing erosion, due to improved soil cover.
2. minimisation of risk, due to reduced crop failure from diseases, pests or erosion, and the stochastic advantages of crop diversity.
3. economic efficiency, through
    - reducing the need for weeding.
    - providing a variety of commodities.
    - providing a continuous supply of commodities.
    - diminishing storage problems.
    - spreading labour demands more evenly throughout the year.

Apart from economic and ecological advantages, intercropping also permits the realization of aesthetic principles (cf. Kocher Schmid 1991:280, 1998:117f.).

The ecological soundness of intercropped swiddening was traced by Geertz (1963:16) to its "systemic congruity" with mature tropical forest, of which it provided "a canny imitation"—

1. through its generalized character, involving a large number of different species (op.cit.:16-19, relying also on Conklin 1957:147)
2. through its direct-cycling character—though more pronounced with secondary regrowth than with a young swidden—involving processes among the biotic community rather than between it and the substrate (op.cit.:19-24)
3. through its architecture, involving closed cover (op.cit.:24f.).

While the economic and ecological advantages of intercropping remain largely uncontested, Geertz' 'forest mimicry' hypothesis has been challenged on the basis of increasing ethnographic evidence for low-diversity intercropping or even monocropping, and upon closer examination of the ecosystemic properties of young swiddens. Indeed, the ecological characteristics of Barí swiddens suggested to Beckerman (1983b:100) that these were "not an imitation of the jungle but a reversal". More generally, he and other contributors to a special issue of the journal Human Ecology (1983) argued, mainly on the basis of field data from South America, that:

- the diversity–stability hypothesis was far from proven (Hames 1983)—this corresponds to the recognition that high species diversity occurs particularly in unstable rather than mature areas of tropical rainforest (cf. p.39);
- even high-diversity intercropped swiddens are less complex than mature forest ecosystems (Boster 1983; Vickers 1983); Beckerman (1983b:88) observed that "neither in number of species nor in number of varieties can Barí horticulture compete with the taxonomic abundance of the rain forest";
- swiddens are structurally simpler than mature forest ecosystems (Beckerman 1983b);
- swiddens are structurally transient, in contrast to mature forest ecosystems (Vickers 1983);
- crop composition reflects swidden age, micro-environmental conditions and plant needs, rather than a standard pattern modelled on mature forest (Boster 1983; Stocks 1983);
- intercropping is primarily an economic phenomenon, in that it arises from the efficient use of space to maximize yields, rather than an ecological phenomenon to be understood as forest mimicry (Vickers 1983);
- swiddens may be zoned, contrary to the notion that crops are "interspersed in such a way that most individuals have as their nearest neighbor an individual of a different species" (Beckerman 1983b:88) in reflection of

the species distribution in mature forest ecosystems; nevertheless, zoning is economically efficient and ecologically sound (Beckerman 1983b; Stocks 1983);

- swiddens may be monocropped, although interplanting of multiple varieties may produce patterns corresponding to intercropping (Boster 1983; Hames 1983), with corresponding ecological effects due to differential branching patterns, leaf shapes and growth periods (Boster 1983); a motivation for monocropping may be labour efficiency, in particular concerning monitoring activities (Beckerman 1983a; Hames 1983).

Similar evidence had convinced Flowers et al. (1982:203) that intercropping,

> "rather than being regarded as the distinguishing characteristic of swidden cultivation, should be considered as a varying dimension... within the overall subsistence strategy of a group".

Searching for the principles underlying such variation, Beckerman (1983a:8-10,fig.1) integrated ethnographic observations with Lathrap's (1977:733-736)[47] suggestions concerning the evolution of swiddening in the New World, to propose a model which relates crop diversity to labour expenditure. He speculated that minimization of labour time will result in fairly intercropped house gardens; that an increase in labour time and expansion of cultivation activities will result first in low-diversity swiddens which maximise productivity of labour, then in highly diverse swiddens which represent a compromise between maximising productivity of labour and maximising productivity of land; and that still further increase in labour will result in a stark drop in diversity with the emphasis on maximising the productivity of land.

This sequence was in its outline anticipated by Harris (1973), though with reference to labour, rather than crop diversity, as the dependent variable.[48] He proposed an evolution from refuse heaps in the vicinity of houses, through house gardens, to swidden plots further away, each step involving additional labour input, in terms of cultivation, fertilization and protection activities and distances to be covered (op.cit.:400f.; cf. also n.43); and a subsequent shift towards specialized types of agriculture, entailing increased technological complexity which at once demands higher labour inputs and raises productivity per unit land (op.cit.:404). I will return to these models in section 3.5. and in chapters 5 and 6.

Principles of Swiddening—Vegeculture and Vegecrops

Besides the common phenomenon of intercropping, swiddening regimes are typically seen as characterised by the practice of vegetative propagation (e.g. Dounias 2000:90; Keesing 1981:130). While this view is entirely appropriate, our understanding of swiddening (and other forms of plant management) can be enhanced by considering not only how crops are propagated, but also which part of them is used.

The mode of propagation has classically been used in human ecology and archaeology as the criterion to distinguish crops into those propagated generatively, that is by seeds ('seed culture'), and those propagated vegetatively, through suckers, stem cuttings or seed tubers ('vegeculture') (e.g. Grigg 1974:9; Harris 1973:403).[49] The aspect of utilization, on the other hand, is of particular importance in nutritional studies, where plants are distinguished into those whose generative parts are eaten ('seed foods') and those whose vegetative parts are eaten ('vegefoods'), corresponding to the morphological differentiation of crops (cf. p.22). It manifests the different nutritional values of generative and vegetative parts, with the former typically richer in fat and protein since they need to provide nourishment for the germinating embryo.

There is, therefore, a clear distinction in principle between plant part propagated and plant part utilized. In practice, though, both aspects frequently correspond, due to the coevolutionary dynamics between plant reproduction and human herbivory, which I will explore in detail in chapter 4. This overlap has often engendered an uncritical conflation of both aspects, with writers on human ecology implying use when referring to propagation (cf. op.cit.).[50] Such amalgamation, though, may be misleading in cases where both aspects actually diverge. More importantly, it obstructs an analysis of coevolutionary trajectories of the kind I undertake in chapter 4; it also obscures functions specific to only one aspect and their individual connections with other elements of cultivation. In the following, I will therefore consider both aspects separately, referring on the one hand to 'seed-/ vegeculture' and on the other to 'seed-/ vegecrops' (thus expanding the concept of use beyond food).

In principle, any combination of the four variables is possible. All of them are represented in swiddening regimes. Their prominence, though decreases—both across cases and typically within particular regimes—in the order:

1. vegeculture–vegecrops:
   - root crops (especially cassava, sweet potato, yams and taro);
   - bananas[51];
   - sugarcane and other stem vegetables propagated by cuttings;
   - various greens propagated by cuttings.
2. seed culture–seed crops:
   - grains (especially rice in the Old World and maize in the New World);
   - pulses;
   - fruit vegetables such as cucurbits and nightshades.
3. seed culture–vegecrops:
   - various greens propagated by seeds.
4. vegeculture–seed crops:
   - some unusual crops (e.g. pineapple)

Category 4 remains typically insignificant while category 3 assumes a supplementary role; category 2 may attain the status of staples in certain cases (cf. e.g. Conklin 1957) while remaining supplementary in others; in any case, it occurs additionally to category 1, which alone is consistently associated with swiddening regimes and assumes conspicuous prominence throughout. Although it is therefore correct that vegeculture constitutes *the* constant marker of swiddening regimes, this role falls more specifically on the vegeculture–vegecrop configuration.

The vegeculture–vegecrop configuration is functionally linked with the harvesting-, cropping-, and repropagation regimes typical for swiddening, as I will demonstrate in the following. The characteristics which are relevant in these respects become particularly evident vis-à-vis the corresponding ones of the seed culture–seed crop configuration—defining for fixed-field agriculture—which I shall use for contrast. It may seem that thereby I reproduce the conventional opposition between seed- and vegeculture and its implications for cultivation regimes (see e.g. Grigg [1974:9], who has made some pertinent observations in this respect). This is partly true, insofar as I restate the implications of the different modes of propagation. However, use of the different plant parts has its own implications, and their separate consideration allows us to trace connections which remain otherwise hidden. If they reinforce the acknowledged pattern, this must be demonstrated, not implied. Besides, there is no complete correspondence between plant part propagated and plant part used, as explained, and it is useful to keep this in mind.

Regarding the use criterion ('crop'), seed crops typically ripen rapidly and hence require rapid harvesting: there tends to be only a short window during which they attain their peak value, between immaturity and perishing, which corresponds to the original function of the seeds to propagate the plant independent of human interference. Vegecrops, in contrast, are permanent components of the living plant and therefore exhibit constant qualities over longer periods of time, allowing for more drawn-out harvests—as Rappaport (1971:127) observed with the Tsembaga Maring: "there is no special harvest period... a little harvesting is done every day or two". This trait is enhanced when the vegecrop is actually the plant's own storage organ, as is in particular the case with tubers. With staples, required in large quantities, these relationships render concerted and intensive harvesting activities economically desirable in the case of seed crops, while permitting more relaxed regimes in the case of vegecrops. This trend is reinforced by the relative size of the plant parts consumed, as substantial numbers of seeds are necessary to provide caloric values similar to those of single vegetable organs.

A subsequent effect is the need for ex-situ storage upon the concerted harvest of seed crops, whereas this need is reduced with vegecrops. This condition tends to coincide with crop biology and seasonality of the environment. As Grigg (1974:9) noted, crops propagated by seed culture (by implication seed crops) "are predominantly annuals, and have a marked growing season, necessitating some form of storage during the winter or dry season". In contrast, many crops propagated by vegeculture (typically at once vegecrops) have more drawn-out life histories. These, in turn, manifest in drawn-out plot dynamics, as illustrated for example by Rappaport's (1971:127) observation: "With the advent of a new garden, harvesting becomes less frequent in the old garden, finally ceasing altogether somewhere between 14 and 28 months after planting". I will return to this aspect further below.

Regarding the criterion of propagation ('culture'), seeds are easily propagated en masse, whereas propagation of vegetative parts demands more individual treatment. These differences might in turn result in differential demands on the uniformity of environments. Thus, Grigg (1974:9) suggested that plot clearance needed to be less thorough with vegeculture than with seed culture. Also, crops propagated by seeds typically require the ex-situ storage of propagation material, whereas crops propagated vegetatively typically store propagation material in-situ in the living plant, analogous to the situation with the plant part used.

Combining the implications of use and propagation for cropping patterns produces two starkly contrasting scenarios. For seed culture–seed crops, the possibility of mass propagation for the 'culture' element complements the desirability of synchronic harvest for the 'crop' element, in that both suggest technical advantages of uniform stands and hence encourage monocropping. For vegeculture–vegecrops, the opposite applies: the need for individual propagation complements the possibility of relaxed harvesting regimes to favour intercropping. Intercropping, in turn, itself draws out the harvest through the staggered maturation of diverse crops and thereby amplifies the trend. Certainly, vegeculture–vegecrops may likewise occur in monocrop regimes, as manioc cultivation in Amazonia and sweet potato cultivation in the New Guinea highlands famously demonstrate, and as contributors to the Human Ecology special issue on forest mimicry have emphasised (cf. pp.52f.). Yet, the vegeculture-vegecrop configuration seems to have an intrinsic tendency to bring on intercropping regimes somewhat by default. Both in turn support incidental and drawn-out harvesting regimes, the vegeculture-vegecrop configuration through protracted, intercropping regimes through staggered maturation. Besides, even in monocrop situations plots tend to be cultivated following a uniform regime only during part of their lifetime or in part of their area, while the remainder tends to be intercropped (e.g. Sillitoe 1983:chpt.11). Furthermore, instances of monocropping tend to involve non-annual staples which by themselves favour a protracted harvest, thus minimizing any problems of concentrated labour input and storage (Beckerman 1983:3).

To summarise, the seed culture–seed crop configuration tends to encourage monocropping, pulsed harvesting patterns and large scale storage ex-situ, of both propagation material and produce. In contrast, the vegeculture–vegecrop configuration, which characterizes swiddening regimes, tends to encourage intercropping and protracted and sporadic harvesting patterns, which constitute two further, and mutually reinforcing, characteristics of swiddening. Besides, it diminishes the need for scrupulous plot clearance, and for storage of propagation material and produce.

The ideological implications of these contrasting characteristics have been captured by D.G. Coursey (1978a—paraphrased by Keesing [1981:130]) in the formula,

> "seed propagation and vegetative propagation engender different kinds of view of oneself in relation to the plant world and ecosystem: the former more manipulative and interventionist, the latter more perceptive of continuities between natural and cultural worlds, stressing harmony with, rather than control over, the natural environment".

Harris (1973:394,399,405) represented the same contrast as a dichotomy between "ecosystem-transformation" and "ecosystem-manipulation", illustrated by Geertz' (1963:31) vivid and succinct comparisons of wet-rice cultivation with "the fabrication of an aquarium" vs. swiddening with "the imitation of a tropical forest". Ruthenberg (1971:24) seemed to express a similar sentiment when he commented: "The farmer with a stationary home and land that is permanently cropped tries to create favourable growing conditions for his crops; that is, he tries to *control* nature. Shifting cultivators, on the other hand, are usually highly skilled at *adapting* their cropping practices to the environment in which they are working." (my emphases), and: "Shifting cultivators know how to *adjust* to changing natural conditions... But they are less well prepared for the tasks of *transforming* natural conditions..." (op.cit.:245f., my emphases).

If the attributes noted for seed culture parallel the conventional perspective on human–environment interactions, the correspondence is not accidental. Rather, the one motivates the other. After all, there exists "a direct continuous, culture-historical tradition... between the background philosophies of the science and technology of modern Europe and the so-called Neolithic Revolution" (Coursey 1978a:135), which in turn involved almost exclusively seed-propagated crops, vegetatively propagated crops having been "virtually unknown in European cultures before the introduction of the potato from America in relatively modern times" (op.cit.:136). This ignorance has not only prejudiced conventional conceptualisations of other subsistence forms, a theme which will repeatedly recur in this chapter, but indeed of subsistence per se, an issue on which I will expand in chapter 4.

Digression: Correlations Between Swidden Crops and Perennials

I have so far omitted perennial crops. Certainly, the distinction between seed crops and vegecrops, and between seed culture and vegeculture also applies to perennials. Trees and palms provide fruits and nuts (seed crops) as well as leafy greens (vegecrops); many of them are propagated by seeds (seed culture), but some are propagated vegetatively (vegeculture): of screwpines (*Pandanus* spp.), the crowns may be planted (e.g. Sillitoe 1983:107,112); of some trees, such as breadfruit (*Artocarpus* spp.), suckers may be planted (e.g. Yen 1974:260,275); likewise, clumping palms are typically propagated by suckers, the most prominent case being *Metroxylon sagu* (see section 3.6.).[52]

Two crops which bridge the divide between small herbaceous annuals and large woody perennials, and which are very important in a PNG context, are the giant herb banana (*Musa* sp.) and the shrub-like AIBIKA (*Hibiscus manihot*). Both can survive for many years and are respectively propagated by suckers and stem cuttings. Their inclusion (explicitly for banana, implicitly—under greens—for AIBIKA) in the enumeration of swidden crops (cf. p.54) indicates that boundaries between garden crops and perennial crops are somewhat fluid. Besides, a number of garden crops, especially those with trailing habit, such as some root crops and cucurbits, can be rather long-lived, thus blurring the boundary further.[53]

Yet, large woody perennials, in particular trees and palms, do differ from garden (or field) crops in several respects, following largely from their definition as 'woody', 'large', and 'perennial'. Firstly, the aspect of woodiness indicates utility for construction and/ or as fuel, which adds to any specific uses, often multiple themselves and aimed at different plant parts (see section 3.5.). The use patterns of perennials are therefore more complex than those of garden crops, which serve largely food uses alone. This by itself eliminates the potential for any neat correlations between propagation and harvesting regimes. Secondly, the size of perennials leads to the harvesting of either only a small part of a live individual (e.g. leaves, fruit) or of single individuals out of a larger population (esp. for wood or palm sago). Indeed, with suckering palms, harvesting of a single stem means no more than removing part of the clonal clump, which in turn may even enhance the plant's productivity (cf. p.42). Perennials are therefore much less commonly killed by harvesting than garden crops, in particular seed crops (whose harvest may anyway coincide with the natural end of their vegetation period). The death of a genetically distinct individual is brought about only when single-stem palms are felled or their growing bud is harvested for palm cabbage, or when non-coppiceable trees are cut which lack the capacity for resprouting. It is noteworthy in this context that the somewhat ambivalent crops banana and AIBIKA, as indeed such long-lived crops as cucurbits and many tuberous plants (cf. n.53), remain, within limits, similarly unaffected by harvesting. Indeed, perenniality, the third aspect, reinforces the life-prolonging effect of a partial harvest. Both size and perenniality therefore contribute to drawn-out harvesting and repropagation regimes, which may span up to several human generations.

This review makes clear that perennials do not follow the contrasting patterns observed with the seed culture–seed crop configuration vs. the vegeculture–vegecrop configuration of garden crops. Rather, that they take the characteristics of the vegeculture–vegecrop configuration to the extreme: their size and lifespan lead to greatly drawn-out harvesting and repropagation regimes; they typically occur in intercrop assemblages or but small monocrop stands, as yields from single or a few individuals tend to satisfy subsistence requirements; and their complex use patterns which mimic those of intercrop assemblages reinforce this trend.

I suggest that this structural correlation indicates an evolutionary sequence in which the management of perennials provided the substrate on which subsequently the vegeculture–vegecrop configuration was elaborated through concentration of management and harvesting patterns in space and time. Certainly, the association between perennials and the vegeculture–vegecrop configuration has been documented ethnographically, ethnohistorically and archaeologically, and postulated on theoretical grounds (cf. e.g. Bahuchet et al. 1991:235f.—quoted on p.45; Grigg 1974:9,10; Harris 1973:401). In fact, this association is sometimes considered an attribute of swiddening itself, when fallow enrichment with perennial resources is seen as integral to the cycle (see below). It is clearly encouraged by the structural affinity between the two crop configurations. Yet, the suggestion, to which I will return in chapter 6, that both may also represent successive evolutionary stages remains, if at all, implicit in any evolutionary models, which have rather concentrated on the displacement of the vegeculture–vegecrop configuration by the seed culture–seed crop configuration (e.g. Coursey 1978a:137; Harris 1973:407f.,413 [relying on several sources]).[54]

Digression: Nutritional Complementation of Swidden Crops

The classification of crops according to plant part used implies at once differential nutritive content, with implications for overall subsistence strategies. As I have mentioned earlier (p.54), seed crops typically have higher nutritive values than vegecrops, as a function of their role to provide a concentrated source of nourishment for plant germination. This applies in particular to protein content, which prompted Gross (1975) to formulate his protein scarcity hypothesis, an aspect which I have omitted in section 3.2.[55] More precisely, Gross postulated that the reliance on (protein-poor) plantains and root crops in Amazonia *combined* with the insufficient availability of (protein-rich) fish and game to limit population sizes, sedentism and the development of social complexity. As in particular Beckerman (1979) pointed out, and as I have further explored for a PNG context, acknowledging the availability of numerous protein sources other than fish and game undermines Gross' hypothesis. Still, the fact remains that a form of cultivation which generates primarily vegecrops results in a poor protein balance, which needs to be offset by precisely such alternative sources of protein.

If this sounds deterministic, the principal alternative scenario is of meticulously combining different seed crops to provide protein not only in sufficient amounts but also with a balanced amino acid combination. As Beckerman (op.cit.:553) reminded us, this option is realised for example in the Meso-American maize–bean complex, and while it may therefore be successfully applied, it is by no means economically superior, tending to require considerable preparation time and effort. He vividly illustrated his point by alluding to the situation of modern American vegetarians and concluded: "It therefore makes a good deal of housekeeping and economic as well as biological sense to switch from vegetable to animal protein sources if possible." (loc.cit.). Contrary to the initial impression, therefore, a strategy which combines low-protein plant staples with animal (and plant) sources of protein might be nothing less than a burden imposed by environmental limitations, but an economically and biologically more efficient approach to subsistence than one which combines various high-protein plant staples. It might also be a more pleasurable one. As Beckerman annotated, "hunting and fishing are usually recreation, and gardening is work" (ibid.).[56]

Whatever the eventual rating of the one or other strategy, these considerations demonstrate that swiddening, which generates primarily low-protein vegecrops, is necessarily associated with other subsistence practices, such as hunting, fishing, and the collection of animal and plant foods from garden- and non-garden environments (cf. Bahuchet 2000). Indeed, these other practices may provide not only the major proportion of dietary protein but also of other important nutrients, even if they contribute a lesser proportion of the diet by weight (cf. Dornstreich 1977:256). For Amazonia as well as for the Pacific, foods from perennial plants have been documented as important sources of fats, vitamins and other micronutrients, besides protein (Beckerman 1979:540-551 and references quoted; Clement 1993:139-152; Thaman & Clarke 1993c:21f.). I will return to the association of the various practices below.

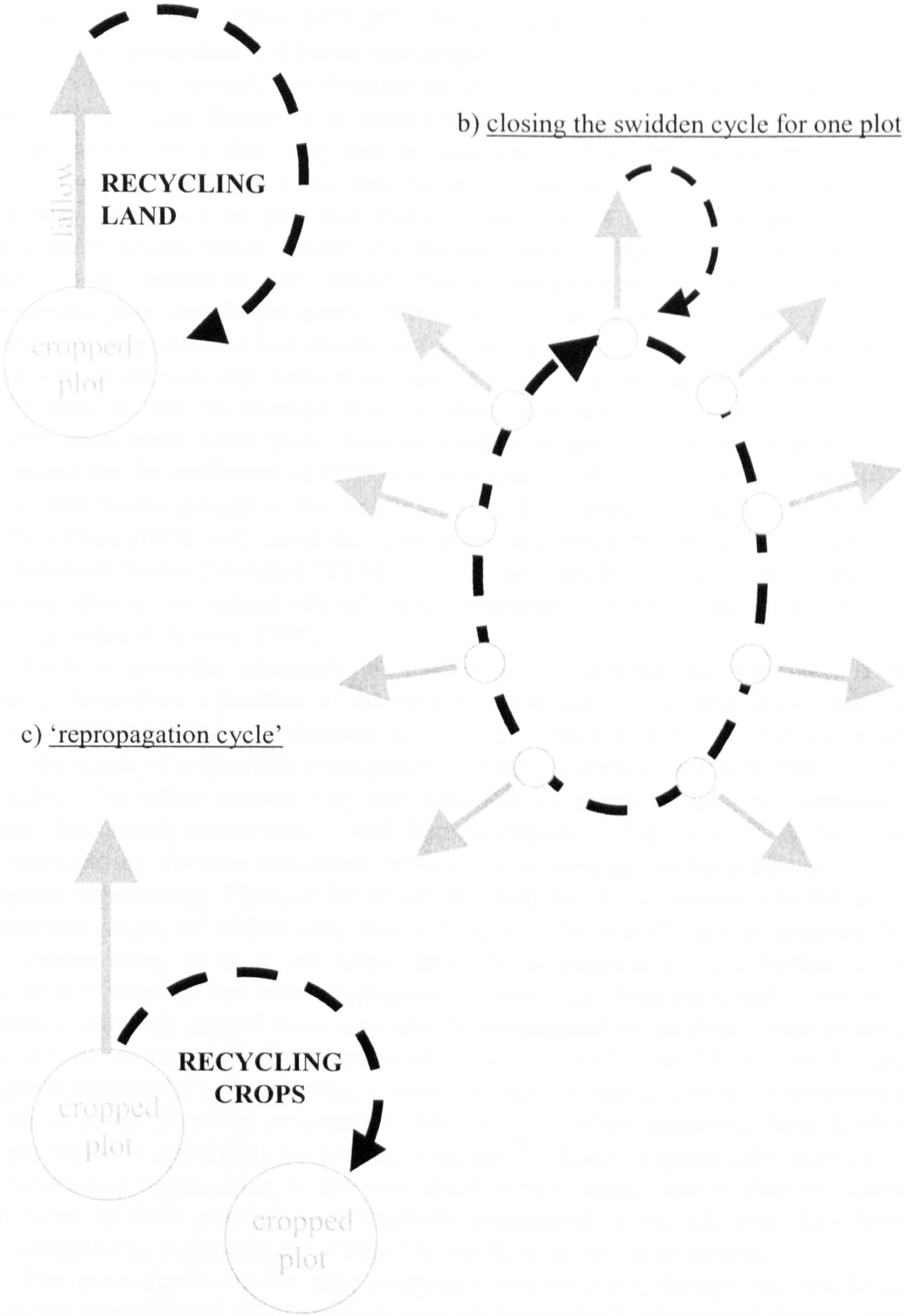
Digression: The Repropagation Cycle

The method of vegetative propagation from the live plant, the drawn-out harvesting regimes, and the drawn-out life histories of many vegecrops combine to produce a further characteristic of swiddening, which though to my knowledge has not received any attention in the literature: the potentially variable length of the repropagation cycle.

There are two different 'cycles' which can be distinguished with swiddening, and which I have graphically represented in Figure 1 (p. 60). The one is classically known as the 'swidden cycle' (e.g. Conklin 1957:29ff.), also labelled as 'cultivation cycle' (e.g. ASWP:chpt.2-data field 109), or, most vividly, as 'cycle cultivation–fallow' (e.g. Dounias 2000:80). It denotes the cyclical recurrence of cultivation and fallowing *in the same plot* and hence the process of *recycling land* (Figure 1a). That this may vary in length, both within one swidden system and among systems, is generally acknowledged and is the subject of many analyses and typologies. There is, however, a second cycle, namely that of land rotation (cf. p.48, n.44). This describes the cyclical recurrence of cultivation activities *in a new plot* each time, until (ideally) they return to the original plot, thus closing the swidden cycle for this particular plot (Figure 1b). This process involves the transfer of propagation material from one plot to the next, thus *recycling crops*. I will accordingly call it the 'repropagation cycle' (Figure 1c). It has two indissociable functions: to ensure the recurrent generation of crops for human use *and* to ensure the indefinite survival of the crop plants through an uninterrupted sequence of maturation and repropagation.

While the former function is self-evident, the latter remains obscure in classical notions of swiddening, as does the distinction itself between the swidden cycle on the one hand and the land rotation/ repropagation cycle on the other. These vaguenesses may partly stem from an academic division of labour. Thus, specific studies of swiddening tend to focus on plot preparation and development, and hence

Figure 1: Swidden Cycle and Repropagation Cycle



a) 'swidden cycle'/ 'cultivation cycle'/ 'cycle cultivation - fallow'

b) closing the swidden cycle for one plot

c) 'repropagation cycle'

on the swidden cycle; while more general studies of land use strategies tend to focus on the spatial and temporal scheduling of activities, and hence on the shifting of plots over time. As both approaches remain separate, the contrast between the two motions remains hidden; and as the latter focuses on activities, its effect on crops as plants rather than resources remains obscure. Its typical conception as "the annual agricultural cycle" (e.g. Ellen 1978:201) furthermore implies an obligatory yearly rhythm for crop generation and hence repropagation.[57]

Ecologically, though, the functioning of the system is not predicated on any such instant transition. Rather, it is limited alone by the crops' lifespans: as long as live crops survive in a plot, they can provide material for repropagation, and the length of the repropagation cycle can be drawn out accordingly. Thus, much as several new plots may be prepared every single year, a single new plot may be prepared every several years. Recall that the summary for Agricultural System 1504 (ASWP 3:1504—quoted on p.25) stated: "Small food gardens are made by a minority of households (less than 30 per cent)." While this may describe the unlikely case that the respective proportion of households are preparing swidden plots annually, whereas the rest subsist without any cultivation, the more likely interpretation, supported by my own data, is that on average every household prepares one swidden plot less frequently than every third year. Similar conditions are reported ethnographically from beyond the far northwest of PNG. For example, Markus Schindlbeck (1980:141) observed that Sawos people at the middle Sepik did not prepare a garden every year, while Roy Ellen (1978:108) noted that during his field research among Nuaulu people of south-central Seram (Maluku) "32 % of the households did not create new gardens" (indicating after all an annual rate of garden preparation of 68 %, more than double that of Agricultural System 1504).

Such a sporadic approach to gardening is favoured by drawn-out plot dynamics, themselves a function of drawn-out harvesting regimes and drawn-out life histories of the crop plants (cf. Rappaport 1971:127—quoted on p.55). Their common basis in the mode of vegetative propagation is clearly demonstrated in Sillitoe (1983: 214-fig.56). The author himself may comment that the graph reveals "no correlation between [the crops'] occurrence... and their propagation" (op.cit.:215). In fact, the graph indicates an obvious difference between crops propagated by seeds and crops propagated vegetatively. Thus, of the 40 crops listed, 16 (40 %) survive into the post-abandonment stage, of which only two (13 %, or 5 % overall) are propagated by seeds—representing 15 % of all crops similarly propagated (13); a further three (19 %, or 8 % overall) are trees propagated by seedlings, thus presumably sexually reproduced, although one of them may also be propagated by cuttings—representing 100 % of all crops similarly propagated; and 11 (69 %, or 28 % overall) are propagated vegetatively, by cuttings, crown cuttings, or lateral shoots—representing 46 % of all crops similarly propagated (24), or 41 % when including three further crops propagated vegetatively by budding rhizome.[58] Clearly, vegetatively reproduced crops (and trees) predominate in the post-abandonment stage, both in absolute terms and in terms of their proportion of similarly propagated crops. My own data from Krisa, presented in chapter 5 (esp. Table 24), conform to the same pattern.

The more drawn-out the repropagation cycle becomes, though, the less kinds of crops can be sustained, as short-lived ones are increasingly eliminated. Hence, crop diversity can also be understood as a function of cropping frequency. This correlation adds a new dimension to Beckerman's (1983a) labour-diversity model (cf. p.53), and casts the transition between its stages two (monocropped swidden) and three (intercropped swidden) in a new, diachronic, perspective. Beckerman perceived the cropping pattern as directly associated with labour expenditure, due to its respectively time-saving or consuming effects on planting, weeding, harvesting and monitoring activities in an *annual cycle* (op.cit.:4-6, also caption to fig.1). With regard to a *multiannual* scenario, though, we may also conceive of the cropping pattern as indirectly associated with labour expenditure, namely via cropping frequency and its respective demands on labour input over a period of several years. If Beckerman's model postulates that the transition between high-diversity swiddens and low-diversity swiddens manifests a maximization of labour efficiency in respect to individual plots, then a multiannual perspective expands this view to apprehend the maximization of labour efficiency not only in space but also over time.

Beckerman did refer to the correspondence between swidden age and crop diversity (op.cit.:3f.), without though tracing the implications of this correspondence in the context of the repropagation cycle. Rather, he touched on the equally intriguing aspect of long-term plot transformation (op.cit.:7). In that sense, the picture which I have painted in the previous paragraph, of diversity progressively reduced with age, applies of course only in respect to garden crops. Even here, there may be a renewed increase in diversity, as further crops get planted "to extend the usefulness of the garden into the fallow" (Boster 1983:57). More importantly, though, entirely new plants become established, whether adventitiously or upon active introduction. Roy Ellen (1978:165) succinctly captured the complementary dynamics for crops and others:

> "It can be seen that unless a garden is exploited or rejected completely by the end of the first year, even without intercropping plants which would not come to fruition during that year, a [old garden] association is ensured, being at the very minimum simply a manioc garden, but typically an association of three dominant types: manioc, bananas and plantains, and papaya. All this implies a further difference between [1st year garden] and [old garden] (of whatever kind)—that the number of different taxa in the former far outweighs that found in the latter, in the ratio of about 3:1, and that it is accompanied by the increasing domination of a smaller number of species (Ellen 1973:460-4)[59]. But it is the planting, or otherwise, of additional species—clove, coconut and sago—at this stage which determines the long-term future (which may mean up to 60 years) of a particular plot."

I will now turn to this transformation of the garden, through "planting, or otherwise", into another form of environment, thus completing the description of the swidden cycle.

Principles of Swiddening—Plot Abandonment and Fallowing

During the cropping period, harvesting, replanting and weeding are recurrent and often simultaneous activities (e.g. Conklin 1957:124). Weeding is important to prevent suffocation of crops, but is not an activity which would characterise the system, or, as Dounias (2000:88) dryly remarked:

> "Tropical forest swidden agriculture is not a weeding agriculture." (my translation).[60]

Weeding in swiddens tends to take up a lesser proportion of people's subsistence efforts compared to other activities and to more permanent forms of cultivation, a relationship captured by Ruthenberg (1971:40) in the formula:

> "Shifting cultivators put most of the effort into land clearance and cultivation, while semi-permanent cultivators devote most of their time to weeding."[61]

Reasons for the lesser need to weed are the suppression of weed growth early on through the effects of fallowing and burning (op.cit.:37; cf. also p.50); and subsequently through the effects of intercropping (Clarke 1976:250; cf. also p.51). As the swidden advances in age, weeding is reduced until finally the plot is abandoned—or so at least the situation appears for an observer focussing on its complement of garden crops.

The established view is that increasing weed growth and decline in fertility combine to force an abandonment of the swidden (e.g. Grigg 1974:58; Ruthenberg 1971:20). More specifically, the following causes have been identified (after Clarke 1976:248 and Sillitoe 1996:28-34 [both quoting Nye & Greenland 1960:75/73][46]):

- proliferation of weeds
- multiplication of disease organisms and pests
- qualitative and quantitative changes in soil fauna and flora
- deterioration of the soil's nutrient status
- deterioration of the soil's physical properties
- erosion of topsoil.

The deterioration in nutrient status follows from the mode of fertilization. The plot's principal fertilizing agent had been the nutrients previously locked up in the original vegetation and subsequently released through burning or rotting (cf. p.49). In such free form, they are rapidly assimilated or leached out, which explains the decline in fertility, and hence yields, already during the first cropping period. This process could of course be countered by applying additional fertilizer, and may indeed be less pronounced on naturally fertile soils; such conditions could move the system towards a state of more permanent cultivation (e.g. Harris 1972:p.248-nn.14,15 [quoting various sources]; Sillitoe 1996), with an attendant change in the focus of productivity (cf. Beckerman's model, p.53) and increase in carrying capacity.[62]

Clearly, declining fertility prevents any long-term extension of the cropping period. It does not necessarily, though, account for actual plot abandonment. In fact, closer examination of this transition suggests that the principal motivation may be the proliferation of adventitious vegetation.[63] Thus, Rappaport (1971:127) observed among the Tsembaga Maring that due to the advancing regrowth

> "the people are induced to abandon their gardens before they have seriously depleted the soil, even before the crops are completely harvested".

His observations are the more significant considering that they apply to a system with enormous emphasis on garden crops in general, and weeding in particular (cf. n.61). Yet more intriguing are his indications that the condition of overgrowth is literally home-grown, in that during weeding Tsembaga people actually protect tree seedlings while pulling up herbaceous plants, thus encouraging woody fallow vegetation which they recognize as 'the mother of gardens', while avoiding a grassy fallow stage (op.cit.:122). When he noted that

> "a Tsembaga gardener is almost as irritated when a visitor damages a tree seedling as when he heedlessly tramples on a taro plant" (ibid.),

he vividly illustrated just how important this encouragement is. Clearly, Tsembaga people play an active role in the process of overgrowth. They are no exception. As Clarke (1976:250) commented, the practice is "fairly common" in PNG. Clarke additionally noted that limited weeding activities at large contribute to the rapid establishment of a tree fallow and identified as another cause a short cropping period, otherwise perceived as a consequence (op.cit.:249f.). A further factor is the sparing of trees in clearing, which accelerates the regeneration of woody vegetation by attracting seed-dispersing birds and other animals (Carrière 2002a) and providing favourable conditions for plant establishment in the space beneath the crowns (Carrière 2002b).

Besides, tree seedlings are not only protected and encouraged, but also actively introduced, a strategy known as 'fallow enrichment'. This may be in the interest of restoring soil fertility rather than tree cover per se. In this respect, *Casuarina oligodon* has attained considerable fame in a PNG highlands context.[64] Yet, its prominence may be an artefact of the researchers' attention to a nitrogen-fixer with striking appearance, which obscured the more humble protection of various adventitious seedlings, which Rappaport and Clarke noted. After all, it seems more plausible that both paid a keener attention to the practices of fallow promotion than their colleagues, than that their hosts were keener fallow promoters than their compatriots. Beyond any unspecific promotion of either woody vegetation or soil fertility, though, aimed at enhancing the success of any future cropping phase in the same plot, trees are retained, encouraged or planted also for their own sake as individually valued resources. This process may be mediated by the planting of species which attract dispersers of economically useful forest trees (Moran 1996:541). More widely documented is the immediate propagation (or protection) of useful trees, as well as palms and other woody perennials such as bamboos, in young and old swiddens.[65] Indeed, intercrop assemblages which combine annuals with variously long-lived perennials, or in fact the use of long-lived garden crops themselves, automatically entail fallow enrichment (cf. pp.57,58).

Legal codes commonly reflect the attention invested in fallow enrichment. According to Grigg (1974:58), it is typical that trees established through planting or protection pass into individual ownership, even though usufructory rights to the swidden lapse with its transformation into fallow. This not only agrees entirely with my own observations from Krisa and ethnographic parallels. It resonates furthermore with legal concepts relating to tree use and management held by people classified as foragers (Brosius 1991; Dentan 1991; cf. p.44). More generally, the regularity of fallow enrichment with perennials resonates with the centrality of trees and palms for forager or near-forager subsistence (cf. pp.44f.). If these resources are so important in the *absence* of any (major) cultivation activities, their subsidiary role in the *presence* of cultivation may indicate less an actual shift of subsistence emphasis than an analytical bias—the more suggested by the resources' otherwise implausible legal importance for swiddeners.

The correspondences between swiddening and foraging reach yet further, though. For, apart from individually propagated or protected perennials, the fallow itself typically provides numerous useful plants. Not only is this unsurprising in view of the utility generally ascribed to immature vegetation (cf. pp.39,40; also Clarke 1976:253). The harvesting from such vegetation, conceptualised as 'continued fallow use', may also be easily construed as foraging, obscuring its reliance on former cultivation activities. Hence, Ruthenberg (1971:27) clarified: "In addition to cropping, shifting cultivators gather 'wild' products from the surrounding fallow. These are usually not truly wild plants, but the remains of domestic plants within a 'tumbledown' fallow." While this acknowledges the functional connection between cropping phase and fallow vegetation, it implies somewhat misleadingly that, firstly, the harvested plants had been present already before the fallow stage ('remains') and, secondly, that they were necessarily connected with human activities ('domestic'). On the other hand, their portrayal as "forest products" (Clarke 1976:251), even in the context of "forest as an enriching fallow" (loc.cit.), tends to diminish the role of previous cultivation in their establishment. Clearly, unmanipulated fallows move us into the same direction of fuzzy categories as did the evidence in the calorie deficiency debate (cf. esp. pp.44ff.). That this ambiguity occurs with a form of subsistence which overall ranks so obviously as cultivation may indicate just how "wobbly" the "line between gathering and cultivation" is (Townsend 1990:746—quoted on p.44).

To add to the non-cultivation component of swiddening, swidden fallows have repeatedly been documented as prime hunting areas.[66] Such evidence of 'garden hunting' led Beckerman (1983a:7) to comment: "One is tempted to ask if some swidden plots are ever so much abandoned as slowly transformed from producers of vegetable food to producers of animal food". While this witty interpretation may capture one dimension of swidden development, it need not exclude the continuing provision of vegetable foods (which are not limited to garden crops, as implied by Beckerman, but are provided in particular by perennials)—or indeed the provision of numerous materials, as I will illustrate in chapter 5.

Hence, we can identify several utilitarian functions of swidden fallows, obtaining through fallow enrichment, continued fallow use, and garden hunting (which may rank as an element of the previous). They, and their consequences for our concept of swidden abandonment, are conveniently summarised by Leslie Sponsel (1986:77f. [referring to various authors]), who reviewed the situation for Amazonia:

> "Swiddens are not necessarily abandoned; instead, they often phase into another type of agroecosystem known as agroforestry. Tree crops mark the transition from swidden to forest, but this is not a sharp boundary in either space or time... The Bora exploit up to 135 plant species in their garden fallows (Treacy 1982)[67]. The Kayapó still harvest plants and hunt in their gardens after 40 years. They even plant species to attract game (Posey 1982)[68]."

When he also noted: "Often tree crops are also planted which encourages succession and eventually the return of the forest" (op.cit.:77), he may have confused two conceptually distinct issues, namely fallow enrichment and fallow promotion, the former relating to use ('tree crops'), the latter to ecology ('succession'), which though does not rule out their convergence in practice. In any case, it confirms the importance of trees for the system (cf. Dounias 2000:97).

Clearly, the swidden fallow is nothing less than an unproductive side-effect of the system, but on the contrary an integral component of it and essential for its functioning, in economic respect as much as in ecological respect (Bahuchet 2000:44-46; Dounias 2000:98; McKey 2000:16,28). What is more, this integral and important component constitutes at once the predominant portion of the entire swidden cycle. Beyond the question whether swiddens are ever abandoned or are rather "transformed" (Beckerman), or "phase into another type" (Sponsel), we may therefore ask whether the very focus on the swidden plot may in fact be misdirected—or, to return to the wording I used in section 3.3. (cf. p.45), whether "***cultivation plots may be a by-product of the desire to generate useful secondary vegetation, diverse biomes, and ecotones***".

This inversion applies both in an ecological and in an evolutionary sense. As addressed in section 3.3. and recapitulated above, trees and palms on the one hand, and immature vegetation on the other play a central role in forager subsistence. Their respective correspondence with the practices of fallow enrichment and continued fallow use strongly suggests an evolutionary sequence in which these aspects were successively elaborated. This process would have required a successive expansion of clearing activities, both to propagate larger numbers of specific perennials and to increase the extent of unspecific secondary vegetation. The particular characteristics of perennials regarding propagation and harvesting regimes (cf. pp.57ff.) would have encouraged the cultivation of short-lived herbaceous crops with similar characteristics—that is members of the vegeculture–vegecrop configuration—in the generated clearings, thus enhancing the efficiency of these. Hence, the conclusion reached by Clay (1988:32,34 [quoting Denevan et al. 1984:349][69]), that "[t]he planting of tree crops to extend production in the face of encroaching forest may 'solve a shifting cultivator's dilemma of how to maintain field production in the twilight of the cropping cycle'" may be less the imaginative rendering of a sophisticated analysis than a sophisticated rendering of the 'vast-forests-eclipsing-humans' fantasy (cf. pp.18f.). In fact, the "dilemma of how to maintain field production in the twilight of the cropping cycle" may be the 'opportunity to extend fallow production at the dawn of the swidden cycle'.

Much as this perspective assigns priority to the fallow in evolutionary terms, so it does in ecological terms. Thus, cultivation plots are but one, and sometimes but a lesser, component of a system which generates numerous useful environments, typically subsumed under the term 'fallow', from spontaneous regrowth, through agroforests, to hunting grounds (cf. Dounias 2000:80). And the more drawn-out the repropagation cycle is (cf. pp.59ff.), the more important these other environments become. The necessary complementation of swiddening with other subsistence strategies, due in particular to the nutritional imbalance of the crops cultivated (cf. p.58f.), then emerges as less a complementarity of pursuits parallel in space than consecutive in time. The juxtaposition in Agricultural System no.1504, of "[s]mall food gardens... made by a minority of households" and "[h]unting, fishing and the collection of wild vegetable foods" thus turns out as two sides of the same coin, where the gardens of the last decade(s) have become the hunting and collecting grounds of today.

3.5. Agroforestry and Related Concepts

In the previous section, I have examined perennials in terms of their ecological integration with swiddening regimes: how the propagation-, cropping- and harvesting patterns of perennials fit in with those of garden crops; and how perennials fit temporally into the swidden cycle. Here, I want to present subsistence concepts which deal explicitly with perennials, and examine these concepts vis-à-vis that of swiddening.

The Spectrum of Terms and Concepts

The most specific concept is that of 'arboriculture', literally 'tree cultivation'. In its strict sense, it involves artificial propagation of the respective tree crop, by seeds or vegetatively, and usually subsequent nurturing. Empirically, however, crops encompass all kinds of life forms, including trees and tree palms, rattans (climbing palms), pandans (screwpines), shrubs, bamboos, canes and any other perennials. Also, artificial propagation tends to occur alongside spontaneous growth, with or without nurturing. In the most extreme case the resource must be considered unmanipulated, which indicates an overlap between arboriculture and the subsistence strategies of foragers (cf. pp.44f.). This indistinction regarding the degree of human manipulation may obtain for different species within the same system, or indeed for one and the same species. Inventories which list tree crops and their mode of propagation make the fuzziness obvious (e.g. Sillitoe 1983:sect.1; Thaman 1993; Thaman & Clarke 1993a:198f.; Yen 1974).

Sometimes, the term 'silviculture' is used synonymously with 'arboriculture' (e.g. Dornstreich 1977:250-tbl.II,257-tbl.V; Ellen 1982:40; Obrist 1990:455f.; also Whitmore 1990:118). This use includes the shared indistinction regarding manipulation. Thus, Dornstreich separated his category 'Silviculture' (op.cit.:250-tbl.II) into 'Cultivated' and 'Wild' tree nuts and fruits (op.cit.:254-tbl.III); Obrist observed that "it can be difficult to draw the line between tree cultivation [i.e. silviculture] and the use of wild-growing trees" (op.cit.:456). While *concepts* are therefore largely identical, the *term* 'silviculture' alludes to forest rather than to individual trees, and can thereby draw attention to the fact that the respective perennials tend to occur in stands and/ or integrated into perennial plant communities.

A third, frequently used term, 'agroforestry', tends to differ conceptually from the former two. It entails an ecologically even more encompassing view than the term silviculture, and may apply to various phenomena and practices, though always incorporating arboriculture/ silviculture. Classical definitions of agroforestry typically describe a spatial or temporal integration of trees with garden crops, sometimes also with forest plants or animal husbandry (cf. e.g. Denevan & Padoch 1987:1; Nair 1993:13f. [quoting various sources]; reviews in Thaman & Clarke 1993b:9f. and Elevitch & Wilkinson 2004a:2). If a faunal component is recognized, it tends to be in the form of ranching. The beneficial integration of 'microlivestock' with trees tends to be rather overlooked, although small terrestrial and arboreal mammals, reptiles, birds and indeed invertebrates can substantially enhance the utility of agroforests (Wilkinson & Elevitch 2004:96f.). A classical instance of microlivestock is the sago weevil (cf. p.34). In regard to floral integration, the two most straightforward cases of agroforestry correspond to the intercropping of annuals and perennials, with the latter either mature (spatial integration) or immature (temporal integration). Both arrangements indicate the considerable overlap of agroforestry with swiddening: the former conforms to the typical house garden scenario (cf. p.53, n.43; also e.g. Nair 1993:chpt.7), the latter to the practice of fallow enrichment (cf. p.64; also e.g. Nair 1993:chpt.5). In the context of formal plantations, the corresponding cases would be understorey cropping and an initial annual crop (cf. Vandermeer 1989:107).

Beyond the integration of variously long-lived individual plants, though, the concept of agroforestry entails the integration of the different approaches to their management, as already suggested by its implicit overlap with swiddening. Geneviève Michon (2005:114) has recently highlighted this aspect by cautioning against its neglect in the institutional arena:

> "Agroforestry research usually concentrates on the complementariness of trees and crops at the field level. We strongly stress that it should pay more attention to the complementariness of agriculture and forestry at the level of local farming systems."

With this wider perspective, the emphasis shifts from intercrop assemblages to mature environments, rendering the reference to garden crops largely irrelevant and engendering a definition of agroforests as "forests [which] are *cultivated* and *located on farmlands*" (op.cit.:x, original emphases). In the same vein, Randolph Thaman and William Clarke (1993b:10) have put forward a broad definition of agroforestry as

> "Any agricultural system (agro-ecosystem) in which planted or protected trees are seen as economically, socially, or ecologically integral to the system."

Perspectives on Agroforestry

Although many authors perceive an integration of agroforestry with swiddening and/ or the wider landscape, individual perspectives and paradigms vary considerably. William Denevan and Christine Padoch (1987) have seen 'swidden-fallow agroforestry' partly as an extension of swiddening, corresponding to the practice of fallow enrichment (op.cit.:2,passim), partly as "a conversion of a short-term cropping system into a long-term agroforestry system" (op.cit.:245). Leslie Sponsel (1986:77—quoted on p.65), has subscribed to the latter view, considering swidden, agroforest and forest as conceptually equivalent and temporally and spatially continuous, with the sequence though representing only one direction of swidden development. Edmond Dounias (2000:80,97) has likewise held that agroforestry was an ecologically limited phenomenon, which though he considered of figurative significance:

> "Swidden cultivation is part of systems integrating trees, of which agroforests are merely one component... They can however highlight the fundamentally 'arboreal' quality of these systems, and remind us that these cannot persist without the forest." (op.cit.:97, my translation)

In contrast, Randolph Thaman and William Clarke (1993a:203) have reversed this relationship between swiddening and agroforestry, regarding the former as but one of the phenomena to be subsumed under the latter:

> "Types of agricultural and wild lands found within the matrix of agroforestry systems include: native or secondary forest stands; sacred groves; monocultural woodlots; orchards, or coconut, cocoa, or oil-palm plantations; mixed tree-and ground-crop

> shifting agricultural plots; home gardens; and even small patches of grassland or adjacent mangrove or coastal forest."

Indeed:

> "In the land-use strategies of Pacific Islanders almost all types of agricultural or wild lands are viewed as integral components of a larger agroforestry system." (loc.cit.).

This perspective seems to comprise about the entire landscape! In fact, by including "wild lands", it considerably expands the authors' earlier definition (quoted on p.68), which stipulates "planted or protected trees" in an "agricultural system". Elsewhere (1993c:17), however, the authors returned to the classical definition, referring to "true agroforestry systems" as containing "both annual crops and trees".

Their imprecision indicates that, firstly, agroforestry is a multifaceted concept, if implicitly so, integrating such diverse criteria as

- longevity of resources ("annual crops and trees");
- functions of resources ("economically, socially, or ecologically");
- techniques of resource management ("planted or protected");
- forms of environments ("agricultural and wild landscapes".

Secondly, that the combined ambivalences of these parameters ("agricultural *and* wild" etc.) make agroforestry ambivalent itself, overlapping not only to an uncertain extent with both the cropping and fallow phases of swiddening, but, in particular through the attribute 'wild', also with foraging.

Edvard Hviding and Tim Bayliss-Smith (2000) have been even more vague in their bounding of the concept. At the one extreme, they went so far as to justify their use of the term agroforestry with reference to the regenerating role of forest after swidden cultivation (op.cit.:21). According to this reading, the definition for swiddening would double as that for agroforestry, making one of the two concepts redundant. The error seems to lie in a confusion of the fallow's ecological function with its economic function. And yet, the authors' interpretation does formally agree with the definition by Thaman & Clarke (1993b:10—quoted on p.68) which includes reference to trees as "ecologically integral to the system". Furthermore, the authors affirmed the economic criterion at another point with the observation that "the secondary growth of old and recent fallows itself forms part of the continuous crops harvested" (op.cit.:17). If the definition by Thaman & Clarke additionally stipulates that the trees should be "planted or protected", then these authors have themselves overridden that criterion. The apparent outsider perspective by Hviding & Bayliss-Smith therefore highlights the intrinsic fuzziness between the concepts of swiddening, arboriculture and foraging, as a spectrum of plant management techniques and functions of the resulting environments.

More in line with conventional understanding, Hviding & Bayliss-Smith also considered the term agroforestry to suggest "a functional integration between cultivation practices (including the cultivation of tree crops) and the management of the forest itself" (ibid.). Indeed, they harked back to the narrow classical definition of agroforestry when describing such cultivation practices as those "which achieve an integration of trees with food plants, either through inter-cropping (crops grown in close juxtaposition to trees) or through shifting cultivation (crops grown after a tree fallow)" (ibid.). After they provided thus a range of agroforestry readings, they summoned them all for an illustration of "Agroforestry in the Marovo Lagoon" (op.cit.:28):

> "The swidden systems of present-day Marovo [New Georgia Islands, Solomon Islands] interact closely with the surrounding forest. Older secondary growth contains a great variety of medicinal plants and other useful trees and shrubs, some of which are planted and others simply forming part of the regrowth succession. The tall, mature and less disturbed forest is also part of the agroforestry complex, particularly by containing old planted groves of tall *Canarium* nut trees."

The authors represented the apparent jumble of practices and concepts in similarly jumbled terms, when they spoke of "agriculture–arboriculture–agroforestry realm" (op.cit.:28) or "garden–fallow–forest interaction in many combinations" (op.cit.:24), conceding that

> "none of the English words used to describe Melanesian cultivation practices are altogether satisfactory" (op.cit.:19).

'Intermediate Systems'

The handicap which troubled Hviding and Bayliss-Smith occurs beyond Melanesia. The convenors of the ETFRN (European Tropical Forest Research Network) symposium "Cultivating (in) Tropical Forests?" (Asbjornsen et al. 2000; Belcher et al. 2000; cf. Appendix 1) lamented similarly:

> "Working around NTFPs [non-timber forest products], shifting cultivation and native agroforestry practices throughout the tropics, we have visited 'forests' where many resources had been purposefully retained, encouraged or even planted, and which often did not correspond to our western perception of plantation, orchard or garden. We all saw the obvious convergence between these different systems, representing variations of the same model of resource management, and recognized a lack of adequate terminology to define them. These forest-like systems, in which human influence and design was of major importance, we called forest-garden, agroforest, man-made forest, or by their local names." (Asbjornsen et al. 2000:5).

To overcome the dilemma, they coined the term 'intermediate systems' for the environments and management strategies they perceived as "intermediate on the continuum from pure extraction to plantation management" (Belcher et al. 2000:9). They recognized an intermediate character in particular for ecosystem structure and function on the one hand and labour input on the other; but also in terms of concepts and possibly, though not necessarily, evolution (Asbjornsen et al. 2000:6; Belcher et al. 2000:10).[70] In two related publications (de Foresta & Michon 1993:710-712; de Foresta et al. 2004:23f.) the same phenomenon was defined as 'complex agroforestry systems' and described as resembling secondary or (slightly simplified) primary forest in structural and functional terms. It was contrasted with 'simple agroforestry systems' comprising only a small number of annual and perennial component species, as typical for densely settled areas, plantations and/ or institutional agroforestry.

From the range of case studies presented at the symposium, the authors distilled four basic manifestations of intermediate systems (Belcher et al. 2000:12-17):

1. modified natural forests:
   modification of the forest environment to encourage particular species, through weeding, opening the canopy or encouraging shade plants, sometimes with additional planting/ transplanting of seedlings;
2. forest gardens within the forest matrix:
   planting and nurturing of particular species in stands within the forest;
3. anthropogenic forests from agricultural antecedents—rotational systems:
   cultivation of perennials as part of a cycle alternating annual with perennial crops;
4. anthropogenic forests from agricultural antecedents—permanent forest culture:
   establishment, upon an initial swidden phase, of "domesticated forests with diversified economic functions and with structures and species diversity approaching those of late-successional or old-growth forests".

A subsequent publication (Michon 2005:66f.) identified two principal forms, corresponding to scenarios 2 and 3/ 4, respectively:

- "interspersed forest culture":
  "'enrichment planting'... integrated within existing forest structures" (i.e. scenario 2);
- "integral forest culture":
  "initial destruction of natural vegetation... and... gradual reconstruction aimed at specific production purposes", through either rotational (i.e. scenario 3) or permanent (i.e. scenario 4) approaches, the latter achieving rejuvenation of the vegetation through "punctual renewal".

A related publication (de Foresta et al. 2004) similarly differentiated between manipulation and replacement of the forest matrix in the generation of agroforests:

> "Agroforests are sometimes managed forests, evolved from progressive and integrated transformations of the original ecosystem through tree planting and natural vegetation management... But most often agroforests in Indonesia evolved from shifting cultivation systems, and are true plantations established after total removal of the original vegetation through planting of desired tree species, and through natural enrichment." (de Foresta et al. 2004:24; see also de Foresta & Michon 1993:715).

An earlier publication (de Foresta & Michon 1993:718) had distinguished two modes of maintenance for the latter: mass regeneration, and regeneration plant by plant. Although these were seen as not necessarily exclusive, they apparently provided the template for the subsequent model of rotational systems (i.e. scenario 3) vs. permanent systems (i.e. scenario 4).[71]

Despite the differentiations applied in the various studies, the phenomena described clearly constitute a continuous spectrum of management approaches towards trees and tree-dominated plant communities. Although an apparent contrast exists between retention and removal of the forest matrix, all scenarios rely on clearing activities, whether for weeding/ opening the canopy (scenario 1); for making small gaps in the vegetation to plant perennials (scenario 2); or for large-scale clearing (scenarios 3/ 4). They therefore differ in degree rather than kind. More specifically, the boundaries are fluid between the four distinct scenarios, as are correspondingly the boundaries between other forms of tropical land use for which they double. Thus, scenario 1 corresponds to the environmental management strategies of foragers (cf. section 3.3.); scenario 2 either to an, as it were, reduced version of swiddening, geared towards perennials alone, or to a pure form of arboriculture (cf. p.67); scenario 3 to the practice of fallow enrichment upon swiddening (cf. p.64); and scenario 4 to the same but without closing the swidden cycle for the respective plot (cf. p.59). Indeed, the recognition of punctual renewal as a strategy for maintaining scenario 4 relates back to the practices of scenario 1. This complexity confirms not only the technical overlap of agroforestry with, variously, foraging, arboriculture, and swiddening, but thereby at once the overlap of the latter three (cf. pp.64,67).

This overlap arises from the balance between artificial propagation and natural enrichment (cf. de Foresta et al. 2004:24—cf. above quote), which is variable in practice but shared in principle among the various scenarios, and which engenders a structural continuity among the resulting plant communities. The reference to natural enrichment confirms on the one hand the role of clearing activities (see above); on the other it indicates the subsequent incorporation of regrowth, through limitation of maintenance activities in turn. This condition is not only conceptually confusing, as conventional notions of plant management emphasize conversely the suppression of regrowth and maintenance of artificially propagated plants. It is also empirically confounding, as it generates plant communities which may appear unmanaged:

> "It is largely this minimal maintenance which favours the development of a significant spontaneous component, and which gives the agroforest its 'disorganized' structure, making it resemble natural forest more than classic plantations." (Foresta & Michon 1993:718; also Michon 2005:4,67)

In fact, limitation of maintenance activities is only one of the two dimensions in which labour input into agroforestry systems is reduced vis-à-vis other land use strategies. The other is a limitation of activities supporting plant establishment, due to the lifespans of any artificially propagated perennial resources. One manual accordingly observed: "The purpose of gardening with perennials is to get the highest return from the least amount of effort." (Elevitch & Wilkinson 2004b:324; cf. also Hart 1991:71,143). This relationship adds to Beckerman's (1983a:8-10,fig.1) labour–diversity model of swiddening and its extended relevance in a multiannual scenario (cf. pp.53,61). If Beckerman perceived a maximization of labour time with low-diversity swiddens in an annual cycle, and I suggested a further maximization of labour and corresponding drop in crop diversity with an extended repropagation cycle, then the management of perennials will maximize labour even further. The introduction of a spontaneous component, though, at once introduces a new variable, whose degree of diversity is inverse to labour input, rather than consistent with it. Within limits, therefore, crop diversity and regrowth diversity run counter to each other in their dependence on labour expenditure, which reflects the contrasting requirements of the respective plants involved.[72]

Hence, both the appearance of agroforests, their composition and their demands on human labour move them close to conditions commonly perceived as foraging. In fact, the integration of a spontaneous component with managed perennials creates a situation in which the "agricultural and wild lands" distinguished by Thaman & Clarke (1993a:203—quoted on p.69) constitute not so much pure forms separated from each other temporally or spatially, as elements blended into a fine-grained mosaic within the same plot. Utilisation of the 'wild' element, a common practice (e.g. de Foresta & Michon 1993:713-715), can then arguably be classed as foraging. If this practice corresponds at once to continued use of swidden fallows, its conceptual ambiguity just reinforces the fuzziness between agroforestry, foraging, and swiddening. A similar fuzziness arises from the recognition of agroforests as "successional systems" (de Foresta et al. 2004:23), which identifies them as products of processes similarly operating in the regeneration of fundamentally unstable and dynamic forests (cf. pp.39ff.) and in the generation of swidden fallows.

I believe that the traced overlaps, in particular between agroforestry and foraging, suggest at once evolutionary connections. This premise is further supported by evidence presented in Michon (2005:chpt.VI,esp.158,161; cf. n.70) that the reviewed agroforestry systems developed from extractive systems. On the one hand, such a direct trajectory from foraging resonates both with the relevance of immature vegetation (regrowth/ natural enrichment) and the central role of trees for forager subsistence (cf. pp.39,40,44f.). Indeed, the legal implications of tree management which have been observed for agroforestry systems (Michon 2005:143,passim) replicate similar ones integral to both forager subsistence and practices of fallow enrichment (cf. p.44,64). On the other hand, the fundamental irrelevance of the *cropped* plot for any of the respective trajectories reinforces my postulates that historically the management of perennials preceded the cultivation of annuals of the vegeculture–vegecrop configuration (cf. pp.58,65), and that in evolutionary terms cultivation plots may only be a by-product of strategies aimed primarily at the generation of secondary vegetation (cf. pp.45,65).

Collectively, these considerations contradict the standard assumption in institutional agroforestry (Nair 1993:63-65 [relying on Kang & Wilson 1987][73]) that the evolution of traditional agroforestry systems has been driven by a successive expansion of the cropping phase, entailing in turn a deterioration of soil fertility and hence the need for fallow enrichment with soil-fertility restorers. The error is to perceive economic relevance exclusively for the cropped plot, and therefore to ascribe a purely ecological purpose to the fallow. It is reflected in the tendency to consider only soil-fertility restoring trees, in particular nitrogen-fixers, as 'fallow improvers' (op.cit.:68f.; cf. also p.64, n.64). The consequent inconsistencies in the allegedly "logical evolutionary pathway" (op.cit.:63) manifest as the widespread lack of evidence, in areas with intensive agroforestry systems, for intermediate stages involving extensive cropping periods (op.cit.:65). "The most plausible explanation" (ibid.) for this circumstance is unlikely the skipping of these stages due to explosive population pressure, as the author suggests, but rather the comparative irrelevance of the cropped plot in practice. Indeed, the simultaneous suggestion of multi-storeyed house gardens—considered the predecessors of actual swidden plots by various scholars (cf. p.53, n.43)—as templates for intensive agroforestry systems (ibid., also 86f.) indicates precisely that.[74]

In fact, the principal driver in the evolution of agroforestry systems, as in tropical rainforest subsistence more generally, may be less fertility than light. Thus, Whitmore (1990:118), who approached the subject of silviculture from a purely ecological perspective, identified "manipulation of the forest canopy" as the common silvicultural denominator. Although he referred in particular to timber species (cf. n.71), his considerations apply also more generally:

> "The biological principle of silviculture is that by controlling canopy gap size it is possible to influence species composition of the next growth cycle. The bigger the gaps the more fast-growing light-demanders will be favoured."

He noted that "[t]his concept has been known in continental Europe since at least the twelfth century", but I suspect that the entailed principles have served subsistence purposes in the tropics far longer. Indeed, their correspondence with the universal relevance of variously extensive clearing activities (cf. p.71) underscores the central role of forest dynamics in tropical rainforest subsistence and indicates once more the derivative character of the cropped plot.

Extensive evidence therefore challenges the notions of the cropped plot as central for the operation of swidden systems and correspondingly for the evolution of agroforestry systems. If they remain standard nevertheless, the reason is likely an underlying ideological bias, arising in turn from the common reliance of academic subsistence studies and institutional agroforestry practice on the Eurasian model of agriculture. This manifests the principles of the seed culture–seed crop configuration, engendering spatial opposition and processual discontinuity (cf. pp.53ff.). It thereby readily obscures the divergent principles of subsistence forms based on the vegeculture–vegecrop configuration (cf. pp.56f.) and, even more so, the management of perennials (cf. p.58). Michon (2005:69-74) has captured the respective contrast in the distinction between an 'ager model' and a 'hortus model' of plant management, which underlie respectively institutional and traditional agroforestry systems. Thus, forest plantations (cf. 'simple agforestry systems', p.70), based on the former, entail the management of few selected species en masse (op.cit.:129-132) and divorced from the processes of the forest environment (op.cit.:71,115). Their ecological and evolutionary continuity with the cultivation of annual grain crops (op.cit.:71) was suitably expressed by de Foresta & Michon (1993:710) who commented: "Simple [agroforestry] systems... are very intensive and are as different from natural forest in their structure and management as is a rice-paddy." If this description resonates with Geertz' (1963:31—cf. p.56) imagery of rice-paddy as aquarium and swidden as forest, the correspondence highlights once more the divergence between seed and vegecultural models of subsistence. The term *agro*-forestry for systems involving the latter is therefore something of a misnomer, which though demonstrates the conceptual pervasiveness of the former.

Conceptual Fault Lines

As just illustrated, and hinted earlier (cf. pp.68,70), a contrast—and potential area of conflict—exists between traditional and institutional agroforestry (cf. de Foresta & Michon 2004:23; Hviding & Bayliss-Smith 1993:18; Thaman & Clarke 1993b:2,4; also Klappa & Russell 2004). The one comprises locally developed approaches to land use and resource management, integral to lifeways and livelihoods, and based on individual experience, the accumulated wisdom of generations and choices made within a socio-cultural context. The other constitutes their description and practical counterpart within a technocratic context, informed by scientific understanding and based on field experimentation (e.g. Nair 1993). This tends to focus narrowly on individual species, yield maximization and income generation, including specific economic or ecological objectives such as provision of new foodstuffs or materials, soil improvement, or erosion control. Consequently, perennials are viewed either as mere soil-fertility restorers (see above) or as pure cash crops (e.g. Ruthenberg 1971:189,195). The wider ecological and subsistence economic implications of traditional agroforestry systems are thus obscured. Hence, Thaman & Clarke (1993a:213) have warned:

> "Because institutional agroforesters, agronomists, and development agents are generally preoccupied with commodity production and maximization of yields, they seem at times almost to suffer from a sort of paralysis in the face of the difficulties or impossibility of producing quantitative assessments of agroforestry systems, especially ones as complex and unbounded as those developed indigenously in the Pacific Islands. What is called for as interest shifts to 'sustainable development' is new ways of evaluation that integrate protective and productive functions, and new land-use institutions that focus on optimization of the whole landscape rather than component-maximization aims."

In the same vein, Edmond Dounias (2000:97,101) explained that local swidden and agroforestry practitioners strive to optimise the system rather than maximize the yields from cultivated plots, as an institutional perspective would have it. His view resonates with that of Geneviève Michon (2005:163), who emphasized that "Southeast Asian forest culture aims at domesticating the production processes of an entire ecosystem, which goes through encouraging diversity."

As a group, the various studies of intermediate systems/ complex agroforests (e.g. Asbjornsen et al. 2000/ Belcher et al. 2000; de Foresta & Michon 1993; de Foresta et al. 2004; Michon 2005) likely constitute the most systematic and comprehensive investigations into traditional agroforestry systems to date. The principal limitations to the universal applicability of the described models are relative rather than absolute. On the one hand, the modelling of several distinct agroforestry scenarios may misleadingly suggest categorical discontinuities within an actually continuous spectrum of phenomena (cf. pp.71f.). This confusion, though, can be countered by recognising the scenarios as mere, if vital, analytical tools. On the other hand, the commercial orientation of the studies defines agroforestry as a comparatively recent and basically trade-dependent phenomenon. Thus, the authors acknowledged the subsistence function of agroforests but explicitly discounted it vis-à-vis their commercial function (de Foresta & Michon 1993:713,715,719; de Foresta et al. 2004:25,26; Michon 2005:27-30), which in turn they perceived as the main factor driving their evolution (Belcher et al. 2000:17; Michon 2005:esp.161f.). The effect has been to capture but the tip of the iceberg, eliminating the better part of agroforestry systems worldwide which have developed over millennia before the advent of the market economy, and which continue to provide for local subsistence independent of any added market value—as emphasized by at least one of the contributors to the ETFRN symposium (Kennedy 2000a, 2000b). Yet, it is likely that uniform principles govern the development and operation of agroforestry systems, whether trade or subsistence oriented, and that therefore the insights gained from commercially oriented studies can be transferred to non-commercial contexts. In fact, this is what I have attempted above (pp.71ff.).

The authors' commercial perspective may partly be a reflection of the particular situation in Southeast Asia (Michon 2005:43f.), where populations are comparatively dense and sedentary (op.cit.:23-26) and commodity production has a long tradition (op.cit.:74-79). Partly, though, it may be a function of the studies' background in institutional agroforestry with its emphasis on income generation and focus on individual species, despite their otherwise critical stance towards it. Thus, the convenors of the ETFRN symposium lamented the "lack of official acknowledgment and institutional support" (Belcher et al. 2000:11) for intermediate systems. Yet, they attributed this failure primarily to the compartmentalisation of strategies into 'extractivism' and intensive cultivation which diverts attention from intermediate phenomena (op.cit.:10,11). Hence, they perceived a problem with the conceptualisation of ecological parameters, rather than with the economic perspective, rendering the study intermediate itself, arrested half-way between institutional approaches and the modelling of traditional systems.

As in particular the studies on intermediate systems/ complex agroforests demonstrate, concepts dealing with perennial resources are fractured along several fault lines. The fractures follow the contrasts:

- traditional vs. institutional agroforestry, and the respective management practices and environments as evolved vs. designed;
- ecological vs. economic dimensions of subsistence, and commercial vs. non-commercial aspects of the latter;
- individual plots and resources vs. landscape level and systemic properties;
- agroforestry vs. swiddening and other forms of subsistence, and the conceptual relationship between them;
- cultivation vs. 'extraction' (foraging), and the degree to which they are represented with agroforestry.

These are especially pronounced in discussions of agroforestry, although they recur in attenuated form in discussions of swiddening and indeed of other forms of subsistence—thus indicating once again the overlap between them. Clearly, agroforestry represents a concept still in formation and in particular vis-à-vis swiddening is as yet lacking an established set of parameters by which it could be bounded and explored. A comprehensive model would need to

- balance an emphasis on individual species with an emphasis on their habitats;
- encompass the variability of local forms with regard to both their economic and ecological dimensions;
- explore their relationship with other forms of subsistence;
- deal with the indistinction regarding the degree of human interference.

I will cover these aspects when I develop—empirically in chapter 5 and theoretically in chapter 6—a model of 'fallow farming' as one cluster of variations on the wider theme of agroforestry, and thereby provide one facet of a larger model of tropical subsistence. For this, I believe it is necessary to explore each of the aspects separately before integrating them again. Thus, I will in chapter 4 address the aspects of cultivation vs. 'extraction' (sections 4.2.-4.5.) and of economy vs. ecology (sections 4.6. and 4.7), including the complementarity between resources and habitats. I have already discussed foraging, swiddening, and arboriculture (sections 3.3., 3.4. and above) as subsistence forms related to agroforestry in terms of technical continuities between them. In the following, I will trace their conceptual continuities, by examining the status of individual resources in the context of arboriculture.

Criteria for Classification

There are basically three criteria which position arboriculture within the spectrum of other subsistence forms; they correspond to three of the four facets of agroforestry identified earlier (p.69) in the perspective taken by Thaman & Clarke (1993a), and are similarly ambivalent:

1. longevity of resource;
2. (utilitarian) function of resource;
3. degree of manipulation (i.e. technique of resource management);
- (form of environment does not apply with a focus on individual resources).

The degree of human manipulation should set arboriculture apart from foraging. Unambiguous classification is difficult, though, since the management of perennials ranges across a whole spectrum of techniques. With the concept of agroforestry, much of the ambiguity stems from the development of a spontaneous component, which causes the resulting environments to be conceptually indistinct and phenomenologically deceptive (cf. p.72f.). The concept of arboriculture demonstrates that a similar ambiguity inheres also in the status of the perennial crops themselves. On the one hand, different species within the same system, or indeed different individuals of the same species may be targeted differently (cf. p.67). On the other hand, one and the same individual will experience different—typically decreasing—degrees of manipulation during its lifetime. Peter Matthews and Chris Gosden (1997:130) captured this situation in the comment: "Within the lifetime of an individual tree it may occupy either side of the foraging and farming dichotomy." While the same applies of course to more short-lived plants, perenniality magnifies the trend and thus makes the ambiguity palpable. More specifically, perenniality highlights that manipulation itself produces cognitive uncertainty. Any plant, even if originally it became established with the help of a human act, grows biologically to maturity through forces independent of human action, and thereby grows figuratively out of human reach. In the literal sense, humans cannot 'make plants grow'—an idea which I will further explore in chapter 4. With long-lived plants, this circumstance becomes but the more conspicuous, as the ratio shrinks of the contributions of human and non-human forces to plant development. It is especially for this reason that "for tree crops, including palms, the line between gathering and cultivation seems particularly wobbly", as Patricia Townsend (1990:746—quoted on p.44) commented in the context of the calorie debate.

Perenniality at once constitutes the criterion to set arboriculture apart from swiddening. Yet, the contrast between perennials and garden crops is almost as feeble as that between different degrees of manipulation, both of which I will trace within a discussion of the final criterion, utilitarian function. As indicated in section 3.4. (cf. p.57), the use patterns of perennials are complex. Their typical woodiness ensures their common and comparatively unspecific uses as construction material and firewood.[75] Their principal uses, however, tend to lie in the specific utility of certain plant parts for food and drink, shelter, objects, food wrappers, medicines, dyes, and so on, besides indirect uses such as attractants for game animals and birds or as substrate for insect foods (see also Thaman & Clarke 1993c:18-24). Table 3 illustrates with some examples from Krisa the several dimensions of this utilitarian complexity:

Table 3: Utilitarian Complexity of Perennials—Examples from Krisa

I species	II plant part used	III use	IV vegetative stage	V derivative use
TULIP (*Gnetum gnemon*)	leaves	vegetable		
	bark	fibre		
coconut (*Cocos nucifera*)	fruit	food (endosperm)	mature	
		drink (water)	immature	
ANASI (*Caryota* sp.)	stem	substrate for grubs (pith)		objects (cortex, more easily removed)
sago (*Metroxylon sagu*)	stem	starch (pith)	mature	mushrooms (leached pulp as substrate)
		substrate for grubs (pith)		
		objects (cortex)		
		vegetable	immature	
	leaflets	thatch	mature	
		fibre	immature	
	rachis	walling & shelving		
	seeds	ornaments		

Hence, there may be different uses (column III) from

1. different species
   (column I)
2. different parts of one species/ plant individual
   (column II in relation to column I)
3. the same part of one species in different vegetative stages
   (column IV in relation to column II)
4. the same part of one species/ plant individual after previous other use
   (column V in relation to column III);

furthermore, relationships 2.-4. themselves may occur with just a single species, as the example of the sago palm demonstrates.

This multiplicity of uses is reminiscent of that recognised with the so-called 'non-timber-forest-products' (NTFPs) or 'minor forest products'. The 'forest' component in these designations implies unmanaged resources, yet the degree of management remains in fact unspecified (cf. Belcher et al. 2000:10; Michon 2005:31-34). For example, a textbook on tropical rainforests (Whitmore 1990:162) lists in the section 'Minor forest products': "wild fruit trees" and other unmanaged plants as well as long-lived crop plants; a review of assessments for NTFPs defines: "A forest is a vegetation type dominated by trees; this maybe pristine natural rainforest, scrub woodland, palm savanna or *plantations*." (Wong 2000:2, my emphasis). NTFPs and arboricultural resources therefore overlap to a considerable degree, sharing the criteria of utilitarian complexity and variable degree of manipulation (if not necessarily longevity, a distinction though qualified below). Although the one concept tends to be associated with foraging and the other with cultivation, their correspondence highlights that both span in fact the two management extremes.

While the utilitarian complexity of arboricultural resources is acknowledged in the field of NTFP studies, it is typically obscured in discussions of swiddening. Swiddening is widely regarded as serving the generation of foodstuffs, and indeed most garden crops are primarily used for food. Yet, this loose correspondence neither testifies to the exclusive use of the respective species for food (present or past), much less does it justify the extension of this notion to perennial crops. Precisely these assumptions, though, are typically made. They may show as a straightforward neglect of non-food perennials, as noted with the review of the Agricultural Systems Working Papers of PNG in section 2.2. (cf. p.21). Less extreme, they may manifest as a biased approach to organising ethnobotanical information, which emphasises food use at the expense of other uses, of more complex use patterns, and of parameters relevant for understanding the management of perennials.[76]

The scheme by which Paul Sillitoe (1983:chpts.2-6) presented Wola crops is representative of many other accounts, if particularly illustrative for being both extensive and detailed. That the author admitted to ethnocentrism in the way he organised his material (op.cit.:chpt.8) confirms that his scheme is indeed imposed. The example refers to the PNG highlands, but its principles apply similarly to lowland situations. To begin with, Sillitoe followed the common pattern of presenting several categories of food crops while combining non-food crops in a residual category at the end of the inventory. Thus, Section I, "Crops described" comprises:

- Chapter 2: Tubers
- Chapter 3: Greens
- Chapter 4: Shoots and stems
- Chapter 5: Fruits
- Chapter 6: Inedibles.

That is, the first four chapters distinguish plants with a single use—food—by the parts specifically employed for that purpose, whereas the remaining chapter assembles plants irrespective not only of part used, but also of use served. More specifically,

- Chapter 6 lists
  - tobacco (*Nicotiana tabacum*)—narcotic
  - palm lily (*Cordyline fruticosa*)—boundary marker and male attire
  - sedge (*Eleocharis cf. dubia*)—female attire
  - coleus dye plant (*Plectranthus scutellarioides*)—dye for strings
  - paper mulberry (*Brussonetia papyrifera*)—bark cloth
  - casuarina (*Casuarina oligodon*)—ornamental, soil improver, firewood.

Although the distinguishing criterion between crop categories is therefore food use, rather than use per se, truly consistent application of this criterion is problematic, as shown by crops listed in other chapters. Thus,

- Chapter 4 includes
  - highland pitpit (*Setaria palmifolia*)—also as boundary marker
  - bamboo (*Nastus elatus*)—also for artefacts.

- Chapter 5 includes
  - karuga screw-pine (*Pandanus brosimus, P. julianetti*)—also for artefacts.

Hence, food crops have other uses also, which challenges the criterion of food use as distinguishing parameter. To discriminate highland pitpit—food and boundary marker (op.cit.:chpt.4)—from palm lily—male attire and boundary marker (op.cit.:chpt.6)—on the basis of food use seems capricious, indeed arbitrary in view of the palm lily's history as an ancient Oceanic food plant (cf. p.41, n.40). Neither does longevity justify such a distinction: highland pitpit is a perennial, the very fact of its function as boundary marker attesting to this quality, confirmed by the accompanying documentation which Sillitoe provides. And much as highland pitpit is both a food plant with further, non-food uses and a perennial, so is the screw-pine (op.cit.:chpt.5). In contrast, tobacco (op.cit.:chpt.6), without food use, is clearly short-lived.

By choosing the economic parameter of food use as the distinguishing criterion to organise crops, Sillitoe not only produced inconsistencies in his scheme, but at once obscured a number of ecological parameters, such as longevity, which cross-cut the economic ones. His detailed data would equally have permitted an organisation of crops according to longevity, plant habit, or degree of human manipulation. Table 4 lists all the perennials he mentions, and their characteristics regarding the parameters of food use, propagation, and habit:

Table 4: Perennials in Sillitoe (1983) and their Characteristics

		food use	artificial propagation	perenniality	habit
paper mulberry	*Brussonetia papyrifera*	–	+	+	tree
casuarina	*Casuarina oligodon*	–	+	+	tree
fig	*Ficus wassa*	+	+	+	tree
marita screw-pine	*Pandanus conoideus*	+	+	+	tree
karuga screw-pine	*Pandanus brosimus, P. julianetti*	+/–	+/–	+	tree
highland breadfruit	*Ficus dammaropsis*	+	+/–	+	tree
palm lily	*Cordyline fruticosa*	–	+/ (–)	+	shrub
hibiscus spinach [AIBIKA]	*Hibiscus manihot*	+	+	+	shrub
climbing cucurbit	*Trichosanthes pulleana*	+	+/ (–)	+	vine
bamboo	*Nastus elatus*	+/–	+	+	bamboo
highland pitpit	*Setaria palmifolia*	+/–	+	+	grass
sugar cane	*Saccharum officinarum*	+	+	(+)	grass
banana	*Musa* hort. var.	+	+	(+)	giant herb
acanth spinach	*Dicliptera papuana*	+	+	+	herb
Javanese dropwort	*Oenanthe javanica*	+	+	+	herb
spiderwort	*Commelina diffusa*	+	+	+	herb

(source: Sillitoe 1983:chpts.2-6)

Closer examination of these characteristics reveals in fact some remarkable trends. Thus, a third (16 of 46—35 %) of all crops are perennials, surviving into the post-abandonment stage of the swidden plot—most of them with food use, some without food use, some with multiple uses. Of these, a third (6—38 % or 13 % overall) are non-woody, thus deviating from the typical image of perennial crops ('tree crops'). Another quarter (4—25 % or 9 % overall) do not even require artificial propagation, but occur also spontaneously. Yet, this scenario is presented in the context of a discussion about swiddening and based on ethnographic evidence of intensive root crop cultivation with partly permanent plots (cf. Sillitoe 1996).

If our theoretical stance is that swiddening involves the cultivation of short-lived resources with food use; arboriculture the variously intensive management of long-lived resources with complex use patterns; and foraging no cultivation at all, then even this classical case must cast considerable doubts on the suitability of our criteria and bounding of our categories. Then, again, the confusion may just be due to vague representation. After all, there are accounts which convincingly demonstrate an orderly separation of the various stages in the larger swidden complex—and thus of the associated concepts. Exemplary is Conklin's (1957) verbally and graphically elegant representation of the sequence in which Hanunóo land use moves from garden preparation to tree crop farming to fallowing in a temporal sequence, and how the respective stages are distinguished locally. Yet, closer examination of his detailed data and comments returns us to the same confusion as before. Thus, the perennials which mark the tree crop stage have of course been planted much earlier, namely in a new swidden (op.cit.:74-87); the various stages of swiddening overlap not only in time, but also in space (op.cit.:esp.135-fig.10); and the "climax forest" which develops from "high forest fallow" is not only used, but in fact enriched, as a paragraph tucked away at the end of the account informs us:

> "Despite the frequent religious taboos on [climax forest] areas... and the Hanunóo preference for [high forest fallow] second growth for new swidden clearance..., climax forest associations are economically important. They furnish almost all of the lashing, binding, and tying needs of the Hanunóo in the form of various rattans... They are also sources of durable wood... for construction and decorative purposes, of medicinal plants not found in other associations, and of wild and *intentionally propagated* plant foods... as a supplement to the regular diet and as a temporary mainstay in times of crop failure..." (op.cit.:138, my emphasis)

If nothing else, "intentionally propagated plant foods" in "climax forest" must subvert any attempt at classification! Hence, it may be possible to distinguish categories in practice, especially if such distinctions reflect local perception, but the dilemma remains of their boundaries in principle. This dilemma is illustrated empirically in cases where, as in Krisa, no distinctions are recognised locally—where the researcher is but presented with an amorphous category that encompasses perennials and non-perennials; food- and non-food crops; herbs and woody structures; and heavily, marginally, and non-cultivated plants alike (see chapter 5).[77]

The dilemma is one I have noted already in the previous section. It is a necessary corollary of the fallow phase as soon as continued use or enrichment are practised. For an unambiguous classification, we would need to identify that point in time at which cultivation no longer affects plant establishment, growth and use, and which would therefore mark the transition from swiddening and arboriculture to foraging. This point seems impossible to define in absolute terms. Thereby it converges with that noted in section 3.3., at which humans cease to be foragers and commence to manipulate vegetation as cultivators. As herbs endure, crops establish spontaneously, and cultivates colonize the fallow—and, indeed, plants are propagated in climax forest!—we are left with confusion not only about the boundary between cultivation and foraging, but about the meaning of cultivation itself. Yet, this confusion may be an artefact of our attempts to classify by inappropriate categories. Once we relinquish them and focus on the processes we actually observe, the hazy zone where the meaning of cultivation remains uncertain may emerge as a template for more encompassing concepts of human–environment interaction. Thereby, we may also gain a better understanding of the processes active at the dawn of human habitation of tropical rainforests, thus opening a window onto the past. Indeed, as Peter Matthews and Chris Gosden (1997:131) reflected:

> "By learning about tree crops, we may learn something about what it meant to become human in the very distant past."

3.6. Sago Palm: The Ultimate Ambivalent Crop

The sago palm (*Metroxylon sagu*) is a species of superlatives—ecologically, economically and conceptually. Few plants are better suited to illustrate the conceptual dilemma between cultivation and foraging; few highlight so aptly the characteristics of arboricultural resources; few provide such outstanding examples of the supreme utility of the palm family for humans; and few exemplify so comprehensively how and why this family in particular and perennials in general are so misunderstood as resources.

The Obscurity of the Sago Palm

Metroxylon sagu shares the fate of the palm family at large, whose exceptional utility for humans is poorly recognised outside their geographical range. Certainly, tropical subsistence would be a lot poorer without palms:

> "The palms may be said to be the family of flowering plants most useful to man in the sense that more genera are put to more uses by more people than of any other group..." (Johns & Hay 1984:196)
>
> "Among the plants of the Tropics it is difficult to find a family of plants of more service to people than the palm family... In fact, this family has been called the most versatile of all due to its many uses." (Martin et al. 2004:302)
>
> "For the people of the humid tropics, the Palmae had, and frequently still have, more importance than any other family. Palms furnish foods of various types, raw materials for construction of homes and domestic items, and folk medicines..." (Clement 1993:141).
>
> "Palms are the most useful group of plants for the rural and indigenous people throughout the tropics. They provide edible fruits, oils, palm-heart, fibers, thatch, housing materials and shelter, domestic artifacts, tools for traditional hunting and fishing, medicines, and other minor products..." (Macía 2004).

Despite this economic importance, palms "seldom receive the recognition they merit" (Martin et al. 2004:302). Indeed, botanical and utilisation data on most palm species, including *Metroxylon sagu*, "are fragmentary" (Ruddle et al. 1978:4). Causes for this neglect are geographical, economic, methodological and conceptual. Thus, Martin et al. (2004:302) speculated that it is

> "perhaps because the family is almost entirely absent in temperate zones where there are more writers of books and magazines as well as researchers".

Johns & Hay (1984:196) hinted at a similar bias when they continued their above quoted statement on the utility of palms,

> "...however in terms of modern economies, the grasses surpass all other families in importance (rice and other cereal crops, and as pasture) and the legumes must probably claim second place."

Besides, there is the difficulty of producing herbarium specimens, the basis for much ethnobotanical research. As a manual on plant collecting in New Guinea (Womersley p1975) warns:

> "palm collecting is on quite a different scale to orthodox botanical collecting" (op.cit.:49).

This is due in particular to the size of even the fragments of specimens involved, hence:

> "An ideal collecting outfit should include a light truck or Land Rover with an extensible ladder; ropes, axes, saws, cutlasses (matchetes or parangs), and pruning shears;... together with two or three labourers." (op.cit.:48)

and further:

> "It is most desirable that a vehicle be driven as near to the collecting locality as possible in order that the fragments be more easily transported. Canoes may be the method of transport in regions without roads. Failing this sufficient bearers should be available to carry the specimens to a base which is accessible to wheeled transport." (loc.cit.)

Another factor is the food bias of observers, traced in the previous section as earlier in section 2.2. (cf. p.21), which either reduces a plant's apparent utility to a single function, namely dietary, or otherwise removes the plant totally from a resource inventory. If this minimizes the importance of arboricultural resources generally, it does so in particular for the supremely useful palm family, and within this family the more so for the sago palm, whose uses exceed those of many other palms, both in terms of their sheer number and in terms of their complexity. In Krisa, just the most important ones comprise (cf. Table 3 and Appendices 15 and 16, reference no.1, for a more comprehensive overview of the Krisa example and Case Study 2 for illustration; also Ellen [2004b:608f.-tbl.2] for an example from Maluku):

- a superior source of dietary starch (pith)
- a substrate for sago grubs (pith)
- a substrate for sago mushrooms (leached pulp)
- a vegetable (shoot)
- thatching material (leaflets)
- material for walls and shelves (rachis)
- material for its own processing (lower and upper leaf sheath)
- material for mats and painting bases (lower leaf sheath)
- tough material for various objects (cortex)
- fibre (young leaflets)
- ornaments (seeds)
- hot-burning fuel for firing pottery and lime (rachis).

A preoccupation with food, the more so of direct food uses, will therefore diminish the sago palm's apparent utility by about an order of magnitude.

The sago palm's food use itself is often overlooked, and so is consequently the species at large. Again, various reasons conspire for the neglect. Ruddle et al. (1978:3) perceived another geographical-economic bias:

> "Palm stem starch, although often of great local importance in barter and trade, is not a major item of commerce with areas outside the humid tropics. For this reason, starch is commonly overlooked by those outside the producing regions, although it probably represents one of the most important food products derived from palms."

By referring to "palm stem starch", the quote at once highlights another reason, namely the confusing aspect of crop morphology. The sago palm's principal food-providing organ is the stem, contrary to most other food plants, including perennials, which provide dietary value in their fruits, seeds, leaves or tuberous organs. Of course, there are some crops, both tropical and non-tropical, which do provide food in their stems, such as sugar cane, celery or rhubarb. Yet, these crops are non-woody. Woodiness, in contrast, suggests inedibility almost by definition. In the case of the sago palm, this inedibility of the ligneous portion is ingeniously countered, as

> "starch [is] recovered from the pulverized stem pith... through water processing and sedimentation" (Ruddle et al. 1978:5).

Still, use of the stem for food remains a perplexing exception among woody plants. Besides, it means a total harvest once. This creates a further contrast with other perennials, which are repeatedly drawn on for their fruit, leaves, bark, sap or latex, whether for foodstuffs or materials. The harvesting pattern for the sago palm therefore corresponds rather to that of either short-lived seed crops, which though are associated with considerable environmental manipulation and mass harvest (cf. pp.55f.), or, more accurately, that of timber trees from little manipulated stands.

On the one hand, therefore, the sago palm represents an arboricultural resource par excellence, with the attendant conceptual ambiguities that obscure much of its economic value. On the other hand, it is itself an anomaly within the class of perennials, which pushes it further into a liminal position. The consequent neglect of the species tends to manifest as a preoccupation with other—typically tuberous—sources of starchy food. Thus, yams not only became the focus of attention in the calorie debate regarding foraging in tropical rainforest (cf. pp.40f.), but have also taken centre stage in ethnographies from the alluvial plains of the Sepik river basin and foothills of the Torricelli and Prince Alexander Mountains, leading to a "relative scholarly neglect of palm sago as a source of food and cultural ideas among these peoples" (Tuzin 1992:103). The classical flagship role of the sweet potato for PNG subsistence (cf. e.g. French 1986:2) may partly be due to the same prejudice, reinforcing the geographical skewing of ethnographic accounts (cf. section 1.1.). As a dietary root crop bias thus conspires with a utilitarian food bias, not only is the apparent utility of the sago palm reduced, but its visibility as a resource altogether eliminated.

Sago Palm Taxonomy and Reproductive Biology

Metroxylon sagu shares its perplexing food value with a number of other palms which are exploited for palm stem starch. Ruddle et al. (1978:3) have identified at least fourteen species belonging to eight genera. Five genera are found in the Indo-Pacific region; three in South- and Mesoamerica (op.cit.:5-9).[78] *Metroxylon*, though, "is by far the most important genus exploited for stem starch in either the Old or the New World" (op.cit.:5).

More specifically, this distinction falls to *M.sagu* (currently recognised as synonymous with *M.rumphii* and *M.squarrosum* [Flach 1997:10]), for which I reserve the singular of the term 'sago palm'. It is indigenous to mainland New Guinea and island Southeast Asia east of Wallace's line, and has been naturalised in the rest of Indonesia, Malaysia, and Thailand; other species of *Metroxylon* occur in island Melanesia, the Caroline Islands in Micronesia, and Samoa in Polynesia (Barrau

1959:154-fig.3; Flach 1997:9-tbl.1a,11-tbl.1b; Ruddle et al. 1978:5; Whitmore 1977 [1973]:77).[79] *M.sagu* outside its native range and other species of *Metroxylon* tend to be used less for their starch than for their fronds which supply house-building material and superior thatch lasting up to 10 years (Barrau 1959:155; Flach 1997:31; Hviding & Bayliss-Smith 2000:50; Thaman 1993:246; Whitmore 1977[1973]:77).

As a source of carbohydrate, *M.sagu* owes much of its outstanding economic role to its reproductive biology. The species is at once hapaxanthic (once-flowering) and soboliferous (suckering), with the effect that, firstly, huge amounts of starch are amassed in the palm bole during its lifetime, reaching a peak for the terminal production of flowers and fruits; and that, secondly, harvesting of this starch-replete bole does not kill the plant (Flach 1997:8,10,12). Of all the species exploited for palm stem starch, only palms of the genus *Eugeissonia* also show this combination of reproductive traits (see Table 5 [p.88]). *Eugeissonia*, however, suffers from a double shortcoming: the genus is restricted to a narrow geographical range, namely mainland Malaysia and Borneo (Ruddle et al. 1978:6-fig.1,7); moreover, its palms have "an exceptionally short stem... [which] precludes the accumulation of large quantities of starch" (op.cit.:7); only *E.utilis* grows to a height of about 8 metres (ibid.), which though compares to bole lengths of 6-16 metres with *M.sagu* (Flach 1997:12).[80]

While *M.sagu* is distinguished from other species in the genus by its unique combination of reproductive traits, the taxonomy of *Metroxylon* remains complex and far from resolved (cf. Barrau 1959:152f.; Flach 1983:17-19; Flach 1997:8-11). In particular, it remains unclear what status to assign to phenotype variations, locally recognised as specific landraces[81] according to such features as cultivation status, maturation period of the palm, spininess and characteristics of spines, colour of fronds, shape and size of fruit, fibrousness of pith, productivity, and colour of starch; following folk taxonomies therefore seems to remain the most reasonable approach for practical purposes (cf. Flach 1997:33,43-48). Taxonomies seem richest in the Sepik river basin of PNG, where reportedly over 20 distinct forms of sago palm are recognised (op.cit.:34f.; see also Ellen 2004a:76f.).

The phenotypical diversity with simultaneous development of large uniform tracts of palms may follow from further particulars of the plant's reproductive biology. Thus, *M.sagu* seems to be an obligatory cross-pollinator, thereby producing very diverse offspring; at the same time, its prolific suckering leads to the establishment of monoclonal stands (Flach 1983:17-19; Flach 1997:48). The observed sterility of some landraces (Barrau 1959:155; Flach 1997:33) may be a function of this condition (Flach 1997:46,48). Similarly, spininess may be less a defining attribute of the respective landraces than a simple inherited characteristic, controlled by just two genes (Barrau 1959:153, Flach 1983:17 and Flach 1997:10,45-tbl.12 [all relying also on other sources]). It would therefore be reliably preserved only through vegetative reproduction. Generally, "[i]t is... possible that only a limited number of stable varieties exist" (Flach 1997:46). The rest would be vegetatively propagated clones of 'pseudo-varieties'.

Table 5: Sago Palms—Comparison of Reproductive Traits

species used for stem starch[*]	genus	species	hapa-xanthic	soboli-ferus	source
sagu and spp.	*Metroxylon*	*sagu* (syn. *rumphii, squarrosum*)	+	+	Flach 1997:8
		spp. (excl. *sagu, amicarum*)	+	–	Flach 1997:10
		amicarum	–	–	Flach 1997:10
pinnata	*Arenga*	*pinnata*	–	–	Ruddle et al.1978:5, Whitmore 1977:37
aequatorialis, mitis, rumphiana, urens	*Caryota*	*urens*	–	–	Ruddle et al.1978:7
		spp.	[no inf.]	+/ –	Whitmore 1977:44-46
insignis, utilis	*Eugeissonia*	spp.	+	+	Flach 1997:8-footnote 2, Whitmore 1977:58
umbraculifera [= talipot], *utan*	*Corypha*	spp.	+	–	Ruddle et al.1978:7, Whitmore 1977:50f.
(1 sp.)	*Mauritia*	spp.	–	–	Ruddle et al.1978:9
(1 sp.)	*Roystonea*	spp.	–	–	Ruddle et al.1978:9
(1 sp.)	*Arecastrum*	spp.	–	–	Ruddle et al.1978:9

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[*] as listed in Ruddle et al. (1978:4-Table 1)

Starch Extraction and Use

Considering the hapaxanthic flowering pattern of *Metroxylon sagu*, the most advantageous time for starch extraction is at the onset of flowering or fruiting—authors as well as ethnic groups differ in their assessment whether starch content is highest with the former or the latter (cf. Flach 1983:49; Flach 1997:26,54; Powell 1976:112; Rehm & Espig 1991:63; Ruddle et al. 1978:13-15; Townsend 1974:222; Whitmore 1977[1973]:77).[82] Sometimes the flower is cut to preserve the starch for extraction later (Ruddle et al. 1978:15); there seem to be also entirely sterile palms with superior capacity for starch accumulation (Barrau 1959:155). The age at which a palm will flower varies, due to "differences between types or differences in growing conditions, or both" (Flach 1983:16). Values provided in the literature vary accordingly: "about 15 years" (Ruddle et al. 1978:5); "8-15 years" (Powell 1976:112); "from 8 to 17 years" (Flach 1983:16 [referring to the wider literature]). Flach (1997) estimated 12 years for growth under ideal conditions (op.cit.:12-15), but observed 15 to 20 or more years in one field site (op.cit.:43). He identified moisture as critical for the length of the growing cycle: humidity consistently above 70 %, and well-distributed rainfall exceeding 2,000 mm per year promote growth; while both permanently stagnant water and water shortage inhibit growth (op.cit.:52).

The method of starch extraction has been widely described (e.g. Barrau 1959:156,157-fig.5; Flach 1983:50; Flach 1997:28-30; Powell 1976:112f.; Raabe 1990:78-81; Ruddle et al. 1978:16-24; Townsend 1974:222-224). It follows a basic pattern of

- cutting the bole,
- exposing the pith,
- grating the pith,
- leaching the pith in a purpose-built apparatus, and
- letting the starch settle in a tank.

Major geographical variations in technology concern in particular the designs of the tool used for grating and of the apparatus. The former consists in a chopper (sago pounder) which is typically applied lengthwise to the trunk, the most effective way to cut the vascular bundles (cf. Flach 1983:45). Two basic designs have been distinguished: a western or Indonesian design in which the head is hafted in a fashion exclusive to the purpose, and an eastern or Melanesian design which employs the same fashion of hafting as for woodworking tools (cf. Appendix 7). Beyond this major classification, local designs and materials appear to vary without discernible patterns (Raabe 1990:79, Ruddle et al. 1978:16-19). In regard to the apparatus, Roy Ellen (2004a:esp.80-85) has described a distinction between hand-pressing and trampling methods, engendering a respective difference in apparatus design. The former is prevalent in the Moluccas and Melanesia, i.e. the native range of *M.sagu*, the latter further west, and has therefore been interpreted by Ellen as transfer to *M.sagu* of technologies originally associated with other palms as the species spread from its centre of origin (op.cit.:95f.).[83] Clearly, Krisa is situated in the technological overlap zone regarding chopper and apparatus designs, employing at once specialised choppers and hand-pressing (cf. Plates 4-6).

Hand-pressing apparatuses typically consist of three principal elements (cf. Ruddle et al. 1978:21f.):

- an inclined gutter[84] from the sago palm's upper leaf sheath, set up at about waist height;
- a filter tightened across the gutter and thus dividing it, often from the fibrous coconut leaf sheath;
- an arrangement of one or more tubs at the lower end of the gutter, typically either wooden or from palm leaf sheaths.

An additional element can be a dipper—such as a bucket element suspended from a flexible pole—to collect and transfer water from a source to the apparatus. For washing, a portion of chopped pith is filled into the upper part of the gutter, mixed with water and kneaded, so that the starch is released and carried off by the water which collects in the settling tub; the pulp remains behind the filter and may be washed out again and eventually discarded.

The procedure basically serves the separation of starch from ligneous tissue through leaching. Ellen (2004a:89-91) has called the cognitive operation involved a third-order food processing problem, requiring complex reasoning, as opposed to first-order problems which involve immediate access to a resource's food value (e.g. picking fruit), and second-order problems which involve analogical reasoning (e.g. tapping sap). He argues, though, that the respective "conceptual hurdle... is... more apparent than real" (op.cit.:91) and therefore the common mystification about the wide distribution of the technique—applied similarly to other palm species in Southeast Asia and indeed South America, as well as to Indo-Pacific cycads (op.cit.:81,91,93)—and about the complexity of the apparatus unwarranted. Rather, he suggests that

> "the practices of leaching and pressing reflect archaeotypes [sic] which are culturally widely distributed regardless of local ecology and potential sources of food, and which readily combine and reconfigure into appropriate cultural schemata as particular situations require" (op.cit.:93).

After all, leaching constitutes principally but a form of washing (as, indeed, represented in the Tok Pisin phrase for sago processing: WASIM SAKSAK—"washing sago"). Washing, though, is cleaning, which suggests its use for detoxification.[85] Starch extraction but inverses the utility of the products—washing water and pulp (cf. op.cit.:93f.). The basic operation is always a transformation of something inedible into something edible on application of water (cf. op.cit.:92). Leaching is therefore a universal technique which is principally distinct from the use of sago palm, and possibly prior to it, an aspect which is relevant for assessing evolutionary scenarios.

The processing of *Metroxylon sagu* is comparatively effortless, notwithstanding the intense labour input: "The pith is easier to grate than any other starch crop, e.g. cassava roots. The starch settles easily because of its large average size." (Flach 1997:26). Processing is also highly productive. Typical amounts of starch extracted from a palm range between roughly 30-300 kg[86] (averaged after Barrau 1959:155; Flach 1997:24,42-tbl.9,42-tbl.10; Ruddle et al. 1978:61,62f.-tbl.3[87]; Townsend 1974:227-tbl.1). In PNG, output per hour seems to average 2-3 kg (Ruddle et al. 1978:64). Accounts differ on the amount of sago starch a person requires when sago is the principal staple, but range around ¾ kg per day (Barrau 1959:158 mentions 2 lbs = 900 g; Townsend 1974:232 mentions 1.47 lbs = 670 g). Flach (1997:26 [after Ohtsuka 1983]) provides a ratio of annual work input to starch output which seems to accord well with these data: "In a subsistence economy, roughly 150-160 hours of work are needed to produce enough starch for one person for a full year (1 kg air-dry starch/ day or approximately 10,000 kJ)." That is, a person's daily ration of starch—estimated even higher than specified by Barrau—can be satisfied by 0.4 hours of work; conversely, 5 hours of work can produce 12.5 kg of starch or 12.5 daily rations, using Barrau's and Townsend's values even between 14-19 daily rations. A calculation by Patricia Townsend (1974:232f.) supports this assessment: "Since a woman can produce sufficient sago in 1 day to provide for 16.7 people [while she has to support on average 3.8 people including herself], she would need to work sago on the average of only 1 day in 4 or 5.". Stanley Ulijaszek and Simon Poraituk (1993:279 [referring to an earlier publication]) report an almost identical observation, namely "that on average, one day's sago-making will provide enough starch to support a household for five days". This confirms the findings of their specific input-output study, that making sago may involve hard physical effort when carried out, sustained over 3-5 hours (and, one may add, in an unpleasant environment), but that it is highly efficient in terms of energy returns, and that therefore it "may subsidize other energetically less efficient but nutritionally important food-getting practices" (op.cit.:279).

Nutritional supplementation is essential, as sago starch is almost completely devoid of any nutrients besides carbohydrates (cf. e.g. Flach 1997:28; Ruddle et al. 1978:57f.; cf. Table 2 [p.36], p.41). Sago use therefore needs to be complemented even more than swiddening with other subsistence practices, such as hunting, fishing, the collection of animal and plant foods from garden- and non-garden environments, and in particular the use of other perennials (cf. pp.58f.). In fact, some important supplementation may derive from the sago palm itself, obtained by three different processes (cf. Table 3). Firstly, there is the derivative use of the pith, in the form of mushrooms which colonize the pulp waste. Secondly, there is the alternative use of the pith as a substrate to incubate grubs of the sago weevil, which is attracted to dead boles (cf. p.34). For this purpose, often the top or base part of the bole are used, which are lowest in starch. This amounts to letting the grubs "convert sago starch into fat and protein, a very efficient way of exploiting the lowest-yielding sago" (Ruddle et al. 1978:39). Thirdly, there is conversion and enrichment of the starch through fermentation (cf. p.35 and below).

The starch can be stored in variously humid conditions. Flach (1997:26) states: "If dried, the starch can be stored without difficulty." Raabe (1990:81f.) refers to several sources which indicate that raw starch may be stored "for longer periods" without any particular treatment, but also that drying through heating or toasting prolongs its life (cf. also Ruddell et al. 1978:27-36 and Flach 1983:52f. on pearl sago production). Townsend (1974:224f.) observed in her field site that sun-dried starch kept for several weeks, while starch stored buried in mud kept for several months. According to Ellen (1988:129 [referring to an earlier publication]), starch stored slightly wet, to encourage fermentation, keeps for up to one month. Presumably, Townsend and Ellen refer to different mechanisms by which preservation is achieved. It seems that there is wet storage *under* water, accompanied by slow disintegration of the starch; and wet storage *outside* water, leading to lactic acid fermentation (Flach 1983:52, 1997:26,30; also Barrau 1959:156f.).[88]

Explanations for wet storage by sago users themselves and outsiders, though, include not only an improved life span of the starch (a typical comment in Krisa is: "the sago will go off when it's not kept wet"), but also cooking purpose: only wet starch is suited to prepare jelly, since dry starch would produce lumps (pers.comm.

Christin Kocher Schmid 2000; the same is implied by Flach 1997:30). Besides, there is the aspect of nutritional enrichment, as fermentation increases the contents of both vitamin B (Barrau 1959:157; Stahl 1989:179) and protein (Beckerman:552f.; cf. p.35). Finally, flavour plays a role. Sago eaters accustomed to wet starch are reported to find dried sago bland (Barrau 1959:157; Flach 1983:52), but I have also received first- and second-hand accounts of the reverse preference, of sago eaters accustomed to dry starch disliking the strong taste of wet starch. I believe that no comprehensive survey has yet been done which maps the geographical distribution of such preference. Anecdotal evidence, though, suggests to me that the preferential use of wet vs. dried starch may parallel the distribution of deep vs. shallow rooted sago economies as traced by Raabe (1990—see below).

There are numerous ways to prepare the starch (cf. e.g. Barrau 1959:158; Flach 1983:52f.; Flach 1997:30; Raabe 1990:82; Ruddle et al. 1978:36f.; Townsend 1974:225). They seem to group, though, into about four basic methods. The probably most widely reported and widespread is the preparation of a paste ('jelly', 'porridge', 'pudding') by stirring with boiling water; this seems to require wet starch, either fresh or fermented. Two other frequent ways of preparation are baking with cover in the ashes ('steaming'—by wrapping in leaves or stuffing in bamboo tubes), and without cover in the ashes or in moulds. A further method is the boiling of little wrapped or unwrapped portions ('dumplings') in water. Grated coconut, mashed banana, or greens are frequently added. Another additive is the juice of certain fruits to the sago jelly, which may improve digestibility by breaking down the starch through acid or enzyme action (Townsend 1974:226 [relying on a further source]). This seems of particular importance in the absence of pottery or modern cooking pots, where water can be boiled only with the stone-heating method and therefore cooking is less thorough (ibid.).

Sago Palm Ecology and Management

Metroxylon sagu is a superior resource owing not only to its efficient yield patterns, but also its efficient management patterns. And much as its reproductive biology plays a major role for yields, so it does for management, where its prolific suckering combines with its habitat requirements. The species occurs naturally in fresh water swamp, where regular inundation supplies nutrients and creates an environment in which the palm has a competitive advantage over other flora:

> "Under extremely wet conditions, grasses take over, and under drier conditions the palm disappears under an increasing cover of other forest trees." (Flach 1983:27; cf. also op.cit.:33 and Rhoads 1982:20)

Forest encroachment seems the main impediment to palm growth in drier conditions, while seedling growth and starch accumulation have been shown to be superior; stands in drier environments are therefore the potentially most productive ones, provided forest proliferation is curbed through appropriate tending (Flach 1983:27,5-7).

Without human interference, sago palm abundance is highest in the intermediately wet zone. Here, profuse suckering creates dense clumps of immature palms and a relative scarcity of mature palms, while starch production decreases (Flach 1983:5, 33; Rhoads 1982:23). Utility for humans is accordingly low. It increases with human impact, the most innocuous being extraction itself. As James

Rhoads (1982:24) observed, felling a palm and clearing a processing site removes plant competitors and opens the canopy, thereby stimulating the growth and maturation of suckers; it will at once stimulate photosynthetic activity and hence starch deposition. Michiel Flach (1983:40f.) identified corresponding, if more systematic, management steps for a commercial setting: 1) killing all other trees; 2) thinning the total number of clumps; 3) thinning ("pruning") individual clumps; 4) cleaning the trunks from dead leaves; 5) clearing the undergrowth. Again, all measures aim either at the increased admission of sunlight or at the removal of competition; they "will result in an explosive growth of trunks in the grove and not only will trunk growth increase but also the starch content per trunk" (op.cit.:41). In further correspondence to the subsistence situation, Flach recommended: "It would be advantageous if improvement of the grove could be carried out in combination with systematic harvesting" (op.cit.:41).

Rhoads (1982:24) identified three forms of sago palm management, based on his own research and comparative ethnographic evidence. He listed, in order of increasing intensity: firstly, the incidental effects of extraction, as described above; secondly, the (trans-)planting of suckers or seedlings; thirdly, the alteration of the environment with or without additional planting, through canopy clearance or the creation of artificial swamps. Only the latter he declared to be truly 'cultivation', while planting alone he defined as 'horticulture'. This classification may have been inspired by models of agricultural origins which postulate an evolutionary sequence in which the artificial propagation of crop plants precedes large-scale environmental transformation. I believe, though, that at least in a tropical rainforest context artificial propagation itself is preceded in evolutionary as well as in conceptual terms by subtle environmental manipulation, as repeatedly suggested in the foregoing sections (cf. esp. pp.45,65f.,73). Correspondingly, I consider that such subtle manipulation constitutes a less intensive form of management than planting, a position which I will further elaborate in chapters 5 and 6. I therefore suggest a revised classification:

1. The incidental effects of extraction. On this point, I am in agreement with Rhoads.
2. Environmental manipulation without planting. With this point, I reverse Rhoads' order and at once dispense with the ambivalent parameter of 'transformation *with or without* planting'. I also suggest to include a practice not explicitly mentioned by Rhoads, namely nurturing of palms through elimination of competitors, which as the removal of undesirable species corresponds in principle to canopy clearance. Any such practices affect the desirable species—here *Metroxylon sagu*—only indirectly, by creating a more favourable biotic or abiotic environment. They therefore expand management form no.1 quantitatively, but not qualitatively.
3. Planting. This practice represents a qualitative departure from the previous. It affects the desirable species directly, by actively changing its distribution. It includes, though, some degree of indirect manipulation almost by definition: however small the planting site is, some vegetation will likely have to be removed; besides, the previous absence of a palm in the precise location suggests that conditions may have been suboptimal and therefore would benefit from manipulation. This usual association of planting with environmental manipulation was not acknowledged by Rhoads, possibly due to its omission in the reviewed literature. It provides

a further argument against his classification of planting as an intermediate category.

This sequence of increasingly intensive management forms corresponds to that identified for perennial resources more generally, and in particular acknowledges the fundamental contribution of clearing activities (cf. p.71). The correspondence at once points to a further, yet more intensive, form of management, which conforms to agroforestry scenario 4 (cf. p.71):

4. Planting following swidden gardening. This practice represents again a quantitative expansion of the previous, involving, as it were, extended site preparation. Thus, it indeed combines planting with large-scale environmental alteration, though in successive stages and in a different form than envisaged by Rhoads.

Besides the order of Rhoads' classificatory sequence, I also consider his labels problematic. 'Horticulture' should, if at all, be reserved for practices involving the preparation of gardens, for its obvious lexical connotation. 'Cultivation', on the other hand, classically refers to practices which involve planting.[89] If this contradicts Rhoads' use of the term, it does retain it for the most intensive forms of plant management in my revised scheme. Whether its meaning should be extended to less intensive forms of management is a matter of debate and will concern me again in the next chapter.

If Rhoads' scheme of classifying deliberate forms of sago palm management may be disputable, his study has clearly demonstrated that the incidental effects of extraction must be considered management also. If the interpretation of 'extraction' as 'management' sounds oxymoronic, this dissonance is precisely the "wobbly line" which Patricia Townsend (1990:746 [without reference to Rhoads]) perceived:

> "Even in the large wild stands [of sago palm], the cutting of palms for grubs and starch is a type of management: by thinning the forest in this way the foragers may improve yields. My point is that for tree crops, including palms, the line between gathering and cultivation seems particularly wobbly. Perhaps because of this ambiguity, palms are being left out of an argument to which they are likely to be crucial."

If her observation has served me earlier (pp.44,65,77) to highlight the confusions attaching to foraging in tropical rainforests, unmanipulated fallow vegetation, and perennial resources, its comprehensive relevance but highlights the extent of a fundamental dilemma in the study of human subsistence. This dilemma relates to the role of human agency in the generation of resources. It unsurprisingly surfaces in particular when the distance becomes palpable between human impact and the eventual resource, either in space (e.g. canopy clearance, removal of intra- or interspecific competitors) or in time (e.g. past swidden preparation, erstwhile planting).

The case of the sago palm illustrates especially how the distance in space renders management at once inconspicuous and paradoxical. For observers with an agricultural background, the targeting of the resource's environment rather than of the resource itself deflects attention from the resource, while the elimination rather than addition of plants to promote a resource is counterintuitive and hence conceptually puzzling. Such indirect forms of management heighten further the sago palm's conceptual ambiguity, in addition to the confusing status which it shares with other arboricultural resources; its perplexing morphology; and its necessary complementation with other subsistence strategies due to its nutritional content, themselves often identified as hunting and gathering. More than any other resource, the sago palm occupies therefore the interface between foraging and cultivation. The resource users themselves, even if they establish sago groves through management scenario 4, may perceive a similar ambivalence:

> "All of this gives sago a primordial significance, in contrast to what the Arapesh see as an artifactual significance attached to gardens, settlements, and coconut palms. Unlike, say, yams and taro, which require constant horticultural attention, sago looks after itself; to the Arapesh, it exemplifies natural abundance and self-sufficiency... And, unlike coconut palms and breadfruit trees, which are planted in the village, sago dwells in the shadowy valley floors, in company with spirits of the dead, bush demons, and other creatures that are the antithesis of the ordinary, mundane beings who populate everyday life in the ridgetop villages (Tuzin 1977)[90]. Sago, then, stands ambiguously between the wild and the domesticated. Primordial in its behavior and habitat, sago gives to culture while requiring nothing from it. It is this feature that nourishes Arapesh imagination and contributes to sago's feminine significance—for Arapesh men impute the same liminality to their women—when it enters as an idiom in ritual, kinship, and other domains of cultural ideology..." (Tuzin 1992:105)

As the sago palm focuses the conceptual confusions which have been recurrently surfacing throughout this chapter, it at once returns us to issues about human prehistory in tropical rainforest, indicated by the context in which Townsend made her above comment. After all, the calorie debate revolved not only around the question as to whether foragers were presently living in tropical rainforest areas, but whether they could ever have done so. The sequence in which we decide to arrange various forms of resource management is therefore not only of taxonomic interest. Rather, it reflects how we conceive of human-plant interaction, which in turn will bear on how we model subsistence prehistory.

Implications for Subsistence Prehistory

Authors reporting on sago palm management have variously described the connection between garden preparation and sago palm proliferation (i.e. scenario 4—cf. p.94), but have typically been hesitant to explore its long-term ecological implications. Roy Ellen (1978:165,171-174) documented how sago palms are planted in gardens which consequently develop into sago groves, analogous to the situation with other arboricultural resources. If he thereby acknowledged the often ignored fundamental similarity between sago palm and other perennials, he implied only resource concentration. Others have hinted at expansion, though with a tendency to consign the phenomenon to the domain of local representations. Markus Schindlbeck (1980:145f.) wondered:

> "It is peculiar how the planting of sago palms is connected with gardening, because people claimed again and again that sago palms had been planted in locations where formerly the forest had been cleared and a garden prepared... Local people say that the sago palms did not do well in dense forest, but thrived after clearing. We should therefore consider a close association between the preparation of gardens and the planting of sago palms." (my translation).

Despite his hesitations, he went so far as to suggest:

> "This frequent planting of sago palms in gardens, which are mostly located in forest and are not prepared in sago areas... means an increase in swamp areas, since the palms churn up the firm ground with their extensive roots." (op.cit.:154, my translation)

It remains, however, unclear whether he reproduced with this image a local allegory in which the creation of swamp symbolises the expansion of sago palm cover, since he also reported the respective capacity of sago roots as mentioned in a local spell (op.cit.:146). Peter Huber (1978:165) has been more decided about the expansion of sago palm, which though he regarded as one resource among many:

> "Consider a lecture delivered by a middle-aged man to his son and one other adolescent of his clan: the lecture concerned the proper way for adult men to act and its central theme was that men should clear gardens *so that sago would grow*. In part this exhortation can be taken literally. The clearing of hillsides is believed to encourage greatly the growth of sago stands formerly shaded by the forest... where no sago stands exist to receive the benefit of garden clearing, they are normally introduced by the gardener. In 1977 one garden site was chosen solely to encourage the growth of a stand of sago which the gardener felt was being choked out by the surrounding forest. Gardens do encourage the growth of sago, and people do make gardens with that purpose in mind—but sago is only one of a number of long-run improvements to the environment which are brought about through gardening, and to some extent the father's exhortation must be seen figuratively to invoke a broader range of considerations." (original emphasis)

Both Schindlbeck and Huber therefore documented ethnographically a process subsequently implied by Flach's (1983, 1997) ecological data, namely expansion of sago palm areas through clearing activities. These remove competition from forest trees and thereby permit the plant to benefit from the advantageous conditions on drier ground (cf. p.92).

Rhoads (1982) not only made this connection explicit in his study, but identified the inconspicuous act of harvesting as instrumental in the process. He concluded:

> "Under contemporary environmental conditions sagopalm communities are in many instances totally reliant upon human interference to promote their succession in environments dominated by other types of vegetation (e.g. rainforest or savanna). Second, the efforts of ancient sagopalm users probably contributed substantially to *Metroxylon*'s present distribution. Finally, human management schemes need not be highly regimented (as is the case with many Melanesian carbohydrate food crops) to ensure the vitality of a sagopalm stand." (op.cit.:25)

With these insights in mind, Rhoads considered a number of points to explore how prehistoric immigration into New Guinea and attendant subsistence changes might have taken place, and which role the sago palm had in these (op.cit.:25f. [referring to a number of authors]):

- New Guinea and Australia have been colonized at least 50,000 years ago, when due to substantially lower sea levels both were part of a single joint landmass, Sahul, separated by sea from Sundaland to the west.
- The immigration of colonizers by sea suggests their prior adaptation to riverine or coastal environments. The immigrants probably found familiar resources around the northwestern coast, including sago palm, fish and shellfish.

- Their further colonization of Sahul meant migration into unfamiliar environments, which required subsistence changes. These could have been supported in two ways: 1) through reorientation of the dietary base—either through greater reliance on coastal fauna, enabling rapid dispersal, or through progressive replacement of known with unknown foodstuffs; 2) through taking up plant management techniques.
- Colonization was fast, as documented by the oldest evidence for human occupation of New Guinea—located in the highlands and suggesting subsistence adaptation to high altitude environments by 25,000-30,000 years ago.
- Between 50,000 and 8,000 years ago, a drier climate meant a retreat of New Guinea rainforest to the highlands fringe, while savannah and open forest covered low-lying regions, including the western part of the shelf joining New Guinea and Australia. Environmental reconstructions suggest no major natural expansion of the sago palm into this area and northern Australia.[91]
- Yet, contemporary subsistence economies in savannah areas in southern New Guinea include the management of sago palms. In contrast, subsistence economies in northern Australia lack sago palm exploitation, even though they do employ preparation of plant food by leaching.

Rhoads concluded that the early colonists did not introduce the sago palm into northern Australia, not because savannah habitat presented an environmental barrier, but because "plant cultivation was not a strategy seriously followed by this region's early inhabitants" (op.cit.:25).

Although he did not make it explicit, this interpretation resonates with his reconstructions of how colonization progressed. He imagined that the northwestern and northern coasts were colonized first, for their similarity with known environments, followed by an expansion inland along the larger rivers (op.cit.:25). He did not pursue his considerations regarding rapid dispersal based on marine resources, but we may assume that this strategy supported further coastal colonization. As for the penetration of inland areas away from the main watercourses, he merely observed: "By about 25,000 years ago people had spread throughout much of Sahul and followed subsistence practices which varied from those thought to be original." (op.cit.:26). Such speedy diffusion and attendant subsistence change seems more compatible with his first class of strategies (reorientation of the dietary base) than with the second one (taking up plant management techniques). This correlation would support his earlier conclusion regarding sago palm use without cultivation, although he himself abstained from such inference.

He did suggest divergent adaptations to account for the differences between the probable lifestyles of the earliest colonists and recorded subsistence forms. To explore the respective processes, he recommended the sago palm as a suitable reference point, considering that the first immigrants likely used the palm but did not practice cultivation "despite its presumable ease and rewards" (op.cit.:26). He also dismissed the notion that cultivation practices had to be introduced to New Guinea from the outside, by noting: "The tropical lowlands must have offered an environment favouring experiments in plant cultivation" (ibid.).

He stopped short, though, of suggesting that the earliest colonists practised a subsistence form which involved incidental management strategies of sago palm (and of other resources, as has been postulated for foragers in tropical rainforest—cf. pp.44ff.); that they transferred these strategies to other environments and resources in the course of their rapid colonization of Sahul; that thereafter adaptations diverged further as the descendants of the first colonists developed various subsistence forms in situ; that one of these was the increasing reliance and increasingly intensive management of sago palm; and that this development occurred in lowland rainforest. Neither did he pursue a number of leads contained in his ecological conclusions and the archaeological evidence he reviewed:

- the practice of preparing plant food by leaching—which species apart from sago palm are/ were processed in this manner (cf. nn.40,85)?
- the subsistence form connected with the archaeological highlands site—what, specifically, does the adaptation entail? how might it have related to contemporaneous lowland adaptations?
- the Pleistocene retreat of the rainforest—what did the contraction mean for the rainforest's role as a laboratory for plant management techniques?
- the role of incidental management regimes—could they have been the basis from which more intensive management regimes were developed, and how?
- the extent of modern, anthropogenic sago palm areas—how did their expansion relate to the development of more intensive forms of sago palm management: cause, effect, or both?

Rhoads' conclusions converge with a theory of New Guinean settlement and culture history which Eva Raabe (1990) formulated upon a comparative literature study examining mainly ethnographic and linguistic evidence on sago use in New Guinea. The essence of Raabe's argument is that "[t]here are two traditions of sago use in New Guinea, the older one of which is that of the Papuan-speaking ethnic groups." (op.cit.:256, my translation). She summarised her theory as follows (op.cit.:257-259, my translation):

> "In the Pleistocene, at first small groups of hunters and gatherers immigrated who already knew of the technique of processing starch from sago palm pith. Their migration paths led through higher altitude forest and savannah into the central highlands as well as along the coasts. No specialisation for specific food sources existed yet at this time. The processing of sago developed successively into the main subsistence form only in the extensive sago swamps of the coasts and river valleys. With this specialisation also the development commences of a certain sexual division of labour, an associated sago symbolism and a certain ritual complex centred on sago. At the end of this development stand Papuan-speaking groups who combine the following characteristics: the use of sago as the most important staple; the processing of sago as mainly women's work; sago as a symbol for everything female; and a close link of sago and sexuality in ritual.
>
> The inexhaustible food potential of the extensive sago swamps enabled sedentism and population growth, which in turn triggered the migration of individual groups. Groups from the lowlands who penetrated higher altitudes changed their staple foods in view of the changed environmental conditions, which led to a decline in the ritual importance of sago. Retained was a more infrequent use of sago as supplementary food, the sexual division of labour and a continuing high appreciation of sago dishes. The groups in the area of the Fly-Sepik watershed seem to form a link between the ethnic groups of the south coast and the Sepik. With them, one finds initiation rituals which are directed at the growth and fertility of the most important

> plant resources, comparable to the sago rituals of the south coast and the upper Sepik (cf. Barth 1971:179)[92]. Even though in the mountain areas the sago palm grows only in small stands, its use is never completely abandoned. One can however distinguish a gradation of sago use in the subsistence economies of the individual groups according to the altitude of settlement, which ranges from strong dependence on this foodstuff to its rare use as an emergency food (Morren 1979:2, Barth 1971:173, 1975:42)[92].
>
> [Corresponding to the migration routes implied, if not expressly postulated, by Rhoads, Raabe here hypothesizes an initial movement along both the south and the north coasts, with the Fly–Sepik route used only subsequently.]
>
> The later immigrating Austronesian groups brought their own form of sago use, in which this foodstuff mostly ranked as an emergency food and processing constituted an almost totally male task. Only in contact with the Papuan population and under the respective environmental conditions do individual Austronesian ethnic groups take on the intensive sago economy, leading to a division of labour and sago symbolism which corresponds to that of their Papuan neighbours."

Raabe's analysis also highlights that the subsistence strategies of the first settlers were generalised, flexible, and characterised by mobility (op.cit.:254f.). This scenario resonates with that portrayed by Rhoads who conceptualised it as the capacity to reorient the dietary base (cf. p.97), and with the opportunism recognised as an intrinsic feature of forager economies (cf. p.43). Most important in the present context, use of the sago palm was likely one element of these strategies, but not an essential one (op.cit.:255).[93] That is, the colonization and occupation of the respective habitats did not depend on its presence, use or management.

Still, Raabe assumed that sago palm was abundantly present prior to the colonists' arrival. Her assumption is not only implicit in her references to "extensive sago swamps" or "inexhaustible food potential" in the above quote, but explicit in her contestation of Rhoads' principal argument, that ancient sago palm users contributed to the species' present distribution, partly through the incidental effects of harvesting. Thus, she insisted (op.cit.:179) that, firstly, the vastness of contemporary sago areas stands in no relation to the small number of initial immigrants into New Guinea and their incidental effects on the vegetation, and that, secondly, such vastness could if at all only have been achieved by planting, which though has been ruled out by the absence of sago palm in Australia. I believe that the timespans involved render such concerns idle. Several millennia of incidental sago palm management, and another several millennia of intensive sago palm management—after the flooding of the landbridge between New Guinea and Australia—may well have accomplished a major expansion of sago palm areas to their present dimensions. Rather, it seems that Raabe fell victim to the common fallacy of equating abundance with lack of human impact, in turn based on the notion of unmediated resource exploitation which was exposed and contested in the calorie debate (cf. p.41).

Yet, her argument remains that sago palm constituted but a minor resource in the past. It combines with Rhoads' dynamic conceptualisation of human–sago palm interaction to qualify notions according to which contemporary subsistence economies reliant on sago could provide models for prehistory. If, therefore, Ruddle et al. (1978:68) speculated that sago was "probably once a common staple throughout Melanesia" (cf. also Barrau 1959:155), they may have been misled both by the present abundance of sago palm and by its "primordial significance" which Tuzin made out, paraphrasing Arapesh conceptions (cf. p.95). The more nuanced suggestions by Townsend (1990) and Dwyer & Minnegal (1991), that contemporary users of primarily wild sago could serve as templates for modelling prehistoric foraging in tropical rainforest (cf. p.44), may be appropriate less in regard to sago as the principal resource, than to the management strategies which enable its use.

The ambiguities of the sago palm therefore extend to its deceptive abundance and archaism, fuelled by its association with forager lifeways. Indeed, this very ambiguity of its status, rather than its capacity as a plentiful source of carbohydrate, establishes its role for exploring prehistoric subsistence. If I suggested at the end of the last section that "the hazy zone where the meaning of cultivation remains uncertain" offers a means to explore "the processes active at the dawn of human habitation of tropical rainforests", the sago palm constitutes the resource par excellence to pursue this task. As it touches the core of the foraging–farming duality, it can teach us about the processes that led from the generalised subsistence economies of the first colonists to the specialised subsistence economies of today. It is the examination of this duality to which I will now turn.

CHAPTER 4

RECONCEPTUALISING SUBSISTENCE IN HUMAN ECOLOGY

4.1. The Dilemma with Conventional Categories

The foregoing chapter has shown that foraging, swiddening, arboriculture/ agroforestry and sago use are by no means as distinct from one another as their labelling suggests; neither are they placed as unambiguously on either side of the foraging–farming divide as appearance would have it. Indeed, the one ambiguity reinforces the other, as the overlaps between strategies amplify their inherent fuzziness.

Thus, sago use may in some cases conform to foraging, in others to arboriculture, which itself may involve both wild and cultivated resources, hence conform partly to foraging in turn. Both sago use and swiddening are necessarily combined with other strategies, typically foraging, which in turn may take place in swidden fallows, themselves often agroforests containing arboricultural resources. Foraging, though, has been suspected as imaginary altogether, which would remove the ambiguity of all other strategies at the price of leaving a vacuum not filled by either.

The confusion is heightened by the dual function of these concepts as labels for individual techniques within an overall subsistence strategy on the one hand, and for such overall strategies themselves on the other. The latter function is evident for example in the desire which motivated much of the calorie debate (cf. section 3.3.) to classify or declassify the social groups in question as foragers. The tension between both functions is illustrated by titles such as "Swidden Systems and Settlement" (Harris 1972) or "Sago Subsistence and the Trade in Spices" (Ellen 1979), which seem to describe a social group's overall approach to subsistence, while in fact representing the author's exploration of a single, if prominent, facet of it. That it can only be a facet is already entailed in the physiologically necessary complementation of both swiddening and sago use with other subsistence strategies (cf. pp.58f.,91).

Deceptive Contrasts and the Proliferation of Categories

The relationship between conceptual ambiguity and technical diversity is well illustrated, though not explored, in Roy Ellen's (1982:chpts.6,7) discussion of "Ecosystems and Subsistence Patterns". Initially, Ellen set out from an apparently clear-cut inventory:

> "...although the number of strategies and specific techniques is very large..., the number of basic types of subsistence technique is relatively limited. At any rate, it has been usual to distinguish only a small number... If we adapt a widely recognized scheme, it is useful to distinguish six basic types of technique: 1. gathering of vegetable species; 2. collecting of animal species and their products (small game, insects, honey,...); 3. fishing; 4. hunting and trapping; 5. animal husbandry (including fish farming); and 6. plant cultivation. The first four involve the

> procurement of *non-domesticated* resources, the last two the procurement of *domesticated* resources." (op.cit.:128, original emphases)

The last sentence, which clearly refers to the foraging–farming divide, suggests a straightforward differentiation between the various techniques, which though at closer inspection cannot be maintained. Firstly, the correspondence between use of domesticates and plant cultivation/ animal husbandry is but partial, as indicated in section 3.3. (p.42) and further explored in section 4.5. below. Even if we eliminate this complication, by assuming that Ellen employed the concept of domestication but metaphorically (see pp.159ff. below), intending it to mean the deliberate management of organisms, a definite separation of techniques 1-4 from 5/ 6 remains difficult, as repeatedly pointed out in the last chapter in regard to vegetal resources.

A subsequent explanation by Ellen hints at further inconsistencies in the scheme:

> "There is a degree of arbitrariness in assigning particular techniques to the categories listed... For example, are we to understand the appropriation of shellfish as collecting or fishing, the appropriation of small reptiles as collecting or hunting? Clearly, the categories used depend on the criteria adopted and the significance attached to them. Here they are based on a mixture of narrowly technical features (that is, kinds of tools), the kind of species involved (plants, animals; terrestrial, aquatic...), and the degree of manipulation, through breeding and control of life-support mechanisms." (op.cit.:129, underline added)

Besides Ellen's own admission of arbitrariness, his reference to "degree of manipulation, through breeding and control of life-support mechanisms" confirms the above qualifications: firstly, that he did employ the concept of domestication literally rather than metaphorically, as indicated by his allusion to "breeding" (a common, if problematic synonym for domestication, as I will demonstrate on pp.151f.), whose juxtaposition with "control of life-support organisms", presumably denoting management, blends two principally distinct concepts; secondly, that the dividing line between techniques 1-4 on the one hand and 5/ 6 on the other is more blurry ("degree") than the original scheme suggests. Furthermore, the reference to a "mixture" questions the original scheme's hierarchical organisation, according to which "degree of manipulation" should have been the principal organising criterion, and "technical features" and "kind of species" subordinate ones.

These inconsistencies demonstrate that the six chosen categories are less well bounded against one another, and that the opposition underlying them is less categorical and fundamental than Ellen made out. He himself avoided to address these inconsistencies by limiting his examples of arbitrariness to parameters in the two subordinate sets of variables (technical features: collecting/ fishing/ hunting; and kind of species: shellfish/ small reptiles), rather than the principal one (degree of manipulation). Overall, he remained satisfied that

> "...although no single overall classification is possible (or perhaps desirable), the one adopted does have the considerable advantage of being familiar, relatively unambiguous, and consisting of categories which may be defined so as to contrast significant technical and ecological variables" (op.cit.:129, underline added).

As just pointed out, though, the unambiguousness which he applauded is a spurious one. It is brought about by precisely the endeavour to "contrast significant... variables". After all, concentrating on some variables—however significant—at the expense of others artificially limits variety and thus reduces the scope for ambiguity;

more acutely, aiming at contrast eliminates ambiguity by definition and thereby creates deceptive dichotomies. If such limitation appeals for its economy and convenience, and finds consequently wide application, thus generating the third apparent advantage of familiarity, this does not necessarily prove its utility. In fact, it is ultimately self-defeating as its inbuilt tension encourages a secondary proliferation of categories.

Ellen himself unwittingly demonstrated this dynamic some thirty pages on (op.cit.:167-tbl.7.3 [following Dornstreich (1977:249,250) as presented on 166-tbl.7.2]), when he added in regard to his own research in Seram (Moluccas) the categories of

- swiddening;
- starch extraction from non-domesticated [non-cultivated][94] sago palms;
- starch extraction from domesticated [cultivated][94] sago palms;
- silviculture.

The focus of the study, "relationship of resource areas to food-getting activities", suggests a correspondence of these categories with locally recognised ones. If this justifies their inflation, it at once challenges the universality of the original scheme. On the other hand, closer examination demonstrates that this scheme is principally sufficient, which in turn questions the need for new categories. Thus, swiddening, extraction of starch from domesticated (cultivated) sago palms, and silviculture might as well be grouped as plant cultivation, corresponding to technique 6. Likewise, starch extraction from non-domesticated (non-cultivated) sago palms might be placed with gathering, corresponding to technique 1 and listed additionally by Ellen. Otherwise, sago extraction of whichever kind might be classed as silviculture. Keeping both categories separate seems barely justifiable in the case of palms which have *not* been planted, but fanciful in the case of those that have. The possible objection that, as a palm, sago demands its own cognitive category (cf. Ellen 1998) is invalidated by the very inconspicuousness of the coconut and other palms, which apparently find easy accommodation with other categories. Neither can the sago palm's role as a staple food serve as justification, since this would at once set the cultivation of staples in gardens apart from plain swiddening. Furthermore, neither of these reasons could at once account for the further subdivision of the category according to domestication (cultivation) status.

In fact, sago use epitomises a process of fragmentation brought about by the apparent insufficiency of cognitively salient categories in the basic scheme, combined with the need to accommodate any such categories within the foraging–farming duality. Thus, sago palm is exceptional not so much for its intrinsic qualities as for the criteria used for classification. As indicated at the end of the last chapter, sago use focuses the conceptual ambiguities inherent in the classificatory approach and thus exemplifies the ambivalences which attach also to other strategies. It thereby becomes at once the prime target for the conceptual sprawl which aims to dissolve them.

Diversity, Complementarity and Continua

If the above sequence is exemplary for the fragmenting effects of a conceptually ambiguous classificatory scheme, it is by no means exceptional. The same phenomenon recurs in numerous accounts of tropical subsistence. And while some authors have been content to acknowledge the apparent diversity, many have strained to reign in the sprawl and reconcile it once more with the farming–foraging duality.

In regard to plant management alone, Edvard Hviding and Tim Bayliss-Smith (2000:22f.) have listed as the typical mixture for Melanesia: "fully 'agricultural'" practices; agriculture with forest regeneration (i.e. swiddening); arboriculture; "wild plant cultivation"—oxymoronic in the conventional scheme; and "the gathering of wild plants from the forest". I have already in section 3.5. (pp.69f.) noted their confusion with this situation, which though they did not attempt to resolve other than by pointing out the inappropriateness of English labels (op.cit.:19). I have also referred to Phillip Guddemi's (1992) observation that the Sawiyanö living within the Sepik upper catchment practise cultivation but also engage in extensive hunting and gathering activities, including the exploitation of sago (cf. section 3.1.), corresponding to the complex patterns documented in the Agricultural Systems Working Papers for the region (cf. section 2.2.).

Mark Dornstreich (1977) cited the Gadio Enga, living in a mid-altitude environment in headwaters of a southern Sepik tributary, as "a good example of a small-scale tropical society which follows a highly mixed... subsistence pattern" (op.cit.:246). He provided a detailed breakdown of the activities involved, on which subsequently Ellen relied (see above). The inventory comprised: (1) gardening; (2) sago making; (3) silviculture; (4) gathering of plant foods; (5) animal husbandry; (6) trapping; (7) fishing; (8) collecting of animal foods; (9) hunting (op.cit.:250-tbl.II). Brigit Obrist (1990:454) used this classification[95] as the template against which to examine "ethnographic reports about nine ethnic groups occupying different ecological zones" within the Sepik catchment, ranging from the river basin through its hilly hinterland to its upper tributaries. She found "that each of these groups engages in at least eight of the nine listed food-getting activities".

Obrist appreciated the comparative potential of Dornstreich's scheme, since "[m]any researchers have observed subsistence activities in varying detail, but there is little agreement in the choice of categories" (op.cit.:462). Being "more refined than most" (op.cit.:454), Dornstreich's classification allowed for "a well-balanced investigation of overall food patterns" and could also "serve as a key to further analysis of the sociocultural context" (op.cit.:455). Dornstreich himself had felt that "this concept of subsistence diversity is a particularly useful way to compare the subsistence patterns of different small-scale societies" (1977:262). As later implied by Obrist, his innovation had been borne from dissatisfaction with conventional typologies, for

> "if the Gadio were to be referred to as 'swidden agriculturalists', 'tropical mixed horticulturalists', or 'hunter-gardeners'—terms which are probably the best available according to current anthropological usage—... major dimensions of Gadio subsistence would be ignored" (op.cit.:248).

More generally, and in line with my above considerations, Dornstreich lamented:

> "If one looks at the way anthropologists have dealt with the subject of subsistence, it is immediately clear that they have never adopted any consistent typology for classifying subsistence patterns, nor is there a standard format for describing them. It is true that familiar terms are used, and that societies are accordingly labelled as 'horticultural', 'hunter-gatherer', 'pastoralist', or something similar, but these terms are superficial and do not bear any definite and detailed relationship to the full range of people's actual subsistence behaviour..." (op.cit.:247, underline added).

This "will inevitably produce classificatory inconsistencies and dilemmas" (ibid.).

Almost three decades later, Dornstreich's criticism still fundamentally holds. In fact, it applies to his own study. If appreciating the diversity of subsistence activities had represented a considerable advancement, being necessary for their comprehensive scrutiny and hence that of dietary components, it had not in itself produced a "consistent typology" and a "standard format". This, after all, would mean a scheme which applies *universally.* It would provide us with the tools to relate different subsistence forms to one another in functional respect, thus avoiding "classificatory inconsistencies and dilemmas". It would at once allow us to integrate the details of a particular case into a functional whole. Neither operation can be accomplished through the examination of idiosyncratically defined categories alone, however detailed.

Indeed, Dornstreich's identification of a 'mixed' subsistence economy constitutes less a reformation of conventional typology than an expansion of it: the combination of a number of pre-defined subsistence strategies redefined as techniques. Guddemi (1992:313) performed a similar operation when he described Sawiyanö subsistence as a "mixed economy of foraging and horticulture", defined it as "hunter-horticulturalism" and declared it to be "an adaptation in its own right", namely to "certain tropical lowland interfluvial forests". Like Dornstreich, he thus postulated a new form based on old ones, suggesting it additionally as a particular environmental adaptation. He was adamant that

> "the hunter-horticultural subsistence style is not, either temporally or conceptually, a mere transition state between true hunter-gatherer subsistence (which has proved so elusive to find) and a fully sedentary horticultural way of life" (ibid.).

But if he rejected the notion of transition, he affirmed the fundamental validity of established categories, manifested by their amalgamation into the concept of hunter-horticulturalism. Like him, numerous authors have either implicitly or explicitly embraced the standard division between foraging and farming, if devising different schemes to accommodate within it the unorthodox forms of subsistence which they observed—ranging from a necessary complementarity (Sponsel 1989) to a continuum of subsistence behaviour (Harris 1989).

Conservative Innovation: The Foraging–Farming Duality Remains

This cursory review demonstrates that, no matter how innovative any approaches for conceptualisation may be, they are conservative in one crucial aspect: ***they preserve the fundamental conceptual tenet that there are basically two distinct approaches by which humans can make a living, namely foraging and farming.*** Yet, this long-held conception of subsistence is increasingly at variance with ethnographic observations. Furthermore, it is precisely its defining contrast which causes the noted sprawl of categories and indeed the proliferation of modes for accommodating ethnographic observations. This identifies the foraging–farming duality itself, the most elemental ingredient of standard notions of subsistence, as the very root of the conceptual confusions.

This duality, and the technical and ecological variables which it classically organises, may be familiar, as Ellen (1982:129—quoted on p.102) asserted. Yet, familiarity which confounds rather than illuminates can be of little value (cf. Dornstreich [1977:247]—quoted on p.104). In fact, the source of the familiarity may well be some culturally specific mode of classifying, which generations of anthropologists have casually employed and thereby academically cemented. Indeed, the "cross-cultural objectivity" and indigenous recognition of the scheme, which Ellen also cited (ibid.), is questioned by examples such as those quoted in sections 2.2. (n.15) or 3.5. (pp.79ff., n.77), of encompassing local concepts of gardens, forests, and the practices associated with their management. There may be certain conceptual overlaps between cultures in regard to subsistence techniques and a universal tendency to distinguish between a human and non-human sphere, but this must not imply the perfect agreement of concepts which analysis requires.

Furthermore, the proliferation of labels has not only demonstrated the insufficiency of basic categories, but has at once heightened confusion by introducing additional variables. While Ellen's (1982) scheme (cf. p.101) relied on a common set of criteria, the more elaborate concepts discussed in chapter 3 are disparately defined and highly complex in themselves, as the following matrix illustrates:

Table 6: Complexity of Subsistence Concepts

subsistence concept	**relationship with Ellen's (1982:128) techniques**	**principal criterion for classification**
foraging (cf. section 3.3.)	subsumes techniques 1-4	combination of activities (appropriation) and resources (spontaneous)
swiddening (cf. section 3.4.)	part of technique 6	ecological cycle (alternation between cropping and fallowing)
silviculture (cf. section 3.5.)	spans techniques 1 and 6	class of resources (perennials with distinct habit)
sago use (cf. section 3.6.)	spans techniques 1 and 6	one particular species (sago palm)

Roy Ellen (1994:215) commented correspondingly:

> "The literature is bedevilled by classifications of putatively comparable forms based on non-comparable criteria."

In the best case, the established concepts can therefore be heuristically useful, providing a focus for investigation and discussion, such as I have used them in the foregoing chapter. In the worst case, they obscure important functional connections, or indeed degenerate into superficial labels which preclude any meaningful analysis and comparison, as tendencies in the calorie debate indicated (cf. section 3.3.). In no circumstances can they enable comprehension of entire subsistence systems through holistic analysis and the construction of a functional model. This would require the "standard format" demanded by Dornstreich (cf. p.104), by which resources, activities and other parameters of subsistence could be compared *across techniques*. In this context, Roy Ellen (loc.cit.) has appropriately pointed out that

> "it is far better to avoid single all-embracing classifications, and to examine variation in terms of a series of technical, ecological and botanical criteria".

If such detailed analysis is indispensable for any holistic and representative assessment, though, it does not by itself produce a universally valid approach. Rather, I suggest that the key to this is to deconstruct the underlying foraging–farming divide which as the principal ingredient in conventional classification has at once proved its principal obstacle. This deconstruction, and the subsequent development of a standard format based on new foundations I shall attempt in the remainder of this chapter.

I will proceed by critically examining several concepts integral to the study of subsistence, which though are fraught with inconsistencies and contradictions: nature, ecology and wildness; cultivation, domestication, agriculture and production; and subsistence itself. In the process, I progressively establish the explanatory framework which informs my methodology and in which I ultimately interpret my data. Anthropological discussions on the subject are scarce; major exceptions are the work by Tim Ingold (e.g. 1992, 1994, 2000) on novel theoretical approaches to organism–environment interaction, and by David Rindos (1984) on a Darwinian evolutionary approach to human–plant interaction in the context of domestication and agricultural origins.[96] Otherwise, there tends to be an equally tacit as pervasive assumption that the subject was unproblematic, which creates the impression that a uniform framework for understanding human subsistence was well established. Yet, the prevailing confusions demonstrate the contrary. I trace them in the following sections with particular reference to Ingold's and Rindos' work respectively, and against a critical engagement with Roy Ellen's (esp. 1982, 1994, 1996a, 1996c) work on human ecology and associated cognitive processes. Thereby, I at once recover an existing, if much misunderstood, conception of human–environment interaction, which relies on a scientific understanding of the world.

4.2. Clarifying the Explanatory Framework: Science and the Diversity of Nature

The Ambivalence of Nature

One of the most notorious confusions in subsistence studies is manifested and perpetuated by liberal use of the term 'nature'— "perhaps one of the most multivalent in the English language" (Ingold 1994:21 [referring to Williams 1976][97])—in diverse connotations, whose distinctiveness though remains often obscure. If this permits plays on words and fuels extended discussions, these arise as much from a conflation of meanings as from the genuine complexity of the subject (e.g. Ellen 1996a). Exemplarily, Roy Ellen (1982:277) concluded towards the end of his treatise on subsistence:

> "*Homo sapiens* and nature are not two independent entities; society is not the negation of nature. It is now clear that humans are paradoxically a part of nature and apart from it; constrained by it, but transforming it."

In two sentences, and indeed a single pun, he captured what I will demonstrate in this section are (at least) four different conceptions of nature. If these remained implicit then, Ellen has more recently (1996c, 1996a:4-10) suggested that human cognition seems prone to recognize

- nature as thing
- nature as other
- nature as essence.

I will refer to this threefold distinction, if with different interpretation than used by Ellen, to explore in the following how different cognitive propensities give rise to the various conceptions of nature implied in the previous quote. Their delineation will serve me as a starting point to clarify the explanatory framework of my study.[98]

Nature I and II: Complementary and Categorical Others

The first propensity, for recognising the 'thinginess of nature', is most clearly manifested in the conception of environment as a tangible entity (which I shall call '**Nature I**') in reference to another tangible entity which it surrounds, in particular an organism. Hence, nature as thing may refer to an(other) organism; a collective of organisms; or, most typically, the combination of biotic and abiotic entities often labelled as landscape. In contrast to this designation, Ellen (1996a:4-7, 1996c:105-110) has attributed thinginess only to inventories of natural kinds and their representations, while apprehending the environment/ landscape rather as spatial other, thus assigning its recognition to the second propensity (1996a:7f., 1996c:110f.). For the present discussion, though, I consider it productive to uniformly acknowledge the thinginess of the tangible world. Certainly, this thinginess is variously represented in human minds: its components may be variously classified; its sensory stimuli may be variously apprehended; its spatial appearance may be variously perceived. Furthermore, the quality which we ascribe to the relationship between the surrounding and surrounded entity will vary with our conceptions of organism–environment interaction: the concept of niche—as in classical ecology—sees meaning as provided by the environment; the concept of use quality—sensu von Uexküll[99]—sees it as attached by the organism; the concept of affordance—sensu Gibson[100]—sees it as manifested through engagement (Ingold 1992:41-44). What remains constant, though, is the thinginess itself; and this is constituted vis-à-vis the thinginess of the organism. Hence, both entities are fundamentally concrete *and* exist only in mutual reference to each other. As Ingold (2000:20) reminds us, "environment is a relative term—relative, that is, to the being whose environment it is".

That is, the environment and the organism through which it is respectively defined occupy the same level in the order of things; one complements the other to make up a complete whole. Only in this sense of equally ranked and mutually dependent entities can we conceive of the one being at once "constrained by" and "transforming" the other, as in Ellen's statement (cf. p.108). And it is in this sense that Ellen's (1996a:1) introductory sentences to the volume 'Redefining Nature' must be understood:

> "Humankind has evolved over several million years by living in and utilizing nature, by transforming and assimilating it into culture. Indeed, the biological success of our species has been widely accepted to rest upon its abilities to influence, manipulate and completely change this thing called nature."

If "this thing called nature" is utilized, influenced, manipulated and changed, though, it might more appropriately be called the environment, a term which describes a distinct and well-defined concept capable of reducing the ambiguities entailed in the amalgamous concept of nature. As environment, however, its assimilation "into culture" can only be metaphorical. Unless we extend the concept of culture to cover material aspects of human life (i.e. the physicality of anthropogenic landscapes and of 'material culture'), environment can enter into it only as ideational representation or indeed as cognitive substrate for the second notion of nature: as other.

This, the image of 'nature as other', underlies classically the cognitive category of nature (**'Nature II'**), which in Western[101] thought provides the defining contrast with everything perceived as exclusively and quintessentially human: society, culture, mind, reason... This meaning is only implicit in Ellen's (1996a:7-9, 1996c:110f.) understanding of the otherness of nature, which he regards as principally spatially defined, as mentioned above. I will show (pp.115,132f.) that this spatial definition may be culturally bound and therefore obscure more fundamental cognitive patterns. Hence, I will keep here to the more abstract definition of otherness. The respective opposition—typically as nature:culture in subsistence studies—seems to resonate with that between environment ('Nature I') and organism. In fact, though, its hierarchy transcends it: the involved elements occupy different levels in the order of things. If environment is, in a sense, a complementary 'other', nature is a categorical 'other'. This applies irrespective of the relative position accorded to the latter. As Peter Dwyer (1996) has argued, experientially the conception of nature emerges from culture (op.cit.:esp.181); conventional Western thought, however, has it the other way round, according a prior position to nature (op.cit.:esp.157). If Dwyer's argument follows from comparative ethnographic study, it is compelling in a purely logical sense, too: nature as a conception is of course a product of the human mind, or culture[102], or of whatever we choose to call our human reality.

Nature III and Reflexivity

Even though nature as other is an artefact of our human reality, there is the pervasive notion that it described at once a more fundamental, reality 'out there' (**'Nature III'**): that it was possible to equate an idiosyncratic 'nature as other' with a universal 'nature as essence', or, as Ingold once put it, "reality *for*" with "reality *of*" (1992:44, original emphases). In fact, Ingold applied the designation 'reality *for*' to an organism's relationship with its environment (Nature I). I believe, though, that its application to the categorical other of nature (Nature II) may equally, if not better, satisfy the meaning of his subsequent statement:

> "Only for a subject that can totally disengage itself from its life in the world can reality *for* coincide with reality *of*... It may be a feature of the human condition that we can switch back and forth between engagement and disengagement, between outward-directed action and inward-directed thought." (ibid.)

Yet, this apparent capacity of humans can only be metaphorical. On the one hand, engagement as viewed through the organism must remain subjective, only ever able to manifest as experience. Engagement is therefore less with the environment as a complementary other, as an observer would perceive, but with the organism's own representation of it as a categorical other. For this reason, I consider that 'reality *for*' can appropriately be transcribed as 'nature as other'. On the other hand, and more important in the present context, such experience of "outward-directed action" must always be contingent on "inward-directed thought" and vice versa; conversely, thought is always action, and action always thought in the sense that we can never truly disengage from reality other than in our imagination—*but not by virtue of it.*

In a more recent publication, Ingold has in fact challenged the notion of disengagement (2000:chpts.1,3). As he explains there, the concept of reality as nature, defined vis-à-vis that of culture, portrays its object of inquiry as complete without complement, in contrast to the relational concept of environment; it therefore implies at once an external observer, who, as it were, "can look upon it, in the manner of the detached scientist, from such a safe distance that it is easy to connive in the illusion that it is unaffected by his presence." (op.cit.:20). The corollary is that human reason needs to be removed from the world in order to apprehend it, an operation which leads to entanglement in infinite regress: with the apprehending reason bound to the external observer, the world can only ever be (re-)constructed, so that truly apprehending the world remains an unattainable goal, reconstruction repeating itself with each reconstructive operation:

> "And since, at every stage in this regress, the reality of nature appears as its representation, 'real' reality recedes as fast as it is approached." (op.cit.:42)

The logical dilemma which Ingold describes results from a doubly problematic intellectual operation. To begin with, both reality and its mental (or otherwise bodily) representation are uniformly glossed as 'nature'. This then permits to implicitly substitute the former, which is prior to the mental/ bodily capacity that apprehends it, with the latter, which is subsequent. The result is that the involved capacity, glossed as 'culture', is repositioned as subsequent itself, which means it has to resort to its own illusion to justify the existence of this illusion, and therefore, ultimately, of itself. In other words: replacement of reality with its representation leads to an apparent inversion of cognitive causality and hence an ontological absurdity.

If this paradox manifests for Ingold as the infinite regress of apprehending reason, it lies for Ellen (1996a:30f.) in the "logical tautology" that "[c]ulture emerges from nature as the symbolic representation of the latter". He locates its origins in human evolution, where the emergence of "self-ontology" led to a "bifurcation between experience and representation", leading in turn to the possible co-existence of nature per se and 'nature' in inverted commas (ibid.). As I have indicated above with reference to Ingold's conflation of reality *of* with reality *for*, the assumption is problematic that experience and representation were wholly distinct from each other, and that the one referred to reality, the other to its mental rendition. Ellen's clarification, though, highlights that the cognitive category of nature is intrinsically fractured. As he repartitions nature into a prior, experiential, component, and an emergent, representational component, he can therefore dismiss its perceived opposition with culture as "a pseudo-problem arising out of reflexive symbolic constructs (ordinary language) within culture itself" (ibid.). This conclusion concludes however his article, so that any further implications remain unexplored.

While Ellen traces the paradox of the nature–culture dichotomy to the dual meaning of nature, Ingold (2000) traces it to the cognitive separation of nature from culture. He seeks to overcome this split by retaining his earlier conflation of reality *for* with reality *of* while re-integrating the previously disengaged observer. For this, he postulates a new ontology which regards

> "the human being not as a composite entity made up of separable but complementary parts, such as body, mind and culture, but rather as a singular locus of creative growth within a continually unfolding field of relationships" (op.cit.:4f.).

This stance allows him to recognise "form as *emergent* within the life process" (op.cit.:19, original emphasis), leading him to conclude that "what we may call mind is the cutting edge of the life process itself" (ibid.). As his 'ecology of life' (op.cit.:chpt.1) identifies life and mind as the prime movers, it seems to approach the transcendental event of revelation, a concept on which he indeed heavily relies (cf. op.cit.:index). That his is an existential endeavour emerges most clearly from his motivation as the quest to discover "what the world is really like" (op.cit.:95).

And yet, this endeavour has been conceived within the Western scholarly tradition whose spirit Ingold embraces by affirming his "belief in the absolute worth of disciplined, rational inquiry" (op.cit.:6). Hence, his ecology of life, like the lifeworlds he thereby seeks to understand and emulate, must remain bound by the same reflexivity which has burdened us with the ontological absurdity of the nature–culture dualism, and which has proved the very obstacle to discovering "what the world is really like". After all, only the recognition that our concepts may be products of our imagination has prised apart Nature II from Nature III, and has thus created the problem of infinite regress in the first place. If such reflexivity is not a fundamentally human predicament thanks to the phylogenetic development of self-awareness, as Ellen suggested, then it is at least fundamental to the Western intellectual tradition of critical reflection. Thereby it at once disqualifies this tradition from providing genuine solutions to apprehending the reality of the world instead of just shifting the focus of the dilemma. To paraphrase an aphorism attributed to Albert Einstein: we cannot solve our problems with the same thinking that has created them.

Whether we are culturally conditioned reflective Westerners or universally destined reflective humans, this but seems to leave us with transcendental revelation for uncovering the truth, which is transcendental precisely because it breaches the limits of reflexivity: the interface between our representations and reality.[103]

Alternatively, as Ellen (1996a:25) remarked, "if we do not distinguish between representation and represented, we are sucked into solipsism—the view that the self is the only knowable thing". But if we speak of transcendence, representation and reality, or, more specifically, if we speak with Ellen of the evolutionary emergence of self-ontology (cf. p.111) or with Dwyer of culture being prior to nature (cf. p.109), we of course subscribe, once again, to the same thinking that created these concepts in turn. There is no escape from reflexivity. And if we truly managed to escape, if we managed to reconcile representation and represented, we would have removed the very purpose of our scholarly inquiry in general, and of anthropology in particular.

Nature IV and Science

There is, however, another way of looking at the world, which does not require a radical—and ultimately impossible—overhaul of our ontology, but merely that we apprehend and acknowledge its ideology. This is conveyed precisely by a central tenet of anthropology, namely the complementarity of emic and etic. These two concepts

> "distinguish the understanding of cultural representations from the point of view of a native of the culture (emic) from the understanding of cultural representations from the point of view of an outside observer of the culture (etic)" (Rhum 1997:148)

If reflexivity intrudes here once more with the notion of 'representation', and if Ingold dismissed on these grounds "the much used and abused distinction between 'etic' and 'emic' accounts" (2000:41), we may rephrase the definition, reflexivity-free, by substituting "cultural representations" with "the world". This approach, then, carves up the world vertically, so to speak, rather than horizontally, thereby turning it into plural *worlds*. It accepts that the members of every culture (in the specific sense, as distinct from the abstract sense)[104], and, indeed, these individual members in turn, live in their own worlds, which constitute the realities *for* them; and while one may aim to understand and translate another's world—which is after all not only the professional business of anthropologists but goes on in every cross-cultural encounter, and indeed in every social interaction—this can only ever happen in terms of one's own. In the graphic text-book rendering of Roger Keesing (1981:69),

> "we can never take our glasses off to find out what the world is 'really like', or try looking through anyone else's without ours on as well".

For those raised in the Western tradition at least, these terms (glasses) may include the notions and operations of reflexivity and transcendence, which though are not prior to our being in the world, or indeed subsequent, but integral to it. Hence, the question whether or not beyond these multiple and *equally valid* lifeworlds there is an actual, true reality 'out there', a reality *of* the world, becomes immaterial. In this scenario, reality is in the eye of the beholder and thus varies with perspective: it is fragmented.[105] Contrary to Ingold's one-time suggestion, therefore, that reality *for* could coincide with reality *of* only "for a subject that can totally disengage itself from its life in the world" (cf. p.110), I consider the reverse to be true: for any subject, reality *for necessarily* coincides with reality *of*, since life *in* the world is predicated on engagement; the chasm between the two realities opens through our (culturally-specific?) illusion of disengagement.

If I thereby seem to reproduce Ingold's more recent approach, I differ in one fundamental axiom: with Keesing, I do *not* believe that investigations within the

Western scholarly tradition can enlighten us as to "what the world is really like" (cf. p.111). Accordingly, I consider that Ingold's ecology of life is similarly incapable of attaining this purpose—whatever its merits otherwise—as are the classical projects of science which he contests. In fact, and contra Ingold, science does not intrinsically carry any such claims. True enough, many of its practitioners are quick to assert the contrary. But if they thereby maintain a logically absurd position, this does not automatically extend the same absurdity to the investigative project of science itself. All that science inherently claims is to offer a framework for exploring what *in the Western tradition* is seen as 'the natural world', i.e. the physico-biological realm (**'Nature IV'**), and within this framework to apprehend the principles, i.e. 'natural laws', by which this realm is organised.

There is no intrinsic assertion that the observer was not bound by the observed principles as far as this realm is concerned, similarly as there is no intrinsic assertion in anthropology that the observer was not bound by their own cultural "glasses": neither can extricate themselves from their predicament as physico-biological or cultural human, and therefore all observation remains ultimately relative. Likewise, there is no statement as to how exhaustively the principles of the physico-biological realm are apprehended at any historical moment in time; nor whether they can be exhaustively apprehended at all; nor indeed that these would be the only principles that mattered for an understanding of the world, whether within the Western tradition or beyond. The insights generated by science are historically, epistemologically and ontologically contingent, and science itself makes no claims to the contrary. In fact, without acknowledging historical contingency, science—much as any other form of inquiry within the Western tradition—would lead itself ad absurdum, since its very raison d'être is precisely the perpetual quest for knowledge.[106] I therefore believe that Ingold fights the wrong enemy when he challenges "the claim of natural science to deliver an authoritative account of how nature really works" (2000:15). For, science is concerned with nature the physico–biological realm, not with nature the reality. Yet, Ingold himself is concerned with the latter, and might thereby expose himself to the very criticism he levels at science.

Conflating Nature I-IV

Similar confusions are rife among practitioners of science and anthropology. They arise from the circumstance that nature is a profoundly polysemous concept, which manifests various cognitive propensities in variously pure or mixed form. All of these must find accommodation within the fundamental reflexivity of Western thought, which in its simultaneous quest for dissecting the world and apprehending its unity, for analysis and synthesis, is as apt at delineating categories as prone to amalgamating them.[107]

Hence, the paradoxically transcendental ambitions of Western rational inquiry impute to science a monopoly on the truth, conflating nature the physico-biological realm ('Nature IV') with nature the external reality ('Nature III'). The same ambitions at once elevate human reason to the status of transcendental force itself, thus amalgamating nature the opposite of culture ('Nature II') with the previous.[108] By identifying human reason, in turn, as the quintessential attribute (rather than emergent property) of the human organism, they ascribe this power at once to the latter, thereby adding nature the environment ('Nature I') to the sequence.

If these confusions result equally in the substitution of categories, and ultimately in the blending of Nature I-IV into a single amorphous concept, they rely on diverse mechanisms (see Table 7 below). Thus, the mix-up between Nature II and III follows from an inversion of cognitive causality which replaces 'nature as other' with 'nature as essence' (cf. pp.110ff.). That between Nature III and IV, in contrast, seems to follow from a cognitive analogy regarding 'nature as essence', by which the principles of natural laws as contingent essences of the physico-biological realm transmute into the ultimate essence of reality (cf. pp.112ff.). A cognitive analogy similarly underlies the conflation of Nature I and II, in this case regarding 'nature as other', which confuses complementary and categorical otherness (cf. p.109). Finally, the analogy of 'nature as thing' leads to an equation of Nature I with Nature IV; it becomes possible because the former exhibits not only the quality of otherness but also of tangibility, while the latter is characterised not only as essence in terms of its organising principles but also as thing in terms of its constituent elements.

Table 7: The Diversity of Nature and Attendant Confusions

	NATURE I	NATURE II	NATURE III	NATURE IV
meaning	environment	opposite of culture	external reality	physico-biological realm
quality	otherness		essence	
	thinginess			thinginess

As the final operation closes the circle of consecutive substitutions and thereby apparently sanctions the entire process, it both cements and exposes the fundamental error contained in the sequence. This lies in disregarding the circumstance that the physico-biological realm (IV) is complete in itself, as are reality (III) and the opposite of culture (II), while the environment (I) is relational, defined vis-à-vis an organism. Hence, it can never correspond to any of the others. Rather, the environment (I) *together* with its necessary complement the organism (I') are part of the physico-biological realm (IV). And yet, the latter has—via its confusion with reality (III)—been conflated with the opposite of culture (II), whose characteristic of otherness it has at once adopted—a categorical otherness, which though resonates with the contingent otherness of the environment (I). Following this resonance, the contingent opposite of the human organism (I') is readily substituted with the categorical opposite of human reason (II').

I believe that it is this operation (shaded in Table 7) which lies at the root of the Western nature–culture dualism, and which continues to plague anthropologists studying human–environment interaction, as manifested in the confusions caused by the foraging–farming divide. For, it renders not only II-IV totally accessible to the disengaged scrutiny of reason (II'), as contested by Ingold (cf. p.110), but also renders the agencies of organism (I') and reason (II') interchangeable. Thus, plain environmental manipulation, i.e. the interaction between organism (I') and environment (I), comes to appear as the capacity of the human mind (II') and its various manifestations (consciousness, intent, reason, design, creativity, etc.) to manipulate the environment (I)—in fact, an operation only accessible to the human organism (I')—and through the prior conflations also natural laws (IV) and ultimately reality (III). This may sound absurd in the abstract, but I will demonstrate throughout this chapter how pervasive the respective confusion is in practice.

If the above sequence traces the anatomy of the confusion analytically, I suspect that the cognitive process which generates it follows the opposite direction. Thus, I consider that experientially an erroneous contrast between environment (I) and culture (II') precedes all others, as a specific manifestation of universal cognitive propensities. These are that, first, environment as 'thing' must in some form be a necessary ingredient of human lifeworlds, as must be, second, the distinction between 'self' and 'other', in the sense of human vs. non-human. Western thought then projects the otherness of the latter onto the thinginess of the former, thus conceptualising the environment as the antithesis of humanness. Since humans, though, are to some extent clearly also things, their uniqueness must inhere in an intangible characteristic—and this is mind, or culture. It is therefore not so much that "the contrast between nature and culture is a distinction which the human mind is predisposed to make", as Ellen (1996a:12f.) suggests, but that the *Western* mind interprets the more fundamental contrast between self and other in these terms. Indeed, Peter Dwyer (1996) has shown that the same contrast may be sought in a quite different opposition, namely that between the visible and the invisible (op.cit.:esp.179), which leaves the Western concept of culture without environmentally tangible contrast (op.cit.:esp.177) and hence renders its opposite concept of nature irrelevant.[109] Both the logical and the empirical argument demonstrate at once that the spatial definition of nature as other which Ellen (1996a:7f., 1996c:110f.) has regarded as a universal human cognitive propensity is in fact culturally contingent. This justifies my decision to distinguish conceptions of nature less according to the contrast between objects and space, than according to the contrast between concrete tangibility and abstract otherness (cf. pp.108f., esp. p.109).

In the Western model, the conflation of environmental thinginess and non-human otherness generates the problem that humans remain part things, although the cognitive operation they have performed tells them otherwise. Thus, their minds keep forever looking out on the environment, including their own bodies, nurturing the fantasy that they may at once comprehend and control it, yet aware that they remain bound by it much as anything else 'out there'. Advances in brain science and psychology merely advance, but do not dissolve, the interface between the mental and the material. It is this deeply engrained Western agony which Ellen expressed in his pun that "humans are paradoxically a part of nature and apart from it", and which I myself once phrased as humans being at once "agents and antagonists of nature" (Klappa 1997:3).

In the light of the foregoing discussion, we can say more specifically that humans are part of nature the physico-biological realm (IV); counterpart of nature the environment (I); and apart from nature the opposite of culture (II) and the imaginary external reality (III) they hope to apprehend. Thus:

> "*Homo sapiens* [I'] and nature [+I=IV] are not two independent entities; society [II'] is not the negation of nature [I, IV]. It is now clear that humans [I', II'] are paradoxically a part of nature [+I, IV] and apart from it [:II, III]; constrained by it [I, IV], but transforming it [I]."

The nub of the pun's paradox is the fraught relationship between conceptions I+I' and II:II', because the transition between both marks the categorical disjunction between a non-hierarchical and a hierarchical opposition. This becomes manifest, though, only in reference to the human components of I'/ II'. Thus, II may be equated with III and IV at the price of logical consistency; II may even be equated with I at the price of losing the human organism, which nevertheless leaves both I and IV united in their tangibility; but equating II' with I' creates an actual contradiction, namely the mistaking of something intangible for something tangible, by substituting the human mind for the human organism.

Academic Confusion in Science and Anthropology

The attendant agony has translated into academic confusion, as historically "nature and culture became reified as scientific concepts" (Ellen 1996a:13). With scientific inquiry, the problem remains mute, as the offending culture (II') enters into it only in form of potential illusions: the investigator's illusion of omniscience (leading to the conflation of II and III) and the related conflation of the physico-biological realm (IV) with reality (III, via II); the further conflation of nature (II) with the environment (I); and ultimately the illusion of agency of mind (II') regarding environment (I). They may affect the way investigators conceive of their object of study (i.e. as nature I, II, III or IV) but remain inconsequential as far as that object is concerned. Anthropology as a discursive discipline, though, has taken culture (II') as an object of study itself, and has thereby contracted a double affliction.

Firstly, anthropologists have been inclined to buy into the widespread conflation of II, III and IV. Thereby, they have not only sanctioned the universalist aspirations of scientific practice which Ingold contests, but by contrasting this with culture (II') have at once claimed the same aspirations for their own discipline, thus committing the mortal sin of ***ethnocentrism***. In Ingold's (2000:14f.) words:

> "The anthropological claim of perceptual relativism—that people from different cultural backgrounds perceive reality in different ways since they process the same data of experience in terms of alternative frameworks of belief or representational schemata—does not undermine but actually reinforces the [alleged!] claim of natural science to deliver an authoritative account of how nature really works. Both claims are founded upon a double disengagement of the observer from the world. The first sets up a division between humanity and nature; the second establishes a division, within humanity, between 'native' or 'indigenous' people, who live in cultures, and enlightened Westerners, who do not."

Secondly, anthropologists have tended to mistake the historical correspondence between the nature–culture duality and scientific concepts for their interchangeability. They have thereby succumbed once more to the agony of the Western tradition, which arises from substituting mind (II') for organism (I'). Since this operation is not only presumptuous in ontological terms, but inadmissible in scientific terms, it renders anthropological practice profoundly ***un-scientific***. When Ellen (1996a:17) confirms that

> "in contemporary anthropology we know and use nature and culture in two ways...: as objective analytic categories, and as a perceived universal cognitive opposition",

the casual lexical equation of these "two ways" as uniformly "nature and culture" is precisely the one that gives rise to the illicit semantic equation of the physico-biological realm, or the environment, with nature the opposite of culture. In fact, Ellen seems to be performing this very operation two pages earlier in his discussion on domestication and other ambivalent phenomena, when he states:

> "The complexities of biological reality... make drawing the frontiers between organism and environment, between what is cultural and what is natural, almost impossible." (op.cit.:15)

He seems to go beyond a mere identification of domesticated organisms as cultural, a designation which is a matter of opinion and principally negotiable. Rather, he seems to be extending the same ambiguity that inheres in the contrast between nature and culture to the contrast between environment and organism, and indeed seems to be equating both contrasts with each other. If this is what he means, he commits a double conflation of organism with mind: by equating the domesticated organism with what is cultural, he identifies it as a product of reason (an operation which I will examine again in sections 4.5. and 4.6.), which thereby comes to substitute for the human organism—the only entity really capable of relating to any other organism, domesticated or otherwise. If the substitution of organism with mind remains thereby oblique, the confusion is the same: I' turns into II', a contingent opposition into a categorical one, a non-hierarchical concept into a hierarchical one. Mind not only becomes an environmentally transformative agent, but thereby a transformer of natural laws. As this logical twist bestows on humans transcendental powers, anthropology demonstrates the nature–culture dualism once more, undermines its scientific aspirations, and obstructs its project of discovering principles of human–environment interaction.

4.3. Clarifying Disciplinary Remits: The Bifurcation of Anthropology

Cultural Relativism vs. Scientific Positivism

As I have shown in the foregoing section, the dilemma within anthropology arises from its dual concern with what its practitioners nevertheless call uniformly 'nature': on the one hand, the nature which is defined as the antithesis of humanness (II:II'); on the other hand, the nature which is defined as integral to humanness and with which also science is concerned (I+I', IV). Anthropologists may be quick to establish that the latter is historically contingent on the former and that this in turn is culturally contingent, thereby demonstrating the reflexivity of their anthropological project. Yet they are as quick to suspend the same reflexivity when it comes to employing the latter themselves, ***mistaking it for a universal reality (III) in which either the realities of others take place, or in which the historically formative nature–culture dualism is played out once more.*** The one mistake leads to ethnocentrism and thus contravenes anthropology's own doctrine; the other leads to un-scientific reasoning and thus contravenes the principles of both science and anthropology.

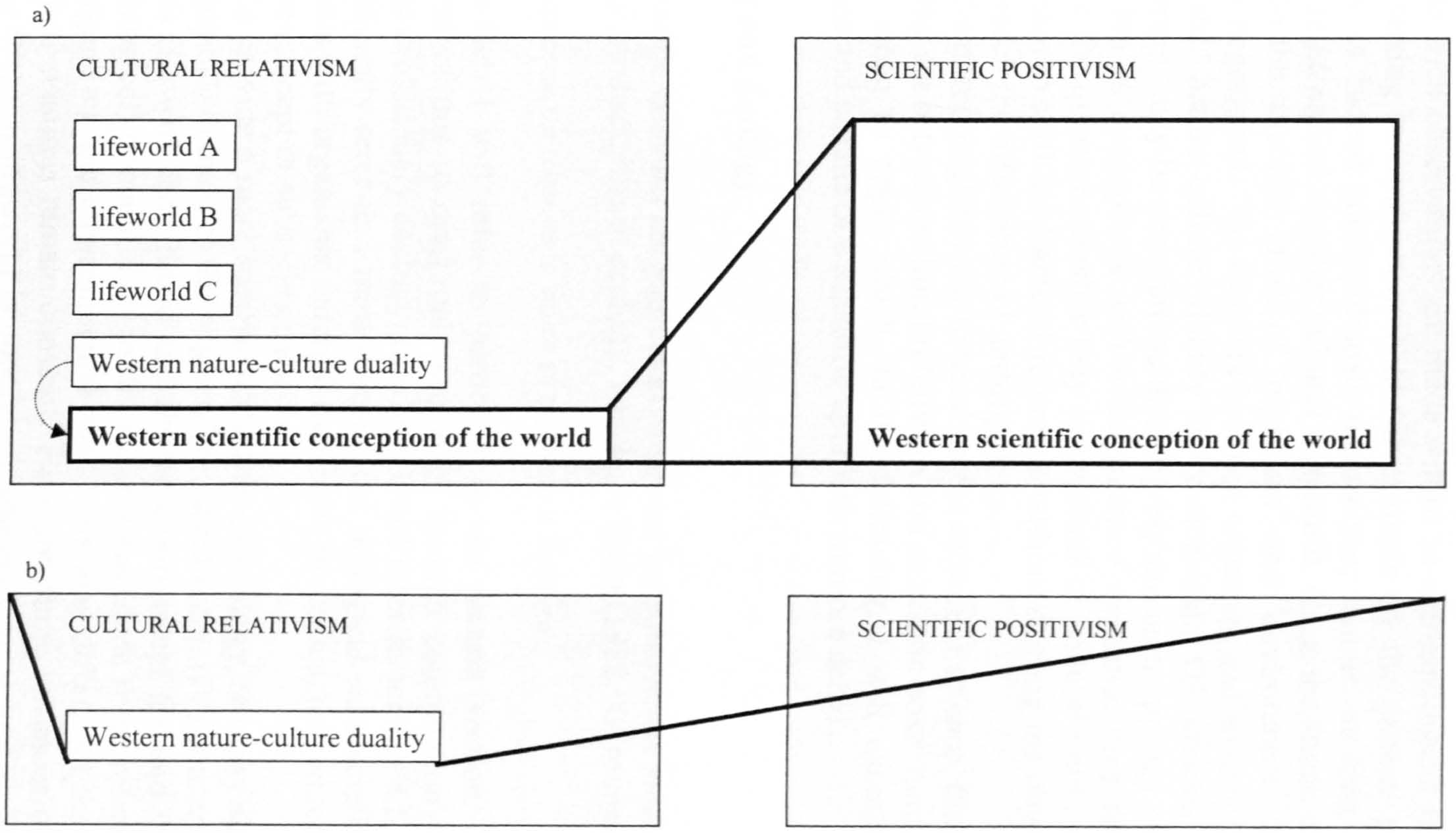
If anthropologists want to remain true to the dogma of their discipline, they need to acknowledge that they are aiming to operate on two levels of inquiry (see Figure 2a on p.119): the one is that of cultural relativism, which demands that the nature–culture duality of Western thought must be kept separate from other conceptions of the world *including* the Western scientific one, notwithstanding any historical transformations between the former and the latter; the other is that of scientific positivism, which endorses this scientific conception of the world and operates within it. The 'bifurcation' of the environment which Ellen (1996a:19) observed with the distinction in folk and analytic conceptions is therefore but an instance of the ***bifurcation of anthropology*** (or, more specifically, of ecological anthropology/ human ecology). Ellen made his observation upon a cursory review of anthropology's changing relationship with 'nature' (op.cit.:18f.)—via possibilism, cultural ecology, ethnoecology, adaptation and the systems approach, post-modern cultural constructionism, and evolutionary ecology—which led him to conclude that

> "the nature–culture distinction is constituted in different ways in different theoretical approaches in ecological anthropology, bridging three levels of analysis: one in which the environment is a biological given, one in which it is bifurcate (analytic and folk), and one in which all senses of nature or environment are 'constructed' and negotiable" (op.cit.:19).[110]

The bifurcation of the second approach, though, but reproduces the bifurcation between the first and the third, since a truly anthropological stance must consider the scientific view of the world, which treats the environment as "a biological given" (1), and against which folk models are analytically examined (2), as but another folk model itself and therefore as "'constructed' and negotiable" (3).

Of course, the bifurcation itself, like the disciplinary division between (social) anthropology and (natural) science more generally, is but another manifestation of the nature–culture duality (Figure 2b).[111] Yet, this does not mean that the same duality will be reproduced within science itself. On the contrary. Science, like nature, constitutes the positive pole of the duality; the reflexive, bifurcating pole is made up by culture and its agent anthropology. If anthropology is therefore by definition

Figure 2: The Bifurcation of Anthropology



caught up in a warp of reflexivity and perpetual bifurcation, science is not. Within the Western lifeworld, of which anthropology is a part, science deals, indeed, with a 'given'. And while therefore anthropology may legitimately take science, its practitioners, their conceptions, and their objects of study as its own objects of study, it may no longer do so once it has put on the hat of science. Then the objects of study of science must become its own.

It is therefore very well for anthropologists to note, as did Ellen (1996a:15—quoted on p.116) that "drawing the frontiers between... what is cultural and what is natural" becomes "almost impossible" in regard to anthropogenic landscapes, matter generated in particle accelerators, and domesticated plants and animals (op.cit.:14f.)—as long as such observations are made within an anthropological frame of reference, hence referring to *conceptions* held for example by the general public, the media, scientists, or indeed anthropologists themselves; that is, as long as the respective objects are *identified* as either cultural or natural. Once the frame of reference shifts, though, to the scientific idiom of "organism" and "environment", there is no longer space for negotiation: "the frontiers between organism and environment" are finite as far as the nature–culture duality is concerned. Of course, 'organism' and 'environment' may be conceptions themselves, and anthropology may examine these in turn; but as conceptions *with which science operates*, they are non-negotiable. Therefore the question whether they *are* natural or cultural entities is irrelevant. To ask it means to shift the frame of reference without shifting the object of inquiry, and thus to breach the bifurcation of anthropology.

If anthropologists want to tread on the terrain of science, they have to perform a balancing act between cultural relativism and scientific positivism, and they need to be clear when to apply which. In the following, I will examine the respective boundaries and pitfalls of a scientific approach in more detail.

Humans and Ecology

Two scientific domains are particularly relevant for subsistence studies. The one is the biological subdiscipline of ecology, which, as Ellen (1982:90) reminded us,

> "concerns the relations in which an organism is involved",

and to which I will refer in particular in the present section. The other is the application of this to diachronic scenarios through combination with evolutionary theory, as evolutionary ecology, to which I will refer in section 4.5. In section 4.6., I will additionally refer to a third domain, the biological subdiscipline of physiology, which deals with organisms' internal metabolic processes, and which will serve me to clarify the concept of subsistence itself.

To provide a more specific definition of ecology, we may say that ecology as an (ontological) domain of the physico-biological realm (IV) concerns the relations of organisms (I') with their biotic and abiotic environment (I), and that ecology as an (epistemological) domain of scientific inquiry has made these relations its objects of study. Organisms and environmental conditions may differ, but the principles which govern their relations remain constant. They constitute instances of natural laws, as far as the Western lifeworld is concerned, and ecological inquiry aims to apprehend these.

In regard to human lifeways, this undertaking has however proved difficult, due not only to the complexity of the subject, but also to anthropologists' misconceptions of what ecology can and cannot explain. Two types of errors have been committed: the one to exceed the remit of ecology; the other to unduly restrict it. Thus, sociobiology (cf. Ellen 1982:90f.) and cultural materialism (cf. op.cit.:59ff.,193) fell victim to the first error, by attempting to account for human behaviour in exclusively ecological terms. The former confused the principles underlying the (intra-specific) interactions among humans with those underlying the (inter-specific) interactions between different kinds of animals; the latter reduced the principles of human–environment interaction to the biological sphere alone, besides equating such principles with the motives for interaction. The former thereby committed an error of investigative domain; the latter the dual error of, firstly, reductionism and, secondly, functionalism—"the logical fallacy of demonstrating that certain practices have effects and then assuming that this is their purpose" (op.cit.:193). Either claimed thus to apprehend ecological principles beyond their true remit, whether in epistemological terms (by shifting domains), in pragmatic terms (by reducing reality and thus virtually expanding relevance), or in logical terms (by inflating causality).

Such "uncritical reasoning from animal to human ecology", and the recognition "that the specific characteristics of human populations have often been suppressed through a desire to formulate a theory which embraces all living matter" (op.cit.:91) prompted a backlash which though overshot its aim in the opposite direction. Instead of acknowledging that human lifeways can only be explained insufficiently in ecological terms, this countermovement unwittingly implied that humans might be partly or wholly exempt from the operation of ecological principles. Thus, Ellen complained that "jargon and concepts have been applied mechanically, such that mice and men become *a priori* ecological equals" (op.cit.:90). What he was really criticising, though, is the uncritical transfer of jargon and concepts to non-ecological, namely sociological and anthropological, domains of inquiry. After all, men and mice *are* ecological equals—what makes them equal is precisely the designation of 'ecological'.[112]

For sure, "[e]cology itself cannot answer all the questions we might wish to ask, it cannot even pose them" (op.cit.:275), while it is equally true that "social structure[s] have a dynamic of their own which is not described adequately or accurately in ecosystem terms" (op.cit.:92). Hence: "Ecology as *human* ecology cannot ever be an autonomous discipline" (op.cit.:279). Indeed, as an anthropological endeavour, it is necessarily linked to classical anthropological inquiry, which supplies complementary information of the kind ecological inquiry is incapable of generating. It does not follow, though, that "[e]cology is best represented as a problematic—a discursive practice—rather than a discipline" (op.cit.:279). Certainly, ecology may serve as a template on which to model social scientific inquiry, and whose concepts may provide stimuli for social scientific discourse, and this may partly be what Ellen had in mind here. Ecology per se, however, *is* a discipline, namely a scientific one, and is through the attribute of 'scientific' precisely the opposite of 'discursive' (cf. again Figure 2a). For all I understand about science, there is simply no scope for anthropologists to redefine the purpose of ecology, and present it as one possible, if somewhat limited, interpretative framework for human behaviour (op.cit.:e.g.275,279). Rather, the *framework* is a scientific conception of the world. Ecology refers to *one dimension* within it, namely the fundamental, and universal, principles by which organisms interact with one another and with their abiotic environment. Anthropologists may choose to operate outside the scientific framework altogether, but then they cannot employ ecological inquiry.[113]

In the terms of science, ecology describes not a facultative, but an essential aspect of human existence. It necessarily applies to humans, much as physics, chemistry, or genetics do within their respective remits: the distinctness of the human condition can change or evade ecological principles as much or as little as it can change or evade the principles of gravity, oxidation, or sexual reproduction. There is no question that ecological models *alone* are insufficient to describe the complexities of human existence—much as physical, chemical, or genetic models alone are insufficient for that purpose. This insufficiency, however, is not to be confused with irrelevance. Whatever there may be special about humans is to be found *beyond* their ecological relations, not *instead of* them. The recognition of human distinctness remains unaffected by the "desire to formulate a theory which embraces all living matter", or by acknowledging that men and mice are, indeed, ecological equals.

Humans:Animals vs. Persons:Organisms

The root of the confusion is, once again, the agony of the nature–culture duality. As humans reserve for themselves the category of 'culture', they at once remove themselves from that of 'nature'. If both reflection and scientific inquiry demonstrate this model to be wanting, 'culture' remains an obstacle to repatriating humans into 'nature', forever suggesting that humans were, in some way, fundamentally different, and thus not quite 'natural'. With the bifurcation of anthropology, as of academic disciplines at large, the same struggle is played out there.

Ingold (1994:19-25) has approached this dilemma from the aspect of 'human nature' (cf. n.98), whose division replicates that between 'nature' and 'culture'. Thus, he noted:

> "The trouble arises because the legacy of dualistic thinking invades our very conception of what a human being is, for it has given us the vocabulary for expressing it. We are, according to this conception, constitutionally divided creatures, one part immersed in the physical condition of animality, the other in the moral condition of humanity." (op.cit.:21)

The question, therefore, in which part 'human nature' resides, "gives us conflicting answers" (ibid), which establish

> "a paradox at the heart of Western thought, which insists with equal assurance both that humans are animals and that animality is the very obverse of humanity" (op.cit.:23).[114]

Its resolution, which though contains a new complication:

> "A human being is an individual of a species; being human is to exist as a person. In the first sense humanity refers to a biological taxon (*Homo sapiens*), in the second it refers to a moral condition (personhood). The fact that we use the same word 'human' for both reflects a deep-seated conviction that all and only those individuals belonging to the human species can be persons, or in other words that personhood is conditional upon membership of the taxon." (ibid.)

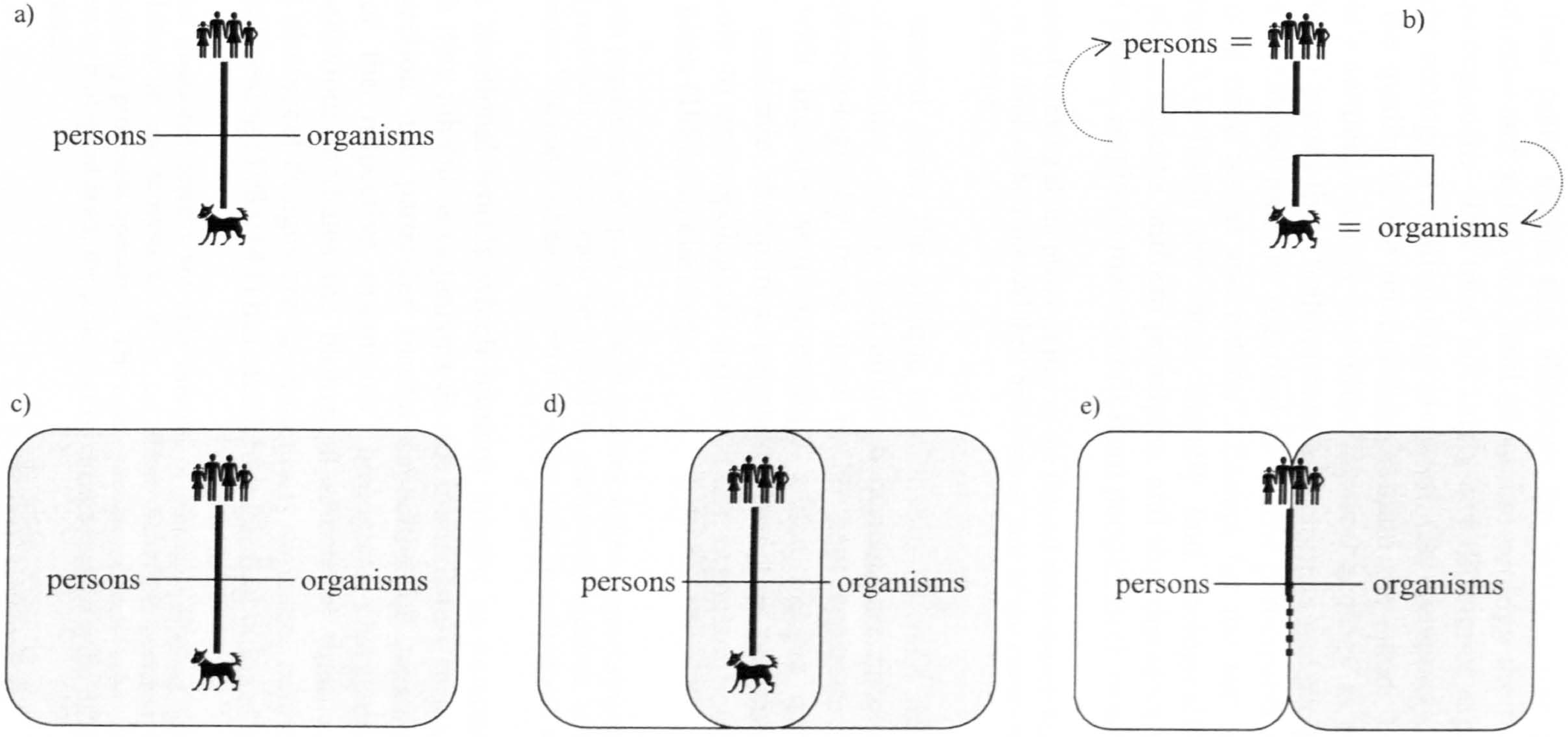
It is this "assumption that the two notions of humanity are essentially the same, that the condition defines the species" (op.cit.:30), which stands in the way of a scientific approach to human subsistence. For, it suggests that human lifeways can be assessed comprehensively only within a discipline, such as in particular anthropology, which acknowledges the uniqueness of the 'human condition'. A discipline such as ecology, in contrast, which merely recognises biological taxa and thus renders humans one animal among many is accordingly conceded little authority on the issue.

Such focus on the object of inquiry, that is, on humans vs. (non-human) animals, confuses however the issue. After all, anthropology and ecology are not principally defined by their *objects* of study, but by their *purpose*, or investigative domain: anthropology deals with persons, and their (socio-cultural) relations, while ecology deals with organisms, and their (biological) relations. Humans, though, are both persons *and* organisms; conversely, non-human beings may be both organisms *and* persons—if not commonly within Western ontology[115], so at least in non-Western ontologies (where personhood may also inhere in other entities) (Ingold 1994:24; 2000:esp.chpt.6).

We are therefore dealing with the intersection of two distinct semantic pairs (see Figure 3a [p.124]): the one refers to object of inquiry (human beings vs. non-human beings), the other to domain of inquiry (personhood vs. organism-hood). The common mistake is to confuse objects with domains and treat them as analogous (Figure 3b): to equate humans with persons and non-human beings with organisms, and thereby to create a disjunction between the both. The first step towards a comprehensive assessment of human lifeways is therefore to reverse this error: to detach the conflated concepts and reconcile them with their respective counterparts. The second step is to provide a framework in which these can be explored.

In this respect, Ingold (2000) has suggested we expand the remit of ecology, which should therefore subsume also non-biological interactions (Figure 3c). Hence, for him, "relations among humans, which we are accustomed to calling 'social', are but a sub-set of ecological relations" (op.cit.:5). In his 'sentient ecology' (op.cit.:esp.10,24-26), humans and non-human beings alike figure as 'organism-persons', linked "in a single, continuous field of relationships" (op.cit.:87): Yet, accommodating the intersection between objects and domains of inquiry does not necessarily require a radical overhaul of Western ontology sensu Ingold. If we follow established conventions, we can place humans qua organisms under the remit of ecology, and qua persons under the remit of anthropology; likewise, we would place non-human beings qua organisms under the remit of ecology, and qua persons under the remit of anthropology (Figure 3d). If the latter operation challenges the literal confines of *anthropo*-logy, it at once demonstrates how the belief in human uniqueness has become lexically—and by implication epistemologically—manifest.

Figure 3: Two Semantic Pairs: Humans:Animals vs. Persons:Organisms



'sentient ecology'

classical ecology

humankind as composite

Humans: Ecologically United with Others, Epistemologically Divided within

This clarification regarding objects and domains bears twofold on studies in human ecology, as indicated by the two intersecting axes: on the one hand, it highlights the ecological equality of humans and other beings; on the other hand, it indicates that the ecological and the socio-cultural domains relate to each other only obliquely.

The first point means that although the investigative perspective may be variously trained—and within the field of *human* ecology the focus is self-evidently on the *human* organism—this must not imply any difference regarding the principles underlying the ecological relationships involved. Or, conversely, the perspective may switch, but the quality of the relationships remain the same. This applies similarly within Ingold's sentient ecology as within classical ecology as employed by Rindos. Ingold (2000:87) argues that "both humans and animals and the plants on which they depend for a livelihood must be regarded as fellow participants in the *same* world, a world that is at once social and natural". Except for the last specification, Rindos (1984:esp.chpts.3,4) holds the same, namely that ecologically the interaction of people and plants follows uniform principles, and that therefore much as people may benefit from plants, so plants may benefit from people. Both would agree that

> "instead of thinking about plants as part of the natural environment for human beings, we have to think of humans and their activities as part of the environment for plants" (Ingold 2000:87).

The second point, the oblique relationship between the ecological and the socio-cultural domains, means that although humans are ontologically part of both domains, epistemologically these need to be kept separate. If this condition is eliminated with Ingold's sentient ecology which merges domains, the classical division of academic disciplines stipulates that the personhood of humans is accessible only to anthropological inquiry, their organism-hood only to ecological inquiry. As Ellen (1982:92) clarified:

> "Human populations are parts of social systems and ecological systems. For the most part [principally?] these must be treated as analytically separate, and with different properties. The implications of one for the other must be understood, not conflated."

That is, the ideational worlds which humans inhabit as persons and the biological world which they inhabit as organisms do not immediately impinge on each other. In the one direction, the particular mental capacities of persons are but emergent properties of the respective organisms' biological characteristics; in the other direction, behaviour mediates the biological effects of these capacities. Ideational designs and biological designs are fundamentally separate; neither can directly affect the other. As Keesing (1981:144) has clarified regarding cultural evolution:

> "These ideational designs are only one set of elements shaping the behavior of a population in an ecosystem; it is on these *behavior patterns* that biological evolutionary processes operate.... The *consequences* of such [behaviour] changes are subject to biological laws; the *processes* of change may be quite different." (original emphases)

Thus:

> "If we take an evolutionary view, it is not the beliefs but their behavioral consequences that are adaptive or maladaptive." (op.cit.:150)

From a purely biological perspective, therefore, which is concerned with behaviour and its physical effects only,

> "the desires and intentions of people are fundamentally irrelevant" (Rindos 1984:89).

Of course, "the desires and intentions of people" are fundamentally relevant for *motivating* behaviour, a correlation which is the subject of anthropological inquiry. What manifests physically, though, are the tangible effects of such behaviour only, which alone are therefore accessible to ecological inquiry. Hence, behaviour as the point of articulation between motivations and their tangible effects becomes at once the subject of both anthropological and ecological inquiry; delimits their respective remits; and indicates how they can productively complement each other for studies in human ecology.

In sum, a comprehensive human ecological approach to subsistence requires the twofold recognition that (1) humans as organisms are fundamentally similar to other organisms; and (2) human organism-hood and personhood are to be apprehended separately. Hence, I believe that Ellen (1982:93) erred doubly when he stated:

> "Anthropologists are criticized for focussing on the interrelationships between *Homo sapiens* in particular and the environment (autoecology), rather than on an examination of ecosystems as such (synecology) within which populations of *Homo sapiens* happen to dwell... While this may emphasize the narrowness of existing ecological approaches, and, while the examination of systems in themselves is not only legitimate but vital, *the replacement of autoecology by synecology would logically require the end of anthropology...*" (my emphasis)

In fact, a shift of ecological perspective, from autoecology to synecology, may be necessary for a comprehensive assessment of subsistence—consider, for example, a scenario in which hunting pressure is indirectly connected with the abundance of a vegetal resource, through the seed-dispersing activities of the respective game animal. The suggestion, though, that this shift would obliterate the anthropological project implies that human autoecology was a subset of, or indeed identical with, anthropology. Since this perspective, however, conflates two distinct epistemological domains, the suggestion itself, rather than the shift of ecological perspective, may logically require the end of anthropology.

4.4. Clarifying Ethnographic Applicability: The Utopian Division of Humanity

Students of human ecology have tended to disregard not only the epistemological separation of domains of inquiry, but also their ontological connectedness. Thus, they have confused the universally composite nature of humans, as both organisms and persons, with a composite image of humanity. Thereby some humans have come to appear primarily as persons, rooted in the socio-cultural domain; others primarily as organisms, rooted in the ecological domain (see Figure 3e on p.124).

'Ecological Populations': Contra Biological Uniformity and Psychic Unity

The one confusion actually fuels the other, as apparent in the following explanation by Ellen (1982:92):

> "Where the ecosystem approach has been used most profitably is for simpler systems, where small populations are engaged in restricted environmental modification. This is because such populations most closely resemble the characteristics of those ecological populations of non-human species upon which classical ecological theory has been based. But the biological model cannot just be expanded to incorporate the complexity of modern social systems. The flow of capital, investment, technology, information and money cannot be reduced to energy units."

With this statement, leading on from that arguing for the analytical separation of social and ecological systems (cf. p.125), Ellen apparently meant to illustrate his admonition. In fact, he contradicted it. By limiting the inapplicability of "the biological model" to "modern social systems", he implied its fundamental applicability in other, non-modern, social contexts, thus transgressing disciplinary remits—for, *biological* models must by definition be inapplicable to *social* systems. Correspondingly, he rendered "ecological" as an attribute of "populations" (i.e. objects of inquiry) rather than investigative concerns (i.e. domains of inquiry), and thus as a facultative condition of the species surveyed, including, by implication, humans. He thereby placed, to return to his earlier example (cf. pp.121f.), not only mice in the ecological domain and men in the social domain, but shifted some of the latter to the former on account of shared characteristics between the both. If the one operation (separating mice from men) is incompatible with a scientific approach that distinguishes by domain, not object, of inquiry (as it would likewise be with Ingold's sentient ecology); the other (separating some men from others for their resemblance to mice) is incompatible also with central tenets of both biology and anthropology. According to the former, members of any one species exhibit a fundamentally uniform capacity for environmental transformation; according to the latter, members of the species *Homo sapiens* exhibit a fundamentally uniform capacity for culture—as encapsulated in the doctrine of the psychic unity of humankind.

Of course, the incorrect attribution of 'ecological' may be considered a merely lexical error: a shorthand indicating that the respective populations would preferentially lend themselves to ecological investigation. Thus, the references to "simpler systems", "small populations" and "restricted environmental modification" may suggest that the respective research scenarios involved a smaller number of variables, and hence that data collection and analysis were more manageable than in the respective opposite situations. Yet, the three aspects do not necessarily relate in the implied fashion.

Firstly, the complexity of the *social* system impinges primarily on *social* inquiry and leaves ecological inquiry principally unaffected. If "capital, investment... and money" as the variable manifestations of a monetary economy are specific to some societies, "technology" and "information" are universal to all, and, as Ellen himself commented, either "cannot be reduced to energy units". Were the notion of complexity to refer to the *ecological* system, this would still not correspond directly to the population size of humans. Rather, ecosystem complexity is a function of abiotic and biotic factors, only one of which is *Homo sapiens*. Secondly, population size of this taxon seems, if anything, *inverse* proportional to ecosystem complexity, as indicated in particular by the simplification observed with intensive farming systems (e.g. Ellen 1994:207; Campbell & Reece 2002:1188) and in general by the global anthropogenic biodiversity crisis (e.g. op.cit.:1124-1126), both of which tend to be considered a function of high population densities and correspondingly high environmental impact. Thirdly, and despite this general trend, degree of environmental modification depends also on such variables as subsistence form, technology, and extent of activities in time and space, which relate in less than straightforward ways to population size and social complexity in turn.

Furthermore, it is unclear how, precisely, to define the "restricted environmental modification" which is to suggest the investigative suitability of one scenario over another. How, for example, to compare the "massive interference with the forest to promote food plants", which Bahuchet et al. (1991:231—quoted on p.45) postulated as a concomitant of forager subsistence in rainforest, with the more localised interference in the case of fixed-field agriculture? Any such assessment would require (1) a specification of the relevant variables, such as (a) extent in space, (b) extent in time, and (c) deviation from a reference condition; and (2) a method of measuring the variation in these variables—which may be relatively straightforward in regard to (a), but much less so in regard to (b) or even (c).

Finally, there is no necessary correlation anyway between degree of environmental modification and ease of ecological investigation; after all, ecological investigation does not apprehend environmental modification per se, but the pattern of the ecological relations underlying it. Their principles, however, apply uniformly to the animal *Homo sapiens*, as well as to any other animal, no matter how their ecological relations manifest. Since "classical ecological theory" pertains to them all, it is unsuited as a discriminating criterion.

It is therefore misleading to identify subject areas for human ecological research impressionistically, based on the assumption that ecological and/ or social complexity, size of groups, (indeterminate) degree of environmental modification effected by these, and ease of ecological investigation were correlated in any straightforward way. In fact, the attendant inconsistencies demonstrate that the incorrect attribution of 'ecological' is not merely a lexical error, but indeed a semantic one: the apparent search for easy access to the ecological *dimension* of human existence is really the search for its ecological *manifestation*. This, though, is a semantic impossibility. It testifies at once to the mistaken division of humanity and to its root, namely the substitution of 'ecological' for 'natural', in another intrusion of the nature–culture dualism into the study of human ecology.

‘The Savage’: Hypothetical Alter Ego of Western Humanity

This dualism manifests in fact doubly here, through the projection of two types of ‘others’ and the corresponding involvement of two types of nature: non-human and human. On the one hand, the physical ‘other’ of the environment becomes as ‘non-human nature’ the antithesis of humanness (cf. p.115). On the other hand, the social ‘other’ of a contrasting human group becomes as the ‘savage’ the manifestation of the animality in ‘human nature’ (cf. Escobar [1993:382]—quoted in n.111). Both operations are grounded in the division of the world according to the criterion of human reason, which renders the attendant correspondence between the non-human other of nature and the human other of the savage their complementarity. In a misunderstood ecological idiom, the environment as a misconceived analogue of nature then becomes the habitat of the savage, thereby misconceived as organism.

Due to a misconception of ecology, therefore, the animality of savage humans seems to invite ecological assessment as much as the humanity of generic humans seems to preclude it (cf. pp.122f.). In both cases, the error lies in a confusion of the environment–organism complementarity with the nature–culture duality (cf. pp.114ff.). It has led students of human ecology to at once remove humans from the remit of ecology and reintroduce them in the form of “ecological populations”. They have thereby replicated the agony of the Western tradition which paradoxically separates humans from nature and recognises nature in humans, and which attempts to diffuse the attendant tension by projecting it onto humanity at large. Experientially, therefore, the savage as other may be less the social other captured in the pseudo-physical idiom of nature, but the pseudo-physical alter ego of Western humanity which it attempts to capture in a social idiom. Yet, this very operation creates a new tension, as it produces two distinct classes of humans which are at once united in their humanity and divided by its unilateral absence. The oxymoron of human nature therefore at once endorses and challenges the tautological humanity of humanity: if the savage provides the vehicle to repatriate humans into nature, the attendant need to deny him humanity questions the whole undertaking.

The underlying fallacy is a confusion of the various meanings of nature. Much as conceptions of non-human nature encompass thinginess, otherness and essence (cf. section 4.2.), so do conceptions of human nature (cf. n.98 and p.122). As Ingold (1994:21f.) has explained, the notion of humans as “constitutionally divided creatures” stems from the simultaneous recognition of nature as “essential quality” and as “material world”. According to this dual conception, the essential quality of “being human” lies in humanity, which therefore inheres by definition in all of humanity, and in humanity alone; the material world, though, of a “human being” is shared with that of other animals.

Ingold perceived the “paradox at the heart of Western thought” (op.cit.:23) to lie in this division between the essential and the material. I believe it arises more specifically from a cognitive rift between the two, akin to that which arises from substituting the contingent opposite of human organism (I’) with the categorical opposite of human reason (II’) (see p.114). Since the recognition of thinginess and essence manifests different cognitive propensities, the respective concepts refer to different dimensions of the world. Combining them in the amalgam of human nature, and thus artificially forcing them into ontological alignment, is bound to create paradoxa of the kind obtaining with the concept of nature. If Ingold’s solution is, again, to transcend the disciplinary divisions between science and the humanities (1994:30), established conventions would have science deal with the thinginess of human beings, and the humanities deal with the essence of being human. Anthropology, which is concerned with both aspects, needs to switch perspective accordingly, as described in section 4.3.

Anthropology also needs to distinguish between essence and thinginess on yet another level of analysis, due to its concern with two kinds of otherness: it deals not only in the abstract with human humanity and its alter ego of human animality, but at once with concrete instances of either in the manifestation of the social other. The latter is in fact its principal purpose: to discover the essence of human nature at large (whether in terms of being human or human beings, or both) through exploring and comparing the thinginess of ethnographic cases; that is, to apprehend essence *by way of* the thinginess of the other. This, however, must not be confused with an imaginary ability of anthropology to apprehend essence *as* the thinginess of the other. In other words: the savage lies *behind* ethnography, not within it. Much as the 'ideal state' of the West, constructed against the 'state of nature' of the savage, was conceived as utopian in post-Renaissance social discourse (see n.111), so is the savage itself hypothetical, not factual.

T.M.S. Evens (1997:353-355) remarked accordingly in a dictionary entry on the philosophical movement of phenomenology and its intrinsic relevance to anthropology that "the 'primitives' anthropology pursues always remain in a sense human essences" (op.cit.:354); however:

> "The relevant sense has nothing to do with what is rudimentary and backward; it is, rather, a matter of what is first and fundamental, a limit that does not chronologically precede but rather continues to occur (Leenhardt 1975; Agamben 1993)[116]. 'Primitives' of this kind... are sought after by anthropologists as what always makes human beings human, even if it is no longer thought that such phenomena can be captured in the absolute terms of ontological naturalism." (op.cit.:354f.)

'Hunter-Gatherers': Subsistence Templates for Nature

Evens' last statement, though, portrays an ideal rather than real condition. In particular students of human ecology have continued in the effort to capture phenomena in absolute terms, erroneously equating at once the thinginess of ethnographic cases with the essence of human nature, and the latter with its constituent aspect of thinginess—animality—itself. In their illusive quest for "ecological populations", for the human animal in factual existence, they have thus rediscovered the savage in the guise of the hunter-gatherer.[117] Ingold (1996:146f.) is explicit:

> "To this day, the human status of savages, now known more politely as hunters and gatherers, has remained equivocal, to say the least. Though no one would any longer deny them full membership in the human species, it is still commonly held that in deriving their subsistence from hunting and trapping 'wild' animals and gathering 'wild' plants, honey, shellfish and so on, they are somehow comparable in their mode of life to non-human animals... in a way that farmers, herdsmen and urban dwellers are not."

The error follows from the misguided search for phenomena. As Keesing (1981:124f.) commented under the heading "Hunter-Gatherers and the 'Natural State' of Humankind":

> "Interpretations of hunter-gatherer society, in regards to such questions as relationships between the sexes and concepts of property, have been heavily shaped by ideologies. Those who see contemporary hunter-gatherers as direct sources of evidence about the earliest forms of human society seek in them some confirmation of assumptions about human nature or the nature of society. Hunter-gatherers are ourselves, as it were, in a *natural state*. We look at them to find out our true nature, which for us is submerged beneath or transformed by the institutions of a complex society and a powerful technology." (original emphasis)

and further, quoting Rosaldo and Collier (n.d.)[118]:

> "In their questionable status as ancestors, modern hunter-gatherers have been analyzed to discover 'elementary' social forms and/ or basic human nature, uncontaminated by disparities in wealth and power that result from food producing adaptations."

Clearly, the references to gender, property, wealth and power indicate that more than purely ecological concerns are bound up with the concept of the hunter-gatherer. Yet, the very designation of 'hunter-gatherer' points to the fundamental role accorded to subsistence. The last quote in fact spells out the imagined connection. Thus, "food producing adaptations"—the synonym for farming (see section 4.6.)—are seen as contaminants of a natural state, which would conversely obtain with foraging. That the interpretation of subsistence itself has "been heavily shaped by ideologies" was manifested for example in the "political-philosophical overtones" (Dentan, 1991:139) which permeated the calorie debate and contributed to its polarisation (cf. esp. p.38). Answers to the question whether "hunter-gatherers do not, did not, and could not live in tropical rain forest" (Dwyer & Minnegal 1991:187) accordingly varied with definitions of pure foraging, of rainforest environments and with the perceived hostility or abundance of these.

This emphasis on subsistence appears recent in European social thought. According to Alan Barnard (1999), only from the mid-18th century onwards did writers postulate a correspondence between (theoretically imagined or ethnographically documented) form of subsistence and form of society. Earlier discourse had focused on social form per se, with the contrast between the 'state of nature' and 'civilisation' apprehended in such oppositions as passions versus reason (Samuel Pufendorf—op.cit.:375f.); insecure individualism versus secure sociality (Thomas Hobbes—op.cit.:375); or common versus individual property (Hugo Grotius/ John Locke—op.cit.:375/ 378). The introduction of human–environment relations to the argument may have reflected an increasing concern with 'the natural world' during the last centuries, upon increasing separation from it in daily life (cf. Thomas 1983). The same concern may account for the contemporary association of 'nature' with the environment or the physico-biological realm, and of 'human animality' with human organism-hood.

I suspect, though, that these innovations manifest an ancient conceptual undercurrent of both the Judaeo-Christian and the Classical traditions. This undercurrent links subsistence and humanness; more specifically, it links the particular activities and achievements associated with *agricultural* subsistence to the particular qualities attributed to 'being human'. Thus, cultivation and domestication of plants and animals have since biblical times been considered the epitome of human intent and creative power (see also sections 4.5., 4.6.); correspondingly, agri-*culture* has typically been regarded by its practitioners as quintessentially human enterprise and essential ingredient of culture (cf. e.g. Harlan 1992:4). Anecdotally, though certainly not accidentally, the disdain which a Catholic Sister expressed in 1998 for the 'non-gardening nomads' in the far northwest of PNG (cf. p.15) echoes a judgement by Julius Caesar, who remarked on his second expedition to Britain in 54 B.C.:

> "Of all the Britons, the inhabitants of the coastal region of Kent are by far the most civilised... Most of the inland tribes *do not sow grains...*" (Julius Caesar. *Bellum Gallicum.* V.14, my emphasis)

I believe that this agro-centric view of the world not only underlies the contemporary manifestations of the nature–culture duality, and more specifically informs the way we apprehend human–environment relations, but that it underlies the nature–culture duality itself. That is, that ***the foraging-farming duality, which apparently replicates the nature–culture duality, in fact generates it.*** Thus, I consider that an agricultural lifestyle engenders a dichotomous view of humanity, separating people who farm from those who do not, as well as a dichotomous view of the tangible world, separating farmed from non-farmed entities. Farming people and farmed entities are then placed in the realm of 'culture', non-farming people and non-farmed entities in the realm of 'nature'.

More specifically, I believe that this dichotomy is an ideological concomitant of the seed culture–seed crop configuration, as in fact Caesar's quote makes explicit. As indicated in chapter 3 (pp.56,74), this configuration engenders a compartmentalised, and indeed hierarchical view of the world, manifesting in an adversarial and interventionist conception of human–environment relations. This largely empirical observation receives theoretical support when examined for the underlying cognitive processes of recognising thinginess and otherness, as detailed earlier in the present chapter (esp. p.115). Thus, seed culture necessarily entails marked spatial oppositions, unilaterally associated with sporadic but intense human activities. This pattern is likely to favour cognitive alignment of the spatial contrast with that between self and other, resulting in a spatial conception of non-human otherness in the form of a tangible environmental 'nature'. In other words, correlating agriculture with culture, and thus absorbing it into 'self', renders the remainder of the tangible environment the 'other' of nature.[119]

The same process may conversely be conceived as the 'self' receding progressively from its environmental relations which thereby turn into the 'other' of nature. This is what Peter Dwyer (1996) suggested upon a comparison of ethnographic evidence from three different ethnic groups in Papua New Guinea. He concluded:

> "That which we, as Western thinkers, regard as 'other' was, in the beginning, the essence of 'self'; there was no 'other' as we understand it because the self-aware, purposive and intentional being was necessarily part of those relations." (op.cit.:179)

He suspected that the same applied generally to people "we like to call 'hunters and gatherers'" (op.cit.:181); conversely that nature as the 'other' emerged with subsistence change towards intensive farming:

> "Intensification of production will simultaneously alter people's perceptions of both the visible and invisible world. At the outset a landscape in which use values are generalized, extensive and ungraded and in which invisible beings are all-pervading must be understood in totality as a landscape of human action and interaction. Hence, it is 'cultural'; there is no 'nature' and no contrast. But a landscape in which use values are particularized, intensive and graded and in which invisible beings are of nebulous form and peripherally located provides different opportunities. Here,

> through a process of cultural accretion, is the potential to invent 'nature'. Intensification and its correlates combine to categorize the visible world. Culture is internalized; it implodes. The created periphery of the visible world, increasingly divorced from human contact and understanding, emerges as 'nature'. It is imaginary and, in a materialist world, may stand for the 'other'." (op.cit.:178)

As Dwyer's evidence excludes seed cultural systems, his argument expands my own, suggesting a continuum of ever-increasing contrast between centre and periphery of the visible world (cf. op.cit:177)—or an incremental retreat of the self from its environmental relations—with increasing emphasis on farmed space. This, though, must reach its apotheosis in an agricultural way of life based on the seed culture–seed crop configuration, which almost by definition divorces centre and periphery.

The conclusion that the root of the nature–culture duality is an agricultural way of life takes me beyond the argument I advanced in section 4.2. (p.115 above). There, I qualified the conventional assumption, as expressed by Ellen (1996:12f.), that "the contrast between nature and culture is a distinction which the human mind is predisposed to make", suggesting instead that "the *Western* mind interprets the more fundamental contrast between self and other in these terms". I can now add that the Western mind *as conditioned by the experience of agriculture* projects the other onto the visible world and thereby, as phrased in the title of Dwyer's article, 'invents nature'.

Looking at the nature–culture duality from the perspective of subsistence, rather than vice versa, then explains why in particular hunter-gatherers should have become templates for 'ecological populations': they *appear* natural because they *define* what is natural. Their template function is primary, not secondary. Ingold (2000:chpt.3) might therefore be putting the cart before the horse when he blames the naturalisation of the hunter-gatherer economy on the constructionism engendered by the nature–culture duality. He argues that in Western thinking the environment can become part of the social realm only in form of a constructed image, which is then accessible to anthropological inquiry; and that therefore any real interaction with environmental entities must be taking place in the biological realm, which is accessible only to ecological inquiry. Hence, "the 'naturalisation' of the activities of hunting and gathering... is a product of the 'culturalisation' of the perceived environment" (op.cit.:59). This analysis may trace the mechanism by which hunter-gatherer life-worlds get distorted in Western representations; it accounts less, though, for the selection of hunter-gatherers as targets of such naturalist bias. For, why should cultural constructionism render only certain forms of subsistence natural and not others? According to my above argument, the cause lies in the fundamentally agro-centric outlook of Western ontology itself. If subsistence form defines what is and is not natural, then the respective classification of subsistence forms is foregone. Any suggestion, therefore, that for some reason—logical sensu Ingold or pragmatic sensu Ellen—hunter-gatherers were, or seemed, more natural (or 'ecological') than others can only ever be tautological, reinforcing the image by reference to itself.

Yet, on this assertion rests our entire classification of subsistence. It seems to lend scientific credence to the composite image of humanity, and to the respective division of human–environment relations. In fact, it but reproduces an agro-centric folk model of agriculturalists. It is therefore unlikely to produce the "consistent typology" and "standard format" which Dornstreich (1977:247—quoted on p.104) demanded. Rather, a universal scheme for classifying subsistence in terms of human ecology must rely on universally valid principles of human-environment interaction. This requirement returns us to a scientific conception of the world, the ecological relations between organisms, and their evolutionary change over time. According to this conception, I will in the following section examine the phenomena which form the stock in trade of prevailing subsistence classification, and which conventionally go by the labels of foraging and farming.

4.5. Clarifying Human–Environment Interaction: Inevitable Impact, Illusive Control

Foraging

Consistent with the agro-centric folk-model of subsistence, foraging has typically been negatively defined as the absence of farming (e.g. Barnard 1999:382).[120] More specifically, it has variously been described as the absence of agriculture (ibid.) and/ or the reliance on

- undomesticated organisms (e.g. Ellen 1994:200; Lee 1997:202; Lee & Daly 1999:3—quoted on p.43; Riches 1996:288).
- uncultivated or unmanipulated organisms or environments (e.g. Ellen 1994:201).
- wild organisms (e.g. Lee & Daly 1999:3; cf. Ingold 1996:147—quoted on p.130).

with the latter condition tending to subsume either of the previous two. The precise connotations of the various concepts differ, as I will detail below. Nevertheless, authors usually mix and match labels, as evident in the duplication of references just cited and in the uncritical use of terms in the calorie debate (pp.41f.), suggesting that they aim less at accurate description than at allusion to the one pole of a categorical contrast, namely *absence of human impact on resources before their appropriation.*

This condition has however proved difficult to determine, both in practice and in principle, as set out in the following and illustrated with Paul Roscoe's (2002) considerations regarding "The Hunters and Gatherers of New Guinea". To begin with, exclusive states have proved elusive, not least because "contemporary foragers practice a mixed subsistence" (Lee & Daly 1999:3—quoted on p.43). Authors have therefore tried to identify thresholds for the designation of forager groups, typically by establishing proportions of foodstuffs from wild sources, often expressed in calorific terms (e.g. Endicott & Bellwood 1991:esp.156; Roscoe 2002:154f. and references quoted; Townsend 1990:746; Sillitoe 1998:25, 2002:63). Yet, this form of quantification is ambiguous regarding both the height of the threshold and the units in which it is to be calculated. In Roscoe's (op.cit.:154 [referring to multiple sources]) words:

> "Must a group depend exclusively on foraging... to be considered a hunter-gatherer society, or is it sufficient that it depends for 50 %, 75 %, or some other percentage of its subsistence on wild resources...? If the latter, should percentage dependence be measured in calories, protein, weight, labor invested, or what—bearing in mind that each of these measures could yield a different classificatory result?"

In fact, the challenge lies less in the identification of thresholds than in the definition of the thus bounded category. Roscoe (op.cit.:153 [referring to multiple sources]) again:

> "According to common definition, hunters and gatherers are those who subsist by gathering wild plants and hunting wild animals... Yet these criteria beg a number of questions, not least the issue of what constitutes 'wild'... Is it hunting or pastoralism

> if people capture and raise (but do not breed) the piglets of a wild sow they have killed, and is it gathering, pastoralism, or cultivation when wild palms are felled and chopped up to encourage 'larvae plantations'...?"

More specifically, the parameters postulated theoretically as criteria for classification, such as degree of environmental manipulation or effort expended before appropriation (e.g. Ellen 1982:129—quoted on p.102, 1994:201), do not translate straightforwardly into practice. For example, Ellen's explanation that 'food collecting' was "a way of life in which populations extract from the environment without sustained efforts to regulate it" (1994:201) would require the ultimately arbitrary decision as to when efforts are or are not 'sustained', involving like decisions regarding their intensity (how much calorie expenditure? over which period of time?) and frequency (once a day? a week? a year? a generation?). Similarly impossible to measure is degree of manipulation, as I have set out at the beginning of section 4.4. (p.128). Thus, any attempt at converting the theory to practice must result in subjective standards. Roscoe (op.cit:154), aware of these limitations, embraced them nonetheless:

> "If I have belabored these definitional difficulties, it is only to underscore the impossibility of definitively surveying 'the hunters and gatherers of New Guinea'. For pragmatic reasons alone, I have chosen to identify as a hunter-gatherer group any that appears to derive at least 75 % of its subsistence calories by procuring wild resources—'wild' meaning resources that living members have not themselves deliberately bred or planted."

If definitive endeavours are obliterated, though, by the abundant qualifications which pragmatic solutions require, why employ categorical concepts at all? Apparently, students of subsistence continue to subscribe to the notion of zero-impact scenarios, if only in principle. They are, however, chasing a chimera. In fact, zero-impact scenarios are as imaginary as the naturalness of hunter-gatherers. They may offer a hypothetical antithesis to agricultural subsistence, but cannot represent an actual condition as manifested in ethnographic or ecological reality. For, this reality entails human–environment interaction, which by definition is relational, and permanently so. There is no environmental tabula rasa which humans would affect periodically and which would thereafter revert to a virgin state. Like the savage and Nature II, it exists only as an utopia (cf. section 4.4.). Postulating its existence constitutes another instance of Evens' "ontological naturalism" (see p.130), which tries to force the two cognitive propensities of recognising essence and thinginess into alignment.

Human impact is inevitable, and it manifests in three different ecological dimensions. Firstly, there is the utilised environment at large, which is necessarily affected by human activities. As Paul Roscoe (2002:153) puts it: "The very presence of consuming humans on a landscape affects food resources"; in Mitsuo Ichikawa (1996:473) words:

> "But heavy dependence on the forest also means that Mbuti activities have an impact on the forest environment".

Secondly, there are the individual utilised organisms. Their germination, establishment, growth, reproduction and propagation may indeed remain unaffected by direct human interference before the point of appropriation. Since they are always part of the utilised environment, though, they will at least be indirectly affected, through impacts on other biotic and abiotic factors. Furthermore, use of the parental organism may directly affect its offspring, and thus future resources. Thus, the universal acts of feeding, digestion and excretion can strikingly affect plant dispersal and distribution; in this respect, Rindos (1984:131-136) quotes several fascinating examples of how accidental seed drop—the 'dump heap' scenario—and gut passage combined with toilet habits can promote patterned colonisation by utilised plants. Similarly, Jones & Meehan (1989:128) have noted the incidental distribution of seeds in camp sites, and people's awareness of it, among the Australian Gidjingali people.

Thirdly, there are the utilised species, or their constituent populations, as phylogenetically defined classes of resources. Use immediately alters their demography, both in terms of numbers and composition. This in turn may affect resource abundance in the long run, whether in terms of depletion or enhancement, depending on the resource's reproductive strategy (cf. sections 3.3. and 3.6.). Furthermore, it may act as a selective pressure affecting the resource's phylogenetic development, and lead to domesticatory processes (see below).

That is, ***resource use cannot be ecologically neutral.*** To define foraging as the reliance on organisms unaffected by humans therefore creates the paradox that foraging could apply only to unutilised organisms, in unutilised environments. This returns us to Brosius' (1991:131—quoted on p.45) suggestion, made in the context of the calorie debate, that "[w]e may be forced to conclude that foragers have not ever existed on any biome". Indeed: within an ecological conception of subsistence, there *is* no foraging in the conventional sense—save, possibly, for pioneer situations. In fact, the ecological argument reinforces the logical argument—presented in section 4.3. and drawn from Ingold and Rindos—that humans and other organisms constitute mutually environments for one another; and the ethnographic argument—presented in sections 3.3. and 3.6. and drawn from the calorie debate, Flach and Rhoads—that there is no one-way relationship between humans and the resources they utilise, exemplified by the collateral effects of sago use. Together, they leave no doubt: human-free nature remains as utopian as the natural humans paradoxically thought to inhabit it.

Farming

Refuting foraging as an illusion leaves us with the unbalanced residue of farming, which thereby becomes a universal human attribute and ecological commonplace. Of course, this recognition requires an encompassing definition of farming, which does exist in principle, although in practice much confusion prevails.

Firstly, there is the pervasive reference to the motivational aspects of human behaviour, with farming defined explicitly or implicitly through deliberateness of action. As I have just hinted, though, the inevitability of human impact leaves no room for a categorical discrimination by this parameter. Furthermore, the corresponding assumption that such deliberateness of action determined in some way its ecological effect represents an illicit conflation of human agency with human action, of ideational and biological worlds, and therefore breaches the bifurcation of anthropology. After all, human desires and intentions are not biologically relevant parameters, as appropriately pointed out by Rindos (1984:89, cf. p.126).[121]

Secondly, there is the fractured character of the concept, with farming variously taken to refer to cultivation, domestication, agriculture, or a combination of these, often by one and the same author (cf. p.135, also p.42). Such imprecision may be a legacy from Childe, who "did not distinguish conceptually between agriculture, cultivation, and domestication, although he used all three terms in his accounts of the Neolithic Revolution" (Harris 1989:13).

Thirdly, there is little agreement on definitions for the three constituent concepts themselves; and while various authors have lately offered some explicit, if dissimilar, interpretations for the concept of domestication (e.g. Blumler & Byrne 1991; Chase 1989; Harlan 1992; Harris 1996; Leach 2003; Rindos 1984; Terrell et al. 2003; Yen 1989, 1991b; see also pp.150ff.,159ff.), the concepts of agriculture and cultivation continue to be rather impressionistically used.

Unfortunately, this uncritical attitude constitutes a major obstacle to advancing our ecological understanding of subsistence, which would require clear designations for such fundamental subsistence elements. In the following, I will therefore attempt some definitions for the three concepts as far as they pertain to plants.[122] In my overall perspective, I will follow Rindos (1984:100,101), who distinguished

- cultivation as human behaviour,
- domestication as a coevolutionary process, and
- agriculture as a highly developed animal–plant symbiosis;

and who emphasised the universality of the underlying principles, manifested in "the naturalness of the human–plant relationship" (op.cit.:chpt.3).

The 'Primary Colours' of Plant Management

Before I address these specific concepts, though, I will more generally explore the biobehavioural aspect of human-plant interaction, subsumed under the concept of <u>management</u>.[123] In order to establish a universally valid scheme, which will allow us to describe any possible case, we first need to identify the basic building blocks of plant management—its 'primary colours'.

As a first step, we must distinguish the environmental <u>flora</u> from the <u>activities</u> directed at it, so we can treat both elements independently. We can then further divide the environmental flora itself into four utilitarian categories, namely:

- <u>desirables</u>:
  plants which are useful as current or future resources, or for supporting such resources (i.e. food plants for game animals, shade or companion plants for crops, etc.).
- <u>undesirables</u>:
  plants which constitute a controllable nuisance or threat, either for the resources or for humans; in particular plants which diminish the proliferation of resources, through competition for space, light, water, nutrients, pollinators, dispersal agents, etc., but also plants occupying space which humans wish to use, for paths, shelter, etc.
- <u>untouchables</u>:
  i.e. plants which constitute an uncontrollable threat for humans, typically for spiritual reasons.
- <u>neutrals</u>:
  plants which belong to neither of the previous.

Assigning these categories is contingent on the circumstances, as illustrated with examples from Krisa and the neighbouring community of Isi in Table 8. Parameters may affect the designation of individual plants as well as the taxon as a whole, and beyond those listed may include plant habit, site management or accessibility, changing dietary fashions, individual preferences, etc.

Table 8: The Contingent Character of Utilitarian Plant Categories

species	parameter (selected examples)	details
WASI KOXOU (*Ficus* sp.)	nutritional situation of human population	**neutral** (as floral component) under satisfactory nutritional conditions; **desirable** (as famine food) under conditions of nutritional stress;
KWILA (*Intsia bijuga*)	maturity of plant individual vs. maturity of surrounding vegetation	**desirable** (as construction wood) when mature; **undesirable** (as weed) when immature in young gardens; **neutral** (as floral component) when immature in old gardens;
KWILA (*Intsia bijuga*)	belief system	**untouchable** (as seat of dangerous powers) in Isi[*], where though it becomes **desirable** (as construction wood for men's ceremonial houses) through the appropriate ritual; **desirable** (as profane construction wood) in Krisa;
TIOBU and TIKASIBU (two named individuals of *Ficus* sp. on Krisa territory)	belief system in connection with site history	**untouchable** (as seat of dangerous powers) in the function of marking the sites of ancient ceremonial houses.

As regards the respective activities, neutrals are by definition removed from human attention; untouchables are avoided; only desirables and undesirables experience directed action, resulting in either of the following subsistence benefits:

- appropriation of desirables,
- enhanced abundance/ utility of desirables,
- control of undesirables.

The actions involved can be reduced to three basic elements of human behaviour towards live plants, namely

- translocation,
- modification,
- extermination,

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[*] Isi is a community neighbouring Krisa, though culturally distinct from it; data are taken from Kocher Schmid (2004). All other data stem from my own field research in Krisa.

which though can combine for more complex scenarios. Relating them to the two utilitarian categories of desirable and undesirable flora in form of a matrix, as in Table 9, then provides a means for organising the various practices of plant management. As will become clear, the respective motivations are of secondary importance in this context.[124]

Table 9: A Matrix for Plant Management Practices

<table>
<tr><td>utilitarian category/ elemental activity</td><td colspan="2">DESIRABLES</td><td>UNDESIRABLES</td></tr>
<tr><td>TRANSLOCATION</td><td colspan="2">seed drop
sowing
planting
transplanting
[in-situ/ ex-situ storage]</td><td rowspan="2">▨</td></tr>
<tr><td rowspan="3">MODIFICATION</td><td colspan="2">training</td></tr>
<tr><td colspan="3">trimming
pruning
pollarding
coppicing</td></tr>
<tr><td colspan="2">harvesting/ appropriation</td><td>▨</td></tr>
<tr><td rowspan="4">EXTERMINATION</td><td rowspan="3">nurturing, tending</td><td>cleaning</td><td rowspan="2">weeding (immature)</td></tr>
<tr><td>protection (immature)</td></tr>
<tr><td>retention (mature)</td><td rowspan="2">clearing (mature)</td></tr>
<tr><td colspan="2">promotion (propagule →)</td></tr>
</table>

Firstly, translocation alters the distribution of plants and their chances of survival. It may occur deliberately or accidentally, thus limited in the former case to desirables by definition, in the latter by its behavioural and utilitarian effects: undesirables either remain undesirables in a new location where they will be exposed once again to control measures, or become neutrals and hence removed from human attention. For desirables, translocation constitutes a direct encouragement of the respective plants. If deliberate, it aims at improving a plant's accessibility and enhancing its exposure to favourable environmental conditions. Relevant actions are

- the collective sowing of seed;
- the individual planting of seed or vegetative parts;
- the individual transplanting of entire plants.

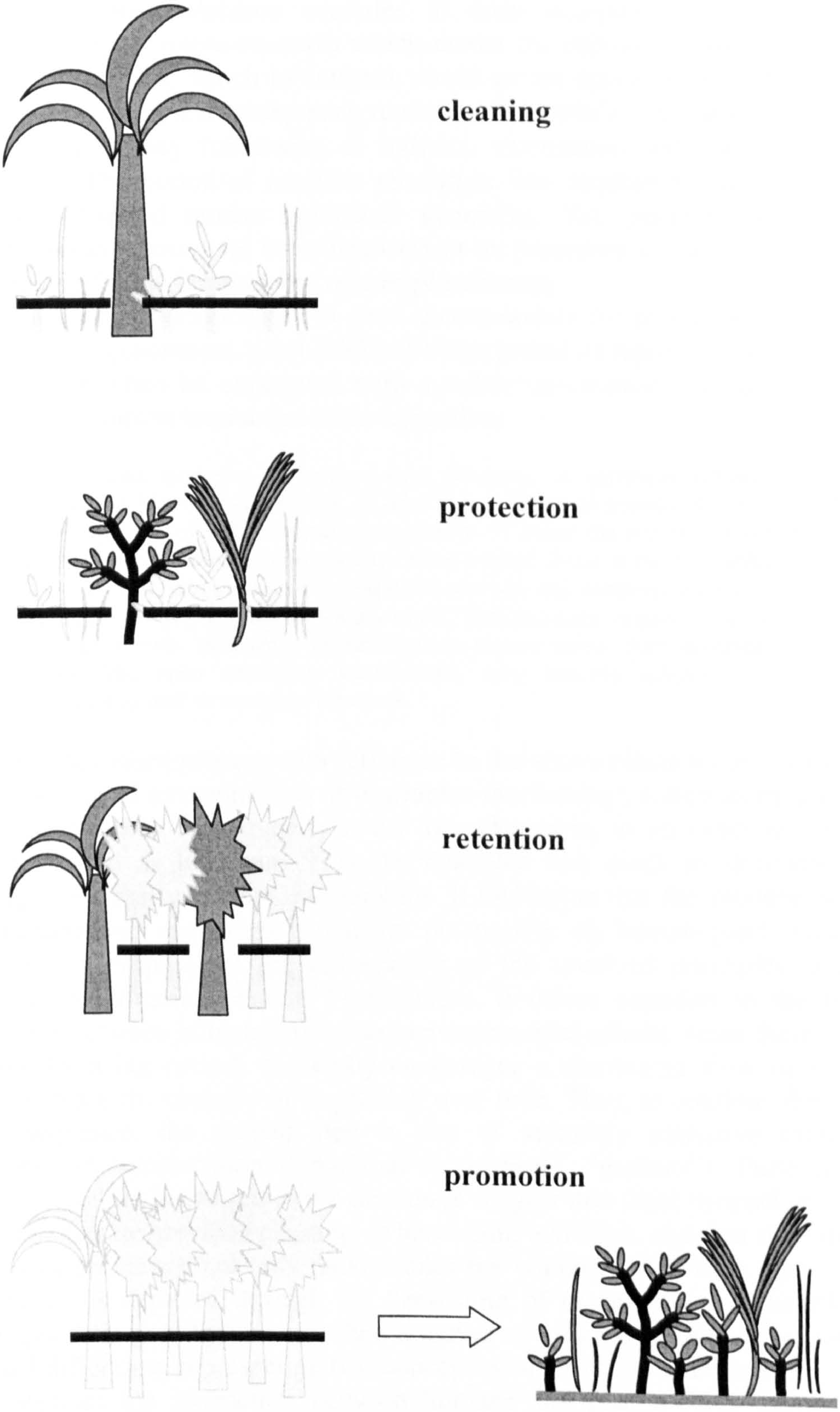
Accidental translocation occurs typically through seed drop in the context of use. Under favourable conditions, it compares ecologically to deliberate propagation (under unfavourable conditions, the plant dies and the event becomes invisible in behavioural and utilitarian terms). Either depends on the availability of suitable propagation material through in-situ or ex-situ storage, which, again, need not be deliberate for this purpose. In fact, storage may equal translocation, as is evident with animal caching behaviour or the subterranean storage function of planted tubers (Rindos 1984:160).

Secondly, modification alters the habit of individual plants, with the plant surviving in-situ and plant distribution remaining the same. It involves in particular actions such as training, trimming, pruning, pollarding, and coppicing, which typically aim at improving the survival or use qualities of desirables, although all but training may also serve the control of undesirables. The category further subsumes the removal, in harvesting (or appropriation), of plant parts without killing the plant, thus covering such acts as the picking of fruit and leaves, the tapping of sap, or indeed the replanting of vegetative parts after the harvest of underground storage organs. In fact, both purposes of modification may be indistinguishable, as evident with sago palm management: harvesting of mature boles for starch amounts to 'pruning' the clumps, which stimulates growth and maturation of the remaining suckers (cf. section 3.6.). This example at once demonstrates that one and the same plant individual may contain both desirable and undesirable portions. Also, that modification of undesirables need not be deliberate, but may occur incidentally in the context of harvesting, as of other activities, such as clearing for trails, shelter, etc.

Thirdly, extermination kills plants, which once again alters their distribution. It applies to desirables as harvesting of entire plants; otherwise it is the principal means to control undesirables—conceptualised as weeding for immature plants, as clearing for mature plants. Like incidental modification, this may occur in the context of other activities, and need not be deliberate. In any case, extermination creates a floral vacuum. This can be replenished by other parts of the vegetation which are thereby encouraged indirectly. This oblique relationship (indicated by grey font in Table 9) between two vegetational components, and between action and effect, makes for a number of scenarios. Obviously the most important ones in utilitarian terms involve the encouragement of desirables through removal of undesirables. Four which are particularly relevant in the context of this study can be distinguished according to the perspective assumed, the plants' absolute and relative stages of maturity, and the extent of the flora affected (see Figure 4 on p.142):

- Actions—which may be grouped together as nurturing (or tending)—addressed at *specific* plant individuals, of *particular* kinds of plants, which have *already become established*:
  - cleaning, i.e. the removal through weeding of undesirables (immature) around desirables (any stage of maturity);
  - protection, i.e. the conservation during weeding of desirables (immature) among undesirables (immature);
  - retention, i.e. the conservation during clearing of desirables (mature) among undesirables (mature).
- The *unspecific* encouragement of various kinds of desirables within *mixed* floral assemblages, by *stimulating the germination/ sprouting and growth* of their propagules through some form of clearing, including by fire:
  - promotion.

Figure 4: Indirect Encouragement of Resources



The latter scenario is sometimes conceived as 'tolerance' (a term heard frequently at the International Congress of Ethnobiology [ICE] 2004). Two related considerations advise however against use of this concept, and they illustrate the advantages of the modular scheme of plant management which I have just outlined, and which is based on action and a complementarity between desirables and undesirables. Thus, tolerance connotes at once acceptance and inaction—both theoretically unproductive concepts which evoke the utilitarian category of neutrals, rather than desirables, which in contrast would attract appreciation and action. More specifically, the notion of acceptance renders a desirable's occurrence incidental and thereby obscures any functional, if indirect, connection with action directed at undesirables. The notion of inaction reinforces this impression, diverting attention away from directed human behaviour generally. Yet, precisely the connection between directed action and its indirect effect on resources is central for recognising and modelling fallow farming and related phenomena.

The modular scheme can at once accommodate the reverse scenario of forest depletion and regeneration. Ellen (1978:76) anticipated its representation in the format described here when he explained, with a rather uncommon (though cf. op.cit.:85) perspective on human interaction with vegetation:

> "The obvious tendency to procure such products, in particular rattans, timber, bamboo and *Metroxylon* products, as near to the village as possible inevitably leads to the depletion of stable primary associations of forest the nearer one gets to the main loci of settlement. Consequently, when mature forest is cut for gardens it has almost always been considerably exploited already and contains plant associations more typical of regenerated secondary forest. This accounts, in part, for my reticence in using the term 'primary' with reference to mature forest. Such depleted primary growth, like open secondary associations, may become subject to marginal cultivation as well as complete clearance."

Coding the described process with reference to the above elements produces as a first step a sequence of extermination of desirables (harvesting), followed by proliferation of vegetation which subsequently ranks as undesirable, in an exact reversal of the scenario glossed as tolerance. This demonstrates that much as desirables can be encouraged indirectly, so can undesirables. It highlights that the modular scheme of plant management engenders a uniform perspective on human–plant relationships, which in turn emphasizes the universality of the involved principles, despite the difference in utilitarian benefit. Furthermore, it draws attention to the functional connections between human actions and environmental effects; since these tend to be separated by a lag period, it thereby encourages a diachronic view of subsistence which can trace the changes of vegetation over time. Thus, to continue the coding of Ellen's sequence, the second step is one of variously extensive extermination (clearing) and translocation ("marginal cultivation", "gardens"). Furthermore, the kinds of desirables harvested in the first stage suggest that these themselves may have been promoted by previous clearing or harvesting activities, and that their harvesting in turn will encourage not only undesirables but similarly their likes again. Whether forest becomes depleted through the harvesting of resources, or localised clearing encourages their growth becomes then a matter of idiom and perspective rather than of factual difference, representing two conceptual sides of the same coin.

Besides the interaction between humans and plants, there exists a further dimension of plant management, namely behaviour related to pest control and the modification of substrate and topography. This may include such activities as fencing, netting, application of insecticides or fungicides, fertilizing, tilling, mounding, erection of soil retention barriers, terracing, damming, or excavation of irrigation channels.[125]

Reference to these three dimensions—the contrast between desirables and undesirables (or, more generally, the division of the environmental flora into four utilitarian categories), the three elements of human–plant interaction, and additional behaviour directed at fauna and wider environment—can accommodate any form of plant management, from large-scale fixed-field agriculture to such apparent borderline cases as Australian Aboriginal fire-stick farming (e.g. Harlan 1992:22, Yen 1989:57 [both referring to Jones 1969][126]); the replanting of yams heads (e.g. references cited in Ellen 1988:126; Jones & Meehan 1989:123); the incidental effects of sago use (e.g. Brosius 1991; Flach 1983; Rhoads 1982); the imperceptible transformation of primary to partly secondary forest (Ellen 1978:76,85); or any other of the 'grey areas' described for example by Ellen (1988:126; 1994:206) or Harris (1996:447 [quoting multiple references]). In particular, it can deal with complex and diffuse situations, such as the proliferation of tabooed species (cf. n.124); the various forms of agroforestry (cf. section 3.5.); or scenarios described by respectively by Stéphanie Carrière (2002a) and Emilio Moran (1996:541), in which ecologically or economically valuable forest species (desirables II) are indirectly encouraged in swidden fallows by retaining or introducing food plants (desirables I) for their animal dispersers during the garden stage (cf. p.64). Indeed, the scheme can conveniently accommodate the incidental effects of subsistence activities typically classed as foraging. For, it is irrelevant from an ecological point of view, which regards only behaviour and its physical effects, whether any of these activities happen deliberately or not: motivation is not an ecologically pertinent variable (cf. section 4.3., esp. p.126, n.121; also pp.135ff.). Incidental effects follow the same ecological principles as intended ones.[127]

Cultivation: No Grey Shades

After establishing some general principles of human behaviour towards plants, we can now turn to the more specific concept of cultivation. This must be one of the most frequently used in the vast literature on subsistence, yet it remains almost completely undefined, not even Rindos offering an explicit inventory of what it entails. Exceptionally, Ruthenberg (1971:2-n.2; cf. p.48) states:

> "The word *cultivation* is used in this book in the sense of the preparation and use of land for growing crops. This does not necessarily imply that the ground around the plants must be loosened."

This definition is rather encompassing, and may in principle be stretched to include any form of plant management. Aspects critical for this expansion are the notion of 'land', which tends to evoke images of major clearings and exposed substrate, but in fact leaves open the size of the affected area; and the notion of 'crops', which tends to evoke images of massed annuals, but in fact may refer to any plant resource in any concentration whatsoever.

Really limiting to the universal application of the concept is rather the notion of 'growing', which is not only an explicit part of Ruthenberg's definition, but indeed regularly implied by the concept of cultivation. Besides its curious semantics, to which I will refer in section 4.6., it comes with the notion of *deliberate* action, which is an anthropologically though not ecologically meaningful parameter (cf. p.126, pp.135ff., and above). Even discarding this limitation, there remains its common association with the *direct* encouragement of resources and, indeed, modification of the substrate,[128] as is apparent in the concern generated by the 'grey areas' of plant management. At the most, it tends to extend to *specific* indirect encouragement (nurturing); its expansion to unspecific indirect encouragement (promotion) would seem somewhat contrived. This leaves cultivation as a partial, and typically non-ecological concept, which fares poorly with the greyer shades of plant management. It may therefore be convenient as a shorthand for certain forms of management, but is little suited as a reference point around which to build a universal scheme for exploring the ecological dimension of subsistence.

Throughout this study, I will use the term 'cultivation' only in reference to plant management practices which involve deliberate translocation (i.e. sowing, planting, transplanting). To designate the plants so treated, I will use the verb as a noun, thus referring to 'cultivates'. This term may be uncommon—although it was at least used by Geertz (1963:23)—but is the only label available which refers solely and unambiguously to cultivation and not at once to other aspects of plant management, in particular processes of domestication (cf. n.141).

Domestication: Evolution under Management

If cultivation, or, more broadly, management, refers to human behaviour towards plants and its environmental effects, domestication refers to the ***change of the involved taxa under the influence of the relationship***. Both relate therefore to two fundamentally different dimensions of human–environment interaction: the former involves individual organisms, i.e. real entities; the latter classes of organisms, i.e. virtual entities. While the former develop ontogenetically, in the course of an individual's lifetime, the latter develop phylogenetically, in the course of Darwinian evolution[129]. Hence, change in the former can manifest as change in the latter only through the mediation of demographic processes, an aspect whose neglect is causing much confusion in the literature.

David Rindos (1984) has probably offered the most profound and coherent treatment to date of plant domestication in its relation to subsistence, arguing for a coevolutionary process. Strictly speaking, coevolution refers to the evolutionary adaptation of two interacting species to each other *through reciprocal genetic change* (Campbell & Reece 2002:1181). Therefore, as biologists caution: "There is actually little evidence for coevolution in most cases of interspecific interaction", although they "agree more generalized adaptation of organisms to other organisms in their environment... is a fundamental feature of life" (ibid.). Besides, the requisite genetic change is difficult to demonstrate empirically (cf. loc.cit.), and has certainly affected humans much less than the taxa with which they interact.[130] Rindos, though, employed less a strictly genetic concept of evolution than the algorithms by which it operates, and which apply similarly to other heritable attributes of the involved organisms, in particular behaviour transmitted through cultural mechanisms.[131] According to this loose notion of coevolution:

> "Domestication is a process mediated by morphological and autecological adaptations in the plant and by behavioral changes in man." (op.cit.:138)

This process is not limited to plants as resources and humans as resource users: animals may become products of domestication, much as they may become its agents. In this more inclusive definition, therefore:

> "Domestication is a coevolutionary process in which any given taxon diverges from an original gene pool and establishes a symbiotic protection and dispersal relationship with the animal feeding upon it." (op.cit.:143)

The notions of "feeding" and "symbiotic" are key to the characterisation of this process. Thus, the starting point is a predator–prey relationship, in which an animal simply feeds on 'wild' resources, potentially depleting them (op.cit.:197,216,255,258). From this, a symbiosis, i.e. a mutually beneficial ecological relationship, can develop through 'useful' mutations in the resource and 'appropriate' behaviour changes in the feeding animal (op.cit.:143).[132]

The potential for 'useful' mutations depends in particular on two aspects. On the one hand, the organisms' inherent characteristics may favour or inhibit changes conducive to domestication.[133] For example, Rindos (op.cit.:143) mentions requirements for germination, while Harris (1973:396f.) highlights the pre-adaptation of tropical crop progenitors to environmental condition which favour the production of storage organs.[134] On the other hand, pre-existing symbioses with other animals may limit the potential for human involvement.

In successful cases of plant domestication, changes have tended towards (after Rindos 1984:183 [quoting Schwanitz 1966][135] and Vogel & Angermann 1984:487):

- gigantism (increase in size), frequently accompanied by polyploidy (increase in chromosome number)
- increase in size of utilized organ
- increase in size and decrease in number of propagules
- simultaneous ripening of seed crop
- decline of seed dormancy (i.e. increase of simultaneous germination)
- loss of natural dispersal mechanisms (e.g. sterile fruit, indehiscence [i.e. lack of seed scattering upon maturation])
- loss of protective mechanisms, including toxic and bitter compounds
- retardation or acceleration of development (change from annual to perennial or vice versa)
- diversity of form.

Collectively, these aspects indicate a change of the respective taxa's ecological strategies from r- to K-selection, i.e. from an emphasis on producing offspring to an emphasis on ensuring its survival (Rindos 1984:178-189).

Such changes, or rather the steps which have incrementally brought them about, can only be adaptive under respectively changed conditions. These in turn arise from 'appropriate' behaviour changes in the feeding animal, relating to such acts as "protection, pollination, dispersal, storage, or even simple predation" (op.cit.:112). Of these, Rindos treats dispersal as the single most important parameter for the early stages of domestication (op.cit.:esp.112-120 and passim). He may have overestimated its importance due to his preoccupation with temperate-zone grain crop agriculture, for which this mechanism presumably played a key role (see pp.153ff.). Nevertheless, its mechanics superbly illustrate the principles of coevolutionary processes and highlight the ecological perspective which I have been advocating throughout this chapter. I shall therefore reproduce Rindos' explanation in some detail.

The key aspect is that dispersal of propagules beyond the mother plant tends to confer advantages to the offspring, in terms of reduced risk of competition and predation for the individual and increased geographic success for the taxon as a whole (op.cit.:113). One means to accomplish dispersal is employing dispersal agents; however:

> "The establishment of coevolutionary dispersal relationship involves various compromises for the plant, which obviously must produce a propagule that is attractive to the dispersal agent. The propagule will have to be adapted to—or, more accurately, not be destroyed by—the dispersal agent. Because agents may vary in the effectiveness with which they disperse the propagule, the plant may increase fitness by compromising on the number of dispersal agents and by evolving a relationship with a few high-quality agents. Yet, because the agent is basically a predator, it would be difficult to establish a coevolutionary dispersal relationship without providing some benefits to the animal. This benefit, frequently food, attracts the agent to the propagule.... Thus it is commonly found that the plant offers some of the propagules as bait for the dispersal agent. Although some of the propagules (or parts of a given propagule) may be destroyed, dispersal is nevertheless accomplished; hence the plant arrives at a compromise between attraction and dispersal." (op.cit.:114)

The two principal modes for achieving this compromise are the development of accessory structures of expendable tissue (e.g. fleshy fruit) and the aggregation of propagules (e.g. in ears or heads) (op.cit.:145). If this represents the overall evolutionary scenario, the demographic processes involved are that:

> "Seeds [that] have a more advantageous dispersal agent, in either qualitative or quantitative terms, will be selected for and will thus preferentially spread those [heritable][136] aspects of the phenotype of the parental taxon that are favorable to interaction with the dispersal agent." (op.cit.:113f.)

Consequently, the reproductive success of the favoured seeds will increase, all other things being equal. In other words: the respective genotype's Darwinian fitness[137] will be enhanced. The same is true for the agent, who obtains a richer and more reliable food source, and hence increased chances of survival and reproduction. If the benefit of domestication for the human agent ranks as a truism in anthropological and Western folk conceptions of subsistence, the former aspect, of domestication as similarly advantageous for the resource, remains an unorthodox notion. And yet:

> "That the coevolutionary sequence has been successful for the plant needs no demonstration—one need only consider the present distribution of a crop like wheat or maize and compare it with that of a putative ancestral taxon for the group." (op.cit.:140)

Much as dispersal, so can other forms of human–environment interaction function as selective pressures which favour variants with particular useful traits over others, thereby shifting gene frequencies and encouraging domesticatory processes. The respective activities, some listed by Rindos (op.cit.112—cf. p.146) as dispersal, storage (a particular means of dispersal), pollination, predation (harvesting/ appropriation) and protection (or, more broadly, encouragement), fall into two broad categories:[138]

- ones affecting the resource itself (dispersal, pollination, predation, etc.);
- ones affecting its environment (protection, etc.).

These two categories naturally parallel the distinction, in the modular scheme of plant management, into direct and indirect interaction with desirables (the former indicated by black, the latter by grey font in Table 9 [p.140]). Similarly, any of the involved activities can be sufficiently described with reference to the three behavioural management elements introduced there:

- translocation of the resource, or, more specifically, of its genetic material (dispersal, pollination);
- modification or extermination of the resource (predation);
- translocation, modification, or extermination of other organisms (protection).

This illustrates that much as management is the engine of domestication, so can domestication arise under any management scenario, *including the incidental effects of harvesting*—therefore appropriately labelled 'incidental domestication' by Rindos (see n.138). This is consonant with the universality of the involved coevolutionary principles which apply to human agents much as they apply to other animals. It at once contradicts authors (e.g. Blumler & Byrne 1991:27-29; Harlan 1992:64, 117, 189) who have dismissed the idea that domestication could occur without cultivation.[139]

Domestication—Modes of Selection

The respective selective pressures operate according to either of three modes (see Figure 5 on p.149): (1) stabilizing (eliminating extreme variants, thus stabilising the phenotype); (2) directional (favouring variants of one extreme, thus shifting the average phenotype in this direction); or (3) diversifying (favouring variants of opposite extremes, thus leading to two phenotypically different populations) (Campbell & Reece 2002:458). In regard to the emergence of domesticates, either (2) or (3) may be active, considering that the symbiosis is yet to be established and thus a change in traits required. Thus, we can conceive of the following scenarios:

(2) the progenitor is gradually becoming extinct while a domesticate with new characteristics develops:
    this scenario is considered uncommon, although it may be typical for tropical perennials (see pp.153ff.); it has been hypothesized e.g. for the coconut (*Cocos nucifera*) (e.g. Johns & Hay 1984:250), and may similarly apply in cases where progenitors of modern crops have proved elusive (cf. Heiser 1995:201);

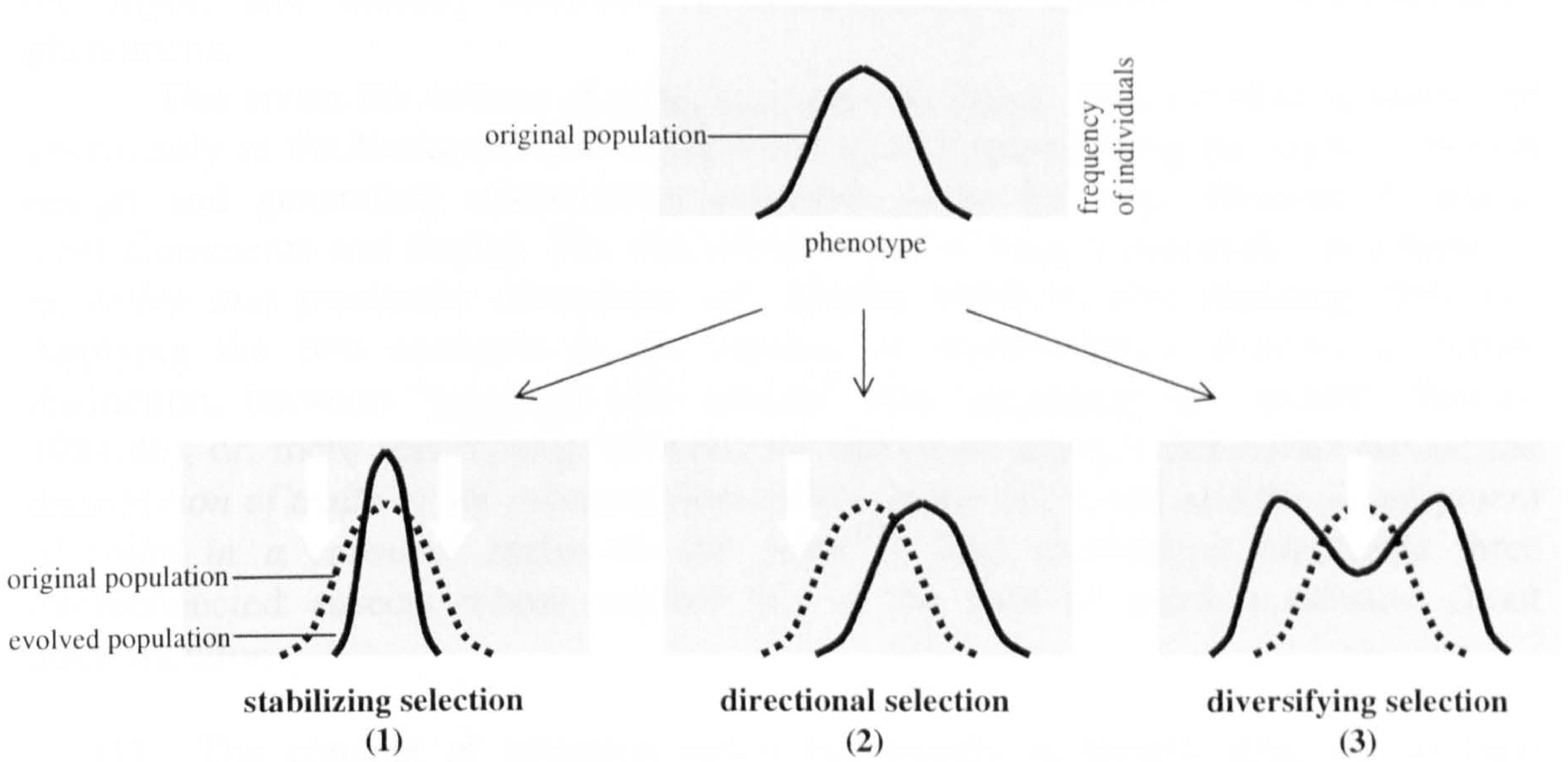
(3) the progenitor comes to coexist as wildtype[140] with a domesticate with new characteristics:
    this is the most typical scenario; in the long run, it proceeds towards full speciation, which though is extremely rare in practice, most domesticates retaining their ability to cross with the respective wildtypes (Harlan 1992:113); the morphological differences, though, can be striking, as

> classically demonstrated by the contrast between teosinte and maize (Heiser 1995:201; see also Campbell & Reece 2002:797-fig.38.19).

The same pressures continue to affect the domesticate itself. Thus, (1) acts towards stabilization of the domesticate; (2) towards its further removal from the progenitor; and (3) towards its diversification into genetically distinct populations, known (for plants) as 'landraces'[141]. Modes (3) and (1) respectively correspond to the effects of what Masayoshi Shigeta (1996) has identified as "cognitive selection" and "utilitarian selection": the former aims at cognitively appealing features, which due to their abundance increases landrace diversity; it thereby provides the substrate for the latter, which aims at the more limited number of utilitarian traits and thereby decreases variation in the long run (op.cit.:esp.263). If the former demonstrates that the benefits for the domesticating agent need not manifest instantly in utilitarian terms, James Boster (1996) has gone so far as to argue that humans select indeed primarily for "perceptual distinctiveness" rather than utility (op.cit.:esp.280-282), due to their own, evolved, cognitive capacities.

Figure 5: Modes of Selection

(reproduced from Campbell & Reece 2002: 458-fig.23.12; the white arrows indicate selective pressure)



Domestication—The (Ir)Relevance of Consciousness and Intent

By focusing on the instantaneous gratification for the selecting agent, Boster's argument may help to dispel a common myth about domestication: that it proceeded towards some preconceived end, established by human design, as demonstrated ex post by its utility. The problem with this belief is not primarily its functionalist error (cf. p.121). After all, utility—of whatever kind—*is* the driving force behind the development of domesticatory relationships. Its design manifests, however, through ecological negotiation, not imposition, and emerges ultimately from the resource, not the agent. Following the fundamental evolutionary principle of selection on variation, any change in the resource is *prior* to one in the agent, whose response is subsequent. In terms of this principle, therefore, the agent is merely reactive, not proactive. For sure, humans may proactively pursue particular domesticatory *strategies* in order to obtain resources with specific traits; and they may be successful in this endeavour, suggesting indeed the realisation of some envisaged design. Such achievements indicate that humans are, within limits, able to manipulate domesticatory trajectories to their own ends. Regarding them as prototypical, however, obscures not only that complex and/ or long-term scenarios typically evade such manipulation, but more importantly that the *mechanics* of domestication, which similarly underlie either, engender a dynamic of change and response which is inverse to that promulgated by the myth, and thereby obstructs a comprehensive analysis of domesticatory phenomena.

This enters the notions of consciousness and intent, which tend to be employed uncritically in the literature, thus compounding and perpetuating the myth of human design and generating unnecessary academic strife (cf. esp. Blumler & Byrne 1991:Comments and Reply). The distinction between both is essentially one *between reflective and predictive awareness* (cf. Rindos 1984:99; also Redding 1991:43). Applying the two concepts in the context of domestication requires a further distinction, between "selection (the means)" and "evolution (the result)" (Rindos 1984:86), or, more specifically, between *the effects an agent's behaviour has on the distribution of traits in the resource population* on the one hand, and the *development of traits in a resource taxon* on the other.[142] This explication highlights three interconnected aspects whose neglect lies at the root of much confusion about domestication:

(1) The concept of selection refers not simply to human acts, but to their relevance for the demography of the resource population (recall that the bell-curves in Figure 5 represent phenotype frequencies).

(2) There is no immediate connection between selection and evolution, which operate, as it were, perpendicular to each other (cf. the position of the white arrows relative to the x-axis in Figure 5).

(3) The point of articulation between selection and evolution are useful traits, which arise *without* the agent's direct interference, but accumulate demographically through its behaviour and thereby manifest the taxon's evolution.

We are therefore dealing with three elements which need to be considered separately regarding their accessibility to human consciousness and intent:

(a) human acts, or behaviour;

(b) selection, or the demographically relevant aspect of (a);

(c) evolution, or the screening of traits through (b).

Both human behaviour in general and selection in particular may either be or not be conscious and intentional. The respective conditions, however, are not necessarily consonant with each other, since the objects of motivation may differ. Thus, behaviour motivated by utilitarian concerns may have involuntary demographic effects, as the discussion about plant management has shown: sago palm may be consciously and intentionally harvested for its food value, but be thereby at once unconsciously and unintentionally encouraged; human use may aim at one taxon and incidentally affect another; and so on. Hence, acts may be deliberate, but the ensuing selective pressure may not. We can therefore speak of conscious and intentional selection only when the respective acts are *at once motivated by their demographic effects*, that is, by the desire to maintain a particular mode of selection. Accordingly:

> "Darwin distinguished between *methodological selection*, the systematic modification of a plant variety or animal breed according to a predetermined standard, and *unconscious selection*, the preservation of valued individuals and the destruction of individuals of less immediate value with no intention of altering the breed. This distinction he summarized in one word—*intention*." (Rindos 1984:86).

Clearly, human behaviour, and selection as one manifestation of it, are accessible to human manipulation and hence intent. Evolution, however, as the manifestation of selection *on variation* is not, for variation remains outside human control. Thus, humans may ex post become conscious (i.e. reflectively aware) about the evolution of a taxon and their contribution to it through their past selective acts; they cannot, however, ex ante choose intentionally (i.e. projectively aware) one path of evolution over the other. After all, this would require not only an awareness of all potential outcomes of iterative cycles of selection and subsequent reproduction, but furthermore an inevitability of the variants generated. It would, in effect, imply that humans could *determine* the course of evolution, by *generating* the desired traits.[143]

"Evolution", however, "is not deterministic but opportunistic" (Rindos 1984:100), and

> "even when men breed their tame animals, they merely act upon successive variations already brought forth in the course of natural reproduction: in no wise do they create these variations" (Darwin, paraphrased by Ingold 1979:274).

Breeding, in fact, rates as the example par excellence of evolutionary processes controlled by humans. It represents no more, though, than intentionally designating individuals for sexual reproduction[144] and subsequently selecting intentionally their offspring for the next cycle of reproduction. In both cases, the effects are merely demographic; no traits emerge through human manipulation. I shall explore the erroneous notion of creation in more detail in section 4.6. Here, I will rather illustrate the converse point, that evolution remains outside human control, by adducing three specific arguments in regard to breeding.

The first is pragmatic, relating to the amount of variables to be controlled. Thus, certain phenotypic effects require the combined presence of several interacting genes before the trait can be expressed and hence detected (Rindos 1984:95); the effects of hybridisation remain unpredictable (op.cit.:96), as does the expression of traits when non-Mendelian genetics[145] get involved (Richards 1996:124); and inbreeding plants make experimental design so complex as to be unmanageable in practice (op.cit.:124f.). Consequently, "most breeders would agree... that selection is often little better than random" (op.cit.:125 [quoting Simmonds 1979:132][146])

The second argument is biobehavioural, relating to the context specificity of traits, which may appear neutral or negative in the short term but turn out positive in the long term, or vice versa. Thus, susceptibility to pests will show only under conditions of infestation (e.g. Rindos 1984:87); grain nondormancy becomes advantageous only when irrigation eliminates the risk of total crop failure under drought (ibid.). Also, traits developing over many generations are unlikely foreseen by the breeders, as with size increase in the pear (op.cit.:89); similarly, traits which rely on the involvement of several genes may appear unexpectedly (op.cit.:95, cf. n.145). Not only is it therefore typically impossible to anticipate the expression of traits, but also their utility.

The third argument is agrobotanical, relating to the relationship between crops (i.e. desirables) and weeds (i.e. undesirables). Thus, the notion of 'improving' organisms according to preconceived ends conflicts with the persistence of undesirable traits in crops, and conversely the manifestation of desirable traits in weeds. As Rindos (op.cit.: 88f.) elaborates:

> "Even today, many agricultural plants are not 'completely' domesticated. For example, even after millennia of interaction with man, not all varieties of wheat [also oats, soybeans, and lentils (ibid.)] are characterized by a totally indehiscent [i.e. non-shattering] rachis, the ne plus ultra of domestication in the small grains... Furthermore, many weeds show the desirable (to people) trait of indehiscence, but in this case we have long accepted that the indehiscence is merely a response of the plant to the conditions of tillage. It is absurd to claim that man invented weeds... For these indehiscent weeds, people have become the dispersal agent, and they are threshed and sown along with the crop. We are thus forced to consider the possibility that *morphological change in crop plants also is a response to selective forces and that the desires and intentions of people are fundamentally irrelevant.*" (my emphasis; cf. p.126)

An intentionalistic framework, in contrast, would demand that crops were prior to weeds, both conceptually and developmentally, in that crops had emerged through human intent, while weeds had emerged unintentionally thereafter (cf. op.cit.:92). Such a scenario not only conflicts with a truly ecological perspective, according to which human–crop and human–weed relationships must follow fundamentally similar principles. It is contradicted empirically by cases where historically weeds have become transformed to crops (e.g. Rindos 1984:146,150). Conversely, Melanesian ethnobotany abounds with examples of ancient domesticated crops whose status has declined to famine foods, little better than weeds (e.g. compare Sillitoe 1983:chpts.2-5 passim with 1996:80-tbl.4.1.). The interchangeability between both is entailed in the purely utilitarian distinction between desirables and undesirables, which, as explained earlier (p.139), is contingent merely on context rather than a categorical attribute of the respective taxon or indeed plant individual.[147] It is principally independent of any coevolutionary processes acting on the respective taxon's relationship with humans.[148]

In sum, therefore:

> "We may... accept that people chose the best, easiest, or most attractive option available to them—but this type of historical reconstruction of human behavior must be done with great care. It is extremely easy to fall into error *by attributing to people knowledge that they could not have had*" (Rindos 1984:98, my emphasis).

Much less does intentional behaviour imply an awareness, as it were, by the selected organism of their ultimate purpose in the imagined human scheme of things:

> "When we claim that people chose to domesticate plants to provide a more stable and predictable source of food or that they became agricultural to solve an overpopulation problem, we are making the *unconscious assumption that the plants involved were capable of responding 'appropriately'.*" (op.cit.:3, my emphasis)

Hence, the idea of preconceived ends can apply to selection, but not to evolution. If Harlan (1992:3) therefore implied anything more than a metaphor, he erred doubly when he exalted: "Crops are artifacts made and molded by man as much as a flint arrowhead, a stone ax-head, or a clay pot." Persuaded no doubt by the "spectacular" morphological modifications in the course of domestication (op.cit.:113), he at once confused these *cumulative* effects of selection on variation (evolution) with the immediate effects of selection, and these in turn with its substrate (variation). As the foregoing arguments have shown, the artefactual status of crops is at best metaphorical, variation emanating from the plant, not the human agent. Even so, the status of contemporary crops is comparable only to contemporary artefacts such as guided missiles, chainsaws and pressure cookers; neither could have arisen without a long sequence of precursors, and neither could have been foreseen, or intended, at the time.[149, 150]

Domestication—Process and Contingency

Tracing Harlan's error demonstrates that domestication refers to a process, rather than an event. The transition from progenitor to domesticate is therefore gradual. As Harlan (1992:64) himself noted: "There are inevitably many intermediate states." Their designation as either the one or the other may be problematic, a dilemma similarly occurring with the identification of chronospecies in palaeontology (cf. Skelton 1993:464f.). Besides, the potential for domestication depends on a taxon's inherent characteristics, pre-existing symbioses with other agents, and human behavioural choices (cf. pp.146f. above). Some taxa may therefore never become as fully domesticated as others.

Hence, domestication is neither absolute nor universal, but processual and contingent. There exist consequently all shades of domesticatory relationships, both as regards the degree of dependence on human management and the degree of genetic distinctness. If both aspects tend to correspond somewhat in practice, they manifest different principles and are thus best kept separate analytically. At the one end of the spectrum are full domesticates, for which humans have become the obligate dispersal agents. This is typically due to the loss of sexual reproduction (consider the sterile fruit of the banana!) which renders the domesticate genetically isolated from the wildtype by definition. Further down the line are the numerous resources which do reproduce without human interference but benefit to various degrees from human management and have under its influence formed genetically distinct populations, often with further diversification into landraces. Usually, they retain their ability to interbreed with a coexisting wildtype, unless extreme divergence of traits eliminates sexual compatibility; there are, however, cases where wildtypes remain elusive, suggesting a comparatively slow process of transformation rather than diversification (cf. scenarios (3) and (2) respectively on p.148). At the far end of the spectrum range populations which remain genetically unstable—taxonomically indistinguishable from any wildtype or without any such apparent counterpart—yet due to the localised distribution and diversity of their variants give "the impression of a considerable intensity of selection in the past" (Yen 1985:323), such as various taxa within *Canarium*[151] to which the quote referred.[152] Plants with such characteristics tend to be placed in the hazy category of semi-domesticate; they have been widely reported from the Pacific (e.g. Matthews & Gosden 1997:129f.; Sillitoe 1983:chpts.3-6 passim; Thaman 1993; Yen 1974, 1985) and are typical components of agroforestry systems (cf. section 3.5.).

Such semi-domesticates are typically trees or other perennials. This seems less accidental than a function of their characteristics, namely:

(1) generation period,
(2) plant architecture,
(3) environmental requirements,
(4) propagation–predation–reproduction relationships,

all of which put perennials at a domesticatory disadvantage vis-à-vis annuals.[153]

Firstly, the long generation period of perennials draws out domesticatory processes by definition, since these rely on iterative selection on variation and hence on the frequency at which sexual reproduction provides new variants.

Secondly, the high-rise architecture of many perennials (trees, tree palms, rattans, lianas) tends to limit the involvement of humans in dispersal, the principal mechanism for establishing domesticatory relationships through *direct* interaction with a resource (cf. pp.147,148). Rather, it favours dispersal agents such as arboreal animals and birds, who surpass humans in their capacity to access seeds and thus establish dispersal relationships. A temperate-zone example is the oak–squirrel symbiosis (Rindos 1984:93f.), in which the oak phenotype has become adapted to squirrels harvesting and caching (i.e. storing/ planting = translocating) acorns—a relationship which to upset would require a strong selective pressure by humans, thus explaining the otherwise puzzling circumstance that oaks have never become human domesticates despite their apparently ideal suitability and widespread use as an alternative food source.[154] The trend towards pre-existing symbioses with non-human dispersers likely increases in the tropics, and especially so in Melanesia, with the increase in arboreal, bat and avifauna diversity (e.g. Gressit 1982:907).

Thirdly, the typical environmental requirements of perennials tend to limit the potential for humans to establish domesticatory relationships through *indirect* interaction with the resource, that is, environmental manipulation (cf. p.148). On the one hand, disturbance, in form of the "ability to alter consistently local environments in such a way as to place the coevolved [coevolving!][155] plant at a distinct advantage", is one of the most effective means to establish domesticatory relationships (Rindos 1984:159). On the other hand, though, longer-lived taxa tend to thrive with increasing temporal distance from disturbance (e.g. Campbell & Reece 2002:1189). Hence, the very mechanism which permits substantial selective pressure, namely environmental manipulation, can apply to perennials only to limited extent, due to their common preference for more stable ecological conditions. A notable exception to this trend are plants which perennate as suppressed juveniles through periods of dormancy, and whose maturation is triggered precisely through disturbance, as has been postulated for vines with underground storage organs (cf. pp.40f.). Another qualification is that scenarios are less categorical than gradual, with many perennials benefiting from moderate or sporadic disturbance, as manifested in such management activities as cleaning or promotion, respectively (cf. Table 9 [p.140]).

Fourthly, these trends are amplified through the evolutionary correlations between propagation, predation (the most elemental form of interaction with resources) and reproduction. Their analysis relies on the distinction of plant parts into three classes according to their propagative quality: sexual (or reproductive) propagules, asexual propagules, and vegetative organs (Rindos 1984:144,112-n.6).[156]

- Sexual propagules include all forms of seeds and accessory structures. They provide the most common means of propagation among flowering plants, serving at once to perpetuate a taxon and to promote its adaptability through continual generation of variants. Both purposes favour domestication under predation, since this constitutes a dispersal opportunity rapidly manifested through appropriate variants (cf. pp.147f.). Sexual reproduction, though, favours not only the rapid development of traits, but at once their destabilisation, through interbreeding of diverging populations (cf. n.153). Likelihood for the latter increases with obligatory cross-pollination and where relaxed management schemes limit reproductive control, thus permitting populations to mix easily.[157]
- Asexual propagules include bulbs, tubers, corms, rhizomes and suckers.[158] Some of these structures may have dispersal function (e.g. the tubers of the potato, see Rindos 1984:150); all of them have perennating function, either serving to extend the life of the respective plant individual (clone) through vegetative reproduction (Hather 1996)[159] and/ or to tide suppressed juveniles over environmentally unfavourable conditions (cf. the reference to vines with underground storage organs, above). Three scenarios are possible under predation: (a) enhanced *dispersal*, favouring domestication; (b) enhanced *performance* through thinning, likewise favouring domestication; (c) endangered survival, discouraging domestication (see vegetative organs).[160] Artificial propagation corresponds to scenario (a), and may combine with scenario (b). New variants on which selection can operate may emerge through previous sexual reproduction, or (rarely) through somatic mutation. Vegetative reproduction permits immediate and permanent fixation of traits (cf. Rindos 1984:150), while extending generation periods and thus domesticatory time spans.
- Vegetative organs include all structural parts without reproductive function, including flowers and sterile fruit (Rindos 1984:145).[161] Predation on these typically constitutes a threat to the plant, leading to the development of various defence mechanisms—including toxic compounds, sclerids, thorns, etc.—in the taxon which discourage the predator (op.cit.:146). Domestication therefore requires countermeasures which ensure the continued survival and reproduction of the plant, through artificial propagation and/ or manipulation of its environment. This may happen incidentally in the context of predation (op.cit.:150-152); more typically, it relies on pre-existing patterns of plant management (op.cit.:146-150). Thus, new plants may enter existing plant-management schemes, through inadvertent colonization or deliberate introduction (op.cit.:146,150—examples: rhubarb and sorrel); or predation may shift from sexual propagules to vegetative organs for already managed, and

domesticated, plants (op.cit.:144-146—examples: lettuce, chenopods, turnip, peas). With artificial propagation, vegetative organs compare to asexual propagules under scenario (a).

This review of propagation–predation–reproduction relationships, in combination with the tendencies noted regarding generation period, plant architecture, and environmental requirements, indicates two diverging trends for annuals and perennials. Thus, annuals are typically

- quick to adapt to changed conditions due to their generation period;
- amenable to domestication through predation due to their habit and reproductive biology;
- amenable to domestication through environmental manipulation due to their ecology; once operational, environmental manipulation at once ensures a considerable measure of reproductive control, thus stabilising populations.

The evolutionary result has been that domesticated annuals typically conform to the seed culture–seed crop configuration and are managed in highly modified environments, in a self-amplifying scenario further reinforced by its technical exigencies (cf. pp.55f.). The spatial aspect of this scenario apparently engenders a compartmentalized world view, which though to various degrees seems common with cultivator societies at large (cf. pp.132f.). Its predatory foundations, though, are specific to the seed culture–seed crop configuration. They presumably manifest ideologically as a fundamental orientation towards consumption and individual resources rather than maintenance and plant communities. If this suggestion curiously inverts conventional notions about the respective subsistence forms, it may indicate the basis for the manipulationist and particularist view of human–environment interaction typically held by seed cultivators (cf. pp.56f.,74). Reinforcing and expanding the cognitive effects of spatial contrast and human intervention, this ideology of predation may therefore be what ultimately distinguishes seed culture ideologically from other forms of land use.

In contrast to the scenario with annuals, perennials—especially in the tropics—are typically

- little amenable to domestication through predation, due to their habit and/or reproductive biology, save in cases of vegetative dispersal—which can be mimicked by artificial propagation—or of crowding;
- little amenable to domestication through environmental manipulation, save in cases where disturbance encourages maturation; therefore in turn prone to destabilisation of populations through interbreeding with the wildtype;
- slow to adapt to changed conditions due to their generation period, but potentially amenable to trait-fixation through vegetative reproduction, thus generating a stop-and-go scenario.

These limitations affect especially high-rise perennials which do not propagate vegetatively. The limited degree of management typically directed at these may therefore be more an effect of their limited domesticability than a cause for their limited degree of domestication. After all, human management choices are less spontaneous than follow ecological expediency, as a response to traits in the resource. With this coevolutionary perspective, the relaxed management regimes typical for complex agroforestry systems (cf. section 3.5.), of which the respective trees form major components, emerge as a concomitant of these components' characteristics rather than deliberate decisions or 'inventions' (cf. pp.150ff.).

The respective management regimes in turn shape the course of any domesticatory processes in the resource. Thus, Peter Matthews and Chris Gosden (1997:130) observed:

> "Such cycling into and out cultivation [during the swidden–fallow cycle], and the many routes of natural seed dispersal [by fruit pigeons and flying foxes, and through drift in fresh and sea water], make it difficult or impossible to identify natural wild populations of *Canarium indicum*."

That is, the lack of human control over both dispersal and environmental conditions—heightened by functional cross-pollination and lack of vegetative reproduction (Yen 1991b:565)—counters any tendencies for *Canarium* populations to separate into wildtype and domesticate. Still, morphological comparison between archaeological remains and modern specimens "suggests that *C.indicum* has been domesticated" (Matthews & Gosden 1997:130). The limited selective pressures have therefore acted to shift the taxon's genotype as a whole (through directional selection, see p.148) rather than split it into two (through diversifying selection, see p.148).

For vegetatively reproducing resources as functional perennials, the potential for environmental manipulation to act as a domesticatory mechanism is by and large similarly limited. The possibility of cloning, though, permits at once establishment of domesticatory relationships through artificial propagation and retention of traits over long periods of time. In fact, the faculty of vegetative reproduction may itself be initiated or enhanced in the process of domestication, much as may possibly be the faculty of self-fertilisation which analogously leads to a retention of traits (cf. n.153). Yen (1991a:87) has for example suggested that vegetative reproduction in breadfruit arose only with the species' domestication, since it "would hardly be adaptive in the close competition of the tropical rain forest". We may similarly conceive of extensive suckering in palms as a function of domestication, which would be maladaptive without recurrent thinning (cf. n.160).

With the possibility of clonal reproduction, variation generated through intermittent sexual reproduction in the wake of relaxed management regimes will fuel rather than dilute the domesticatory process. Thus, Peter Matthews (1995:116 and references quoted) has noted a common scenario where residual taro plants, propagated vegetatively during the garden stage, are during the fallow stage left to reproduce sexually and set seeds; their offspring appear later as adventitious seedlings in new gardens, offering new material for selection. According to Douglas Yen (1991b:563), "this binary character is shared by important crops such as the Araceae, Dioscoreaceae, sugar cane, sweet potato and a number of endemic New Guinea domesticates". David Rindos (1984:151f.) has pointed out how local taxonomies can encourage the adoption of volunteer seedlings into the domesticate population, by classing according to morphotypes which subsume genetically heterogeneous plants. Although the process is taxonomically inverse to Shigeta's 'cognitive selection' (cf. p.149), the effects of both correspond biologically, increasing genetic diversity in the domesticate.

A similar situation obtains with the sago palm, which reproduces both through suckers and sexually, and for which local taxonomies distinguish phenotypes with typically unstable genetic basis (cf. section 3.6.). Although the degree of taxonomic differentiation may by proxy indicate domesticatory processes, *Metroxylon sagu* is commonly denied not only the status of cultivate, but indeed of domesticate.[162] Thus, Groube (1989:299) noted: "To call the sago palm itself a 'domesticate', when it appears to be unaltered from the wild plant, is another terminological problem." He may however have followed the right observation with the wrong conclusion. As in the case of *Canarium* and similar resources, human involvement may have shifted, rather than split the genotype of the taxon, resulting in a domesticate without corresponding wildtype (cf. p.148). In fact, management (in the form of thinning, i.e. plain predation, and further environmental manipulation) enhances the maturation of *M.sagu* even under otherwise optimal environmental conditions (Flach 1983), and has historically expanded its distribution (Rhoads 1982).[163] Its fitness therefore increases with human involvement, thus clearly removing it from a purely predator–prey relationship with humans. According to definition, therefore, *M.sagu* would have to be classed as at least a semi-domesticate, if not true domesticate—a condition which accords well with its role as a dominant staple in many parts of Melanesia. If this suggestion appears eccentric, one may wonder if it did less so if the palm were more sparsely distributed and subject to classical cultivation regimes. It is well to remember, though, that domestication is a process independent of particular forms of management, and that its success typically shows in the abundance of the domesticate (cf. p.147)—maybe paradoxically the aspect which has persuaded generations of academic and lay travellers to sago areas of their wildness.

A similar confusion of perspective has apparently occurred in regard to the babassu palm (*Orbignya phalerata*), an important resource for swiddeners in tropical Brazil. An article by Hecht et al. (1988), which describes its ecology, distribution and use aimed principally at demonstrating the economic and ecological sustainability of the respective land use system, identified as agroforestry following swiddening. If the study has attained some fame on this count, its most intriguing aspect in the present context are the overwhelming, but unacknowledged, indications that babassu is a domesticate. Thus, the authors observe that "the palm's current domination of the landscape results from human activities" (op.cit.:27); that "[s]tands of babassu are maintained and expand by human agency" (op.cit.:29); and that "[t]he particular features of babassu make it extremely well adapted to the biological stability of shifting cultivation" (op.cit.:31). The palm's adaptation rests in particular on its hidden germination, which means that seedlings are burrowed in the ground for several years and thereby survive swidden clearing and burning (op.cit.:27f.). This scenario demonstrates very clearly the domesticatory mechanism of placing the resource taxon at an ecological and hence evolutionary advantage through manipulating local environments (cf. pp.148,154), manifesting in an increase in resource abundance. If the authors identify "[t]he babassu palms' current dominance in the landscape and expansion over extensive areas of Brazil" as "testimony to their remarkable adaptability to shifting cultivation" (op.cit.:28), they precisely capture the very essence of domestication, namely a taxon's adjustment to human management schemes. That they nevertheless conceive of the palm's resulting abundance as a "subsidy from nature" (op.cit.:title,31) and of its harvesting as "extractive" (op.cit.:passim) contrasts curiously with Harlan's (1992:3) conviction of domesticates as "artifacts made and molded by man" (cf. p.153). The contrast illustrates once more the conceit of seed cultivators who mistake their direct interaction with the resource for the evolutionary transformative agent; dismiss any other form of human–environment interaction as irrelevant; and relegate its effects to the realm of non-human 'nature'.

Domestication as Metaphor

As just demonstrated with particular reference to the sago and babassu palms, the defining criterion of domestication is the transformation of a predator–prey relationship into a symbiosis through a coevolutionary process, involving taxa rather than individual organisms. Without this criterion, no domestication obtains in the biological sense, and any use of the concept can only be metaphorical. Such use is however common in the study of subsistence, and may indeed occur alongside the biological one, thus confusing already complex matters further. In particular, the following aspects of human–plant/ animal relationships are often considered domesticatory:

(1) <u>Changes of individual organisms under the influence of the relationship</u>.
These concern the ontogeny of the organism, not the phylogeny of the taxon, are therefore developmental, not evolutionary as domestication would require (cf. p.145).[164] Ingold apparently blended both concepts when he suggested:

> "Of an ancient tree that has presided over successive human generations it would seem more appropriate to say that it has played its part in the domestication *of* humans rather than having been domesticated *by* them." (op.cit.:86)

With a biological perspective, though, the concept of domestication cannot apply to individual trees. The converse scenario, of individual trees domesticating humans, may be unorthodox but is biologically valid in principle, although in practice it would require genetic change in the thus domesticated humans.

(2) <u>Certain facets of plant/ animal management</u>.
This is closely related to the previous, but focuses less on the respective organisms than on the corresponding human behaviour, emphasising:

a) <u>Deliberateness of action</u>.
This reading conceives of domestication as an active process, driven by human consciousness. As I have pointed out, though, neither do domesticatory processes depend on any consciousness on part of the agent (cf. pp.150ff.), nor is consciousness an ecologically relevant parameter at all (cf. p.126, n.121).

b) <u>Reproductive control</u>.
This reading mistakenly equates the process of domestication with one of the means potentially, though not necessarily, instrumental in it (cf. pp.151f., nn.144,157).

c) <u>Management</u>.
This reading expands the previous two and converges with the next, by substituting the concept of domestication for various forms of deliberate management, in particular cultivation or husbandry (cf. nn.94,162). Michon's (2005) notion of "domesticating forests" may represent a particular instance of this reading, referring less to management per se than to its evolution, thus providing a curious behavioural parallel to the biological concept. For example, Michon refers to the "emergence of domestication" and "adoption" of the

"domestication process" being variously driven by ecological, economic, and socio-political factors (op.cit.:161f.); and to the "evolution of local forest culture" as "a new paradigm for 'forest domestication'" (op.cit.:164).

d) Social and psychological integration of organisms with human communities.
This reading follows from the etymology and historical use of the concept of domestication, as denoting integration with the human household (cf. Harlan 1992:63; Leach 2003:356). In regard to animals, domestication then tends to be equated with 'taming' (cf. Harris 1996:451f.), seen as imparting to the respective organism qualities like docility, property value (Leach 2003:356) and personhood (cf. n.115; Harris loc.cit.). In regard to the wider environment, it may denote rendering "an area intimately known and spiritually safe" (Harlan 1992:63). It is likely this sense in which the sago palm and its habitat appeared ambiguously placed "between the wild and the domesticated" to Tuzin (1992:105; cf. 95; cf. n.162). Chase (1989) has been explicit, perceiving domestication as

> "a human social and cultural process relating to the structured knowledge by which individuals and groups agree upon a certain interpretation of the natural realm of plants and animals and carry out their routine daily actions on the basis of this interpretation" (op.cit.:47)

and

> "one facet of the people–plant equation, primarily a cultural phenomenon expressed in attitudes towards the natural environment, influencing routine economic activities and natural processes among species" (op.cit.:49).

In a similar vein, Terrell et al. (2003) have argued that domestication should refer less to the consequences of subsistence activities than to their performance (op.cit.:esp.325f.); based in turn on ethnobotanical knowledge and skill (op.cit.:esp.325,333f.,347). They have accordingly rejected symbiosis as the defining criterion of domestication, replacing it with the plain act of predation (op.cit.:esp.358). This reading, though, would at once make the concept of management redundant, while denying recognition to the coevolutionary dimension of human–environment interaction.

e) Environmental transformation.
This reading refers to precisely the aspect of consequences which Terrell at al. refuted, though emphasising ecological rather than evolutionary effects. Thus, Yen (1989) conceived of the extensive, if incidental, environmental changes effected by Australian hunter-gatherers as 'domestication of environment'. Chase (1989) and Groube (1989), writing in the same volume, labelled similar phenomena in Australia and Pleistocene New Guinea less contentiously as respectively 'domiculture' (presumably for its simultaneous lexical continuity and contrast with horticulture/ agriculture) and 'taming of the rainforests', the latter at once supplying the pertinent argument: "The 'Taming of the Shrew' is distinctly different from 'The Domestication of the Shrew'" (op.cit.:300). In fact, Yen (op.cit.:62) denied that individual taxa had been domesticated, which on the one hand he defined however non-biologically through deliberateness of action, while on the other hand his evidence of range extensions and improved productivity of resources under human management (op.cit.:59-61) indicates precisely that. Furthermore, he suggested "a form of group selection, in which the plant targets are aggregated as interbreeding units" (op.cit.:66), which may result in the collective domestication of the respective targets. Yen may therefore have labelled the described phenomenon correctly in biological terms but for the wrong

reasons, and may thereby have at once innovatively expanded the concept of domestication and contributed to its persistent confusion with management and its deliberate mode.

The coexistence of these various readings tends to be compounded by a tendency to mix them among one another and with the Darwinian concept of domestication. Examples are Roscoe's (2002:153) reflection "whether 'domestication' should mean breeding, nurturing, or both"—while in fact neither denotes domestication in the Darwinian sense, but the one reproductive control, the other indirect forms of plant management; Ellen's (1996a:14f.) amazement that according to one author "the conservation and regulation of 'wild' animals is essentially the same as domestication"—which it is not, since it refers to behaviour, not to its potential evolutionary effects; or Harris' (1989:15; 1996:443) conviction that Rindos' framework was so all-embracing that it could accommodate also the perspectives of Chase (1989) and Yen (1989). In fact, Yen's perspective differs from Rindos' once, referring to behaviour and its ecological effects, not to evolution; while Chase's perspective differs twice, referring to behaviour in terms of its motivational aspects rather than its ecological effects.

If such confusions are inadmissible, they are predestined by the multitude of idiosyncratic concepts of domestication. And therein lies their problem. It is not that the phenomena they describe were irrelevant for the study of subsistence. Quite the contrary. Appreciating their relevance, though, requires their conceptual separation from one another, and from domestication in the Darwinian sense. The latter has conceptually been well established since Charles Darwin (cf. Leach 2003:356), and should therefore remain the sole candidate to be thus labelled. Some authors feel that this perspective limits their potential to explore the cultural dimensions of human–environment interaction (e.g. Chase 1989:44,49f.). With this position, however, they expand less the catalogue of investigative approaches, than indicate that they have mistaken natural science for an alternative, rather than complementary investigative domain, and humans as solely ideational rather than also physical beings, and have thereby once again breached the bifurcation of anthropology.

Agriculture: Fixed-Field Cultivation of Seed Crop Domesticates

After this review of both cultivation and domestication, we can turn to the concept of agriculture, which is typically perceived as involving both, yet how precisely so tends to remain vague, as reflected by a corresponding variety and elusiveness of definitions. Explicit references are largely limited to dictionary entries (e.g. Shipton 1997:9; Seymour-Smith 1986:7), which emphasise the technical and cultural aspects of agriculture, referring to cultivation and domestication as subsistence attributes rather than as ecological and evolutionary relationships between humans and their resources. Rindos (1984), as a rare non-dictionary reference, has in contrast focused on these relationships, defining agriculture as a highly developed animal–plant symbiosis, involving environmental manipulation within a coevolutionary context (op.cit.:100,101). This definition is sufficiently broad to accommodate also symbiotic relationships between plants and non-human animals (op.cit.:e.g.94,101-112,256).

In between these two extremes ranges a whole spectrum of conceptions reflecting the confusion engendered by the fuzziness of the foraging–farming duality. Thus, some authors have tended to equate agriculture with any form of plant management involving cultivation (and/ or the employment of domesticates). This has led them to subsume also phenomena such as swiddening and arboriculture in titles like "The Agricultural Systems of the World" (Grigg 1974)[165], "The Adaptation of Traditional Agriculture" (Fisk 1978), "The prehistory of tropical agriculture" (Harris 1973), "Pleistocene agriculture in the Pacific: why not?" (Spriggs 1993), or "Early agriculture and what went before in Island Melanesia" (Spriggs 1996)[166]. In extreme cases, authors have—if implicitly—extended the concept of agriculture even to indirect, unspecific or indeed incidental management regimes, which accounted for much of the polarization in the calorie debate (cf. section 3.3.).

If they have all somehow equated agriculture with farming as the opposite of foraging, others have taken a more limited view of agriculture, recognising it as but one instance of farming. Thus, Harris has more recently (1989, 1996) presented agriculture as the ultimate step in the evolution of plant management, characterising it as the almost total dependence on domesticated crops, cultivated with large labour expenditure within agroecosystems (esp. 1989:17-fig.1.1,19; 1996:445-fig.15.1.). Occasionally, authors have vacillated in their perspective; for example Ellen (1994) alternated between agriculture involving or (oxymoronically) not involving environmental modification, with the far end of the scale taken by "minimal" management regimes (op.cit.:207 vs. 216)—a confusion possibly encouraged by Harris' earlier (1973) distinction of agriculture into transformative and manipulative forms (op.cit.:esp.394,399,405; cf. p.56).

In view of this anarchic situation, I suggest keeping to Rindos' definition regarding the character of the human-plant relationships involved (symbiosis), though narrowing it in line with Harris' understanding regarding the kind of management activities performed (cultivation [cf. p.144]), and with the lexical connotations of the term regarding the environmental conditions thereby generated (fixed fields)[167]. I further suggest an explicit reference to the seed culture-seed crop configuration, which is partly, though not necessarily, implied in the latter aspect, since this is a defining characteristic of the form of plant management which has served as the prototype for the concept (cf. pp.55f.,p.156). Hence, agriculture as an activity should denote the cultivation of seed crop domesticates, as subsistence form the substantial dependence on them (Rindos 1984:195,236; Harris 1989, 1996), always within the context of spatially fixed and repeatedly cultivated fields. Contra Rindos, therefore, it should denote only *one specific form* of a highly developed symbiosis between *humans* and plants.[168] Agriculture in this sense is, more precisely, fixed-field agriculture. If this has served Western scholars as the template for farming, it has introduced a greatly biased perspective to the study of subsistence. The following summary shall highlight how this bias arises from the conflation of several dimensions of subsistence and thereby obstructs analysis.

Summary: A Taxonomy of Human-Environment Interaction

As Ellen (1996d:103) noted: "We cannot think about the world unless we assign it to categories." This axiom applies similarly to the limited domain of subsistence. Here, scholarly thinking has long relied on the binary opposites of foraging and farming, and numerous conclusions have been based on this division, not least hierarchical and deterministic conceptions of human cultural evolution.[169] If the dualistic taxonomy suits a human propensity to think by means of contrast, it delivers however a skewed picture of the world, for it is doubly unrepresentative of real-life subsistence scenarios, as I have variously detailed in this section. On the one hand, foraging as the absence of human impact refers to an utopian construct, and therefore farming as its opposite to a universal phenomenon. On the other hand, the alternative notion of farming as manifesting human control over ecological and evolutionary processes refers either to a biologically irrelevant parameter or an illusion altogether: the intent which motivates behaviour remains in any case outside the remit of biological assessment, and in no circumstance is biologically effective itself (cf. n.121). Robert Dunnell (1991:39) has rebutted both beliefs in condensed form, when he commented that "[i]ntention is not empirical" and to assume otherwise was to "confuse cause-giving or scientific explanations with reason-giving or cultural explanations"—in other words: to breach the bifurcation of anthropology.

With the binary framework thus dismantled, what remains is an at once clearer and more comprehensive view of the actual processes of human–plant interaction, unobstructed by concerns about impact and intent and the attendant value judgements. On this basis, I present in Figure 6 (p.166) a synopsis which integrates the aspects addressed in this section in a partial[170] and preliminary taxonomy of the domain. This highlights that

- there are many more parameters (their taxonomic connections indicated by straight lines) than the simple duality between foraging and farming suggests, and that they interrelate in multiple and complex, not linear, ways (their functional connections indicated by dashed arrows).
- management (highlighted in medium grey) and coevolution (highlighted in dark grey) are distinct from each other, if connected via an organisms' demography (which spans both), while motivation remains external to either.
- agriculture (characteristic features indicated by black outlines) represents a composite category, with the defining variables drawn from several aspects and parameters of human–plant interaction.

Like agriculture, the subsistence concepts reviewed in chapter 3 refer to clustered phenomena rather than discrete taxonomic items. None of them can therefore usefully serve for any comparative or organising purposes. For the same reason, I consider it premature to assume the historical transformation of such or similar phenomena unilineally into one another (cf. Harris 1989:16-22; 1996:444-447)[171]. And I believe it is wholly invalid to postulate their historical emergence from cultivation and/ or domestication (ibid.). After all, the latter represent not analogues, but constituent elements of the former, and hence refer to a conceptually different and therefore fundamentally noncomparable category.

Indeed, I would hold that it is invalid to postulate cultivation (a type of management) and domestication (a coevolutionary process) themselves as sequential (ibid.). Biologically speaking, domestication is of course a function of management, which though need not assume the form of cultivation. As Rindos (1984) has convincingly established, domestication may very well proceed without cultivation or any management regime other than pure harvesting, in line with evolutionary theory and contra the assertions of Harris and others (cf. p.148 and nn.138,139 above). Some management regimes certainly speed up domesticatory processes (if only for the taxa suited to them); equally, though, certain domesticatory relationships engender specific management regimes.[172] Cultivation and domestication are therefore mutually dependent to some extent and hence may tentatively indicate each other.[173] They are, however, neither identical, nor occur necessarily together, nor conversely in any particular sequence.

Basically, cultivation and domestication refer to different dimensions of human–plant interaction, and therefore may principally combine in any way whatsoever, both in time and space. Nina Etkin (1994:3) made precisely this point when she observed:

> "cultivation... is defined by human activities, while domestication refers to the genetic response[174] of plants to human action: thus wild plants can be cultivated, and cultivated plants may not be domesticated."

Conversely, domesticates may not be cultivated, and with both conditions standard in Melanesia (cf. pp.104,152), Tim Ingold (2000:85) noted:

> "The forests of Highland New Guinea are full of wild domestic pigs, as well as a variety of plants that also appear in cultivated swiddens."

Ingold attributed "the source of these anomalies" to the duality between foraging and farming itself, which in turn he challenged on ontological grounds (see section 4.6.). More specifically, though, these anomalies stem from illicitly conflating the two distinct concepts of cultivation and domestication into that of (agricultural) farming, and then inappropriately using this as the template for gauging forms of subsistence in which both do not likewise occur jointly or in similar manifestations.

The complexity of any analysis increases further through the circumstance that cultivation/ management and domestication/ coevolution refer not only to different dimensions of subsistence, but are themselves continuous rather than categorical. Again, Melanesian ethnobotany illustrates the point, as the variety of scenarios is heightened by the frequency of semi-domesticates (cf. p.154) and the profusion of ambiguous management regimes, which span a range from incidental, through unspecific, to indirect encouragement (cf. Table 9 [p.140]), and indeed vary within single taxa and over the lifetime of individual plants (cf. sections 3.5., 3.6.).[175]

In fact, management is less a continuous than fully polythetic concept as described by Rodney Needham (1975; cf. also Ellen 1996d:104). That is, it classes facts (here: human activities and their environmental effects) which are linked through serial likenesses rather than discrete attributes (op.cit.:esp.351,355f.). To a lesser extent, the same applies to the more limited concept of cultivation, which though in its casual substitution for management at once takes on the latter's complexity. Management, in turn, as a necessary component of human-environment interaction at once imparts its polythetic character to any derivative concepts not explicitly defined by discrete attributes. Polythetic concepts, though, are difficult to impossible to compare, as Needham observed (op.cit.:358), and attempts to do so within monothetic taxonomies "are likely to be defective and unproductive" (op.cit.:365). This complication adds to the argument that the composite character of the typical subsistence concepts must discourage their comparison.

Comparison becomes only possible when these concepts are broken down into their component parts. What Needham (op.cit.:362) observed for a social anthropological context applies similarly in the context of human ecology:

> "In the study of social facts what is needed is not a convenient technique for cutting down the number of variables, but a means of accommodating as many as possible."

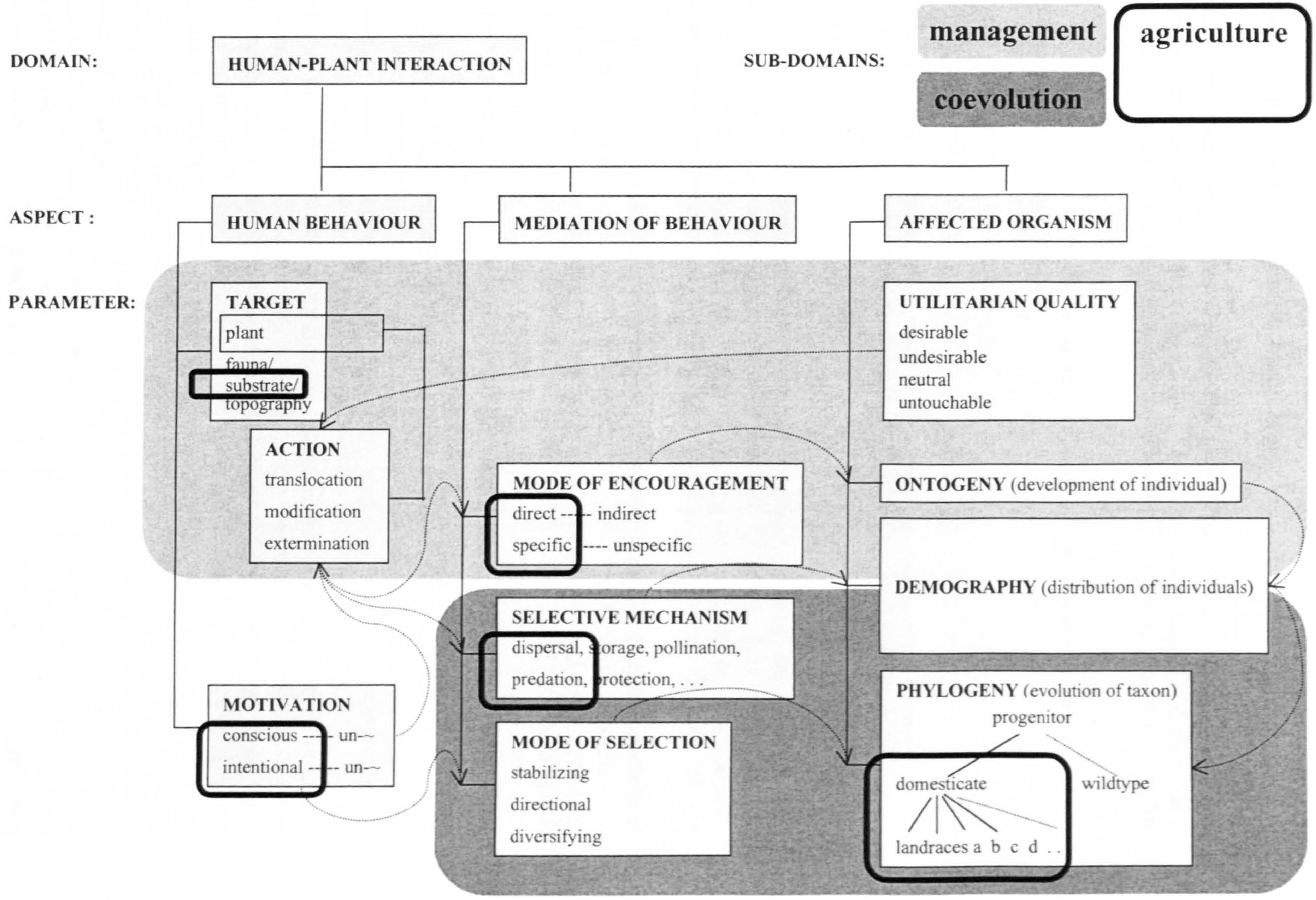
Furthermore, these component parts must conform to universally valid propositions, so-called 'basic predicates' (op.cit.:365f.), which through a "radical style of abstraction" (op.cit.:365) provide a single idiom for the description of all the concepts to be compared. I suggest that the 'primary colours' which I have distilled for plant management offer precisely that (cf. pp.138ff.).

There remains, nonetheless, the continuous character of many of these predicates, and of parameters such as in particular domestication. The continuum often claimed to stretch between foraging and farming lies therefore in fact with the component elements of the latter. In any case, there is no discontinuity in the entire spectrum of subsistence attributes which could reliably separate subsistence forms from one another and organise them systematically. The categorical difference of foraging is utopian; the contrasting poles within management and coevolution represent but extremes of multi-dimensional spectra; the presence or absence of specific parameters is either illusive or inconclusive.

The problem arises from confusing the taxonomy of human–plant interaction with the taxonomy of subsistence forms. The former organises ecologically and evolutionary effective processes (as discussed in this section and represented in Figure 6), the latter phenomena known by labels such as 'agriculture', 'swiddening', 'agroforestry', and so on (as discussed in chapter 3). While the processes classed in the former *underlie* the phenomena classed in the latter, they *do not determine* them in any straightforward way. Rather, it is the fashion in which the processes are functionally connected which shapes and characterises the phenomena. The significant configuration lies therefore with organising principles, not with organised parameters. To assume otherwise is to confuse pattern with system (cf. Ellen 1982:258).

I will return to these ideas in section 4.8. There, I propose a new model of subsistence for human ecology, which I apply subsequently to the Krisa case in chapter 5. Before I take up the systemic approach, though, I will in the next section resume the search for a meaningful discontinuity, which as it turns out lies with quite another dimension of human–environment interaction than the foraging–farming divide suggests.

Figure 6: A Taxonomy of Human–Environment Interaction



4.6. Clarifying Production: The Fantasy of Creation vs. Subsistence as Process

Foraging:Farming as Procurement:Production

The duality between foraging and farming has often also been conceptualised as one between procurement and (food) production.[176] Thus, the 'Encyclopedia of Social and Cultural Anthropology' (Barnard & Spencer 1996) states under its glossary entry for 'agriculture':

> "In its widest sense, the production of food, as opposed to the procurement of food from the wild." (op.cit.:595)

Barfield's 'Dictionary of Anthropology' devotes an entry to the notion of 'food production' itself, opening:

> "food production began more than 10,000 years ago when broad-spectrum procurement was supplanted by the domestication and cultivation of edible plant and animal species in many parts of the world..." (Messer 1997:196 [referring to various sources])

It continues to list permanent cultivation as complete reliance on farming, and swidden cultivation as involving a residual level of foraging, thus suggesting an incomplete correspondence between foraging:farming and procurement:production, consonant with the widespread uncertainty regarding the precise division of the former.

The notion of production in regard to human-environment relations goes back to Karl Marx and Friedrich Engels, who claimed it as a feature distinguishing humans from animals, with Engels limiting it implicitly to societies who had risen above the state of 'savages' (Ingold 1979:274f.,277,282f.; 1996:146; 2000:77f.; also Cook 1973). The archaeologist Gordon Childe then explicitly correlated production with 'neolithic' approaches to subsistence (viz. farming)[177], in contrast to 'palaeolithic' ones (viz. foraging) (Harris 1989:13; Ingold 1979:277,281; 2000:78). Subsequently, other archaeologists labelled the latter as procurement (Harris 1989:13), a term adopted later independently by Nurit Bird-David to characterise the particular behavioural, social and cosmological aspects of hunter-gatherer subsistence (Ingold 1996:148f.; cf. p.30). Recently, David Harris (1989:17-fig.1.1, 20; 1996:444-447) has limited the meaning of both concepts to human activities, as distinct from the domesticatory status of the resources targeted, while introducing a threefold division of subsistence forms. Thus, he separated 'wild plant food procurement' from 'wild plant food production', and this in turn from 'crop production' (1996) or cultivation/ agriculture (1989). His scheme therefore assimilated at once the awareness that cultivation and domestication refer to two distinct processes, and the growing recognition of 'grey areas' in human–environment relations and corresponding proposals of a continuum (cf. 1989:12-16; 1996:442-444). If its tripartite design reminds of more common schemes with an intermediate third element (cf. e.g. Messer as quoted above; also various authors quoted in section 4.1.), it arises though from correlating two dimensions of human–environment interaction rather than combining variants of the same dimension.

The duality proffered by Engels and boldly profiled by Childe has therefore been up to some negotiation regarding its meaning and precise delimitations. Yet, its dichotomous essence remains and has served to reinforce the utopian division of humanity (see section 4.4.).

Human–Environment Relations as Production

The notion of production occurs, however, not only with binary conceptions of human–environment relations, but at once with the search for their universal attributes—much as the notion of culture the opposite of nature variously denotes a divided humanity and one united in its uniqueness vis-à-vis all other species. This dual perspective on production may have been preformed by the ambiguous stance held by Marx and Engels (cf. p.167). The actual link of their theories with subsistence studies, though, seems to have been more oblique and mediated primarily by their economic models.

These involve a concept of production appropriate for economic investigations, which though becomes confusing with ecological investigations. For sure, production as the generation of goods from natural resources (Cook 1973:30f.) indicates a point of articulation between both, which share such pertinent concerns as the appropriation and use of energy and materials, application of technology, control over resources, organisation of work, and division of labour (cf. Cook 1973:39f.; Ellen 1982:278f.). Hence, Ellen (1982:278) suggested:

> "The focus on production brings together both ecological and economic approaches, and emphasizes their essential complementarity rather than their antagonism."

Yet, students of subsistence have time and again mistaken this complementarity for similarity and have consequently recast economic production in ecological terms, as 'food production'. This operation has resulted in imprecise and indeed paradoxical meanings, compounding the confusions attaching to the foraging–farming duality, and perpetuating the utopian division of subsistence forms despite universalist aspirations.

The respective contradictions emerge when we scrutinize the economic concept of production for its implications in terms of human–environment relations. A brief selection of quotes shall outline the topic. Thus, production has been described as "the transforming reaction of man on nature" (Ingold 1996:146, quoting Engels 1934:34)[178]; "the process whereby the world is engaged and transformed by human labor" (Keesing 1981:178) and "the process by which the members of a society appropriate and transform natural resources to satisfy their needs and wants" (Cook 1973:31). The labour component has been described as "the socially patterned way humans relate to the environment to obtain energy to reproduce society" (Plattner 1989:381); "a creative activity in which humans interact with nature... in order to produce something useful" and "an active, conscious process through which both the laborer and the object of labor are transformed" (Roseberry 1997:325f.). Collectively, these references delineate production as a socially mediated process driven by human labour, which engages an entity variously conceived as 'the environment', 'nature', or 'the world' for the ***intentional, transformative and creative appropriation of energy and materials***.

The like interest of subsistence studies in the engaged entity may suggest the convenient transfer of the concept, an operation which though in practice is fraught with complications. To begin with, the central element of the economic concept, namely 'appropriation of energy and materials', can represent human–environment relations only partly, while lacking the organising function sought after. Thus, it must on the one hand be considered a necessary and universal human activity, which removes its potential to categorically divide forms of human–environment interaction. On the other hand, the exclusive reference to this activity ironically eliminates both the better part of human–environment relations in general, and cases which are conventionally deemed 'productive' in particular. As for the 'intentional, transformative and creative' aspect, this may either reinforce the void or fill it with confusion. Thus, it may be considered in reference to the generation of goods, which retains its economic meaning. The respective overall interpretation of production both agrees with and complements the economic definition, thereby matching Ellen's (1982:253f.) dual characterisation of human ecological systems:

> "There are... two fundamental processes underlying the ecology of human social systems: (1) the appropriation of materials from the environment, their alteration and circulation through social relations; and (2) the according of such materials with value which in turn affects the dynamics of the objective process of appropriation, alteration and circulation."

This reading excludes, however, any references to human–environment interaction beyond appropriation itself, in particular its environmental effects or prerequisites. These concerns are addressed by the more common reading, which considers the 'intentional, transformative and creative' aspect in reference to the entity conceived as 'the environment', 'nature', or 'the world'. If the respective assertions are adequate and permissible in economic terms, though, they are no longer so in ecological terms. For, whereas the former address the generation of goods from resources, the latter address the generation of these same resources themselves. Any transfer of the economic concept of production can therefore only be metaphorical. Otherwise, it involves the very misconceptions I have tried to dispel in the previous section: the utopian notion of zero impact and the illusion of control. In fact, it involves an even more obscure one: the fantasy of creation. I will deal with these in turn, with reference to the various scenarios which the ecological misreading of economic production may entail.[179]

To begin with, the economic concept of production includes three distinct notions: intent, transformation, and creation. In regard to human–environment relations, the notion of transformation may in turn apply to either of three entities, corresponding to the three dimensions I have explored in regard to the impact of foraging (cf. pp.136ff.): the utilised environment, the utilised species, and the utilised organism.

As I have demonstrated, transformation of the environment is inevitable, whether intentional or not. It can therefore serve as little as a criterion to distinguish 'productive' from 'unproductive' forms of human–environment interaction, as it can characterise human–environment relations in general as 'productive'. Humans do exhibit an unprecedented capacity for environmental transformation, viz. niche construction (cf. n.131), which may set them apart from other animals, but in a qualified rather than absolute way. Similarly, this capacity may be realised unequally across subsistence forms, but parameters are continuous and criteria contingent on perspective (cf. pp.128,162ff.). Hence, there are no categorical discontinuities regarding environmental transformation between either animal and human subsistence, or between various forms of the latter. Nor is such transformation dependent on intent, as the concept of economic production would stipulate.

If Engels (Ingold 1979:282f.) asserted either, he was similarly misled by appearances as are contemporary students of subsistence, who may have as much inherited Engels' error as erred independently. After all, they but express the same conviction, deeply embedded in Western thought and rooted in the experience of agriculture, of a fundamental discontinuity between humans and the tangible world; a consequent one between a transformed and a pristine environment; and ultimately one between transforming and non-transforming human groups. The error lies in recasting this conviction, which provides meaning within an agricultural folk model, as a scientific axiom accounting for ecological processes (cf. Dunnell 1991:39—quoted on p.163), and hence, once again, breaching the bifurcation of anthropology.

The same error underlies the notions of production as the transformation of species in the process of domestication, and of organisms in the process of management. As I have demonstrated in the foregoing section, domestication is contingent, processual and principally independent of intent; while management is continuous and universal. Like environmental transformation, both therefore lack reference to a categorical discontinuity, as well as disagreeing with the economic concept of production in regard to intentionality.

If the notion of 'food production' as a premeditated and specifically human or non-forager achievement is therefore erroneous, it is deeply entrenched. Indeed, its persistence draws on a belief beyond that of intentional transformation, which though it nurtures. This is that such transformation not only indicated categorical differences among forms of human–environment interaction, but achieved itself categorical change in the transformed entities—that it was creative. That is, that beyond the rearrangement of an entity's component elements a new entity was generated, hence a new conceptual and/ or ontological plane attained. In the economic sense of production, this shift obtains with the transformation of resources into goods through fabrication and ascription of value. The categorical difference between both stages is indicated by the different terms used, indicating in turn a categorical difference between humans, who engage in the respective activities, and other animals, who do not (but cf. Ingold 1979). In the ecological sense, though, no such categorical difference obtains, either in terms of the object matter involved, or the subjects engaging with it. For, any comparable shift would have to refer to the transformation of some substrate into the very resources then economically transformed into goods (cf. n.179). The transformation of organisms into resources through ascription of use values (cf. Ellen 1982:252f.) may satisfy this condition in economic terms. In ecological terms, though, there is little capacity for humans to intervene creatively. The assimilation of ideas and inanimate matter for the creation of organisms, analogous to the creation of objects, remain human fantasies.[180]

That the creation of organisms and of objects follows fundamentally dissimilar principles is graphically illustrated in a parable by the Sophist author Antiphon (retold by Ingold 2000:81 [following Vernant 1983:260][181]), of

> "an old wooden bed, buried in the ground, taking root and sprouting green shoots. What comes up, however, is not a new bed, but fresh wood! Beds are made, but wood grows."

And yet, recognition of this obvious difference is eclipsed by an enduring belief to the contrary. It finds support in the terminology used, and expression in the assertions made. A prominent example for the former is the verb 'to grow'. In its intransitive form, as used in above quote, it appropriately illustrates the lack of human participation in the growth process. In its transitive form, though, as used regularly in subsistence studies (cf. p.144), it suggests the opposite. Clearly, the notion of 'growing plants' can only be metaphorical, considering that plants grow by themselves, not by human action. Yet, the curiously dual meaning of the word permits an implicit cognitive substitution of the one with the other, thus imperceptibly blending the reality of plant development with the fantasy of creation (cf. n.179). This fantasy becomes manifest in such assertions as

> "*Homo sapiens* is the only species which has evolved techniques for producing its own [means of] subsistence non-genetically, by directly manipulating and transforming the physical environment through organized social activity." (Ellen 1982:91; cf. Cook 1973:42)

With this statement, Ellen but echoed the conviction of many contemporary students of subsistence. Indeed, he but phrased an ancient theme in modern terms. As Alfred Crosby (1986:23) reflected in reference to the Neolithic Revolution in the Middle East:

> "The poet or poets who wrote the book of Job were very impressed with the horse... Jehovah claimed full credit for the horse for himself, asking poor Job: 'Did you give the horse his strength? Did you clothe his neck with a mane?' Job did not answer, knowing a rhetorical question when he heard one, but he might have offered the thought that humanity had done something that, practically speaking, was almost as impressive as creating the horse. Humanity had tamed it."

As Crosby annotates the divine rebuke, he at once traces its genesis in human presumption. Yet, in endorsing the attitude by extolling the act, he commits the sin once more, thus assuring continuity between the posture registered by the ancient poets and that taken by himself as heir to the ancient tradition. He may credit *farming* humanity as semi-divine upon the achievement of 'taming'—a concept by which he ingeniously if somewhat sketchily subsumes both domestication and cultivation/ husbandry—but the little adverb 'almost', which accomplishes this glorification, at once exposes the triumph as hubris.

If the claim of creation is an illusion, precisely its hidden transcendental pretensions may ensure its permanence, as it becomes at once sacrosanct and inaccessible to scientific scrutiny. Yet, it is challenged by the very forces of life which it presumes to control. As the processes of growth and reproduction outdo any human involvement, it is they who prove truly creative. From the conflict between fantasy and fact then arises the cognitive uncertainty which manipulation of organisms produces, and which the cases of perennials and semi-domesticates magnify, by dwarfing the role of human agency in the unfolding of organisms and species (cf. sections 3.5. and 4.5.).

Two Distinct Concepts of Production

In fact, the role of humans in the processes of life is not productive but destructive. While humans do not create organisms within their subsistence activities, they do kill them, and necessarily so.[182] And it is this switch from an animate to an inanimate condition which marks a fundamental conceptual boundary in the realm of human-environment relations. As I will demonstrate, its concealment engenders precisely the confusions about the creative capacity of humans which mars the notion of 'food production'.[183] In contrast, its acknowledgment contributes to clarification, by permitting to separate life processes from human actions, and hence to differentiate between two principally distinct, though regularly conflated, concepts of production: ecological and economic.

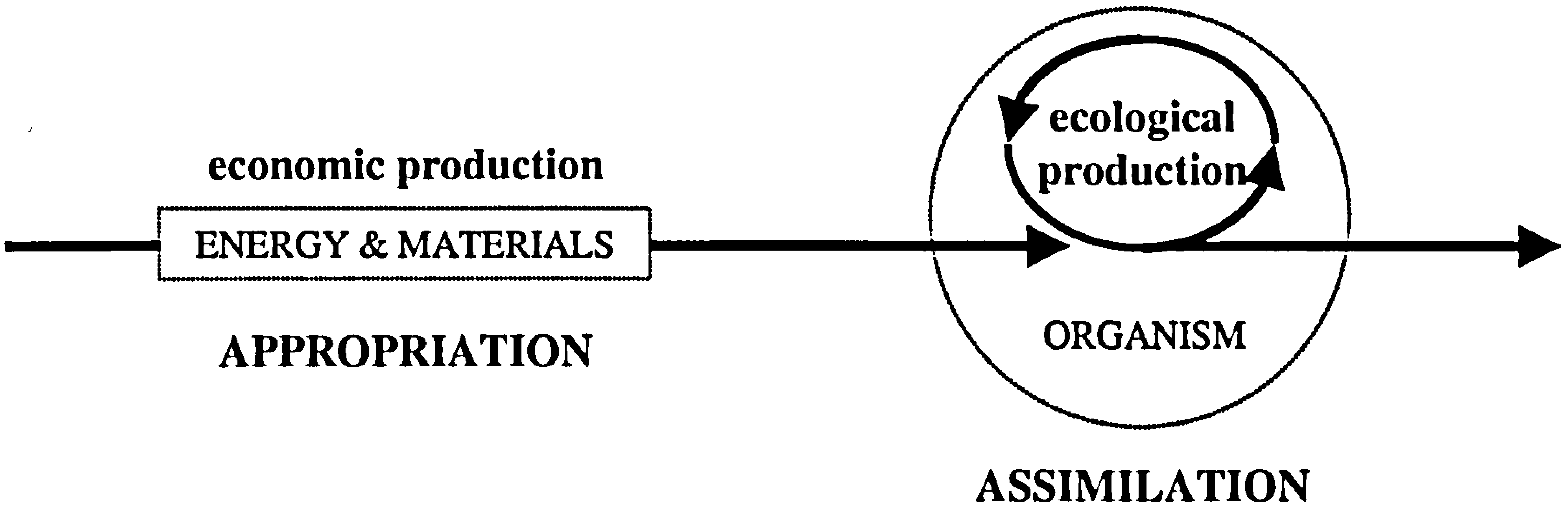
Their relationship was explored by Ingold (1979:275), who recapitulated suitably:

> "Ecological production refers to the thermodynamic process whereby energy from the sun fuels the creation of organic material in Nature. Economic production, on the other hand, refers to the expenditure of labour... in order to obtain from Nature the means of subsistence."

Thus, economic production describes the (intentional, transformative and creative) appropriation of energy and materials from the environment, as detailed earlier. Ecological production, on the other hand, describes the assimilation of such energy and materials through internal metabolic processes, thereby sustaining the organism's growth and reproduction. For autotrophic organisms ('self-feeders': in particular green plants), it typically proceeds as photo-assimilation, that is, the conversion of inorganic to organic matter on the application of sunlight. For heterotrophic organisms ('other-feeders': in particular animals), it involves the utilization of such organic matter and thereby the energy and materials bound in it.

For one and the same organism, economic production (appropriation) logically precedes ecological production (assimilation).[184] Conversely, ecological production by one organism precedes economic production by another organism which feeds on it.[185] (Figure 7 provides a graphical representation of the involved relationships.)

Figure 7: Economic and Ecological Production



Indeed, the act of feeding terminates ecological production in the food-providing organism and commences it in the feeding organism. In Ingold's words,

> "we might regard the action of the hunter in throwing his spear as functioning to 'switch off' a process of ecological production in the game, and his action in processing and eating the meat as functioning to 'switch on' a process of ecological production in his own body" (op.cit.:276).

The same relationship was not lost on Marx, who observed in an entirely analogous fashion—as paraphrased by Cook (1973:32)—that

> "production implies consumption in the sense of using up the means of production just as consumption implies production in the sense of the nutritive process through which men consume foodstuffs so as to, in effect, produce their own bodies".

Whether viewed with an ecological perspective, following Ingold, or with an economic one, following Marx, subsistence therefore involves two "autonomous but complementary" (Ingold 1979:276) spheres of productive activity—which apply indeed not only to humans, but to all organisms (cf. n.184).

More precisely, these spheres are articulated in a trophic relationship in which one organism produces (i.e. assimilates) organic matter, which is subsequently produced (i.e. appropriated) as sustenance by another. What subsistence does *not* entail—but what the notion of 'food production' wrongly implies—is a conflation of both forms of production in the sense that the appropriating organism would have been the agent also in the preceding process of assimilation. Whatever Roy Ellen therefore meant when he asserted the 'non-genetic production of subsistence' as a capacity of *Homo sapiens* (cf. p.171), taken literally this is an absurdity, implying the generation of human sustenance without the involvement of any other organisms.[186] In biological terms, this would mean the synthetic mass-production of organic matter which humans are fit to assimilate, or indeed the genetic engineering of humans themselves with the faculty of photo-assimilation!

Summary: Appropriation, Transformation, Creation, and Process

If we therefore want to conceptualise human–environment relations as production, we are faced with a number of dilemmas. Either we understand production in line with the economic concept, and thus literally as the *appropriation of energy and materials from the environment.* This reading reduces subsistence to an economic and appropriation-related phenomenon, disregarding at once its ecological dimension and its better part. It also obliterates any reference to the foraging–farming duality. The second option is to keep with this duality and understand production metaphorically, as the *transformation of environments, organisms, or species.* This reading runs largely counter to the meaning of economic production as appropriative. Furthermore, though, it refers to an ecological commonplace, thus contradicting its very assertion of human uniqueness in particular or general. Besides, its implicit reference to intent is both ecologically meaningless and empirically obscure. If it ultimately relies on a notion of *creation,* this constitutes a fantasy suggesting that (some) humans could master the categorical forces of life. In fact, these forces permeate the affected organisms, not human acts, which in turn can categorically accomplish but extermination.

'Food production' is therefore a polysemous concept which blends economic, ecological and folk models of human–environment interaction. If such amalgamation makes it ineffective as a conceptual aid, its disaggregation highlights that the imaginary contrast between foraging and farming is cross-cut by an actual contrast between ecological production/ assimilation and economic production/ appropriation, and, more broadly, between the respective events affecting either the one or the other. This contrast typically manifests in a temporal sequence, as between events occurring during a resource organism's lifetime and events leading to and following its death.[187]

The fundamental division in the field of subsistence lies therefore not with different approaches to making a living, but with the consecutive steps integral to it. This change of perspective at once introduces the notion of *process,* where the foraging–farming divide has been concerned with status, and hence stasis. Recognizing that subsistence is a sequential affair then opens the way for a diachronic treatment of various subsistence phenomena, particularly important where long-lived resource organisms are involved.

Postscript: The Elements of the Subsistence Process

The processual perspective on subsistence reveals that plant management, which constitutes a single biobehavioural domain (cf. pp.138ff., esp. Table 9), is empirically sequential. Thus, harvesting pertains to appropriation, while any other activities occur prior to appropriation and may be subsumed as maintenance.

If both are conceptually equal, empirically their relationship varies. Harvesting is clearly integral to any form of subsistence; maintenance, however, is facultative, although in practice its total absence is unlikely, since acts like seed drop, storage or clearing are practically universal and need not be deliberate to occur. Whether present or absent, these acts are of course distinct from the incidental effects of harvesting itself, which obtain in any case and thus disqualify the notion of foraging as zero-impact scenario (cf. section 4.5.). An alternative definition of foraging, though, as the absence of maintenance activities, i.e. plain harvesting, and its contrast with farming as their presence is conceivable and would correspond to the above noted categorical discontinuity between assimilation and appropriation. Indeed, this definition likely supports its illusive counterpart, by implicitly suggesting that lack of maintenance meant lack of impact.

If the feasible reading seems to rescue the foraging–farming duality after all, it comes with a number of difficulties. Firstly, farming in this sense represents no real opposite to foraging (harvesting) but rather an additive (+maintenance), hence entails more variables. The dualistic scheme, though, tends to obscure this, thus conflating once more the two stages of subsistence and obliterating any potential gains of contrasting foraging with farming in redefined form.[188] Furthermore, there is the tendency to empirically establish this contrast by proxy, in that activities get identified by the modes in which they are performed. Thus, a casual and sporadic approach to harvesting is typically taken to imply foraging, i.e. absence of maintenance, while the converse goes for an organised and regular approach. This conception transpires equally in lay accounts (cf. pp.19f.) as in scholarly works such as Ellen's (1988) discussion of Nuaulu subsistence. Both the conflation of maintenance and harvesting, and the further correlation of the respective activities with their modes of action have effectively conspired to prevent the recognition of long-term systems of land use, such as I will describe in detail in chapter 5.

Secondly, the categorical discontinuity of the redefined contrast between foraging and farming which obtains in conceptual terms does not really manifest empirically. On the one hand, the above noted universality of particular maintenance acts renders foraging, again, rather hypothetical—if here not in principle, so largely in practice. On the other hand, the continuity of the various maintenance parameters would anyway mark out foraging and farming but as complementary poles of a—multi-stranded—continuum. Yet, the principal distinction between both stages would permit their relative quantification, and thus a weighing of one against the other. Since all involved parameters refer to human activities, labour could serve as a universal variable to measure and compare them. This is in contrast to the fundamental impossibility of applying quantification measures with the more complex version of the foraging–farming duality (cf. p.165) and consequently of quantifying environmental manipulation, whether in terms of transformed environments or the resources obtained from these (cf. pp.128,135ff.). Despite its feasibility in principle, though, identifying management forms as either foraging or farming according to relative labour values is little meaningful, since thereby the relationship of the various activities to each other remains obscured.

Attempting to align the foraging–farming duality with a sequential conception of subsistence causes therefore more problems than it solves, providing the final argument against employment of the two concepts. If anything, farming and foraging represent two consecutive steps in the process of subsistence, rather than two distinct approaches to it. These steps, though, are sufficiently, appropriately and unambiguously captured by the concepts of maintenance and harvesting, which I therefore suggest should be employed only. Yet, they alone are insufficient to describe the subsistence process in its entirety, whose ultimate purpose is, after all, use. Use completes the trophic relationship between humans and their resources, whether in form of actual assimilation or external conversion of energy and materials (cf. n.185). I will examine this final stage of the subsistence process in more detail in the next section.

4.7. Clarifying Resources: Man Shall not Live on Food Alone

Resources form the connective element in the sequence just outlined, and constitute the central purpose of subsistence activities. Thus, they provide at once practical sources of sustenance and analytical points of reference for assessing pre- (maintenance), para- (harvesting), and post-appropriation (use) events. I shall deal with either aspect in turn, developing in the process a methodology for apprehending the material aspects of subsistence.

Defining Sustenance

For my purposes, 'sustenance' shall refer to all material means of survival, whether food or non-food. It therefore encompasses the entirety of resources, employed for uses ranging from food, through fodder, fuel, manure, medicine, or magic, to the sweeping category of material culture: shelter, furniture, household equipment, kitchen utensils and tableware, tools and weapons, personal attire and body adornment, grooming implements, toys, art- and ceremonial objects, musical instruments, and so on, including ephemeral items which are discarded after single use, such as food wrappers, paint mixing dishes, or garlands and body decoration from fresh plants.

This comprehensive view of sustenance considerably expands that prevalent in subsistence studies. On the one hand, human ecology has its utilitarian focus principally trained on food uses and the respective resources, at the expense of any others.[189] Partly, this may be a function of the overwhelming importance of food for human survival.[190] Partly, it may stem from an uncritical transfer of animal models to the study of human subsistence in the ecologization of anthropology, oblivious that feeding may just about describe resource use by animals but not by humans (cf. sections 4.3, 4.4.). Partly, it may follow the subsistence orientation of the investigators, whose typically Western, modern, urban, and principally agro-pastoral backgrounds tend to limit their perception of resource uses.[191] Ethnobiologists, on the other hand, tend to assume a broader view, including in particular resources used for medicine, and occasionally magic, fuel, fibre, fodder, or manure. This broadened interest in resources, though, typically accompanies a reduced interest in subsistence at large, thus disembedding resource use from its subsistence context and diminishing its respective analytical potential. In any case, the food bias tends to remain, causing a corresponding analytical bias, as evident with the utilitarian classification of perennials in general and the sago palm in particular (cf. sections 3.5., 3.6.). Uses which manifest in comparatively permanent forms continue to be sidelined altogether (exceptions see below).

Material culture studies, on the other hand, which deal with precisely these permanent forms, tend to ignore their physical basis. Anecdotal evidence suggests to me that students of such subjects as archaeology and history readily draw a connection between artefacts and resources. Anthropological colleagues, however, have repeatedly been mystified at my suggestion alone that material culture involved *materials*; a further correlation of these with environmental *resources* seemed totally inconceivable. Clearly, artefacts to them are more representations than manifestations, which in turn privileges not only material culture collections from areas with spectacular tangible and intangible forms of expression in general (cf. p.5), but attention to items with esoteric value (masks, ancestor figures, cult objects, etc.), distinct artistic expression (carvings, body adornment, etc.) or cultural salience (netbags, canoes, etc.) over everyday, mundane ones (shelter, utensils, etc.) in particular, thus additionally skewing any potential resource samples.

This trend is widely reflected in the literature. Where, exceptionally, artefacts are linked with resource use, they serve not as instances of use, but as media representing it (e.g. Emboden 1995). Where, in contrast, artefacts are specified with their material composition (e.g. "wood with shell", "rattan and pigments"), this serves, in museological fashion, to identify them rather than their material origins (e.g. Meyer 1995). Correspondingly, Yen (1985:315) has noted: "Symptomatic of the neglect of wild plants in Oceania are the problems of identification of artefactual raw materials in ethnological collections and from archaeological sites." Where, indeed, these materials are identified, even botanically, this tends to provide but background information for basically technical-symbolic (e.g. Lemonnier 1993) or technical-cognitive (e.g. Ellen 2004a) treatments, although the concern in these cases with mundane objects (eel traps and sago processing equipment, respectively) expands the scope of items typically investigated. Where, unusually, the ethnobotanical examination of mundane objects has been foregrounded, this has emphasised material composition (e.g. Sillitoe 1988); has highlighted utilitarian aspects (e.g. Obrist 1987; Wronska-Friend 1993; also Balick & Cox 1996:chpt.4); or has integrated both concerns (Powell 1976:150-174), without equal attention, though, to the environmental origins of the utilized resources and thus the wider subsistence context.

Indeed, a comprehensive assessment of material culture with this view has rarely been attempted. Jocelyn Powell (1976) complemented her detailed ethnobotanical descriptions with environmental observations, concentrating however on the historical origins of presently used plant resources (op.cit.:175-181) and broaching the issue of actual plant management only in passing (op.cit.:175f. and passim). Manuel Boissière (1999) limited on the one hand his ethnobotanical descriptions of material culture to construction and traditional attire (op.cit.:part3), which on the other hand he related to management practices and their environmental effects (op.cit.:parts2,4) only in general terms (op.cit.:395-397). Harold Conklin (1957:74-87) emphasised food- at the expense of technological uses, despite inclusion of the respective information, but did relate these specifically to the resources' planting data (op.cit.:esp.78ff.-tbl.9), thus providing an embryonic exploration of the link between resource use and management. William Balée (1994) has expanded on this link by complementing detailed descriptions of artefactual resources use (op.cit.:chpt.4) with inventories of plant resources in various anthropogenic environments (op.cit.:chpt.6), and by correlating present strategies for resource use with past environmental manipulation (op.cit.:chpt.8). Although he therefore demonstrated a functional connection between use and management, he considered this as principally opportunistic—a perspective which seems well justified in regard to a historical scenario (op.cit.:217-222), but much less so in regard to a self-reproducing contemporary one (op.cit.:esp.160,163,165). Christin Kocher Schmid has, exceptionally, highlighted the purposeful character of such a connection, by profiling the link between utilitarian and floristic diversity (1998, also 1991), and the interrelatedness of selected artisanal practices and management strategies (2004; n.d.; cf. also n.124). As far as I can judge, her work thereby provides the most relevant example to date—at least for the Pacific region, if not universally—for an integration of information on use and management. There are as yet no studies which explicitly identify material culture as a research tool for sampling resources and thereby exploring subsistence more generally—which is what I propose and will further detail below.[192]

An academic division of labour has thus effectively eclipsed the material aspect of the human condition. True to the nature–culture duality, its exponents have treated humans as either prototypical animals or disembodied persons (cf. Figure 3 [p.124]), neglecting the intersection between both and thereby ignoring that *Homo sapiens*, the thinking animal, is at once homo faber, the toolmaker. The biblical quote entitling this section may refer to the spiritual needs of humans, but food neither satisfies their physical nor psychological needs. Much as physical needs are not reducible to feeding, so are psychological needs not reducible to symbolic expression, whether related to food or other aspects of human life. Both manifest also in the desire to transform and utilise materials, whether it be foodstuffs through cuisine, or raw materials through construction work and artisanry. Clearly, the dichotomous scheme that separates human beings from being human (cf. sections 4.3., 4.4.) fails not only certain forms of subsistence, but also certain aspects of it. I propose to transcend this limiting division by introducing a concern with materials to material culture studies, and a concern with material culture to subsistence studies, thus highlighting artefactual use of resources as a valid and necessary area of inquiry.

Assessing Sustenance

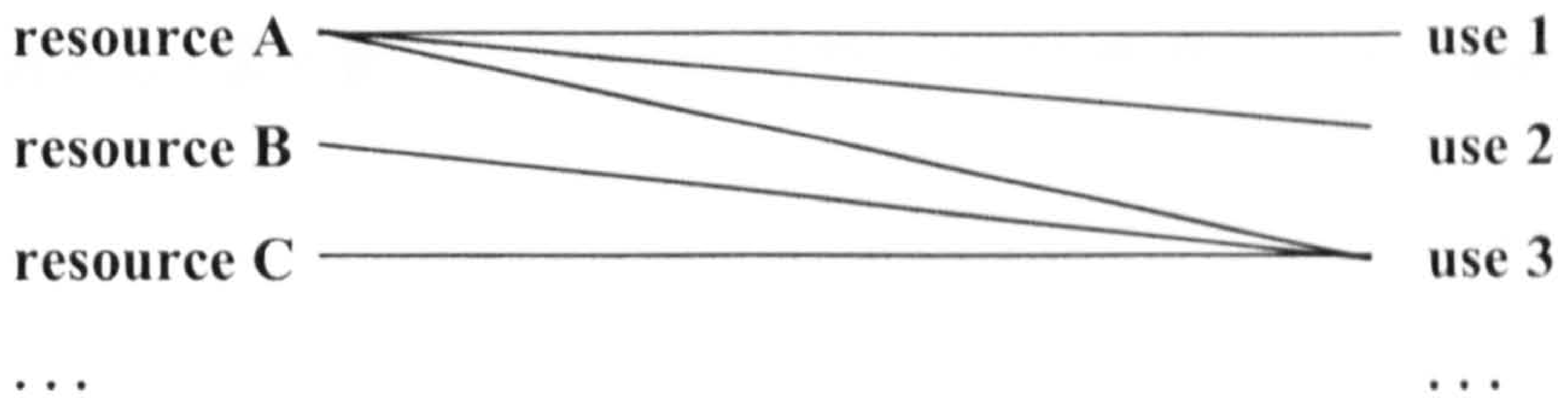
If material culture covers an important segment of resource use, in itself it provides as partial a record as food. Both necessarily complement each other, since there is an incomplete correspondence between the range of uses and the range of resources, as schematically represented in Figure 8a (p.179). Premature attention to selected uses therefore leads easily to sample skewing. For example, attention to food will detect both garden crops and the sago palm (*Metroxylon sagu*), but not the LIMBUM palm (*?Gulubia costata*) (cf. p.21); attention to construction materials, in turn, will detect both of the latter but not the former. Comprehensive assessment of resources therefore relies on a comprehensive attention to their multiple uses and hence to the diversity of human needs. Food and material culture are particularly relevant in this respect, since they represent both large segments of resource use and highly specific instances of it; in contrast, medicine and magic may be highly specific, but not dominant, while the converse tends to apply for fuel, fodder and manure.[193]

Empirically, an emphasis on use not only ensures a comprehensive coverage of resources, but also contextualises ethnobiological information and thus facilitates its elicitation. Besides, it offers an accessible format for representation. I recommend to manifest these benefits in documentation procedures, by inventorising uses in addition to resources (Figure 8b), thus compiling simultaneously:

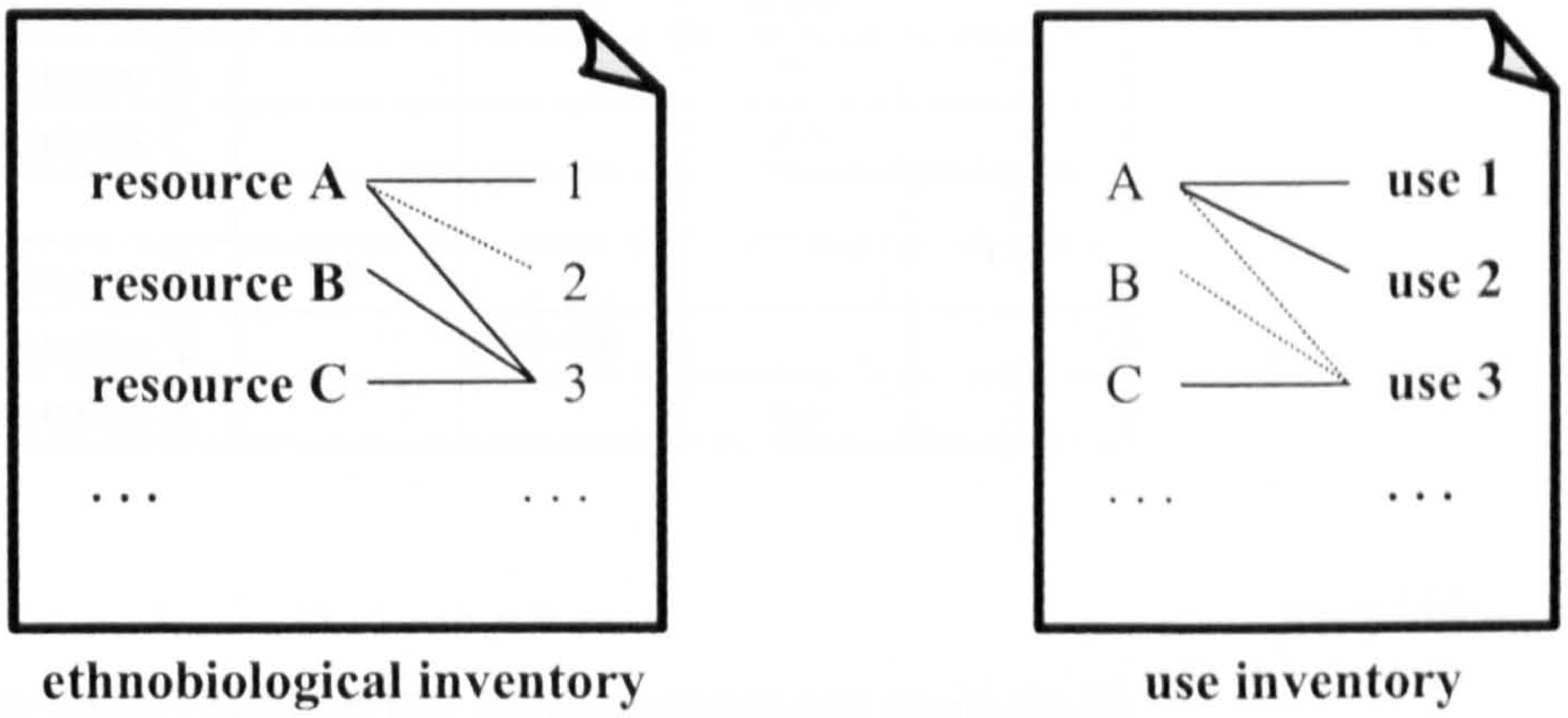
- a use inventory, which refers to individual uses, listing the various resource organisms that can meet each one, and which thereby constitutes the principal record of the material purposes of subsistence;
- a classical ethnobiological inventory, which refers to individual resource organisms, listing the various uses for each, and which thereby constitutes the ultimate repository of ethnobiological information.

Figure 8: Ethnobiological and Use Inventories

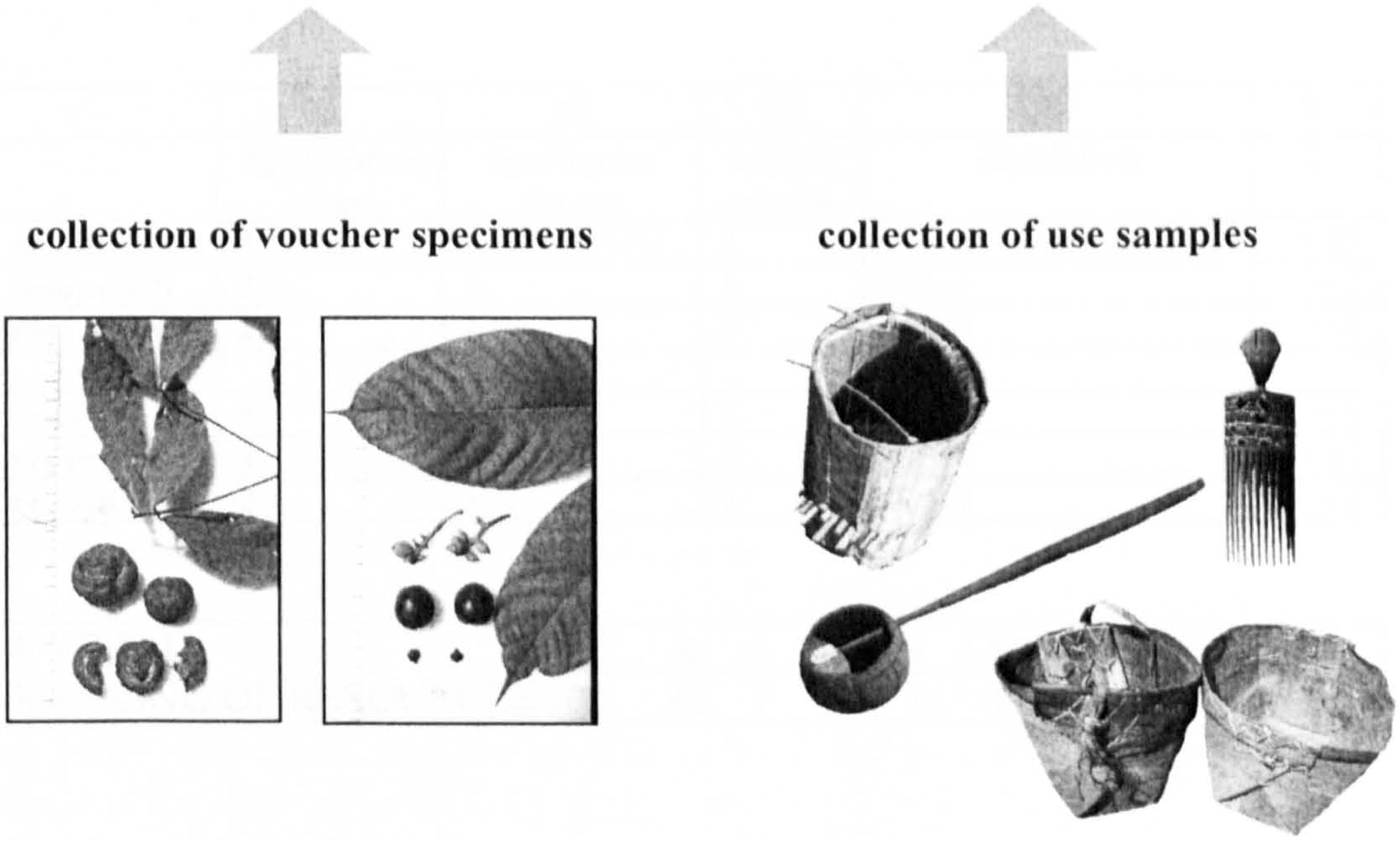
a) incomplete correspondence between range of uses and range of resources:



b) complementary inventories (dashed lines indicate elicitation gaps):



c) supporting collections:



d) gradation of resources and uses:

A > X ——————————— use 1

>

Y > A ——————————— use 2

>

A > C = Z > B ——————————— use 3

. . . . . .

e) visual representation of resource use:

	use 1	**use 2**	**use 3**	**...**
resource A	+++	++	+++	
resource B			+	
resource C			++	
...				
resource X	+			
resource Y		+++		
resource Z			++	

f) quantification of resource use (explanations see main text):

aa)

	use 1	**use 2**	**use 1**
RATING OF USES	5	4	2

bb)

	I	**II**	**III**	**IV**	**V**
	significance of use	significance for use	number of uses	calculation	Σ
resource A	5 / 4 / 2	+++/ ++/ +++	3	{(5x3)+(4x2)+(2x3)}x3	= 87
resource B	2	+	1	2x1x1	= 2
resource C	2	++	1	2x2x1	= 4
...					
resource X	5	+	1	5x1x1	= 5
resource Y	4	+++	1	4x3x1	= 12
resource Z	2	++	1	2x2x1	= 4

cc)

OVERALL RANKING OF RESOURCES	**A**	**Y**	**X**	**C = Z**	**B**
	87	12	5	4	2

Theoretically, both inventories should tally. In practice, elicitation gaps are likely, which makes the use of two complementary registers the more advisable, since either may supplement the other.

The reference point in either inventory may be substantiated with material records. Thus, ethnobiological inventories are classically supported by collections of voucher specimens; similarly, use inventories may be supported by collections of use samples (Figure 8c). Voucher specimens, of course, serve primarily for identification of the resource, while any reference to use relies on additional documentation. Use samples, in contrast, represent both resource and use, and therefore manifest precisely the link under investigation.

Evidently, some uses lend themselves more readily to preservation than others, and in this sense material culture is particularly privileged. This combines with the advantage that it covers a multitude of uses, where for example food or firewood describe rather limited ranges of applications—a circumstance which tends to be obscured in the literature.[194] Furthermore, the permanence of artefacts favours not only recording, but at once sampling of resource use. After all, surveys of foodstuffs are notoriously inaccurate due to poor recall, especially of 'wild' foods and snacks, which are often synonymous; due to behaviour changes under the influence of an inevitably intrusive research situation; and due to the likelihood that biased research designs obscure gendered and age-specific use of resources (cf. e.g. Etkin 1994:5f. and references quoted). In contrast, artefacts constitute recall in themselves and document resources independent of their environmental origins; are typically made in a more relaxed context outside the actual research situation; and are thereby at once less affected by an observational bias.[195] While artefact collections cannot substitute for food surveys, due to the asymmetrical relationship between resources and uses (cf. Figure 8a), they can therefore to some degree offset the shortcomings of a food-oriented approach to resource use, by providing an additional, and partly overlapping, source of ethnobiological information.

Apart from the subjective gradation of uses in terms of methodological accessibility, there is their objective gradation in terms of significance for human livelihoods. In this sense, food does come first, but is closely followed by shelter, firewood, and equipment linked to the appropriation and processing of foodstuffs. Within single uses, the resources which cater for them are in turn graded in their significance for use fulfilment. Conversely, single resources are graded for the number of uses they meet. Resource use therefore varies in three dimensions:

- significance of use;
- significance of resource for use;
- number of uses per resource.

I present these relationships schematically, with hypothetical gradations, through linked comparative lists in Figure 8d; in form of a three-dimensional spreadsheet in Figure 8e; and with a view to statistical evaluation in Figure 8f.

The latter illustrates how resource use might be quantified, without claiming to be authoritative. Thus, uses receive ratings (in figures) according to their significance for livelihoods (aa, entered in bb-I); resources receive ratings (in crosses) according to their significance for the respective use (as per Figure 8e, entered in bb-II), and counts according to the numbers of uses they meet (as per Figure 8a-e, entered in bb-III). The values for the three dimensions are then related arithmetically (bb-IV): significance of use is multiplied with significance per use (representing the individual fields in Figure 8e); the respective sums are added (representing the rows in Figure 8e); these are then multiplied with the number of uses overall (representing the relationship among resources, i.e. the vertical dimension in Figure 8e). The grand total received for each resource (bb-V) can then serve as the index to rank resources against each other (cc). In Appendix 16, which will become relevant in chapter 5, I apply these operations to a selection of ethnobotanical data from Krisa.[196]

Certainly, any such assessment involves considerable arbitrariness. To begin with, the identification of uses themselves is highly problematic, and with it the rating of resources for number of uses (Ellen 1982:216). Even more challenging, though, is the rating of resources for their significance per use (contra loc.cit.), due to the larger number of parameters involved. Thus, we may for example measure the qualitative importance of a resource, in terms of either its value for subsistence or the preference of its users; or its quantitative importance, in terms of either volume used or frequency of use. These ambiguities combine with the difficulties that the former is not easily quantifiable, while neither is intrinsically meaningful. After all, cultural preference may not tally with technical or physiological value, and neither may tally with quantity of resource use, due to limited abundance or need.[197] Besides, use patterns may be irregular, demanding impossibly large sample sizes for meaningful quantification. Empirically, therefore, an impressionistic or semi-quantitative assessment which combines both qualitative and quantitative aspects of resource use, and incorporates local estimates is likely to provide the most accurate representation of resource significance. Subjective decisions by the investigator, if based on—equally subjective—local perceptions, are therefore largely unavoidable.

Furthermore, any assessment of resource use will suffer not only from intrinsic arbitrariness, but at once from the need for simplification. In that sense, the blueprint I have presented above involves only the bare minimum of parameters defining resource significance. Additional ones might be the ease with which resources can be replaced with alternative ones; resource accessibility, reliability, seasonality or mobility (as of animal- vs. vegetal resources); commercial use; role for group identity and cohesion; and so on (cf. e.g. Terrell et al. 2003:351f.). These qualifications notwithstanding, the scheme described in Figure 8 offers a means for detecting general trends. It relies, first, on eliminating conceptual and methodological bias as far as possible, thus attending to both food and material culture, in order to comprehensively ascertain local resource use; and second, on ranking resources and uses, to apprehend patterns within it.

Finally, I want to point out that the definition of resources themselves is inherently ambiguous, involving decisions regarding identification and bounding of units, a notorious problem in ethnobotanical studies. Firstly, resource users themselves do often not agree on identifications, and/ or may use a variety of terms concurrently. Secondly, taxa recognised in the vernacular regularly diverge from those recognised scientifically, and each further language and hence taxonomy used locally tends to compound the confusion. Thirdly, scientific taxonomies themselves are not uncontested and immutable either, as illustrated by the revisions and reservations regarding, for example, the classifications of the 'ti'-plant, *Cordyline fruticosa* (Ehrlich 1989:54-56); the banana (e.g. Rehm & Espig 1991); or the sago palm (cf. section 3.6.). This problem is heightened in botanically underexplored regions such as New Guinea, and for undercollected species such as from the palm family—which though tends to furnish a large proportion of local uses (cf. section

3.6.).[198] Fourthly, scientific identifications are only as good as the respective voucher specimens and the professional expertise employed. Therefore, drawing representative correlations between vernacular and scientific terms requires at least

1. sufficiently large interview samples, to ensure reliability of local identifications (necessary sample size typically increasing with decreasing prevalence of the resource);
2. good quality voucher specimens (or alternatively in-situ identification) for each resource recognised locally, to provide a tangible link between local and scientific identification;
3. professional identification with attention to both botanical and taxonomic issues.

Ideally, it would be desirable to fulfil all three requirements. The material and professional constraints of ethnographic practice, though, permit typically fulfilment of but the first to any significant extent. Yet, this usually receives scant attention in the field of ethnobotanical study, where emphasis is on the production and identification of voucher specimens (e.g. Martin 1995). This, in turn, may be a valid strategy where research focuses on closely limited domains of study (op.cit.:10f.), and where the targeted species lend themselves to collection and preservation. Even so, preparation of specimens is laborious and time-consuming, while its results are often unconvincing, with botanists loathing the poor quality of samples typically produced (pers.comm. Bob Johns and David Floyd, botanists at Kew Botanical Gardens, 1999). It becomes totally impracticable where a substantial number of plants is involved, such as in particular palms, whose anatomy effectively obstructs the preparation of specimens (cf. pp.84f.), and/ or where the studied domain encompasses subsistence at large. Zoological specimens present further problems through the bulk of spirit collections and the time and skill required for preparing birds and mammals. Besides, emphasis on preparing specimens will divert attention from more relevant subjects (see below).

Furthermore, though, the methodological focus on scientific validation promotes a tendency to elevate the use of scientific labels to the sine qua non of ethnobiological study, at the expense of rigorous data collection. This encourages dubious identifications, based less on large interview samples and professional examination of specimens than on single references matched to cursory descriptions in the literature. The potential for error increases in the presence of a trade language such as Tok Pisin in PNG whose use may seem uniform across the country but is often locally idiosyncratic, and with it the local identification of resource organisms which thereby becomes non-transferable to other locales (cf. n.17; contra Ehrlich 1989:59).

Case Study 1 (p.184) illustrates the dangers of a perfunctory approach in light of the multiple intricacies of local and scientific identification. It also demonstrates that the association of local terms with Latin binomials eliminates the background of the research by definition and may lend a specious authority to research results which once released into the public domain may mislead other scholars. Scientific identification should therefore be undertaken only with the utmost care and based on reliable data. If it cannot be accomplished with reasonable certainty, no identification is at any rate preferable to a spurious one.[199]

Besides, even accurate scientific identifications may add less value to a study than other means could provide and hence may become an extravagant luxury in the context of limited means. Certainly, they entail access to ecological information, but so do local accounts (see below). Their sole truly valid function is the potential they offer for comparative studies. Otherwise, information about the resource's life form and use values will be more instructive, in particular to an audience unfamiliar with the local flora. To return to the example from Case Study 1, the dubious sequence "IRRIYAU (GALIP nut (*Canarium* sp.))" may have been presented both more correctly and more usefully as "IRRIYAU (nut-bearing tree)", especially considering that it illustrated a text primarily addressed at students new to Melanesian ethnography and hence both to Tok Pisin terms and PNG flora.

Similarly, the typical organisation of extensive ethnobiological data according to scientific classification (e.g. Balée 1994:150f.-tbl.6.5,156f.-tbl.6.8,161ff.-tbl.6.9) or even alphabetically (e.g. Powell 1976) may be useful for biological assessments, but is unhelpful for comprehending local patterns of resource use, which readily cross-cut the categories of either. It may therefore obscure important functional connections for investigators themselves and obstruct understanding for their prospective audience. Rather, organisation of data should follow local life-form categories, use classes, or a combination of both, thus replicating the units meaningful in a subsistence context, which after all is the principal subject under investigation.

In summary, therefore, I advocate an emphasis on local terms, locally meaningful categories, and social science methods, to render ethnobiological inquiry a useful tool in the study of subsistence. Of course, only comprehensive scientific identification of the resources investigated will ultimately round off any such study. This, however, must be a long-term goal. In the short term, it must be balanced against the need for scientific rigour with limited means, and for conceptual and textual accessibility. More specifically, the "basic point of reference [must be] the local plant name" (Kocher Schmid & Ellis 1999), since only this allows access to, and integration with, local observations of resource ecology and ways of classifying resources and environments. Scientific identification, in contrast, is not intrinsically relevant to these endeavours and must therefore remain a secondary exercise. Accordingly, I will in the ethnographic part of this study (chapter 5) present ethnobiological data principally with reference to local terms only, although I will add likely identifications for common resources and provide some preliminary identifications for others. Otherwise, I will rely mainly on locally informed life-form categories and resource characteristics to provide contextual information. Such a principally emic perspective at once supports methodological concerns, as I will detail under the next heading.

Case Study 1: Intricacies and Dangers of Ethnobotanical Identification

Based on a brief visit (ca. 2 weeks) to Vanimo and its hinterland in 1997, Paul Sillitoe presented a list of several cultivated tree species in a textbook on social change in Melanesia (2000:148) to illustrate local land use. The entries in his list followed the format 'LOCAL NAME (common English or Tok Pisin name (*Latin scientific name*))', and included among others

"IRRIYAU (GALIP nut (*Canarium* sp.))".

Jean Kennedy and William Clarke subsequently took this as evidence that "*Canarium* was planted" (pers.comm. 2003). With *Canarium* one of the genera prominent in the archaeological record in Melanesia, a statement of this kind may at once have wider repercussions in the field.

Data from my own long-term field research in the region suggest that the situation is vastly more complex than presented by Sillitoe, and that his statement is at best fortuitously semi-correct and hence its firmness misleading:

1. Most of the local names in Sillitoe's list are in the Krisa vernacular, yet the trees are identified as resources of people in the Pual river basin, who speak Mbo, an unrelated language (Donohue & San Roque 2004:6). Sillitoe seems therefore to have recorded the tree names in Krisa, while making the respective land use observations among Mbo-speakers. This suggests that he relied on Tok Pisin as an intermediary language to match local terms to the respective resource organisms, rather than on identifying resources in situ with local people. This methodological inconsistency remains inconsequential for resources which show a close correlation between vernacular term, Tok Pisin term, and scientifically recognised species, such as WISIA/ TULIP/ *Gnetum gnemon*. Still, the linguistic inconsistency remains, since WISIA in Krisa is MESE among Mbo-speakers (pers.comm. Christin Kocher Schmid 2005). Conversely, this inconsistency remains mute with resources whose names are shared among Krisa people and Mbo-speakers, such as apparently IRRIYAU/ GALIP/ *Canarium*, but whose lesser prominence tends to come with traits that in turn highlight the methodological inconsistency (see items 2.-7. below).
2. The Tok Pisin term GALIP is used interchangeably with TALIS in Krisa; the same applies for Mbo-speakers (pers.comm. Christin Kocher Schmid 2005). The Agricultural Systems of Papua New Guinea Working Papers (ASWP:chpt.2) identify GALIP as *Canarium indicum*. The Jacaranda Dictionary (Mihalic 1971) lists GALIP once as *Canarium polyphyllum* (op.cit.:86), once as *Canarium indicum* (op.cit.:356), and TALIS as *Terminalia catappa* (op.cit.:190). Jean Kennedy (pers.comm. 2003) notes in this context that "[t]he Jacaranda dictionary is quite unreliable on plant names", which though "sometimes may reflect local usages like galip/ talis synonymy"; and that "[t]here could be multiple species of both *Terminalia* and *Canarium* present" in the region.
3. I have recorded the Tok Pisin terms GALIP/ TALIS as matched to the vernacular term IL (comprising both a forest and a coastal form) in Krisa.
4. I have also recorded the term TALIS applied to trees I myself consider *Terminalia*, which are rare in Krisa and hardly ever planted, if at all. There may however be more extensive planting in the Pual basin.
5. Correlation of various information suggests that the vernacular IRRIYAU is a composite of the Mbo generic term for tree, LRI, and a shared Krisa–Mbo term AO. Thus, Christin Kocher Schmid (pers.comm. 2000) confirms that the term LRI denotes "tree" in Mbo; several voucher specimens by Christian Coiffier (see item 6.) carry the label LRI AAO; I have recorded AO as a Krisa tree name, as well as RIAO and AO as corresponding terms in Mbo and the Krisa vernacular respectively, provided by native speakers, for one and the same plant specimen.
6. A herbarium collection prepared by Christian Coiffier in 1998 in various Mbo-speaking communities contains five voucher specimens labelled as LRI AAO, identified by Coiffier himself as *Terminalia sp.*, while preliminary identification at Kew yielded for one of them *Rubiacea – Mastixiodendron*, for another ?*Cunon*. A sixth specimen is labelled as LRI IL, a seventh as LRI SAAP, both of which Coiffier likewise identified as *Terminalia* sp. The former identification was confirmed in Kew; the latter was corrected as *Rubiaceae – Psychotria*.
7. Additionally, I have recorded reverse identification of *Terminalia* and *Canarium* with Krisa vernacular names. Thus, several people knowledgeable about Forestry abbreviations, which are used in the context of logging, correlated these with local terms and identified TER (Terminalia) as NUNG, which though is recognised as a large family, including for example PLA (Planchonia), PLR (Planchonella), PLW (Planchonella white) and LIT (Litsea); and identified CAG (Canarium grey), CAR

(Canarium red) and CAD (Candlenut) as **AO**, which, again, comprises at least one further species.

Some of the conclusion which may be drawn are:

- vernacular terms in the region tend to amalgamate numerous species of like appearance, as evident in Coiffier's confusions (6.) and the merging of timber species (7.);
- **AO/ LRIAO** seems to include *Canarium* (7.), **IL/ LRIIL** *Terminalia* (3./ 4., 6.);
- **GALIP/ TALIS**, **IL/ LRIIL** and *Terminalia* are linked (2., 3., 4., 6.);
- it is however likely that **GALIP/ TALIS** like the vernacular terms amalgamate numerous species, including various species of both *Terminalia* and *Canarium* (2.) and both **AO/ LRIAO** and **IL/ LRIIL** in turn.
- planting of either species may not be prominent in the region.

While there is therefore a tentative correlation of **AO/ LRIAO** (**IRRIYAU**)–**GALIP/ TALIS**–*Canarium*, there is a stronger one of **IL/ LRIIL**–**GALIP/ TALIS**–*Terminalia*, although neither may offer a good illustration of planted resources. In any case, it is unlikely that Sillitoe could explore these complexities during his short period of field research. Without the respective caveats, however, his apparently authoritative statement provides a false sense of reliability.

Beyond Sustenance: The Central Role of Resources for Subsistence

Much as uses offer an empirical point of entry for investigating resources, so do resources in turn for investigating management, and hence for moving beyond assessments of sustenance towards assessments of the means to obtain it. After all, sustenance represents but one facet of subsistence.[200] It describes resources as sources of energy and material only, which upon appropriation become subject to use. Resources are at once organisms, though, which prior to appropriation are—by definition—subject to management (cf. p.140). This dual role makes resources central for subsistence, both empirically and analytically.

If this behavioural perspective (see Figure 9a on p.190) outlines the complementarity of human actions in the subsistence process (corresponding to the complementarity of ecological and economic production—cf. Figure 7 [p.172]), a biological perspective (Figure 9b) reveals which attributes of the resource organism account for it. On the one hand, there are the organism's morphological and physiological characteristics, which define its utility, manifesting in human use decisions in the post-appropriation stage. On the other hand, there are its ecological characteristics, which define its habitats, their constitution affected by human management schemes in the pre-/ para-appropriation stage.

Empirically, investigating the post-appropriation stage necessarily relies on examining actual uses, since these represent a culturally mediated selection from potential uses: there is a one-way relationship between an organism's morphology/ physiology and its contribution to human sustenance. Investigating the pre-/ para-appropriation stage, however, is not bound in the same way, since here ecological relationships are active which render scenarios inevitable: resource ecology, habitat and management are all mutually dependent, and can therefore in principle serve similarly as entry points for inquiry.

In practice, however, they provide variously valuable information. To begin with, documentation can involve a number of different, and complementary, methods and resulting data sets, in particular:

A. generic information, involving:

  1. ecological profiles ('resource ecology'), which describe the conditions under which a taxon will thrive (according to local experience and/ or scientific studies, with reference respectively to local or scientific identification);
  2. local classification/ description of vegetation types ('habitat') and management activities ('management'), which may imply or complement one another (e.g. "garden"—"preparing a garden", "sago patch"—"processing sago"[201], etc.) and provide a basic outline of pre-/ para-appropriation scenarios.

B. specific information, involving:

  1. location records ('resource ecology', 'habitat'), which identify the site and its characteristics (B.3.) of a particular organism, as observed in-situ or elicited ex-situ (e.g. as part of a meal or artefact), thus complementing its ecological profile (A.1.);
  2. plot surveys ('resource ecology', 'habitat'), which inventorise resources present in a site, thus complementing their ecological profiles (A.1.);
  3. site characterisations ('habitat'), which record site appearance, and/ or classification according to local categories (which, in turn may involve reference to past management [A.2., B.4.]);
  4. site/ resource histories ('management'), which document past management actions (according to personal or transmitted accounts internal or external to the community);
  5. observations of management activities ('management'), which permit to substantiate and elaborate local classifications/ descriptions (A.2.).

The most valuable information allows for a correlation between use and management, thus spanning the entire subsistence process. Particularly instructive are sequences which start out from the use side (A.1./ B.1, when prompted by instances of use), since they narrow the investigative focus and thereby increase sampling efficiency. After all, what ultimately matters for human livelihoods are the resources that end up in meals or artefacts, rather than those dispersed in the environment, which may be useful in principle but never used in practice (cf. pp.41f.).

Similarly illuminating are direct references to management (A.2., B.4., B.5.), since they instantly capture an actual aspect of subsistence, without the detour via a resource's ecology (A.1.) or habitat (B.3.) which inflates research effort and diminishes the meaningfulness of results. After all, neither ecology nor habitat can unambiguously indicate management schemes, their mutual dependence being inevitable but not inevitably predictable.[202] Furthermore, the floral effects of indirect or unspecific management regimes may be imperceptible in particular to outsiders.

For plant individuals from species which thrive under a variety of regimes, such as occurring equally planted as spontaneous, no judgment may be possible anyway without recourse to historical information.

Plot surveys (B.2.), which constitute the stock in trade of ethnobotanical and subsistence studies (e.g. Denevan & Padoch 1987)[203], may therefore expend much effort to little effect: they relate directly neither to management nor to use, yet demand substantial expenditures of time, labour and logistics—complications which have effectively hampered the generation of subsistence data regarding fallows, forest and sago swamps (cf. p.24). Ironically, they may be outdone by simple interviews about uses, management activities and vegetation types. By necessity, these involve reference to local resource categories in turn, recommended above also for reasons of clarity, expediency and investigative discipline. A methodological bias towards local perspectives, supported with actual observations, is therefore advisable, which suitably matches customary anthropological concerns. Still, the complexity of the subject also calls for a large diversity of methods, to allow for triangulation of the results.

In particular, a strict conceptual separation must be maintained between uses and habitats/ management schemes, and each investigated independently. After all, the incomplete correspondence between range of uses and range of resources, which I have observed above (cf. Figure 8a), recurs between resources and their management (Figure 9c), and consequently between uses and management in turn (grey scheme). (Even if there were a total correspondence between resources and management, the incomplete one between resources and uses would at once extend to management, resulting in the same effect overall.) Neither can therefore substitute for the other: uses cannot imply management, and vice versa; both are not analogous, but functionally related through resources in various ways.

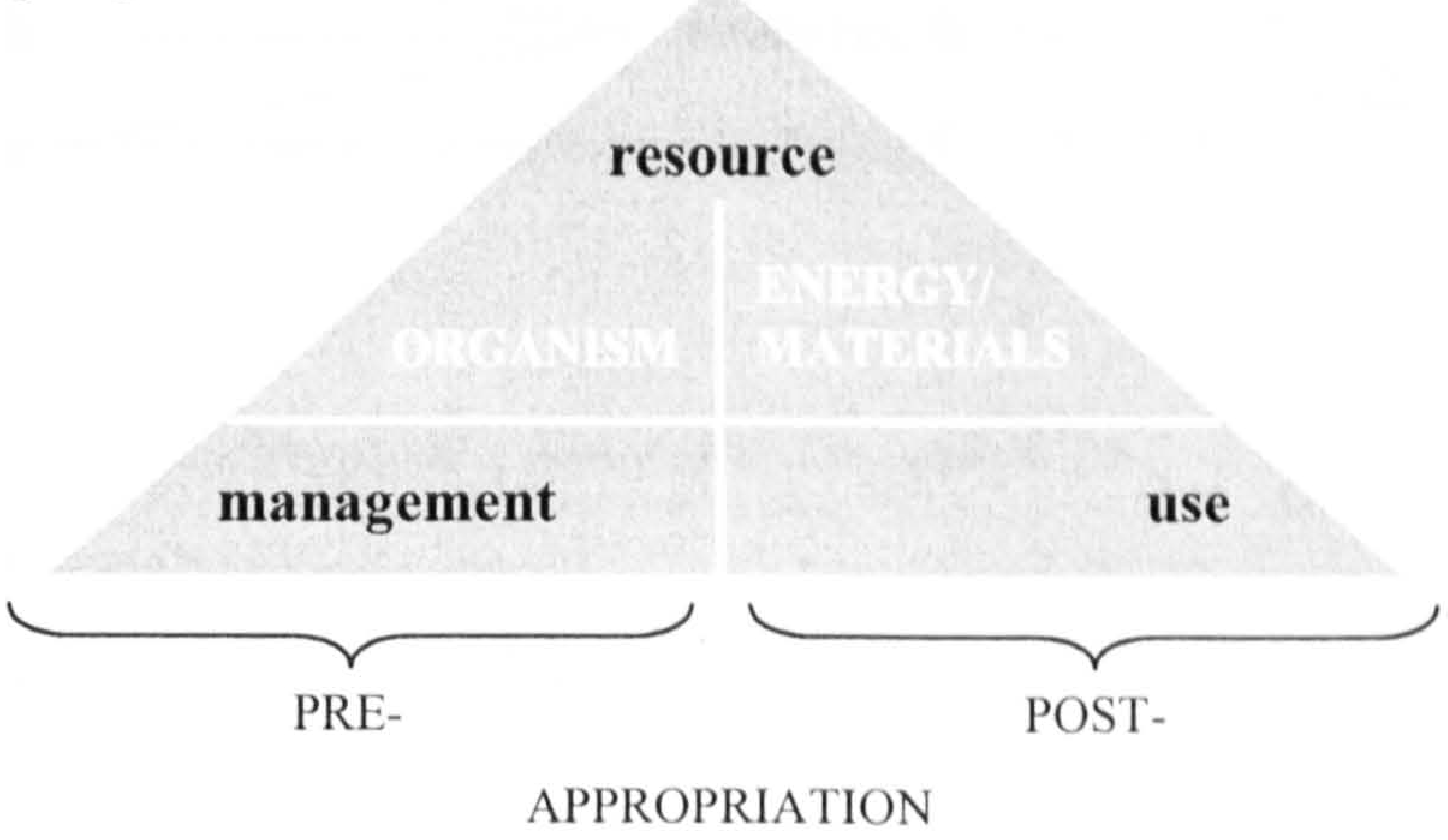
Again, therefore, premature attention to selected uses, habitats/ management schemes or resources will lead to sample skewing. To expand on the example which introduced the previous heading (p.178), the sago palm relates both to food and construction in terms of use, and to swampland and its management in terms of habitat; garden crops relate to food and young gardens, the LIMBUM palm to construction and old gardens. A comprehensive investigation of both food and construction material on the one hand, and of swampland, young gardens and old gardens on the other will accordingly reveal all three resources. Exclusive concern with either of these, though, their uses, or their habitats/ management schemes will at once miss the respective others.

The most typical instance of such sample skewing arises from a preoccupation with foodstuffs in terms of uses, and with clearly cultivated sites in terms of habitat and management. Their illicit, if usually implicit, equation then fosters the notion—especially in regard to societies which practice some form of cultivation—that food principally came from gardens and gardens principally supplied food, and that these relationships sufficiently described subsistence. It finds expression in the conviction of the Catholic Sister, quoted at the beginning of chapter 2, that a lack of gardens was responsible for malnutrition (p.15); in the corresponding concerns of patrol officers and their efforts to remedy the situation (pp.19f.); in the methodological bias towards gardens and food plants in the Agricultural Systems Working Papers (pp.20ff.); and ultimately in the conceptual tenet, in subsistence studies, of swiddens as food production sites and fallows as their by-product, which obscures a potentially inverse economic relationship between both (cf. p.65). The present study attempts to counter precisely this tendency, by attending equally to foodstuffs and material culture, and to cultivation practices and 'grey' shades of management.

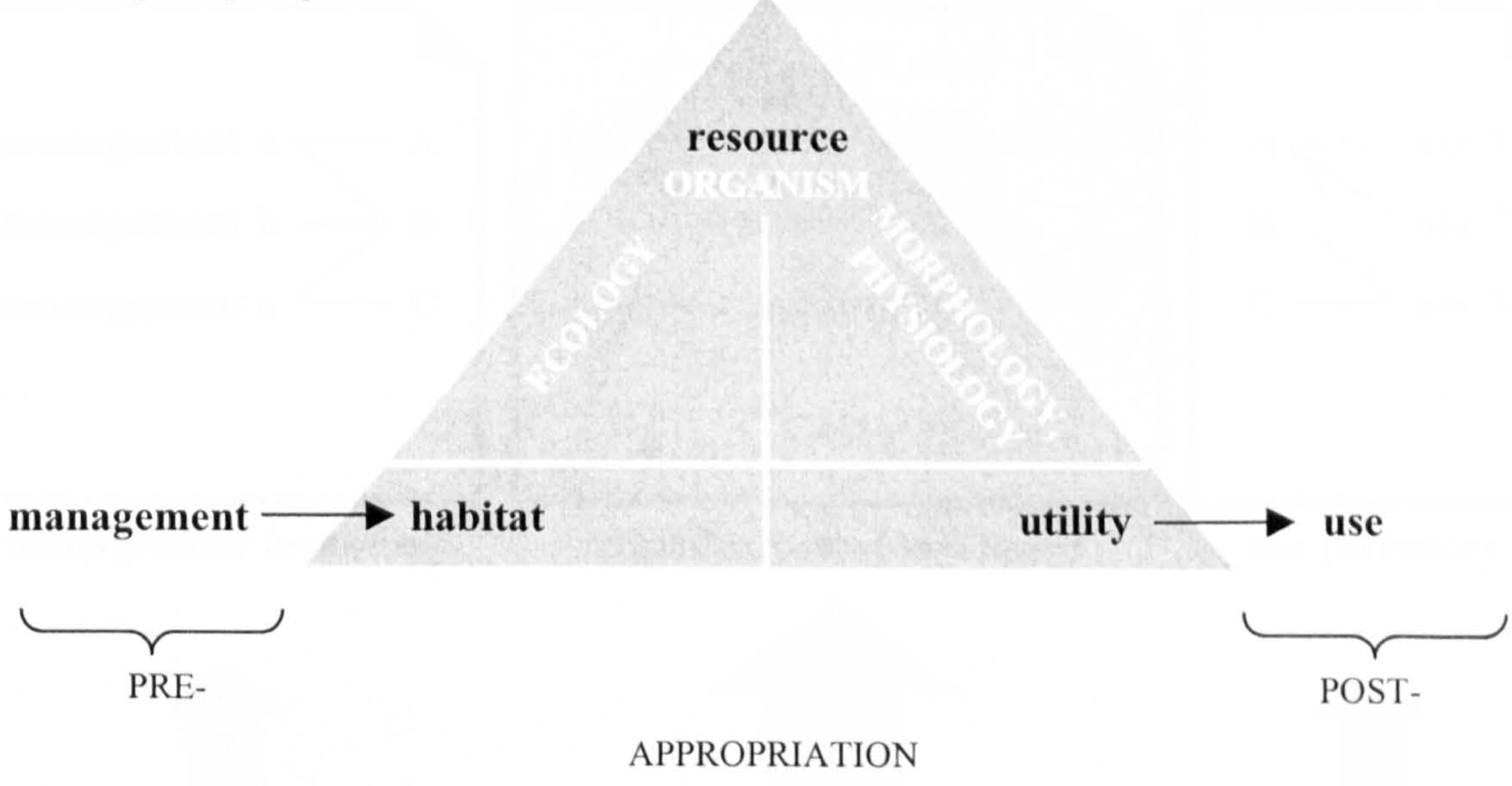
If the separate concern with management adds a third inventory to the previous two, they all collapse ultimately into a single ethnobiological one (Figure 9d). It relates management to uses via resources, and evens out elicitation gaps; and on each aspect combines both generic information on typical scenarios, obtained from interviews and reference works, and specific information on actual cases, obtained from surveys, observations, and collections. With the correlation between management and uses, the ranking exercise performed earlier (p.181) can now be extended to management: Figure 9e continues the examples from Figure 9c/ d and Figure 8f, supplementing hypothetical relationships where necessary. Thus, management is rated by multiplying the number of resources it affects (representing its importance for resources) with the sums of these resources' index values (representing its importance for uses) (aa). The grand total received for each management scheme can then serve as the index to rank schemes against each other (bb). Although incompleteness of my data from Krisa does not permit me to continue the quantification presented in Appendix 16 in the described way, I will approximate the respective operations through an impressionistic evaluation of Appendix 17, which will become relevant in chapter 5.[204]

Figure 9: The Central Role of Resources—Empirically and Analytically

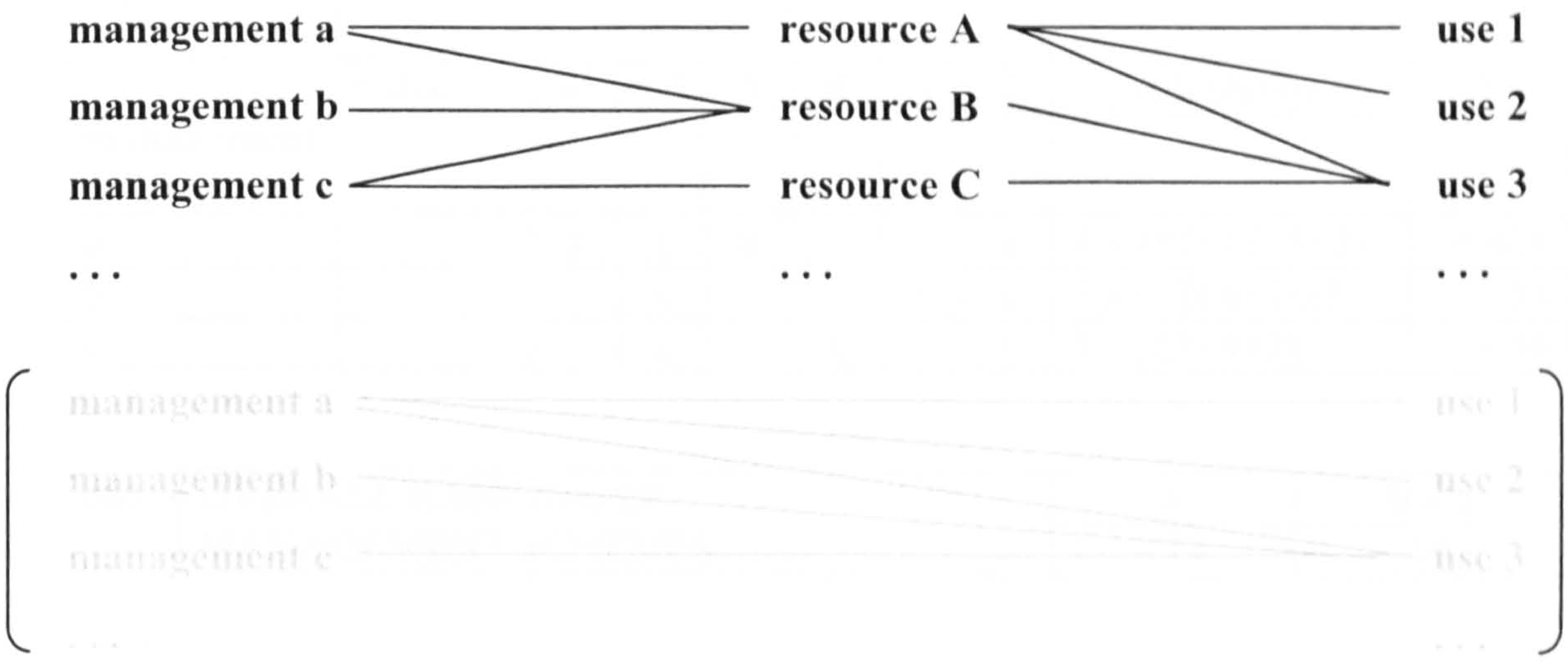
a) the central role of resources for subsistence -
the behavioural perspective:



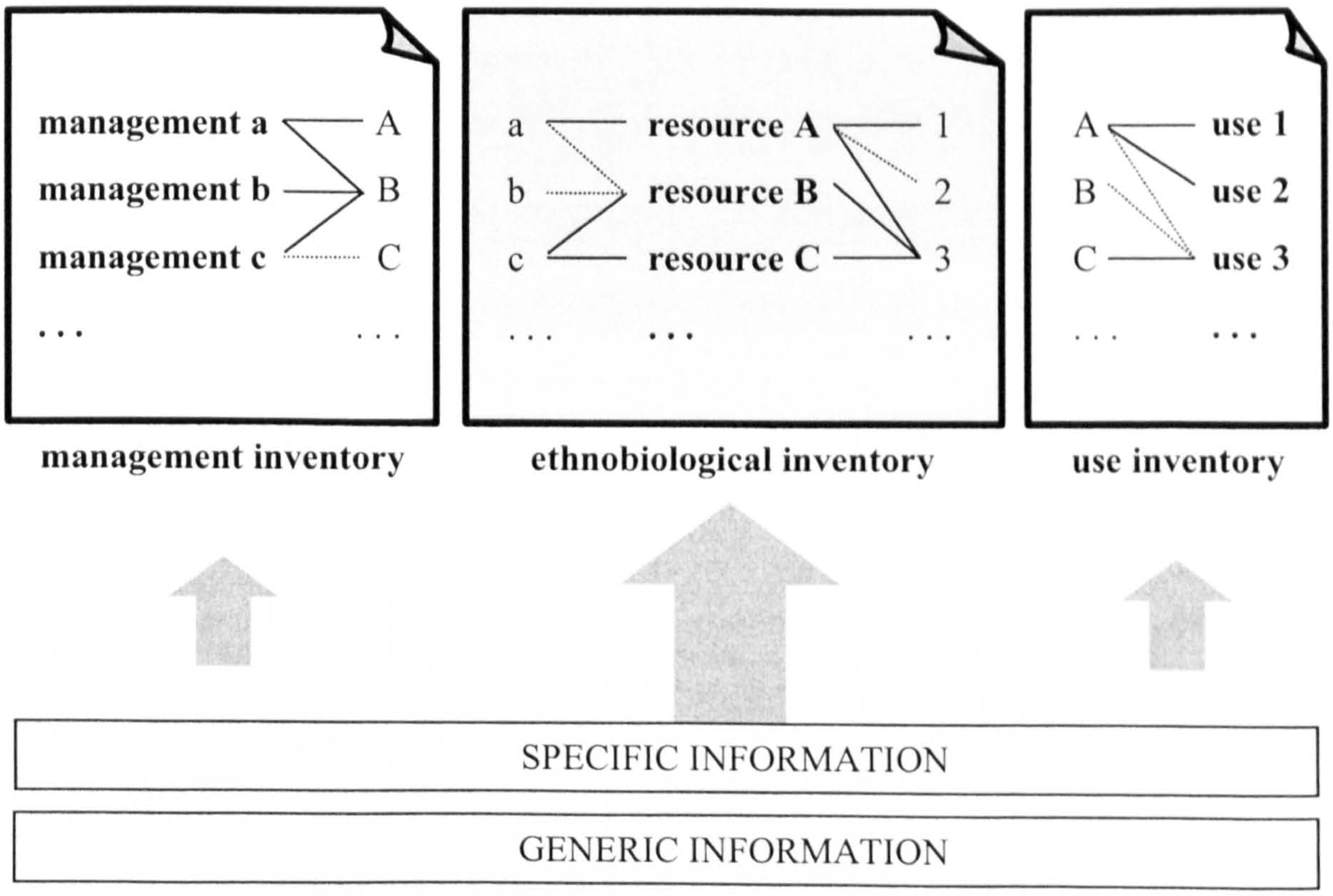
b) the central role of resources for subsistence -
the biological perspective:



c) incomplete correspondence between uses, resources and management schemes:



d) a single ethnobiological inventory:



e) ranking of habitats/ management schemes (explanations see main text):

aa)

	resource	**A**	**Y**	**X**	**C**	**Z**	**B**		
	value	87	12	5	4	4	2	calculation	Σ
management scheme									
a		x	x	x			x	4 x (87+12+5+2)	= 424
b			x			x	x	3 x (12+4+2)x3	= 54
c			x		x		x	3 x (12+4+2)	= 54

bb)

OVERALL RANKING OF MANAGEMENT SCHEMES	**a**	**b = c**
	424	54

Summary: An Investigative Sequence

I have in this section expanded the conventional meaning of resources and defined them as analytically central for the study of subsistence. I have demonstrated that they represent the functional link between use and management, and that these in turn constitute fundamentally independent spheres of subsistence and therefore need to be separated conceptually. In practical terms, I have argued for local categories as points of reference, in particular regarding the resources themselves, since this

- reduces confusion;
- matches a methodological emphasis on local perspectives.

I have further outlined an investigative sequence which advances principally from uses, through resources, to management. Use provides a suitable point of entry, since it

- offers a comprehensive coverage of resources (vs. a random approach);
- contextualises information and thereby facilitates elicitation (vs. detached treatment of resources);
- narrows the investigative focus and thereby increases sampling efficiency (vs. approach via habitats).

Material culture, in turn, as one manifestation of use offers a highly apposite, if much neglected, angle on uses, since it

- covers a multitude of uses (vs. food);
- represents large segments of use (vs. medicine);
- represents highly specific instances of use (vs. firewood).

Artefact collections, in turn, as samples of material culture

- represent at once resource and use (vs. voucher specimens);
- favour recording and sampling due to their permanence (vs. meals/ snacks).

Certainly, artefact collections represent but one facet of material culture (vs. shelter); material culture represents but one facet of use (vs. food); and use represents but one facet of human interaction with resources (vs. management). They all therefore require complementation with their respective counterparts. Similarly, resources constitute but one facet of subsistence. Their link with use and management points to the behavioural dimension, which I have necessarily touched on but not yet explored, while I have sidelined the motivational dimension altogether. In the last section of this chapter, I will integrate them all in a synoptic view.

4.8. Summary: A New Scheme

Review

I opened this chapter by summing up and expanding on the confusions encountered in the study of tropical subsistence, as reviewed in chapter 3. I noted in particular the validity of Dornstreich's (1977:247) long-standing, if as yet unmet call for a "standard format" and "consistent typology" for describing and classifying subsistence forms. In the main part of the chapter, I have then laid the foundations for developing a scheme that would address these concerns through its reliance on universally valid principles of human–environment interaction. For this, I have explored various notions integral to the study of subsistence, and have in the process broken down the foraging–farming duality, identified earlier as the principal obstacle to true conceptual innovation.

In **sections 4.2.** through **4.4.**, I have examined the concept of nature and its convoluted relationship with science; delineated the remit of ecological inquiry; and highlighted the bifurcation of anthropology. In section 4.4., I have also suggested that the foraging–farming duality constitutes but an ethnocentric folk model of agriculturalists, which via the self-generated nature–culture duality has attained a spurious scientific authority.

In **section 4.5.**, I have analysed the respective phenomena with a scientific perspective; rejected foraging as utopian, farming as either universal or illusive; and suggested that we replace their duality with a complex taxonomy that demonstrates the multiple ecological and evolutionary parameters of human–environment interaction. I have pointed out that these parameters determine subsistence forms not by their plain aggregation but only through the principles by which they are functionally integrated, and that they are, therefore, unsuitable as indicators in themselves. More specifically, I have described two major, principally independent, domains within this taxonomy, namely management and coevolution. Regarding the former, I have correlated utilitarian resource categories with human actions to identify the 'primary colours' of plant management and thereby develop a universally applicable set of attributes. I have used this in turn to explain domesticatory processes as understood in biology, and have more generally discussed the concept of domestication as understood in biology and anthropology and examined its implications for subsistence.

In **section 4.6.**, I have explored the notion of production, demonstrating that the categorical discontinuity of subsistence lies not with the contrast between procurement/ foraging vs. production/ farming, but perpendicular to it with the complementarity of ecological and economic production, which in turn marks subsistence out as processual. I have subsequently identified the three consecutive elements in this process as maintenance, harvesting and use, and have at once rejected a revised reading of the foraging–farming duality as analogous to the former two.

Finally, in **section 4.7.**, I have dealt with resources as the connective element in the subsistence process and central purpose of subsistence activities. I have expanded the meaning of resources; identified them as the functional link between management and use; and have described practical procedures for their comprehensive assessment.

I have therefore successively narrowed my focus from the explanatory framework down to resources, and from theory to methodology. In the process, I have

- dismantled the foraging–farming duality on several counts, thus opening the way for a more nuanced treatment of subsistence;
- examined in detail four concepts which describe key elements of subsistence, namely
  - use,
  - resources,
  - management,
  - domestication;
- ascertained three principles as essential for the meaningful study of subsistence, namely
  1. the bifurcation of anthropology
  2. the processual character of subsistence
  3. the systemic integration of subsistence elements.

In the following, I will expand my view again, as I reflect on these principles and integrate the specific concepts discussed, to suggest a new model of subsistence in human ecology.

A New Model of Subsistence in Human Ecology

The first principle, bifurcation of anthropology (cf. esp. section 4.3., also n.179), requires that phenomena are apprehended *within the* respective disciplinary remits: ecological inquiry applies to organisms and their relations, *classical social* anthropological inquiry to persons and theirs. The physical aspects of human existence fall accordingly under the remit of the former, the ideational aspects under the remit of the latter. Subsistence relates to both aspects, hence its study must involve both disciplines. With respect to the four concepts examined in detail, *resources* and their *domestication* fall under the remit of ecological inquiry; so do *management* and *use* as manifestations of behaviour; their motivations as well as their wider socio-cultural context, in contrast, fall under the remit of anthropological inquiry. We can accordingly distinguish three discrete spheres which need to be addressed separately, and through the respectively appropriate disciplines, for a comprehensive assessment of subsistence in human ecology:[205]

(1) the resource base, including the coevolutionary trajectories of the resource organisms and their ecological and utilitarian characteristics;

(2) subsistence behaviour, by which people engage with (1) through management and use, according to the respective ecological and utilitarian characteristics, and with effects for coevolutionary trajectories;

(3) the socio-cultural matrix, which embeds and motivates (2), comprising such aspects as social organisation, kin terms and marriage rules, legal codes, spiritual beliefs, distribution and content of esoteric and profane knowledge, taxonomies of living kinds and vegetation forms, and so on.

These need to be understood, in turn, on the basis of the second principle, processual character (cf. esp. section 4.6.). It means that subsistence cannot be described as an event, but only as a sequence of stages, since it refers ultimately to the trophic relationships between humans and their resources. This is most evident with spheres (1) and (2): resources figure as organisms prior to appropriation and as sources of energy and materials thereafter (cf. esp. Figure 7); correspondingly, behaviour divides into the consecutive stages of management and use (cf. esp.Figure 9a); management, in turn, divides into maintenance and harvesting. Conflating management and use (cf. p.188) obscures the diversity of subsistence phenomena, conflating maintenance and harvesting (cf. p.174) their diachronicity; conflating activities with their modes of action (cf. p.174) aggravates this situation. It is therefore essential to independently consider pre-, para- and post-appropriation events and distinguish acts from schedules[206].

Only once these have been separately identified and described can the third principle be applied, systemic integration of elements. Much as the various parameters of human–environment interaction connect in functional rather than merely aggregate ways to generate subsistence phenomena (cf. pp.162ff.), so do overall the various elements and spheres of subsistence to generate subsistence forms. The surface patterns of these forms (labelled casually as 'hunting-gathering', 'swiddening', 'agroforestry', 'sago subsistence' or similar) reveal therefore little about the principles active in the reproduction of the system; about similarities and differences with other systems; and about trajectories of change in the past and future. Access to these relies, rather, on tracing precisely the functional connections which define the system.

With this view, then, the contrast between 'mode of subsistence', viz. "technical relations of production", and 'mode of production', viz. "social relations of production" (e.g. Ellen 1982:128; cf. n.205), may evaporate. As Ellen (1994:198) noted:

> "The concept of mode of subsistence as an *aggregate* of extractive processes can in itself say nothing of the means by which its particular manifestations are socially integrated." (original emphasis)

And elsewhere (1982:175):

> "Both *techniques and patterns* necessarily imply the existence of social relations..., but can never predictably specify their character." (my emphasis)

Yet, a shift from pattern to system will turn the incongruity into likeness. In a subsistence *system*, subsistence activities, social fabric and cosmology relate selectively and meaningfully, with either a function of the other. The "legitimate separation of the technical from the social" (Ellen 1994:199) must apply, not in the classification of subsistence systems, but in their prior analysis.

In this sense, I have in the present chapter proposed a scheme based on universal principles of human–environment interaction which will permit us to analyse subsistence in human ecology comprehensively and therefore comparatively, and believe that I have thereby fulfilled Dornstreich's call for a "standard format". Its widespread application may in turn yield the comparative data necessary to develop a meaningful classification of subsistence forms, and hence the "consistent typology" which he also demanded. I will in the next chapter apply the analytical format to the selected case of Krisa subsistence, which I will consequently identify as an instance of 'fallow farming', thereby demonstrating the generation of taxa for a new typology.

The Scheme Applied: Field Methods

Before I turn to the case study, I will briefly address how the combination of methods I employed translate the scheme into practice. Besides the standard ethnographic methods of observation, participant observation, and conversation, I carried out specific investigations, which I present in overview in Table 10 with reference to their analytical dimensions:

Table 10: Research Methods

method	details see	principal analytical dimensions
evaluation of archival sources	pp.8f., Appendix 4	diachronicity
recording of oral history		diachronicity
detailed census	Appendix 9	socio-cultural matrix diachronicity
consumption & activities survey	Appendix 10	resource base behaviour (management, use) socio-cultural matrix
garden survey	Appendix 11	resource base behaviour (management) socio-cultural matrix
land use survey	Appendix 12	resource base behaviour (management) socio-cultural matrix
artefact collection & material culture inventory	Appendix 13 (evaluation: Appendices 15, 16)	resource base behaviour (use) socio-cultural matrix
herbarium collection & ethnobotanical inventory	Appendix 14 (evaluation: Appendices 15, 16, 17)	resource base behaviour (management, use) socio-cultural matrix

The ethnographic material which derives from these investigations is organised in three sections in chapter 5 (cf. p.14).

In **section 5.1.**, I set the scene in terms of geography, history and politics. In particular, I describe inter- and intra-community mobility patterns in regard to various timeframes and levels of social inclusion; their connection with kinship; and the motivations which underlie them. I thereby trace the collective relationship of people with land and territory, a fundamental ingredient of subsistence. I also explore how social institutions and motivations have changed during the last decades, and how this is affecting mobility patterns in turn.

In **section 5.2.**, I focus on resource use and subsistence activities, as the most conspicuous aspects of subsistence. I commence by investigating at first foodstuffs and then the multitude of non-food resources. Next, I examine approaches to resource appropriation and consumption, and the social groupings involved. Lastly, I describe the environmental context of the respective activities, and correspondingly the personal relationship of people with land and territory, as the unit from which the collective relationship with these is built.

Finally, in **section 5.3.**, I explore gardening as a theme with variations. In the process, I demonstrate it as that element of local subsistence which is critical for local livelihoods less for its capacity to generate resources than the anthropogenic environments of which these are part. I conclude with an hypothetical evolutionary sequence which traces possible antecedent forms and hints at the future. I thereby link up on the one hand with the insights gained in chapter 3 regarding the probable evolutionary relationships between subsistence forms; on the other hand I revert to the concerns presented in chapter 2 regarding the historical and contemporary dismissals by agriculturally-minded outsiders and their potentially erosive effects. I thereby prepare the ground for the two corresponding sections in the last chapter.

Hence, I conclude both chapter 5 and this study at large with concerns about the direction in which land use and livelihoods in Krisa are headed—concerns which ultimately motivated the study itself (cf. p.12). These stem from the conviction that the driving force behind the current transformation is a gross imbalance of power which precludes informed choice while precipitating radical change, rather than from a romantic illusion that the traditional (if dynamic) system of subsistence was intrinsically superior to any potential innovations. I do believe that in the context of limited population size the traditional system entails a high degree of both ecological and economic sustainability, and supplies a nutritionally sound if not superior diet (in particular when contrasted with dietary change under the influence of modernisation). However, these judgments rely on inferences and approximations, such as through correlating meal composition and nutritional content of foodstuffs, or tracing the apparent reproduction of the traditional system over long periods of time. Conclusive assessment would require their substantiation—or refutation—with empirical evidence in particular on nutrient intakes; morbidity and mortality; and ecological impact. The respective investigations might provide complementary data in a second stage of research. Here, though, I want to explore less any values of the system but its principles—not judge but model it. Such modelling itself remains unsubstantiated, in turn, in regard to the evolutionary trajectory which I hypothesise. Although the principles of tropical rainforest subsistence which I have distilled in chapter 3 make my speculations plausible, these await their substantiation with archaeobotanical evidence. Lastly, my evolutionary model largely excludes references to causative factors, whose consideration would add a further layer of speculation and may therefore be reserved for research following any archaeobotanical clarifications.

I have indicated such limitations through the respective qualifications, use of the conditional, or corresponding adverbs. Any assertions, in contrast, are based on empirical evidence and/ or careful analysis. Unless otherwise indicated, they rely on observations or explicit statements by locals, or are well-founded abstractions from—usually statistical sets of—field notes. Unfortunately, space limitations have restricted the potential to present much of the original data alongside the analysis and the resulting assertions. This has not only removed ethnographic depth but may also engender an unwarranted notion of impressionistic assessments or conjectures. A reasonably general treatment of the topic has however been necessary for distilling the overall character of Krisa subsistence, to render the case study useful both for complementing the evidence presented in chapter 3, and for substantiating the theory developed in chapters 3 and 4 (cf. p.13).