Chapter 12
Relationships Between Scientific Ecology and Knowledge of Primate Ecology of Wapishana Subsistence Hunters in Guyana

Thomas Henfrey

12.1 Introduction

While difficulties over definition and theoretical orientation have ensured that traditional, local or indigenous knowledge (hereafter referred to as local ecological knowledge, or LEK) has become a problematic concept (Purcell 1998; Ellen and Harris 2000), its role in the debate on development has advanced from radical critique to established orthodoxy (Dove 2002). LEK, which I here define as ecological knowledge acquired by resource users independently of any formal scientific training (in contrast with scientific ecological knowledge, or SEK), exhibits substantive and epistemological continuity with scientific approaches (Agrawal 1995; Ellen 2004). Research on applications in agriculture especially has provided strong demonstrations of its scientific validity and practical value (e.g. Richards 1985, Warren et al. 1995). However, LEK also differs in significant, if not uniform, ways from SEK (Sillitoe 2002a). In addition, a strictly scientific treatment neglects some important features of LEK (Escobar 1995, Stirrat 1998; Agrawal 2002).

Because of this partial overlap, LEK and SEK are complementary along several dimensions key to practical problems in resource management (DeWalt 1994; Moller et al. 2004). From the perspective of traditional resource users, SEK offers a body of knowledge and range of techniques with which they might extend their management capacities as they seek to adapt to changing circumstances (Sillitoe 1998; Puri 2001, for practical cases see Hanna 1998; Pinkerton 1998; Becker 2003; Becker and Ghimire 2003). Some scientists now seek equitable partnerships with traditional resource users in creating joint research programmes based upon common interests in ecological conservation (Bodmer and Puertas 2000; Ticktin and Johns 2002; Ticktin et al. 2004; Moller et al. 2004).

T. Henfrey (✉)
Centre for Ecology, Evolution and Environmental Change (cE3c), Lisbon University,
Schumacher Institute for Sustainable Systems, Bristol, UK
e-mail: tom@schumacherinstitute.org.uk

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From the perspective of scientific research in ecology, LEK can be employed as a source of hypotheses via which to focus research more efficiently on important ecological issues (Posey 1986, 1990; Townsend 1995). For example, collaborations between scientists and Inuit hunters have extended scientific data sets on the ecology of beluga whales (Myrmin et al. 1999; Huntington et al. 1999) and long-term changes in abundance and distribution of caribou (Ferguson et al. 1998; also see Huntington 2000 and references therein). Indigenous ecologists have also contributed information on entomology (Posey 1986), ichthyology (Ponte Johansons 1995), food habits of game animals (Balée 1994; Cormier 2004), herpetology (Nabhan 2003), primate behavioural ecology (Townsend 1995) and interspecies mutualisms (Vasquez-Davila 1995; Donovan and Puri 2004).

Comparisons between such data and information in the scientific literature have generally shown close matches. Ethnoprimatological data provided by a single Murui informant corresponded closely in detail with information published in the scientific primatological literature (Townsend 1995). Balée, although he does not give details, reports that a biologist's field tests of information provided by Ka'apor hunters on the food plants of game animals proved it was highly accurate (Balée 1994). However, at the time of this study, such examples were few in number, and empirical backing for the lofty claims often made on behalf of local ecological knowledge surprisingly scarce (Donovan and Puri 2004). One project to have conducted studies in LEK alongside simultaneous studies in scientific ecology endorses the value of LEK in providing scientific information relevant to resource management, but cautions that the information supplied requires verification via scientific methods (Gilchrist et al. 2005). Accordingly, this chapter compares the ethnoprimatological knowledge Wapishana hunters in Guyana, South America, contextualised in relation to the wider cultural significance of primates, with findings from corresponding areas of scientific ecology.

12.2 Background: Wapishana Settlement and Cultural Ecology

Research was part of a pre-doctoral study on the applications in subsistence of the local ecological knowledge of Wapishana people in southwestern Guyana (Henfrey 2002, 2017, 2018). Fieldwork took place over a total of 20 months during 1998, 1999 and 2000 (see Fig. 12.1). The 5000 or so Guyanese Wapishana (part of a wider population also resident in adjacent areas of Roraima State in northern Brazil) reside in nine main villages and numerous smaller settlements. These settlements are mostly located along an arc at the boundary between Guyana's South Rupununi savannah and adjacent forested areas in the Kanuku Mountains and the basins of the Kwitaro and Kujuwini Rivers. The main research site was one of the more remote of these villages, in the Kwitaro River basin and approximately 100 miles from the district capital at Lethem.

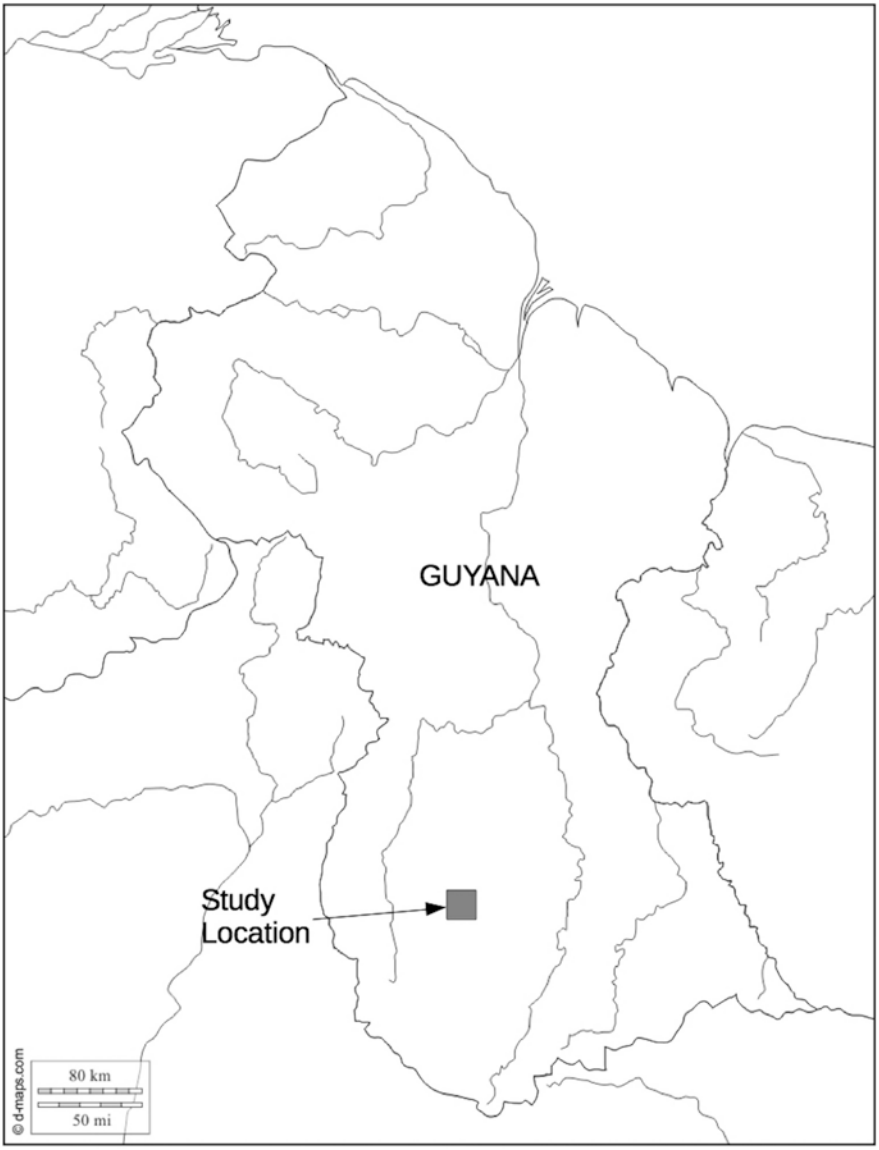

Fig. 12.1 Location of the study site

Sustained contact between Wapishana people and non-Amerindians in the South Rupununi began with the arrival of cattle ranchers in the final decade of the nineteenth century (Baldwin 1946: 36–39) and of Roman Catholic missionaries in the 1920s (Bridges 1985). Most villages, including the study village, have been incorporated into the national administrative system. Its very limited state-built infrastructure includes a primary school at which most current residents obtained some formal education, including learning spoken and written English. However, the dominant local language is Wapishana, spoken as a first language by the vast majority of local residents.

Remoteness, extremely poor road access and a lack of economic potential conspired to limit outside interest in the area over the course of the twentieth century, although this scenario is changing rapidly with Guyana's increasing engagement with global politics and economics. Limited alternative opportunities and lack of external interference have both obliged and allowed lifestyles to remain largely unchanged in many respects, particularly in terms of subsistence activities. However, the pace of change in Guyana since it opened its economy to foreign investment in the 1990s makes it unlikely this situation will persist.

Settlement straddles the savannah–forest boundary. Most families have a main dwelling in the central village on the savannah and one or more subsidiary dwellings at farms or hunting camps in the forest, the main site of subsistence pursuits. Daily life and livelihoods are dominated by subsistence activities, based around long fallow swidden agriculture combined with, in varying degrees, hunting (primarily of ungulates, large rodents and ground-dwelling birds), fishing, collection of wild animals and plants, and home gardening. At the research site, hunting remains an important economic pursuit for the majority of families and is a largely male activity. Most families also rear domestic livestock, a small number of these on a commercial basis, and some people supplement subsistence agriculture by growing peanuts for commercial sale. The trade in balata, the dried latex of the forest tree *Manilkara bidentata*, in the past provided an opportunity for a regular cash income. Most men were involved in the trade in some capacity, usually as the 'bleeders' who extract the latex from the tree, up until its collapse in the early 1980s.

To date, the effects of human activities on biodiversity levels and ecosystem function seem to have been largely neutral or beneficial. Forest cover is persistent or expanding, while population density is sufficiently low and customary mechanisms for land tenure are sufficiently flexible that farms remain widely spaced and fallow periods long. Human activity seems not to have eliminated any species of exploited animal or plant, and game remains abundant even in heavily visited areas of the forest in the farming zone. However, residents report local changes such as depletion of sedentary and/or heavily exploited animal species (including land tortoises, *Geocheleone* spp., and iguanas, *Iguana iguana)* in the immediate vicinity of the village and removal of etai palms *(Mauritia flexuosa)* along some creeks, which some people associate with a deterioration of hydrological cycles.

Awareness of dependence on biological resources, and their vulnerability to overexploitation, is behind an emerging conservation ethic expressed in public meetings, interviews and informal decisions by many, in the village, particularly leaders, teachers and other progressive persons. This phenomenon is invariably cast in utilitarian terms, as a means to secure and improve local livelihoods, retain political and economic independence and continue to provide the option of living along traditional lines. While generally aware that the very fact of making sustainable (more or less) use of the forest demonstrates a local management capacity, people also recognise that this capacity has limitations, and that expanding the skill base and management capacity could become increasingly important in the future. In 2012, the indigenous people of the South Rupununi produced a collective management plan, based on existing patterns of resource use and local ecological knowledge and management capacity (Gomes and Wilson 2012).

The potential for scientific ecology to contribute to such an expansion of local capacity depends on a complex intersection of factors. One is the compatibility between local ecological knowledge and scientific approaches to the study of ecology, including the extent to which the two overlap in terms of substantive content, epistemology and practical skills. This area of potential intersection of knowledge systems, ethnoecological knowledge in its most limited sense, represents a latent potential for traditional resource users to engage scientific approaches on their own terms. Whether this potential can be realised additionally depends on political conditions, specifically the capacity of traditional resource users to exert economic and hence sociocultural, self-determination (e.g. Toledo 2001), and the coherence of a scientifically informed ethnoecology with the wider sociocultural context of understandings of and interactions with the natural world (Posey et al. 1984).

The political circumstances for Guyanese Wapishana are relatively favourable. State recognition of indigenous land tenure, though imperfect and incomplete, does to a large degree allow autonomy in local governance and decisions over land use (Henfrey 1999). Active petitioning of the national government for an extension of titled lands, ongoing since the Amerindian Lands Commission report at the time of Guyana's independence and more recently supported by extensive self-documentation of land use in the affected areas, reflects a strong local and regional capacity for political self-assertion.

The study reported here addresses the epistemological dimension of Wapishana ethnoprimatology. It first describes the cultural ecology of Wapishana relationships with the local primate fauna. It then provides a detailed account of a study of the overlap between the substantive ethnoprimatological knowledge of Wapishana hunters and corresponding scientific information.

12.3 Cultural Significance and Understanding of Primates

The area inhabited and used by the Wapishana is home to eight species of wild primate: black spider monkey, *roomi* (in Wapishana) (*Ateles paniscus*); red howler monkey, *soboru* (*Alouatta seniculus*); common capuchin, *powato* (*Sapajus apella*); wedge-capped capuchin, *oao* (*Cebus olivaceus*); brown-bearded saki, *wishi* (*Chiropotes satanas*); Guianan white-faced saki, *oroa* (*Pithecia pithecia*); squirrel monkey, *chaumaa* (*Saimiri sciureus*); and midas tamarin, *witaro* (*Saguinus midas*). All were seen and heard, except *P. pithecia*, in the study area (the areas of forest used exclusively by Wapishana residents of Maruranau) during the course of research, including close to swiddens and in other areas heavily frequented by people.

Wapishana ethnoclassification recognises these as distinct natural types, each with a unique name, whose referent in the course of normal usage corresponds with the biological species. Both males and females of the highly sexually dimorphic *P. pithecia* form part of the segregate referred to as *oroa*; informants questioned about this said it is because they are the male and female of the same kind. However, terminologically distinguished subcategories exist within both *soboru* (a smaller kind referred to as *sooman siki*) and *powato* (a larger kind termed *wainsari*). I interpreted this as possibly reflecting the marked size differences between males and females of *Alouatta seniculus* and *Sapajus apella*, although no Wapishana informant identified them as markers of sex-specific differences.

Depending on circumstances, these primary segregates are grouped into several cross-cutting larger categories. The term *powato* is polysemous. Its plural form *powatonnao* also refers to a larger group comprising the eight primate species plus various other arboreal mammals; this grouping appears to be based on perceptual similarity. *Dukornainao*, translated by informants as meaning tree-dwelling creatures, is one of several higher-order categories based on habitat type. Its usage is inconsistent – sometimes apparently interchangeable with *powatonnao*, while at other times referring to a wider category also including various tree-dwelling birds. The term *aimaakannao* is also inconsistently used as a broad, but inexhaustive, collective category within the zoological domain, sometimes apparently restricted to mammals or quadrupeds, or sometimes a wider range of biological taxa. The zoological domain has no unique beginner or discrete collective term as such. Its cultural salience is demonstrated by its exhaustive partitioning into two binary categories based on perceived edibility: *wunii* (or edible animals) and *mawuniki* (animals which are not eaten). Assignment of less inclusive segregates to these groups is flexible according to changes in both cultural preferences and personal dietary choice. Wapishana classification of the zoological domain thus corresponds less to the rigid taxonomies described by some researchers (e.g. Berlin 1992; Atran and Medin 2008), which I consider to be artefacts of the elicitation context, and more to the flexible and dynamic frameworks described in more ethnographically situated studies (Ellen 1993; Sillitoe 1980, 2002b).

Most Wapishana hunters consider the larger six primate species as potential game – hence within the category *wunii*. The small size of squirrel monkeys and tamarins means hunters tend to disregard them as not worth pursuing, though both may be opportunistically captured as pets; I also observed one specimen of *C. olivaceous* being kept as a household pet. Hunting pressure on primates seems to be declining for both technological and cultural reasons. The cost of guns and ammunition in this highly cash-poor society, and to a lesser extent a government reluctance to issue firearm licences following an armed uprising in the Rupununi region in 1969, means that most hunters rely on bows and arrows made from natural materials, with which arboreal animals are harder to kill. Some people also reported changing dietary preferences, especially amongst some young people who express aversion to consumption of primate meat (hence, to them, becoming *mawuniki*, i.e. inedible meat). Ad hoc observations on my part suggested hunting pressure is not severe, with most species, including *Ateles paniscus*, evident even in areas subject to regular human use.

Hunting pressures on large primates, and other popular game species, are mitigated by a series of dietary prohibitions applied to the entire household (usually a tri-generational extended family group) following birth of a child or certain illnesses. These are particularly extensive in the case of spider monkeys, which are particularly sensitive to hunting pressure and, according to both ecological and ethnoecological reports, of great ecological importance as a key disperser of many tree species. The nature of this mechanism is thus suggestive of regulatory functions akin to a traditional form of conservation, part of a wider range of symbolically mediated restrictions on resource use, flexibly applied via customary mechanisms and the intervention of specialist spiritual practitioners (Henfrey 2002, 2018). Spider monkeys in particular are also important in various forms of traditional medicinal practice and various folk tales, some of them alluding to times of greater affinity with humans including shared language and ancestry. While of less direct economic importance than the main game animals, primates are thus recognised by Wapishana people as having both cultural significance and ecological value.

12.4 Ethnoecological Methods

Data reported here derive from a wider study of the ethnoecological knowledge of Wapishana hunters, mainly focussing on the six largest primate species found locally plus six other animal species of dietary, economic, ecological and/or cultural significance (Henfrey 2002, 2017). Of a total of 130 interviews with 18 individual hunters on the ecology of these twelve species, 45 covered primates and comprise the data set addressed in this chapter: *Ateles paniscus* (interviews with 12 different individuals), *Alouatta seniculus* (9), *Cebus apella* (7), *C. olivaceus* (5), *Pithecia* (7) and *Chiropotes satanas* (5).

I identified and recruited interviewees via peer recommendation (cf. Davis and Wagner 2003), targeting those locally regarded as most knowledgeable about the ecology of forest animals. This reflected the aims of the study: To obtain the best possible ethnoecological data set for comparison with scientific findings, not to examine patterns of variation in ethnoecological knowledge or document it comprehensively or systemically. Interviewees therefore came from a small subset of the population: mature men, regular hunters with a local reputation for skill in this regard. The majority had been involved in the balata (latex of the tree *Manilkara bidentata*) trade, and many claimed to have acquired much of their ecological knowledge during extended stays in the forest connected with this work.

Following earlier ethnoecological studies (Townsend 1995; Huntington 1998), the main data collection method was semi-structured interview. I also collected significant quantities of ethnoecological data by other methods: ad hoc recording of comments made during trips to the forest, observations of people's behaviour while hunting, their interpretations of animal signs and their explanations of how they track and hunt animals. However, for the sake of analytical uniformity, this chapter reports only data collected in interviews.

Interviews were conducted in English, as the strongest common language and the more effective in which to frame the categories of information in which I was interested. All animal and plant segregates mentioned in the course of interviews were named in Wapishana; in addition, both interviewer and interviewees commonly employed Creolese names.

Each interview focused on one species of mammal, named in Wapishana in the opening sentence of the interview, usually by the interviewer in a statement along the lines of 'What do you know about [segregate X]'. The interviewee first talked freely for as long as he wished. I subsequently asked specific questions: First clarifying any ambiguous or otherwise unclear points and expanding on points of particular interest and then following a predetermined question schedule reflecting the basic data collection goals I would have set for a preliminary synecological study. The questions covered diet, dispersal behaviour of frugivores, sociality, predation, reproduction, classification and human use. Finally, a series of leading questions invited the interviewee to add any further information on any of the points raised. I subsequently pooled interview data using a basic form of consensus analysis (including points common to two or more interviewees, rejecting those mentioned only once) to obtain overall ethnoecological profiles for each species.

I systematically compared the ethnoecological profiles for each species with data published in ecological studies. For each plant food for which I was able to assign a scientific gloss to the Wapishana name, I scanned the ecological literature for records of consumption of plants of the same genus and family. For other subject areas, I compared ecological and ethnoecological data to determine whether the two were compatible. For each observation in the ethnoecological data set, I also scanned the ecological literature for information on the same subject. When the latter was available, I noted whether or not the corresponding information in the two data sets was consistent.

12.5 Ethnoecological Findings

12.5.1 Summary of Ethnoecological Findings by Species

The following are brief accounts of ethnoecological findings on the six primate species in question, reported in full elsewhere (Henfrey 2017: 187–194):

12.5.1.1 Black Spider Monkey

All interviewees identified fruit as the major food. Most referred to seasonal variation in diet, animals being fatter (and more attractive targets for hunting) during the rainy season glut in fruit production, which is also when the single young is born. Some mentioned that spider monkeys call more often during the dry season when fruit is scarce and that they increase their consumption of leaves to compensate.

Most interviewees reported endozoochorous dispersal of seeds. A few also mentioned a habit of drinking water from pools that form in hollows in trees.

Reported group sizes ranged from 1 to 15, with a modal value of 4–6. One interviewee reported that groups separate to forage during the day and aggregate at sleeping trees at night. Those who considered habitat use concurred that they are found largely in high forest, where they occupy fixed home ranges and sleep on emergent trees. Most interviewees identified harpy eagles as the main predator. Several also mentioned their habit of pelting people with rotten wood.

12.5.1.2 Red Howler Monkey

Fruits and young leaves were identified as the main types of food in almost all cases, with opinion evenly split as to whether fruits or leaves are the most important food. Most identified a seasonal food shortage during the dry season, at which time the diet consists mostly of leaves. Most interviewees said that seeds are dispersed endozoochorously, although a few others contradicted this, saying that seeds are not swallowed.

Suggestions as to group size were quite consistent: most respondents reported groups of 4–6 animals, with wider answers ranging between 2 and 12. Several interviewees said that groups include both larger and smaller individuals (the latter being terminologically distinguished in the Wapishana language as *sooman sik)*.

Views varied as to territoriality – several interviewees claimed that howler monkeys occupy fixed home ranges, several others claimed that they do not – and daily activity patterns. All interviewees reported that treetops are used to rest, and the majority further specified a preference for sites with substantial epiphyte cover. Several interviewees suggested falls to be quite common, for a variety of reasons, and carcasses of hunted animals often to show evidence of broken bones. All identified harpy eagles as a major predator, some also mentioned big cats, while several mentioned chronic external worm infestations as a continuous condition.

12.5.1.3 Brown Capuchin

All interviewees identified fruits as the major food source; many noted certain palm fruits as being of particular importance. Most interviewees also mentioned arthropods as an important food: particularly, according to some, in the dry season when fruit is scarce. Several observed that they break open hard-shelled fruits or nuts by banging them against branches. Many also mentioned farm raiding, especially for maize and sugar cane.

Suggested group sizes varied, from approximately 4–10 to 20–30, which I interpreted as meaning that group size itself is variable. Several interviewees distinguished larger individuals via the term *wainsari*, identified by one as the leader of the group, by another as a large male, and observed by another as sometimes being found alone. Many interviewees referred to the formation of mixed-species groups with other species, in particular squirrel monkeys.

Several interviewees observed that breeding coincides with fruiting of the *koram* tree (*Inga alba* and perhaps other species of *Inga*) during the rainy season. All identified kokerite palms (*Attalea regia*) as the preferred resting place, some specifying the use of the large woody spathes to shelter from rain. Eagles, usually harpy eagles, were consistently noted as the major predator. Capuchins are reputed to outwit the attempts of jaguar to capture them, including in Wapishana folklore, which often alludes to the intelligence of this species.

12.5.1.4 Wedge-Capped or Weeping Capuchin

Interviewees all reported fruits and arthropods as the major foods, with several specifying the fruits of various species of *Inga* as of particular importance. Most also noted a seasonal food shortage during the dry season; a couple identified the fruit of *Parinari excelsa* as a key food source during this time. Some interviewees suggested seeds may be dispersed exozoochorously, at least of some species, when fruits are carried some distance from the parent tree before they are eaten and the fruit discarded.

Reported group sizes range from 4 to 12. Some interviewees mentioned (but did not terminologically distinguish) a larger kind that occasionally form groups of one or two individuals. Several interviewees mentioned that groups rest in the spathes of kokerite palms (*Attalea regia*). Most interviewees identified eagles as the main predator, in most cases the harpy eagle.

12.5.1.5 Guianan Saki

All interviewees agreed that fruits are eaten, in some cases adding either leaves and flowers, or insects. Several identified as the major foods the fruits of the kokerite palm (*Attalea regia*) and/or those of various *Inga* species. While some interviewees claimed selective endozoochorous dispersal of seeds, opinions varied as to whether or not seeds or dispersed.

Observations on group size ranged from two to six individuals, some specifying that groups include both sexes. All interviewees recognised the difference between males and females of this highly sexually dimorphic species, which are not terminologically distinguished. While some interviewees reported aggressive intergroup interactions, one interviewee said groups might temporarily aggregate to feed at the same kokerite tree.

Some interviewees noted that this species is common in the farm area (much of which comprises thick secondary growth in fallows). Many drew attention to their distinctive locomotory pattern based more on jumping between tree trunks than climbing through branches. A number of eagle species were named as predators, with some interviewees noting that sakis will hide from predators rather than attempt to flee.

12.5.1.6 Brown-Bearded Saki

All interviewees agreed that the diet is composed of fruit alone, with most specifying that unripe fruits are eaten. Several labelled this behaviour destructive, on the grounds that the seeds are often masticated and, in any case, picked before they are mature and so have no chance to grow. This information was contrasted with the behaviour of other monkeys known to disperse the seeds of their food plants and so – like people – contribute to their propagation.

Observations on sociality suggested groups of anything from 8 to 40 individuals, most commonly between 15 and 20. Two interviewees described how groups disperse into smaller subgroups to forage and aggregate at particularly ample food sources. Both suggested this information might reflect the uneven distribution of fruit and the fact that few single trees supply enough fruit to feed the entire group at once. Observations on habitat use suggested a preference for large areas of continuous high forest.

12.5.2 Comparison of Ethnoecological and Ecological Data

Space does not permit the inclusion here of a full description of the ethnoecological data set or its comparison with scientific data. For details of this and full references to scientific studies consulted, see Henfrey (2002: 179–212, 2017: 185–226). Table 12.1 provides a summary overview.

Table 12.1 Summary of comparison between ethnoecological and ecological data sets

Species	*Ateles paniscus*	*Alouatta seniculus*	*Sapajus apella*	*Cebus olivaceous*	*Chiropotes satanas*	*Pithecia pithecia*
Number of interviews	12	9	7	5	5	7
Proportion of food plants corroborated in ecological studies to family level	95% (20/21)	73% (8/11)	83% (10/12)	82% (9/11)	91% (10/11)	83% (5/6)
Proportion of food plants corroborated in ecological studies to genus level	81% (17/21)	36% (4/11)	42% (5/12)	64% (7/11)	45% (5/11)	50% (3/6)
Number of other observations for which comparable ecological data available	15	18	11	8	8	7
Proportion of other observations for which ethnoecological and ecological data are compatible	0.87	1.00	1.00	1.00	0.88	1.00

The ethnoecological and ecological data sets show high levels of substantive overlap. The majority of food species identified via ethnoecological methods were corroborated in ecological studies. Percentage corroboration at family level ranged from 73% (red howler monkey, *Alouatta seniculus*) to 95% (black spider monkey, *Ateles paniscus*), at genus level from 36% (red howler monkey, *Alouatta seniculus*) to 81% (black spider monkey, *Ateles paniscus*).

These figures are impressive considering the incompleteness and, in some cases, scarcity of ecological data on these species at the time. Ecological data sets are far from complete, and for many species, comparison relied on data from locations geographically distant and ecologically very different from the setting of this study. It is perhaps noteworthy that the highest correspondence at both genus and family level came from the species with the best quality data set, a multi-year field study of the ecology of *Ateles paniscus* (black spider monkey) in Surinam (Roosmalen 1985). This correspondence suggests that food lists derived from ethnoecological research are largely reliable, in which case food items occurring only in ethnoecological data sets will in most cases correspond to those eaten locally but not recorded in conventional ecological studies. However, this conjecture is impossible to prove without conducting formal ecological research in the same area over periods sufficiently long to assemble comprehensive food lists.

Considering qualitative observations, correspondence was very strong. I found directly comparable information in the ecological literature for 67 distinct observations in the ethnoecological data set. In 64 cases, the observations are at least consistent; in most of these, they are identical. For many ethnoecological observations, the ecological literature provided no comparable information: ethnoecology may thus extend the range of existing ecological data sets (cf. Ferguson et al. 1998; Huntington et al. 1999; Myrmin et al. 1999) or at least point towards new lines of investigation (Posey 1986), treating novel information from ethnoecological studies as hypotheses for testing by formal methods in scientific ecology.

Substantive correspondence between ethnoecological and ecological data sets is unsurprising, given the common ground between hunters and scientists in both aims and available techniques. Scientific researchers seek to reveal the behavioural ecology of the animal species of interest. Hunters apply detailed knowledge of their behaviour to increase the effective availability of animals that are often scarce and usually furtive in their behaviour.

Most participants in ethnoecological interviews qualified statements of knowledge with some reference to its acquisition. Almost all information reported was based on direct experience. Their reported methods were a subset of those employed by field biologists: direct observation of behaviour, interpretation of tracks and other spoor such as feeding signs and droppings, and examination of stomach contents of hunted animals. Correspondences between ecological and ethnoecological data sets therefore reflect overlap in aims and methods. Differences in opportunities for observation mean this correspondence is only partial.

12.5.3 Limitations of the Ethnoecological Data Set

While ethnoecological data appear to be accurate, they are also limited in various respects. Dietary information is incomplete, and in some other topics, ethnoecological methods yielded minimal or no data of direct scientific value. Some of these limitations I believe to be, at least in part, the result of specific weaknesses in the methodology employed here, upon which future ethnoecological studies may improve. Others may be inherent to ethnoecological studies.

Lists of corroborated food species in the ethnoecological data set were far shorter than those in the most complete of the ecological studies. Published studies list 171 food plants for *Ateles paniscus* (Roosmalen 1985) compared with 26 in the current work, 97 versus 15 for *Alouatta seniculus* (Julliot and Sabatier 1993) and 66 versus 18 for *Sapajus apella* (Guillotin et al. 1994). Food lists were comparable in length for *Cebus olivaceus* (Wright 2002) and *Chiropotes satanas* (Norcock and Kinzey 1994), but only the *C. olivaceus* study covers at least a full year.

The case of *Ateles paniscus* strongly suggests gaps in the ethnoecological data set. The fruit of *Bagassa guianensis* is an important component of spider monkey diets in Surinam (Roosmalen 1985; Norcock and Kinzey 1994) and French Guiana (Simmen and Sabatier 1996). Its referent in Wapishana, for which I made a reliable field identification, was only mentioned by one ethnoecological informant and hence discarded from the data set, although the tree itself was familiar to all interviewees. This may reflect a biogeographical difference: *B. guianensis* is relatively uncommon in the study site and locally absent from many people's primary hunting areas, limiting their opportunities for observation. The discrepancy may also result from the relatively small number of interviewees and the weakness of the method used for consensus analysis.

For food items other than fruits, the discrepancy between the two data sets is even greater. Ethnoecological interviews identified of only one species whose leaf is consumed by each of *Ateles paniscus* and *Alouatta seniculus* (although most interviews on these species identified leaves as a category of food), whereas ecological studies report 28 for *Ateles paniscus* (Roosmalen 1985: 74) and 98 for *Alouatta seniculus* (Julliot and Sabatier 1993: 536). Ethnoecological data on other food categories such as flowers and invertebrate foods are similarly impoverished. For arthropods and other invertebrate foods, the difficulty of field identification means the same is often true in ecological studies (e.g. Freese and Oppenheimer 1981).

In some respects, the Wapishana biological lexicon constrains the potential of the ethnoecological data set. For example, very few named terminal categories in the Wapishana language refer to plants of liana habit: most are subsumed under a single residual category. In one ecological study of the feeding behaviour of *Ateles paniscus* in Surinam, 25.6% of food species reported were lianas (Roosmalen 1985). In ethnoecological interviews on this and other species, interviewees often reported that the fruits of several kinds of lianas were eaten, but that the plants concerned either did not have Wapishana names or that if they did, they did not know them. The same may well apply to invertebrate foods, as Wapishana classification clumps many categories of invertebrates into groups corresponding to relatively high taxonomic ranks, often order (Henfrey 2002). I found the Wapishana terminology for ecological zones not to be very detailed, so lexical factors might also limit ethnoecological observations on habitat use.

Further weaknesses in the ethnoecological data set were apparent in subject areas not included among the data reported here. My earliest phase of interviews included questions on group dynamics and breeding rates. In the former case, answers given were invariably to the effect that juvenile animals, on maturity, remain in the natal group to breed with either parents or siblings. Such answers clearly contradict basic biological theory on inbreeding avoidance and are of little biological value, though may be part of significant cultural narratives.

It is hardly surprising that ethnoecological enquiry does not produce accurate information on these topics, as they are not accessible to the opportunistic observation that is its main method. The collection of such information by biologists depends on regular observations, sustained over extended periods, of particular animals recognised as either individuals or groups. Wapishana and other indigenous naturalists whose main immediate concerns are much more practical do not interact with animals on such a basis and so cannot reproduce data sets collected under the conditions in which most biological field research takes place.

12.6 Discussion: Suggestions for Improvement in Ethnoecological Research Methods

In the light of both the findings of this research and methodological prescriptions of other ethnoecological studies since published, in this section I suggest various methodological improvements. I believe their implementation would substantially improve data on diets in particular. Some weaknesses of the ethnoecological data set in this study, however, I believe to be inherent to this type of research, however good the methodology.

Sample size is one factor: clearly, the greater the number of people providing information, the more the information they can collectively provide. Simple linear regression using the full data set from this study (i.e. also including animals other than primates) indicated a strong positive correlation between the number of interviews on any particular animal species and the number of corroborated food plants elicited ($r^2 = 0.691$, $p < 0.001$). The same analysis did not indicate any relationship between numbers of corroborated food plants in the ethnoecological data set and the numbers of food species reported in the most complete ecological study available for each species ($r^2 = 0.043$, $p = 0.6$). This strongly suggests that further interviews on any animal species would have extended the list of food plants. For no species did we conduct sufficient interviews to reach a point of diminishing returns where further interviews introduced few or no new food plants. Acting upon this finding may not always be possible, as any study is constrained by limits of time and resources and can only incorporate as many interviews as these allow. However, additional interviews are in most circumstances a more efficient way to accumulate ecological data than conventional field research methods. Given sufficient field time, I would suggest following the recommendation of Davis and Wagner (2003) that peer recommendations be followed comprehensively in order to identify all those regarded as experts within a particular local setting.

Increasing the number of interviewees would both necessitate and facilitate a more sophisticated method for determining which responses to include. With the rough method employed, increased sample size raises the possibility of including erroneous observations, if two or more interviewees provide identical, factually inaccurate, information. It is also important to identify rare, accurate information provided by collaborators with particularly extensive or specialised knowledge. Consensus analysis (Romney et al. 1986) gave unsatisfactory results with this data set, which deals with dispersed knowledge in which most information was provided by only a small number of informants, but could perhaps be modified to deal with a larger data set.

Another useful method for corroborating doubtful information and dealing with contradictory responses is group interviews (Huntington 1998). Individual interviews remain crucial, as they compel the interviewee to respond. It is likely that many people provide information that they would not in a group context, in which people are effectively competing for speaking time and may be inhibited by the prospect of censure for inaccurate responses. Discussion in a group context may also encourage people to modify their opinions in the light of what other people are saying; the dynamics of this process are complex and not necessarily based upon deference to superior knowledge (Ellen 1993). I therefore propose that group interviews would be most effective as a follow-up to a programme of individual interviews. Pooled information from individual interviews could form the starting point for discussion in group sessions concerned with establishing a consensus on controversial or infrequently mentioned points.

Dietary lists might be more complete if food plants, rather than the animal species themselves, are the starting point of interviews. While simply naming the plants may be acceptable, more effective would be to observe them in situ or provide either specimens or high-quality pictorial representations. In the present study, interviewees often volunteered information, within and outside of the interview context, in response to the sight of a fruit or a plant known to be food for a particular animal. I also conducted a small number of interviews on tree ecology, which yielded much information on animal consumers and dispersers absent from those based upon the animal species as their starting point, even in cases where the same interviewees had spoken about the same animals. This suggests that interviewee recall is an important factor: focusing on the plant eaten rather than the animal stimulated the recall of different information.

Conducting ethnoecological interviews on every single plant that might possibly be an animal food could be rather laborious, particularly if only a few species of consumers are of interest. More efficient is the use of botanical voucher specimens to serve as concrete stimuli for responses. Interviewees could be asked to pick out the plants eaten by a particular animal, asked whether a particular animal eats the species represented by each voucher specimen in turn or asked to list the animals who feed on each species in turn, depending on the aims and setting of the study and the time available. It is clear that for ethnoecological information to be scientifically useful requires translation of the local botanical and zoological lexicons. For this purpose, as well as the potential methodological application of voucher specimens, a study such as this one would be most effectively conducted in conjunction with a thorough study of ethnonomenclature, especially of plants.

One study of Guajá hunters' knowledge on the diets of monkeys used botanical voucher specimens as the basis for elicitation, obtaining far longer lists of food plants for several primate species than those obtained in the present study (Cormier 2004). In the Guajá study, 90 food plants were listed for *Alouatta belzebub*, 88 for *Sapajus apella* and 74 for *Chiropotes satanas*. This data may partially reflect differences in knowledge and sample size: monkeys are far more important to Guajá than Wapishana hunters, and in the Guajá study, data came from 25 informants. However, I strongly suspect that using plants rather than animals as the starting point of interviews is also a significant factor.

12.7 Conclusion

This chapter has addressed the relationship to scientific ecology of a limited aspect of Wapishana ethnoprimatology: ethnoecological information on various primate species, organised into categories derived from the concepts of scientific ecology and compared with information collected in ecological studies. Ethnoecological data is largely consistent in both form and substance with that of scientific ecology, is accurate in detail when assessed in scientific terms and for many species extends the existing ecological data set. It is also limited in various respects, in which scientific ecology provides a possibility for extending its epistemological and analytical range.

The area of overlap also encompasses scientific epistemology: The generation of hypotheses and the collection of field data according to which these hypotheses can be tested. Applying ethnoecological data within its cultural context, by combining it with information on resource use, generated hypotheses concerning the ecological consequences of resource use amenable to testing via scientific methods (Henfrey 2002, 2017). The demands of collecting data associated with such testing can be partly fulfilled by applying practical and technical skills associated with performative aspects of local ecological knowledge to ecological research, an endeavour to which the skills of indigenous hunters are well suited and readily transferable.

Many of the subject areas inaccessible to ethnoecological enquiry include precisely those of most importance in conventional management programmes based upon scientific ecology. Traditional resource management systems include a variety of mechanisms for monitoring populations and regulating harvest based on different premises from scientific management, requiring far less data input (Johannes 1998). These represent a set of methodologies and practical measures available in LEK but beyond the range of SEK. LEK and SEK are thus complementary not only in terms of producing partially overlapping data sets, but also in that each can extend the epistemological and practical scope of the other.

There thus exists a strong basis for the complementary integration of LEK and SEK, able to extend the range of each without eliminating any of their essential features. The greatest likelihood of such a synergistic combination arises from employing LEK in its original context: interactions of resource users with their biotic environment in the conduct of routine domestic and subsistence tasks. This complementarity means that scientific ecologists concerned with resource management can apply their skills most effectively by placing them at the disposal of traditional resource users, as tools to extend their management capacity and provide a stronger base for local decision-making, within the context of equitable relationships based on mutually respectful dialogue.

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