CHAPTER 11

BACK TO THE TREES? DIET AND HEALTH AS INDICATORS OF ADAPTIVE RESPONSES TO ENVIRONMENTAL CHANGE

THE CASE OF THE PUNAN TUBU IN THE MALINAU RESEARCH FOREST

Edmond Dounias, Audrey Selzner, Misa Kishi, Iwan Kurniawan and Ronald Siregar

INTRODUCTION

It may seem a truism to say that the future of forest ecosystems is inseparable from the future of people living in these forests. But facts on the ground sadly indicate that this evidence is not fully addressed by decision-makers and practitioners of forest management. Accordingly, damage to the health of both the forest and humans should be investigated jointly. Unfortunately, research that is devoted to the consequences of biodiversity loss on human health has long focused on the ecological and global systems and persists in neglecting the more local human sociological and psychological factors that come into play. It becomes more and more urgent that environmentalists, ecologists, anthropologists and medical scientists sit around the same table to investigate the relationships between the many components of forest anthropogenic systems in order to assess the problems that simultaneously compromise the health of forest-based people and the sustainability of their ecosystems. Forest managers and policy-makers urgently need to be oriented towards solutions that combine ecosystem management and health-sector interventions to improve human health and well-being while maintaining a healthy ecosystem.

The dramatic situation of the few remaining hunter-gatherer groups who still depend highly on forest resources is emblematic of what is at stake in the context of rapid conversion of forest regions. Recent studies of hunter-gatherers provide models of how humans lived when their lifestyles and their genetic endowment were more clearly compatible. Assessing hunting and gathering ways of life is indeed of vital importance to general human health. The cumulative experience of foraging societies can usefully be viewed as a benchmark for present-day efforts to promote health and prevent disease, even in the world's industrialised countries.

Changes in diet and exposure to emerging diseases are sensitive indicators of the ecological and cultural costs that former hunter-gatherers such as the African Pygmies, the Brazilian Yanomami and the Punan of Borneo, for instance, are actually paying to secure their share of modernity. Such indicators reveal the socio-political problems that necessitate concerted and urgent interventions, which respond to both development and conservation interests.

The 'Rousseauistic' image of the noble savage living in harmony in his environment has long persisted, but such romanticism has in turn perversely reinforced the conviction among many practitioners of forest management and conservationists that the forest is unsuitable for humans. The high correlation between the diversity of parasitic and infectious diseases and the distribution of tropical humid forests, have also nourished the persistent belief that forests are inhospitable environments. Such perceptions underestimate the numerous services provided by natural ecosystems in controlling the emergence and spread of infectious diseases. The protective function of biodiversity maintains the balance among predators and prey, and among vectors and parasites in plants, animals, and humans (Chivian, 2001). Governments which seemingly distrust nomadic peoples, whatever the latitude, have leapt at this view to justify decisions to push forest-dwellers outside the forest, purportedly for their own benefit. For decades, promises of better access to education and health services, to markets and job opportunities have been recurrently used by authorities to persuade hunting and gathering societies to embrace a more sedentary lifestyle. But modernisation, often hastened by government incentives, has generally resulted in increased poverty, and the fanciful advantages that development and social change are supposed to bring often turn out to cause social and health disorders. The apparently noble arguments brandished supposedly for the sake of these people often hide a desire for access to the rich biological and mineral resources that are located in the vast territories extensively used by foragers and pastoralists. In poorly inhabited areas, these nomadic people represent an appreciable mass of potential laborers, voters, taxpayers and animists to be proselytised. They also convey an image of savageness that blurs the international credibility of countries aspiring to be viewed as developed and respectable nations. Last but not least, these peoples seldom care about administrative frontiers (Lee and Daly, 1999; Panter-Brick *et al.*, 2001).

The relocation of nomadic people driven by economic, environmental and political factors jeopardises their health conditions by exerting enormous pressure on the environment. Once foragers become sedentary and spend time in larger aggregations, a human reservoir is established that encourages the proliferation

Food consumption in a Punan family. Kuala Rian, June 2003 (Photo by Edmond Dounias)

and continuation of a heavy pathogen load. Environmental changes in local land use after settlement may as well combine with global alterations of climate to disrupt the natural ecosystem, hence producing new favourable habitats to vectors and causing an increased risk of transmission of viral and parasitic infections to humans (Patz *et al.*, 2000).

Objectivity obliges us to recognise that nomadic peoples also have to struggle with their own contradictions: in a world of growing globalisation, they claim their right to continue living in close relation with nature, while at the same time, they are attracted by consumer goods and desire, legitimately, a share of modernity. The renunciation of their nomadic lifestyle is a heavy price to pay to be recognised as full citizens and to benefit from social justice. Unfortunately, choices are generally driven by the immediate and ephemeral, though comprehensible, satisfaction of material well-being and much less by long-term moral and patrimonial considerations for the well-being of future generations.

RESEARCH GOALS

The overarching objective of this chapter is to explore the impact of the conversion to sedentary lifestyle on Punan diet and their related health status. The field study that was carried out in the Malinau Research Forest between 2000 and 2005 aims at comparing the dietary regime and nutritional status of a range of distinct Punan communities. These former hunter-gatherer communities share common socio-cultural characteristics, and all adopted extensive upland rice cultivation almost six decades ago. However, they are distinctively positioned along a gradient of dependency on agricultural products and accessibility of urban facilities. To assess how social change and sedentarisation may affect the diet and the health of these former hunter-gatherers, we undertook a comparative and quantitative study of the changing dependency on forest resources of Punan still living upstream in remote villages, compared to Punan now resettled in the district head city of Malinau. Upstream Punan still seasonally migrate into the forest and depend highly on forest resources for their subsistence. On the other hand, downstream Punan have turned their backs on their former nomadic way of life, and their livelihoods now totally depend

on local markets, city subsidies and fees from concessionaires. These two populations have the same origins (the Tubu watershed), the same language, the same cultural background and oral traditions, but diverge in their diet, access to health services, relation to the outside world and their perceptions and use of forest resources. We implemented a research programme which combines first-hand data in the fields of economy, demography, spatial and social mobility, seasonality of resources and activities, biomedical survey and a quantitative food consumption survey.

Our research belongs to the field of human ecology and focuses on the interactions between the diet and health status of the Punan. One of its key objectives was to assess the actual contribution of non-timber forest products (NTFPs) to the food and health integrity of the Punan and to determine to what extent differences in access and use of NTFPs can explain the gap in health conditions between remote and peri-urban settlements.

The research consists of analysing Punan food behaviour from several interacting perspectives (Figure 1):

- From a social perspective: relationship between food consumers via food-sharing rules, meal distribution and festive, ritual, ostentatious and curative dishes.
- From a cultural perspective: habits, perceptions and representations concerning medicinal and food resources.
- From an ethno-ecological perspective: knowledge, know-how and access modalities concerning the spatial and seasonal availability of resources.
- From a biological and anthropological perspective: nutritional value of food, and the influence of diet on physiological and epidemiological status.

By comparing the diet and health situations of the Punan of the same group (the Punan Tubu), but in two contrasting social and ecological environments (remote villages compared to recent settlements close to Malinau town and with reference to their recent past as nomadic hunter-gatherers, we question the health consequences of 'development'. In the process of adaptation, every population develops defences against the predators, parasites and pathogens in its environment. But social change such as settling down near a city may not necessarily have positive effects on the well-being of people. Social change may even sometimes destroy or invalidate the defence mechanisms or present new challenges for which there are no defences, thus precipitating an increase in disease and adding to the population's adaptation load. Social change, as generally observed among hunter-gatherers when they shift from nomadic

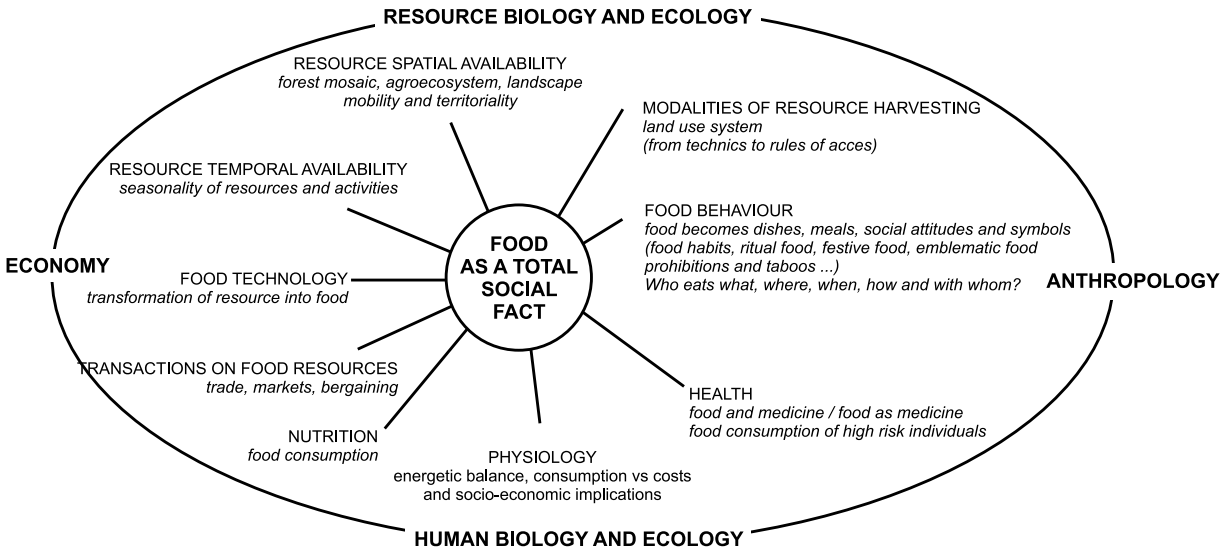

Figure 1. Matrix for the interdisciplinary study of food

life to settling in permanent villages, may also threaten their nutritional status in various indirect ways.

To achieve the goals of this multidisciplinary research, a series of complementary study protocols was implemented throughout the Tubu watershed (Figure 2).

What's the use of weighing food?

The study of nutritional status and its implication in food and health security is a focal issue in our approach. It refers to food habits that are oriented by cultural choices and free will. But it is also conditioned by environmental constraints and depends on local strategies of access to resources (wild as well as domesticated). In such a perspective, the comparison of Punan communities from the upper Tubu with semi-urbanised Punan from Malinau is of utmost interest.

The goal of the QFCS is to estimate the nutritional value of the dishes for each category of consumers and to identify possible chronic as well as seasonal nutrient deficiencies that may affect health, especially among high-risk groups (children, pregnant women, etc). The reference unit considered is the *rumah tangga* (the house) that may include several *keluarga* (households) who may collectively or separately prepare and consume dishes.

How did we proceed?

A comparative quantitative food consumption survey was carried out in three villages: one sub-urban settlement near Malinau city (Long Payang), one settlement in middle Tubu (Rian Tubu) and one among the most remote settlements of the Tubu watershed (Long Pada). Food consumption was recorded on a quarterly basis, every three months from May 2003 to July 2004, in order to assess the impact of seasonality on food strategies. We surveyed a total of 43 households distributed over 27 houses.

The survey protocol consisted of weighing systematically during four consecutive days:
- Ingredients before cooking;
- Meals after cooking;
- Food distribution between consumers; and
- Leftovers.

1,214 dishes were measured over the 15-month period of study.
- May–June: 84 house-days, 878 dishes, in 3 villages (Long Pada, Rian Tubu, Long Payang);
- September: 14 house-days, 73 dishes, in 3 villages (Long Pada, Rian Tubu, Long Payang);
- December: 12 house-days, 75 dishes, in 2 villages (Long Pada, Rian Tubu);
- March '04: 17 house-days, 96 dishes, in 3 villages (Long Pada, Rian Tubu, Long Payang);
- July '04: 18 house-days, 92 dishes, in 3 villages (Long Pada, Rian Tubu, Long Payang).

We first started using Yamamoto YB99 baby scales to weigh ingredients and dishes. As precision of these scale is only 20 g, we also used Oliver precise handy scale (maximum weigh 200 g, precision 0.01 g) to weigh ingredients used in small quantities such, salt, spices or potassium glutamate. In 2004, we continued with a CB 12K 1N Kern industrial scale (capacity 12 kg, readability 1 g).

Direct observations provided precious information about the social dimension of food consumption. Who eats with whom? Who receives food from whom? Do households living under the same roof share their meals? If not, why? How many people (and who) eat from the same plate compared to how many (and who) eat individually? What is given to domestic animals?

Complementary to the quantitative and seasonal food consumption survey, we also carried out a longitudinal food survey. The meals of all the households of three villages were systematically noted, but without weighing, and the origins of the ingredients and the identity of the consumers were recorded. Nearly 400 meals were monitored monthly, represented by almost 9,000 monitored meals that are being calibrated by using weight measurements during the quantitative food survey in order to get a more accurate view of diet fluctuation throughout the year. The analyses of the large data set collected during the food consumption survey are still in progress.

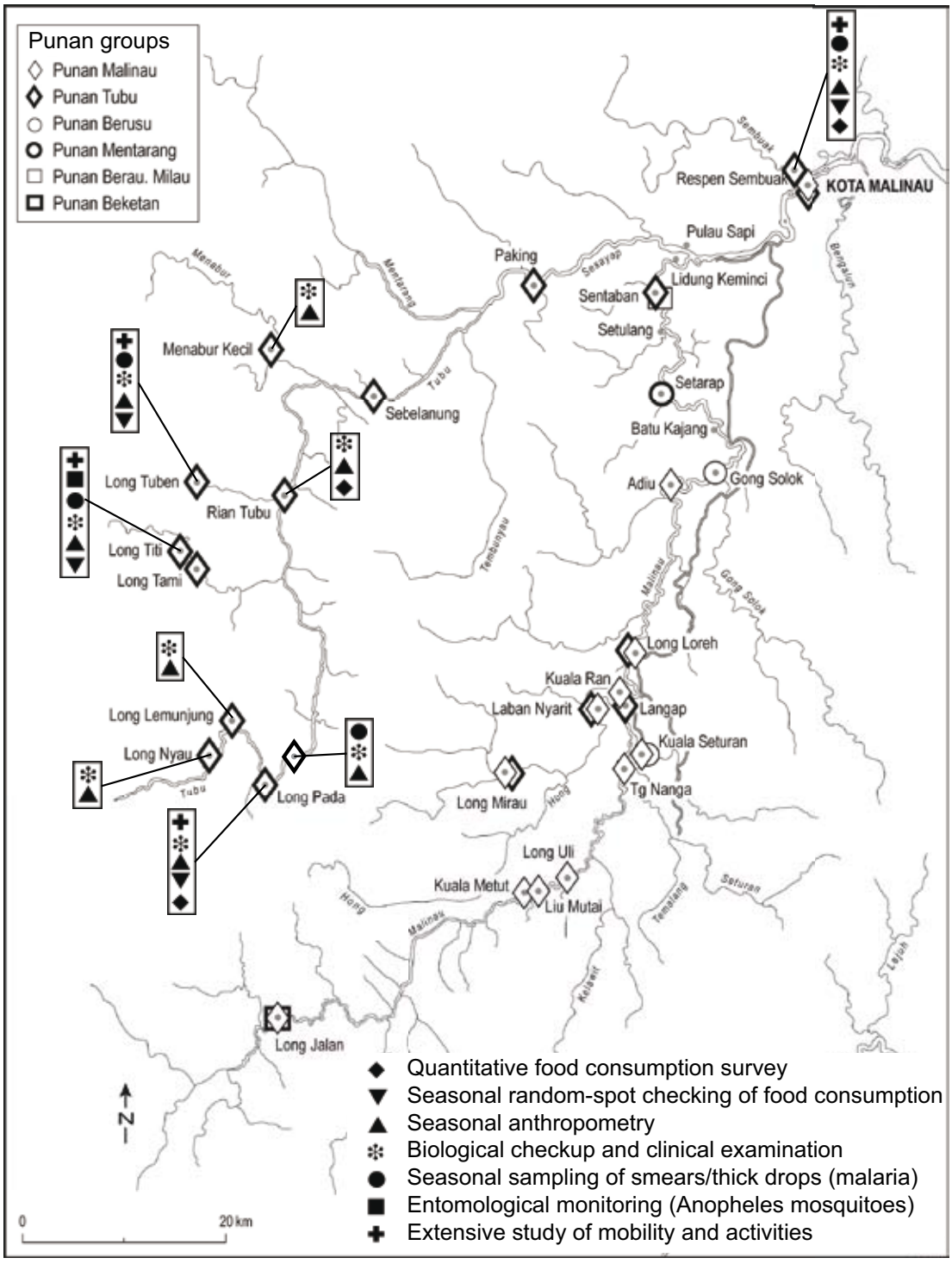

Figure 2. Nutritional ecology of the Punan Tubu. Location of sites and study types

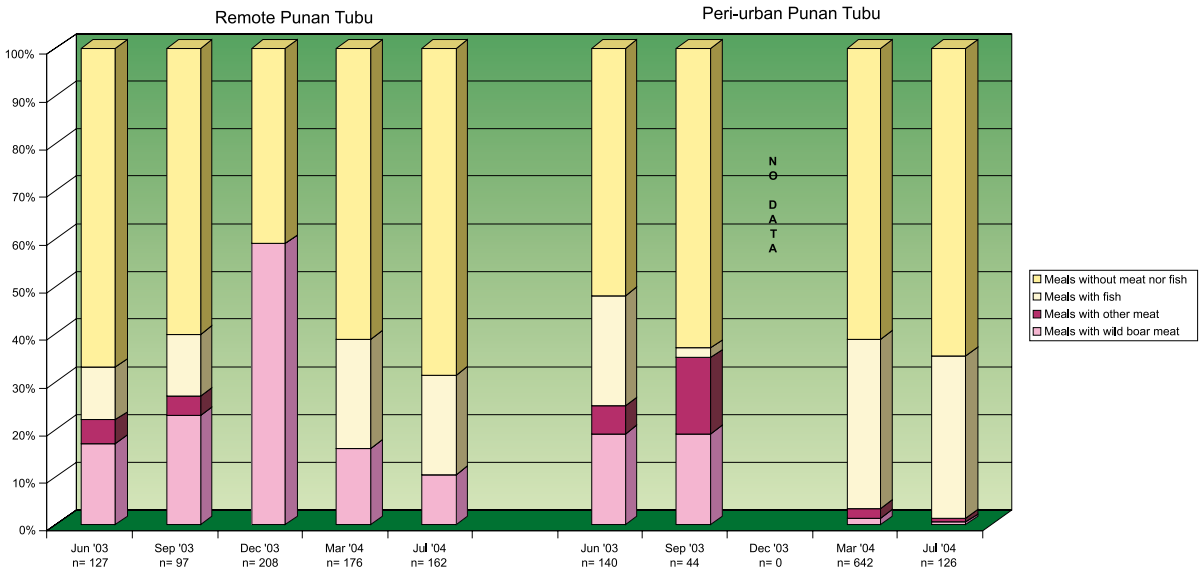

Figure 3. Seasonal use of the main food categories for the three distinct locations

RESULTS

Figure 3 presents the proportions of major categories of food (meat, fish, vegetables and starchy staple food) used in Punan meals. This figure is composed of three distinct graphs that show the seasonal fluctuations (June' 03, Sept '03, Dec '03 and March '04) in using these categories of food within the three compared locations (peri-urban, middle Tubu, remote Tubu). These graphs show:

- Significant differences between locations during the same season. For instance, if we consider March '04, meat was rare in the diet of peri-urban Punan whereas it was abundant in remote Tubu. By contrast, vegetable consumption was much higher near cities and less frequent in remote villages;
- Significant differences between middle Tubu and remote Tubu. The differences we observed cannot always be explained by distinct accessibility to cities between these two settlements. They also express different strategies among remote villages, mainly based on time allocated to agricultural versus non-agricultural activities;
- Significant fluctuations of diet according to season.

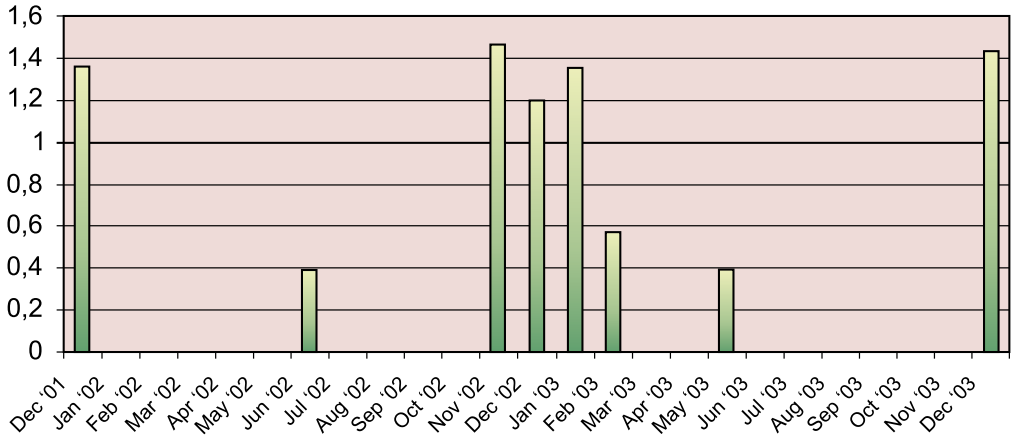

Figure 4. Seasonal fluctuation of the daily rate of wild boar captured in Long Pada village

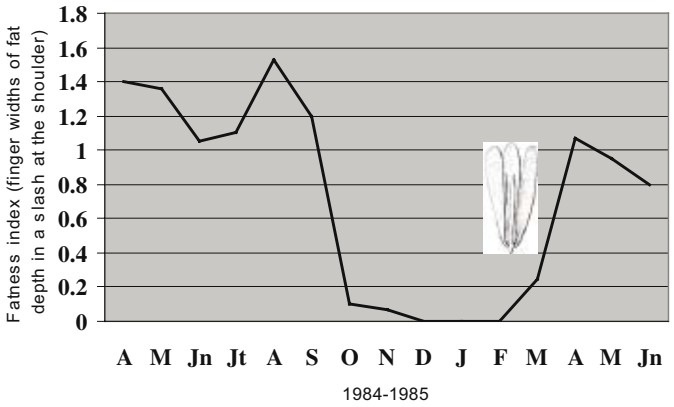

Figure 5. Seasonal fluctuation of wild boar meat

The sources of animal protein are mainly meat (eggs are eaten only by peri-urban residents) and, to a lesser extent, fish. The sources of protein are much more diversified in remote areas, and protein is consumed in these areas in greater quantities. Meat and fish consumption are facilitated by persisting social regulations such as mutual aid and food sharing, which impose rules of systematic redistribution of bushmeat and massive fish catches among the whole community. Downstream, where rules of mutual aid are in constant decline, opportunities to consume protein-rich food are more erratic and the food is more costly.

As it is commonly known, the Punan have a strong preference for wild boar meat (Dounias, in press). But since wild boar is a seasonal resource, the contribution of other sources of meat to the diet also fluctuates accordingly. Wild boar meat is more difficult to obtain near the city (and this fatty meat rapidly deteriorates after a couple of weeks, so the possibilities for storage and delayed cooking are limited). On the other hand, the proximity to markets offers greater opportunities to find other meat (from Sambar deer, monkeys, chicken), thus explaining the higher meat diversity in peri-urban villages.

Wild boar is a very seasonal prey as this mammal migrates following patterns that are not yet well understood but are thought be highly dependent on the erratic mast fruiting of dipterocarp trees (Figure 4). As shown in Table 1, the type of wild boars captured varies also according to seasons (mainly gravid or brood females in December, mainly adult males five months later). To conclude, the contribution of wild boar meat to the diet fluctuates both in quantity and quality. The nutritional value of meat (illustrated by Figure 5 by the fluctuating fat content contained in wild boar meat) also changes according to seasons. For instance, the organoleptic characteristics of the meat are affected when the females are gravid, or during the season of reproduction when high concentrations of uric acid during mating periods compromise the palatability of male prey meat.

Carbohydrates, which provide energy and are the staples of the diet, are mainly provided by cultivated tuber and cereal crops (Table 2). Six types of food crops are grown in the remote areas, twice the number in the other areas. Depending on the season, rice is the staple food in 80% to 100% of the meals (percentages provided hereafter accordingly correspond to the percentage of meals containing the food). After sedentarisation, rice rapidly replaces sago as the major staple food. However, the Punan are not true farmers, and remote villages are far from being self-sufficient in rice. However, opportunities to bring rice back from the city are more frequent in middle Tubu. During periods of rice shortage, the remote Punan depend heavily on starchy tubers. Again, different food habits emerge between middle and remote Tubu villages. While middle Tubu villagers prefer to eat cassava flour, those living more upriver predominantly eat cassava tubers.

Sago starch used to be the staple food for the Punan Tubu before they became sedentarised. It

Table 1. Seasonal fluctuation in the type of captured wild boars

	December 2001	May-June 2002
Hunting expeditions per day	1.4	0.9
Unsuccessful hunting expeditions	22%	68%
Contribution of wild boars to total preys	83%	47%
Most frequently captured	Gravid/brood females (53%)	Males (63%)

Table 2. Seasonal fluctuation of consumption of the main food categories by the Punan Tubu (g/capita/day) (weighed meals: Jun 03: n = 878; Sep: 03: n = 73; Dec 03: n = 75; March 04: n = 96)

	Month	Remote Punan Tubu	Peri-urban Punan Tubu
Meat and eggs	Jun '03	130.4	72.9
	Sep '03	60.9	65.1
	Dec '03	191.3	No data
	Mar '04	31.8	14.8
Fish and shellfish	Jun '03	43.9	42.2
	Sep '03	34.9	4.9
	Dec '03	0.0	No data
	Mar '04	58.9	63.9
Starchy staples	Jun '03	889.1	1000.2
	Sep '03	545.9	1033.4
	Dec '03	298.7	No data
	Mar '04	581.7	886.5
Vegetables	Jun '03	91.8	87.5
	Sep '03	49.1	74.8
	Dec '03	33.2	No data
	Mar '04	62.4	203.1
Oils and fats	Jun '03	2.5	9.5
	Sep '03	0.1	4.3
	Dec '03	0.0	No data
	Mar '04	0.7	11.9

remains important only for the remote villagers (12% of meals) and only during seasonal migration into the forest for hunting and NTFP gathering. Sago has totally disappeared from the diet of peri-urban Punan. The extraction of sago starch is a long and complicated process, which affects the nutrient content of the resource. After cooking, the energy value and caloric return of sago starch is very high. Unfortunately repeated filtration of starches wash out the few vitamins contained within it. Manufactured noodles, an exotic and rare delicacy for the remote Punan Tubu, appear in 5% of the meals prepared by their peri-urban relatives.

The peri-urban Punan Tubu eat twice as many vegetables as the remote Punan Tubu. The gap is even more pronounced when meat is seasonally difficult to obtain downriver and the dietary regime of the peri-urban residents becomes almost vegetarian. Near the city, the Punan Tubu, who practise swidden-fallow agriculture, cultivate 45 species of vegetables, spices and seasoning plants, three times as many as are cultivated by the remote Punan Tubu, and they consume them much more frequently. Upriver, fern crosiers and cassava leaves represent 85% of the total amount of vegetables consumed, compared with only 47% near the city.

The remote Punan Tubu consume oil and fat in more moderate quantities. The fat they use for cooking is mainly obtained from wild boar and is progressively replaced further downstream by manufactured palm oil, a monosaturated fatty acid that is poorly digested but is fairly cheap to produce (without taking into account the damaging ecological impact of oil-palm plantations). Palm oil is extensively used locally for cooking and is also found in snacks and many other manufactured foods.

Table 3. Proportion of shared plates decreases with proximity of the city (% of meals)

	Jun '03	Sep '03	Dec '03	Mar '04
n	4042	255	374	486
Peri-urban Punan Tubu	10	no data	no data	17.4
Middle Tubu	20	19.2	18.7	27.8
Remote Tubu	25	40	33.1	28.9

Table 4. Increasing proportion of snack consumption with proximity of the city (% of meals)

	Jun '03	Sep '03	Dec '03	Mar '04
Peri-urban Punan Tubu	21.5	10.4	no data	0.1
Middle Tubu	1.7	2.8	1.5	0.4
Remote Tubu	0.8	1.5	1.3	1.2

Changes in food habits: food sharing and consumption of snacks

Food habits are also important to assess. For instance, they may inform us on mother/child relations and on how mothers manage weaning, which is a critical nutritional breakthrough during childhood. Collective activities and mutual aid for house building, swidden clearing, planting or harvesting, are social and festive occasions marked by food sharing. Food sharing is commonly practised by collectivist societies as an efficient adaptive response to temporary food scarcity (Dounias and Colfer, in press). The frequency of food sharing is thus a relevant indicator of persisting or degrading collectivist practices.

In Table 3, the frequency of shared plates is compared between remote and peri-urban settlements. Whatever the season, the proportion of shared plates is lower in peri-urban settlements, thus expressing a severe regression of mutual aid near the city. We observed the same tendency for gifts of food before cooking, like the distribution of bush meat. *'Nowadays if you want to eat you have to pay'* is a popular lament in peri-urban resettlements. Another illustration is the decreasing proportion of food resources that are obtained as gifts or through exchange: 18.1% compared to 5.1% among the remote and peri-urban Punan Tubu, respectively. By contrast, the proportion of purchased ingredients, another symptom of more individualistic economic strategies, increases with access to markets: the proportion is 26.2% for the remote Punan Tubu compared to 57.2% for the peri-urban Punan Tubu.

Another remarkable aspect of food consumption shown in Table 4 is the poor proportion of snacks compared to other forest dwellers. Our data also reveal significant differences between remote and peri-urban villages and more frequent snacks among peri-urban villagers who can buy cakes and 'fast food' from mobile vendors. The types of snacks differ according to location: hot drinks and fruits in remote villages compared to cakes and ice creams, 'fast food' and fatty and salty appetizers near the city.

Comparative biomedical survey among the Punan villages of the Tubu watershed and Respen Tubu

The biomedical survey included six components:

- Regular update of the Punan census and extensive study of child mortality;
- Seasonal anthropometric measurements;
- Blood sampling and analysis;
- Urine sampling and analysis;
- Stool sampling and analysis; and
- Clinical examination and provision of medical treatment.

Table 5. Pregnancies and child births during lifetime (data for post-menopausal women only)

	Remote Punan Tubu (n=20)	Peri-urban Punan Tubu (n=27)
Pregnancies during lifetime	8.8	7.8
Miscarriage (% of pregnancies)	20.7	25.0
Still alive (% of births)	48.4	67.5
Dead before weaning (% of death)	56.7	53.2
Dead between weaning and 5 year old (% of death)	14.4	31.2
Dead after 5 years old (% of death)	28.9	15.8

Regular update of the Punan census and study of child mortality

A nominal census of the members of every household of the Tubu watershed was regularly and seasonally updated by registering births, deaths and in-coming visitors and by correcting mistakes concerning name, gender and age, as well as any change in location. Since 2002, the census that we have been undertaking and regularly updating among the Punan of East Kalimantan has revealed a high proportion of children who die before reaching the age of five. The data also revealed a significant difference between the peri-urban Punan of Respen Tubu (ratio of child death is 6%) and the remote Punan of the Tubu watershed (first estimation of child death ratio was 35%). In order to clarify the possible causes of child death, especially during the first two years, we decided to undertake a study focusing on female fecundity and child care among the Punan Tubu. The study was composed of two complementary protocols:

- Semi-quantitative and factual questionnaires submitted to every woman who had already given birth at least once by the time of the study;
- Qualitative in-depth interviews to try to catch women's perceptions on the major causes of child mortality.

The questionnaire (195 respondents aged 16 to 72 years old, 81 near city, 114 in remote villages) was composed of four modules regarding

- The woman's background (literacy, marital status);
- Pregnancy, labour/delivery and post-labour (with record of all births);
- Knowledge and practice of contraception; and
- Experience of breastfeeding.

The average age of the respondents was 35.2 years old. A preliminary overview of the data reveals that the average number of pregnancies experienced by remote Punan women during their lifetime is 8.8 in remote locations vs. 7.8 among peri-urbans. Miscarriage affects 20.7% of pregnancies in remote locations compared to 25% near the city. Among children who were born, only 48.4% are still alive in remote areas compared to 67.5% near the city. Table 5 shows that the majority of children die before weaning, particularly in remote areas, and a relatively high proportion of children die after the age of five. As figures refer to post-menopausal women (more than 50 years old) who similarly have grown up in the forest, the comparison reveals a beneficial effect of city proximity on the lifespan of children, which results in a significant decrease in the number of pregnancies (this age bracket is little concerned with recently introduced contraceptive methods). Through vaccination facilities, city proximity increases children immunisation against infectious diseases and epidemics that continue heavily killing upriver beyond the age of five. But Punan women rarely consult doctors during pregnancy, whatever the location, and miscarriage remains high among both communities and is even higher among the peri-urban. This could be a consequence of change in dietary regime caused by resettlement near the city, but data are lacking to confirm this assumption.

The goal of the qualitative interviews was to try to obtain a clearer idea of the ways in which Punan women respond, practically and philosophically, to the high rate of mortality affecting their children. Recurrent questions concerned women's experience regarding child health (causes of death and disease, difficulties regarding breastfeeding and weaning), women's

Table 6. People measured seasonally

			Male children	Female children	Male adults	Female adults
May - June '03	n = 524	Remote Tubu	94	74	96	122
		Peri-urban	21	21	44	52
September '03	n = 349	Remote Tubu	88	72	50	84
		Peri-urban	8	15	13	19
December '03	n = 451	Remote Tubu	98	99	86	99
		Peri-urban	20	20	16	23
March '04	n = 422	Remote Tubu	95	88	73	105
		Peri-urban	11	16	16	18
July '04	n = 422	Remote Tubu	110	77	92	96
		Peri-urban	8	13	11	15

Table 7. Synthesis of BMI results

		Remote Punan Tubu		Peri-urban Punan Tubu	
		Male	Female	Male	Female
June '03	n	96	126	40	46
	Severe underweight	0.0%	5.6%	7.5%	6.5%
	Underweight	4.2%	27.8%	22.5%	32.6%
	Normal	94.8%	65.1%	67.5%	54.3%
	Overweight	1.0%	1.6%	2.5%	4.3%
	Severe overweight	0.0%	0.0%	0.0%	2.2%
September '03	n	47	78	14	18
	Severe underweight	2.1%	2.6%	0.0%	0.0%
	Underweight	25.5%	25.6%	35.7%	50.0%
	Normal	72.3%	71.8%	57.1%	44.4%
	Overweight	0.0%	0.0%	7.1%	5.6%
	Severe overweight	0.0%	0.0%	0.0%	0.0%
December '03	n	74	95	21	18
	Severe underweight	1.4%	5.3%	9.5%	5.6%
	Underweight	8.1%	22.1%	23.8%	38.9%
	Normal	90.5%	70.5%	66.7%	44.4%
	Overweight	0.0%	2.1%	0.0%	11.1%
	Severe overweight	0.0%	0.0%	0.0%	0.0%
March '04	n	61	97	21	16
	Severe underweight	0.0%	2.1%	14.3%	6.3%
	Underweight	9.8%	26.8%	19.0%	48.3%
	Normal	90.2%	69.1%	66.7%	25.0%
	Overweight	0.0%	2.1%	0.0%	18.8%
	Severe overweight	0.0%	0.0%	0.0%	6.3%

Ilah Baya, one of the most renowned Punan traditional healers of the Tubu watershed. Improved conciliation between traditional healing and modern medicine is a major challenge for the future of forest dwellers. Long Pada, June 2002 (Photo by Edmond Dounias)

general and reproductive health, perceptions regarding handicap, sterility and lifestyle changes (past nomadic lifestyle compared to current sedentarised and farming lifestyle). Additional questions were added depending on information emerging from the questionnaire (all women interviewed had previously answered the questionnaire). Fifteen women were interviewed and interviews were recorded, analysed and coded (an average of 120 minutes for each interviewee).

Seasonal anthropometric measurements

As a complement to the food survey, we made biometric measurements of nearly 400 people every three months (Table 6). Measurements such as weight and size allowed for the calculation of Body Mass Index (BMI) which is a commonly used index to assess nutritional status. We also made six different skinfold and perimeter measurements that are, for instance, necessary to follow up child growth and calculate body fat, which is another standard indicator. In total, eight measurements were made on adults (above 15 years old) in order to follow the seasonal variation of body fat in relation to diet (food richness in fat is mainly provided by wild boar meat, health status and activities). Five measurements were made of children (2–15 years old) in order to estimate (i) the speed of growth on a semi-longitudinal basis, (ii) the instantaneous nutritional state, and (iii) body morphology in relation to physiological performance. Skinfold measurements were performed using a Harpenden caliper and following the method recommended by Durnin and Womersley. The anthropometric database is comprised of 828 individual files, and nearly 14,000 measurements were performed: weight (children, adults); stature upright (children, adults); stature seated (children only); brachial perimeter (children, adults); waist perimeter (adults only); bicipital skinfold (children, adults); tricipital skinfold (adults only); suprailiac skinfold (adults only); subscapular skinfold (adults only).

The Body Mass Index values of adult respondents are organised according to five categories (Table 7): severe underweight, underweight, normal, overweight, obesity. This table shows that a fraction of the women population is chronically underweight, whatever the location. Most of these women are relatively elderly widows who are highly dependent on gifts from other villagers for their subsistence as they generally cultivate only small cassava gardens and receive meat from others. Heads of households have a sense of self-sacrifice, and as far as food sharing is concerned they often give priority to the younger members of the family. Such behaviour seems deeply anchored in tradition, thus explaining that we observe no difference between remote and peri-urban locations.

On the opposite side, the results also show that being overweight and obesity remain rare among the Punan and as yet affects only peri-urban women. Emerging obesity in Respen Sembuak in this category may be due to new social expressions of prosperity among 'rich' families who are influenced by the wealthy Chinese shop owners and traders.

Table 8. Anthropometric measurements (mean ± SD) of adult Punan Tubu and Iban

	Height (cm)		Weight (kg)		Body fat (%)		BMI (kg.m-2)	
	Men	Women	Men	Women	Men	Women	Men	Women
Remote Punan Tubu (n = 271)	156.4 ± 5.2	145.8 ± 4.4	50.8 ± 5.7	41.7 ± 5.5	22.4 ± 3.7	22.8 ± 4.2	20.6 ± 1.7 ab	19.9 ± 2.3 a
Periurban Punan Tubu (n = 119)	156.0 ± 6.8	146.9 ± 4.4	48.9 ± 7.8	43.6 ± 7.8	20.4 ± 5.3	26.2 ± 6.2	19.9 ± 2.7 a	19.6 ± 3.3 b
Iban Dayak farmers (n = 753)	157.0 ± 5.6	147.3 ± 5.0	51.6 ± 8.4	48.5 ± 10.7	19.3 ± 5.3	33.5 ± 6.2	20.9 ± 2.8	22.2 ± 4.3

Source: modified from Strickland and Duffield 1998, and Dounias *at al.* 2004

* Superscript letters following BMI values indicate significant differences ($p < .05$) between periurban and remote Punan Tubu for each gender (a > b) by Duncan's multiple range test

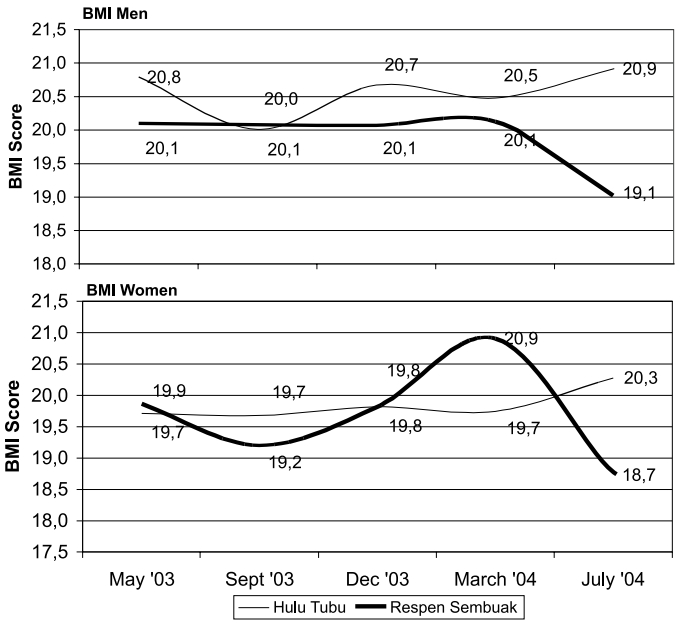

Figure 6. Seasonal fluctuation of BMI among adult Punan

Whatever the season, the average BMI values of both men and women in both remote and peri-urban Punan Tubu settlements remained above the 18.5 threshold value below which chronic energy deficiency could be suspected (Table 8). The remote Punan have a significantly higher BMI than the Punan Tubu, who have become farmers near the city. Nevertheless, the two Punan Tubu groups have lower BMI values than the Iban of Sarawak, a group of Dayak farmers of Borneo whose BMI values were recently measured. The BMI values of the Iban farmers are closer to the values that are theoretically considered as optimal for adults (22.7 for men and 22.4 for women). Comparisons of BMI between recently sedentarised hunter-gatherers and their immediate farming neighbours in other places of the world have revealed a similar difference (Dounias and Froment, 2006). The difference in fitness between former hunter-gatherers and farming groups should thus not be attributed to the farming lifestyle alone, but should rather be considered a consequence of the disruptive change in lifestyle from nomadic to sedentary.

Body fat percentage, another frequently used nutritional index, is the fraction of the total body mass composed of adipose tissue. It is often used to monitor progress during a diet or as a measure of physical fitness. Values obtained for adults in both remote and peri-urban Punan Tubu settlements are within the range of those of extremely fit or athletic people. Interestingly, the trends differ with regard to gender: peri-urban women have a much higher score than those in remote communities. By contrast, peri-urban men have a lower score than those in remote communities. This may be due to the custom of assigning the 'lion's share' of the rind of wild boar meat to hunters. Values from the Iban farmers indicate that the gap in fitness between men and women increases with sedentary lifestyle. According to European standards, Iban women can be considered as 'stout'.

Signs of being overweight, as opposed to obese, which is extremely rare among rural south-east Asians, clearly occur as a consequence of sedentarisation and related changes in diet. Depending on the season, 4.3% to 18.8% of peri-urban Punan Tubu women, but only 1.6% to 2.1% of women in remote villages, are overweight.

So far we still need to analyse these results with regard to the contrasted calendar of activities and the distinct gender division of labour between the two types of settlements, but also in the light of different exposure to disease. Indeed, in July 2004 contagious disease affected the city dwellers and not the remote villagers. As a consequence of this temporary sickness, the BMI dropped significantly. We should mention that during the time when the Punan were nomadic hunter-gatherers, they were rarely exposed to contagious diseases, and during epidemics they practised an efficient barter behaviour that prevented them from having any direct physical contact with potentially contaminated traders.

Blood sampling and analysis

Around 430 people aged four years old and above voluntarily gave blood (310 in upper and middle Tubu, 120 in Respen Tubu). Venous blood was taken away in two tubes of 3.5 ml each using a Vacutainer® blood sampling system. One dry tube (spontaneous coagulation) served for the extraction of serum (conserved in 1.5 ml micro-tubes) and residue was destroyed. The second tube contains EDTA (anti-coagulant) and served for the preparation of smears and thick drops on slides as well as for the extraction of plasma (also conserved in 1.5 ml micro-tubes). Deposit in the EDTA tube (buffy coat) was also preserved.

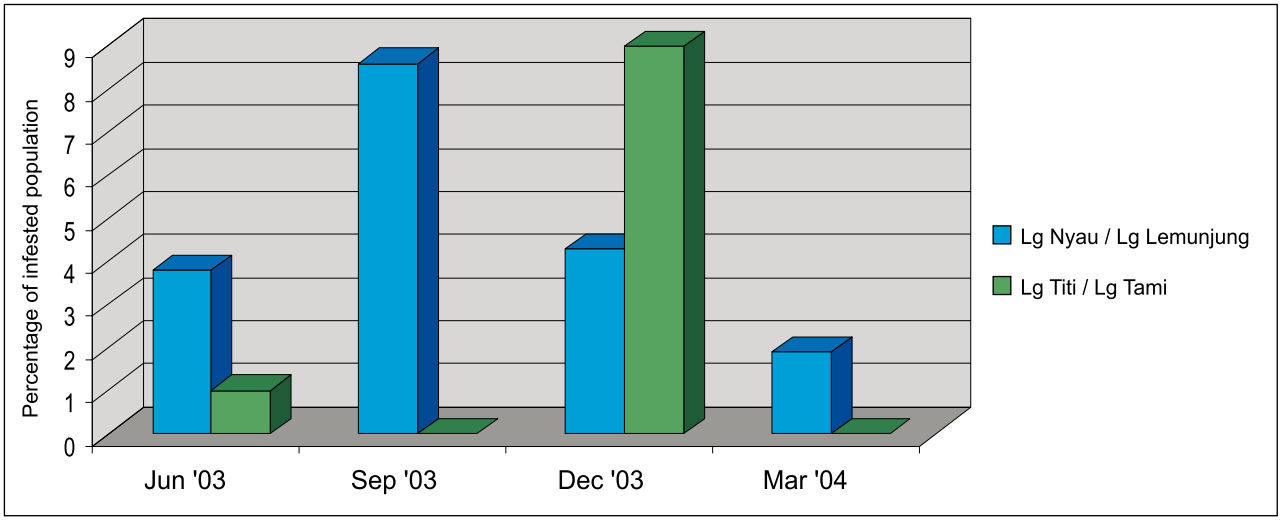

Figure 7. Compared malaria prevalence in two contrasted areas of the Tubu watershed

Analyses are currently being performed by the following French laboratories:

- The research Unit 034 of IRD – Emerging Viral Diseases and Information Systems. This research team is mainly interested in the transmission of emerging viral diseases from hunted mammals to human consumers of bush meat;
- The research Unit 'Oncogenic Virus Epidemiology and Pathophysiology' at the Pasteur Institute in Paris. This Foundation has developed a worldwide network of laboratories which carries out routine analyses for the search of the most common tropical diseases.

The goal of such analyses is to search for potential infectious and parasitic serologies (dengue fever, filariasis, hepatitis, sexually transmissible diseases) and genetic markers (electrophoresis of serum proteins).

We also took away a few drops of capillary blood from fingers on a seasonal basis. We used a lancing device which is totally painless to take away nearly 850 samples over a 15-month period of observation. Blood samples were taken in two groups of villages: Long Nyau and Long Ranau in upper Tubu, versus Long Titi and Long Tami along the Kalun River. Slides of smears and thick drops were coloured with GIEMSA and fixed in ethanol immediately after removal. The slides were analysed by a private laboratory in Jakarta.

The prevalence of malarial pathogens between the two groups during successive seasons is compared in Figure 7. The prevalence differs significantly between the two locations both in intensity and in frequency. The rates we obtained are consistent with the average reported throughout Kalimantan. The prevalence of malaria is much less important than in transmigration villages of West Kalimantan. Seasonal fluctuations are more intense along the Kalun. In 2002, 26 children died of malaria in these villages within a five-month period. We are probably confronted with an epidemic scenario, which is rarely reported in the literature.

The high probability for such an epidemic scenario requires a combination of several factors:

- Firstly, low immunity to malaria by the group studied. The nomadic Punan were rarely exposed to malaria until they finally settled down in permanent villages;
- Secondly, it is necessary to be exposed occasionally to areas where malaria is endemic. This happens when some families migrate to Sarawak for a few months or even years, and possibly bring back malaria with them from agro-industrial camps in which men have been recruited temporarily.

Table 9. Urine analyses

		Remote				Peri-urban			
		Children		Adult		Children		Adult	
		Male	Female	Male	Female	Male	Female	Male	Female
n		47	44	103	118	9	10	36	38
Leucocytes	Negative	44	23	89	55	9	4	25	17
	Positive	3	21	14	63	0	6	11	21
Nitrites	Negative	47	44	101	117	9	9	35	38
	Positive	0	0	2	1	0	1	1	0
Proteins	Negative	47	43	100	111	9	10	33	37
	Trace	0	1	2	4	0	0	1	0
	Positive	0	0	1	3	0	0	2	1
pH	Acid	46	38	96	105	9	9	36	37
	Neutral	1	6	7	13	0	1	0	1
	Positive	0	0	0	0	0	0	0	0
Blood	Negative	43	38	86	87	8	6	31	26
	Trace	3	4	11	13	0	3	2	6
	Positive	1	2	6	18	1	1	3	6
Ketone	Negative	42	44	87	105	7	9	31	32
	Trace	4	0	13	8	2	1	4	5
	Positive	1	0	3	5	0	0	1	1
Glucose	Negative	47	44	102	118	9	10	36	38
	Positive	0	0	1	0	0	0	0	0

Table 10. Limited parasitic load of the Punan by comparison to other forest dwellers (percentage of infested population)

		Hookworms (*Ankylostoma and Necator*)	Whipworms (*Trichuris*)	Roundworms (*Ascaris*)	Amoeba	
					Pathogen	non pathogens
Remote Punan Tubu		35	9	60	5	6
Peri-urbans (not only Punan)		60	90	76	10	34
Other Southeast Asian hunter-gatherers	Semang	93	56	12	9	30
	Temiar	78	23	2	3	18
	Jahut	52	29	20	8	28
	Semai	74	12	13	10	39
	Jakun	64	62	65	3	31
	Semelai	70	72	71	6	17
	Temuan	79	91	59	12	37
African Pygmies	Mbuti Pygmies	85	70	57	36	-
	Aka Pygmies	71	-	-	-	-
	Kola Pygmies	-	85	51	-	-
	Medjan Pygmies	-	83	90	-	-
Amerindians	Yanomami	59	80	86	49	85
	Ticuna	83	77	76	69	55
	Palikur	90	19	76	31	16
	Campa	45	20	28	21	37
	Xingu	81	-	18	61	87

- : no data

Urine sampling and analysis

471 people aged four years old and above corresponding to those who gave blood, with very few exceptions, voluntarily gave nearly 3 cc of their urine in individual jars. Urine analyses were performed on fresh early morning urine samples. We used Bayer multiple reagent strips (N-Multistix®), which enable a quick and easy check of the presence of glucose, ketones, blood, protein, nitrite, pH, urobilinogen, bilirubin, leucocytes in urine as well as specific gravity. The results presented in Table 9 do not reveal particular problems for most of the components tested. The only obvious results are the high proportions of subjects with low pH (acid) urine and significantly high levels of detected leukocytes. The combination of low pH and positive leukocyte test suggests frequent kidney infection, kidney stones and, more importantly, chronic urinary infection, especially among women of remote villages who show the highest rates of infection.

Stool sampling for testing parasitic load

350 inhabitants of Long Nyau, Long Lemunjung and Rian Tubu voluntarily gave stool samples. Stools were collected in 50 ml containers, then a small fraction was removed and kept in 15 ml tubes in a solution of Mercurothiolate Iodine Formol (MIF, for conservation) and Lugol 5% (for colouration). Stool samples were firstly analysed in Puskesmas Malinau, then 'double-checked' by a private laboratory in Jakarta. If we exempt six samples taken in Respen Tubu, all of the samples come from upper Tubu.

The results for the Punan are shown in Table 10 and are compared with results published for other tropical forest hunter-gatherers of south-east Asia (mainly Orang Asli of Peninsular Malaysia), Central Africa (diverse Pygmy groups) and Amazonia. The rates of intestinal parasites we obtained for the Punan are significantly low compared to those reported elsewhere. Fecal pollution among the Punan villages is very limited (even if compared with transmigration villages of West Kalimantan) and this might be due to the use of the river for sanitation where feces are recycled by aquafauna.

Clinical examination and medical treatment

This component of the biomedical survey was undertaken in close partnership with the local health services. Dr Dwipa Anakangunggede from Pulau Sapi accompanied us in May–June 2003 and ensured systematic and detailed clinical examination of all the people and relatives who were measured and gave blood and urine (n=525 people) samples. Medical treatment was provided for free when needed. Information concerning the health status of examined people and treatment provided ad hoc were recorded on individual sheets.

Simultaneously with these studies, and continuing during 2005 and 2006, we proceeded, in close partnership with the local health services and the humanitarian organisation Doctors of the World, to perform repeated clinical examinations (a total of 2,280 examinations were made in 50% of the total population and only on patients who spontaneously expressed their will to consult the doctor) and provide medical care to the remote Punan Tubu communities when necessary.

The most reported diseases are non-communicable diseases that tend to affect adults and that are revealed by symptoms like flu, fever intestinal pain, hypotension and vertigo. Acute respiratory infections are also frequent, especially among young patients and several probable cases of malaria were noted. When malaria was clinically suspected, the patient was tested with Paracheck®, an inexpensive, rapid and reliable on-site diagnosis to *Plasmodium falciparum* malaria. If the test was negative, the patient was treated for *P. vivax* malaria (no on-site test yet available to detect this form of malaria).

Many people who asked to be examined expressed very minor and fuzzy symptoms and were actually revealed to be in perfectly good health. Diarrhea and cutaneous diseases were reported only occasionally. A few cases of tuberculosis were suspected, but more detailed analyses in a hospital environment are necessary to confirm the diagnosis.

Several cases of over-infected vesicular lesions observed occasionally in a single location may suggest a local epidemic of smallpox. In

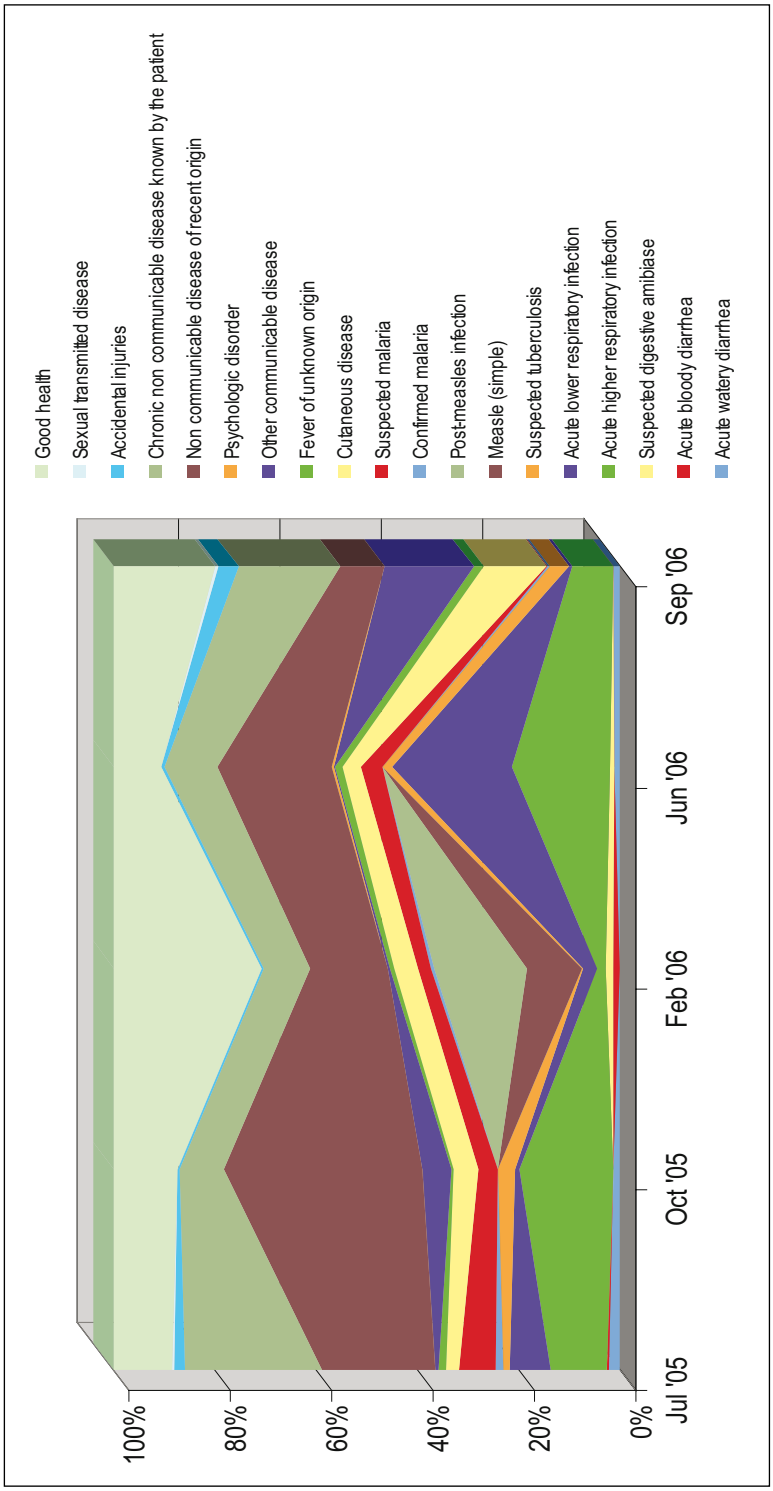

Figure 8. Main disease types recorded in the Tubu watershed

the same location, we also noticed a highly contagious epiphenomenon of throat infection. We also observed a few cases of *kuam*, a kind of vesicular, eruptive and painful lesion that affects the mouth of newborns, sometimes making it impossible for the baby to breastfeed. The state of teeth and auditory canals is often unhealthy. Such chronic problems are no doubt due to poor body hygiene, and may largely contribute to the chronic headaches, vertigos and backaches that people complain about so frequently. A preventive intervention regarding ear and dental health will be considered in the future.

Capture of mosquitoes and ectoparasites (ticks)

We also conducted seasonal night catches of mosquitoes by using mini light traps in order to monitor the exposure to malaria and to identify the vectors. We found two species of *Anopheles* that are the main vectors of malaria in the Tubu watershed.

In partnership with the Research Unit 034 of IRD 'Emerging viral diseases and information systems' that aims to understand the ecology and epidemiology of germs and disease emerging or reemerging in a changing environment, we harvested these ectoparasites on carcasses of wild boars and sambar deers. Ticks are known as potential vectors of viruses that may possibly be transmitted from wild boars to humans. Considering the long-term dependency of the Borneo population on wild boar meat (almost 40,000 years), we may consider the possibility that the foraging peoples of Borneo have adapted to local forms of viruses, and such potential adaptation may be of vital importance for general human health in response to new emerging viral diseases. Tick samples were sent to the University of Mahidol in Bangkok, where a research team from IRD is studying new emerging viruses. They found two new flavi-viruses in the ticks we sent them. Further analyses are still in progress and we cannot elaborate further at this stage.

DISCUSSION

From the studies we conducted on diet and disease among the Punan Tubu, we can summarise the following major points:

- The diet of remote Punan villagers is much better than those of peri-urban Punan, especially as sources of proteins are more diversified. The problem the remote villagers face is that they are not self-sufficient in rice and they need to shift to cassava as their major staple food for several months preceding the new rice harvest. They also seasonally depend on sago during occasional migrations into the forest (*mufut*).
- Body Mass Index and Body Fat Data reveal that fitness is also better in remote villages. Being seasonally underweight affects women similarly in both locations, and the origin of this malnutrition is probably cultural as it affects principally older people. Rare cases of obesity were observed only among peri-urban women.
- Biomedical analyses do not reveal serious problems among the Punan populations. The prevalence of malaria is not higher than in other places of Kalimantan, but is more acute among the Punan who, as former hunter-gatherers, have not developed efficient immunity again vector-borne diseases. The parasitic load is much lower than in any other groups of forest peoples living in similar conditions throughout the world. This proves that the forest and water environments of the Punan are quite healthy. Urine analyses do not reveal serious problems, apart from high proportions of acid pH and positive leukocyte tests that may suggest frequent kidney infection, kidney stones and urinary infection.
- If, on one hand, the remote Punan are globally much better off in terms of diet and fitness than the Punan living near the city, on the other they are more exposed to drastic changes of seasons. For them, access to market to compensate for a seasonal lack of resources from the forest is very limited. The risks to health are due neither to malnutrition nor to a dangerous life in the forest. Major risks are due to infectious epidemics coming from outside their forest and that are irregular and unpredictable.
- Our study demonstrated high fluctuations between seasons within the same year. People respond to these intra-annual fluctuations through a diversified production system that combines agriculture,fishing, hunting andgathering and by a seasonal mobility

(migration into the forest when resources at the village are scarce).

- The dipterocarp forests of this part of Kalimantan are also characterised by high fluctuations from one year to another. Such irregular inter-annual fluctuations may drastically affect resource availability during certain years and provoke unpredictable epidemics against which remote forest people have little or no immunity. One possible answer to erratic epidemics would be systematic vaccination campaigns, but this requires a continued refrigeration of the vaccines that is difficult to implement when conditions of access are difficult. However, inter-annual fluctuations are nearly impossible to assess without conducting fieldwork over a very long period of time. Such studies are not only costly and time-consuming, they are also socially and ethically problematic as local peoples expect short-term feedback from research.

Our comparison of distinct Punan communities that differ in their dependency on agricultural resources shows that the more remote the community, the more diversified the diet and the better the nutritional status and physical fitness. The contribution of forest resources to the dietary regime also decreases with proximity to the city. However, the higher dependency on agriculture is not the proximate cause of the deterioration of diet and physical fitness. Rather, it seems that the easier accessibility of cities and their markets has equivocal consequences. It can be an advantage during years of drastic food shortage, corresponding to an absence of mast fruiting in the Dipterocarp forests of Borneo, which have dramatic consequences for the ecological success of forest dwellers. Markets also ensure a more regular supply of a wide range of vegetables and fruits, but also of dairy products and eggs. For instance, calcium and micronutrients provided by these types of food greatly contribute to the prevention of dental problems. When combined with a minimum of education and information on hygiene and sanitation, their role in improving dental health and consequently attenuating child morbidity should not be neglected. But improved access to markets results in greater dependence on a regular cash income and more pronounced individualistic behaviour that jeopardises the fundamental collectivist principle of the Punan culture, an efficient adaptive response to seasonal food uncertainty during their nomadic past.

Industrialisation and urbanisation accompanying the economic boom in the interior of Borneo have had an impact on the dietary habits of the people. As we have shown in this chapter, there is a trade-off between the advantageous new crop resources, which bring with them a sedentary lifestyle, and the detrimental effects of modification in the availability and distribution of wild food resources near permanent settlements. Such changes affect nutritional status, as clearly shown by the peri-urban Punan, who tend to have an excess intake of energy-dense foods, especially snacks that are rich in fat and free sugars but low in complex carbohydrates. Evidence from epidemiological studies has confirmed the link between such diets and the risks of chronic degenerative diseases of middle and later adult life, especially cardiovascular diseases and certain types of cancer (Colfer *et al.*, 2006). Although they are not yet a critical problem for the Punan, other nutritional disorders, such as anemia, excessive weight, hypertension, elevated cholesterol levels and diabetes, are emerging signs of dietary imbalance.

Most recent archaeological and anthropological literature on the 'paleolithic diet' hypothesis (*The Paleolithic diet page*) advocates that the food regime of former hunter-gatherers was relatively healthy: it was rich in protein and fibres, while poor in salt, milk and sugar. In the strict nomadic lifestyle of earlier times, migrations were performed along extended and linear territorial trails that not only reduced food hazards (Dounias and Leclerc, 2006), but also ensured good physical fitness. This resulted in low body adiposity and prevention of cancer and cardiovascular complications. However, such relatively good fitness was achieved at the expense of a high mortality and a relatively short life span (Eaton and Eaton, 2000). The legendary good diet and fitness of the former hunter-gatherers does not resist their brutal jump into modernity. Even if it does not have a direct effect on their health, the rapid conversion to farming has certainly contributed to their imbalanced dietary regime. In the long run, this may ultimately compromise their health status and ecological success.

CONCLUSION

Forest ecosystems are dynamic, as are the human societies depending on the forest. Forests dwellers have had to adapt to permanent changes of forest ecosystems. However, the changes that they face today are much more extreme and radical than those they have experienced in the past. As deforestation, drastic modification of resource availability and the invasive influence of the cash economy occur more rapidly, social, cultural, economic and political systems become increasingly difficult to accommodate. The choices made by foraging societies are no longer validated by experience, and are revealed to be costly in terms of ecological success.

Social change may not necessarily be accompanied by a well-balanced biological optimum. It may sometimes invalidate defence mechanisms and nutritional status. The imbalanced biological side may in return compromise the social and cultural integrity of the society.

However, increasingly poor diets and associated illnesses are only symptomatic warnings, alerting us to the ecological and socio-cultural mal-adaptations that these societies are undergoing. More acute than malnutrition and diseases are the ill-effects caused by social prejudice which is a source of insecurity and discrimination. The healthy future of former hunter-gatherers depends today on factors such as access to education and the acknowledgement of their traditional rights. Providing medical assistance to cope with the malnutrition and diseases of these people is moral evidence that would only provide short-term respite from the immediate symptoms. However, this should not overlook other more helpful log-term interventions that consider the ecological, social, political and economic drivers of change that indirectly affect the health of forest peoples. Improving their health is not in the hands of medical doctors alone.

Data on nutritional ecology in such environments are difficult to obtain, and too few results are available in the literature to support solid diachronic as well as synchronic comparisons. There is definitely a need for further long-term studies on these issues. But time is short, and there is also an urgent need for immediate action in favour of the rapidly changing populations and environments of the forest.

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