

From foraging to farming among present-day forest hunter-gatherers: consequences on diet and health

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SUMMARY

Throughout history, forests dwellers have adapted to permanent changes of forest ecosystems that, in essence, are dynamic. Accordingly, they have long served as models of how humans lived when their lifestyles and genetic endowment were complementary. What is now commonly described as the “paleodiet” tends to be put forward as a benchmark for present-day efforts to promote health and prevent nutritional diseases, even in industrialized countries. Although forest ecosystems provide food and medicines to forest dwellers, over the last half-century these ecosystems have undergone unprecedented pressure to make way for economic growth and industrialization, often at the cost of ecological functions that may affect human health, both in short term (i.e. increase in infectious diseases) and long term (incidence of global change). As radical alterations occur such as deforestation, modification of resource availability, and the penetration of cash economies, forest dwellers encounter increasing difficulties in accommodating their socioeconomic, cultural, and political systems, thus impeding their ecological success. Diets and diseases are sensitive indicators of the ecological and cultural costs that former hunter-gatherers currently pay to achieve their share of modernity. This paper exposes the nutritional and epidemiological consequences of the maladaptation of former hunter-gatherers in relation to their recent sedentarization. It is primarily based on case studies carried out among the Baka and Kola Pygmies of Cameroon, and the Tubu Punan of Borneo.

Keywords: forest hunter-gatherers, mobility, sedentarization, epidemiological transition, nutritional transition

De la collecte à l’agriculture chez les chasseurs-cueilleurs forestiers actuels: conséquences sur leur alimentation et leur santé

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À travers leur histoire, les peuples forestiers ont toujours su s’adapter aux changements permanents des écosystèmes forestiers qui, par essence, sont dynamiques. C’est la raison pour laquelle ils ont longtemps servi de modèle pour analyser la vie des humains lorsque leur mode de subsistance et leur profil génétique étaient intimement liés. Ce que l’on qualifie communément de «paléorégime» tend à constituer l’argument clé des discours en vogue jusque dans nos sociétés industrialisées, qui veulent promouvoir une vie saine et exempte des troubles nutritionnels. Depuis un demi siècle, les écosystèmes forestiers qui fournissent incontestablement toutes sortes de nourritures et de médicaments aux peuples forestiers, sont l’objet de pressions sans précédent ; elles visent certes à favoriser le développement économique et l’industrialisation, mais se font au détriment des fonctions écologiques. La dégradation de ces fonctions affecte la santé humaine, tant à court terme (p. ex. accroissement des maladies infectieuses) qu’à long terme (p. ex. incidence du changement global). Face à ces altérations radicales — déforestation, modification de la disponibilité des ressources, pénétration de l’économie de marché — les peuples forestiers peinent à ajuster leurs systèmes socio-économique, culturel et politique, compromettant alors leur succès écologique. Le régime alimentaire et la santé sont des indicateurs sensibles du prix écologique et culturel que les derniers chasseurs-cueilleurs doivent aujourd’hui payer pour avoir accès à la modernité. Cet article expose les conséquences nutritionnelles et épidémiologiques de la maladaptation de ces chasseurs-cueilleurs consécutive à leur sédentarisation récente. Il repose principalement sur des études de cas réalisées chez les Pygmées Baka et Kola du Cameroun, et chez les Punan Tubu de Bornéo.

De la búsqueda de alimento a la agricultura entre los cazadores-recolectores de hoy: consecuencias para la dieta y la salud

E. DOUNIAS y A. FROMENT

A través de la historia, los pobladores del bosque se han adaptado a los cambios permanentes de unos ecosistemas forestales que, en esencia, son dinámicos. De acuerdo con ello, y durante mucho tiempo, han servido de modelos de como vivía el ser humano cuando sus estilos de vida y las facultades genéticas que poseía eran complementarios. Lo que ahora se describe comúnmente como «paleodieta» tiende a ser propuesta como una cota de referencia en los esfuerzos actuales por fomentar la salud y prevenir las enfermedades nutricionales, incluso en países

industrializados. Aunque los ecosistemas forestales proporcionan alimento y medicinas a los pobladores del bosque, estos ecosistemas han experimentado una presión sin precedentes durante el último medio siglo en pro del crecimiento económico y la industrialización, a menudo a expensas de aquellas funciones ecológicas que podrían afectar a la salud humana, tanto a corto (es decir, aumento de las enfermedades infecciosas) como a largo plazo (efecto del cambio global). A medida que suceden cambios radicales como la deforestación, diferencias en la disponibilidad de recursos, y la penetración de economías monetarias, los pobladores del bosque encuentran cada vez más dificultades para adaptar sus sistemas socioeconómicos, culturales y políticos, viendo entorpecida por ello su prosperidad ecológica. La dieta y las enfermedades son indicadores sensibles de los costos ecológicos y culturales que tienen que pagar en la actualidad los cazadores-recolectores de antaño para poder encontrar su espacio en la vida moderna. Este artículo presenta las consecuencias nutricionales y epidemiológicas de la maladaptación de quienes fueron cazadores-recolectores en relación a su sedentarización reciente. Está basado principalmente en estudios de caso realizados entre los pigmeos Baka y Kola de Camerún y los Tubu Punan de Borneo.

INTRODUCTION

In late spring 2008, an unnamed community of Amerindians living in a remote area of Acre Province in the Brazilian forest was widely talked about in the media, with massive support of anachronistic images showing frightened archers shooting their arrows towards the airplane that was flying over their settlement (<http://www.uncontactedtribes.org>). According to Survival International, more than one hundred communities scattered around the world still refuse contact of any sort with outsiders. This refusal makes them today much more vulnerable than other forest dwellers who gradually increased their relations with the rest of the world — some foraging societies like the Kubu of Sumatra and a few Punan groups of Borneo are even described as “professional hunter-gatherers” who have been involved in commercial trades of non-timber forest products for several centuries (Fox 1969, Hoffman 1984, Persoon 1989) — since the drastic change affecting the last remains of natural forests appears inevitable. With regard to globalization and to its many induced environmental transformations, there is no longer a way out for these unwavering societies — generally confined in protected areas — to avoid the opening up of their territories and their exposure to invasive migrants in search of land and better life conditions, to the extension of ranching, to the overwhelming expansion of logging and mining industries, to the conversion of forests into monocropping landscapes by agro-industrial plantations (Scott 2009). As radical alterations occur, forest foragers encounter increasing difficulties in accommodating their socioeconomic, cultural, and political systems, thus impeding their ecological success. When they are not victims of violence exerted by outsiders, they are dramatically devastated by nutritional disorders and epidemics (Napolinato 2007, Napolinato and Ryan 2007).

The health problems that affect today the last nomadic hunter-gatherer societies are dramatically emblematic of the interconnections between the ecology of health and conservation of biodiversity. While trying to adapt to the consequences of their renunciation of their original lifestyle, which is seriously affected and modified by various forms of environmental change, these societies are forced in just a few decades to make an adaptation whose achievement took several centuries for our western societies.

Diets and diseases are sensitive warnings of the ecological and cultural costs that former hunter-gatherers currently pay to achieve their share of modernity. By focusing on nutrition

and epidemiology, the goal of this paper is to demonstrate the maladaptation of former nomadic hunter-gatherers that is a direct consequence of their recent and brutal sedentarization — generally hastened by external drivers (Dounias *et al.* 2007). Arguments are primarily based on first-hand case studies carried out among various groups of Pygmies (Baka, Kola) in Cameroon, as well as among a group of Punan living in the Tubu watershed in Eastern Borneo.

CHANGE AND INDUCED TRANSITIONS THROUGH HUMANKIND'S HISTORY

Change among human societies induces a continuous emergence of infectious diseases (Cohen 2000, Wilson *et al.* 1994). During their lifetime, humans are constantly exposed to countless endemic and epidemic infectious diseases, and their history is marked by a succession of new emerging diseases (Diamond 1997, May *et al.* 2001, McNeil 1976). Infectious diseases exert a selective pressure on human evolution and are widely admitted to be a driving force of natural selection that have shaped the evolution of the human genome and oriented the differentiation of human populations that we observe today (Barreiro *et al.* 2008, Williams and Nesse 1996).

In fact, when considering the difference in life expectancy between existing human societies, the significant gap that separates poor and developed countries occurred only after the industrial revolution and is more a consequence of the booming progress among the latter countries in controlling infectious diseases than an impaired immunodeficiency among individuals (Casanova and Abel 2005): the comparison of mortality curves from Palaeolithic period to modern times (WHO website) shows that the increase in life expectancy occurring in the 20th century is not correlated to an increased immunity to infectious agents. The persistent lack of immunity to infection has in fact been overshadowed by medical progress (Kwiatkowski 2000).

Hominid history has been marked by a succession of major physiological, demographic, cultural and dietary transitions — from quadrupedalism to bipedalism; from scavenging to hunting; from hunting and gathering to farming and herding; from rural to urban. . . — which have been accompanied by epidemiological shifts. As stressed by Froment (2010), the epidemiology of hominization could be summarized as a continuous process of autodomestication.

Epidemiological transitions were globally marked by a succession of pathocenoses revealing a long progression of humankind from a high prevalence of infectious diseases to the current predominance of chronic diseases (Grmek 1969, Olshansky and Ault 1986). These changes in disease were accompanied by a demographic transition, which enabled humankind to shift from a regime of high fecundity counterbalancing high mortality, to a regime of low mortality inducing a fall in fecundity (Barrett *et al.* 1998). They should as well be interpreted in close interaction with an overall nutritional transition that evolved from a “paleodiet” lately praised by nutritionists as a model of well balanced food consumption (Eaton and Eaton 2000), to the current western diet that is heavily rich in saturated fat, salt and sugar but dramatically poor in fibres (Popkin 2002). There is no longer need to demonstrate the strong link between the modern food regime and the expansion of chronic and degenerative diseases in industrialized countries (Daily and Ehrlich 1996, Meslé and Vallin 2000).

Among these various transitions, the shift from hunting to farming and the correlated shift from a nomadic to a sedentarized lifestyle are unanimously considered as the major epidemiological transition in the history of humankind (Barrett *et al.* 1998, Larsen 1995, Omran 1971, Popkin 2002, Swedlund and Armelagos 1990, Wirsing 1985).

This sedentarism transition occurred during the Neolithic age and massively increased the development of commensal mammals (mainly rodents) that are major vectors of plague and hemorrhagic fevers (Wolfe *et al.* 2005). Furthermore, sedentarization induced significant social modifications that were indirect causes of new health disorders — work overload, territorial conflicts, advent of political hierarchy and its related inequities in resource access and redistribution, etc. These changes favoured the spread of infectious diseases that were until then quiescent. The Neolithic age was also marked by the domestication of mammals (Clutton-Brock 1987): diphtheria, syphilis, influenza, salmonella, plague, tuberculosis, leprosy and many other diseases that first hit humankind in these ancient times, have their microbial equivalent among animals. Brucellosis and anthrax became common diseases among cattle herders. Malaria exploded with the advent of the very first farming clearings, and irrigated rice-growing sizeably increased human contact with microbes (cholera, anterovirus) and parasites (bilharzia, distomiasis) (Gualdé 2006, Guégan and Choisy 2008, Susanne *et al.* 2003).

Recalling what happened during the Neolithic age is important since the related epidemiological transition that took place throughout the several thousand years of this historical period is taking place within just a few decades for the last present-day nomadic hunter-gatherers.

EPIDEMIOLOGICAL ADVANTAGES OF A NOMADIC LIFESTYLE IN TROPICAL FORESTS

The widely admitted pattern that diversity of plant and animal species declines along with distance from the equator (Chown and Gaston 2000) also supports the distribution of parasitic

and infectious species around the world. Guernier *et al.* (2004) have demonstrated the fundamental role of climatic factors and established the link between latitude and richness of human pathogens. The high correlation between the diversity of parasitic and infectious diseases and the distribution of tropical humid forests has nourished the persistent belief that forests are inhospitable environments for humans.

Besides the fact that forests — be they natural or anthropogenic — directly provide plenty of food, medicines, raw materials, clean water and other resources to forest dwellers, the many, though indirect, ecosystemic services obtained from the high biodiversity that is hosted in forests have for long been underestimated (Millennium Ecosystem Assessment 2005). One of the key services consists of controlling the emergence and spread of infectious diseases by maintaining a subtle balance among predators and prey, and among vectors and parasites in plants, animals, and humans (Chivian and Bernstein 2008). However consideration of such indirect protective functions of biodiversity is fairly recent and still requires further research.

Over the last few decades, humid tropical forests have undergone unprecedented pressure to make way for economic growth and industrialization of the developing countries in which these forests are located. Food insecurity is generally put forward as the main threatening pressure on health. However, deforestation and the related loss of ecosystemic services exert much more pressure as they dramatically increase the burden of transmissible diseases (Patz *et al.* 2000). But more indirect consequences also contribute to global change and over a longer term, with damaging effects on human health worldwide.

Mobility was an excellent adaptive response of hunter-gatherers to the risk to contract a parasitic or infectious disease. Living in ephemeral and temporary camps considerably reduced exposure to transmissible diseases, airborne and food-borne diseases, and faecal pollution. More than the scarcity of food, excessive parasites (fleas, lice and ticks) in the camp provided a strong motivation to move to another place. A fundamental principle of this mobility lies in the necessity to live and move in small communities that are scattered in vast territories (human density below one inhabitant/square km (Dunn 1977)). Small, dispersed human communities are less visible to vectors and are comparatively unattractive hosts to pathogens. Nomadic Punan and Pygmies were free of malaria since they constantly moved outside the flight range of anopheles before the malaria-causing parasites (*Plasmodium* spp.) were able to reproduce (a part of the reproduction cycle occurs in the mosquito, the other part intervenes in the blood of the host bitten by the mosquitoes).

In many foraging societies, a death within the community pushed the survivors to abandon camp, split and shift to new settlements. This cultural practice aimed to protect the living relatives from the wandering and harassing spirit of the dead, and reduced at the same time the risk of any lethal factor contaminating other members of the group.

The absence of food storage among forest foraging peoples reduced the likelihood of proliferation of potential vectors of rodent-borne diseases. For the same purpose, most

of the rainforest shifting cultivators cultivated crops that were propagated clonally and thus naturally stored in the field, not in the home.

The nomadic Punan had little trouble with smallpox that was, in contrast, a serious problem for nearby Kenyah farmers, because the Punan practised silent barter, which served as a social fence protecting them from the epidemics that plagued their sedentary Kenyah neighbours. To avoid direct physical contact during epidemics, the Punan and the traders convened on marked sites where the hunter-gatherers could deposit their non-timber forest products in exchange of the goods left in the same place by the traders (Knapen 1998).

In conditions of low pollution and high recycling by aquatic fauna, the Punan who use the river for sanitary purposes are less exposed to faecal pollution than some other forest-dwellers who are not accustomed to defecate into flowing water. Favouring healthy rivers in which to collect clean water for domestic purposes is still a decisive argument advanced by the Tubu Punan to refuse to resettle downstream and closer to town (Levang *et al.* 2006).

High mobility was significantly made easier by i) light burdens and limited material goods; ii) the art of producing ephemeral everyday tools and instruments which were abandoned after use and renewed according to needs (Dounias 2001); iii) a limited number of dependents (infants, young children and elders). Groups migrated following extended and linear territorial trails. A simple clearing of the undergrowth to establish a temporary camp along these trails provided favourable light conditions to the regeneration of most frequently used food resources. The seeds of eaten plants that were left near huts could take advantage of the surrounding organic remains (detritus, faeces, food leftovers, ashes accumulated around the fireplaces) to germinate in optimal conditions (Ichikawa 1999).

Exogamic matrimonial alliances opened extensive though codified access to the territories owned by the allied families, thus extending the spectrum of potentially accessible resources.

The stereotype of the noble savage in perpetual quest for food is definitely outmoded. Historical ecology has now validated the fact that nomadic hunter-gatherers perfectly managed the spatial and temporal availability of their key food resources. Their daily search for food was definitely not a random and uncertain activity (Laden 1992).

Lastly, nomadic lifestyle favoured a good physical fitness and high muscular activity. This was confirmed by lower rates of body fat compared to that of farming neighbours (Dounias *et al.* 2007) and the absence of risk for arterial hypertension, high rates of cholesterol, cancer or cardiovascular accidents (Eaton and Eaton 1999). Since the forerunner works by Sahlins (1972), the advantages of a nomadic lifestyle have been largely backed up by the paleodiet hypothesis (PaleoDiet.com 1997). Supported by the most recent archaeological evidence, this hypothesis argues that nomadic hunter-gatherers were rarely subjects to famine and enjoyed a sane food regime that was rich in protein and fibres, and poor in salt, milk, and sugar.

However, these undisputable advantages of a nomadic lifestyle should not give way to excessive romanticism regarding their life conditions and epidemiological situation (Edgerton 1972). The relatively good physical condition of forest foragers was partially jeopardized by various causes of brutal death: accidental trauma (injury during hunting expeditions, falling trees), predation (by large carnivores), poisoning (accidental consumption of toxic food, venomous biting) and various forms of "social" regulation (warfare, cannibalism, infanticide, geronticide, witchcraft, sacrifice, etc). Hunter-gatherers were not spared autochthonous diseases (Wirsing 1985). If their nomadic lifestyle in small communities prevented them from fast-spreading diseases, it was helpless against slowly evolving diseases. But the diseases that caused the massive extinction of Amerindian hunter-gatherers were those that were introduced by outsiders (TABLE 1): smallpox, yellow fever, typhoid fever, malaria, measles, whooping cough, and poliomyelitis (Neel 1977, Newman 1976). Mobility provided a fairly good ecological equilibrium

TABLE 1 *Differential febrile reactivity to measles vaccination between Amerindians and cosmopolitans (adapted from Black 1990). Several mutually non-exclusive hypotheses — weakness of immune system, social disorders, inbreeding depression (the breeding of related individuals resulting from isolation is a well known cause of fitness degradation) (Black 1975, Cook 1998) — are advanced to explain this significantly higher reactivity by Amerindians, which is illustrative of the massive extinction of native Amazonians after their first contact with Westerners. An absence of heterosis enhances their sensitivity to exotic viruses. The isolation of hunter-gatherer groups that is commonly reported throughout the Neotropics is an exception among forest foragers in the Old World, who have for long been involved in economic exchange and matrimonial alliances with their farming neighbours. The crossing of gene pools and induced hybrid vigour ensure a more efficient resistance to exotic pathogens.*

NB: for equivalent febrile status, rectal measurements of temperature always provide significantly higher values than axillary measurements.

Group	%>39°C	%>40°C	Average elevation T° (°C)
Amerindian children (n = 150) ^a	25.3	3.3	1.0
Caboclo children (n = 142) ^a	7.7	2.8	0.6
Amerindian adults (n = 238) ^a	13.0	2.9	0.9
Icelandic adults (n = 148) ^b	7.4	1.4	0.6

^a axillary T°; ^b rectal T°

and a relative tolerance to familiar diseases. They managed to put up with them through cultural ripostes like pharmacopeia and traditional healing (Telban 1988). For instance, hunter-gatherers living in the Neotropics were constantly exposed to treponematosi, amoebic and bacillary dysenteries, pneumopathies of viral origin, salmonella, streptococcal arthritis, ascariasis, bartonella, leishmania, and American trypanosomiasis.

The child mortality registered nowadays among former hunter-gatherers is not so different from what was reported for Europe a few centuries ago. Low life expectancy and high child and infant mortality among contemporary foragers (Figure 1) are clear reminiscent evidence of the Darwinian selection that have ensured their demographic stability and the sustainability of their lifestyle, which depends on the extensive availability of forests resource in space (territory) and time (seasonal fluctuation) (Froment 2001).

SEDENTARIZATION AND ITS TRAIL OF NEW DISEASES

Renunciation of a nomadic lifestyle and shift to permanent settlement are necessarily accompanied by a reassembling of the family unit. The increasing density in the human habitat inexorably alters the surrounding landscape and eventually exerts hunting and gathering pressure on proximate forest resources. The rapid decline of nearest resources has to be compensated by seasonal migrations or more distant hunting and gathering expeditions. These migrations and expeditions become increasingly problematic to organize because of the loosening of access rights on previous territories and drastic modification of gender division of labour within the communities — women are increasingly involved in agricultural activities and less participate to hunting, fishing and collecting of forest products — that generally compromises family mobility — seasonal expeditions in the forest are now most exclusively composed of male participants (Dounias and

Leclerc 2006). Adoption of agriculture is often the only and inexorable alternative that efficiently compensates for the decline in forest resources near villages. But it is also a turning point since it marks, more than sedentarization, a definitive renunciation of the former nomadic lifestyle.

Forest lands that are cleared for installation of new permanent settlements are exposed to more pronounced ranges of temperature and atmospheric humidity between night and day. Rudimentary housing and absence of warm clothes and blankets favours acute pulmonary infection, which dramatically increases child morbidity (Figure 2).

Parasitic load, a consequence of faecal pollution, goes along with sedentarization and induced promiscuity. High rates of intestinal worms are a direct consequence of increased contact with all sorts of human and animal detritus, combined with an absence of sanitation. Such contacts cause intestinal infections of bacterial and viral origins and are the principal cause of malnutrition, infectious diarrhoea, anaemia and possibly delayed growth among children, with potentially dramatic consequences for their psychic development.

Through the history of humankind, new zoonotic diseases have constantly emerged from wildlife; their expansion is hardly limited to sedentary lifestyle. 58% of species that are pathogenic to humans have a zoonotic origin (Woolhouse and Gowtage-Sequeria 2005). The risk of contracting a zoonotic disease is increased by the proliferation of rodents that are attracted by domestic remains and food storage in permanent villages. Permanent settlements also facilitate contact with a broader range of domesticated animals, thus increasing the interspecific transfer of pathogens. Enhanced human density in permanent villages and accelerated communication between settlements (roads, modern navigation equipment) have been facilitating factors of zoonose proliferation since the infected victims now come into contact with larger human population. Today, as the volume and speed of trade and travel are constantly rising, the epidemiology of emerging infectious diseases has acquired a worldwide scale. The former nomadic hunter-gatherers who are now confined in

FIGURE 1 Age pyramids of Pygmy and Punan hunter-gatherers (adapted from Dounias and Froment 2006). The large bases of the two charts on the left reveal a high birth rate that counterbalances the high child mortality. By contrast, the tighter base of the age pyramid for periurban Tubu Punan expresses a lower birth rate subsequent to decreasing child mortality owing to facilitated access to medical care. Current life span remains low: among Kola Pygmies as well as among remote Tubu Punan, elders aged above 65 years old represent less than 2% of total population, versus more than 17% on average in industrialized countries

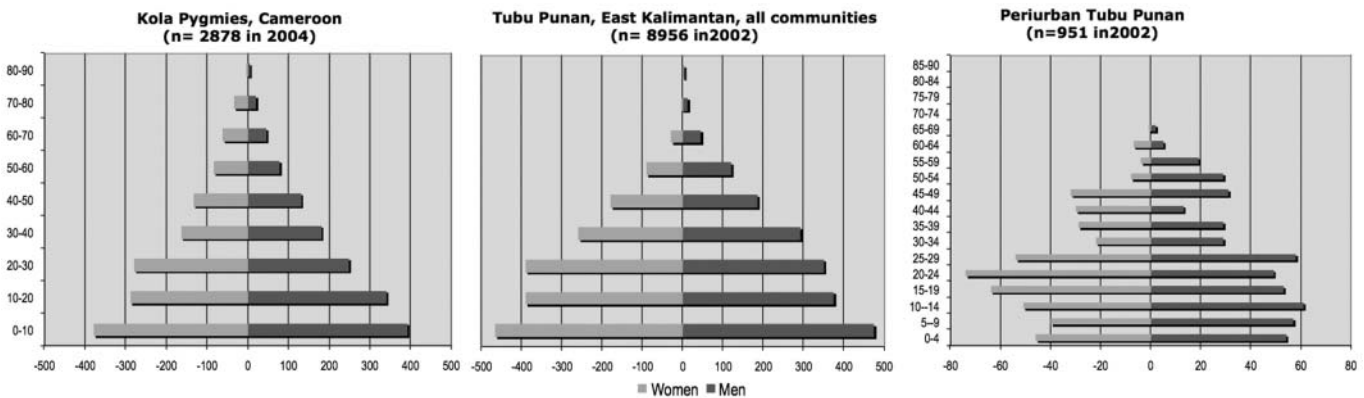
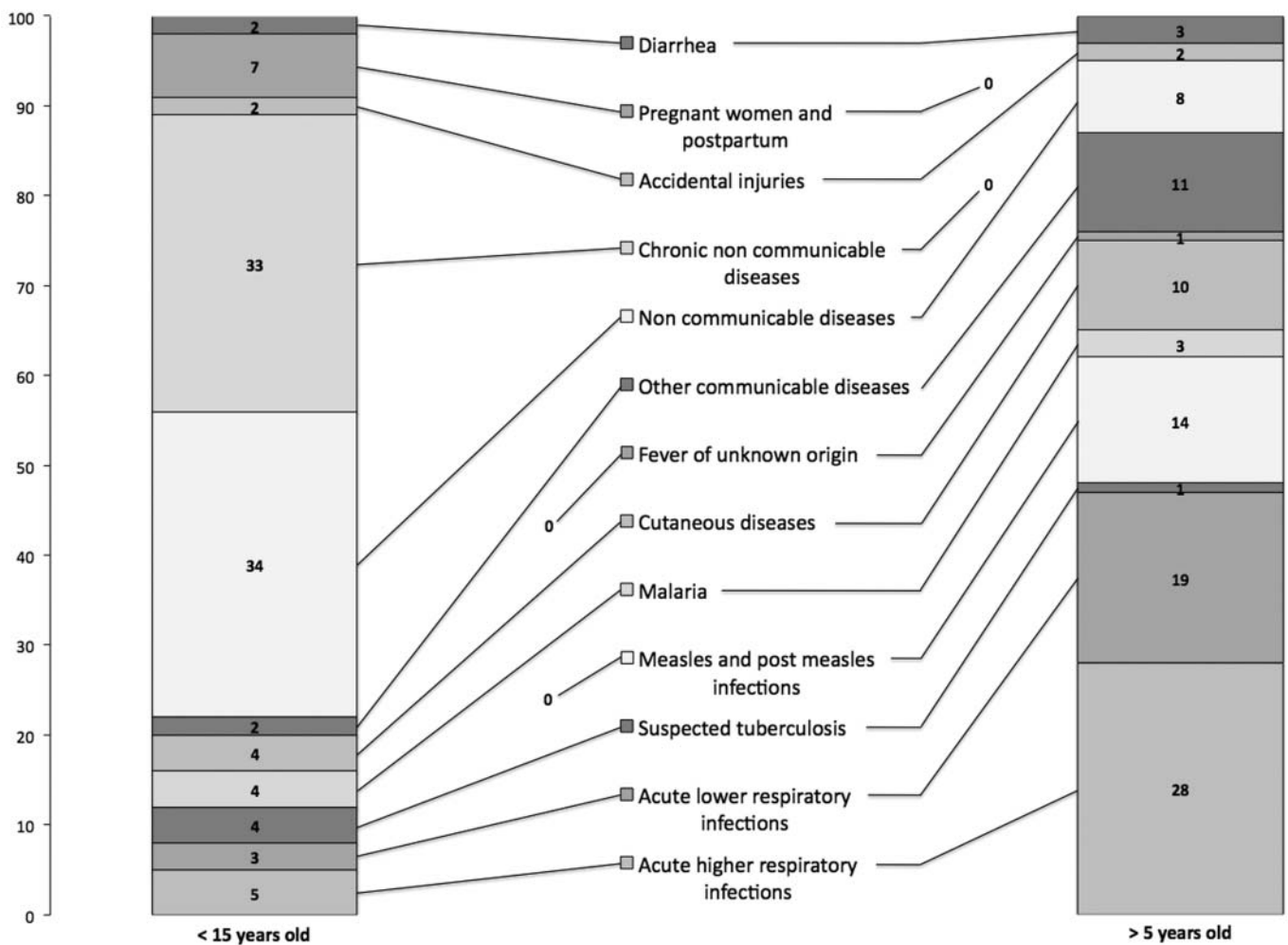


FIGURE 2 From July 2005 to March 2008, eight successive campaigns of clinical examination and medical care were carried out in collaboration with the French humanitarian NGO Médecins du Monde among the most remote settlements of Tubu Punan in Eastern Kalimantan. 2,639 consultations were given, representing an average of 333 patients per campaign (at least 45% of the total population benefited from these campaigns). Children less than 5 years old, young people aged between 5 and 15 years old, and adults aged above 15 years old represented 27%, 21% and 52% of the patients, respectively.

The two graphs comparing the major causes of ailments between children and adults reveal striking differences. While morbidity among children is highly dominated by acute transmissible diseases (respiratory infections, measles and post-measles infections, coetaneous diseases), non-communicable diseases predominate among adults who mainly suffer from headaches, vertigo, dental problems, arthritis and muscular pains. Children pay the highest cost of the emergence of infectious diseases.

As stated by WHO (1998) among the 140,000 people who die daily in the world, 30,000 are children and infants less than 5 years old, who die from diarrhoea and dehydration, measles and acute respiratory infections; 50,000 die from infection (5,000 from HIV AIDS, 3,000 from malaria); 40,000 from cardio-vascular diseases; 15,000 from cancer; and 10,000 from brutal death



permanent and more crowded settlements undergo unprecedented exposure to zoonotic diseases and unconsciously contribute to their spreading (Wolfe *et al.* 2005). Blood analyses reveal higher levels of immunoglobulins — an indicator of propensity for infection (Froment 2001) — among these tribes than among their neighbouring agriculturalists. Sedentary hunter-gatherers are trapped in a vicious circle since infection often leads to malnutrition, which affects bodily resistance, thus preparing a propitious field for the advent of new infection. . .

The native garb of most forest foragers was minimal when they were still nomadic. Today most of them wear European

clothes, urged on them by missionaries and local authorities, even though such clothes are not well suited for use in the forest. In the absence of soap, the same clothes are worn dirty until they wear out, creating a hospitable ground for infectious skin diseases.

A LEGITIMATE THOUGH DELETERIOUS ACCESS TO MODERNITY

Modern forms of exploitation of forest resources by outsiders bring in opportunities to formerly nomadic forest dwellers to

experience the “charms” of industrialization and urbanization as well as their dramatic consequences on diet and nutritional status, especially for children. Modernization not only brings new food, but also alters the availability of local resources and the social modalities of their distribution within communities. Sedentarised periurban Punan as well as Kola and Baka Pygmies in Cameroon tend to eat foods that are richer in fat and free sugar — fast absorbed sugar that is not naturally contained in food but is rather artificially added — but that are poor in slow burning glucides. The links between such a diet and the emergence of chronic degenerative diseases — cardiovascular disorders, cancer — especially during adulthood, are now well established. New nutritional troubles like anaemia, obesity, hypertension, high rates of cholesterol and diabetes, are commonly reported among recently sedentarized hunter-gatherers. Globally, the legendary good physical condition of hunter-gatherers is seriously compromised by sedentarization and appears to be less enviable than that of their farming neighbours.

Accordingly, yaws affects the sedentarised Baka Pygmies in eastern Cameroon much more frequently than their Bantu neighbours (80% versus 37% respectively) because these two communities have unequal access to dispensaries that are located along roads or in proximity to cities (Froment 2004).

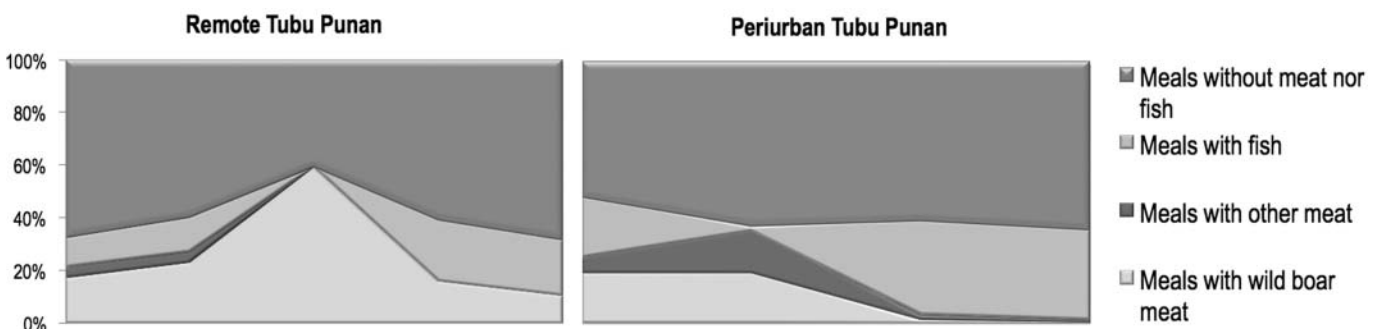
In their large majority, civil servants have a scornful perception of hunter-gatherer lifestyle and refuse to be outposted in a remote settlement. The very few who have no choice but to accept these posts (young and recent holders of their diploma) generally disappear after a few months of purgatory. For the hunter-gatherers, the fleeting illusion of development is rapidly replaced by frustration and a sad feeling that they have been left behind. Concomitantly, the collectivist social regulations (mutual aid, food sharing) that sealed these communities when they were still nomadic, fade and make way to more opportunistic and individualistic attitudes (Kaskija 2007, Levang *et al.* 2004). Among the Punan (Dounias *et al.*

2007) but also among the Orang Asli (Colin *et al.* 2003, Endicott and Dentan 2004, Lin 2008), the increasingly individualistic behaviour jeopardizes high-risk persons like elderly widows who depend on the generosity of other members of the community for nutrition and health.

Even in the absence of measured dietary deficiencies, forest dwellers all complain about lean periods in food supply, which are characterized by a decline in availability of culturally valued food. Such temporary shortage may provoke severe psychological unrest (Harrison 1982), which has a cultural component exhibiting tangible effects and possibly negative health consequences. In case of occasional lack of meat, nomadic hunter-gatherers like African Pygmies and Punan express a “meat hunger” and complain of tiredness, loss of vital strength and illness (Thomas 1987). Meat is perceived as essential for health not only because it is a vital source of nutrients: hunting indeed requires all one’s mental and physical abilities and abundance of meat is accordingly perceived as a sign of the hunter’s good condition. In contrast, a meat shortage is unconsciously and symbolically associated with an unhealthy hunter who affects, through him, the vitality of the whole community (Motte-Florac *et al.* 1993). Hunting is certainly the productive activity which is the most impacted by sedentarization (Figure 3).

Mental diseases like stress and depression are increasingly observed among former forest foragers. They are premises to other disorders including marital violence as well as substance abuse. These addictions are not only the causes of direct intoxication; they also precede other exploding pathologies such as tuberculosis. Former nomadic hunter-gatherers are easy prey for proselytism. Religious dogmatism may sometimes mitigate some addictions: Christian religion has certainly reduced the consumption of alcohol among the Punan of Borneo, but increasing reported cases of emphysema and cancer among these forest peoples are certainly the consequence of heavy cigarette smoking (Strickland and Duffield

FIGURE 3 Comparison of diet between remote Punan and periurban Punan of Eastern Kalimantan (Borneo) (in cumulative percentage over 12 months of quantification). The frequency of vegetarian meals is the same for both groups and barely varies through the year. Meals based on meat or fish more discriminate the two groups. Remote Punan consume fish only in case of bushmeat scarcity, whereas periurban Punan who have lesser access to bushmeat have adopted fish as their main source of animal protein. Wild boar, which is the favourite source of meat for these hunter-gatherers, ensures 97% of the biomass of meat consumed by the remote Punan. This meat is banned from town where the majority of civil servants are muslims not native to Borneo. Furthermore, wild boar is rare in the deforested lands surrounding the cities and periurban Punan have to make do with the other game they can catch only occasionally. Meat hunger and related mental disorders are common among periurban Punan (adapted from Dounias *et al.* 2007)



1998). The prevalence of sexually transmissible diseases, especially HIV-AIDS, is dramatically rising and is another sad proof of the “fatal attraction of development” (Froment 2004, Hamill and Dickey 2005).

The new generation of Punan who have grown up near the city are accustomed to live with electricity and television. Nevertheless, they are persistently harassed by a discrimination that compromises their access to job opportunities. Nutritional disorders and mental diseases are undisputable signs of their fast-rising psycho-cultural ill-being. A dramatic illustration of such ill-being is given by suicide rates among younger Amerindian (especially the Guarani of Brazil) and Aborigine communities, which are among the highest in the world. (Coloma *et al.* 2006, Woodman and Grigs 2007).

CONCLUSION

The purpose of evoking the Neolithic age transition as an introduction is not to extrapolate the past into modern times. It aims to emphasize on the evolutionary dimension of the interactions of humankind and the surrounding pathogens. The sudden shift of contemporary forest hunter-gatherers from nomadic to sedentary lifestyle has nothing in common with the slow evolutionary process that occurred ages ago. The slow evolutionary transition that happened during the Neolithic age (but which can be considered as brutal when compared to the time length of human presence on earth) and that was a crucial stage of humankind adaptation to a new pathogenic environment does not undergo for modern times hunter-gatherers. Processes and pathogens remain the same, but time scale of encounter, thus propensity to adapt is tremendously impaired. Human adaptation to the epidemiological transition engendered a great diversity of situations and cultural strategies along a wide spectrum ranging from the persistence of a nomadic and hunter-gatherer lifestyle to a very speculative form of monocropping agriculture, encouraging all kinds of intercultural interactions.

The forest dwellers on the Neotropics illustrate this diversity of trajectories of transition to agriculture. Agriculture has for long been a determining part of the economy of Amazonian forest dwellers because this region is the centre of domestication of many staple crops (cassava, arrow root, sweet potato) and fruit trees (cocoa, cashew nut, avocado, couroup, guayava, papaya), that are commonly cultivated today throughout the tropics. Semi-nomadism (seasonal mobility from a permanent settlement) would best characterize the lifestyle of forest Amerindians who settled down in small, and most frequently, isolated communities. The current explosion of epidemiologic problems in the last uncontacted tribes of Amazonia is definitely not imputable to the renunciation of nomadic lifestyle, but rather to the loss of isolation.

With regard to their extremely high ecosystem diversity, the mosaics of tropical forests are dynamic in essence. So are the various human societies whose livelihoods depend on forest resources. Accordingly, and contrary to the preconceived idea that these societies have for long been stuck in

an immutable way of life, adaptation is consubstantial of the history of forest dwellers who have always had to adapt to the continuous changes in forest ecosystems.

Nevertheless these indigenous peoples are confronted today with unprecedented changes in their environment. These recent drastic alterations of forest ecosystems are no longer of natural origin but are direct consequences of human activities that are generally carried out by protagonists of industrialized countries. For instance, there is some sad irony to point out that those who are going to suffer most from the effects of climate change are those who are the least responsible for the worldwide accumulation of greenhouse gases (Dounias 2009).

Rapid land use conversion of the forests and induced reductions of resource availability irremediably modify the social, cultural, economic and political systems of forest foragers. The solutions that these people are forced to implement in a rush in response to such changes are no longer tested empirically and their long-term societal and ecological consequences are too complex to anticipate. For present-day hunter-gatherers, possible adaptation strategies are twice compromised by the brutality of change and by the imposition of the way to take to abandon a nomadic lifestyle.

The last hunter-gatherer societies are paying heavily for their legitimate aspiration to be beneficiaries of ongoing globalization. The ecological and cultural consequences of this aspiration are clearly revealed by the changes in their diets and continuous exposure to emerging diseases, which are explicit indicators of their growing maladaptation to their changing forest environments. However, declining diets and increasing illnesses are only symptomatic warnings of these ecological and sociocultural maladaptations, and the great majority of actors who are committed to assisting these people content themselves with treating these “symptoms”. Interventions by outsiders eventually nourish a Daedalus syndrome: they pretend to bring solutions which in fact raise more complex problems which in turn require more complex solutions, guiding the people that they pretend to help to unavoidable collapse.

Providing medical assistance to cope with the malnutrition and diseases of these people would only provide short-term respite from the superficial symptoms. However, this should not overlook other more helpful long-term interventions that should consider the ecological, social, political and economic drivers of change that indirectly affect the health of forest foragers: more acute than malnutrition and diseases are the insecurity and discrimination caused by social prejudice. As stressed by Colfer (2005) and Colfer *et al.* (2006), the healthy future of these groups depends on socioeconomic and socio-political factors such as access to education, acknowledgement of traditional rights, protection against outsiders, equity of chance on job opportunities. Déjà vu!

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