CONTENTS

Scientific Papers

57 (2-4–2011) — BULLETIN ARSOM – MEDEDELINGEN KAOW

ISSN 0001-4176

ARSOM·KAOW

Bulletin des Séances
Mededelingen der Zittingen

Académie Royale des Sciences d'Outre-Mer

Sous la Haute Protection du Roi

Koninklijke Academie voor Overzeese Wetenschappen

Onder de Hoge Bescherming van de Koning

57 (2-4)

2011

Avis aux auteurs

L'Académie publie les études dont la valeur scientifique a été reconnue par la Classe intéressée.

Les textes publiés par l'Académie n'engagent que la responsabilité de leurs auteurs.

Bericht aan de auteurs

De Academie geeft de studies uit waarvan de wetenschappelijke waarde door de betrokken Klasse erkend werd.

De teksten door de Academie gepubliceerd verbinden slechts de verantwoordelijkheid van hun auteurs.

Abonnement 2011: 70,00 €

avenue Louise 231
B-1050 Bruxelles (Belgique)

Louizalaan 231
B-1050 Brussel (België)

TABLE DES MATIERES — INHOUDSTAFEL

Communications scientifiques
Wetenschappelijke mededelingen

Bulletin des Séances
Mededelingen der Zittingen

Académie Royale des Sciences d'Outre-Mer

Sous la Haute Protection du Roi

Koninklijke Academie voor Overzeese Wetenschappen

Onder de Hoge Bescherming van de Koning

ISSN 0001-4176

57 (2-4) 2011

COMMUNICATIONS SCIENTIFIQUES

WETENSCHAPPELIJKE MEDEDELINGEN

Classe des Sciences humaines

Klasse voor Menswetenschappen

Bull. Séanc. Acad. R. Sci. Outre-Mer
Meded. Zitt. K. Acad. Overzeese Wet.
57 (2-4 – 2011): 215-235

Van de *Belgische Koloniale Biografie* naar het *Biografisch Woordenboek van Belgen Overzee** [1]**

door

Guy VANTHEMSCHE***

TREFWOORDEN. — Geschiedschrijving; Kolonialisme; Congo; Naslagwerken; Biografie.
SAMENVATTING. — In deze tekst blikken we terug op de ontstaansgeschiedenis en de kenmerken van de *Belgische Koloniale Biografie*, een bekend naslagwerk dat in het leven werd geroepen door het Koninklijk Belgisch Koloniaal Instituut, de voorloper van onze Academie. We leggen uit waarom beslist werd om een eindpunt te zetten achter de bestaande reeks en een nieuw onderzoeksinstrument te lanceren, het *Biografisch Woordenboek van de Belgen Overzee*. We stellen ook de nieuwe elektronische omgeving voor waarin het zal gepubliceerd worden.

MOTS-CLES. — Historiographie; Colonialisme; Congo; Ouvrages de référence; Biographie.
RESUME. — *De la* Biographie coloniale belge *au* Dictionnaire biographique des Belges d'Outre-Mer. — Dans ce texte, nous jetons un regard rétrospectif sur la genèse et les principales caractéristiques de la *Biographie coloniale belge*, ouvrage de référence bien connu créé par l'Institut royal colonial belge, précurseur de notre Académie. Nous expliquons pourquoi la décision a été prise de clôturer cette série et de la remplacer par un nouvel instrument de recherche, le *Dictionnaire biographique des Belges d'Outre-Mer*. Nous présentons également le nouvel environnement électronique dans lequel il sera publié.

De aandacht voor „Grote Belgen overzee" vóór de start van de *Belgische Koloniale Biografie*

In de opbouw van nationale identiteiten speelt het verleden een grote rol [2]. Dat ge(re)construeerde verleden bestaat uit allerhande markante gebeurtenissen en uit grote individuen. Beide elementen werden geacht de „eigenheid" van de natie te reflecteren. De roemrijke figuren spelen daarbij een dubbele rol. Enerzijds symboliseren ze de essentie van de nationale kwaliteiten, anderzijds hebben ze

---

* Mededeling voorgesteld tijdens de zitting van de Klasse voor Menswetenschappen van 8 november 2011. Tekst ontvangen op 9 november 2011.

** De cijfers tussen haakjes [ ] verwijzen naar de noten en referenties, pp. 231-235.

*** Lid van de Academie en voorzitter van de Commissie voor de Biografie; Vrije Universiteit Brussel, Faculteit der Letteren en Wijsbegeerte, Vakgroep Geschiedenis, Pleinlaan 2, B-1050 Brussel (België).

ook bijgedragen tot de opbouw ervan. Die complexe omgang met feiten en persoonlijkheden uit het verleden heeft zich uiteraard ook voorgedaan in het jonge België [3]. In de 19de eeuw hebben de politieke autoriteiten en de culturele elites (bewust of onbewust) bijgedragen tot de constructie van een pantheon van Grote Belgen uit het verleden. Die *gloires nationales* moesten bijdragen tot de morele verheffing van de huidige en toekomstige generaties. Voor die helden moesten dan ook passende monumenten worden opgericht. Dat gebeurde soms letterlijk: standbeelden en bustes sierden de mooie plekken van steden en gebouwen. Maar er werden ook papieren monumenten opgetrokken. Biografieën, die soms regelrechte hagiografieën waren, voegden zich naast de kleinere, meer bescheiden notities die vervat waren in tal van naslagwerken die min of meer „wetenschappelijk" waren.

Op het einde van de 19de eeuw verkreeg de jonge Belgische natie ook een koloniale dimensie [4]. Vrij onverwacht en eerder toevallig maakte Congo voortaan deel uit van de nationale lotsbestemming. Na jarenlange inspanningen was de tweede koning der Belgen, Leopold II, de soevereine vorst geworden van een enorm gebied in het hart van centraal Afrika. Dat was gebeurd zonder veel openlijke hulp van de Belgische politieke autoriteiten, in het begin zelfs tegen hun wil in. Geleidelijk aan was de publieke steun voor die koloniale onderneming echter groter geworden. Tussen 1885 en 1908 hadden tal van Belgen ook lijfelijk deelgenomen aan de opbouw van de Onafhankelijke Congostaat. Het ging om enkele duizenden individuen: militairen, missionarissen, zakenlieden, geleerden, avonturiers. Velen stierven, ofwel in militaire operaties, ofwel (meestal) geveld door ziekte. In 1908, toen België dat gebied officieel als kolonie overnam, werden de metropolitaanse overheden en bevolking er uiteraard nog nauwer bij betrokken. In de daaropvolgende decennia, tot aan de onafhankelijkheid van de kolonie in 1960, kwamen vele tienduizenden Belgen fysiek in contact met Congo (en vanaf 1919 tot 1962, met de mandaatgebieden Ruanda en Urundi).

De kolonisatie verleende bijgevolg een nieuwe dimensie aan de Belgische nationale identiteitsopbouw, een proces dat op het einde van de 19de eeuw nog steeds aan de gang was [5]. De gebeurtenissen in Congo verschaften plots een aanzienlijke voorraad aan nieuwe *memorabilia* waarmee het nationale bewustzijn verder kon worden verstevigd. In de gevaarlijke en als „primitief" voorgestelde tropische regio's werden de Belgische nationale kwaliteiten immers uitgedragen door een schare van onversaagde landgenoten. Zij deinsden er niet voor terug — zo ging het verhaal — om hun gezondheid en zelfs hun leven op het spel te zetten voor een hoger doel: het verspreiden van de Beschaving en/of het Evangelie; de strijd tegen de slavernij en andere barbaarse praktijken; de roem van het Vaderland en van de Dynastie; de weldaden van de Vooruitgang en van de Rede. Die nieuwe helden moesten natuurlijk op een passende wijze gehuldigd worden. Sommigen onder hen leefden nog; zij konden letterlijk en figuurlijk in de bloemetjes gezet worden. Anderen, vaak pioniers die op jeugdige leeftijd gestorven waren, werden gehuldigd met monumenten, standbeelden, busten of

commemoratieve platen [6]. Maar voor vele andere blanke „Congohelden" werden passende papieren rouwkransen geweven. Ze werden herdacht door middel van biografische notities: *exegi monumentum aere perennius* … [7].

Dergelijke huldigingen werden gepromoot door de hoogste instanties van het land. Met het oog op het nakende eeuwfeest van 's lands onafhankelijkheid (1930) nam minister van Koloniën (en Premier) Henri Jaspar het initiatief om een *Ligue du Souvenir congolais* op te richten [8]. De liga kreeg verschillende opdrachten mee: herdenken van de belangrijkste gebeurtenissen van de Congolese geschiedenis; monumenten en gedenkplaten aanbrengen om de helden van de kolonisatie te huldigen (die zijn te vinden op vele plaatsen, zo bijvoorbeeld in het Afrikamuseum van Tervuren [9]); hun graven opzoeken en onderhouden; schrijvers oproepen om de actie van de Belgen in Centraal Afrika te beschrijven; en vooral ook een officiële lijst opstellen van de overledenen in Congo vóór 1908: „*porter ces héros à l'ordre du jour de la Nation*" en „*publier le Livre d'Or des héros congolais*".

Het Gulden Boek verscheen inderdaad in 1931, maar was hoofdzakelijk een klassieke historiek van de grote Congolese *épopée*. Het werk bevatte wel een namenlijst van alle Belgen die tussen 1876 en 1908 waren overleden in dienst van het koloniale avontuur (ongeveer 1450 individuen), maar gaf verder geen levensbeschrijvingen (buiten plaats en datum van geboorte en overlijden) [10]. Voordien waren er trouwens al verschillende andere biografische repertoria gepubliceerd die hulde brachten aan de Belgen die betrokken waren geweest bij de eerste fasen van het Congolese avontuur. Die naslagwerken hadden geen wetenschappelijke pretentie. Hun stichtend karakter was des te meer uitgesproken. De titels lieten er geen twijfel over bestaan: de termen „pioniers", „heroïsme", „patriottisme", „beschaving" werden duidelijk in de verf gezet. Die onverschrokken figuren konden op treffende wijze bijdragen tot de ontwikkeling van de Belgische nationale fierheid. Enkele grote individuen stegen uit boven het gemiddelde, omdat ze een bijzonder grote rol gespeeld hadden in Afrika. Aan hen werden afzonderlijke monografieën gewijd, of de betrokkenen bouwden voor zichzelf een aandenken op, onder de vorm van gepubliceerde herinneringen of een autobiografie. Maar ook het gros van de pioniers werd niet vergeten: zelfs voor bescheiden figuren werd een plaats vrijgemaakt in de biografische naslagwerken [11]. Dat was materieel overigens ook doenbaar omdat het totale aantal Belgen dat in het verre Congo gestorven was, uiteindelijk niet zo enorm was. In de beginfase 1876-1908 ging het om verschillende honderden, hooguit enkele duizenden personen.

De herdenking van verdienstelijke Congopioniers bleef bovendien aan de lopende band doorgaan tot 1960 (en zelfs daarna). In de koloniale tijdschriften verschenen voortdurend nieuwe *in memoriams* die de overleden ex-kolonialen herdachten. Uiteraard werden dergelijke teksten ook geproduceerd door andere beroepsgroepen; alleen was de groepsgeest misschien iets sterker bij de oud-gedienden van de Congo. Stilaan stapelden die notities zich op. Ze vormden een

aanzienlijke (potentiële) „grondstof" voor gespecialiseerde biografische repertoria. Enkele jaren voor de onafhankelijkheid van Congo werd nog een uitgebreid *who's who* gepubliceerd, met korte biografische nota's van (ook heel bescheiden) Belgen en buitenlanders die op dat moment in de kolonie actief waren [12]. Opnieuw was de toon gezet van in de inleiding: „*En publiant cet ouvrage, les éditeurs espèrent avoir servi* […] *la cause du Congo et de son avenir*", meer precies tegen de antikolonialistische aanvallen waarvan Belgisch Congo het mikpunt was. Blijkbaar was dat een *idée fixe* voor dat soort naslagwerken…: we zullen diezelfde stelling hierna nog ontmoeten.

Vanaf het einde van de 19de eeuw had de Belgische actie in Centraal Afrika bovendien ook een ander effect. Politici en academici vertoonden een groeiende belangstelling voor het Belgisch expansionisme in de wereld vóór de totstandkoming van de Congolese kolonie. Meer zelfs: men wilde en moest aantonen dat de Belgen en de Belgische volksaard *altijd* gericht waren naar wijdse horizonten. Vanaf de Middeleeuwen en vooral in de Nieuwe Tijd hadden sommige inwoners van het territorium dat later België zou worden, een zekere, soms zelfs een *grote* rol gespeeld in de overzeese gebieden [13]. Ook voor hen werd vrij snel een symbolisch pantheon opgebouwd: een galerij van merkwaardige „Belgen" die actief waren geweest overzee en die door de huidige en toekomstige generaties gememoreerd moesten worden. Toen dat pantheon tot stand kwam, werden de aanhalingstekens bij het woord „Belg" zelfs probleemloos weggelaten. Niet zonder anachronisme projecteerde men de (veronderstelde) „kwaliteiten" van de inwoners van het kleine, jonge koninkrijk in het verleden. Men ging er immers van uit dat de avontuurlijke Zuid-Nederlanders, of dito inwoners van de XVII Provinciën of zelfs van de Middeleeuwse vorstendommen, altijd volbloed „Belgen" waren geweest, met alle formidabele eigenschappen van dien.

De geboorte van de *Belgische Koloniale Biografie* (1941-1948)

In 1928 werd het Koninklijk Belgisch Koloniaal Instituut opgericht (KBKI) [14]. In dit officiële genootschap, voorloper van de huidige Koninklijke Academie voor Overzeese Wetenschappen (KAOW), zetelde toen een breed en divers gamma van vooraanstaande koloniale figuren. Naast geleerden bestond het ook uit politici, zakenlieden, missionarissen en hoge ambtenaren. Pas veel later zou deze instelling uitsluitend bestaan uit wetenschappers. In de eerste drie decennia van zijn bestaan, vervulde het Instituut bijgevolg verschillende functies. Het moest niet alleen de wetenschappelijke kennis over Congo uitbreiden en verspreiden; het was ook een *think tank*, een debatforum en een intellectueel uithangbord voor de Belgische kolonisatie. Aan laatstgenoemde onderneming verleende het KBKI dus enig academisch *sérieux*; meer nog: het was één van de intellectuele apparaten van de koloniale praktijk [15]. Logischerwijze zou het Instituut zich vroeg of laat ook bezighouden met de geschiedenis van de kolonie.

Reeds in 1925, dus enkele jaren vóór de stichting van het Instituut, had de overheid een commissie opgericht „*chargée d'écrire, en collaboration, une histoire générale du Congo*" [16]. In dat verband moesten ook de getuigenissen van oudkolonialen verzameld worden. Van die onderneming kwam echter niets in huis; het is niet duidelijk waarom. De commissie werd ontbonden bij de oprichting van het KBKI. Het duurde nog enkele jaren vooraleer het Instituut zich effectief interesseerde voor de geschiedenis van Congo. Pas in 1941 stelden twee leden van het KBKI, E.H. Léon Lotar en Edouard De Jonghe, aan hun collega's voor om een biografisch woordenboek te realiseren betreffende de Belgische kolonisatie. Ze vonden gehoor bij hun confraters: een speciale commissie werd in het leven geroepen om dat werk tot een goed einde te brengen. De Commissie voor de Belgische Koloniale Biografie was geboren. Vandaag bestaat ze nog steeds, onder de benaming „Commissie voor de Biografie".

Dat gebeurde niet toevallig tijdens de Duitse bezetting [17]. De activiteit van de koloniale ondernemingen en organisaties in België was noodgedwongen sterk verminderd. De kolonialen die in het land gebleven waren, konden tijd vrijmaken voor de arbeidsintensieve zoektocht naar biografische gegevens. Het werd inderdaad een werk van lange adem: het eerste volume van de *Belgische Koloniale Biografie* verscheen pas in 1948. Men ging immers bijzonder grondig aan de slag. Twaalfduizend vijfhonderd personen werden individueel aangeschreven om inlichtingen te bekomen. De Commissie klopte ook aan bij honderd twintig koloniale ondernemingen en tientallen instellingen. Uiteindelijk werden niet minder dan vijftienduizend individuele fiches verzameld. Op die basis werd in 1943 een voorlopige lijst van drieduizend achthonderd eenentachtig personen gepubliceerd, die verdienden om in het toekomstige naslagwerk te worden vermeld [18]. Die lijst werd slechts op beperkte oplage verspreid (driehonderd vijftig exemplaren), maar door de circulatie ervan werden nog vele „lacunes" opgemerkt en gesignaleerd. Zo beschikte de Commissie uiteindelijk over een fichier van niet minder dan zevenentwintig duizend individuen die in het biografische naslagwerk zouden kunnen worden opgenomen [19]. In 1945 begon de redactie van de eerste notities. Zoals gezegd, duurde het nog drie jaar vooraleer het eerste volume verscheen.

Omvang en reikwijdte van de *Belgische Koloniale Biografie* (BKB) en van de daaropvolgende *Belgische Overzeese Biografie* (BOB)

Tijdens de daaropvolgende tien jaar verschenen, in vrij snel ritme, niet minder dan vier andere volumes, nog steeds onder de titel *Belgische Koloniale Biografie* (1951, 1952, 1955, 1958). De dekolonisatie zette geen eindpunt achter de onderneming, maar het naslagwerk moest natuurlijk een andere titel krijgen. Voortaan werd de reeks *Belgische Overzeese Biografie* genoemd. Concept en werkwijze bleven ongewijzigd, maar het verschijningsritme vertraagde aanzienlijk. Men

moest tien jaren wachten vooraleer het volgende volume werd uitgebracht, nu onder de nieuwe titel (1968). Na twee volgende delen (VIIA in 1973 en VIIB in 1977) kwam er nog minder vaart in de publicatie: de delen VIIC en VIII kwamen er pas, respectievelijk, in 1989 en 1998. Momenteel, in 2013, is het volgende deel IX nog niet drukklaar gemaakt.

Op wie had de *BKB-BOB* precies betrekking? De inhoud van het naslagwerk is enigszins veranderd in de loop van de jaren. Het oorspronkelijke programma, vastgelegd in de jaren 1940, focuste exclusief op Congo. Men wou een levensbeschrijving bieden van alle individuen — *petits et grands* — die in Congo aanwezig waren in de beginfase van het koloniale avontuur (tussen 1876 en 1890). Ook zij die nadien een markante rol gespeeld hadden in de kolonie kregen een plaats in het naslagwerk. Men had vervolgens ook aandacht voor diegenen die betrokken waren bij de Congolese geschiedenis, zelfs indien ze nooit ter plaatse waren geweest. Twee belangrijke preciseringen. Ten eerste: de personen in kwestie moesten overleden zijn vóór 1930 [20]. Ten tweede: de nationaliteit deed er niet toe. Naast Belgen kwamen ook buitenlanders aan bod (anders zou iemand als Stanley door de mazen van het net zijn geglipt…). Ander opmerkelijk aspect: ook voor Afrikanen werd een plaats ingeruimd. Het eerst volume van de *BKB* opent bijvoorbeeld met een notitie over *„Abd Er Rahman Abougouroun, Traitant nubien"* .

In de loop van de daaropvolgende jaren werd gesleuteld aan die selectiecriteria. De Commissie voor de Biografie omschreef nauwkeuriger de voorwaarden waaraan de koloniale persoonlijkheden moesten voldoen om een plaats te krijgen in het biografisch woordenboek (meer bepaald het hiërarchische niveau en de duur van het verblijf in Congo) [21]. Het was duidelijk dat de opstellers nog altijd een zekere graad van consistente exhaustiviteit nastreefden. De datum vóór dewelke de personen overleden moesten zijn, werd uiteraard ook geleidelijk aangepast naarmate de tijd verstreek. Maar vooral werd het onderzoeksveld nu ook opengesteld voor alle Belgen die een merkwaardige rol hadden gespeeld in de Belgische overzeese expansie sinds 1830, waar ook ter wereld, maar enkel in de gebieden die men later als „ontwikkelingslanden" zou omschrijven. Bij de verschijning van het zesde deel in 1968 (meteen ook het eerste onder de nieuwe titel *BOB*) had het naslagwerk zijn exclusieve Congolese focus dus al verlaten. Nadien werd ook de datum „1830" losgelaten. Men ging verder in het nationale verleden terug om de Belgische actie overzee te documenteren.

Na meer dan een halve eeuw noeste arbeid is op die manier een merkwaardig referentiewerk tot stand gekomen. De acht verschenen volumes (gepubliceerd in tien afzonderlijke delen [22]) bevatten ongeveer vijfduizend vijfhonderd notities — een schat aan informatie voor al wie de overzeese (en vooral de koloniale) geschiedenis van België wil onderzoeken. De optie van de initiatiefnemers om ook de bescheiden pioniers van de Onafhankelijke Congostaat en van de Belgische kolonie mee op te nemen, was bijzonder geslaagd. In de inleiding van het achtste (en voorlopig laatste) volume van de *BOB*, verschenen in 1998, allu-

deert de toenmalige voorzitter van de Commissie voor de Biografie, Pierre Salmon, op de kritiek die sommigen hadden op het feit dat het naslagwerk ook „*d'obscurs agents, pionniers et missionnaires coloniaux ou africains*" opgenomen had [23]. Net die optie heeft vele „kleine garnalen" echter van de vergeetput gered. Anders zouden de huidige en toekomstige historici hun spoor volledig zijn kwijtgeraakt. Maar hoe grondig de verantwoordelijken van de *BKB-BOB* ook tewerk zijn gegaan, toch werden in de loop van de jaren ook vele belangrijke figuren vergeten. Ook enkele domeinen werden onvoldoende gedekt. We komen straks terug op dit probleem.

De opstellingswijze en de inhoud van de *BKB*: het stempel van de koloniale propaganda

Maar uiteraard wordt de waarde van een naslagwerk niet alleen bepaald door het aantal lemma's. Ook de ideologische context en de analysemethode — en bijgevolg de inhoudelijke kenmerken van de notities — zijn van primordiaal belang. Van bij de aanvang gingen de initiatiefnemers van de *BKB* er prat op een „*œuvre à caractère scientifique et objectif*" te realiseren. Maar tegelijk lieten ze eveneens een andere toonaard weerklinken. Het biografische repertorium moest namelijk ook „*évoquer la mémoire*" van de koloniale pioniers; hierdoor had men „*une pensée pieuse*" voor hen [24]. Het voorwoord van volume V, verschenen amper twee jaar vóór de dekolonisatie, stelde zelfs heel uitdrukkelijk „*que la Biographie coloniale belge ne se présente pas uniquement comme une œuvre scientifique ou historique. Elle constitue avant tout un mémorial de l'entreprise édifiée par les Belges au centre de l'Afrique depuis quatre-vingts ans à l'initiative du roi Léopold II*" [25]. De biografische notitie die gewijd werd aan de initiatiefnemer van de *BKB*, priester Léon Lotar, stelde het even duidelijk maar ietwat lyrischer voor: „*Dans [son] esprit, cette biographie coloniale devait être un instrument de travail pour l'historien, mais aussi une stèle commémorative élevée à tous les pionniers de l'œuvre congolaise, à ceux qu'une bonne étoile conduisit au succès, comme à ceux que le destin sacrifia dès les prémisses de leur offrande*" [26].

De initiatiefnemers van het nieuwe naslagwerk waren duidelijk niet vertrouwd met de knepen van het historiografische vak. Dat blijkt bijvoorbeeld uit de richtlijnen die E.-J. Devroey, de secretaris van de Commissie, formuleerde: „[…] *les notices ne doivent pas prendre la forme de panégyriques* […] *au contraire, les critiques aussi bien que les éloges doivent y trouver leur place*". De ietwat naïeve juxtapositie van de begrippen „*éloges*" en „*critiques*" spreekt boekdelen. Blijkbaar zag men de geschiedschrijver als iemand die goede en slechte punten uitdeelt… Diezelfde ambiguïteit spreekt ook uit volgende passage: „[…] *sans renoncer au droit légitime d'examen et d'analyse, ils* [= les auteurs des notices] *s'abstiendront de discuter, à leur point de vue personnel, les idées ou actions du*

personnage" [27]. Hier gaat men uit van een eveneens simplistische visie op de scheiding tussen de „persoonlijke opinie" van de auteur en de „objectieve waarheid" die zogezegd kan worden vastgesteld.

Nog afgezien van het feit dat die woorden meer dan een halve eeuw geleden geschreven werden (ondertussen is de historiografische methode toch wat veranderd), zijn die nogal onwetenschappelijke premissen helemaal niet verwonderlijk wanneer men nagaat wie de bouwheren van het naslagwerk waren. Hoe was de Commissie voor de Belgische Koloniale Biografie van het KBKI eigenlijk samengesteld? Haar eerste leden hadden allemaal persoonlijk deelgenomen aan de opbouw van de kolonie: als ambtenaar en later als missionaris (Léon Lotar, de eerste voorzitter van de Commissie, die overleed vóór de afwerking van het eerste deel van de *BKB*); als magistraat (Fernand Dellicour, de tweede voorzitter); als ingenieur (René Cambier en Egide Devroey); als militair en vice-gouverneur-generaal (Alphonse Engels); als arts (Alphonse Rodhain); als wetenschapper-etnograaf en leidend koloniaal ambtenaar (Edouard De Jonghe, de eerste secretaris van de Commissie). Onder de latere leden van de Commissie figureerde bijvoorbeeld ook Georges Moulaert, een zeer invloedrijk figuur van het Belgische koloniale establishment. Hij had hoge militaire functies bekleed, was vice-gouverneur-generaal geweest, alsook topman van grote koloniale ondernemingen (bvb. Kilo-Moto goudmijnen) en voorzitter van de *Association des Intérêts coloniaux belges* [28]. Zoals het hoorde, kregen al die figuren na hun overlijden trouwens ook een plaats in het naslagwerk dat ze mee hadden opgebouwd… [29].

Uiteraard evolueerde de samenstelling van de Commissie geleidelijk aan. Vooral vanaf de jaren 1980 werd de generatie van de pioniers en „practici" van de kolonisatie stilaan vervangen door wetenschappers die vanuit hun professionele of academische carrière met de ontwikkelingslanden in contact waren gekomen. Het reglement van het KBKI en van de daaropvolgende KAOW schreef (en schrijft) trouwens voor dat de Commissie voor de Biografie moest bestaan uit leden van de verschillende klassen van de instelling. Hun wetenschappelijk profiel was dus zeer divers (geneeskunde, ingenieurswetenschappen, enz.). De eerste (en lange tijd enige) historicus was Jean Stengers, lid vanaf het midden van de jaren 1950. Een andere geschiedkundige, specialist van de Afrikaanse geschiedenis, de reeds vermelde Pierre Salmon, bekleedde het voorzitterschap van de Commissie in de jaren 1980; hij leidde de publicatie van de laatste twee delen van de reeks (VIIC en VIII).

Een positieve ingesteldheid tegenover het kolonialisme ligt dus in de lijn van de verwachtingen. Zelfs de meest argeloze of verstrooide lezer kan hieraan niet voorbijgaan. Wie de inleiding op het eerste deel van de *BKB* openslaat, leest een panegyriek van koning Leopold II, geschreven door de toenmalige voorzitter van het KBKI, Octave Louwers. Terloops gezegd: dat is ook de enige „biografische" beschrijving over deze sleutelfiguur van de Belgische overzeese geschiedenis die we in de *Biografie* terugvinden:

Trois traits dominent la vie glorieuse de Léopold II dans son aspect colonial: le génie politique et diplomatique, la noblesse des sentiments, le désintéressement. […] Il avait mené à son terme une œuvre de titan; Il prenait rang parmi les plus grands hommes d'Etat de l'Histoire. […] Mais lui, le bâtisseur d'Empire, le Rassembleur de Terres pour le profit de la Patrie et de la Civilisation, […] disait qu'Il entendait doter son pays d'une colonie, ouvrir l'Afrique centrale à la civilisation [30].

Als inzet kon dit tellen. We moeten ons echter afvragen of en, zo ja, hoe die vermeende positieve ingesteldheid ook concreet heeft ingewerkt op de inhoud van de notities. Het is echter niet evident om de Commissie en de auteurs van de notities „aan het werk" te zien. Grote delen van het archief van het KBKI en van de KAOW zijn immers verloren gegaan. Gelukkig werden er toch enkele dossiers bewaard. Zij leveren enig inzicht in de werking van de Commissie en de opstellingswijze van de *BKB* [31].

We zagen dat de Commissie heel wat bruto biografisch materiaal had verzameld in de loop van haar voorbereidend werk. Boeken, tijdschriftartikels, gegevens verstrekt door bedrijven, missies, openbare instanties, enz., waren samengebracht op „fiches" die over iedere persoon waren opgesteld. Die fiches werden overgemaakt aan de auteurs van de desbetreffende notitie (met de soms dringende en herhaalde aanvraag om dat basismateriaal terug te bezorgen eens de notitie was geredigeerd…). Het KBKI schreef ook massa's brieven naar gemeentebesturen, bedrijven, instituten allerhande om ontbrekende biografische gegevens te bekomen [32].

Maar wie waren de auteurs van de notities eigenlijk? De theoretische criteria voor de keuze van de medewerkers waren openbaar gemaakt [33]. De leden van het Instituut (later van de Academie) kregen de voorrang: uit de vooraf opgestelde lijst mochten zij de personen aanduiden over wie ze een tekst wilden schrijven. Pas nadien werden potentiële auteurs aangezocht buiten de rangen van de Academie. Blijkbaar gebeurde die keuze op basis van een strenge selectie: „*Les collaborateurs pris en dehors de l'IRCB ne seront définitivement agréés qu'après examen de leurs titres en séance de la Commission et à la majorité des suffrages*" [34]. In de praktijk deed men echter vooral een beroep op personen die een nauwe band gehad hadden met de te beschrijven personaliteit. Zo werd de biografische notitie van missionarissen veelal geschreven door personen die zelf deel uitmaakten van de Kerk [35]. Of werd de levensbeschrijving van zakenlieden „toevertrouwd" aan collega's uit de bedrijfswereld [36]. Wanneer iemand een te beschrijven figuur (min of meer goed) gekend had, kon hij ook optreden als auteur van de notitie die aan die persoon gewijd werd. Proximiteit met en sympathie voor de overledene waren dus basiselementen die vele levensbeschrijvingen kleurden. Zeer vele lemma's, ook onder de meest recente, baadden in een sfeer die mijlenver verwijderd is van wat de hedendaagse onderzoeker mag verwachten van een wetenschappelijk naslagwerk. Bijzonder veel personaliteiten waren klaarblijkelijk erg dynamisch, vaderlandslievend, toegewijd, onbaatzuchtig, verdienstelijk, moedig, enz…. *De mortuis nil nisi bene*!

De inhoud van de notities — vooral betreffende belangrijke en/of „gevoelige" personen — werd echter ook (mede) bepaald door andere factoren. De leden van de Commissie grepen namelijk rechtstreeks in om de teneur van de teksten te bepalen of te beïnvloeden. We zullen wat uitvoeriger ingaan op twee concrete voorbeelden, die toevallig bewaard zijn gebleven in de wrakstukken van de archieven. Beide voorbeelden zijn erg revelerend voor de doelbewuste *propagandistische* sturing van het biografische naslagwerk.

Eerste voorbeeld. In 1950 schreef ingenieur René Cambier, lid van het KBKI, de notitie betreffende A. J. Wauters, de „geograaf" en publicist die onder meer de drijvende kracht was achter het befaamde tijdschrift *Le Mouvement Géographique* en die in aanvaring was gekomen met Leopold II. Cambiers confrater, de reeds vernoemde invloedrijke Georges Moulaert, was ook lid van de Commissie voor de Biografie en kreeg dus inzage in de ontwerptekst. Hij vond dat de notitie niet zomaar in de *BKB* gepubliceerd kon worden. „*Mr. Cambier devrait supprimer ce paragraphe. Pas de polémique (comme pour van Hencxthoven)*" [37]. Ook verschillende andere uitdrukkingen en zinswendingen moesten volgens de waakzame Moulaert aangepast worden. De passage die moest geschrapt worden, luidde als volgt: „*Il est facile de blâmer les monopoles d'Etat, source de nombreux abus, qui n'ont certes pas manqué au Congo.* […] *Si le Congo a eu recours à des moyens extrêmes, et éminemment critiquables, ce ne fut que pour peu de temps et contraint par la nécessité*". De auteur Cambier stemde in. Hij schrapte de gewraakte paragraaf — hij komt inderdaad niet voor in de gepubliceerde versie [38] — en wijzigde nog verschillende andere woorden en zinsdelen op basis van de vingerwijzingen van Moulaert [39].

Tweede voorbeeld. In 1957 was Joseph-Marie Jadot (magistraat, schrijver en lid van het KBKI en zelfs van de Commissie voor de Biografie) belast met de redactie van de notitie over de socialistische politicus Fulgence Masson. Deze laatste was betrokken geweest bij de parlementaire debatten betreffende de overname van Congo door de Belgische staat. In zijn oorspronkelijke versie had Jadot geschreven dat Masson de overname van Congo had geweigerd om volgende redenen: „*Pour Mr. Masson, la Belgique avait traité le Congo en pays conquis, y avait poursuivi une politique de profits et de richesses, pressuré d'une main avide les malheureuses populations et cela pour couvrir des dépenses exclusivement somptuaires en Belgique, politique contraire à l'Acte de Berlin*". Dat was in het verkeerde keelgat geschoten zowel bij Dellicour, voorzitter van de Commissie, als bij dezelfde Moulaert. Het loont de moeite om hun beider reacties wat uitvoeriger te citeren, want ze tonen goed aan in welke sfeer het naslagwerk baadde en welke het *reële opzet* ervan was. „*Il est vraiment impensable que Jadot ait pu rédiger une telle notice – pour alimenter toutes les dangereuses propagandes.* […] *Dorénavant Jadot est à surveiller!* [sic] *Le désir de se singulariser. Quels que soient les frais d'impression la notice Masson de Jadot ne peut être insérée*", zo liet Moulaert weten [40]. Commissievoorzitter Dellicour liet zelfs een uitgebreide principiële stellingname noteren, die net daarom voor ons bijzonder interessant is:

Les quatre premiers volumes de la Biographie coloniale constituent un hommage mérité à la dynastie. […] Que doivent penser de Léopold II les lecteurs non informés qui lisent la notice telle qu'elle est rédigée? Je suis le premier à revendiquer l'indépendance de nos collaborateurs. Nous avons cependant un certain droit de contrôle. Nous avons ici à considérer: a) Les adversaires de la colonisation n'hésitent pas à se servir de toutes les armes même les plus déloyales. Ce serait de la naïveté de notre part de leur fournir des arguments qui n'ont d'ailleurs aucune base sérieuse. b) De plus en plus les Congolais lisent nos publications. On peut être certain que la Biographie coloniale ne leur échappe pas. Faut-il attirer leur attention sur cette magnifique appréciation d'un député belge sur le rôle joué par la Belgique au Congo? […] Ma lettre ne plaira peut-être pas à tout le monde [41]. En ne l'écrivant pas, j'aurais toutefois manqué à mes devoirs de Président chargé de veiller à la digne présentation d'une œuvre accomplie sous l'égide et sous la responsabilité de l'Académie royale des Sciences d'Outre-mer [42].

Uiteindelijk werd Jadots notitie niet in de *BKB* gepubliceerd. In volume V verscheen wel een korte levensbeschrijving van Masson, maar ze was ondertekend door iemand anders, namelijk door Marthe Coosemans, een lerares secundair onderwijs [43]. Sinds 1928, dus lang vóór de lancering van de *BKB*, hielp ze de (blinde) E. H. Lotar (de latere initiatiefnemener van het naslagwerk) bij zijn wetenschappelijk onderzoek; na zijn dood bleef ze zich interesseren voor koloniale geschiedenis. Ze werd één van de meest prolifieke medewerkers van de *BKB*, hoewel ze zelf geen lid was van de Academie [44]. De Commissie voor de Biografie vertrouwde haar tientallen, ja zelfs honderden notities toe, meestal kleine teksten over figuren van ondergeschikt belang.

Maar net deze medewerkster werd niet hoog aangeschreven door een aantal leden van de Commissie. Ze durfde al wel eens de bal mis te slaan; naderhand stelde men soms vast dat ze feitelijke fouten had gemaakt. We laten nogmaals Moulaert aan het woord: „*Mais les „Coosemans" et „Lacroix" doivent être expurgées de tout un fatras romantique et de lieux communs*", zei hij in 1952 [45]. Maar vijf jaar later was er niets veranderd: „*On ne peut plus confier ces notices à Coosemans ou du moins il faut les faire revoir et compléter par des personnes qualifiées*" [46]. „*Beaucoup de notices sont plus que médiocres, les notices surtout* [de] *Coosemans ou Lacroix doivent faire l'objet sur minutes d'un contrôle sévère*" [47]. Het globale oordeel van Commissievoorzitter Dellicour over de kwaliteit van de reeds gepubliceerde volumes was trouwens ook niet bijzonder enthousiast. Zo schreef hij in 1956 volgend ontluisterend oordeel over volume V, dat bijna was afgewerkt: „*Il est déjà possible de se faire une opinion d'ensemble. Je regrette de dire que l'impression n'est pas brillante. A tout instant on voit apparaître des notices qui n'auraient pas dû être admises. Dans beaucoup de notices le style est bâclé. D'autres sont alourdies par des renseignements sans intérêt. On ne peut s'empêcher de penser que certains de nos collaborateurs ont cédé avant tout à la tentation d'aligner le plus de lignes*

possibles" [48] (terloops gezegd: de auteurs van de notities kregen ook een vergoeding uitbetaald: één Belgische Frank per regel van veertig aanslagen…). Nogmaals Moulaert trad hem hierin bij: *„Les missionnaires allongent aussi indéfiniment les notices par des détails sans intérêt – déplacements – voyages – etc.*" [49].

Ook de academische buitenwereld merkte op dat de *BKB* niet altijd vrij te pleiten was van enige tekortkomingen. In 1949 had de piepjonge historicus Jean Stengers een bespreking geschreven over het eerste volume van dit naslagwerk in het *Belgisch Tijdschrift voor Filologie en Geschiedenis* (Stengers maakte toen nog geen deel uit van het KBKI). Na verschillende lofbetuigingen maakte hij, op de hem eigen subtiele manier, duidelijk dat de verantwoordelijken van het naslagwerk moesten letten op een aantal problemen: betwistbare selectiecriteria; opname van personen die maar een heel dunne band hadden met de koloniale geschiedenis; hagiografische toon van bepaalde notities („*La notice consacrée à Georges Lorand par M. Arthur Wauters est une page d'hommage de haute envolée* […] *mais ce n'est évidemment pas une notice biographique*"); onbillijke en bevooroordeelde behandeling van de protestantse missionarissen; onvoldoende wetenschappelijke bibliografie of bronnenonderzoek (bvb. over de controversiële episode rond Stokes [50]); en vooral: het gebruik van een prokolonialistische toon:

> *Nous ne pouvons nous empêcher de penser, enfin, que la Biographie coloniale sera lue un jour par des Noirs qu'aura formés notre futur enseignement universitaire. Il ne faut pas que, ce jour-là, les intellectuels indigènes puissent nous accuser d'avoir présenté le point de vue des colonisateurs, auxquels ils seraient tentés, pour leur part, d'opposer le point de vue des colonisés. Du lieutenant de la Kéthulle de Ryhove, on nous dit qu'il „eut l'occasion de se distinguer dans la répression de la première révolte des Budja, indigènes de la Haute Mongala, d'une férocité sans bornes. Adversaires de toute pénétration blanche, ces noirs avaient massacré plusieurs agents de la Société Anversoise pour le Commerce du Congo (col. 576)". Les noms de „Mongala" et de „Société Anversoise" évoquent à vrai dire d'autres souvenirs que celui de la „férocité sans bornes" des noirs. On entend encore Brazza répétant sur son lit de mort: „Il ne faut pas que le Congo français devienne une nouvelle Mongala"* [51].

Dat belette niet dat Stengers enkele jaren later zelf toch werd opgenomen in het KBKI, en nadien ook lid werd van de Commissie voor de Biografie; hij schreef zelf ook enkele biografische notities. Ook de befaamde Franse historicus Henri Brunschwig, specialist van de Afrikaanse koloniale geschiedenis, liet in de *Revue Historique* een kritische noot weerklinken: „*Les divers articles sont, évidemment, de valeur inégale. Certaines bibliographies paraissent peu au courant des travaux étrangers* […]. *Mais dans bien des cas, la* Biographie coloniale belge *apporte les seules bonnes synthèses en français*" [52]. Niet specifiek over de *BKB*, maar wel over de historische publicaties van het KBKI in het algemeen, liet de historicus Jacques Paquet zich eveneens bijzonder scherp uit: „*L'Académie*

a beaucoup publié ces derniers temps, peut-être trop. Se montre-t-elle assez exigeante sur le choix de ses collaborateurs et des manuscrits qu'elle édite? Recruter les uns avec discernement, accueillir les autres à condition qu'ils offrent un intérêt réel et toutes garanties d'ordre scientifique: le crédit des publications qu'elle patronne est à ce prix" [53].

Deze vrij gedetailleerde bespreking van de eerste vijf volumes van de *BKB*, gepubliceerd tussen 1948 en 1958, laat ons toe een vrij ontluisterend beeld van het naslagwerk op te hangen. Binnenskamers uitten de initiatiefnemers zelf enig ongenoegen over de kwaliteit van vele teksten. Maar bovenal was de *Biografie* opgevat als een wapen in de politieke strijd voor de verdediging van Belgisch Congo. Wie als auteur kritische of zelfs maar afwijkende noten liet horen, werd het voorwerp van censuur en exclusie (we herinneren ons de woorden van Moulaert: „*Doénavant, Jadot est à surveiller!*"). Conformisme en autocensuur of minstens een grote voorzichtigheid waren daarvan het gevolg bij al wie meewerkte aan de *BKB*. De kolonisatie en haar agenten werden complexloos opgehemeld. „Delicate" aspecten werden met de mantel van de liefde toegedekt. De *Biografie* was doordrenkt met de propaganda die vorm had gekregen onder het regime van de Onafhankelijke Congostaat, toen Leopold II zich verweerde tegen de aanvallen op zijn beleid. Leopolds voorstellingswijze en argumenten werden later door de Belgische koloniale autoriteiten overgenomen. Zo ontwikkelde het koloniale establishment een standaarddiscours en een retoriek die ook werd geassimileerd en gereproduceerd door het KBKI en haar Commissie voor de Biografie.

Momenteel vonden we geen gegevens over de werking van de Commissie vanaf de jaren 1960 en over de opstellingswijze van de vervolgreeks *BOB* (volumes VI, VIIA, B, C en VIII). Door het overlijden van de pioniers — bijvoorbeeld de sterke figuren Moulaert en Dellicour resp. in de late jaren 1950 en 1960 — is de koloniale censuur die we zopas documenteerden wellicht minder scherp geworden. Maar toch lijkt de voordien gezette toon te hebben doorgewerkt. Tot in de jaren 1970 vindt men overduidelijke sporen van de klassieke „leopoldiaanse" retoriek terug. In zijn notitie over Dellicour, geschreven in 1972, had Jean Sohier het nog steeds over „*la violente campagne anglo-saxonne de dénigrement*" van de Onafhankelijke Congostaat [54]. In 1974 werd generaal Weber nog voorgesteld als een typisch voorbeeld van „[ces] *premiers pionniers du Congo qui ont contribué à faire mieux connaître un pays encore à l'état sauvage,* […] *et à le faire progresser vers la civilisation et l'indépendance*" [55]. De notitie die ex-gouverneur-generaal van Belgisch Congo Léo Pétillon in 1972 schreef over Mgr. Jean-Félix de Hemptinne, apostolisch vicaris van Katanga, is helemaal doordrenkt met de katholieke overtuiging die ze beiden deelden („*[La part de sa vie] qu'il donna à Dieu fut bien plus belle*") [56]. Het duurde nog tot het begin van de 21ste eeuw vooraleer E. D. Morel, de Brit die een belangrijke rol speelde in de Belgische koloniale geschiedenis door zijn campagne tegen het Congo van Leopold II, een plaats kreeg in de *BOB* (in het laatste volume, IX, nu nog ter perse…).

Hoe recenter, hoe beter de kwaliteit van de notities echter wordt. In de laatste volumes beantwoorden steeds meer levensbeschrijvingen aan de vereisten van de historische wetenschap. De notitie van de hand van antropoloog Luc de Heusch over de vermoorde Congolese premier Patrice Lumumba, verschenen in 1968 in deel VI, is bijvoorbeeld al verrassend gebalanceerd en is helemaal ontdaan van de koloniale retoriek die, nauwelijks enkele jaren voordien, de bovenhand had [57]. Dezelfde opmerking geldt voor de notitie die de linkse advocaat Jules Chomé in datzelfde deel schreef over de profeet Simon Kimbangu — een tekst die mijlenver verwijderd is van de koloniale propaganda [58]. Het is momenteel niet duidelijk hoe het kwam dat dergelijke teksten, die kritisch waren voor de koloniale *vulgata*, zo relatief vroeg in het naslagwerk terechtgekomen zijn. Het valt ook op te merken dat de talrijke notities die in de recente of zelfs de oudere volumes werden gewijd aan wetenschappers — en die vaak eerder de vorm van een klassiek *curriculum vitae* aannemen — weinig politiek geladen zijn. Hun bruikbaarheid in het zuiver factuele vlak wordt daardoor vergroot.

Opzet van het nieuwe biografisch naslagwerk, het *Biografisch Woordenboek van Belgen Overzee*

In 2009 besliste de Commissie voor de Biografie van de KAOW om de publicatie van de bestaande reeks *Belgische Overzeese Biografie*, de voortzetting van de oude *Belgische Koloniale Biografie*, stop te zetten. Ze lanceerde echter meteen een nieuw naslagwerk, met als titel *Biografisch Woordenboek van Belgen Overzee*. Waarom deze beslissing, en welke inhoudelijke en methodologische richtlijnen heeft ze aangenomen voor de redactie van het nieuwe werkinstrument? Zoals we gezien hebben, is de vroegere *BKB-BOB* een biografisch repertorium dat vele diensten heeft bewezen aan de onderzoekers, door het uitgebreide veld aan beschreven figuren. Vele historici maken vandaag nog steeds dankbaar gebruik van deze publicatie; ook in de toekomst zal het werk nog vaak geraadpleegd worden. Daarom heeft de KAOW trouwens beslist om de volledige reeks te digitaliseren en online beschikbaar te stellen op haar website www.kaowarsom.be. Via een alfabetische en cumulatieve namenlijst kan de onderzoeker de pdf-versie van elke individuele notitie opzoeken en downloaden. Hij of zij kan ook *full text* eender welk woord opzoeken in de globale pdf-bestanden die per volume zijn opgemaakt.

Maar toch was het duidelijk dat de bestaande reeks niet meer beantwoordde aan de vereisten van de huidige wetenschap.

We hebben, *ten eerste*, al gealludeerd op de inhoudelijke lacunes. De reeks was sterk georiënteerd op Congo, ondanks haar openstelling, in de jaren 1960, naar andere continenten. De participatie van Belgen aan de geschiedenis van Latijns-Amerika, Azië, Oceanië of andere delen van Afrika, kwam niet altijd goed uit de verf. Ook kwamen bepaalde activiteitsgebieden niet steeds aan hun

trekken. In domeinen als de kunst, de diplomatie en de economie kunnen bijvoorbeeld nog heel wat Belgen worden vermeld die actief waren in de brede „overzeese" wereld. Konden die lacunes dan niet worden opgevuld door de reeks gewoon verder te zetten?

Uiteraard wel, maar door een nieuw werkinstrument te lanceren, met een andere titel, hebben de Commissie voor de Biografie en de KAOW, *ten tweede en vooral*, het signaal willen geven dat ze zich niet meer kunnen identificeren met de aanpak en de ingesteldheid die aan de basis lagen van de vorige reeks. Ze willen zich uitdrukkelijk distantiëren van de andere vermelde tekortkomingen — meer bepaald de inhoudelijke *bias* en de elogieuze *in memoriam*-stijl. Dit signaal wordt verder versterkt door de beslissing om totaal *nieuwe* notities te laten redigeren over bepaalde figuren die reeds aan bod kwamen in de *BKB-BOB*. Uiteraard is het niet de bedoeling om de vijfduizend vijfhonderd individuen allemaal opnieuw onder de loep van de biograaf te leggen! Tal van notities, vooral in de jongste delen, zijn immers gebaseerd op grondig en degelijk wetenschappelijk onderzoek, en bevatten niet meer de minste zweem van de koloniale mentaliteit waarvan we zopas enkele voorbeelden uit de jaren 1970 citeerden. Precies mede daarom werd de *BOB* ook online geplaatst: de vorige reeks raadplegen is dus zeker nog zinvol.

Maar over een aantal belangrijke personaliteiten kan daarentegen zeker en vast een nieuwe biografische notitie geschreven worden, en die opdracht is zelfs vrij urgent, gezien de recente *revival* van de Belgische historiografie over de kolonie en, algemener, gezien de nieuwe manier waarop het globaliseringsproces benaderd wordt. Om dat project te ondersteunen heeft de Commissie voor de Biografie haar samenstelling gewijzigd, door een aantal historici van verschillende universiteiten en onderzoeksinstellingen als experts uit te nodigen. Samen met de leden van de Commissie zelf, werd zo in een eerste fase gewerkt aan de opstelling van een lijst van personen aan wie een biografische notitie zal gewijd worden. Die lijst staat ook online op de website van de KAOW. Ze ligt niet vast, eens en voorgoed, maar is een evolutief werkinstrument — net zoals de wetenschap en haar methodologieën ook zelf voortdurend veranderen. Ze kan en moet voortdurend aangevuld worden, ook op basis van suggesties die van buiten de Commissie komen. Iedereen mag, op eigen initiatief, aan de Commissie voorstellen om deze of gene figuur toe te voegen aan de reeks personen over wie een levensbeschrijving kan geschreven worden. De Commissie beslist natuurlijk of ze al dan niet ingaat op die suggesties, en blijft ook vrij in de aanwijzing van de auteur van de desbetreffende notitie. De tekst zelf van iedere notitie wordt ook nagelezen en geëvalueerd door de Commissie, die zich uitspreekt over de ontvankelijkheid ervan. Ze kan, zo nodig, wijzigingen aan de voorgelegde teksten aanbrengen of suggereren.

Het veld dat het *Biografisch Woordenboek van Belgen Overzee* bestrijkt is zeer breed. Alle overleden personen van Belgische nationaliteit en alle inwoners van de territoria die, vanaf de Middeleeuwen, aan België voorafgingen, komen in aanmerking voor een beschrijving — op voorwaarde dat ze een zekere rol gespeeld hebben in de „overzeese" gebieden zoals die gedefinieerd worden door

de statuten van de KAOW (grosso modo, de wereld buiten Europa en Noord-Amerika). Congo en de voormalige mandaatgebieden Ruanda-Urundi vormen dus zeker niet de exclusieve geografische focus, maar het spreekt vanzelf dat die gebieden, door de enorme Belgische implicatie, kwantitatief prominent aanwezig zullen zijn en blijven. Het naslagwerk wil ook geen beperking van activiteitsdomein; zowel de politiek, de diplomatie, de economie, als de wetenschappen en de kunsten komen in aanmerking. De Commissie hoopt precies dat de terreinen die vroeger wat stiefmoederlijk behandeld werden, nu goed aan hun trekken zullen komen.

Belangrijke precisering: niet-Belgen komen echter niet in aanmerking voor opname in het *Biografisch Woordenboek*, zelfs al hebben ze meegewerkt aan de Belgische overzeese expansie (bijvoorbeeld als „pioniers" van de Onafhankelijke Congostaat). Dat enkel „Belgen" aan bod komen, heeft niets te maken met oogkleppenmentaliteit, met oubollig eurocentrisme, of met een misplaatst superioriteitsgevoelen. Het naslagwerk is helemaal geen instrument voor Belgische nationalistische propaganda, zoals vroeger wel het geval was. Het geografische criterium is enkel een middel om efficiënt te werk te gaan. Waar anders de grens leggen? Welke niet-Belgen die ooit in aanraking gekomen zijn met „overzeese Belgen" zouden dan *wel*, en welke andere *niet* opgenomen worden? Dit naslagwerk is immers geen historisch woordenboek van de Belgische kolonisatie, waarbij al diegenen aan bod moeten komen die in dit fenomeen een rol hebben gespeeld. Afrikanen die een rol speelden *tijdens* het koloniale bewind vinden dan weer wel hun plaats in dit werk: zij waren, volgens de toenmalige juridische opvattingen, immers Belgische koloniale „onderdanen" [59].

Het naslagwerk wordt elektronisch gepubliceerd: de goedgekeurde notities worden onmiddellijk op het net geplaatst en toegankelijk gemaakt voor alle bezoekers van de website. Deze manier van werken verhelpt een groot euvel van de vorige reeks *BOB*. Zij had namelijk te kampen met soms jarenlange periodes tussen de redactie van de notitie en de uitgave onder boekvorm (we herinneren eraan dat tussen de laatste volumes een tijdspanne van meer dan tien jaar lag). Door de elektronische publicatie hoopt de Commissie ook de interactiviteit met het publiek te vergroten. Lezers van het naslagwerk kunnen hun opmerkingen en bedenkingen, zelfs hun voorstellen tot correctie of aanvulling rechtstreeks aan de Commissie voorleggen, via een speciaal daartoe voorzien elektronisch formulier. Die boodschappen zullen door de Commissie worden onderzocht; ze kunnen, na goedkeuring door de Commissie en na consultatie van de oorspronkelijke auteur, ook uitmonden in traceerbare aanpassingen van de begintekst. Na verloop van een aantal jaren, indien het pakket van beschikbare notities groot genoeg is geworden, kan het *Biografisch Woordenboek* eventueel ook onder papieren vorm verschijnen.

Bij het ter perse gaan van dit artikel (april 2013) zijn er een dertigtal notities gepubliceerd op de website van de Academie (www.kaowarsom.be). Laten we hopen dat dit aantal in de komende jaren snel toeneemt.

NOTEN EN REFERENTIES

[1] Met dank aan Jean-Luc Vellut, Henri Nicolaï, Hendrik Deelstra en Sabine Cornelis voor nuttige opmerkingen bij het overlezen van de ontwerpversie van deze tekst.

[2] Anne-Marie Thiesse, *La création des identités nationales. Europe XVIIIe-XXe siècles* (Paris, Le Seuil, 2001).

[3] De bibliografie hierover is ondertussen vrij uitgebreid geworden. Zie bijvoorbeeld: Jo Tollebeek & Tom Verschaffel, „'A profitable Company'. Het pantheon als historisch genre in 19de-eeuws België", in *Bijdragen en Mededelingen betreffende de Geschiedenis van de Nederlanden*, **115** (2000): 223-243; Jo Tollebeek & Tom Verschaffel, „Group Portraits with National Heroes: The Pantheon as an Historical Genre in 19th-century Belgium", in *National Identities*, **6** (2-2004): 91-106; Robert Hoozée, Jo Tollebeek & Tom Verschaffel (Eds.), *Mise en scène. Keizer Karel en de verbeelding van de negentiende eeuw* (Antwerpen-Gent, Mercatorfonds; Gent, Museum voor Schone Kunsten, 1999, 319 pp.); Jeroen Janssens, *De helden van 1830. Feiten en mythes* (Antwerpen-Amsterdam, Meulenhoff, 2005); Jeroen Janssens, *De Belgische natie viert. De Belgische nationale feesten 1830-1914* (Leuven, Universitaire Pers Leuven, 2001, 269 pp.); Tom Verschaffel, *Beeld en geschiedenis. Het Belgische en Vlaamse verleden in de romantische boekillustratie* (Turnhout, Brepols, 1987); Tom Verschaffel, „Het verleden tot weinig herleid. De historische optocht als vorm van de romantische verbeelding", in J. Tollebeek & F. Ankersmit (Eds.), *Romantiek en historische cultuur* (Groningen, Historische Uitgeverij, 1996, pp. 297-320); Johannes Koll, „Belgien. Geschichtskultur und nationale Identität", in M. Flacke (Ed.), *Mythen der Nationen: ein europäisches Panorama* (Berlin, Deutsches Historisches Museum, 1998, pp. 53-77); Marnix Beyen, „Féconder l'avenir par le passé. La politique commémorative de l'Etat belge pendant les années jubilaires 1880, 1905 et 1930", in G. Kurgan-van Hentenryk & V. Montens (Eds), *L'argent des arts* (Bruxelles, Editions de l'Université de Bruxelles, 2001, pp. 73-88); Sébastien Dubois & Jeroen Janssens, *La Belgique mise en scène. Symboles, rituels, mythes (1830-2005)* (Bruxelles, Archives Générales du Royaume, 2005); Sébastien Dubois, *L'invention de la Belgique. Genèse d'un Etat-nation (1648-1830)* (Bruxelles, Racine, 2005). Deze opsomming is verre van exhaustief.

[4] Guy Vanthemsche, *La Belgique et le Congo. L'impact de la colonie sur la métropole des années 1880 aux années 1980* (Bruxelles, Le Cri, 2010).

[5] Een recente exploratie van dat thema vindt men in Tom Verschaffel, „Congo in de Belgische zelfrepresentatie", in V. Viaene, D. Van Reybrouck & B. Ceuppens (Eds.), *Congo in België. Koloniale cultuur in de metropool* (Leuven, Universitaire Pers Leuven, 2009, pp. 63-79).

[6] Matthew Stanard, *Selling the Tenth Province: Belgian Colonial Propaganda 1908-1960* (onuitgegeven PhD thesis van Indiana University, 2006, hoofdstuk 4).

[7] … en voor de Afrikaanse actoren was de aandacht natuurlijk miniem.

[8] Ligue du Souvenir congolais. *Statuts*, S.l.n.d., 15 pp. Opgericht op 18 maart 1929, bestond het Erecomité van deze vzw uit politieke, kerkelijke en koloniale notabiliteiten, onder meer kardinaal Van Roey en zowat alle ministers. De Raad van Bestuur werd voorgezeten door de voormalige administrateur-generaal van Koloniën, Nicolas Arnold.

[9] *Cf.* Véronique Bragard & Stéphanie Planche, „Museum Practices and the Belgian Colonial Past: Questioning the Memories of an Ambivalent Metropole", in *African and Black Diaspora*, **2** (2-2009): 181-191.

[10] Ligue du Souvenir congolais, *A nos héros coloniaux morts pour la civilisation (1876-1908)* (Bruxelles, 1931, 291 pp.). Het boek bevat wel tal van foto's van de pioniers. Ook werden de plaatsen opgelijst waar die personen begraven waren.

[11] Albert Cateaux & Edouard Janssens, *Les Belges au Congo. Notices biographiques* (Antwerpen, Imprimerie Van Hille-De Backer, 1908-1911, 3 vol.). (Dit werk hernam, onder meer, vele biografische notities die voordien waren gepubliceerd in de *Bulletin de la Société royale de Géographie d'Anvers*); H. Depester, *Les pionniers belges au Congo* (Tamines, Duculot-Roulin, 1927). (Bevat enkele biografische notities in de loop van een tekst die voor de rest narratief van aard is.); Léo Lejeune, *Le Vieux Congo. Souvenirs recueillis par Léo Lejeune* (Bruxelles, L'Expansion Belge, 1930). (Geen biografisch repertorium; bevat wel levensverhalen van militaire pioniers in het kader van de kroniek van de militaire campagnes.) Ondanks zijn titel is volgend werk geen biografisch repertorium: Adolphe Burdo & Charles de Martrin-Donos, *Les Belges dans l'Afrique centrale* (Bruxelles, P. Maes, 1884-1893, 3 vol.).

[12] *Le Congo belge et ses coloniaux. Livre d'or / Belgisch Kongo en zijn kolonialen. Gulden boek* (Léopoldville, Ed. Stanley, 1953, XVI + 553 pp.).

[13] Die studies worden opgelijst in M. Huisman & P. Jacquet, *Bibliographie d'histoire coloniale (1900-1930). Belgique* (Paris, Société de l'histoire des colonies françaises, 1932, 83 pp.).

[14] Koninklijk Besluit van 4 september 1928. In 1954 werd het Instituut omgedoopt tot Koninklijke Academie voor Koloniale Wetenschappen; in 1959 bekwam het de huidige benaming KAOW.

[15] Marc Poncelet, *L'invention des sciences coloniales belges* (Paris, Karthala, 2008, pp. 264-278).

[16] Koninklijk Besluit van 16 maart 1925, gecit. in „Note du Secrétaire général en vue de la création d'une Commission de l'Histoire coloniale belge", in *Bulletin des Séances IRCB*, **23** (4-1952): 1064. Dit KB werd opgeheven door het KB dat het Instituut oprichtte (4 september 1928).

[17] Volgende paragraaf is gebaseerd op gegevens verstrekt door Fernand Dellicour, „A propos de la 'Biographie coloniale belge'", in *Bulletin des séances IRCB*, **21** (3-1950): 651-656; voorwoord van dezelfde in het eerste deel van de *Belgische Koloniale Biografie* (Brussel, 1948, vol. I, p. XXXI).

[18] *Liste provisoire des personnes susceptibles de figurer dans la Biographie coloniale belge et décédées avant 1930* (Bruxelles, IRCB, 1943, 84 pp.). (Met model van het formulier voor de opstelling van de biografische notities.)

[19] Egide-Jean Devroey, „Rapport du secrétaire des séances sur l'activité de la Commission de la Biographie coloniale belge pendant l'exercice 1945-1946", in *Bulletin des Séances IRCB*, **17** (1946): 810. In bijlage ook de lijst van de boeken en tijdschriften die werden geraadpleegd voor de opstelling van de lijst.

[20] Hieromtrent volgende anekdote: na het verschijnen van het eerste volume, in 1948, liet ene Jean Cloesen aan de redactie weten dat hij nog leefde, hoewel de notitie die — dus onrechtmatig — aan hem was gewijd, beweerde dat hij gestorven was in … 1896! *Cf.* Marthe Coosemans, „Cloesen, Jean Hubert (1859-1896)" (*BKB*, Brussel, 1948, vol. I, kol. 239-240, en afzonderlijk erratum in dat volume, d.d. 10 mei 1949).

[21] *Bulletin des Séances IRCB*, **23** (1952): 247.

[22] We herinneren eraan dat vol. VII verscheen in drie afzonderlijke delen: VIIA, VIIB en VIIC.

[23] Pierre Salmon, „Introduction" (*BOB*, Brussel, 1998, vol. VIII, kol. VII).

[24] Fernand Dellicour, „A propos de la 'Biographie coloniale belge'" (*op. cit.*, pp. 655-656).
[25] Fernand Dellicour, „Avant-propos" (*BKB*, Brussel, 1958, vol. V, p. VII).
[26] Marthe Coosemans, „Lotar, Léon-Jean-Baptiste (1877-1943)" (*BKB*, Brussel, 1955, vol. IV, kol. 542).
[27] E.-J. Devroey, „Rapport (…)" (*op. cit.*, p. 816).
[28] Raymond Vanderlinden, „Moulaert, Georges (1875-1958)" (*BKB*, Brussel, 1968, vol. VI, kol. 758-762).
[29] Behalve de botanicus Walter Robyns (°1901), aan wie deze eer niet te beurt viel omdat hij pas in 1986 overleed.
[30] Octave Louwers, „Hommage au roi Léopold II, fondateur de l'empire colonial belge" (*BKB*, Brussel, 1948, vol. I, pp. V-XXVII [citaten op pp. V, XIII, XVI, XVII]).
[31] Algemeen Rijksarchief te Brussel (ARA), fonds KAOW-ARSOM, nrs. 73-85 en 142-143.
[32] Zie bijvoorbeeld de omvangrijke briefwisseling in ARA, KAOW, nr. 72.
[33] E.-J. Devroey, „Rapport (…)" (*op. cit.*, p. 812).
[34] *Ibidem*.
[35] In dat verband vestigt Jean-Luc Vellut de aandacht op de „recuperatie" van de geschiedenis van het oude koninkrijk Kongo door de katholieke clerici (waaronder Mgr. Cuvelier) die optraden als auteur van vele notities in het *BKB* (sommigen onder hen waren weliswaar historicus) („*Les pieuses notices consacrées aux Africains de la côte atlantique contrastent avec les notices moins généreuses consacrées aux Africains musulmans de la côte Est sur qui l'on fit retomber toutes les fautes de l'esclavagisme*") (boodschap van 17.02.2011).
[36] Een concreet voorbeeld: in 1952 vroeg E.-J. Devroey (secretaris-generaal van het KBKI) aan zijn confrater H. Barzin, betrokken bij het bedrijf Geomines, om de notitie van twee ingenieurs te schrijven, D. Raffo en A. Xhignesse; eventueel kon de notitie door iemand anders van Geomines geschreven worden. Zie ARA, KAOW-ARSOM, nr. 142, Devroey aan Barzin, 17.10.1952. Raffo is nooit in het naslagwerk terechtgekomen; Xhignesse, die inderdaad ooit bij Geomines gewerkt had, kreeg zijn plaats(je) in *BKB*, vol. IV, kol. 965-966 (met als auteur precies Barzin).
[37] ARA, KAOW-ARSOM, nr. 142, nota van G. Moulaert in correspondentiedossier met R. Cambier. Emile Van Hencxthoven (1852-1906) was een jezuïet die een controversiële rol gespeeld had in de vroege jaren van de Onafhankelijke Congostaat. Zijn notitie in de *BKB* (vol. II, kol. 465-471) is van de hand van J. Van de Casteele die … zelf ook jezuïet was. Zie de recente studie van A.-S. Gijs, „Emile Van Hencxthoven, un jésuite entre Congo et Congolais … Conflits de conscience et d'intérêts autour du supérieur de la mission du Kwango dans l'Etat Indépendant du Congo (1893-1908)", in *Revue d'Histoire Ecclésiastique*, **105** (3-4 – 2010): 652-688.
[38] René Cambier, „Wauters, Alphonse-Jules" (*BKB*, Brussel, 1951, vol. II, kol. 969-972).
[39] In een ander geval, de notitie betreffende Cecil Rhodes (*BKB*, vol. II, kol. 809-812), was dezelfde Cambier ook op de vingers getikt. Secretaris Devroey en voorzitter van de Commissie Dellicour hadden hem laten weten dat een bepaalde passage (het is niet precies geweten welke) niet aanvaardbaar of delicaat was. Cambier antwoordde: „Je ne vois pas ce que le passage signalé a d'incompréhensible ou de choquant. Cette histoire, qui date de 50 ans, est bien connue et ne peut plus froisser personne" (ARA, KAOW, nr. 142, Cambier aan Devroey, 30.09.1950).
[40] ARA, KAOW-ARSOM, nr. 143, G. Moulaert aan E.-J. Devroey, 13.02.1957.

[41] Wellicht niet aan Jadot zelf; maar op dat moment was Jean Stengers al plaatsvervangend lid van de Commissie voor de Biografie (zie *BKB*, vol. V, p. IX). Misschien verwees hij naar hem? We hebben er het raden naar.
[42] ARA, KAOW-ARSOM, nr. 143, Dellicour aan E.-J. Devroey, 20.12.1956. In een brief van 26.01.1957 drukte Moulaert zijn goedkeuring uit voor dit standpunt: „Je suis tout à fait d'accord avec le Président […]. La Commission est responsable des publications et doit donc exercer un contrôle judicieux sur les notices à publier".
[43] Marthe Coosemans, „Masson, Fulgence (1854-1942)" (*BKB*, Brussel, 1958, vol. V, kol. 590-591). Vreemd genoeg is de notitie gedateerd 24 april 1953, terwijl de briefwisseling rond de controversiële tekst van Jadot dateert uit 1957. Elke notitie moest toen ook de initialen weergeven van het lid van de Commissie dat de notitie had „nagekeken en goedgekeurd"; ironisch genoeg blijkt dat in voorliggend geval … Jadot zelf te zijn!
[44] A. Lacroix, „Coosemans, Marthe (1886-1969)" (*BOB*, Brussel, 1973, vol. VIIA, kol. 149-150).
[45] ARA, KAOW-ARSOM, nr. 143, Moulaert aan E.-J. Devroey, 24.08.1952.
[46] ARA, KAOW-ARSOM, nr. 143, Moulaert aan E.-J. Devroey, 13.12.1952. Deze brief van Moulaert reageert op een bespreking die Stengers gemaakt had van volume II van de *BKB*, waarin tekortkomingen werden aangeduid.
[47] ARA, KAOW-ARSOM, nr. 143, Moulaert aan E.-J. Devroey, 13.02.1957.
[48] ARA, KAOW-ARSOM, nr. 143, Dellicour aan E.-J. Devroey, 20.12.1956.
[49] ARA, KAOW-ARSOM, nr. 143, Moulaert aan E.-J. Devroey, 13.02.1957. Dezelfde over een notitie betreffende de militair Henri Hackars (*BKB*, vol. IV, kol. 366-371): „[…] trop de romantisme — mais je n'ose y toucher". ARA, KAOW-ARSOM, nr. 143, Moulaert aan E.-J. Devroey, 30.05.1956.
[50] Deze episode wordt aangeraakt in de (wel bijzonder aanvechtbare) notitie over de Belgische officier Hubert Lothaire, die verantwoordelijk was voor de standrechtelijke executie van de Britse handelaar Stokes in 1895. Volgens auteur Alphonse Engels was de eerste een „vaillant officier", terwijl de tweede „un rôle infâme" gespeeld had. Alphonse Engels, „Lothaire, Hubert-Joseph (1865-1929)" (*BCB*, Brussel, 1948, vol. I, kol. 615-623 [citaat kol. 622]). De naam van de Brit werd overigens verkeerdelijk als Stockes gespeld. Over de ware toedracht van de zaak Stokes-Lothaire, zie D. Vangroenweghe, *Voor rubber en ivoor. Leopold II en de ophanging van Stokes* (Van Halewijck, Leuven, 2005).
[51] *Belgisch Tijdschrift voor Filologie en Geschiedenis* / *Revue Belge de Philologie et d'Histoire*, **27** (1949): 864-868 (citaat op p. 868).
[52] *Revue Historique*, **79** (CCXIV – juli-september 1955): 91.
[53] *Zaïre. Revue congolaise*, **IX** (8-1955): 872-874. Paquet sprak die bijzonder harde woorden uit betreffende een werk gepubliceerd door de Academie: Léon Anciaux, *La participation des Belges à l'œuvre coloniale des Hollandais aux Indes orientales* (Brussel, 1955).
[54] Jean Sohier, „Dellicour, Fernand (1881-1968)" (*BOB*, Brussel, 1977, vol. VIIB, kol. 94).
[55] G. de Rosenbaum, „Weber, Charles (1875-1952)" (*BOB*, Brussel, 1977, vol. VIIB, kol. 382).
[56] Léo Pétillon, „Hemptinne (de), Jean-Félix (1876-1958)" (*BOB*, Brussel, 1977, vol. VIIA, kol. 296).
[57] Luc de Heusch, „Lumumba, Patrice" (*BOB*, Brussel, 1968, vol. VI, kol. 678-684).
[58] Jules Chomé, „Kimbangu, Simon" (*BOB*, Brussel, 1968, vol. VI, kol. 576-579).

[59] J. P. Brasseur, *La nationalité belge de statut colonial* (Elisabethville, Editions de la Revue Juridique du Congo Belge, 1941, p. 5): „Il s'ensuit que les habitants du Congo, qui ne sont plus étrangers, sont des sujets belges, parce que soumis à l'Etat belge. Ils ne sont cependant pas citoyens belges de la Métropole, possédant tous les droits et devoirs inhérents à cette qualité".

Bull. Séanc. Acad. R. Sci. Outre-Mer
Meded. Zitt. K. Acad. Overzeese Wet.
57 (2-4 – 2011): 237-263

Hunting and Social Complexity in Predynastic Egypt*

by

Stan HENDRICKX**

KEYWORDS. — Egypt; Predynastic; Hunting.

SUMMARY. — Although the economy of the Predynastic Naqada culture (Egypt, 4th millennium BC) is based on agriculture and animal husbandry, hunting scenes are remarkably important in contemporaneous iconography. The semantic relationship between representations of hunting and military triumph shows that hunting is a remarkable part of a social ritual with religious and political aspects. Hunting is an important element of the elite manner of living and as such a major source of information on the development of social complexity leading to the pharaonic culture in Egypt.

TREFWOORDEN. — Egypte; Predynastisch; Jacht.

SAMENVATTING. — *Jacht en sociale complexiteit in het Predynastische Egypte*. — Alhoewel de economie van de Predynastische Naqadacultuur (Egypte, 4de millennium v. Chr.) gebaseerd is op landbouw en veeteelt, zijn jachtscènes opvallend belangrijk in de iconografie van die tijd. De semantische relatie tussen voorstellingen van jacht en militaire triomf toont aan dat de jacht een opvallend onderdeel is van een sociaal ritueel met godsdienstige en politieke aspecten. Jagen is een belangrijk aspect van de elitaire levenswijze en als dusdanig een substantiële informatiebron over de ontwikkeling van de sociale complexiteit die zal uitmonden in de faraonische cultuur van Egypte.

MOTS-CLES. — Egypte; Prédynastique; Chasse.

RESUME. — *Complexité de la chasse et de la société dans l'Egypte prédynastique*. — Malgré que l'économie de la culture nagadienne prédynastique (Egypte, 4e millénaire av. J.-C.) soit basée sur l'agriculture et l'élevage, les scènes de chasse ont une importance considérable dans l'iconographie. La corrélation sémantique entre les représentations de chasse et de triomphe militaire montre que la chasse constitue un élément essentiel d'un rite social avec ses caractéristiques religieuses et politiques. La chasse est un aspect important du mode de vie de l'élite et une source d'information substantielle concernant le développement de la complexité sociale qui aboutira à la culture pharaonique de l'Egypte.

*
* *

* Paper presented at the meeting of the Section of Human Sciences held on 15 February 2011. Final text received on 24 January 2012.

** Member of the Academy; prof. Media, Arts and Design Faculty, Provinciale Hogeschool Limburg, Elfde Liniestraat 25, B-3500 Hasselt (Belgium).

In a recent article, LINSEELE & VAN NEER (2009) showed that hunting had hardly any economic relevance in Egypt during the 4th millennium BC. Among the animal remains from Predynastic settlement sites, wild animals generally make up around 1 % or less of the archaeozoological material. Only during the Badarian and the very beginning of the Naqada period (*ca.* 4400-3800 BC) do wild animals represent a significant portion of the faunal assemblage, around 10 %. This indicates a strong decrease in the importance of hunting over a relatively short period. The main exception is the ceremonial centre HK29A at Hierakonpolis, where wild animals make up about 15 % of meat consumption during the Naqada II period (LINSEELE *et al.* 2009), which will prove to be of exceptional importance for the discussion presented here. In this article, I suggest that hunting was an important aspect of the elite manner of living, and that its implications went far beyond food procurement, and into the realm of social status and hierarchy.

The scarcity of wild animal remains from Predynastic settlement sites is in strong contrast with the importance of hunting scenes in contemporaneous iconography. On White Cross-lined pottery, characteristic of Naqada I – early Naqada II, both hunting in the Nilotic and the low-desert environments are represented (GRAFF 2009, pp. 83-86; HENDRICKX 2006, 2010) (figs. 1, 2). This apparent contradiction between the economic importance and the depiction of hunting is not at all unique to Predynastic Egypt. For example, hunting was a popular concept for the Medieval aristocracy in Europe. But, at that time, only about 5 % of meat consumption originated from hunting (GUERREAU 2000, p. 27; MORSEL 1997, pp. 257-258). As for Predynastic Egypt, a very important discrepancy between iconography and real life can be observed (AUDOIN-ROUZEAU 1994).

Together with a few very exceptional scenes of military triumph, hunting representations are the only topics that are rendered in more complex early Predynas-

Fig. 1. — Provenance not recorded. White Cross-lined plate (New York, MMA 35.10) (HAYES 1953, p. 18, fig. 10).

Fig. 2. — Gebelein. White Cross-lined bowl (Princeton, Art Museum 30-493) (KANTOR 1953, p. 73, fig. 4B).

tic scenes (KOHLER 2002, HENDRICKX 2010, HARTUNG 2010). Moreover, these two topics are strongly related through the concept of order over chaos. Although never narrative in the strict sense of the word, these scenes are loaded with information [1]*. The scenes of military triumph are characterized by bound prisoners and victorious persons with raised arms and/or mace heads (figs. 3, 4). The actual fighting is never shown, only the expression of victory as a result. A similar principle can be recognized for the hunting scenes in which the hunt is not shown as an action resulting in the killing of animals. In most cases, the hunter himself is not even represented. He can be "replaced" in desert hunting scenes by one or more hunting dogs (fig. 5). For the hippopotamus and crocodile hunt, respectively a harpoon and a net act as symbols for the hunters. The frequent absence of the hunter is of course remarkable and already indicates that the recounting of particular hunting events is not the subject of the representations. In this respect, the occasional combination of desert and Nilotic hunting into one image should also be mentioned. Although rare, this combination occurs on a palette preserved in the Medelhavsmuseet in Stockholm (fig. 6), a White Cross-lined bowl from Abydos (HARTMANN 2008, pp. 168-179, Abb. 4-5) (fig. 7) and a rock drawing from the desert west of Luxor (DARNELL 2009, fig. 8) (fig. 8). The latter is especially remarkable because a single hunter is capturing at the same time a hippopotamus with a harpoon and a desert animal with a lasso. Furthermore, he holds a mace head and has his arms raised similar to the victorious persons in military scenes. The simultaneous performance of all these actions is of course impossible and not only reiterates that these depictions cannot be considered imitations of reality, but also confirms the relationship between hunting and military action.

A few items make the parallel between hunting and warfare more explicit by combining their depictions into one scene. Desert and Nilotic animals followed by a dog occur in combination with bound prisoners on a White Cross-lined jar from tomb U-415 in the elite cemetery U at Abydos (DREYER *et al*. 2003, p. 83, Abb. 6; HARTUNG 2010, p. 118, fig. 4c; HENDRICKX & EYCKERMAN 2012) (fig. 3). The combination of a hunting and a military scene is more explicit on another jar from the same tomb U-415 (DREYER *et al*. 2003, p. 81, Abb. 5) (fig. 4). Although at first sight the decoration of this remarkable jar consists of two independent registers, a parallel can be made between the victorious person with a mace head among the prisoners and the bull in the middle of the hippopotamus hunting scene (HARTUNG 2010, pp. 110-111; HENDRICKX & EYCKERMAN 2010, p. 123) [2]. In real life, bulls are in no way related to hippopotamus hunting, but the animal is nevertheless prominently represented and the oversized horns emphasize its power. During dynastic times, the bull is one of the most important royal symbols, a concept that can already be found on the decorated palettes of late Predynastic times. Both on the "Narmer palette" (Cairo JdE 32169) and on the "Bull palette" fragment (Louvre E.11255), bulls are depicted

* Numbers in brackets [ ] refer to the notes, pp. 256-258.

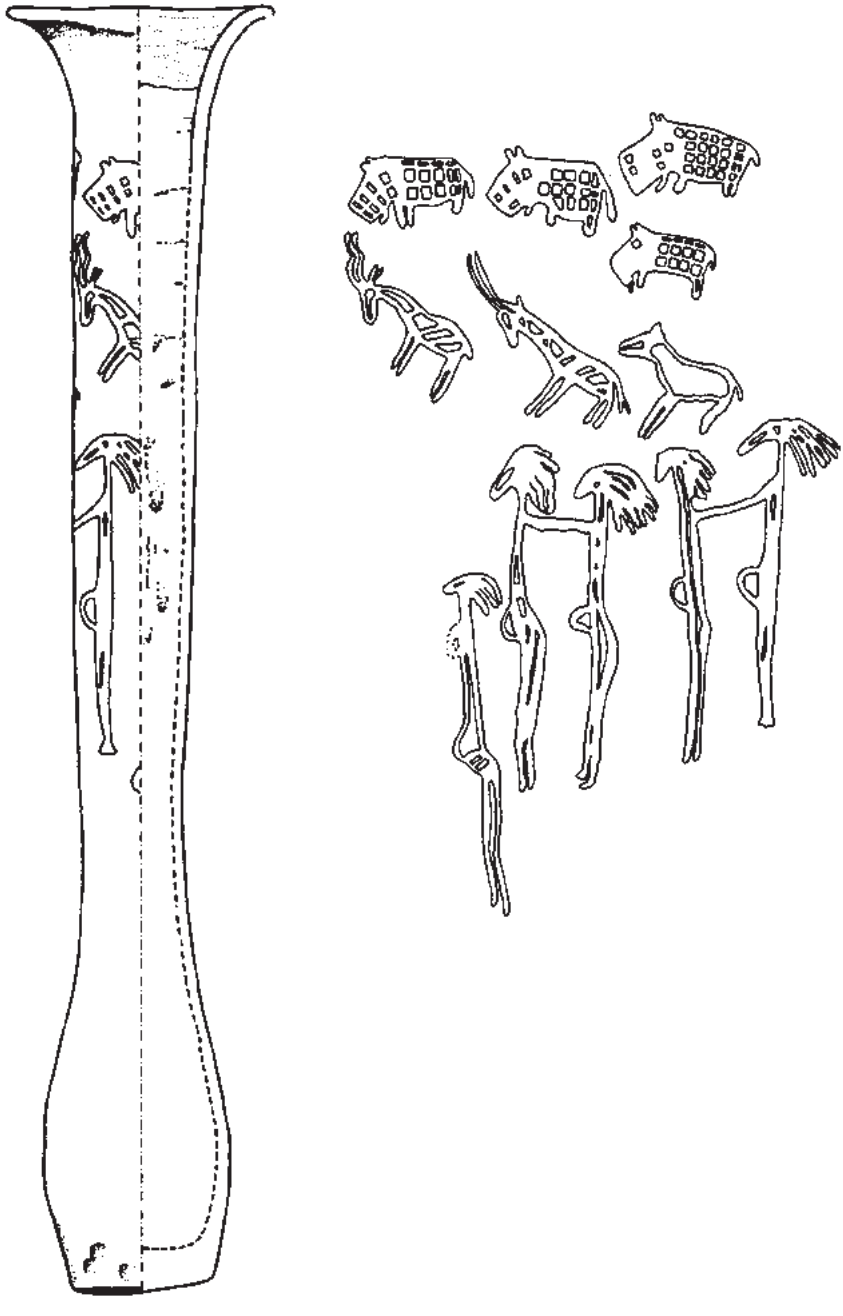


Fig. 3. — Abydos U-415. White Cross-lined jar (HARTUNG 2010, p. 118, fig. 4c).

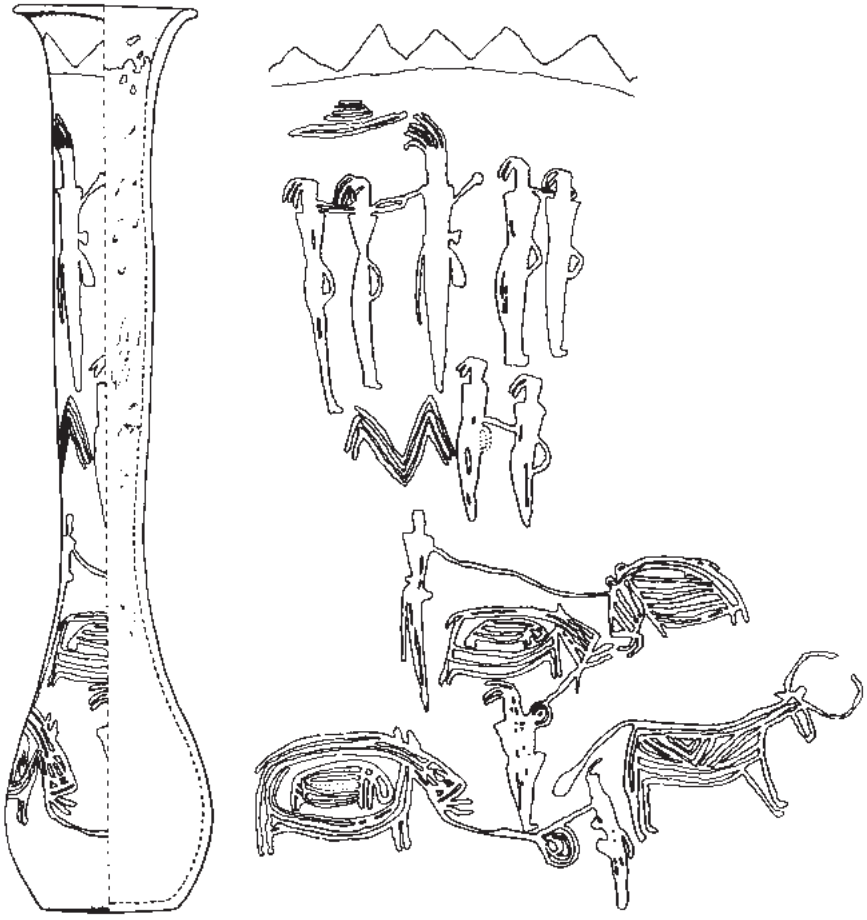


Fig. 4. — Abydos U-415. White Cross-lined jar (DREYER *et al*. 2003, p. 81, Abb. 5).

Fig. 5. — Naqada. White Cross-lined vessel (Philadephia E.1418) (photo: Jean Walker, courtesy of the University of Pennsylvania Museum of Archaeology and Anthropology; drawing: KANTOR 1953, p. 73, fig. 4D).

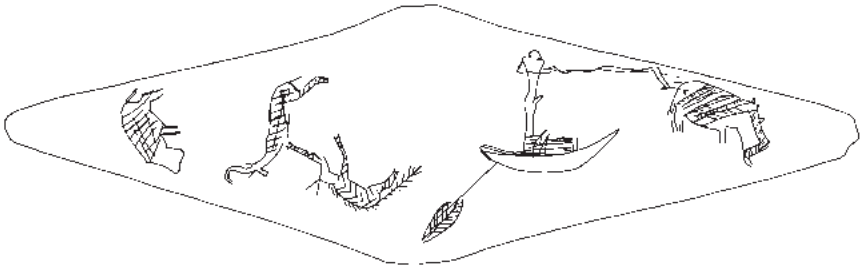


Fig. 6. — Provenance not recorded. Decorated rhomboid palette (Stockholm Medelhavsmuseet E.M.6000) (drawing: Merel Eyckerman).

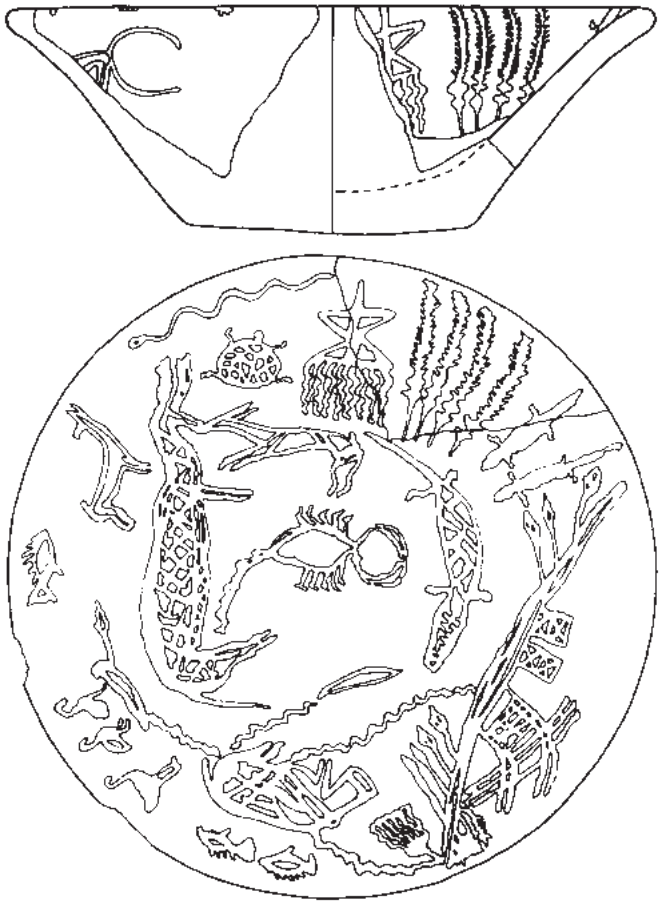


Fig. 7. — Abydos U-264. White Cross-lined bowl (Cairo CG 2076) (HARTMANN 2008, p. 169, Abb. 5).

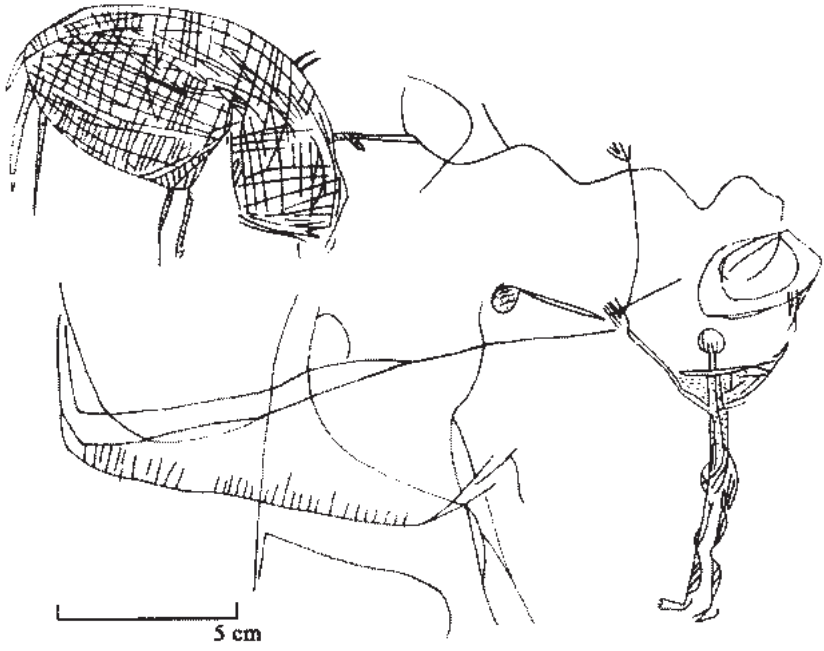


Fig. 8. — Was-ha-Waset. Rock drawing WHW cat. no. 353 (DARNELL 2009, p. 89, fig. 8).

overthrowing enemies. Despite the significant chronological difference, bulls on White Cross-lined pottery of the Naqada I period must also have been the personification of a "ruler"(NAVAJAS 2009), although the definition and extent of his power remains to be defined in detail. The combination of the hippopotamus hunt and the bull would in this way be a forerunner of the royal hippopotamus hunt of the Early Dynastic period (SAVE-SODERBERGH 1953, pp. 15-19; MULLER 2008) (cf. *infra*).

Also at cemetery U, a White Cross-lined jar with a military domination scene (KOHLER 2002, pp. 503-504) was found in combination with two hippopotamus figurines in tomb U-239.

Remarkably, one of the figurines was painted red and shows a deliberate incision on the neck, in the same spot as the impact of the harpoons in the painted hunting scenes. There can be no doubt that the hippopotamus figurine was ritually killed (HARTUNG 2010, pp. 110-111). The presence of the figurine and the White Cross-lined jar in the same tomb is another example of hunting combined with military triumph. It is also important to note that the tombs U-239 and U-415 are among the most important of their period in cemetery U [3] confirming the direct link between hunting and social power.

The fact that on White Cross-lined and Decorated pottery the hunters can be replaced by their dogs indicates their association with elites, and that much importance was given to these animals. The selection and breeding of dogs must have been an aspect of the elite manner of living (Baines 1993, pp. 64-65). The upturned tails, characteristic of dog representations, can only be the result of selective breeding. Dog burials occasionally found in settlements and cemeteries (Flores 2003, pp. 56-57) confirm the importance of the animal. The most remarkable examples are the numerous dog burials found at the early Naqada II "royal" burial place HK6 at Hierakonpolis (Friedman *et al.* 2011, pp. 180-181). Dogs are only a portion of the animal burials at the site. Many kinds of wild animals, including young elephants, were buried in tombs surrounding the main human burial (Linseele & Van Neer 2009, pp. 62-64; Friedman *et al.* 2011, pp. 175-186). The number and characteristics of the animal burials in the earliest "royal" context known for Egypt reflect the social relevance and symbolism of hunting. The importance given to dogs is, for example, also obvious through the exquisitely worked Early Dynastic bone and ivory dog figurines (Scharff 1929, Tf. 17, no. 87; Kahl & Engel 2001, Abb. 30-31). Most of these are gaming pieces, with lion figurines as counterparts, although they were probably not part of the same sets [4]. Both lions and dogs are shown with collars, severing to some extent the difference between wild and domesticated. The "tame" lions may symbolize the containment of aggression (Baines 1993, p. 66), but in a more direct manner, both lions and dogs can be considered as animals related to the king, possibly acting as guards. This interpretation seems problematic because the lion is attested as a royal symbol during dynastic times, which is not the case for the dog. However, on the most important tableau from the Nag el-Hamdulab royal cycle, a dog prominently figures behind two standard bearers but in front of the king, who is followed by a fan bearer (Hendrickx *et al.* 2012). Parallels for such an important role of the dog are not known from Dynastic Egypt. On the "Scorpion mace head" (Oxford AM E.3632), the "Narmer palette", and the "Narmer mace head" (Oxford AM E.3631), all dated immediately after the Nag el-Hamdulab cyclus, the dog has disappeared from the procession including standard bearers, fan bearers and the king. In my opinion, the dog in the Nag el-Hamdulab scene represents the same idea of power and control as the dogs in Predynastic hunting scenes. Although the Nag el-Hamdulab tableaux contain different iconographic elements that became part of the formal royal iconography of Early Dynastic and Dynastic times, the dog was not among them.

The relationship between hunting and militarism is certainly not restricted to Predynastic Egypt and considering the relationship between hunting and militarism in other cultural contexts is useful in order to highlight certain aspects of the Predynastic case. Ancient Greek hunting scenes are often paired with battle images (Barringer 2001, pp. 32-37). In Greek antiquity, hunting was considered a sport of the elite and an element of military training (Anderson 1985, pp. 17-29; Barringer 2001, pp. 10-59). As Xenophon stated in the middle of

the fourth century BC, "Hunting brings bodily health, improves sight and hearing, is an antidote to senility, and excellent training in the art of war" (ANDERSON 1985, p. 17). Many centuries after Xenophon, the Austrian noble man Wolf Helmhard von Hohberg (1622-1688) expressed in his *Georgica curiosa* (1682) almost the same ideas "Es ist das Jagen eine tapffere und ritterliche übung, und dem Adel gleichsam ein Praeludium belli" (ROSENER 2000, p. 133) [5]. However, the Greek hunting representations can be quite anecdotic, showing the action of catching and killing animals, and even hunting accidents. This is also the case for the well-known Neo-Assyrian reliefs such as those of the palace of Ashurbanipal (*ca*. 685-627 BC) (BARNETT 1976). They show staged hunts in game parks in great detail and the killing of animals is the essential element of the scenes. Moreover, the Assyrian royal hunt is paralleled by the royal victory in these scenes (WEISSERT 1997), similar to the concept of the early Naqada representations under discussion. However, the latter stand out in antiquity because of their unrealistic rendering and lack of "bloody" details.

Dynastic Egyptian hunting scenes are somewhat more realistic than Predynastic ones, occasionally showing the killing of animals, although still without any emphasis on wounds or blood (VANDIER 1964, figs. 443, 452-455, 458-459, 462-463). Despite mentioning huge numbers of captured desert animals (HERB & FORSTER 2009, p. 32), the economic importance of hunting is as limited as it was for the Predynastic period (LINSEELE & VAN NEER 2009, pp. 64-70). Moreover, much effort was invested in capturing animals and keeping them temporarily in game parks during the dynastic period (HERB & FORSTER 2009). Even though the animals were, in the end, certainly intended for consumption, the traditional view of pharaonic hunting exclusively for the procurement of food (VANDIER 1964, p. 787) was abandoned for some time (STAEHELIN 1978; ALTENMULLER 1980, 1989; DECKER 1992). Staehelin discussed the hunting scenes in the religious context of the tombs. The animals represent the forces of chaos, to be destroyed in order to perpetuate life in the hereafter. The origin of the hunting iconography is considered by Staehelin as royal, but during the Old Kingdom the royal prototypes were integrated into the decorative schemes of non-royal elite tombs. Along the same lines, BAINES (1995, p. 111) considered the late Predynastic and Early Dynastic hunting scenes as likely symbolizing the maintenance of order and the containment of disorder. The "order over chaos" interpretation has meanwhile gained wide acceptance (HENDRICKX 2006, HENDRICKX & EYCKERMAN 2010, FRIEDMAN *et al*. 2011, RAFFAELE 2010), and it is important to point out that this does not necessarily contradict the idea of providing the deceased with game, but can be complementary.

The combination of military domination and hunting is of essential importance for the interpretation of all Predynastic animal representations. Hunting and military scenes can be traced throughout the Naqada period, although their prevalence and media vary. Although the White Cross-lined pottery disappeared during the early Naqada II period, the hippopotamus hunt continued to

be represented on Decorated pottery, be it only exceptionally. The few examples are limited to hippopotamus-shaped vessels on which harpoons or hunters with their harpoons are depicted (HENDRICKX & DEPRAETERE 2004, p. 819) (fig. 9) [6].

Desert hunting scenes are also exceptional on Decorated pottery (HENDRICKX 2006, p. 726, tab. 1) and are not part of the "regular" Decorated iconography, which includes mainly boats and elements such as the so-called "Naqada-plant" (GRAFF 2009). The rarity of hunting scenes and the complete absence of the military victory theme at first sight seems to indicate a rupture between the iconography of Naqada I-IIA/B and Naqada IIC-D. However, this only reflects the development of a specific iconography related to the hereafter on Decorated pottery (GRAFF 2009, pp. 122-124). Most Decorated vessels have been discovered in Predynastic tombs and their preferential preservation compared to settlement contexts biases our view of the iconography. Several hunting scenes are depicted in the Naqada IIC "Decorated Tomb" at Hierakonpolis (HENDRICKX 2010, pp. 115-117), where there is also a well-known representation of the king smiting three bound captives with a mace (fig. 10). This is a continuation of the victory scenes on the White Cross-lined pottery and a direct predecessor of the smiting scene on the "Narmer palette". Victory and hunting scenes continued to be depicted throughout the Predynastic period and the Early Dynastic times, but a shift in media from pottery to perishable materials resulted in very limited documentation for the Naqada IIC-D period [7]. During the Naqada III/Early Dynastic period, both hunting and military victory again became prevalent iconographic themes on different types of non-perishable media, including greywacke palettes and ivory/bone objects. One of the most interesting depictions for that period is a seal impression from the tomb of Den, 4th or 5th king of the First dynasty, at Umm el-Qaab (fig. 11). It shows a scene in which the concept of the royal hippopotamus hunt is combined with decapitated captives (MULLER 2008, pp. 481-483, Abb. 1-2). The king raises a spear in one hand, a weapon not directly related to the decapitation of captives, and in his other hand he holds a coil of rope with attached float(s), presumably to be used in combination with the spear for the hippopotamus hunt. As MULLER (2008) argued, the king represented order over the chaotic forces symbolized both by the hippopotamus and the decapitated enemies. The depiction of decapitated captives in combination with the royal hippopotamus hunting scene shows that the enemy in the natural environment and the enemy in the social environment have been equated. In my opinion, all of the Predynastic hippopotamus hunt representations should be considered in this context [8]. The desert hunting scenes have the same meaning because the desert itself and the animals living in it are elements of chaos, opposed to the order guaranteed by the king. Integration of hunting into royal iconography related to military victory represents the formal version of symbolism that originated in the (early) Naqada I period and continued to be important during dynastic times (SCHULZ 2000).

Fig. 9. — Badari, tomb 3759. Fragment of hippopotamus-shaped vessel (Oxford, AM 1924.326) (PAYNE 1993, fig. 50, no. 928).

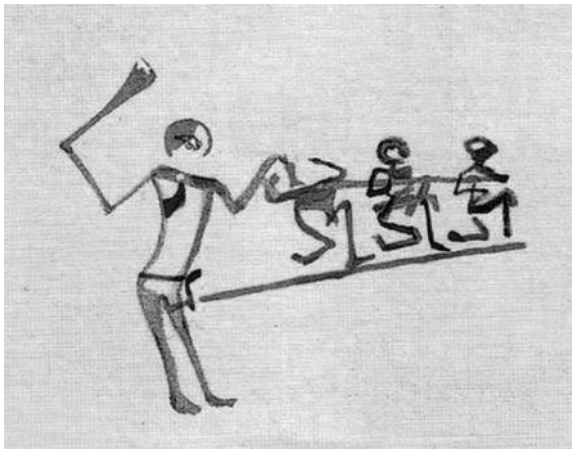


Fig. 10. — Hierakonpolis, "Decorated tomb" (detail) (QUIBELL & GREEN 1902, pl. XXVI).

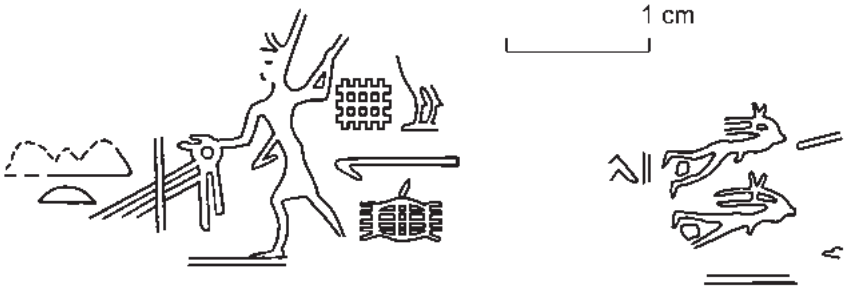


Fig. 11. — Abydos, tomb of Den. Reconstruction of seal impression (MULLER 2008, p. 480, Abb. 3).

The symbolic importance of hunting can be demonstrated by examining the depiction of killing and capture. As mentioned before, the actual killing of animals is not shown in Predynastic hunting scenes, neither are slain animals [9]. The most frequently represented action is that of catching animals by lassos or traps. However, two important exceptions to this principle should be noted, namely the hippopotamus and the wild ass. As already mentioned, the hippopotamus hunting scenes show hunters with spears actually hitting the animals [10]. In some cases, only the spears hitting the animals are shown, not the hunters. Capturing a mature hippopotamus would have been a very difficult undertaking [11], but this may not have been the primary reason for depicting the killing of the animal. In the royal hippopotamus hunt, the spearing is essential, as is shown through the title Ḥrw-msnw, "Horus the Spearer" (MULLER 2008, p. 482). Hippopotami are very harmful for agriculture because of their nightly foraging, and they are most dangerous when disturbed. In this respect, it is not difficult to understand why they represent chaotic forces to be controlled by the king, responsible for establishing order over chaos (SAVE-SODERBERGH 1953, pp. 12-16; MULLER 2008, p. 488).

The wild ass is the other animal whose slaughter rather than catpure is depicted, although this is not shown directly but in a rather symbolic manner. Among representations of the wild ass in rock art, the very large majority have an oblique line at the back of the head, apparently representing an arrow or a spear (HUYGE 2009). Similar representations are not known from White Cross-lined or Decorated pottery, but a single potmark on a Black-topped jar [12], identical to the rock art representations, confirms the Predynastic date of the latter. Also, the wild donkey exceptionally occurs on White Cross-lined pottery (GRAFF 2009, no. 112; HARTMANN 2008, Abb. 5). The ritual killing of (wild) donkeys is attested in reality for the First dynasty at Abusir and Helwan (HUYGE 2009, pp. 299-300), while more recent documents refer to the wild donkey hunt as symbol for the destruction of enemies (KEMNA 1992). Obviously, a strong parallel can be observed between the hunt for the hippopotamus and the wild

donkey, focused on the destruction of enemies. However, it should be noted that although attacked with spears/arrows, both the hippopotamus and the wild donkey are never shown as dead. On the contrary, they are in the same static position as all other Predynastic animal representations. The case of these two animals nevertheless confirms the symbolic importance of hunting, both in the Nilotic and the desert environments.

Despite the remarkable case of the wild donkey, it remains a fact that all other desert animals are shown as captured. This of course avoided the reality that hunters had to carry their catch, but this practical reason must not have been the only one. Evidence from Hierakonpolis shows that captured animals could be kept in captivity for some time (Linseele & Van Neer 2009, pp. 63-64). This was evidenced by pathologies on the skeletal material of a swamp cat (Linseele *et al*. 2007), and several baboons (Van Neer *et al*. 2004, pp. 111-112). Furthermore, the gut content of a young elephant also indicates that it was kept in captivity (Marinova & Van Neer 2009). These examples probably strongly underrepresent the actual number because in most cases only long-term captivity will be observable in animal remains. The slaughter of wild animals seems to have been saved at the right moment and the right place. One such place was the ritual site HK29A at Hierakonpolis where a huge amount of animal bones were found as accumulated food waste deposited just outside the oval enclosure in which festivities must have taken place (Friedman 2009, Linseele *et al*. 2009). The material consists on average of 14.7 % wild animal remains (excluding carnivores), which stands out against the average of 1.6 % at Hierakonpolis (without HK29A) (Linseele & Van Neer 2009, p. 55, tab. 2) [13]. In addition to the remarkable meat consumption, large amounts of fish were part of the festival meals. Again, the characteristics of the fish consumed are different from those in settlement sites. Particularly large fish were selected while the strong underrepresentation of heads and tails indicates that the fish was not prepared on the spot but only consumed (Linseele *et al*. 2009, pp. 115-118). A similar but less well documented situation existed at el-Mahasna (Anderson 2011, pp. 19-22) and a few Decorated vessels also bear testimony of animals being brought to ritual places (Graff *et al*. 2009) [14]. The actual nature of the activities remains elusive to us, but there can be no doubt that they had an important social impact. This certainly would have reflected on the hunters who provided the exceptional foodstuff.

Hunting was not only a symbolic concept but also an actual activity. Although desert hunting camps do not leave many traces and are notoriously elusive to archaeologists [15], numerous rock art sites in both the eastern and western desert testify to frequent human presence. Hunting scenes are often depicted in rock art which could be considered as a direct illustration of what actually happened at a particular place in the desert, unlike the hunting scenes on other media. In some cases, rock art sites coincide with very favourable hunting locations, facilitating an interpretation of rock art sites as occurring in the context of hunting expeditions (Gatto *et al*. 2009, pp. 159-165).

However, there can be no doubt that the iconography of hunting scenes at rock art sites should be integrated in the broader conceptual context of the Predynastic period and should not be considered solely as renderings of actions taking place at specific locations. Boats occur most frequently in rock art, even in the sites considered as hunting locations. Obviously boats have no direct relation to the local environment, and of course cannot be a rendering of reality at the site. Furthermore, the meaning of boats in rock art can hardly have been funerary, contrary to the boats on Decorated pottery. Between these two groups of boat representations, important differences exist. In rock art, boats are frequently occupied by men armed with bows, and/or throwing sticks or maces, which is never the case for Decorated pottery. Occasionally, roped animals are linked with boats, which indicates that in the context of rock art, the boats are elements of power and symbols of status (HENDRICKX & EYCKERMAN 2010, pp. 130-131). Boats also occur in combination with prisoners, as can be seen on two of the Qustul incense burners [16], and in an especially obvious manner on the Gebel Sheikh Suleiman rock art tableau, where a prisoner with an arrow in his chest is tied to a boat without any occupant (MURNANE 1987, fig. 1B). In these cases, boat scenes are placed in a royal context. The use of boats as symbols of power in relation to both hunting and military violence reiterates their interlinked relationship. Furthermore, nautical processions shown in rock art sites at the Wadi of the Horus Qa-a (DARNELL 2009, pp. 97-99) and especially at Nag el-Hamdulab (HENDRICKX *et al*. 2012) are combined with prisoners and hunting scenes. The Nag el-Hamdulab sites are dated to just before the time of Narmer (HENDRICKX *et al*. 2012), but the "Painted Tomb" at Hierakonpolis already shows the combination of boats, hunting and military violence in the Naqada IIC period.

The visual, as opposed to archaeological, documentation of Predynastic hunting practice is very limited. Although a few individual hunters are represented on Decorated pottery and in rock art, there can hardly be any doubt that hunting was a collective event. For hippopotamus hunting, this is an obvious necessity. Hunting in the desert also would have been happened in groups when the distance from the alluvial plain was substantial. The most informative representations are found on the "Hunters' palette" (London, British Museum EA.20790 / Paris, Louvre E.11254, SPENCER 1980, no. 577) (fig. 12), and on a rock drawing from "Was-ha-Waset" (WHW cat. no. 86) in the desert west of Luxor (DARNELL 2002, pp. 145-146) (fig. 13). The "Hunters' palette" is an object of great craftsmanship and clearly an elite document. The hunters line the palette on both long sides, surrounding a number of desert animals [17]. Most of the hunters are not engaged in any kind of action; they are only holding their weapons. However, one hunter is lassoing a gazelle [18], and another hunter is, remarkably, aiming his bow at a lion followed by a cub. The impressive male lion has been hit in the head by two arrows, but has also "overthrown" a hunter in front of him who unrealistically still holds his bow and mace head. The only possible parallel for this scene is on the

pointed lower part of the "Hunters' palette", which shows another male lion hit by arrows, but there are no directly related hunters. The fact that lions are being killed becomes even more remarkable in comparison to a lion represented on the roughly contemporaneous "Battlefield palette" (London, British Museum EA.20791, SPENCER 1980, no. 576). The meaning of the lion dominates the prisoners lying on a battlefield and beyond doubt represents the king. On the "Hunters' palette", while shooting the fierce lion emphasizes the importance of the hunting action, it remains an open question whether the lions are part of the desert animals representing chaos in the central part of the palette. This is certainly not the case on the "Battlefield palette". In pharaonic times, the lion could be hunted on the one hand, but on the other hand it could also represent the king (KLEINSGUTL 1997, pp. 29-50) [19]. Above the two lions being attacked on the "Hunters' palette" is the combination of a "double bull" and a building, the former probably identifies the latter. The "double bull" places the hunting scene in a religious context and illustrates once more the symbolic importance of hunting scenes.

Despite the religious context, the "Hunters' palette" allows a glimpse into the reality of hunting parties. The hunters wear caps with feathers and have animal tails attached to their belts. They have different types of weapons and four of them wear backpacks [20]. The (leather?) cap [21] and the backpack would have been functional, but this is of course not the case for the feathers and the tail. These elements must indicate that hunting included an element of display that had symbolic meaning. The tails can be identified as those of *Lycaon pictus*, an animal well known for its organized manner of hunting in group (HENDRICKX 2006, pp. 739-742). On several late Predynastic decorated palettes, large representations of *Lycaon pictus* line the edges of the palette, identical to the composition of the hunters on the "Hunters' palette" (HENDRICKX 2006, fig. 10). The analogy between the animals and the hunters is in the organized manner of group hunting that they both practised. But it remains unknown to what extent the Predynastic hunters identified themselves with the *Lycaon pictus*. The animal disappeared from the visual record after Predynastic times, leaving us without pharaonic parallels that might have provided additional information. Finally, it should be noted that the hunters carry weapons which are not well suited to capturing animals alive: bows, mace heads, throwing sticks and spears. A few hunters carry a bow in one hand and a mace head in the other, but no arrows. The most important aspect of weaponry is the manner in which they are held. Except for the two hunters lassoing a gazelle, and the two other hunters involved in the lion "incident", all of the hunters hold one weapon on each side of the body, with the arms bent and the hands upwards in an attitude similar to the raised arms of victorious persons on the much older White Cross-lined jars mentioned earlier (*cf.* fig. 8). This attitude and the choice of weapons indicate that the "Hunters' palette" is not only about hunting (in a religious context) but also has a military aspect. This might also be the reason for the two types of hunting shown on the palette, lassoing the desert animals and killing the lions.

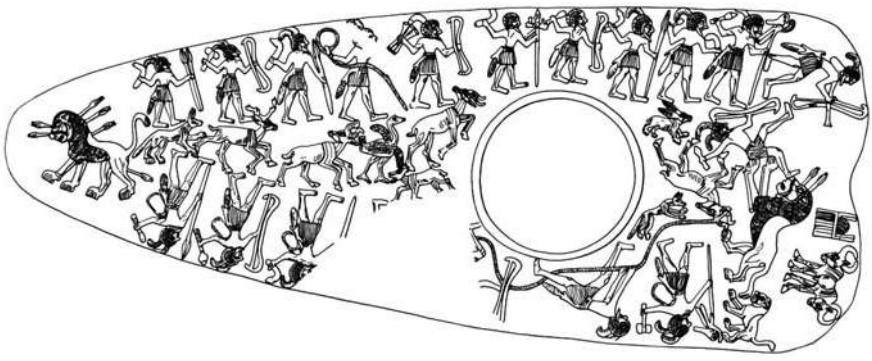


Fig. 12. — Abydos (?). "Hunters' palette" (London, British Museum EA.20790 / Paris, Louvre E.11254) (drawing: Merel Eyckerman).

The rock art panel from "Was-ha-Waset" provides a far more informal picture of a group of hunters (fig. 13), although it might be considerably older than the "Hunters' palette" (DARNELL 2002, p. 147). A group of hunters "walk" with at least two dogs and a few other animals among which a gazelle and a barbary sheep, are clearly recognizable. As on the "Hunters' palette", most of the hunters have feathers on their heads and tails attached to their belts. Several of them hold a looped object, probably the abridged rendering of a lasso. Weapons such as bows or mace heads are absent. The presence of dogs and lassos (?), which are essential attributes for capturing animals, makes the scene more realistic than the "Hunters' palette". Moreover, this confirms the relevance of bows, mace heads, etc. as the military aspect of the "Hunters' palette". Other representations of hunters from the same site have hippopotomous images on their chests (DARNELL 2002, pl. 88; HENDRICKX *et al*. 2009, fig. 23), even though the drawings are located far from the Nile. Hunting in the desert and in the Nilotic environment are to be considered as complementary.

The location of rock art has implications for considering the hunters' status. Many rock art hunting scenes occur far out in the desert, often at distances that cannot be covered in a single day [22]. Hunting expeditions to these areas must have taken several days. The possibility for absence from agricultural or other work and the lack of economic importance of hunting in itself point to the elite status of the hunters, which is underlined by the juxtaposition of hunting and military action. The circumstances of hunting required cooperation, and could have fostered the sense of belonging to a group, allowing the participants to strengthen their contacts and organize their interests as an elite group. The return of the hunters, with their dogs and game, could have been an event that attracted much attention. The feathers and animal tails worn by the hunters certainly would have emphasized this. The impact was not restricted to the moment of return, but

Fig. 13. — "Was-ha-Waset". Rock art panel no. 86 (DARNELL 2002, p. 146, fig. 17).

was continued by the attraction of animals kept temporarily in captivity. Hunting parties would have been an opportunity for elite display, and the religious festivals when the wild animals were slaughtered and consumed would have provided a second occasion for such display. Logically, these important socio-religious events would have been organized by the elite, of which the hunters are part.

A point that has hardly been raised for the Predynastic period is hunting as a means of delineating and occupying territory. In Medieval Europe, defining and marking space were important aspects of hunting as elements for structuring and dominating the surrounding world (Morsel 1997, Guerreau 2000). Of course the environmental situation of Medieval Europe and Predynastic Egypt is very different and the (partial) overlapping between agricultural land and hunting areas is not relevant for Egypt. But in both contexts hunting would have emphasized the geographical difference between the farming activities of ordinary people, which took place in the immediate vicinity of their living places, and the hunting expeditions of the elite into remote areas. Exploring deserts implies control over them. The rock art representations bear permanent testimony of this in the desert, while the game returned to the Nile valley confirms this control for, and over, the whole of society. Hunting stories and music also may have been aspects of great social importance which are not materially evident.

As part of marking space, types of animals on Predynastic pottery and other objects may have indicated specific geographic areas. This straightforwardly for hippopotami and crocodiles, but for other animals it may be inferred from the quantitative importance of desert animals represented on Decorated pottery, which does not agree with the archaeozoological record [23]. For example, the frequently depicted addax is not attested on Predynastic sites, while the equally frequent ibex is only attested occasionally (Linseele & Van Neer 2009, pp. 58-60). On the other hand, the most frequent desert game animal, Dorcas gazelle, is very rare on Decorated pottery (Graff 2009, p. 157, Ab15-16). It is striking that the habitat of the two desert animals dominating the visual imagery on Decorated pottery is limited to the eastern desert for the ibex (Osborn & Helmy 1980, pp. 515-521), and to the western desert for the addax (Manlius 2000, pp. 262-263; Osborn & Helmy 1980, pp. 482-484). It can therefore be suggested that the selection of addax and ibex on Decorated ware refers to the identification of two distinct desert environments. In the context of "order over chaos" concept, this can be taken as a demonstration that all of the desert is concerned [24]. A comparable point is made with the inclusion of mythological animals in animal rows on decorated ivories and palettes (Huyge 2004), which indicates that the concept applies to all of the known and unknown world.

However, not all animal representations can be interpreted this way. The regularly depicted Barbary sheep occur on both sides of the Nile and are relatively frequently identified in archaeozoological remains (Linseele & Van Neer 2009, p. 60). Barbary sheep have a particular iconographic position, being especially important in hunting scenes on White Cross-lined pottery and on decorated female figurines (Hendrickx *et al*. 2009). Barbary sheep are among the caprids which are best adapted to desert environments, and are the largest animals found far out in the desert. This could have made them a suitable symbol for desert hunting in general. The female figurines decorated with hunting scenes have been considered the predecessors of the women of the "Acacia House" as known

from the beginning of the Old Kingdom onwards (HENDRICKX *et al*. 2009, pp. 212-219). These women are associated with hunting and butchering in the context of meat sacrifice and offering ritual, including also music and dance. This fits very well with the interpretation of the rituals at the much older site HK29A at Hierakonpolis — and probably many other places — that can be considered as the origin of the women of the "Acacia House".

All in all, hunting was an important aspect of the elite manner of living but not from the simplistic view of food procurement. Hunting allowed the elite to identify, structure and control the environment far beyond the Nile valley and therefore to transcend the daily lifestyle of the farmers dominated by agriculture. The organized life of work in the fields and animal husbandry was the opposite of hunting wild animals in the extreme environmental conditions of the desert or the spectacular hunt for hippopotami and crocodiles on the Nile. On a more symbolic level this expressed control over chaos. The conceptual aspect of hunting was from the very beginning of the Naqada culture paralleled by military victory. Their iconographic materialization became an important element for the establishment of hierarchic social structures. The integration of the hippopotamus hunt into royal iconography and the disappearance of the dog as symbol of power just before Narmer confirm the importance of the hunting concept at the highest level. Possibly, the conceptual importance of hunting results during the Old Kingdom in a funerary meaning, derived from royal prototypes. But for Predynastic times, hunting should be considered one of the most important, if not the most important, iconographic elements outside the funerary atmosphere.

ACKNOWLEDGEMENTS

I thank John C. Darnell, Ulrich Hartung and Colleen Manassa for allowing me to use documentation from their ongoing work. David Silverman and Jennifer Houser kindly provided the photos used for figure 5. Elizabeth Hart kindly corrected and improved the English of the present contribution and made most useful comments on a previous draft. Finally, I gladly acknowledge the illustration work by Merel Eyckerman, research assistant at the Media, Arts & Design Faculty (Hasselt).

NOTES

[1] The absence of narrative details in Predynastic representations is not limited to hunting or victory scenes, but applies to all of the visual representations of that period. The reason for this is complex and falls beyond the scope of the present article, but it is beyond doubt that Predynastic representations are highly symbolic and part of a visual language that becomes more and more structured over time (GRAFF 2009, HENDRICKX & EYCKERMAN 2012).

[2] On the published drawing (HARTMANN in DREYER *et al*. 2003, Abb. 5), the bull seems hardly related to the hippopotamus hunt. However, when compared with the available photographs (Hartmann in DREYER *et al*. 2003, Tf. 15; DREYER & POLZ 2007, Abb.

261), it can be seen that the position of the lower animals, including the bull, was slightly shifted in the drawing to make the rounded surface of the vessel accorded with the flatness of the drawing. In reality the bull is an integrated part of the scene.

[3] HARTMANN 2011, p. 924, attributes tombs U-239 and U-415 respectively to phase Ia3 and Ia2, which correlate with the Naqada I period.

[4] *Contra* KAHL & ENGEL 2001, p. 26. The game set depicted in the tomb of Hesyra (QUIBELL 1913, pl. 11) consists of three male and three female lions. This was also the case for the set composed of three lions and three lionesses found in tomb VIII at Abu Roach (MONTET 1946, pp. 186-189).

[5] For a more differentiated view on the military relevance of Medieval hunting, see MORSEL 1997, pp. 259-260; GUERREAU 2000, p. 27.

[6] DROUX (2011, p. 350, no. 5) questioned the identification of these vessels as hippopotami without presenting an alternative interpretation. However, the body shape of the animals, short tails and bulging eyes point to hippopotamus, despite the rather pointed face. This is corroborated by the depiction of harpoons used for hippopotamus hunting on the body of the animals although this is of course to some extent a circular argument.

[7] Accepting that perishable materials were already decorated during the Naqada I period, this "shift" may have been limited to the disappearance of victory scenes from Decorated pottery.

[8] Because the hippopotamus hunt is not part of "regular" iconography on Decorated pottery, considered as funerary, there is no reason during Predynastic times for an interpretation of the animal in a funerary context, although such a meaning seems to have been developed out of the royal iconography during the Old Kingdom (STAEHELIN 1978, ALTENMULLER 1989).

[9] A possible exception could be on a Decorated jar from Gebel Silseleh (GRAFF 2009, no. 191). Dead animals are exceptionally also represented in rock art (ALMAGRO BASCH & ALMAGRO GORBEA 1968, fig. 71b; DARNELL 2002, pp. 146-147, fig. 16).

[10] For the available documentation, see BEHRMANN 1989, HENDRICKX & DEPRAETER 2004, DROUX 2011.

[11] BEHRMANN 1996, on the other hand, considered the capturing of hippopotami possible and presented evidence that this might have actually taken place.

[12] It concerns a Black-topped jar in the SCA storeroom at Ashmunein, said to be from Deir Abu Hinnis. The publication is planned but has been delayed because of the recent political events in Egypt.

[13] But LINSEELE *et al*. 2009, p. 120, mentioned 1-3 % of hunted animal remains for settlement sites at Hierakonpolis and an average of 8 % for HK29A. The difference between domesticated and hunted animals nevertheless remains marked.

[14] The rows of wild animals featuring on Decorated pottery can be considered in the same way (GRAFF *et al*. 2011, pp. 456-457). In a related manner, the animal rows on decorated ivories are regularly "controlled" by dogs or other symbols of power at the end of the row (HENDRICKX 2006, pp. 736-739). This should be seen as the combination of the reality of animals being brought out of the desert with the theoretical concept of control over chaos. For BAINES (1995, p. 111), the iconography of these ivories is not yet standardized although he considered them in an elite and possibly even royal context. However, there can be no doubt that these representations are part of a well-structured visual language.

[15] Most recently, Colleen Manassa identified a few very small-scale Predynastic sites consisting of merely a few herds, as hunting camps in the eastern desert beyond

Moalla [Manassa, pers. com. and presentation at the "Egypt at its Origins 4" conference at the Metropolitan Museum (30.07.2011)].

[16] Qustul, tomb L24, Chicago, OIM 24069 (WILLIAMS 1986, pp. 138-145) and Qustul, tomb L11, Chicago, OIM 24058 (WILLIAMS 1986, pp. 145-146). See also HENDRICKX & EYCKERMAN 2010, p. 131.

[17] For a structuralist reading of the "Hunters' palette", see TEFNIN 1979. See also HENDRICKX 2006, pp. 740-742.

[18] At least one more hunter seems to have been involved in this action, but because of a missing fragment it is not entirely clear how this was depicted.

[19] A similar observation can be made for the bull representing the king, for example on the "Narmer palette", but frequently shown as being hunted in rock art.

[20] Starting with the earliest descriptions of the "Hunters' palette" (LEGGE 1900), the backpacks have generally been considered as shields (NIBBI 2003). However, this should be rejected for several reasons, the most important being the loop handles that can be recognized in several cases on top of the backpack, the imitation of stitching along the edges and the uselessness of shields for hunting.

[21] For a more detailed discussion of the leather caps, see DARNELL 2002, p. 146.

[22] The Was-ha-Waset site with the scene of the group of hunters is located at 14.3 km as the crow flies from the Nile valley but that would be a horrendous trip of scaling the mountain where it is unassailable. Using the major track, the Alamat Tal Road to Gebel Tjauti, and then to WHW, the distance is 21 km from the closest Valley point, more like 30 to 35 from the closest major settlement, and probably a good long day's journey on foot, considering the terrain (Darnell, pers. com.). In the eastern desert, rock art sites are located at even greater distances. In the Wadi Hammamat, the Wadi Minah/Wadi Abu Wasil and Wadi Barramiya, rock art sites can be located up to about 100 km (following the wadi beds) from the valley (WINKLER 1938, map; MORROW & MORROW 2002, pp. 23-27).

[23] For a more detailed discussion, see GRAFF *et al.* 2011, pp. 457-459.

[24] When the addax is part of a ritual scene that also includes humans, its meaning should be considered in the context of the renewal of life (GRAFF 2009, pp. 106-108). This does not necessarily contradict the reference to the western desert suggested because the actual meaning of elements within the Naqada IIC-D visual language strongly depends on the context of the elements (GRAFF 2009, HENDRICKX 2002, HENDRICKX & EYCKERMAN 2012).

REFERENCES

ALMAGRO BASCH, M. & ALMAGRO GORBEA, M. 1968. Estudios de arte rupestro nubio. I. Yacimientos situados en la orilla oriental del Nilo, entre Nag Koloradna y Kasr Ibrim (Nubia egipcia). Memorias de la Misión arqueológica española en Egipto, 10. — Madrid, Ministerio de Asuntos Exteriores / Ministerio de Educacion Nacional, 327 pp. + 49 pls.

ALTENMULLER, H. 1980. Jagdritual. — *In*: Lexikon der Agyptologie, Bd. III. Wiesbaden, Harrassowitz, pp. 231-233.

ALTENMULLER, H. 1989. Nilpferd und Papyrusdickicht in den Gräbern des Alten Reiches. — *Bulletin de la Société d'Egyptologie de Genève*, **13**: 9-21.

ANDERSON, D. A. 2011. Evidence for early ritual activity in the Predynastic settlement at el-Mahâsna. — *In*: FRIEDMAN, R. F. & FISKE, P. N. (Eds.), Egypt at its Origins 3. Proceedings International Conference "Origin of the State. Predynastic and Early

Dynastic Egypt" (London, 27 July – 1 August, 2008). Leuven, Peeters, *Orientalia Lovaniensia Analecta*, **205**: 3-29.

ANDERSON, J. K. 1985. Hunting in the ancient world. — Berkeley, University of California Press, 192 pp.

AUDOIN-ROUZEAU, F. 1994. Bêtes médiévales et familiarité: animaux familiers de l'esprit, animaux familiers de la vie. — *Anthropozoologica*, **20**: 11-40.

BAINES, J. 1993. Symbolic roles of canine figures on early monuments. — *Archéo-Nil*, **3**: 57-74.

BAINES, J. 1995. Origins of Egyptian kingship. — *In*: O'CONNOR, D. & SILVERMAN, D. P. (Eds.), Ancient Egyptian Kingship. Probleme der Agyptologie, Bd. 9. Leiden/ New York/ Köln, pp. 95-156.

BARNETT, R. D. 1976. Sculptures from the North Palace of Ashurbanipal of Assyria (668-627 B.C.). — London, British Museum Publications, 75 pp.

BARRINGER, J. M. 2001. The hunt in ancient Greece. — Baltimore, John Hopkins University Press, 312 pp.

BEHRMANN, A. 1989. Das Nilpferd in der Vorstellungswelt der Alten Agypter. Teil I, Katalog. Europaïsche Hochschulschriften. Reihe XXXVIII. Archäologie. Bd. 22. — Frankfurt am Main, Peter Lang, XIII + 500 pp.

BEHRMANN, A. 1996. Das Nilpferd in der Vorstellungswelt der Alten Agypter. Teil II, Textband. Europäische Hochschulschriften, Reihe XXXVIII. Archäologie, Bd. 62. — Frankfurt am Main, Peter Lang, 203 pp.

DARNELL, D. 2002. Gravel of the desert and broken pots in the road: Ceramic evidence from the routes between the Nile and Kharga Oasis. — *In*: FRIEDMAN, R. F. (Ed.), Egypt and Nubia. Gifts of the desert. London, British Museum Press, pp. 156-177.

DARNELL, J. C. 2009. Iconographic attraction, iconographic syntax and the tableaux of royal ritual power in the Pre- and Proto-Dynastic rock inscriptions of the Theban Western Desert. — *Archéo-Nil,* **19**: 83-107.

DECKER, W. 1992. Sports and games of ancient Egypt. — New Haven, Yale University Press, 212 pp.

DREYER, G. & POLZ, D. (Eds.) 2007. Begegnung mit der Vergangenheit – 100 Jahre in Agypten. Deutsches Archäologisches Institut Kairo 1907-2007. — Mainz, von Zabern, XVI + 348 pp.

DREYER, G., HARTMANN, R., HARTUNG, U., HIKADE, T., KOPP, H., LACHER, C., MULLER, V., NERLICH, A. & ZINK, A. 2003. Umm el-Qaab. Nachuntersuchungen im frühzeitlichen Königsfriedhof 13./14./15. Vorbericht. — *Mitteilungen des Deutschen Archäologischen Instituts Abteilung Kairo*, **59**: 67-138.

DROUX, X. 2011. Twinned hippopotamus figurines of the Predynastic period. — *In*: FRIEDMAN, R. F. & FISKE, P. N. (Eds.), Egypt at its Origins 3. Proceedings of the International Conference "Origin of the State. Predynastic and Early Dynastic Egypt" (London, 27 July – 1 August, 2008). Leuven, Peeters, *Orientalia Lovaniensia Analecta,* **205**: 349-378.

FLORES, D. V. 2003. Funerary sacrifice of animals in the Egyptian Predynastic period. British Archaeological Reports S1153. — Oxford, Archaeopress, VIII + 160 pp.

FRIEDMAN, R. F. 2009. Hierakonpolis locality HK29A: The Predynastic ceremonial center revisited. — *Journal of the American Research Center in Egypt*, **45**: 79-103.

FRIEDMAN, R. F., VAN NEER, W. & LINSEELE, V. 2011. The elite Predynastic cemetery at Hierakonpolis: 2009-2010 update. — *In*: FRIEDMAN, R. F. & FISKE, P. N. (Eds.), Egypt at its Origins 3. Proceedings International Conference "Origin of the State. Predynastic and Early Dynastic Egypt" (London, 27 July – 1 August, 2008). Leuven, Peeters, Orientalia *Lovaniensia Analecta*, **205**: 157-192.

GATTO, M. C., HENDRICKX, S., ROMA, S. & ZAMPETTI, D. 2009. Rock art from West Bank Aswan and Wadi Abu Subeira. — *Archéo-Nil*, **19**: 151-168.

GRAFF, G. 2009. Les peintures sur vases de Nagada I – Nagada II. Nouvelle approche sémiologique de l'iconographie prédynastique. — Leuven, Leuven University Press, *Egyptian Prehistory Monographs*, **6**, 432 pp.

GRAFF, G., EYCKERMAN, M. & HENDRICKX, S. 2011. Architectural elements on Decorated pottery and ritual presenting of desert animals. — *In*: FRIEDMAN, R. F. & FISKE, P. N. (Eds.), Egypt at its Origins 3. Proceedings International Conference "Origin of the State. Predynastic and Early Dynastic Egypt" (London, 27 July – 1 August, 2008). Leuven, Peeters, *Orientalia Lovaniensia Analecta*, **205**: 437-465.

GUERREAU, A. 2000. Les structures de base de la chasse médiévale. — *In*: BAGLIANI, A. P. & VAN DEN ABEELE, B. (Eds), La chasse au Moyen Age. Société, traités, symboles. Firenze, Sismel, pp. 25-32.

HARTMANN, R. 2008. Zwei fragmente der White Cross-lined Ware aus dem Friedhof U in Abydos zu Gefässen aus dem Agyptischen Museum Kairo. — *In*: ENGEL, E.-M., MULLER, V. & HARTUNG, U. (Eds.), Zeichen aus dem Sand. Streiflichter aus Agyptens Geschichte zu Ehren von Günter Dreyer. Menes 5. Wiesbaden, Harrassowitz, pp. 163-182.

HARTMANN, R. 2011. The chronology of Naqada I tombs in the Predynastic Cemetery U at Abydos. — *In*: FRIEDMAN, R. F. & FISKE, P. N. (Eds.), Egypt at its Origins 3. Proceedings International Conference "Origin of the State. Predynastic and Early Dynastic Egypt" (London, 27 July – 1 August 2008). Leuven, Peeters, *Orientalia Lovaniensia Analecta*, **205**: 917-938.

HARTUNG, U. 2010. Hippopotamus hunters and bureaucrats. Elite burials at cemetery U. — *In*: RAFFAELE, F., NUZZOLO, M. & INCORDINO, I. (Eds.), Recent discoveries and latest researches in Egyptology. Proceedings First Neapolitan Congress of Egyptology (Naples, 18-20 June, 2008). Wiesbaden, Harrassowitz, pp. 107-120.

HAYES, W. C. 1953. The scepter of Egypt. A background for the study of Egyptian antiquities in the Metropolitan Museum of Art. 1. From the earliest times to the end of the Middle Kingdom. — New York, Harper, XVIII + 399 pp.

HENDRICKX, S. 2002. Bovines in Egyptian Predynastic and Early Dynastic iconography. — *In*: HASSAN, F. A. (Ed.), Droughts, food and culture: Ecological change and food security in Africa's later Prehistory. New York, Plenum Publishers; Dordrecht, Kluwer Academic, pp. 275-318.

HENDRICKX, S. 2006. The dog, the Lycaon pictus and order over chaos in Predynastic Egypt. — *In*: KROEPER, K., CHŁODNICKI, M. & KOBUSIEWICZ, M. (Eds.), Archaeology of Early Northeastern Africa. In Memory of Lech Krzyżaniak. Poznań, Poznań Archaeological Museum, *Studies in African Archaeology*, **9**: 723-749.

HENDRICKX, S. 2010. L'iconographie de la chasse dans le contexte social prédynastique. — *Archéo-Nil*, **20**: 106-133.

HENDRICKX, S. & DEPRAETERE, D. 2004. A theriomorphic Predynastic stone jar and hippopotamus symbolism. — *In*: HENDRICKX, S., FRIEDMAN, R. F., CIAŁOWICZ, K. M. & CHŁODNICKI, M. (Eds.), Egypt at its Origins. Studies in Memory of Barbara Adams. Proceedings International Conference "Origin of the State. Predynastic and Early Dynastic Egypt" (Krakow, 28 August – 1 September 2002). Leuven, Peeters, *Orientalia Lovaniensia Analecta*, **138**: 801-822.

HENDRICKX, S. & EYCKERMAN, M. 2010. Continuity and change in the visual representations of Predynastic Egypt. — *In*: RAFFAELE, F. NUZZOLO, M. & INCORDINO, I. (Eds.), Recent discoveries and latest researches in Egyptology. Proceedings First

Neapolitan Congress of Egyptology (Naples, 18-20 June, 2008). Wiesbaden, Harrassowitz, pp. 121-144.

HENDRICKX, S. & EYCKERMAN, M. 2012. Visual representation and state development in Egypt. — *Archéo-Nil*, **22**: 23-72.

HENDRICKX, S., DARNELL, J. C. & GATTO, M. C. 2012. The earliest representations of royal power in Egypt: The rock drawings of Nag el-Hamdulab (Aswan). — *Antiquity*, **86**: 1068-1083.

HENDRICKX, S., FRIEDMAN, R. F. & EYCKERMAN, M. 2011. Early falcons. — *In*: MORENZ, L. & KUHN, R. (Eds.), Vorspann oder formative Phase? Agypten und der Vordere Orient 3500-2700 v. Chr. Wiesbaden, Harrassowitz, *Philippika*, **48**: 129-162.

HENDRICKX, S., DARNELL, J., GATTO, M. & EYCKERMAN, M. 2012. Iconographic and palaeographic elements dating a Late Dynasty 0 rock art site at Nag el-Hamdulab (Aswan, Egypt). — *In*: HUYGE, D., VAN NOTEN, F. & SWINNE, D. (Eds.), The Signs of Which Times? Chronological and Palaeoenvironmental Issues in the Rock Art of Northern Africa. Proceedings International Colloquium (Brussels, 3-5 June, 2010), pp. 295-326.

HENDRICKX, S., RIEMER, H., FORSTER, F. & DARNELL, J. C. 2009. Late Predynastic / Early Dynastic rock art scenes of Barbary sheep hunting from Egypt's Western Desert. From capturing wild animals to the women of the 'Acacia House'. — *In*: RIEMER, H., FORSTER, F., HERB, M. & POLLATH, N. (Eds.), Desert animals in the eastern Sahara: Status, economic significance and cultural reflection in antiquity. Proceedings interdisciplinary ACACIA workshop University of Cologne (14-15 December, 2007). Köln, Heinrich-Barth-Institut, Colloquium Africanum 4, pp. 189-244.

HERB, M. & FORSTER, F. 2009. From desert to town: The economic role of desert game in the Pyramid Ages of ancient Egypt as inferred from historical sources (c. 2600-1800 BC). An outline of the workshop's inspiration and objectives. — *In*: RIEMER, H., FORSTER, F., HERB, M. & POLLATH, N. (Eds.), Desert animals in the eastern Sahara: Status, economic significance and cultural reflection in antiquity. Proceedings interdisciplinary ACACIA workshop University of Cologne (14-15 December, 2007). Köln, Heinrich-Barth-Institut, Colloquium Africanum 4, pp. 17-44.

HUYGE, D. 2004. A double-powerful device for regeneration: The Abu Zaidan knife handle reconsidered. — *In*: HENDRICKX, S., FRIEDMAN, R. F., CIAŁOWICZ, K. M. & CHŁODNICKI, M. (Eds.), Egypt at its Origins. Studies in Memory of Barbara Adams. Proceedings International Conference "Origin of the State. Predynastic and Early Dynastic Egypt" (Krakow, 28 August – 1 September 2002). Leuven, Peeters, *Orientalia Lovaniensia Analecta*, **138**: 823-836.

HUYGE, D. 2009. Detecting magic in rock art: The case of the ancient Egyptian 'malignant ass'. — *In*: RIEMER, H., FORSTER, F., HERB, M. & POLLATH, N. (Eds.), Desert animals in the eastern Sahara: Status, economic significance and cultural reflection in antiquity. Proceedings interdisciplinary ACACIA workshop University of Cologne (14-15 December, 2007). Köln, Heinrich-Barth-Institut, Colloquium Africanum 4, pp. 293-307.

KAHL, J. & ENGEL, E.-M. 2001. Vergraben, verbrannt, verkannt und vergessen. Funde aus dem "Menesgrab". — Münster, Jochem Kahl, 32 pp.

KANTOR, H. J. 1953. Prehistoric Egyptian pottery in the Art Museum. — *Record of the Art Museum Princeton University*, **12**: 67-83.

KEMNA, K. 1992. Bemerkungen zu den Darstellungen der Wildeseljagd. — *In*: Sesto Congresso Internazionale di Egittologie. Atti, vol. I. Torino, International Association of Egyptologists, pp. 365-370.

KLEINSGUTL, D. 1997. Feliden in Altägypten. Beiträge zur Agyptologie, Bd. 14. — Wien, Afro-Pub, 159 pp.

KOHLER, E. C. 2002. History or ideology? New reflections on the Narmer palette and the nature of foreign relations in Pre- and Early Dynastic Egypt. — *In*: VAN DEN BRINK, E. C. M. & LEVY, T. E. (Eds.), Egypt and the Levant. Interrelations from the 4th through the early 3rd millennium B.C.E. London / New York, Leicester University Press, pp. 499-513.

LEGGE, G. F. 1900. The carved slates from Hierakonpolis and elsewhere. — *Proceedings of the Society of Biblical Archaeologists*, **22**: 125-139.

LINSEELE, V. & VAN NEER, W. 2009. Exploitation of desert and other wild game in ancient Egypt: The archaeozoological evidence from the Nile valley. — *In*: RIEMER, H., FORSTER, F., HERB, M. & POLLATH, N. (Eds.), Desert animals in the eastern Sahara: Status, economic significance, and cultural reflection in antiquity. Proceedings interdisciplinary ACACIA workshop University of Cologne (14-15 December, 2007). Köln, Heinrich-Barth-Institut, Colloquium Africanum 4, pp. 47-78.

LINSEELE, V., VAN NEER, W. & FRIEDMAN, R. F. 2009. Special animals from a special place? The fauna from HK29A at Predynastic Hierakonpolis. — *Journal of the American Research Center in Egypt*, **45**: 105-136.

LINSEELE, V., VAN NEER, W. & HENDRICKX, S. 2007. Evidence for early cat taming in Egypt. — *Journal of Archaeological Science*, **34** (12): 2081-2090.

MANLIUS, N. 2000. Historical ecology and biogeography of the addax in Egypt. — *Israel Journal of Zoology*, **46** (4): 261-271.

MARINOVA, E. & VAN NEER, W. 2009. An elephant's last meal. — *Nekhen News*, **21**: 10-11.

MONTET, P. 1946. Tombeaux de la I^re^ et de la IV^e^ dynasties à Abou-Roach. Deuxième partie: inventaire des objets. — *Kemi*, **8**: 157-227.

MORROW, M. & MORROW, T. (Eds.) 2002. Desert RATS. Rock Art Topographical Survey in Egypt's Eastern Desert. Site catalogue. — London, Bloomsbury Summer School, Department of History, 246 pp.

MORSEL, J. 1997. Jagd und Raum. Uberlegungen über den sozialen Sinn der Jagdpraxis am Beispiel des spätmittelalterlichen Franken. — *In*: ROSNER, W. (Ed.), Jagd und höfische Kultur im Mittelalter. Veröffentlichungen des Max-Planck-Instituts für Geschichte 135. Göttingen, Vandenhoeck und Ruprecht, pp. 255-288.

MULLER, V. 2008. Nilpferdjagd und geköpfte Feinde – zu zwei Ikonen des Feindvernichtungsrituals. — *In*: ENGEL, E.-M., MULLER, V. & HARTUNG, U. (Eds.), Zeichen aus dem Sand. Streiflichter aus Agyptens Geschichte zu Ehren von Günter Dreyer. Menes 5. Wiesbaden, Harrassowitz, pp. 477-493.

MURNANE, W. J. 1987. The Gebel Sheikh Suleiman monument: Epigraphic remarks. — *In*: WILLIAMS, B. B. & LOGAN, T. J. (Eds.), The Metropolitan Museum knife handle and aspects of pharaonic imagery before Narmer. *Journal of Near Eastern St*udies, **46**: 94-95.

NAVAJAS JIMENEZ, A. I. 2009. Bos primigenius/Loxodonta Africana. Iconographie et symbolisme au travers de la céramique White Cross-lined. — *Chronique d'Egypte*, **84**: 50-87.

NIBBI, A. 2003. Some remarks on the ancient Egyptian shield. — *Zeitschrift für Agyptische Sprache und Altertumskunde*, **130**: 170-181.

OSBORN, D. J. & HELMY, I. 1980. The contemporary land mammals of Egypt (including Sinai). Fieldiana Zoology n.s. 5. — Chicago, Field Museum of Natural History, XIX + 579 pp.

QUIBELL, J. E. & GREEN, F. W. 1902. Hierakonpolis II. Egypt Research Account 5. — London, Quaritch, 57 pp. + 39 pls.

QUIBELL, J. E. 1913. Excavations at Saqqara (1911-1912). The tomb of Hesy. — Cairo, Imprimerie de l'Institut français d'Archéologie orientale, 40 pp. + 32 pls.

RAFFAELE, F. 2010. Animal rows and ceremonial processions in late Predynastic Egypt. — *In*: RAFFAELE, F. NUZZOLO, M. & INCORDINO, I. (Eds.), Recent discoveries and latest researches in Egyptology. Proceedings First Neapolitan Congress of Egyptology (Naples, 18-20 June, 2008). Wiesbaden, Harrassowitz, pp. 245-286.

ROSENER, W. 2000. Adel und Jagd. Die Bedeutung der Jagd im Context der adeligen Mentalität. — *In*: BAGLIANI, A. P. & VAN DEN ABEELE, B. (Eds.), La chasse au Moyen Age. Société, traités, symboles. Firenze, Sismel, pp. 129-150.

SAVE-SODERBERGH, T. 1953. On Egyptian representations of hippopotamus hunting as a religious motive. — Lund, C. W. K. Gleerup, 56 pp.

SCHARFF, A. 1929. Die Altertümer der Vor- und Frühzeit Agyptens. II. Bestattung, Kunst, Amulette und Schmuck, Geräte zur Körperpflege, Spiel- und Schreibgeräte, Schnitzereien aus Holz und Elfenbei, Verschiedenes. Staatliche Museen zu Berlin. Mitteilungen aus der ägyptischen Sammlung 5. — Berlin, Staatliche Museen zu Berlin, XI + 194 pp + 38 pls.

SCHULZ, R. 2000. Remarks on the composition of hunting and battle scenes on the chest of Tut-ankh-amun. — *In*: SHERRATT, S. (Ed.), The wall paintings of Thera (Proceedings First International Symposium). Athens, Archaeological Society at Athens and the Thera Foundation, pp. 247-266.

SPENCER, A. J. 1980. Catalogue of Egyptian antiquities in the British Museum. V. Early Dynastic objects. — London, British Museum Press, 110 pp. + 80 pls.

STAEHELIN, E. 1978. Zur Bedeutung der Jagd im alten Agypten. — *In*: TRIET, M. (Ed.), Spiel und Sport im alten Agypten. Beiträge und Notizen zur Ausstellung im Schweizerischen Sportmuseum Basel, 1.9.-30.10.1978. asel, Schweizerisches Sportmuseum, pp. 23-35.

TEFNIN, R. 1979. Image et histoire. Réflexions sur l'usage documentaire de l'image égyptienne. — *Chronique d'Egypte*, **54**: 218-244.

VANDIER, J. 1964. Manuel d'archéologie égyptienne. IV. Bas-reliefs et peintures. Scènes de la vie quotidienne. — Paris, A. et J. Picard, 858 pp. + XL pls.

VAN NEER, W., LINSEELE, V. & FRIEDMAN, R. F. 2004. Animal burials and food offerings at the elite cemetery HK6 of Hierakonpolis. — *In*: HENDRICKX, S., FRIEDMAN, R. F., CIAŁOWICZ, K. M. & CHŁODNICKI, M. (Eds.), Egypt at its origins. Studies in memory of Barbara Adams. Proceedings International Conference "Origin of the State. Predynastic and Early Dynastic Egypt" (Kraków, 28 August – 1 September 2002). Leuven, Peeters, *Orientalia Lovaniensia Analecta*, **138**: 67-130.

WEISSERT, E. 1997. Royal hunt and royal triumph in a prism fragment of Ashurbanipal (82-5-22,2). — *In*: PARPOLA, S. & WHITING, R. M. (Eds.), Assyria 1995. Proceedings 10th Anniversary Symposium of the Neo-Assyrian Text Corpus Project. Helsinki, The Neo-Assyrian Text Corpus Project, pp. 339-358.

WILLIAMS, B. B. 1986. Excavations between Abu Simbel and the Sudan frontier, Keith C. Seele, Director. Part 1: The A-Group royal cemetery at Qustul: Cemetery L. Oriental Institute Nubian Expedition, III. — Chicago, The Oriental Institute of the University of Chicago, XXXVIII + 388 pp. + 110 pls.

WINKLER, H. A. 1938. Rock drawings of southern Upper Egypt. I. Sir Robert Mond Desert Expedition. Archaeological Survey of Egypt 26. — London, Egypt Exploration Society, VIII + 44 pp + 41 pls.

Bull. Séanc. Acad. R. Sci. Outre-Mer
Meded. Zitt. K. Acad. Overzeese Wet.
57 (2-4 – 2011): 265-276

The Unique Frozen Tombs of the Scythians Threatened by Climate Change: Archaeological Survey and Permafrost Research in the Altay Mountains*

by

Wouter GHEYLE[1], Rudi GOOSSENS[2], Alaine WULF[2], Gertjan PLETS[3], Ruben VAN DE KERCHOVE[2], Alexander V. EBEL[4], Eduard P. DVORNIKOV[4] & Jean BOURGEOIS[3]

KEYWORDS. — Scythians; Frozen Tombs; Permafrost; Climate Change; Archaeological Survey; Conservation.

SUMMARY. — The frozen tombs of the Scythian civilization, preserved for over two thousand years in the permafrost of the Russian, Mongolian, Chinese and Kazakh Altay Mountains, are a major archaeological find dating back to the 1920s. Inside the tombs lie bodies which have often been so well preserved that even the tattoos on their skin remain intact. With the permafrost that preserves the tombs now gradually thawing due to climate change, the remaining frozen tombs and the insights they provide into the ancient nomad culture could be lost for ever. Ghent University and the UNESCO World Heritage Centre started a project in 2005 to preserve the remaining frozen tombs. Besides making an inventory of the archaeological heritage, they are looking for ways to detect the tombs that are frozen, and are searching for technical solutions to preserve the tombs in situ.

TREFWOORDEN. — Scythen; Bevroren graven; Permafrost; Klimaatverandering; Archeologische prospectie; Bescherming.

SAMENVATTING. — *De unieke bevroren graven van de Scythen bedreigd door klimaatverandering: archeologisch onderzoek in het Altajgebergte*. — De bevroren graven van de Scythen, die meer dan tweeduizend jaar lang bewaard gebleven zijn in de permafrost van het Russische, Mongoolse, Chinese en Kazachse Altajgebergte, zijn een unieke archeologische ontdekking die teruggaat tot de jaren 1920. De permafrost zorgde voor de bewaring van organisch materiaal, in die mate dat ook tatoeages op de lichamen van de doden intact zijn gebleven. Recentelijk zorgt klimaatverandering ervoor dat de permafrost in Altaj langzaam aan het smelten is; samen met de rijke grafinhoud gaan zo ook de unieke inzichten in de vroegnomadische Scythische cultuur verloren. De Universiteit Gent en UNESCO's Werelderfgoedcentrum lanceerden daarom in 2005 een project om de

---

* Paper presented at the meeting of the Section of Human Sciences held on 16 November 2010. Publication decision taken on 8 November 2011. Final text received on 8 March 2012.

[1] Postdoctoral scientific researcher, Department of Archaeology, Ghent University, Blandijnberg 2, B-9000 Ghent (Belgium).

[2] Department of Geography, Ghent University, Blandijnberg 2, B-9000 Ghent (Belgium).

[3] Department of Archaeology, Ghent University, Blandijnberg 2, B-9000 Ghent (Belgium).

[4] Gorno-Altaisk State University (GASU), Lenkin Str. 1, Gorno-Altaisk, Altai Republic, R-649000 (Russia).

overgebleven bevroren graven te beschermen, onder meer door het maken van een inventaris, het bestuderen van de permafrost en het zoeken naar oplossingen om de graven tegen de opwarming te beschermen.

MOTS-CLES. — Scythes; Tombes gelées; Pergélisol; Changement climatique; Prospection archéologique; Protection.

RESUME. — *Les tombes gelées des Scythes et la menace du changement climatique: recherche archéologique dans les monts de l'Altaï.* — Les tombes gelées des Scythes, qui ont été conservées pendant plus de deux mille ans dans les monts de l'Altaï en Russie, Chine, Mongolie et Kazakhstan, constituent une découverte archéologique de premier ordre remontant aux années 1920. Le permafrost a permis la conservation des matières organiques, à un point tel que même les tatouages sur les corps sont restés intacts. Depuis quelque temps, les changements climatiques provoquent une fonte progressive du permafrost préservant les tombes scythes, de sorte qu'une source importante sur la vie de ces populations nomades pourrait disparaître à jamais. L'Université de Gand et le Centre du Patrimoine mondial de l'UNESCO se sont alors lancés en 2005 dans un projet ayant pour but la protection des tombes gelées encore subsistantes, non seulement par un inventaire du patrimoine de l'Altaï, mais aussi par l'étude du permafrost et la recherche de solutions techniques pour préserver les tombes du réchauffement.

Introduction

The goal of this paper is to give a *status quaestionis* of the UNESCO/Flanders Funds-in-Trust Project "Frozen Tombs of the Altay Mountains: Preservation and Conservation (Phase 1, 2005-2006)" and the related research that was done at Ghent University in the last decade. The project and its outcome have been published in several articles and conference proceedings over the past few years; so this paper will summarize the content of these articles and provide an update (for more details, see *e.g.* BOURGEOIS *et al.* 2007).

The Altay Mountains are situated where China, Kazakhstan, Mongolia and the Altay Republic (Russian Federation) meet (fig. 1). Scattered across the mountains are thousands of surface structures dating from the 3rd millennium BC up to the 19th century AD, funerary monuments as well as ritual structures and petroglyph sites. The most famous of these structures probably are the burial mounds or kurgans of the Early Iron Age Scythians (9th to 2nd century BC) (fig. 2). In the first millennium BC, the Scythian culture covered the Eurasian steppe from the borders of the Black Sea to the Yellow River (PARZINGER 2006a). There are two sources of information about this mainly nomadic civilization. Amongst the written sources, especially the Greek historian Herodotus (5th century BC) is important, as he devoted the fourth book of his Histories to the Scythians and their society. The second source is the archaeology. The interest in Scytho-Siberian art started during the reign of Peter the Great (1689-1725). Since his collections focused on the Black Sea region, the Scythian archaeology of the Altay mountains remained largely unknown until the beginning of the twentieth century.

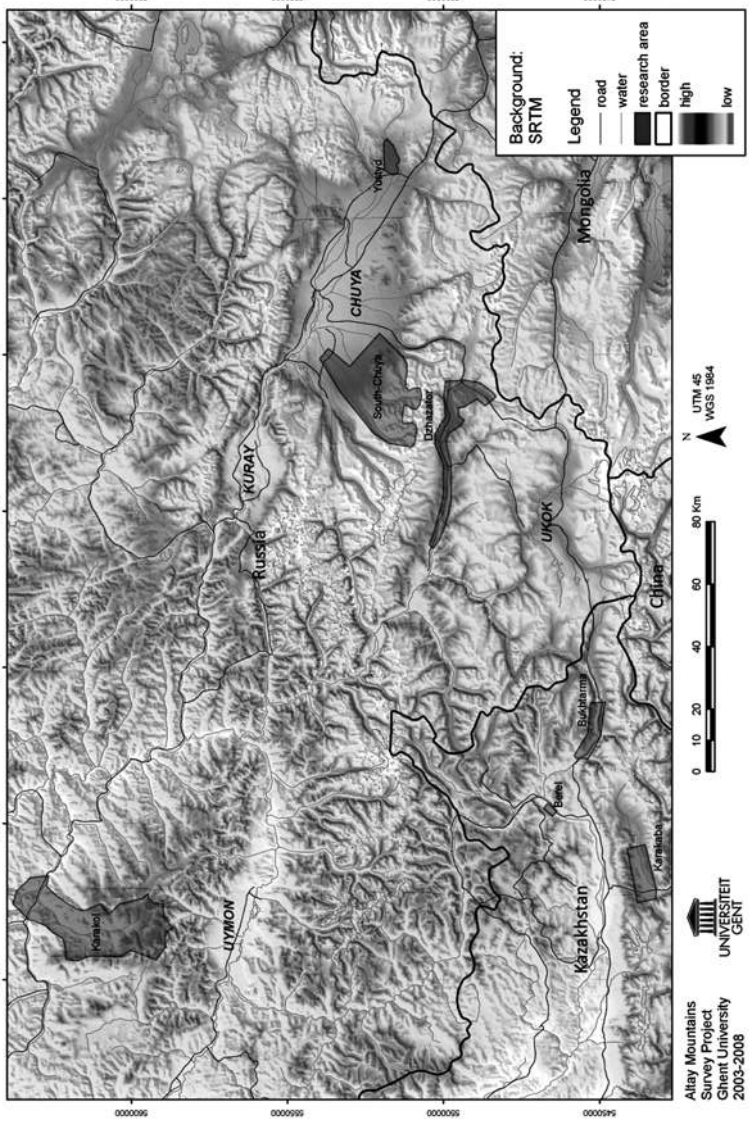


Fig. 1. — The central part of the Altay Mountains with indication of the research areas within the survey project, from 2003 to 2010 (image: UGent).

Fig. 2. — Aerial view on a burial site in the Karakol valley. The Scythian kurgans (foreground) are generally placed in a N-S oriented line, and typically have smaller circular stone setting in the west and some standing stones in the east (image: UGent, deltaflight by J. Bourgeois).

In 1929-1949, the discovery of the frozen mummies of Pazyryk (fig. 3) attracted worldwide interest, thanks to research by M. Gryaznov and S. Rudenko in Pazyryk, Tuekta and Bashadar (GRYAZNOV 1969, RUDENKO 1970). Research in the 1990s brought the fascinating world of the Scythian graves of the Altay Mountains back into the light, through the excavation of some frozen tombs on the plateau of Ukok in the south of the Altay Republic by the Institute of Archaeology and Ethnography of the Siberian Branch of the Russian Academy of Sciences, Novosibirsk (MOLODIN *et al*. 2004). Some ten years ago, excavations in north-eastern Kazakhstan, in Berel, by the Margulan Institute of the Kazakh Academy of Sciences and CNRS France revealed at least two frozen tombs (SAMASHEV *et al*. 2000). And recently, a new frozen tomb was excavated in Mongolia by a team of German, Russian and Mongolian archaeologists (H. Parzinger, German Archaeological Institute, Berlin; V. I. Molodin, Institute of Archaeology and Ethnography of the Siberian Branch of the Russian Academy of Sciences, Novosibirsk; D. Tseveendorj, Institute of Archaeology of the Mongolian Academy of Sciences, Ulaanbaatar) (PARZINGER 2006b).

Fig. 3. — A three-dimensional reconstruction of a part of the tatoos that were found on the body of the man from the second kurgan of Pazyryk (Altay Republic, 5th to 4th cent. BC) (image: UGent, reconstruction by I. Verhaeghe).

A New Threat: Climate Change

Graverobbers and fortune hunters have been the tombs' traditional enemies but, today, climate change causes part of the frozen ground to thaw, and the remaining frozen tombs could be lost forever. Warming is now occurring over most of the globe and is consistent with the global retreat of mountain glaciers, reduction in snow-cover extent, the earlier spring melting of ice on rivers and lakes, and increases in sea-surface temperatures and ocean heat content. The Earth's surface is currently warming at a rate of about 0.17° C per decade or 1.8° C per century and the top ten warmest years have all occurred since 1990. Air temperature in the Altay Mountains increased at a higher rate than the global mean during the 20th century. Significant reduction or disappearance of the permafrost is predicted for the middle of this century in the Altay Mountains. The most significant impacts will be observed near the lower boundary of alpine permafrost, where the frozen grounds are very sensitive to climate change. Many frozen tombs in Altay are situated within this area of sporadic and discontinuous permafrost, and are therefore extremely vulnerable. In these areas, the formation of permafrost under a burial mound is partially due to the structure of the mound itself: although the surroundings have no traces of permafrost, the tombs are frozen due to the cooling influence of the stone mound on top of the burial (fig. 4). Studies show that the temperatures inside the stone mound are typically 3-5° C colder than the air temperature outside (MARCHENKO 1999, 2008).

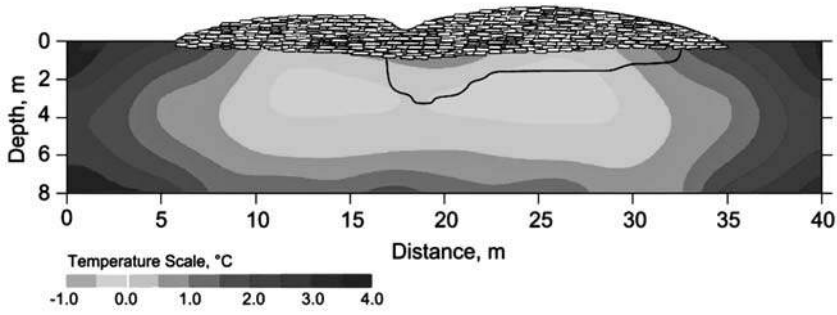


Fig. 4. — A view on a Scythian kurgan with the ice lens situated underneath the stone mound (kurgan 11 at the Berel site in the Kazakh Altay). Two-dimensional steady-state temperature field by Sergei Marchenko, the funerary pit geometry according to SAMASHEV *et al*. 2000.

Other Threats to the Archaeological Heritage in Altay

A more general and less visible threat is undoubtedly the expansion of tourism in the area. More and more tourists from all over the world are visiting this part of Asia, as it is still natural and undisturbed. Mountain hiking, skiing, rafting, camping and even hunting are very popular. Thousands of tourists 'invade' the area every year, and it is obvious that, next to interesting economic potentialities, their presence constitutes a danger for the preservation of the archaeological heritage (PLETS *et al*. 2011). Moreover, in some cases, the area is also confronted with the threat of industrial expansion. The project to build a pipeline from Siberia to China through the plateau of Ukok, as announced by President V. Putin of Russia in March 2006, is probably the most obvious threat of this kind (PLETS *et al*. 2011). A PhD research is now studying the impact of agriculture, tourism and construction works on the heritage of the Russian Altay (drs. Gertjan Plets, IWT 2010-2013). One of the objectives is to propose a plan for sustainable management of the archaeological heritage in several research areas (*e.g*., the Karakol valley).

The UNESCO Preservation Initiative

The exceptional conservation combined with the rich heritage of the Scythians make these tombs extremely valuable for scientific research. The scientific community has, together with the international organizations, the responsibility to preserve these treasures of our past for future generations. UNESCO is interested in including the frozen Scythian tombs in the World Heritage list, and a part of

the Russian Altay Mountains is already listed in UNESCO's Natural World Heritage, briefly mentioning the archaeological monuments in the area (The Golden Mountains of Altay, see http://whc.unesco.org/en/list/768).

Considering the importance of this archaeological heritage for our world and the threat caused by climatic change, a global and ambitious project, "The Frozen Tombs of the Altay Mountains", was set up and supported by UNESCO, with a grant from the UNESCO/Flanders Funds-in-Trust for a first, preliminary programme (Phase 1, 2005-2006). Such a project necessitates international cooperation. At different levels, cooperation with American, Belgian, Chinese, French, German, Kazakh, Mongolian and Russian colleagues was set up. The objectives of the project were: an inventory of the frozen tombs and the archaeological heritage; an examination of the evolution of permafrost conditions to indicate which tombs are likely to defrost within the next decades and a search for solutions for the preservation of permafrost in situ. As a last step, tombs that are thawing and cannot be saved should be excavated. We will develop these objectives in the next paragraphs.

Archaeological Fieldwork in the Altay Mountains: Survey and Inventory

For the purpose of inventory, accurate maps are needed to precisely locate all archaeological structures. These maps do not exist for all of the research area. Taking into account the surface of the research area, the high costs of topographic measurements and the non-existence of a total coverage with aerial photographs, the mapping is being executed with the help of existing satellite images (mainly CORONA, ASTER, QuickBird). The basic advantage of the CORONA images is that these American intelligence images cover a major part of the Altay area and are cheap and useful images to produce topographical maps, as a basis for landscape analysis of the archaeological monuments in the area. This is not the place to discuss the technical details, for which we refer to Goossens *et al.* (2006b). With the resulting maps as a background, survey campaigns were set up to map the archaeological heritage and the possible frozen tombs.

From 2003 on, a series of valleys in the Altay Mountains have been surveyed systematically. Most of them were located in the Russian part of the Altay (Dzhazator, Elangash, Karakol, Irbistu, Ozek, Sebystey and Yustyd), some also in Kazakhstan (Bukhtarma and Karakaba) (see fig. 1). This research was carried out in collaboration with the Gorno-Altaysk State University and the Margulan Institute of Archaeology.

It should be emphasized that all structures are recorded, from huge stone mounds to small stone circles or even structures with unidentified function or date. All periods are concerned. We are convinced that the necessary selection of the burial mounds to be preserved from thawing has to be made within a global analysis of the landscape, with full consideration of the complete archaeological

heritage of the area. Only a holistic approach of these landscapes will give reliable results. All descriptions, photographs, and measurements are recorded in a database. The ALTARI database is written in Access and covers three levels of information (the site location level, the site organization level, and information on the individual structure). Images and plans are available in a direct link. Finally, the database is linked in an ArcView GIS or ArcMap project to the produced maps, DTM's, and other products from the satellite images.

This way, more than fifteen thousand different monuments have been recorded in the ALTARI database. All this information was gathered not only to start up conservation processes or heritage management; it is also the subject of scientific research. The database and maps make it possible to study the archaeological landscape as a whole. Where did the population of a certain culture prefer to construct their burial sites or individual graves? And why? In what part of the landscape are the ritual monuments located? Can we reconstruct the archaeological landscapes from the different chronological and cultural subdivisions, and analyse to what extent the successive populations or cultures did re-use the setting of older burial or ritual sites, or, on the contrary, did avoid these locations? This forms a completely new way of looking at the archaeology in the area, as the research here was mainly limited to excavations of single sites or even single monuments within one site. In the last decennia, the concept of studying the archaeological landscape has developed quickly, and it is rightly considered to be an important part of the archaeological research (Anschuetz *et al.* 2001; Bradley 1998, 2000; Thomas 2001).

Study of Permafrost and Detection of the Frozen Tombs

A next objective of the global project is to map the permafrost of the Altay Mountains, its past and future evolution, in order to contextualize the frozen tombs. First preliminary research in this field was realized by Ghent University, based on field measurements, augerings and ASTER-imagery (Goossens *et al.* 2006a), by the University of Alaska Fairbanks (round-year ground temperature monitoring with temperature data loggers in the Ulandryk Valley) and by the Russian Academy of Sciences in Almaty (augerings and temperature measurements in the Karakaba Valley, Kazakh Altay).

Extensive permafrost research regarding the thermal state of the frozen tombs and the spatial distribution of the mountain permafrost is necessary to forecast which of the tombs are endangered by thawing. To assess this threat and to calibrate future climate models on the local scale of the frozen tombs, a PhD research project was set up at the Geography Department, funded by the IWT (dr. Ruben Van de Kerchove, 2009-2012). The source data are temperature measurements performed in the Russian Altay between 2008 and 2010. The thermal regime is studied at three levels. At first, surface temperatures inside a

tomb are compared to undisturbed natural temperature profiles located in its vicinity. Next, temperatures at depth inside a burial mound are compared to undisturbed borehole-temperatures. Therefore, an archaeological/periglacial experiment was carried out in the Ulandryk Valley, where a burial mound, excavated in 1972, was reconstructed in 2008 and loggers were installed inside the reconstructed burial chamber and covering stone mound. Finally, temperature loggers were installed in a burial mound at the Ukok Plateau, an area known for its frozen burial mounds, intended to study 2D and 3D temperature fluxes inside the coarse debris layer. Some preliminary papers have already been published, and the final outcome of this PhD project will be published in the next few months (VAN DE KERCHOVE & GOOSSENS 2010a,b; VAN DE KERCHOVE *et al*. 2009, 2013).

It was not possible within the first phase of the UNESCO project to undertake any serious attempt into the detection of individual frozen kurgans, but there is already great experience in geophysical prospecting methods for small-scale survey in archaeological zones. Obviously, this part of the global project has to be developed in the next future. The experience of the German Institute of Archaeology (as shown in Mongolia) is of prime importance in this field.

Preservation of the Selected Frozen Tombs

If the consequences of global change are detectable on individual tombs, methods have to be considered to preserve the graves in their frozen condition. The search for technical solutions to preserve the ice lens in situ has already been started and different methods of frozen ground preservation and prevention of permafrost degradation are being studied (MARCHENKO 2006). The height and thickness of the coarse debris (the stone burial mound) is a determining factor for the formation and preservation of an ice lens. So, the easiest way to protect the frozen core of a tomb could be enlarging the stone cover. From a heritage point of view, this is of course not an applicable solution. A second possibility is to protect the kurgan from rainfall, sunlight and snowfall, by shading the burial mound. This method decreases the ground temperature by 3 to 7° C (ZHANG & LIU 1998). Here also, the visual impact on the natural landscape is great and therefore we should maybe focus on a third solution which could be installing self-regulating seasonally-acting cooling devices or thermosyphons (fig. 5). They act like refrigerators, but without needing an external power source. By extracting heat from the ground and dissipating it into the air, they lower the ground temperature and prevent the degradation of permafrost (HAYNES & ZARLING 1988). Obviously, still more research is to be carried out here. There is no doubt that other techniques and methods will be designed in the future. All these techniques should of course consider the problems of sustainability and of respect for the landscape.

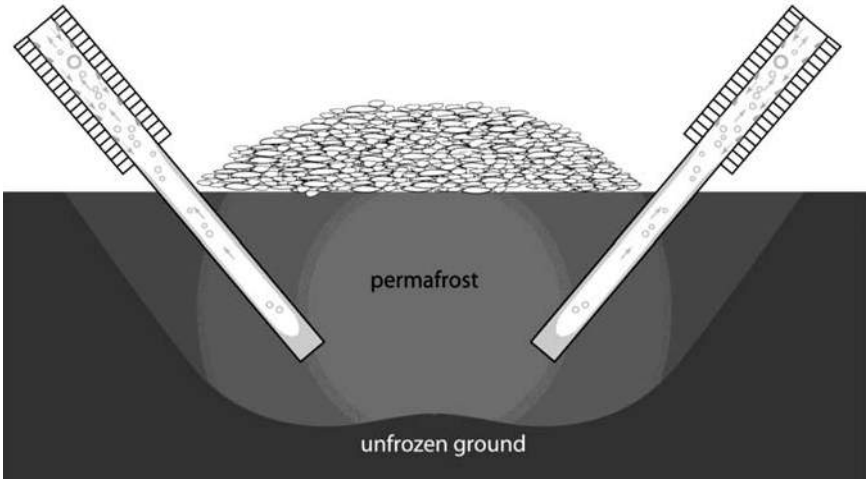


Fig. 5. — Suggested position of thermosyphons to protect the frozen core of a Scythian kurgan from thawing. Image by S. Marchenko (MARCHENKO 2006).

Excavating Endangered Tombs?

It is evident that we will not be able to apply these methods and technologies to all the frozen tombs in the region. A well-balanced selection will most likely have to be made. What to do with the tombs that cannot be saved from thawing? If excavation is the only solution, it will be necessary to work with different groups of experts, using the latest techniques and equipment. Much attention should also be paid to the conservation and restoration of the finds, and to their final destination. In the case of excavations, we also have to take into account the attitude of the local population towards the graves of their ancestors.

Conclusions

The similarities between the different Scythian types of cultures make the frozen tombs of the Altay Mountains a very important source of information for all the cultures dominating the Eurasian steppe zone in the first millennium BC. They form one of the main sources of information for the archaeology of this huge region, covering parts of Europe and Asia, from the Danube and the Black Sea to Manchuria. It is clear that these frozen tombs are of major importance for the international scientific community and for mankind. The countries concerned by this heritage (China, Mongolia, Kazakhstan and Russia) are also the most interested. The geographical context of the graves, the Altay Mountains

themselves, is part of our world heritage. But the archaeological heritage remains unprotected. Nominating and inscribing the monuments to the World Heritage List will change this, and make legal protection possible.

ACKNOWLEDGEMENTS

The authors wish to gratefully acknowledge the Research Fund of Ghent University (2003-2004), the Federal Science Policy of Belgium (2004), the Flemish/UNESCO Fund-in-Trust (2005-2006), the Flemish-Russian Bilateral Agreements (2006-2007), the Research Foundation Flanders – FWO (Project no. G.0042.09, 2009-2012) and the IWT (PhD research on permafrost 2009-2012, PhD research on cultural heritage management 2010-2013) that provided funding for the research in the Altay Mountains over the last ten years. From 2007 onwards, the transport of scientific equipment during expeditions was largely supported by Brussels Airlines.

REFERENCES

ANSCHUETZ, K. F., WILSHUSEN, R. H. & SCHEICK, C. L. 2001. An Archaeology of Landscapes: Perspectives and Directions. — *Journal of Archaeological Research*, **9** (2): 157-211.

BOURGEOIS, J., DE WULF, A., GOOSSENS, R. & GHEYLE, W. 2007. Saving the frozen Scythian tombs of the Altai Mountains (Central Asia). — *World Archaeology*, **39** (3): 458-474.

BRADLEY, R. 1998. The Significance of Monuments. On the shaping of human experience in Neolithic and Bronze age Europe. — London, Routledge, 179 pp.

BRADLEY, R. 2000. An Archaeology of Natural Places. — London, Routledge, 177 pp.

GOOSSENS, R., DE WULF, A., GHEYLE, W. & BOURGEOIS, J. 2006a. Estimation of the permafrost area in the Altai Mountains (Russia) in the framework of the preservation of the Frozen Tombs of the Altai Mountains. — *In*: MARCAL, A. (Ed.), Global Developments in Environmental Earth Observation from Space. Proceedings 25th Symposium of the European Association for Remote Sensing Laboratories (Porto, Portugal, 6-11 June 2005). Rotterdam, Millpress, pp. 595-601.

GOOSSENS, R., DE WULF, A., BOURGEOIS, J., GHEYLE, W. & WILLEMS, T. 2006b. Satellite Imagery and Archaeology, the Example of CORONA in the Altai Mountains. — *Journal of Archaeological Science*, **33**: 745-755.

GRYAZNOV, M. P. 1969. South Siberia. — London, Barrie & Rockliff, The Cresset Press, 252 pp.

HAYNES, F. D. & ZARLING, J. P. 1988. Thermosyphons and foundations design in cold regions. — *Cold Regions Science and Technology*, **15**: 251-259.

MARCHENKO, S. S. 1999. Permafrost-Climatic Conditions in the Northern Tien Shan: Recent and Expected for 21th Century Changes. — *Journal of Earth Cryosphere*, **3**: 13-21.

MARCHENKO, S. S. 2006. A new threat: climate change. The frozen tombs are thawing. — *In*: BOURGEOIS, J. & GHEYLE, W. (Eds.), The Frozen Tombs of the Altai Mountains. Ghent, UNESCO WHC & UGent, pp. 70-71.

MARCHENKO, S. S. 2008. Climate Change and its Impact on the Frozen Tombs of the Altai Mountains. — *In*: HAN, J., FRANK, L. & TRESELIAN, D. (Eds.), The Preservation of the Frozen Tombs of the Altai Mountains. Paris, UNESCO World Heritage Centre, pp. 61-64.

MOLODIN, V. I., POLOS'MAK, N. V., NOVIKOV, A. V., BOGDANOV, E. S., SLYUSARENKO, I. Y. & CHEREMISIN, D. V. 2004. Археологические памятники плоскогорья Укок (Горный Алтай). — Archeologicheskie pamyatniki ploskogor'ya Ukok (Gornyy Altay). Novosibirsk, Institut Archeologii i Etnografii SO RAN, 255 pp.

PARZINGER, H. 2006a. Die frühen Völker eurasiens vom Neolithikum bis zum Mittelalter. — München, Verlag C. H. Beck OHG, 1045 pp.

PARZINGER, H. 2006b. Frozen Tombs of the Pazyryk culture in Mongolia. — *In*: BOURGEOIS, J. & GHEYLE, W. (Eds.), The Frozen Tombs of the Altai Mountains. Ghent, UNESCO WHC & UGent, pp. 57-61.

PLETS, G., GHEYLE, W. & BOURGEOIS, J. 2011. Preservation of the Petroglyphs of the Altai Republic. Overview of the Altai Survey Project and the Recorded Rock Art. — *INORA International Newsletter On Rock Art*, **59**: 18-23.

PLETS, G., GHEYLE, W., BOURGEOIS, J., PLETS, R. & VAN EETVELDE, V. 2011. A Line through the Scarred Lands of the Altay. Perspectives on the Altai Pipeline Project. — *Mountain Research and Development*, **31** (4): 372-379.

RUDENKO, S. I. 1970. Frozen Tombs of Siberia. The Pazyryk Burials of Iron-Age Horsemen. — London, J. M. Dent & Sons Ltd., XXXVI + 340 pp. + 144 pl.

SAMASHEV, Z. S., BAZARBAEVA, G. A., ZHUMABEKOVA, G. S. & FRANCFORT, H.-P. 2000. Le kourgane de Berel dans l'Altaï kazakhstanais. — *Arts Asiatiques*, **55**: 5-20.

THOMAS, J. 2001. Archaeologies of Place and Landscape. — *In*: HODDER, I. (Ed.), Archaeological Theory Today. Cambridge, Polity Press, pp. 165-186.

VAN DE KERCHOVE, R. & GOOSSENS, R. 2010a. Ground surface temperatures (GST) modeling in the Russian Altay Mountains by using MODIS Land Surface Temperatures (LST): assessment of the impact of snow cover, topography, landcover and subpixel variability on the GST-LST relationship. — EGU 2010, Geophysical Research Abstracts.

VAN DE KERCHOVE, R. & GOOSSENS, R. 2010b. The thermal regime beneath cultural blocky materials: ground temperature measurements in and around the Scythian Kurgans of the Russian Altay Mountains. — EGU 2010, Geophysical Research Abstracts.

VAN DE KERCHOVE, R., GOOSSENS, R., DE WULF, A., BOURGEOIS, J. & GHEYLE, W. 2009. Thermal remote sensing imagery in permafrost studies. — *In*: MAKTAV, D. (Ed.), Remote Sensing for a Changing Europe. Proceedings 28th Symposium of the European Association of Remote Sensing Laboratories (Istanbul, Turkey, 2-5 June 2008). Amsterdam, IOS Press, pp. 313-320.

VAN DE KERCHOVE, R., LHERMITTE, S., VERAVERBEKE, S. & GOOSSENS, R. 2013. Spatiotemporal variability in remotely-sensed Land Surface Temperature, and its relationship with physiographic variables in the Russian Altay Mountains. — *International Journal of Applied Earth Observation and Geoinformation*, **20**: 4-19.

ZHANG, L. & LIU, J. 1998. Numerical investigation of experimental roadbed thermal stability on Fenghuoshan permafrost in Tibet. — Yakutsk, SB RAS Publishers.

Bull. Séanc. Acad. R. Sci. Outre-Mer
Meded. Zitt. K. Acad. Overzeese Wet.
57 (2-4 – 2011): 277-289

De documentatie en beschrijving van bedreigde talen en hun bijdrage aan het onderzoek naar taalkundige universalia*

door

Mark VAN DE VELDE**

TREFWOORDEN. — Taalbeschrijving; Taaltypologie; Documentaire taalkunde; Myene-talen; Bantoetalen.

SAMENVATTING. — Deze bijdrage illustreert een aantal recente evoluties in de taaltypologie en de documentaire taalkunde aan de hand van een lopend onderzoeksproject over de Gabonese Bantoetaal Myene. Ze bespreekt de noodzaak van een meer respectvolle omgang met primaire gegevens en geeft aan hoe dit kan. Een korte bespreking van het grammaticale gedrag van relatiefzinnen in het Myene toont aan waarom we meer, betere en beter gedocumenteerde beschrijvingen van de talen van de wereld nodig hebben.

MOTS-CLES. — Description linguistique; Typologie linguistique; Linguistique documentaire; Langues myènè; Langues bantoues.

RESUME. — *La documentation et la description des langues en péril et leur apport aux recherches sur les universaux linguistiques*. — Dans la présente contribution, un projet de recherche sur la langue bantoue gabonaise myènè sert d'illustration à un nombre d'évolutions récentes en linguistique documentaire et en typologie linguistique. La récolte, la sauvegarde et la mise à disposition des données primaires sur les langues en voie de disparition méritent plus d'attention dans les recherches de terrain. Une discussion concise du comportement grammatical des phrases relatives en myènè démontre l'intérêt d'un effort de documentation et de description des langues du monde pour la linguistique générale.

KEYWORDS. — Language Description; Linguistic Typology; Documentary Linguistics; Myene Languages; Bantu Languages.

SUMMARY. — *Documentation and Description of Endangered Languages and their Contribution to the Research of Linguistic Universals*. — This paper uses an ongoing documentation project on the Myene language of Gabon to illustrate some recent evolutions in linguistic typology and documentary linguistics. It deals with the need for a more respectful approach to primary data and provides a brief overview of best practices for doing so. It also points out why we need more, better and more correctly documented descriptions of the languages of the world.

---

* Mededeling voorgesteld tijdens de zitting van de Klasse voor Menswetenschappen van 17 mei 2011. Beslissing tot publicatie genomen op 17 april 2012. Definitieve tekst ontvangen op 22 april 2012.

** Langage, langues et cultures d'Afrique noire, Centre National de la Recherche Scientifique (CNRS), 3 rue Michel-Ange, F-75016 Paris (France).

1. Inleiding

Deze bijdrage illustreert een aantal recente evoluties in de documentaire taalkunde en de taaltypologie aan de hand van het lopende project *Comparative Documentation of the Myene Language Cluster*. Dit driejarige onderzoeksproject wordt gefinancierd door de *Endangered Language Documentation Programme*, zelf een onderdeel van het *Hans Rausing Endangered Language Project* (HRELP, www.hrelp.org), verbonden aan de *School of Oriental and African Studies* in Londen. Samen met het Duitse programma DoBeS (*Dokumentation Bedrohter Sprachen*), is HRELP een concreet antwoord op de vaststelling dat een aanzienlijk percentage van de talen van de wereld dreigt te verdwijnen zonder enig spoor na te laten. Een pessimistische schatting van UNESCO heeft het over vijftig tot negentig procent van de vandaag gesproken talen tegen het einde van de eenentwintigste eeuw. Het engagement van HRELP en DoBeS bestaat erin de documentatie van een groot aantal bedreigde talen te financieren.

In deel 2 situeer ik het Myene geografisch en genealogisch, beschrijf ik in welke mate het met uitsterven bedreigd is en leg ik kort uit hoe het zover is kunnen komen. Deel 3 introduceert het doel en de methodes van de relatief nieuwe discipline van de documentaire taalkunde. Deel 4, tot slot, beargumenteert kort de relevantie van de beschrijving en documentering van de taalkundige diversiteit voor de algemene taalkunde en bespreekt, ter illustratie, enkele voorlopige onderzoeksresultaten van het Myeneproject.

2. Myene

Myene is de verzamelnaam voor zes dialecten die traditioneel gesproken worden in een aantal regio's in het westen van Gabon, nl. het Adjoemba, het Enenga, het Galwa, het Mpongwe, het Nkomi en het Oroengoe. Merk op dat de term *dialect* hier gebruikt wordt in de strikte, taalkundige zin van het woord, nl. een geografisch gedefinieerde variant van een taal, waarbij *taal* op zijn beurt (niet geheel onproblematisch) gedefinieerd kan worden als een verzameling onderling verstaanbare dialecten. Het Mpongwe wordt of werd gesproken in en rond de hoofdstad Libreville, het Oroengoe in de regio van Port-Gentil, het Nkomi rond de lagune van Fernan Vaz en de andere drie dialecten in de regio van het stadje Lambarene, dat onder andere bekend is als de plaats waar Albert Schweizer zijn hospitaal stichtte.

Het Myene behoort tot de familie van de Bantoetalen, die zo groot is dat aan individuele talen doorgaans niet alleen met hun naam maar ook met een zogenaamd Guthrienummer gerefereerd wordt, een combinatie van een hoofdletter en twee (soms drie) cijfers. De letter staat voor één van de zestien geografische zones waarin het Bantoesprekende gebied onderverdeeld is. Het eerste cijfer slaat op een subgroep en het tweede cijfer op een individuele taal. Het Myene draagt

het nummer B11 in deze referentiële classificatie. Er zijn geen andere talen in de B10 groep. Zone B vormt samen met zone A en delen van zones C en H de noordwestelijke tak van de Bantoefamilie, de tak die het dichtst bij het oorsprongsgebied van de Bantoetalen gesitueerd is (ergens op de grens tussen het huidige Kameroen en Nigeria) en waar de taalkundige fragmentatie en de typologische variatie het grootst zijn.

Van tientallen (misschien honderden) Afrikaanse talen weten we alleen dat ze bestaan, of beschikken we hoogstens over een al dan niet betrouwbaar lijstje basiswoordenschat. Onze kennis van het Myene was bij de aanvang van het documentatieproject heel wat beter. We beschikken onder andere over een uitgebreid woordenboek van het Mpongwe, opgesteld door de Gabonese geestelijke André Raponda Walker (Raponda Walker 1934), maar dit naslagwerk heeft de afwezigheid van toonmarkering als groot nadeel. Daarnaast zijn er verschillende kleinere publicaties over aspecten van vooral de historische grammatica van Myenevarianten (Gregoire & Rekanga 1994, Mouguiama-Daouda 1990), en sedert kort ook een beschrijvende grammatica van het Oroengoe door Odette Ambouroue, die moedertaalspreekster is van deze variant en als postdoctoraal onderzoeker deelneemt aan het huidige documentatieproject (Ambouroue 2007). Tot slot zijn er een aantal studies van het tonale systeem van het Myene (deel 2 en 3 van Ambouroue 2007; Gregoire 1991; Philippson & Puech, niet gepubliceerd). Deze studies van de tonaliteit zijn erg uiteenlopend van aanpak en geen enkele bereikt bevredigende conclusies, wat te wijten is aan de buitengewone complexiteit van het Myene toonsysteem. Grégoire en Ambouroue maken gebruik van een klassieke aanpak met onderliggende tonen waarvan de realisatie bepaald wordt door een opeenvolging van geconditioneerde toonregels, terwijl Philippson en Puech werken met beperkingen op mogelijke of optimale toonschema's binnen bepaalde prosodische domeinen. Het onderscheid tussen hoog en laag is equipollent bij Grégoire en Ambouroue (d.w.z. dat een structurele hoge toon contrasteert met een structurele lage toon) en privatief bij Philippson en Puech (een structurele hoge toon contrasteert met de afwezigheid van een toon; er zijn dus geen structurele lage tonen).

Op basis van mondelinge verslagen waren we er bij de aanvraag van het documentatieproject vanuit gegaan dat het Adjoemba alleen oudere sprekers had, dat het Enenga uitgestorven was en dat de andere dialecten niet bedreigd waren. Onze bedoeling was dus zoveel mogelijk materiaal over het Adjoemba te verzamelen, en de andere dialecten (behalve het Enenga) volledig te documenteren, met inbegrip van de taalverwerving. Voor dit laatste zouden we een aantal baby's en peuters drie jaar lang op geregelde tijdstippen filmen en opnemen, om de transcripties achteraf met een specialist taalverwerving te analyseren. Na een eerste onderzoeksverblijf in Gabon bleken de verslagen over de situatie van het Adjoemba en het Enenga correct te zijn, hoewel we na lang zoeken nog één spreker van het Enenga gevonden hebben, een vrouw van rond de tachtig. De andere dialecten blijken echter ook alle met uitsterven bedreigd te zijn. Na twee

jaar hebben we bijvoorbeeld nog geen enkel kind kunnen vinden dat geschikt is om deel te nemen aan een studie over de verwerving van het Myene. In alle plaatsen die we voorlopig bezocht hebben, is de moedertaal van kinderen wier ouders Myenetalig zijn vandaag de dag immers het Frans.

Sinds de koloniale periode worden het Myene en de andere oorspronkelijke Gabonese talen systematisch uit het onderwijs, de media en de administratie geweerd, ten voordele van het Frans. In het onderwijs gebeurde dit tot voor kort (nu hoeft het niet meer) onder andere door middel van het systeem van het symbool. Wie betrapt wordt op het spreken van het Myene tijdens de lessen of daarbuiten, moet een „symbool" dragen. Een leerling kan zich alleen van het symbool bevrijden door een andere leerling te betrappen en te verklikken. Wie het symbool op het einde van de dag draagt, krijgt een straf. Dit perverse systeem vernietigt de loyauteit tussen leden van een taalgemeenschap en verbant het gebruik van een „minderheidstaal" naar de familiale sfeer, maar het bedreigt op zich niet rechtstreeks het voortbestaan van een taal. Kinderen verwerven hun moedertaal immers in de eerste levensjaren, vooraleer ze de schoolgaande leeftijd bereikt hebben. Het voortbestaan van een taal is bedreigd als ouders hun kinderen niet langer in hun moedertaal opvoeden, maar in een andere, dominante taal. Een typische combinatie van redenen zet Myenesprekende ouders ertoe aan hun kinderen van bij de geboorte in het Frans op te voeden. Het Myene wordt al dan niet bewust en al dan niet terecht beschouwd als een obstakel bij de ontwikkeling van het kind tot een succesvol lid van de moderne maatschappij. De dominante taal, het Frans, is overal aanwezig en beschikbaar, zodat het bijvoorbeeld het natuurlijke communicatiemiddel wordt in gemengde huwelijken en ook in de steden, waar sprekers van verschillende Gabonese talen samenwonen. Radio en televisie zorgen er bovendien voor dat het Frans zelfs in eentalige rurale gebieden alomtegenwoordig is in de familiale sfeer. Als het Myene sneller uitsterft dan sommige andere Gabonese talen, dan is dat wellicht het gevolg van het feit dat de Myenebevolking sterk verstedelijkt is. Uit onze ervaring blijkt dat ouders zich niet helemaal bewust zijn van de gevolgen van hun „keuze" voor het voortbestaan van het Myene. Als we hen vragen of hun kinderen Myene spreken, is het paradoxale antwoord steevast „jammer genoeg niet". De teloorgang van het Myene wordt ervaren als een pijnlijk, maar onafwendbaar verlies en onze inspanningen om de taal te documenteren kan bij alle generaties op steun en sympathie rekenen.

3. Het hoe en waarom van de documentaire taalkunde

Taalkundigen die de documentaire taalkunde als een aparte discipline erkennen, situeren haar origine vaak in het artikel *Documentary and descriptive linguistics* van Nikolaus HIMMELMANN (1998). Himmelmann pleit hierin voor een striktere scheiding tussen de twee basisactiviteiten van de beschrijvende

taalkunde: enerzijds het verzamelen van primaire gegevens en anderzijds hun grammaticale analyse. De eerste activiteit heeft volgens Himmelmann nood aan een meer solide theoretische en methodologisch basis, waarvoor hij zelf de aanzet geeft. In dit deel overlopen we een aantal redenen om zorgvuldiger met onze primaire bronnen om te springen dan nu doorgaans het geval is. Daarna bespreek ik enkele zogenaamde *best practices* die in het kader van de documentaire taalkunde ontwikkeld zijn en die we toepassen in het Myeneproject.

De grammaticale beschrijving van talen zonder geschreven traditie is gebaseerd op twee types primaire bronnen: uitgelokt taalgebruik (o.a. door middel van lexicale en grammaticale enquêtes) en spontaan taalgebruik. Het eerste type, ook elicitatie genoemd, is vooral bij het begin van een descriptief project belangrijk, en later om zeldzame fenomenen te exploreren en gaten op te vullen. Het tweede type is uiteraard minder gecontroleerd en moeilijker te verwerven en te beheren, maar het is ook veel rijker en in veel gevallen betrouwbaarder. Onderzoek op basis van corpora van spontaan taalgebruik is vaak noodzakelijk om de taakverdeling tussen grammaticale constructies te begrijpen. De meeste beschrijvende linguïsten zien het als hun voornaamste taak om de massa primaire gegevens te reduceren tot een grammaticaal systeem. Doorgaans is het het resultaat van dit reductieproces dat gepubliceerd wordt, terwijl de primaire gegevens in het beste geval in een persoonlijk of lokaal toegankelijk archief belanden. Als gebruiker van taalbeschrijvingen weten we daarom zelden op hoeveel gegevens een beschrijving gebaseerd is, of deze gegevens spontaan geproduceerd zijn of ontlokt, en wat de kwaliteit is van hun interpretatie. We vernemen bovendien alleen iets over die aspecten die de linguïst relevant achtte op het moment van de beschrijving. Met andere woorden, als we als veldwerkers laks omspringen met onze primaire gegevens en alleen de resultaten van onze analyses beschikbaar maken, dan is ons onderzoek niet of nauwelijks reproduceerbaar en dus niet falsifieerbaar. Hiaten in onze analyse kunnen later niet opgevuld worden door onderzoekers met een ruimer of ander interesseveld en/of betere methodes en technieken, tenzij ze zelf opnieuw van nul beginnen met het verzamelen van primaire gegevens. Dit laatste is niet alleen duur en tijdrovend, in de huidige context van massale taalsterfte zal het vaak onmogelijk zijn. Alles wat we nu niet archiveren, dreigt dus voorgoed verloren te gaan. Een laatste, maar niet minder belangrijke reden om primaire gegevens over talen zonder geschreven traditie zorgvuldiger te verzamelen, bewaren en ontsluiten is dat ze voor de taalgemeenschap zelf veel relevanter zijn dan de beschrijvende grammatica's die erop gebaseerd zijn.

Als we als veldwerkers eenmaal overtuigd zijn van de noodzaak om primaire gegevens te verzamelen die onze onmiddellijke interesses overstijgen en ze bovendien nu en in de toekomst beschikbaar te maken voor collega's en leden van de taalgemeenschap, dan rest de vraag hoe we dat het best aanpakken. Vooruitgang in de documentaire taalkunde heeft geleid tot een consensus rond een hele reeks aanbevelingen om de volledigheid, de duurzaamheid en de toegankelijkheid van primaire taalkundige gegevens te verzekeren.

In het Myeneproject proberen we op twee vlakken volledigheid te bereiken. Enerzijds door een maximale diversiteit na te streven in de types taaluitingen die we documenteren, en anderzijds door de informatie die we verzamelen zo rijk mogelijk te maken. Wat het eerste punt betreft, zorgen we ervoor het taalgebruik van verschillende soorten sprekers te documenteren: jongeren versus ouderen, plattelandsbewoners versus stedelingen en sprekers van verschillende dialecten. Daarnaast proberen we een zo volledig mogelijke documentatie van discourstypes en communicatieve situaties te verzamelen. Om diversiteit op dit vlak te beoordelen, maken we gebruik van een schaal die communicatieve situaties rangschikt van minder gepland (bvb. een uitroep van verbazing) naar meer gepland (bvb. een zorgvuldig voorbereide toespraak). De minst geplande taaluitingen zijn het moeilijkst te documenteren. Andere parameters van variatie zijn het aantal sprekers in een situatie (we nemen monologen, dialogen en groepsgesprekken op), het teksttype (literair, conversationeel, procedureel) en het onderwerp. Wat het laatste betreft, doen we een extra inspanning om bedreigde kennis te documenteren, omtrent onder andere technologieën, de natuurlijke omgeving, maatschappij en geloof, waarbij we erop toezien het project niet in folkloristisch vaarwater terecht te laten komen. Bij het maken van geluidsopnames, streven we de best mogelijke kwaliteit na, zodat alle opnames in de toekomst gebruikt kunnen worden voor akoestisch-fonetische analyses. Video-opnames zorgen voor de toevoeging van contextuele informatie die relevant kan blijken in toekomstig onderzoek, bijvoorbeeld naar de relatie tussen taal, mimiek en gebaren.

De kwaliteit van opnames is eveneens relevant voor de duurzaamheid van documentatie, wellicht het aspect van de verzameling van primaire gegevens waarover het minst nagedacht is vóór de opgang van de documentaire taalkunde. Technologieën voor de opname van geluid volgen elkaar in snel tempo op (magneetband, DAT, minidisc, solid state, …). Het gevolg hiervan is dat bestaande opnames relatief snel ontoegankelijk worden. Opnames op magneetband hebben het voordeel dat ze potentieel van uitstekende kwaliteit zijn (analoge opname), maar magneetband is een kwetsbare drager en toestellen waarmee ze gelezen kunnen worden, zijn steeds moeilijker te verkrijgen. De levensduur van sommige nieuwere technologieën, zoals minidisc, is nog kortstondiger. Het wordt snel een probleem om voor elk type drager in een geluidsarchief een bijhorende lezer te hebben. Bij digitale opname- apparatuur vormt software een bijkomend probleem. Propriëtaire bestandstypes (audio of video) kunnen vaak alleen gelezen worden met apparatuur van hetzelfde merk als dat waarmee ze opgenomen werden. Bovendien zijn veel digitale bestandstypes niet geschikt voor fonetisch onderzoek, omdat ze gecomprimeerd zijn, zodat potentieel relevante informatie verloren gaat. Op dit vlak is de taak van de documentaire taalkunde er vooral een van bewustmaking. De oplossing van deze problemen ligt immers voor de hand. Het volstaat om bij het maken, digitaliseren of opslaan van audiobestanden geen gebruik te maken van gecomprimeerde of propriëtaire bestandstypen. In het

Myeneproject gebruiken we het .wav- formaat. Dezelfde waakzaamheid is geboden bij alle andere software die gebruikt wordt. Tekstbestanden die in een onbekend en/of obsoleet lettertype opgesteld zijn, zijn voor altijd onleesbaar, tenzij ze de UNICODE standaard respecteren. Er zijn steeds meer UNICODE-lettertypes beschikbaar, zodat het ook hier volstaat om bij het begin van een onderzoeksproject een paar juiste keuzes te maken. Producenten van populaire tekstverwerkers (zoals Word) of databaseprogramma's (zoals Filemaker) garanderen niet dat bestanden leesbaar zullen zijn in nieuwere versies van het programma. Ook hier is het dus aan te raden de voorkeur te geven aan niet propriëtaire software.

Het probleem van de duurzaamheid van documentatie is eigenlijk een onderdeel van het ruimere probleem van de toegankelijkheid. Primaire gegevens verzameld tijdens een onderzoeksproject die de duur van dat project overleven, hebben alleen zin als ze toegankelijk en interpreteerbaar zijn. Omdat taal een symbolisch systeem is, zijn opnames van talen zonder geschreven traditie alleen bruikbaar als ze vergezeld zijn van een vertaling en een gedetailleerde annotatie. Het is daarbij belangrijk dat vertaling en annotatie via tijdscodes verbonden zijn aan de bijhorende opname. Om dit te bereiken, gebruiken we in het Myeneproject het annotatieprogramma ELAN, ontwikkeld door het Max Planckinstituut voor psycholinguïstiek in Nijmegen. Het is bovendien van het grootste belang dat een documentatie vergezeld gaat van een bestand met metagegevens. In het Myeneproject bestaan de metagegevens enerzijds uit een tekstbestand met uitleg over de structuur van de documentatie, de opbouw van annotatiebestanden en de gebruikte software en anderzijds uit twee uitgebreide gegevensbestanden. Een daarvan bevat gedetailleerde biografische informatie over de sprekers die in de opnames voorkomen. De andere bevat alle potentieel relevante gegevens over opnamesessies, zoals plaats en tijdstip, deelnemers (met een verwijzing naar het sprekersbestand), onderwerpen en discourstypes, instellingen van de opnameapparatuur, eventuele moeilijkheden bij het opnemen of andere relevante contextuele informatie, een samenvatting van de inhoud, een overzicht van de gerepresenteerde discourstypes, en vooral een lijst van alle bestanden die tijdens een sessie aangemaakt zijn (beeld, audio, video) of ermee verbonden zijn (annotatie, vertaling). Deze bestanden hebben overigens alle een mnemotechnische naam, wat de metagegevens extra robuust maakt. De naam van elk bestand begint met drie letters die naar het dialect verwijzen (bijvoorbeeld *ENE* voor het Enenga), gevolgd door de datum van de opname (JJ-MM-DD), de initialen van de onderzoeker die het bestand gemaakt heeft, een volgnummer en de extensie van het bestandstype.

De laatste schakel in de creatie van een duurzame en toegankelijke documentatie is de archivering. Op het einde van het Myeneproject zal de verzamelde documentatie gearchiveerd worden in het in Londen gevestigde ELAR-archief. ELAR (*Endangered Languages Archive*) belooft een veilige archivering op lange termijn en verbindt zich ertoe de verzamelde documentatie ter beschikking te stellen van alle geïnteresseerden onder de voorwaarden gesteld door de

gedocumenteerde sprekers en de makers van de taaldocumentatie. Deze voorwaarden kunnen er bijvoorbeeld in bestaan dat bepaalde opnames pas na het overlijden van de spreker openbaar gemaakt worden, of dat ze alleen voor onderzoekers toegankelijk zijn, of, integendeel, alleen voor leden van de gedocumenteerde taalgemeenschap. De controle van leden van de gedocumenteerde taalgemeenschap over de toegankelijkheid van de documentatie is overigens één van de vele ethische aspecten van taaldocumentatie waarvoor binnen de documentaire taalkunde strikte richtlijnen geformuleerd zijn.

4. De essentiële bijdrage van taaldocumentatie aan de ontwikkeling van de theoretische taalkunde: een voorlopig resultaat van het Myeneproject

Er zijn veel redenen om bedreigde talen grondig te documenteren. Een goede documentatie kan bijvoorbeeld het uitsterven van een taal afwenden, als de taalgemeenschap dat wenst, omdat ze de basis kan vormen voor een revitaliseringsprogramma. Mijn persoonlijke motivatie is vooral wetenschappelijk en is gebaseerd op de overtuiging dat we toevallige grammaticale kenmerken alleen van algemene principes kunnen onderscheiden door zoveel mogelijk natuurlijke menselijke talen op zoveel mogelijk punten met elkaar te vergelijken. Deze overtuiging ligt aan de basis van de typologische aanpak in de taalkunde, waarvan Joseph Greenberg vaak als de moderne grondlegger beschouwd wordt. Een van de doelen van de taalkundige typologie is op basis van empirische gegevens over de talen van de wereld universele principes te formuleren. Er zijn in deze typologische traditie vier logisch mogelijke types universalia:

— Type 1: Absolute, niet-implicationele universalia: *alle talen hebben eigenschap X*;
— Type 2: Niet-implicationele tendensen: *de meeste talen hebben eigenschap X*;
— Type 3: Absolute implicationele universalia: *alle talen die eigenschap X hebben, hebben ook eigenschap Y*;
— Type 4: Statistische implicationele universalia: *als een taal eigenschap X heeft, is het erg waarschijnlijk dat ze ook eigenschap Y heeft.*

In een recent overzichtsartikel geven Nicholas Evans en Steven Levinson (2009) argumenten voor de bij typologen groeiende consensus dat universalia van het eerste type zo goed als onbestaande zijn. De kandidaat universalia van type 1 waarvan niet meteen tegenvoorbeelden gevonden kunnen worden, zijn ofwel triviaal, ofwel zo abstract dat ze nauwelijks falsifieerbaar zijn. Zelfs schijnbaar triviale universalia zoals „alle gesproken talen hebben lettergrepen" staan dankzij onze toegenomen kennis van de taalkundige variatie op de helling. De meest interessante en overtuigende „universalia" zijn de geconditioneerde tendensen van type 4. Hun geldigheid kan alleen (kwantitatief) getest worden in een

uitgebreid en gebalanceerd staal van de talen van de wereld. Een gebalanceerd staal is nodig om genealogische verwantschap en onderlinge beïnvloeding door contact zoveel mogelijk te neutraliseren. Een uitgebreid staal is nodig om te achterhalen hoe sterk een tendens is.

In de rest van dit deel zal ik bij wijze van illustratie kort bespreken wat een analyse van het Myene ons bijbrengt omtrent de complexe implicationele tendens (een universale van type 4, dus) die bekendstaat als de toegankelijkheidshiërarchie. Deze hiërarchie, oorspronkelijk geformuleerd door Edward KEENAN en Bernard COMRIE (1977), voorspelt onder andere welke elementen uit een zin toegankelijk zijn voor relativisering. De oorspronkelijke formulering van de hiërarchie bevatte teveel taalspecifieke elementen, zodat we hier met een enigszins aangepaste formulering moeten werken (1):

(1) S > P > G > T > Obl > Gen

In dit schema staat S voor *subject*, P (van *patient*) voor het object in een monotransitieve zin, G (van *goal*) grosso modo voor wat in de Nederlandse grammatica overeenstemt met het meewerkend voorwerp van een ditransitieve zin, T (van *theme*) voor het lijdend voorwerp in een ditransitieve zin, Obl voor *oblique* (vergelijkbaar met Nederlands voorzetselvoorwerp), en Gen voor de bezitter in een genitiefconstructie. Met betrekking tot de vorming van relatieve bijzinnen voorspelt de hiërarchie onder andere het volgende (N.B. het gaat telkens om een sterke statistische tendens):

— Elke taal moet het subject van een zin kunnen relativiseren;
— Elke strategie om relatiefzinnen te vormen moet van toepassing zijn op een aaneensluitend segment van de hiërarchie.

Toegepast op het Nederlands zien we dat het subject van een zin inderdaad toegankelijk is voor relativisering. Op basis van een zin als *De regering is vorige week gevallen* kunnen we een nominale constituent maken met het subject van de zin als hoofd en de rest als dependens: *de regering die vorige week gevallen is*. De bezitter in een genitiefconstructie is eveneens toegankelijk voor relativisering. Vergelijk *De vaas van onze buurvrouw is op de grond gevallen* met *de buurvrouw van wie de vaas (*of archaïsch: *wier vaas) op de grond gevallen is*. Omdat in beide gevallen dezelfde strategie van relativisering gebruikt wordt (vooropplaatsing van het hoofd, gebruik van een relatiefpronomen), en beide elementen (S & Gen) zich op de twee uiteinden van de hiërarchie situeren, is de kans volgens de hierboven geformuleerde typologische veralgemening heel groot dat ook alle andere elementen op de hiërarchie toegankelijk zijn voor relativisering. Een strategie voor de vorming van relatiefzinnen moet immers beschikbaar zijn voor een aaneensluitend segment van de hiërarchie. Het Nederlands gedraagt zich wat dit betreft inderdaad net als de overgrote meerderheid (bijna honderd

procent) van de talen van de wereld. Alle andere posities op de hiërarchie zijn toegankelijk voor relativisering (2).

(2) a. P: de vaas die gisteren gevallen is;
b. G: de student aan wie ik het toonsysteem van het Myene uitgelegd heb;
c. T: het toonsysteem dat ik aan de student uitgelegd heb;
d. Obl: de stokjes waarmee we onze lunch gegeten hebben.

Het Myene daarentegen, vertoont een hoogst ongebruikelijk „gat" in de toegankelijkheidshiërarchie. Subjecten zijn toegankelijk voor relativisering door middel van een relatieve werkwoordsvorm. Het subject van de zin in (3) is het hoofd van de relatieve bijzin in (4). Merk op dat het formele verschil tussen de relatieve werkwoordsvorm in (4) en de niet-relatieve vorm in (3) puur tonaal is [1]*. Alle Myenevoorbeelden in deze sectie zijn uitgelokt.

(3) ó↓ŋwánt àɣòlín óɣ àɓá
ló↓ŋw-ántò à-à-gòl-in-í ó-gà à-bál
1-vrouw.DTP I-RP-koop-APPL-RP 1-chef.DTP 6-mango.NTP
'De vrouw kocht mango's voor de chef.'

(4) ó↓ŋwánt ↓áɣòlìn óɣ àɓál
ló↓ŋw-ántò á-à-ɣòl-in-ì ó-gà à-bál
1-vrouw.DTP I-RP-koop-APPL-RP.REL 1-chef.DTP 6-mango.NTP
'de vrouw die mango's kocht voor de chef'

Dezelfde strategie voor relativisering kan gebruikt worden voor voorzetselvoorwerpen (*Obl* in de hiërarchie), zoals *n òkwárá* 'met een hakmes' in (5).

(5) òŋwá↓n ónòmè àzɛ̀rí:n ónɛ̀nʤì ntí:nà y í↓tótɔ̀ n òkwárá
'De jongen heeft voor de leraar met een hakmes de bananenplant omgehakt.'

(6) òkwárà wázɛrìnì n òŋwá↓n ónòmè òné nʤì ntínà y í↓tótɔ̀
'het hakmes waarmee de jongen voor de leraar de bananenplant omgehakt heeft'

We verwachten dus dat ook alle tussenliggende posities op de toegankelijkheidshiërarchie met dezelfde strategie gerelativiseerd kunnen worden. Het object nàɣò 'huis' van de zin in (7), bijvoorbeeld, d.i. P in de hiërarchie, zou het hoofd van een relatiefzin moeten kunnen zijn, die dezelfde structuur heeft als de relatiefzinnen in (4) en (6). Als we echter de relatiefzin in (8) analyseren, dan blijkt dat hij een passieve werkwoordsvorm heeft, gemarkeerd door het

* Het nummer tussen haakjes [ ] verwijst naar de noot, blz. 289.

suffix *-o*. Met andere woorden, de P positie is niet rechtstreeks toegankelijk voor relativisering, maar moet eerst tot S-positie gepromoveerd worden door middel van passivisering.

(7) myáyèní nàɣò
|mí-à-yèn-í nágò|
1SG-RP-zie-RP 9.huis.DTP
'Ik zag het huis.'

(8) náɣò yáyènó myɛ̀
|nágò í-à-yèn-ò=myɛ́|
9.huis.DTP IX-RP.zie-PASS.REL=1SG.PPR
'het huis dat ik zag' (letterlijk: het huis dat door mij gezien werd)

Dezelfde onrechtstreekse strategie is vereist voor de positie G en voor bepaalde types objecten in positie T. De „normale" strategie van relativisering, die gebruik maakt van een relatieve werkwoordsvorm en vooropplaatsing van het hoofd, bestrijkt dus een discontinu segment van de toegankelijkheidshiërarchie (onderstreept in het schema in (9)), tegen de sterke typologische tendens in.

(9) $\underline{S >}$ P > G > $T_{[+saillant]}$ > $\underline{T_{[-saillant]} > (Obl) > Gen}$

Het interessante is dat dit uiterst zeldzame minderheidspatroon de geldigheid van de toegankelijkheidshiërarchie kan bevestigen. (Merk op dat ik de term *minderheidspatroon* gebruik. Het heeft geen zin om van een uitzondering te spreken in het geval van een statistische universale.) Om het „gat" in de distributie van de relativeringsstrategie te verklaren, kunnen we immers een beroep doen op deze hiërarchie. De redenering gaat als volgt. Het subject staat helemaal bovenaan de hiërarchie en is zo gemakkelijk toegankelijk voor relativisering dat alle talen het subject van een zin kunnen relativiseren (hierop zijn bij mijn weten nog geen uitzonderingen gevonden). Omdat het subject de positie is die bij uitstek gerelativiseerd wordt, kan er ooit een sterke tendens geweest zijn om andere posities in de zin eerst tot subject te promoveren door middel van passivisering. De toegankelijkheidshiërarchie is echter niet alleen relevant voor de toegankelijkheid tot relativisering, maar ook voor de toegankelijkheid tot passivisering. De tendens om te passiviseren vooraleer te relativiseren zal dus sterker geweest zijn bovenaan de hiërarchie (P, G en, gedeeltelijk, T). Daar waar de tendens tot passivisering het sterkst was, is ze geherinterpreteerd als verplichting, d.i. als grammaticale regel.

Het Myene bezorgt ons dus een kostbaar, want heel zeldzaam, minderheidspatroon met betrekking tot de toegankelijkheid tot relativisering van verschillende

syntactische posities. Als ons scenario voor de totstandkoming van dit patroon klopt, bevestigt het Myene tezelfdertijd de geldigheid van de toegankelijkheidshierachie die ten grondslag ligt aan de typologische voorspellingen omtrent de toegankelijkheid tot relativisering. Dit toont aan dat de grammatica van elke taal verrassingen bevat die theoretisch relevant kunnen zijn en dat alle talen het verdienen grondig geanalyseerd en gedocumenteerd te worden, ook talen die behoren tot families waarvan we aannemen dat ze relatief goed bestudeerd zijn.

5. Conclusies

Of de documentaire taalkunde aanspraak kan maken op de status van aparte discipline binnen de taalkunde, zoals sommige beoefenaars beweren, heeft weinig belang. Belangrijk is de vraag of deze stroming erin zal slagen taalkundigen ervan te overtuigen kwaliteitsvolle primaire gegevens te verzamelen, ze op een duurzame manier te archiveren en ze ter beschikking te stellen aan de academische gemeenschap. De gewoonte van veldwerkers in de taalkunde (en wellicht ook in andere disciplines) om de gegevens waarop hun gepubliceerde analyses gebaseerd zijn niet openbaar te maken, is een discipline met wetenschappelijke ambities onwaardig. Deze lakse omgang met primaire gegevens is een rem op de cumulatieve vooruitgang van onze kennis, omdat elk onderzoek over een onderbestudeerde taal van nul moet herbeginnen met de verzameling van gegevens. Bovendien zorgt ze ervoor dat gepubliceerde analyses niet falsifieerbaar zijn en dat de relevantie van onderzoeksresultaten zelden verder strekt dan de interesses van de auteur op het moment van publicatie. Nochtans volstaat het een aantal goede gewoontes te creëren en vol te houden (zogenaamde „*best practices*") om naast een beschrijving ook een solide documentatie te produceren in een onderzoeksproject dat op veldwerk steunt. We hebben een aantal van deze *best practices* overlopen in deel 3.

Het documentaire aspect van veldwerk is des te relevanter geworden nu de meerderheid van de talen van de wereld met uitsterven bedreigd is en nu taalkundigen er steeds meer van overtuigd raken dat de variatie tussen de talen van de wereld niet zo oppervlakkig is als de meeste cognitieve wetenschappers in de tweede helft van de twintigste eeuw dachten (zie, opnieuw, EVANS & LEVINSON 2009). We zullen het verschijnsel natuurlijke menselijke taal alleen begrijpen door zoveel mogelijk talen op zoveel mogelijk punten met elkaar te vergelijken. De studie van elke taal levert verrassingen op en vaak hebben die verrassingen de vorm van uitzonderingen op regels die voordien absoluut geacht werden. Het lijkt erop dat de positieve invloed van de documentaire taalkunde groeit en dat ze blijvend is in de gemeenschap van beschrijvende taalkundigen. De frustratie die overblijft, is dat we met veel te weinig veldwerkers zijn. Hoe zullen toekomstige generaties taalkundigen en cognitieve wetenschappers ons beoordelen als

ze denken aan hoe we de resultaten van het millennialange natuurlijke experiment van taaldiversificatie hebben laten wegsmelten zonder ze te documenteren?

NOOT

[1] Tonen worden als volgt genoteerd (geïllustreerd op de klinker a): à lage toon, á hoge toon, â dalende toon, ˈá verlaagde hoge toon. De volgende afkortingen worden gebruikt in de annotatie van voorbeelden: 1, 2, 3, … nominaal klassenprefix; I, II, III, … congruentieprefix; 1SG eerste persoon enkelvoud; APPL applicatiefsuffix; DTP definiet toonpatroon; NTP neutraal toonpatroon; PASS passief suffix; PPR persoonlijk voornaamwoord; REL relatieve vorm van het werkwoord; RP ver verleden tijd.

REFERENTIES

AMBOUROUE, O. 2007. Eléments de description de l'orungu, langue bantu du Gabon (B11b). — Brussel, proefschrift, Université Libre de Bruxelles.

EVANS, N. & LEVINSON, S. 2009. The myth of language universals: Language diversity and its importance for cognitive science. — *Behavioral and Brain Sciences*, **32**: 429-492.

GREGOIRE, C. 1991. Premières observations sur le système tonal du myene-nkomi, langue bantoue du Gabon (B11e) — *Pholia*, **6**: 107-129.

GREGOIRE, C. & REKANGA, J.-P. 1994. Nouvelles hypothèses diachroniques sur la cl10b du myene-nkomi (B11e). — *Africana Linguistica*, **11**: 71-77.

HIMMELMANN, N. 1998. Documentary and descriptive linguistics. — *Linguistics*, **36**: 161-195.

KEENAN, E. & COMRIE, B. 1977. Noun phrase accessibility and universal grammar. — *Linguistic Inquiry*, **8**: 63-99.

RAPONDA WALKER, A. 1934. Dictionnaire mpongwé-français. — Metz, Libre Lorraine.

MOUGUIAMA-DAOUDA, P. 1990. Esquisse d'une phonologie diachronique du mpongwè. — *Pholia*, **5**: 114-120.

PHILIPPSON, G. & PUECH, G. (ongepubliceerd). Tonal domains in Galwa.

Classe des Sciences naturelles et médicales

Klasse voor Natuur- en Geneeskundige Wetenschappen

Bull. Séanc. Acad. R. Sci. Outre-Mer
Meded. Zitt. K. Acad. Overzeese Wet.
57 (2-4 – 2011): 293-305

Contribution of Asia to the Evolution and Paleobiogeography of the Earliest Modern Mammals*

by

Thierry SMITH**

KEYWORDS. — Paleontology; Paleogeography; Mammals; Paleocene-Eocene.

SUMMARY. — The mammals, inconspicuous during the dinosaur period, saw an increase in their size and number of species after the extinction of these giants sixty-five million years ago. This was the beginning of the Age of Mammals. But it was only at the beginning of the Eocene fifty-five million years ago during an extremely fast and intense global warming called PETM (Paleocene Eocene Thermal Maximum) when their diversity exploded. New groups then suddenly appeared on the three northern continents via intercontinental land bridges across which they made important dispersals. These new groups, called "modern mammals", consist of rodents, lagomorphs, perissodactyls, artiodactyls, cetaceans, primates, carnivorans and bats. Although these eight groups represent 83 % of the extant mammal species diversity, their ancestors are still unknown. A short overview of the knowledge and recent progress on this research is here presented on the basis of Belgian studies and expeditions, especially in India and China.

MOTS-CLES. — Paléontologie; Paléogéographie; Mammifères; Paléocène-éocène.

RESUME. — *Apport de l'Asie à l'évolution et à la paléogéographie des premiers mammifères modernes*. — Les mammifères, discrets durant la période des dinosaures, voient leur taille et leur nombre d'espèces augmenter à partir de l'extinction de ces géants il y a soixante-cinq millions d'années. C'est le début de l'âge des mammifères. Mais il faudra attendre l'aube de l'éocène il y a cinquante-cinq millions d'années, lors d'un réchauffement global extrêmement rapide et intense connu sous le nom de PETM (*Paleocene Eocene Thermal Maximum*), pour voir leur diversité exploser. De nouveaux groupes apparaissent alors soudainement sur les trois continents de l'hémisphère nord grâce à des ponts terrestres intercontinentaux par lesquels ils effectuent de grandes dispersions. Ces nouveaux groupes, qualifiés de «mammifères modernes», sont les rongeurs, lagomorphes, périssodactyles, artiodactyles, cétacés, primates, carnivores et chauves-souris. Bien que ces huit groupes représentent 83 % de la diversité des espèces actuelles de mammifères, leurs ancêtres sont encore inconnus. Un bref aperçu des connaissances et progrès récents est présenté ici sur base des études et expéditions belges, en particulier en Inde et en Chine.

---

* Paper presented at the meeting of the Section of Natural and Medical Sciences held on 23 November 2010. Publication decision taken on 24 May 2011. Final text received on 17 June 2011.

** *Direction opérationnelle Terre et Histoire de la Vie*, Royal Belgian Institute of Natural Sciences, rue Vautier 29, B-1000 Brussels (Belgium).

TREFWOORDEN. — Paleontologie; Paleogeografie; Zoogdieren; Paleoceen-Eoceen.

SAMENVATTING. — *Aziatische bijdrage aan de evolutie en paleogeografie van de eerste moderne zoogdieren*. — Zoogdieren waren al onopvallend aanwezig in de tijd van de dinosauriërs, maar ze nemen toe in grootte en soortenrijkdom na het uitsterven van deze giganten, vijfenzestig miljoen jaar geleden. Dit is dan ook het begin van de tijd van de zoogdieren. Toch is het pas bij de aanvang van het Eoceen, vijfenvijftig miljoen jaar geleden, dat hun diversiteit explodeert, tijdens een periode van wereldwijde, extreem snelle en intense klimaatopwarming die bekend is als de PETM (*Paleocene Eocene Thermal Maximum*). Op dat moment verschijnen plotseling en op alledrie de continenten van het noordelijk halfrond een aantal nieuwe groepen, die zich via intercontinentale landbruggen over grote afstanden kunnen verspreiden. Deze nieuwe groepen worden beschouwd als de „moderne zoogdieren" en omvatten de knaagdieren, konijnachtigen, onevenhoevigen, evenhoevigen, walvissen, primaten, carnivoren en vleermuizen. Hoewel ze 83 % van de diversiteit van de huidige zoogdiersoorten vormen, zijn hun voorouders nog onbekend. Een kort overzicht van de kennis en de recente vooruitgang in dit onderzoek wordt hier gegeven op basis van Belgische studies en veldwerk, in het bijzonder in India en China.

1. Introduction

The earliest known mammals are about as old as the earliest dinosaurs and appeared in the fossil record during the late Trias around two hundred and twenty million years ago with genera such as *Sinoconodon*, *Morganucodon* and *Hadrocodium* (KIELAN-JAWOROWSKA *et al*. 2004). However, the earliest placental mammals (Eutheria) were not known before the Early Cretaceous. *Eomaia scansoria* from the Barremian of Liaoning Province, China is the oldest definite placental and is dated from a hundred and thirty million years ago (JI *et al*. 2002).

The Mesozoic is clearly the Age of Dinosaurs and the mammals that lived in their shadow were generally of small size. At the Cretaceous-Tertiary crisis, sixty-five million years ago, the non-avian dinosaurs got extinct and the mammals diversified to occupy the new ecological niches that were then free. This event marks the start of the Age of Mammals. During the Paleocene, which represents the first ten million years of the Cenozoic, the new mammal orders evolved relatively fast and the first large mammals appeared.

At the Paleocene/Eocene boundary, 55.8 million years ago, mammal faunas underwent major evolutionary changes. The majority of modern-type placental orders appeared simultaneously in Europe, North America and Asia, while archaic groups persisting since the Paleocene started to decline. These faunistic events, already known since DEPERET (1908), have been studied worldwide for the last two decades when it became clear that the Paleocene/Eocene transition represented one of the most critical periods of the Earth Cenozoic history. The mammalian evolution is linked to global migrations during the Paleocene-Eocene transition in the northern hemisphere. These gave rise to the first ancestors of modern mammals such as primates (figs. 1, 2), artiodactyl and perissodactyl

ungulates, rodent and lagomorph glires, true carnivores (carnivorans) and other groups on the three northern continents (SMITH *et al*. 2006). Modern mammals dispersed to the southern continents only much later allowing marsupials and archaic placentals to survive longer in the southern than in the northern hemisphere. With the exception of rare bats that are recorded in the Early Eocene of South America (TEJEDOR *et al*. 2005) and Australia (HAND *et al*. 1994), modern groups did not appear before the Oligocene in the southern hemisphere.

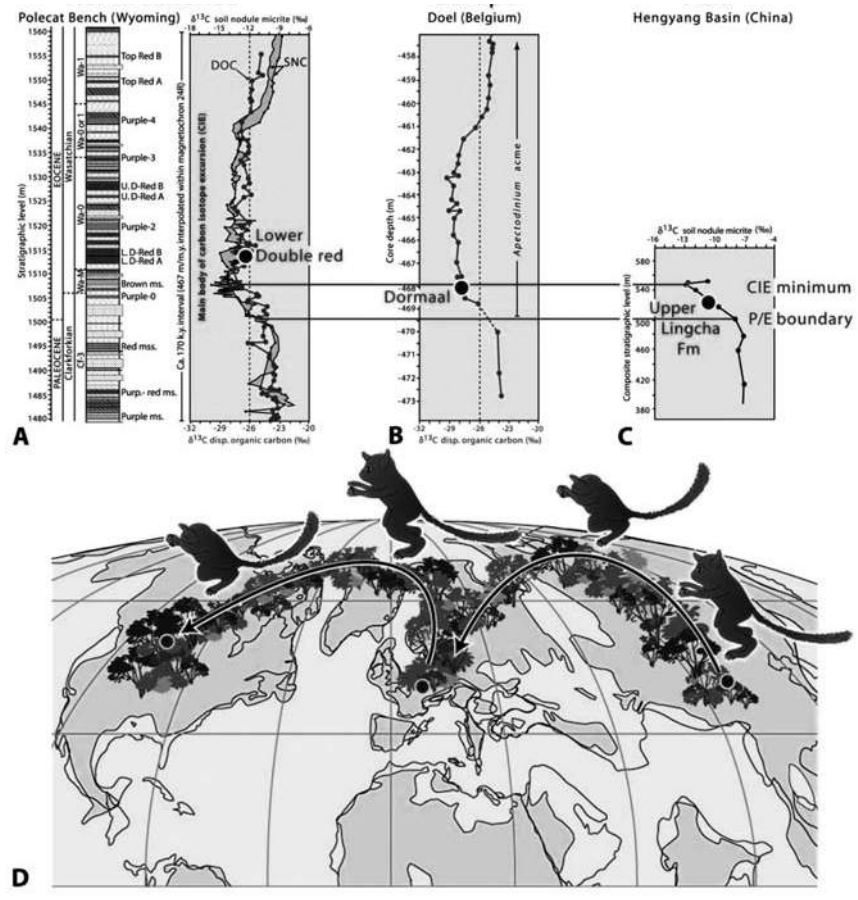


Fig. 1. — Paleogeographic map showing hypothetical migration routes of the earliest primate *Teilhardina* during the PETM at the earliest Eocene. Timing of migration is obtained by correlations of the $\delta^{13}C$ excursion in North America (A), Europe (B) and Asia (C). *Teilhardina* and other modern mammals first occurred in the Lower Double Red (1,512 m) of Polecat Bench, Wyoming, which is situated above the minimum value of the Carbon Isotope Excursion (CIE) (spike at 1,507 m). The Lower Double Red has an estimated age of nineteen – twenty-five thousand years above the P/E boundary based on soil carbonate nodules (SNC) and dispersed organic carbon (DOC) (from SMITH *et al*. 2006).

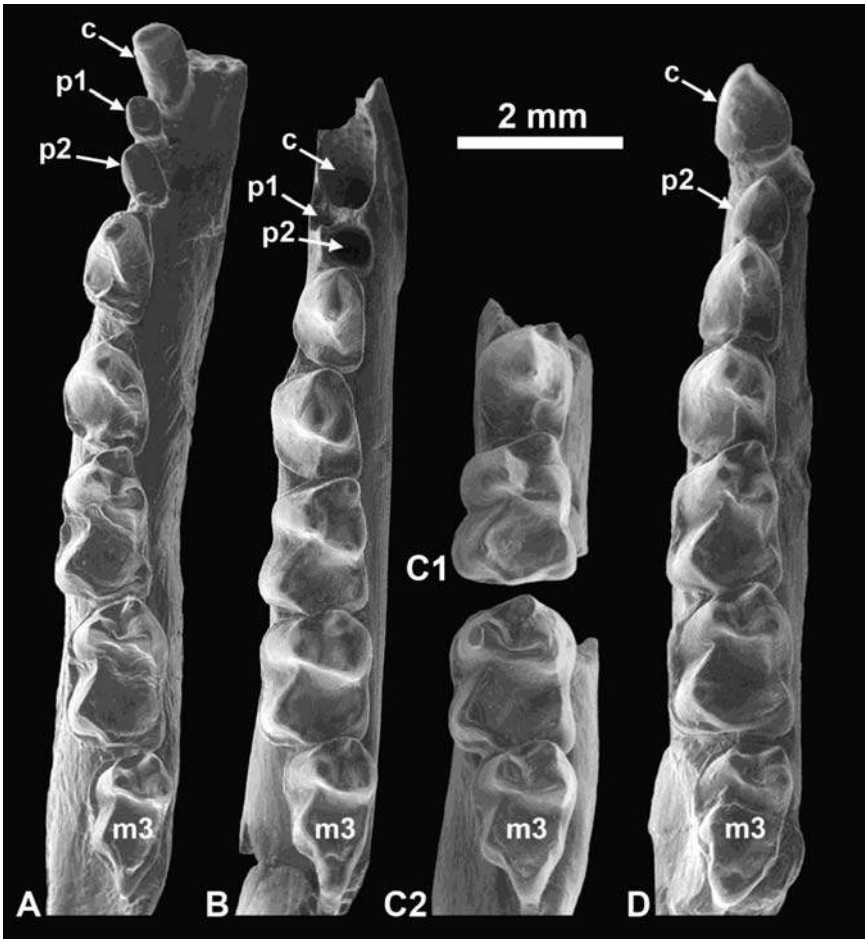


Fig. 2. — Lower teeth of earliest Eocene *Teilhardina* species (SEM in occlusal view): *T. asiatica* from China IVPP V12357 (A); *T. belgica* from Belgium IRSNB M64 (B); *T. brandti* from Wyoming USNM 493913 (C1, reversed), USNM 493914 (C2); *T. americana* from Wyoming USNM 493914 (D, reversed). Main morphological changes from *T. asiatica* to *T. americana* are: canine changes from caniniform to premolariform-shaped, p1 reduces and disappears, m2 becomes square-shaped, m3 hypoconulid lobe increases breadth (modified from SMITH *et al*. 2006).

Our knowledge of the mammal dispersal event on the three northern continents has greatly improved since it was correlated with a negative Carbon Isotope ($\delta^{13}C$) Excursion (CIE) linked to a short greenhouse effect called the Paleocene-Eocene Thermal Maximum (PETM) (MAGIONCALDA *et al*. 2004). This PETM was a hundred fifty thousand year-lasting abrupt global warming event that represented the warmest period of the last sixty-five million years.

Moreover, several hypotheses and some recent discoveries of Early Eocene mammals suggest that Asia was the centre of origin of the modern forms (BEARD 2002, BOWEN *et al*. 2002, HOOKER & DASHZEVEG 2004, NI *et al*. 2004, SMITH *et al*. 2006).

2. Archaic and Modern Placental Mammals

It is commonly admitted that the Cretaceous-Tertiary extinction mainly concerns dinosaurs, large marine reptiles, some invertebrates such as ammonites and belemnites, and a large part of the plankton. Mammals are on the contrary often considered as the winners crossing all the geologic crises. This view is probably far from being real. Mammals indeed survived the Cretaceous-Tertiary crisis but only a few taxa actually crossed the Cretaceous-Tertiary boundary. For instance, only one placental genus, *Cimolestes,* is known from the latest Maastrichtian and earliest Paleocene and only the orders Leptictida and Cimolesta survived in North America (ARCHIBALD 1996). All the other Paleocene orders only appeared at or after the Cretaceous-Tertiary boundary. The most well-known Paleocene orders are the condylarths, the plesiadapiforms (fig. 3A), the pantodonts, the dinocerates, the mesonychians (fig. 4A) and the oxyaenid creodonts. The Paleocene mammal orders are considered as archaic placental mammals and have also been called Paleoplacentals by opposition to Neoplacentals which are the modern placental mammals (LUCAS 2000).

The modern placental mammals are commonly considered as the placental mammal orders that are still present today and that first appeared around the Early Eocene. These are mainly primates (fig. 3B), carnivorans, bats, rodents, lagomorphs, perissodactyls, artiodactyls and cetaceans (fig. 4B) that represent 83 % of the extant species diversity. Other extant groups also appeared during the Early Eocene such as proboscidians, hyracoideans, sirenians and macroscelideans. The extant dermopterans and scandentians seem not to be present from the Eocene. These groups are less cosmopolite and are often represented by a low diversity. Their fossil record is also weak and it is therefore difficult to determine when they first appeared. Xenarthrans and Pholidotans grouped under the term "Edentates" are still poorly understood and their origin remains one of the mysteries of mammalian evolution (see ROSE 2006 for an overview). The hyaenodontid creodonts are a group of carnivorous mammals that appeared at the earliest Eocene but disappeared during the Miocene. This is thus a modern order but that got extinct before present probably due to competition with carnivorans. The insectivores represent a wastebasket group of archaic insectivorous orders (formerly grouped under the name Proteutheria) and lipotyphlan insectivores. Among the latter, only the eulipotyphlans constitute the modern insectivores including the erinaceomorphs and soricomorphs.

Fig. 3. — Plesiadapiform *Plesiadapis cookei* from Late Paleocene of Wyoming (A) and primate *Notharcthus tenebrosus* from Early Eocene of Wyoming (B). Plesiadapiforms were considered for long as ancestors of primates. Studies of nearly complete skeletons of plesiadapiforms and Early Eocene primates suggest that they are sister groups or that their resemblance results from a convergent evolution. Primates have eyes in front with postorbital bar, nails, opposable thumb (hallux) and big toe (pollex), elongate tarsals (calcaneum and astragalus). Plesiadapiforms do not present these characters and have lateral eyes and claws.

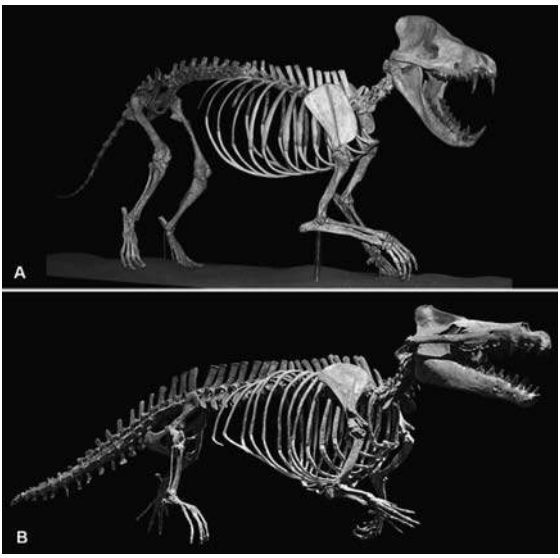


Fig. 4. — Mesonychian *Sinonyx jiashanensis* from Late Paleocene of China (A) and cetacean *Maiacetus inuus* from Middle Eocene of Pakistan (B). Mesonychians were considered for long as ancestors of cetaceans. Discovery of footbones of early whales allowed to recognize artiodactyls as ancestors or sister group of cetaceans (GINGERICH *et al*. 2001).

3. Biodiversity and Evolution of Mammals from Worldwide PETM Key Localities

3.1. Belgium-Europe

The Belgian locality of Dormaal (Flemish Brabant) is the international reference level for the earliest Eocene mammals of the mammalian biochronological scale for the European Paleogene (level MP7 of Schmidt-Kittler 1987; Smith & Smith 1996). The deposits from the Tienen Formation (called "Upper Landenian" in the former terminology) of this locality are known from 1883 (Rutot & Van Den Broek 1884) and have yielded several basal taxa at the origin of modern groups. Among them, are the oldest European modern mammals such as the primate *Teilhardina belgica* (Teilhard de Chardin 1927, Smith *et al*. 2006; *cf*. fig. 2), the artiodactyl *Diacodexis gigasei* (Smith *et al*. 1996), hyaenodontid creodonts (Smith & Smith 2001), and carnivorans (Smith & Smith 2010). Next to these important groups are also archaic mammals, crocodilians, trionychid turtles, lizards, boid snakes, amphibians, and lepisosteid and amiid fishes. The fossil seeds of Dormaal clearly indicate a subtropical environment with an assemblage of fleshy fruits, drupes and berries produced by climbing plants, especially woody lianas (Menispermaceae, Vitaceae and Icacinaceae), aquatic plants (Lythraceae) and trees or shrubs (Nyssaceae) (Fairon-Demaret & Smith 2002). This very warm climate in Belgium fifty-five million years ago has been confirmed by the identification of the negative carbon isotope ($\delta^{13}C$) excursion of the PETM based on the analysis of the dispersed organic carbon of the Dormaal sediments (Grimes *et al*. 2006).

3.2. Wyoming-North America

The Wilwood Formation of the Bighorn Basin along the Rocky Mountains in Wyoming is famous from the end of the 19th century for its richness in mammal remains from the Early Eocene (Wasatchian) and especially for the earliest Eocene mammals of North America (Gingerich 1989). It is astonishing how closely related are the modern mammal species to those from the Belgian locality of Dormaal. Moreover, the Belgian species belong to the same lineages as the North-American ones but are in most cases more primitive (Smith *et al*. 2002, 2006). However, many archaic mammal species are different from those of Belgium suggesting an endemism of the archaic mammals and a cosmopolitism of the modern ones. The Paleocene/Eocene boundary and the PETM have also been identified in several sections containing these earliest modern mammals (Magioncalda *et al*. 2004, Yans *et al*. 2006, Smith *et al*. 2006).

3.3. India-South Asia

The oldest fossil mammals from India are restricted to few isolated teeth and postcranial elements of adapisoriculid mammals from the latest Cretaceous of the Deccan Traps indicating Euro-African affinities (Smith *et al*. 2010). The oldest Cenozoic Indian fauna was from the middle Eocene of Kalakot in the Kashmir Himalaya (Ranga Rao 1971, Kumar & Sahni 1985) and shows Asian affinities. The first Early Eocene mammal fauna from India was discovered only recently in the Cambay Formation of Vastan lignite mine in Gujarat, western India (Rose *et al*. 2006). The fauna includes the earliest modern mammals from the Indian subcontinent, with a high diversity of bats (Smith *et al*. 2007), the first Asian ailuravine rodents (Rana *et al*. 2008), the oldest lagomorphs (Rose *et al*. 2008), primitive adapoid and omomyid primates (Rose *et al*. 2009b), and the first Indian tillodonts (Rose *et al*. 2009a) and basal artiodactyls (Kumar *et al*. 2010). Amazingly, most modern mammals of the Vastan fauna are closely related to European faunas and not to Asian ones. Isotope analysis indicates that the Vastan deposits do not correspond to the time of the PETM but to the second warm event of the Eocene about fifty-four million years ago (Clementz *et al*. 2011). The PETM has been identified in deposits of northeastern India but those have not yet yielded vertebrates.

3.4. China-Eastern Asia

The Early Eocene locality of Wutu in Shandong Province, East China, was for long considered as a key locality to explain the origin and evolution of modern mammals. Although Beard & Dawson (1999) even proposed a late Paleocene age for the Wutu Formation based on the presence of some primitive mammals with North-American affinities, such as the neoplagiaulacid multituberculate *Mesodmops dawsonae* and the carpolestid plesiadapiform *Carpocristes oriens*, it is now widely accepted to be of Early Eocene age. This is based on the microevolution of seed-eating carpolestid mammals (Bloch *et al*. 2001). Moreover, the neoplagiaulacid *Mesodmops* and a primitive carpolestid were discovered in the late Paleocene Chinese fauna of Subeng attesting that these two groups have already been present in Asia before the P/E boundary and survived the P/E boundary (Smith *et al*. 2004, Van Itterbeeck *et al*. 2007, Missiaen & Smith 2008). They are thus relict families in Wutu. Finally, the Early Eocene age is confirmed by a diversified mammal association (fifty-one species) including mainly derived taxa belonging to modern orders such as a hyaenodontid creodont, a miacid carnivoran, several perissodactyls, and an artiodactyl (Tong & Wang 2006). The paleoenvironment and paleoclimate of Wutu is not well understood and is at the moment under the scope of a Sino-Belgian cooperation study project. Next to fossil seeds of *Nuphar* (Nymphaeaceae) recently described (Chen *et al*. 2004) from Wutu are fossil seeds from the oldest definite *Prunus*

(Prunoideae) (Li *et al*. 2011). Carbon isotope analysis is also under progress but the PETM has not been identified.

However, the PETM has been recorded in the Lingcha Formation, Hunan Province, South China, in the locality where the primate *Teilhardina asiatica* was discovered (Bowen *et al*. 2002, Ni *et al*. 2004). This species has therefore the same age or is slightly older than *Teilhardina belgica* from Belgium but it is also the closest-related species among the five *Teilhardina* species identified on the three northern continents (Ni *et al*. 2004, Smith *et al*. 2006; *cf*. fig. 2).

4. Paleobiogeography of Paleocene/Eocene Mammals

Several studies since Deperet (1908) have argued that mammals dispersed through Greenland to explain the similarities between North-American and European faunas during the Early Eocene. The discovery of an early-middle Eocene subtropical fauna in the Eureka Sound Formation of Ellesmere Island, Canadian Arctic, at 79° of latitude confirms the warm conditions and the possibility of land bridges at high latitude (McKenna 1983, Dawson 2001). The strong relationships between the earliest Eocene modern mammals of the Bighorn Basin, Wyoming and those of Dormaal, Belgium implicate that faunal exchanges between Europe and North America started from the time of the PETM. The primitive conditions of the modern mammal species of Dormaal, in comparison to the more advanced species from Wyoming, suggest that they migrated from Europe to North America (*cf*. fig. 1). However, the presence of some typical North-American late Paleocene genera in the Dormaal fauna, such as Phenacodontidae, Nyctitheriidae and Oxyaenidae, also suggest a dispersal event from North America to Europe. Whatever the dispersal scenarios considered, no modern mammal groups have been identified in Paleocene deposits of both Europe and North America with the exception of rodents and a few carnivoran specimens at the latest Paleocene.

The recently discovered Indian fauna of Vastan has important paleobiogeographic implications as it suggests much more exchanges with Europe than with Asia. This has probably to be explained with the paleogeography of the Tethys during the Early Eocene and the timing of the collision of the Indian subcontinent with Asia. Several Indian modern groups present primitive conditions and are represented by a high diversity suggesting that some modern groups such as bats and primates could originate in India. Unfortunately, earliest Eocene and Paleocene mammal faunas of India are still unknown.

The composition of the eastern Asian faunas like those of China indicates more exchanges with North America than with Europe but this concerns mainly primitive groups that probably originated in Asia and migrated to North America via the Bering Strait by the time of the late Paleocene and/or early Eocene. However, the earliest Eocene fauna from the Lingcha Formation in South China suggests a direct dispersal from Asia to Europe (*cf*. fig. 1).

5. Conclusion

The geographic origin of modern placental mammals is not yet identified but recent studies and discoveries suggest South Asia as the dispersal centre. The study of the microevolution of different modern mammal genera, as for example in the primate *Teilhardina,* is particularly indicative of the fast mammal radiation and dispersal during the PETM. Due to this rapid evolution during this short period of time the isotopic analysis is complementary to the morphological study for inferring paleobiogeographic hypotheses.

The comparison of the early Eocene fossil records in Europe, North America, India and China indicates that the dispersal of modern mammals on the three northern continents could have happened in several waves. Up to now, there has been no indication that all modern groups originated from a single area. Discovery of new Paleocene localities in South Asia, particularly in India, would be necessary to elucidate this question.

ACKNOWLEDGEMENTS

I thank Eric De Bast (RBINS) for producing photographs of figures 3 and 4A and Julien Cillis (RBINS) for scanning electron microscopy photographs of figure 2. The paleogeographic map has been carried out by Bonnie Miljour (University of Michigan). I add a special thanks to Paul Gigase (ARSOM-KAOW) for initiating this paper, which is a contribution to project MO/36/020 financially supported by the Federal Science Policy Office of Belgium.

REFERENCES

ARCHIBALD, J. D. 1996. Dinosaur extinction and the end of an era: What the fossils say. — New York, Columbia University Press, 237 pp.

BEARD, K. C. 2002. East of Eden at the Paleocen/Eocene Boundary. — *Science*, **295**: 2028-2029.

BEARD, K. C. & DAWSON, M. R. 1999. Intercontinental dispersal of Holarctic land mammals near the Paleocene/Eocene boundary: Paleogeographic, paleoclimatic and biostratigraphic implications. — *Bull. Soc. Geol. France*, **170** (5): 697-706.

BLOCH, J. I., FISHER, D. C., ROSE, K. D. & GINGERICH, P. D. 2001. Stratocladistic analysis of Paleocene Carpolestidae (Mammalia, Plesiadapiformes) with description of a new late Tiffanian genus. — *Journal of Vertebrate Paleontology*, **21** (1): 119-131.

BOWEN, G. J., CLYDE, W. C., KOCH, P. L., TING, S., ALROY, J., TSUBAMOTO, T., WANG, Y. & WANG, Y. 2002. Mammalian dispersal at the Paleocene/Eocene Boundary. — *Science*, **295**: 2062-2065.

CHEN, I., MANCHESTER, S. R. & CHEN, Z. 2004. Anatomically preserved seeds of *Nuphar* (Nymphaeaceae) from the early Eocene of Wutu, Shandong Province, China. — *American Journal of Botany*, **91**: 1265-1272.

CLEMENTZ, M., BAJPAI, S., RAVIKANT, V., THEWISSEN, J. G., SARAVANAN, N., SINGH, I. B. & PRASAD, V. 2011. Early Eocene warming events and the timing of terrestrial faunal exchange between India and Asia. — *Geology*, **39** (1): 15-18.

DAWSON, M. R. 2001. Early Eocene rodents (Mammalia) from the Eureka Sound Group of Ellesmere Island, Canada. — Can. J. Earth Sci. **38** (7): 1107-1116.

DEPERET, C. 1908. The evolution of Tertiary mammals, and the importance of their migrations. — *American Naturalist*, **42** (494): 109-114; (495): 166-170; (497): 303-307.

FAIRON-DEMARET, M. & SMITH, T. 2002. Fruits and seeds from the Tienen Formation at Dormaal, Paleocene-Eocene transition in eastern Belgium. — *Review of Palaeobotany and Palynology*, **122** (1-2): 47-62.

GINGERICH, P. D. 1989. New Earliest Wasatchian Mammalian Fauna from the Eocene of Northwestern Wyoming: Composition and Diversity in a rarely sampled high-flood-plain assemblage. — *University of Michigan Papers on Paleontology*, **28**, 97 pp.

GINGERICH, P. D., HAQ, M., ZALMOUT, I. S., HUSSAIN KHAN, I. & SADIQ MALKANI, M. 2001. Origin of whales from Early Artiodactyls: Hands and feet of Eocene Protocetidae from Pakistan. — *Science*, **293**: 2239-2242.

GRIMES, S., YANS, J., GRASSINEAU, N., BUGLER, M., STEURBAUT, E. & SMITH, T. 2006. The first stable isotope records from the Dormaal Member and its earliest modern mammal fauna, Belgium. — *In*: Abstract book, international congress on Climate and Biota of the Early Paleogene (Bilbao, 11-17 June 2006), p. 55.

HAND, S., NOVACEK, M., GODTHELP, H. & ARCHER, M. 1994. First Eocene bat from Australia. — *Journal of Vertebrate Paleontology*, **14**: 375-381.

HOOKER, J. J. & DASHZEVEG, D. 2004. The origin of Chalicotheres (Perissodactyla, Mammalia). — *Paleontological Journal*, **47** (6): 1363-1386.

JI, Q., LUO, Z.-X., YUAN, C.-X., WIBLE, J. R., ZHANG, J.-P. & GEORGI, J. A. 2002. The earliest-known eutherian mammal. — *Nature*, **416**: 816-822.

KIELAN-JAWOROWSKA, Z., CIFELLI, R. L. & LUO, Z.-X. 2004. Mammals from the Age of Dinosaurs: Origins, Evolution, and Structure. — New York, Columbia University Press, 630 pp.

KUMAR, K. & SAHNI, A. 1985. Eocene mammals from the Upper Subathu Group, Kashmir Himalaya, India. — *Journal of Vertebrate Paleontology*, **5** (2): 153-168.

KUMAR, K., ROSE, K. D., RANA, R. S., SINGH, L., SMITH, T. & SAHNI, A. 2010. Early Eocene artiodactyls (Mammalia) from western India. — *Journal of Vertebrate Paleontology*, **30** (4): 1245-1274.

LI, Y., SMITH, T., LIU, C.-J., YANG, J. & LI, C.-S. 2011. Endocarps of *Prunus* (Rosaceae: Prunoideae) from the Early Eocene of Wutu, Shandong Province, China confirming extant diversity centers in Eastern Asia. — *Taxon*, **60** (2): 555-564.

LUCAS, S. G. 2000. Evolutionary diversifications of paleoplacental and neoplacental mammals during the Paleogene. — *Geologiska Foreningens i Stockholm Forhandlingar*, **122** (1): 94.

MAGIONCALDA, R., DUPUIS, C., SMITH, T., STEURBAUT, E. & GINGERICH, P. D. 2004. Paleocene-Eocene carbon isotope excursion in organic carbon and pedogenic carbonate: Direct comparison in a continental stratigraphic section. — *Geology*, **32**: 553-556.

MCKENNA, M. C. 1983. Cenozoic paleogeography of North Atlantic Land Bridges. — *In*: BOTT, M. H. P., SAXOV, A., TALWANI, M. & THIEDE, J. (Eds.), Structure and Development of the Greenland-Scotland Ridge. New York, Plenum Press, pp. 351-399.

MISSIAEN, P. & SMITH, T. 2008. The Gashatan (late Paleocene) mammal fauna from Subeng, Inner Mongolia, China. — *Acta Palaeontologica Polonica*, **53** (3): 357-378.

NI, X., WANG, Y., HU, Y. & LI, C. 2004. A euprimate skull from the early Eocene of China. — *Nature*, **427**: 65-68.

RANA, R. S., KUMAR, K., ESCARGUEL, G., SAHNI, A., ROSE, K. D., SMITH, T., SINGH, H. & SINGH, L. 2008. An ailuravine rodent from the lower Eocene Cambay Formation at Vastan, western India, and its palaeobiogeographic implications. — *Acta Palaeontologica Polonica*, **53**: 1-14.

RANGA RAO, A. 1971. New mammals from Murree (Kalakot Zone) of the Himalayan foot hills near Kalakot, Jammu and Kashmir state, India. — *Journal of the Geological Society of India*, **12** (2): 125-134.

ROSE, K. D. 2006. The Beginning of the Age of Mammals. — Baltimore, Johns Hopkins University Press, 428 pp.

ROSE, K. D., DELEON, V. B., MISSIAEN, P., RANA, R. S., SAHNI, A., SINGH, L. & SMITH, T. 2008. Early Eocene lagomorph (Mammalia) from western India and the early diversification of Lagomorpha. — *Proceedings of the Royal Society of London B*, **275**: 1203-1208.

ROSE, K. D., RANA, R. S., SAHNI, A., KUMAR, K., SINGH, L. & SMITH, T. 2009a. First tillodont from India: Additional evidence for an early Eocene faunal connection between Europe and India? — *Acta Palaeontologica Polonica*, **54** (2): 351-355.

ROSE, K. D., RANA, R. S., SAHNI, A., KUMAR, K., MISSIAEN, P., SINGH, L. & SMITH, T. 2009b. Early Eocene primates from Gujarat, India. — *Journal of Human Evolution*, **56**: 366-404.

ROSE, K. D., SMITH, T., RANA, R. S., SAHNI, A., SINGH, H., MISSIAEN, P. & FOLIE, A. 2006. Early Eocene (Ypresian) continental vertebrate assemblage from India, with description of a new anthracobunid (Mammalia, Tethytheria). — *Journal of Vertebrate Paleontology*, **26** (1): 219-225.

RUTOT, A. & VAN DEN BROECK, E. 1884. Explication de la feuille de Landen. — Musée royal d'Histoire naturelle de Belgique, Service de la Carte géologique, 112 pp.

SCHMIDT-KITTLER, N. (Ed.) 1987. International Symposium on Mammalian Biostratigraphy and Paleoecology of the European Paleogene (Mainz, February 18th-21st 1987). — *Münchner Geowissenschaftliche Abhandlungen* (A), **10**, 312 pp.

SMITH, T. & SMITH, R. 1996. Synthèse des données actuelles sur les vertébrés de la transition Paléocène-Eocène de Dormaal (Belgique). — *Bulletin de la Société belge de Géologie*, **104** (1-2): 119-131.

SMITH, T. & SMITH, R. 2001. The creodonts (Mammalia, Ferae) from the Paleocene-Eocene transition in Belgium (Tienen Formation, MP7). — *Belgian Journal of Zoology*, **131** (2): 117-135.

SMITH, T. & SMITH, R. 2010. A new 'miacid' carnivoran from the earliest Eocene of Europe and North America. — *Acta Palaeontologica Polonica*, **55** (4): 761-764.

SMITH, T., ROSE, K. D. & GINGERICH, P. D. 2006. Rapid Asia-Europe-North America geographic dispersal of earliest Eocene primate *Teilhardina* during the Paleocene-Eocene Thermal Maximum. — *Proceedings of the National Academy of Sciences*, **103** (30): 11223-11227.

SMITH, T., SIGE, B. & DE BAST, E. 2010. Euarchontan affinity for the Paleocene Afro-European adapisoriculid mammals and their origin in the late Cretaceous Deccan Traps of India. — *Naturwissenschaften*, **97**: 417-422.

SMITH, R., SMITH, T. & SUDRE, J. 1996. *Diacodexis gigasei* n. sp., le plus ancien Artiodactyle (Mammalia) belge, proche de la limite Paléocène-Eocène. — *Bulletin de l'Institut royal des Sciences naturelles de Belgique*, **66**: 177-186.

SMITH, T., VAN ITTERBEECK, J. & MISSIAEN, P. 2004. Oldest Plesiadapiform (Mammalia, Proprimates) from Asia and its paleobiogeographic implications for faunal interchange with North America. — *Comptes rendus Palevol*, **3**: 43-52.

SMITH, T., BLOCH, J., STRAIT, S. & GINGERICH, P. D. 2002. New species of *Macrocranion* (Mammalia, Lipotyphla) from the earliest Eocene of North America and its biogeographic implications. — *University of Michigan*, *Contributions from the Museum of Paleontology*, **30** (14): 373-384.

SMITH, T., RANA, R., MISSIAEN, P., ROSE, K. D., SAHNI, A., SINGH, H. & SINGH, L. 2007. High bat (Chiroptera) diversity in the early Eocene of India. — *Naturwissenschaften*, **94** (12): 1003-1009.

TEILHARD DE CHARDIN, P. 1927. Les Mammifères de l'Eocène inférieur de la Belgique. — *Mémoires du Musée royal d'Histoire naturelle de Belgique*, **36**: 1-33.

TEJEDOR, M. F., CZAPLEWSKI, N. J., GOIN, F. J. & ARAGON, E. 2005. The oldest record of South American bats. — *Journal of Vertebrate Paleontology*, **25**: 990-993.

TONG, Y. S. & WANG, J. W. 2006. Fossil Mammals from the Early Eocene Wutu Formation of Shandong Province. — *Palaeontologia Sinica* (Whole Number 192, New Series C), **28**: 1-195 (in Chinese).

VAN ITTERBEECK, J., MISSIAEN, P., FOLIE, A., MARKEVICH, V. S., VAN DAMME, D., DIAN-YONG, G. & SMITH, T. 2007. Woodland in a fluvio-lacustrine environment on the dry Mongolian Plateau during the late Paleocene: Evidence from the mammal bearing Subeng section (Inner Mongolia, P.R. China). — *Palaeogeography, Palaeoclimatology, Palaeoecology*, **243**: 55-78.

YANS, J., STRAIT, S., SMITH, T., DUPUIS, C., STEURBAUT, E. & GINGERICH, P. D. 2006. High resolution carbone isotope stratigraphy and mammalian faunal change at the Paleocene-Eocene boundary in the Southern Bighorn Basin, Wyoming. — *American Journal of Science*, **306**: 712-735.

Bull. Séanc. Acad. R. Sci. Outre-Mer
Meded. Zitt. K. Acad. Overzeese Wet.
57 (2-4 – 2011): 307-321

Une expérience de zoologie appliquée: l'holothuriculture à Madagascar*

par

Michel JANGOUX**

MOTS-CLES. — Holothuries; Aquaculture; Ecloserie; Ferme de grossissement.

RESUME. — Très prisées par les peuples d'Extrême-Orient, les holothuries sont depuis une quinzaine d'années intensément récoltées/exploitées dans tout le domaine indo-pacifique occidental. Les risques sont grands de voir la ressource se raréfier avec, à la clé, des conséquences économiques (appauvrissement des populations de pêcheurs) et écologiques (disparition des principaux détritivores littoraux) très dommageables. Le contrôle du processus de fécondation chez l'espèce *Holothuria scabra*, une holothurie à haute valeur commerciale, a permis l'installation d'une holothuriculture (écloserie et ferme de grossissement) performante dans le sud de Madagascar.

TREFWOORDEN. — Zeekomkommers; Aquacultuur; Broedplaats; Kwekerij.

SAMENVATTING. — *Een toegepaste-zoölogie-experiment: de zeekomkommerkweek in Madagascar*. — Als delicatesse beschouwd en zeer geapprecieerd door de volkeren van het verre Oosten, worden de zeekomkommers sinds een vijftiental jaar op een intensieve manier gekweekt en geoogst in Indo-pacific West. Het risico is dan ook groot dat deze rijkdom schaars wordt met twee belangrijke gevolgen: economische gevolgen door de verarming van de visserspopulatie, en gevolgen voor het milieu: verdwijning van de belangrijkste kustafvaleters. De controle op het bevruchtingsproces voor Holothuria scabra, een zeekomkommer met een grote commerciële waarde, heeft als gevolg gehad dat er een zeer efficiënte zeekomkommerfokkerij gestart is (broedplaats en kwekerij) in het zuiden van Madagascar.

KEYWORDS. — Holothurians; Fish Farming; Hatchery; Growing Farm.

SUMMARY. — *An Experiment of Applied Zoology: Holothurian Cultivation System in Madagascar*. — Being popular sea food in Far-East Asia, holothurians have been intensively collected and processed for the past fifteen years in the whole Indo-western Pacific area. The resource is most likely to become scarce with both negative economic (impoverishment of fishermen) and ecological (disappearance of major coastal deposit-feeders) consequences. Control of the fertilization process in the species *Holothuria scabra*, a species with high commercial, value, has allowed the settlement of an efficient holothurian cultivation system (hatchery and growing farm) in the southern part of Madagascar.

---

* Communication présentée à la Classe des Sciences naturelles et médicales tenue le 29 mars 2011. Texte définitif reçu le 31 août 2011.

** Membre de l'Académie; laboratoires de Biologie marine, Université Libre de Bruxelles et Université de Mons.

1. Introduction et historique

Les holothuries, des échinodermes à squelette réduit et à l'allure souvent vermiforme, sont une ressource marine très appréciée des peuples d'Extrême-Orient. Appelées aussi «concombres de mer» ou «bêches-de-mer» [1]*, elles sont proposées au consommateur après avoir été éviscérées puis portées à ébullition et enfin séchées à l'air. Le produit ainsi obtenu (du tégument séché) est commercialisé sous le nom de «trépang», terme d'origine malaise qui traduit l'implication de longue date des pêcheurs de la région de Macassar dans la collecte et la préparation de ces animaux (MACKNIGHT 1976). Ainsi, et à titre d'exemple, le zoologiste Péron, témoin des «razzia» opérées par des flottilles malaises sur des populations d'holothuries au large de l'archipel Bonaparte (nord-ouest de l'Australie) écrivait, en 1816, à propos du devenir de leurs prises: «Servis sur la table des riches et des grands de l'Empire [chinois] ces Tripans s'y présentent à la fois comme une source de vigueur nouvelle et comme un témoignage éclatant de la fortune et de la puissance de l'homme qui en fait usage».

Sans négliger ces aspects socio-aphrodisiaques, qui ne sont pas qu'historiques, le tégument d'holothurie, particulièrement riche en protéines et faible en matières grasses, n'en a pas moins une haute valeur nutritionnelle (CHEN 2004). Ces animaux sont par ailleurs les principaux macrodétritivores des écosystèmes coralliens. Ils participent de ce fait aux chaînes trophiques détritiques dont le rendement est particulièrement élevé (*ca*. 30-40 %), comparé à celui des chaînes trophiques classiques lesquelles ont un rendement de l'ordre de 10 % d'un étage trophique à l'autre (SOROKIN 1993).

Plus d'une cinquantaine d'espèces d'holothuries sont exploitées commercialement. La grande majorité d'entre elles proviennent des zones tropicales de l'océan indo-ouest pacifique (South Pacific Commission 1994, CONAND & MUTHIGA 2007, PURCELL *et al*. 2010). Si l'une de ces espèces, l'*Apostichopus japonicus* des eaux tempérées des mers de Chine et du Japon, fait l'objet d'une aquaculture intensive (XILIN 2004), les espèces tropicales indo-pacifiques sont, quant à elles, simplement récoltées sur toute l'étendue de leur aire de répartition, des côtes africaines aux archipels micronésiens. Parmi ces espèces, *Holothuria scabra*, très commune, largement distribuée et à haute valeur marchande, est récoltée partout de façon intensive, et donc aussi à Madagascar.

La collecte d'holothuries est une activité traditionnelle à Madagascar, particulièrement sur la côte sud-ouest de l'île (PETIT 1930). Pendant quasi tout le XX^{e} siècle, le trépang malgache (une centaine de tonnes par an, soit l'équivalent de mille tonnes d'animaux frais) était essentiellement exporté vers l'Indochine. Dans les années 1990, le marché a connu une véritable explosion avec une exportation maximale vers Singapour de l'ordre de six cent cinquante tonnes en 1995 (chiffres «officiels»). De 2000 à 2005, les quantités exportées annuellement ont

* Les chiffres entre crochets [ ] renvoient aux notes, p. 318.

atteint quelque huit cent vingt tonnes (LAVITRA 2008), un accroissement résultant en bonne partie de l'élargissement des zones de collecte par l'utilisation (illégale) de bouteilles de plongée. Outre que ce mode de récolte accélère le processus de disparition de la ressource, il est responsable de nombreux accidents dus à la non-préparation des pêcheurs à cette technique particulière (RUFFEZ 2008). A la fin du siècle dernier, la situation était telle qu'à défaut du développement rapide d'une technique aquacole appropriée, on se dirigeait vers une situation à grand risque aussi bien sur les plans humain (dangerosité des récoltes en plongée) et économique (le trépang est une ressource importante dans les communautés villageoises du sud-ouest malgache) qu'écologique (principaux macrodétritivores littoraux en région tropicale, la raréfaction/disparition des holothuries aurait des conséquences écologiques dommageables).

Ces diverses considérations, alliées au fait que, d'une part, les laboratoires de Biologie marine des Universités de Bruxelles et de Mons étaient spécialisés dans l'étude des échinodermes (notamment dans celle de leur reproduction et de leur vie larvaire) et que, d'autre part, un partenaire malgache (l'Institut Halieutique et des Sciences Marines [IH.SM] de l'Université de Tuléar) nous avait dit sa vive préoccupation face au problème de la surexploitation des holothuries, ont contribué à la présentation d'un projet de recherche holothuricole belgo-malgache. Pour des raisons explicitées plus haut, l'espèce choisie fut *H. scabra*. Selon les termes du projet, il s'agissait dans un premier temps d'atteindre la maîtrise des processus amenant à la production de juvéniles post-métamorphiques (la phase «écloserie»); dans un deuxième temps d'arriver à contrôler au mieux la croissance des individus post-métamorphiques et obtenir dans les meilleurs délais possibles des animaux de taille commercialisable (la phase «ferme de grossissement») (JANGOUX *et al*. 2001). Le projet accepté, il fut naturellement basé dans la région de Tuléar (fig. 1). La recherche dura au total neuf années (de 1999 à 2008) pour aboutir à la réalisation, à l'échelle pilote, d'un cycle d'élevage complet: environ quatorze mois sont aujourd'hui nécessaires pour obtenir des adultes de taille commercialisable à partir de fécondations réalisées dans l'écloserie. La recherche a été soutenue par des financements émanant principalement de la Coopération Universitaire au Développement (CUD), mais aussi du Ministère malgache de la Recherche scientifique (construction des bâtiments), de l'Université Libre de Bruxelles (ULB) et du Fonds pour la Recherche Scientifique (FRS-FNRS).

2. La phase «écloserie»

D'une durée de cinq années (1999-2004), cette phase consista dans un premier temps en la construction et l'équipement du bâtiment nécessaire à sa bonne réalisation. Il fallut donc installer/équiper des aquariums pour géniteurs, une salle pour les élevages larvaires (quinze cuves de 300 l), une salle pour la culture du phytoplancton destiné à nourrir les larves (pour ce faire, des souches de l'espèce

Phaeodactylum tricornutum furent importées d'Europe) (pl. I)*. Il fallut aussi pouvoir disposer d'un laboratoire humide (dissections, fécondations, mesures diverses), d'un laboratoire sec (pour l'histologie et l'analyse microscopique), d'un local informatique, d'un atelier, et d'une salle de gonflage de bouteilles et d'entreposage de matériel de plongée. On construisit également un réservoir d'eau de mer (15 m^3) avec prise d'eau au large à marée haute ainsi que des petits bassins extérieurs (cinq bassins de 8 m^2) pour y faire croître les juvéniles (jusqu'à 2 à 3 cm de longueur). Enfin, il fallut acquérir un véhicule automobile (acheté d'occasion en Europe) et un bateau (acquis sur place).

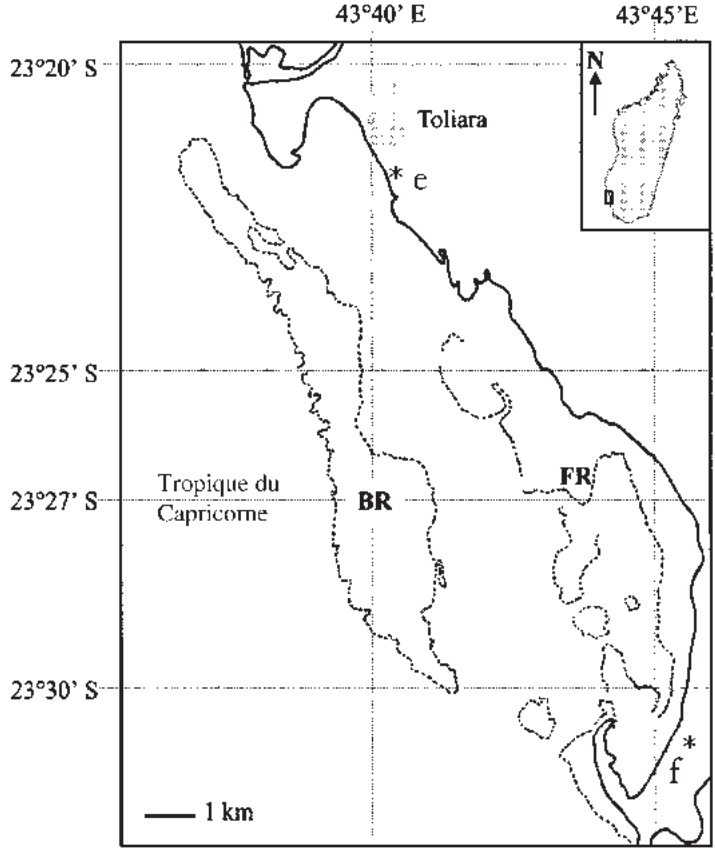


Fig. 1. — Carte de la région de Toliara (Tuléar). BR: récif barrière; e: écloserie; f: ferme de grossissement (Belaza); FR: récif frangeant.

* Les planches figurent à la fin de l'article, pp. 320-321.

2.1. Cycle de reproduction

L'étude du cycle reproducteur de *H. scabra* commença bien avant le début officiel du projet et porta sur une période de trente mois (novembre 1998 – avril 2001). Les gonades de tous les individus prélevés (à raison de trente individus par mois) furent systématiquement analysées: évolution des rapports gonado-somatiques, détermination des sexes, détermination des stades gonadiques, suivi des fluctuations des indices de maturité, etc. Les résultats révélèrent l'existence d'un cycle annuel de reproduction relativement bien marqué, avec un maximum d'individus aux gonades matures s'observant entre novembre et avril, soit, pour l'essentiel, pendant l'été austral. Toutefois, si le nombre de gamètes matures culmine pendant l'été, on en observe aussi en proportion non négligeable pendant toute l'année tant chez les mâles que chez les femelles de l'espèce (Rasoloforinina *et al*. 2005).

2.2. Fecondation

Avoir le contrôle du processus de fécondation, et par là de la production de larves et subséquemment d'individus post-métamorphiques, était impératif pour assurer le lancement du projet. Au début de la recherche, la façon habituelle de procéder pour assurer la fécondation était de faire subir, en période de reproduction, un choc thermique aux animaux (un choc de l'ordre de 10° C). Un tel procédé provoquait, effectivement, l'émission de gamètes aptes à la fécondation par quelques individus. Ce travail se faisait cependant en aveugle: l'espèce ne présentant pas de dimorphisme sexuel et les individus ne pouvant être préalablement disséqués, on ignorait aussi bien leur sexe que le stade de maturité atteint par leurs gonades. L'utilisation d'une telle méthode, au rendement faible, était malgré tout préférable à la dilacération de gonades mâles et femelles matures suivie de la mise en présence d'ovocytes et de spermatozoïdes. En effet, cette façon de procéder, très simple, n'enclenchait jamais la fécondation des gamètes femelles (alors que, chez les oursins par exemple, elle donne d'excellents résultats). Il s'en est suivie une longue période d'essais expérimentaux, tant rationnels qu'empiriques, pour tenter d'induire la maturation ovocytaire et, par là, permettre la fécondation (il faut savoir que les ovocytes aboutis sont, chez les holothuries, bloqués en prophase I de la méiose, la maturation nécessitant la levée de ce blocage). La maturation a finalement pu être induite à partir d'extrait de ponte d'oursins femelles (espèce *Tripneustes gratilla*). Cet extrait, appelé «Nirine» [2], montrait des propriétés extraordinaires puisqu'il entraînait des taux de maturation et de fécondation des ovocytes holothuriens de plus de 90 % et permettait en outre d'assurer la fécondation de ceux prélevés en dehors de la période de reproduction (pour peu qu'ils soient arrivés en blocage de méiose). Par ailleurs, la Nirine n'entraînait pas de mortalité ni

de malformations significatives des larves obtenues par ce procédé (LEONET *et al*. 2009). La méthode a fait l'objet d'un dépôt de brevet (PCT/EP2007/056665).

2.3. LARVES ET METAMORPHOSE

Disposant d'une technique fiable assurant la maturation ovocytaire, des élevages larvaires ont pu être lancés, non seulement en période de reproduction de l'espèce, mais aussi pendant presque toute l'année sauf au plus fort de l'hiver austral (juin-juillet). Pour ce faire, on utilise de larges cuves d'un volume total de 300 l. Il fallut évidemment optimiser les élevages: détermination de la température de l'eau, de la densité d'ovocytes fécondés, de la densité de cellules algales, de la périodicité du renouvellement d'eau, des taux de mortalité, etc. Le but était que toutes les larves survivantes d'un même lot atteignent, si possible ensemble, la compétence à la métamorphose; il était aussi nécessaire de tenter d'établir, toutes choses étant égales, une chronologie standard, de développement larvaire quel que soit l'élevage entrepris. Par chronologie standard, il faut plutôt comprendre chronologie moyenne, les variations en termes de vitesse de développement étant parfois assez marquées d'un lot de larves à l'autre selon l'origine des géniteurs. Ainsi, une fois les œufs fécondés et dans les conditions de l'écloserie, les temps moyens d'apparition des différents stades sont: 5 h pour le stade *blastula*, 20 h pour le stade *gastrula*, 2 j pour la larve *dipleurula*, et 10 j pour la larve *auricularia* compétente (c'est-à-dire apte à se métamorphoser). Quant à la métamorphose en elle-même (de la larve *auricularia* à la larve *doliolaria*), elle prend de l'ordre de cinq jours (pl. I) et aboutit à un stade préjuvénile appelé *pentactula* (fig. 2). La métamorphose des holothuries est très progressive; elle se distingue par là de celle des autres échinodermes chez qui elle se fait beaucoup plus rapidement (à titre d'exemple, la métamorphose de l'oursin comestible des mers d'Europe prend de 30 à 45 min.).

La *pentactula* précède immédiatement le stade juvénile. Pour qu'elle devienne juvénile, il faut impérativement qu'elle s'attache à un substrat (rocher, coquille, pied d'algue, etc.) à l'aide du large tentacule impair qu'elle développe dans sa région postérieure. Au contraire de nombreux invertébrés benthiques (dont certaines espèces d'holothuries), la *pentactula* de *H. scabra* n'a pas d'exigences particulières; l'existence d'un biofilm sur la paroi des cuves d'élevage suffit à enclencher la réaction de fixation [3] et, par là, la transformation finale en juvénile (fig. 3).

Fig. 2. — *Pentactula* âgée (barre: 100 mμ).

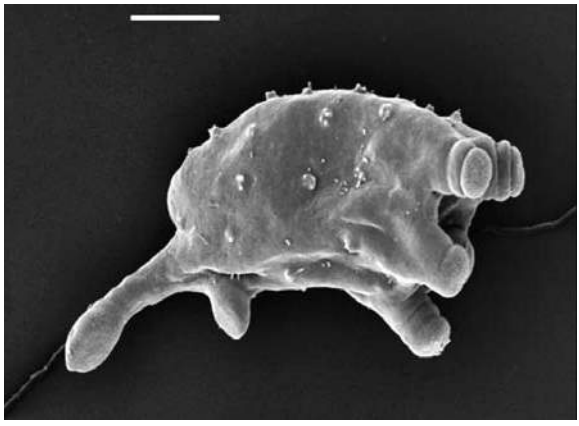


Fig. 3. — Juvénile de cinq jours (barre: 100 mμ).

3. La phase «grossissement»

3.1. La croissance des juveniles

Pendant leurs deux premiers mois de vie, les juvéniles, qui mesurent au départ de l'ordre de 0,5 mm de long, sont laissés dans les cuves d'élevage larvaire, là même où ils ont effectué leur métamorphose. Lorsqu'ils atteignent entre 2 et 3 cm de long environ, ils sont amenés à la ferme de Belaza où se réalisent les étapes ultérieures de la croissance, étapes dites de «grossissement».

Les juvéniles ont une biologie particulière: ils ne s'enfoncent pas dans le sédiment mais restent continûment en surface (ils sont épibiontes), un comportement aisément observable en bassin expérimental (pl. 1). Ils sont constamment en activité et sont particulièrement sensibles à la prédation et aux variations environnementales. En réalité, ils n'acquerront que très progressivement la capacité de s'enfouir dans le substrat comme d'ailleurs celle de pouvoir ingérer le sédiment. Toutefois, dès leur plus jeune âge, ils sont détritivores: ils s'alimentent du film épibenthique recouvrant les cuves d'élevage mais ingèrent également de la matière organique dissoute et/ou en suspension (fines particules).

En condition d'élevage, l'ajout d'extraits d'algues — essentiellement des extraits réalisés à partir de la sargasse *Sargassum latifolium* — donne d'excellents taux de croissance (environ 300 % sur huit semaines au départ de juvéniles de 0,5 mm) (Lavitra *et al*. 2009a). Une telle accélération de croissance des juvéniles est des plus intéressantes car elle permet d'anticiper le moment du transfert des individus dans les installations de Belaza.

3.2. La ferme de Belaza

Distante d'environ 25 km de l'écloserie, au sud de Tuléar, la ferme de Belaza a été construite le long d'une piste carrossable sur un terrain anciennement dévolu à une installation ostréicole. Situé à flanc de collines calcaires (d'où jaillissent des sources d'eau douce) et à l'embouchure d'une large baie liserée de mangroves, l'endroit est propice à l'holothuriculture: une zone calme et un sédiment riche, un biotope qui convenait particulièrement bien à l'espèce cible (*Holothuria scabra*). Le chantier de la ferme dura près d'un an (période 2004-2005). Outre une maison d'habitation, un dortoir pour hôtes de passage, des sanitaires, on y construisit un laboratoire et une salle d'aquariums marins (pompage d'eau de mer), le tout étant approvisionné en eau douce (puisée à la source par une pompe éolienne) et en électricité (produite par un groupe électrogène) (pl. 2). Dix bassins en béton pour le prégrossissement furent également construits. Ces bassins ont le fond recouvert de sédiments prélevés dans la baie; ils accueillent les juvéniles de 2 à 3 cm issus de l'écloserie.

3.3. Le pregrossissement

C'est par la piste que les juvéniles sont amenés à la ferme de Belaza. Ils sont alors âgés d'environ 3 mois à dater du moment de la fécondation. Le transfert vers la ferme correspond à la période où s'opère leur changement de biologie: de strictement épibiontes, ils deviennent partiellement endobiontes (fig. 4). Ils ont acquis la capacité de s'enfouir dans le sédiment, acquisition qui va de pair avec la modification de leur rythme d'alimentation. Pendant les heures les plus chaudes (après-midi et soirée), les individus sont enfouis (endobiontes) et restent immobiles. Au contraire, en fin de nuit et début de matinée, aux heures où la température de l'eau est la plus fraîche, ils se retrouvent en surface (épibiontes) et sont actifs: ils s'alimentent, se nourrissent et défèquent. Un tel comportement s'observe tant chez les juvéniles récemment transférés de l'écloserie que chez les adultes élevés en enclos au large ou issus du milieu naturel.

Le prégrossissement se fait en bassin hors-mer (bassins de 32 m^2 contenant 16 m^3 d'eau; pl. 2) sur du sédiment régulièrement renouvelé et prélevé dans les herbiers à front de mangrove. Moins sensibles aux variations environnementales, les individus en bassin, du fait de leur petite taille, le sont cependant encore à la prédation (ils subissent particulièrement les attaques de crabes portunides du genre *Thalamita*; Lavitra *et al*. 2009b).

Si elle se justifie par la relative fragilité des individus, la mise en bassin de prégrossissement permet aussi la réalisation de multiples observations et essais sur, par exemple, l'alimentation des individus (effets de sédiments d'origines diverses sur la croissance, établissement du rythme optimal du renouvellement sédimentaire, détermination de l'épaisseur de la strate de sédiment effectivement prélevée par les animaux, …), l'étude de leurs maladies (Lavitra *et al*. 2009b)

ou encore l'effet de la densité de population sur leur croissance. Ainsi, on a pu établir que pour une densité d'holothuries comprise entre dix et quarante individus/m^2 la biomasse produite après deux mois d'élevage était semblable mais que la taille des individus était d'autant plus faible que la densité des animaux en bassin était plus élevée (LAVITRA 2008). La densité optimale pour l'étape de pré-grossissement est de vingt individus/m^2.

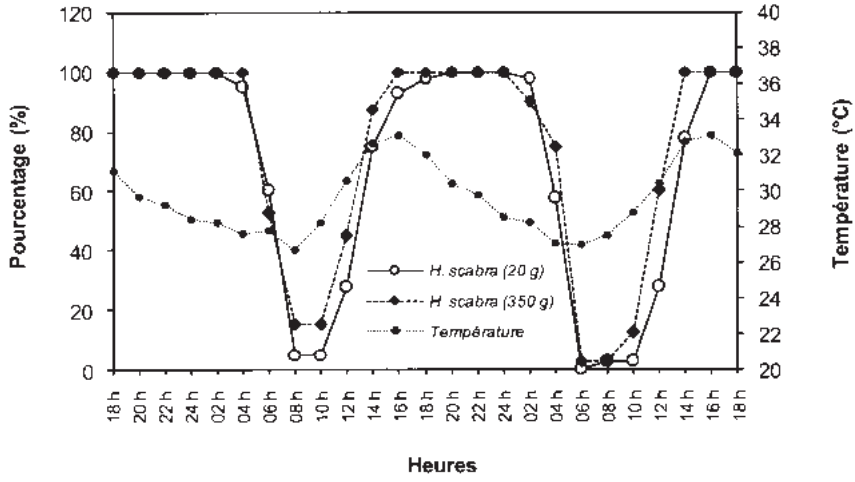


Fig. 4. — Proportions (%) de juvéniles (20 g, 3 cm) et d'adultes (350 g, 15 cm) de *H. scabra* enfouis au cours du temps (deux nycthémères successifs) (n = 25). La courbe reprenant la variation de la température de l'eau est superposée (d'après LAVITRA 2008).

3.4. LE GROSSISSEMENT

Lorsque, dans les bassins de la ferme, les individus atteignent entre 5 et 7 cm de longueur, ils sont transférés dans des enclos de grossissement situés en mer à quelques centaines de mètres du rivage. Les enclos sont relativement grands (600 m^2), ouverts et aux parois grillagées (vide de maille: 1 cm^2). Ils sont toujours partiellement immergés (ils sont implantés au-delà de la limite de la mer basse et la hauteur des parois est quelque peu supérieure à celle atteinte par l'eau à marée haute). Rien n'est ajouté aux enclos: les holothuries s'y développent donc dans des conditions naturelles, hormis qu'elles sont encagées et que leur densité (de l'ordre de deux individus/m^2) est déterminée en début de grossissement. Les enclos font toutefois l'objet de visites régulières à la fois pour le nettoyage de leurs parois (éviter le colmatage du grillage par des algues et des débris divers) et pour assurer une surveillance contre le vol. Après environ huit mois en enclos, les holothuries atteignent une taille de 22 cm (350 g), taille qui est celle de la commercialisation.

4. Une holothuriculture pilote

La difficulté majeure en holothuriculture est l'obtention, en quantité suffisante, d'œufs fécondés par une méthode à la fois reproductible et n'induisant pas d'anomalies développementales. Un challenge rencontré par la mise au point d'un procédé nouveau (le procédé à base de Nirine) qui entraîne la maturation des gamètes femelles et rend possible leur fécondation *in vitro*. Cette méthode permet de disposer d'ovocytes matures en quantité adéquate presque toute l'année, et donc d'obtenir des œufs fécondés pendant plus de dix mois sur douze.

Les élevages larvaires se font dans des structures d'une capacité de 300 l contenant 250 l d'eau de mer et à une densité de l'ordre de 0,5 embryons/ml, soit quelque cent vingt-cinq mille embryons par cuve. Environ 95 % de cet effectif meurt en cours de développement et le nombre moyen de juvéniles obtenu par cuve est d'environ six mille deux cent cinquante (il serait au total de cent vingt-cinq mille si les quinze cuves étaient utilisées simultanément). Comme ces cuves servent aussi — on s'en souviendra — au primo-développement des juvéniles jusqu'à ce qu'ils atteignent environ 2 à 3 cm, seule la moitié d'entre elles est effectivement utilisée pour les élevages larvaires, l'autre moitié étant réservée aux juvéniles. Vu les durées des développements larvaire et primo-juvénile (chacune d'un mois) et compte tenu de la mortalité des primo-juvéniles (environ 50 %), les cuves de l'écloserie peuvent produire jusqu'à trente mille juvéniles transférables vers la ferme de Belaza par bimestre.

Ce nombre est bien trop élevé car, pour optimiser le prégrossissement, les bassins de Belaza ne peuvent accueillir que vingt holothuries par m^2, soit, au total, six mille quatre cents individus (il y a dix bassins de 32 m^2 chacun). Le taux de mortalité dans les bassins de Belaza avoisinant 10 %, ce sont un peu plus de cinq mille cinq cents individus qui en sont issus après deux mois.

Actuellement, la superficie couverte par les enclos en mer est de 360 m^2 et, pour assurer une production optimale, la densité des holothuries doit y être de deux individus par m^2. On ne peut donc y installer que sept cent vingt individus dont, leur mortalité étant de 25 %, environ six cents atteindront une taille commercialisable après huit mois.

En résumé, l'optimisation des diverses étapes de la structure holothuricole malgache permet d'obtenir, après quatorze mois, six cents individus de taille adéquate. Ce nombre est évidemment très inférieur au nombre d'embryons placés en cuves d'élevage (ils sont au départ près de neuf cent mille); il est le résultat tant de la mortalité en cours d'élevage (mortalité qui affecte surtout les larves) que du caractère pilote des installations (les surfaces d'élevage pour les post-métamorphiques sont limitées et ne peuvent accueillir toute la production).

Quatorze mois sont donc nécessaires pour fermer la boucle. Cependant, dans l'hypothèse où le nombre d'enclos ne constituerait plus une limite (par exemple en en installant face aux différents villages côtiers de la région et en y plaçant des individus subadultes issus des bassins de Belaza), la production holothuricole

pourrait être, dans nos conditions, quadruplée. En effet, la Nirine permettant d'effectuer des fécondations pendant au moins dix mois sur douze et l'occupation des structures qui précèdent la mise en enclos (cuves et bassins de prégrossissement) étant respectivement de trois et deux mois, cela permettrait le lancement de quatre séries d'élevage sur l'année et amènerait une production totale annuelle de vingt-deux mille subadultes. Présumant que les conditions d'élevage en enclos seraient idéales (pas de vol et une mortalité de 25 %) et sachant que le poids frais moyen d'un adulte commercialisable est de 350 g, la production serait d'environ 6,4 t fraîches. Une production certes trop faible pour être commercialement rentable, mais là n'était pas le but: il s'agissait plutôt de démontrer la faisabilité scientifique et technique de l'holothuriculture en condition pilote.

5. Vers une exploitation industrielle

Le financement du projet holothuricole aura duré neuf ans; il s'est terminé en mars 2008. Dans les mois qui suivirent, un partenariat tripartite, associant les universités belges, l'institut malgache et une société privée de pêcherie établie à Tuléar (la Copefrito SA), a été constitué pour former la première compagnie malgache basée sur l'holothuriculture (Madagascar Holothurie SA [MHSA]) (EECKHAUT *et al*. 2008).

Utilisant tant les installations de l'écloserie que celles de la ferme de Belaza, MHSA a décidé, pour le lancement de ses activités, de se limiter pour le moment à la production de juvéniles (5-7 cm de long) destinés au grossissement. Avec l'aide d'ONG, des enclos sont installés près de villages côtiers et entretenus par les villageois eux-mêmes ou par des groupes de pêcheurs. Ceux-ci reçoivent la formation nécessaire par les responsables des ONG. L'idée développée ici est de racheter ensuite les holothuries aux personnes qui se sont occupées de l'entretien des enclos et de leur surveillance dès qu'elles auront atteint une taille commercialisable.

La société MHSA se préoccupe aussi de la commercialisation des holothuries sous la forme de trépang. Elle s'intéresse aux traitements divers subis par le tégument des holothuries avant leur exportation vers les marchés extrême-orientaux (LAVITRA *et al*. 2009b).

Enfin, disposant de l'exclusivité du brevet de la Nirine, la société MHSA négocie actuellement des partenariats avec différents groupes privés et publics de pays riverains de l'océan Indien.

REMERCIEMENTS

La recherche holothuricole a eu la chance de s'attacher les talents de: Igor Eeckhaut, Thierry Lavitra, Aline Léonet, Edouard Mara, Jean-Marc Ouin, Thomas Plotieau, Man-Waï Rabenevanana, Richard Rasoloforinina, Guy Seghers, Jérôme Servais et Dévarajen

Vaïtilingon. Elle a disposé, de 1999 à 2008, de financements de la Coopération Universitaire au Développement (CUD) attribués aux laboratoires de Biologie marine (ULB et UMons) et à l'Institut halieutique et des Sciences marines (Utuléar, Madagascar), ainsi qu'à un financement complémentaire de l'ULB, pendant l'année 2003-2004.

NOTES

[1] Du portugais *bicho da mar* qui signifie «bête de mer».
[2] *Nirina* signifie «espoir» en malgache.
[3] Un biofilm est une communauté microbienne enserrée dans des biopolymères qu'elle produit elle-même et qui recouvre toutes les surfaces immergées en mer ou contenant de l'eau de mer.

BIBLIOGRAPHIE

CHEN, J. 2004. Present status and prospects of sea-cucumber industry in China. — *FAO Fisheries Technical Paper*, **436**: 25-38.

CONAND, C. & MUTHIGA, N. 2007. Commercial sea cucumbers: A review for the Western Indian Ocean. — *WIOMSA Book Series*, **5**, 67 pp.

EECKHAUT, I., LAVITRA, T., RASOLOFORININA, R., RABENEVANANA, M. W., GILDAS, P. & JANGOUX, M. 2008. Madagascar Holothurie S.A.: la première entreprise commerciale axée sur l'aquaculture des holothuries à Madagascar. — *Beche-de-mer Information Bulletin*, **28**: 22-23.

JANGOUX, M., RASOLOFORININA, R.,VAITILINGON, D., OUIN, J.-M., SEGHERS, G., MARA, E. & CONAND, C. 2001. A sea-cucumber hatchery and mariculture project in Tuléar, Madagascar. — *Beche-de-mer Information Bulletin*, **14**: 2-5.

LAVITRA, T., 2008. Caractérisation, contrôle et optimalisation des processus impliqués dans le développement post-métamorphique de l'holothurie comestible *Holothuria scabra* (Jaëger, 1833). — Thèse de doctorat, Université de Mons, 166 pp.

LAVITRA, T., RASOLOFORININA, R., GROSJEAN, P., JANGOUX, M. & Eeckhaut, I. 2009a. The effect of food quality and rearing density on the growth and survival of epibenthic juveniles of the sea cucumber *Holothuria scabra*. — *Western Indian Ocean Journal of Marine Sciences*, **8**: 87-96.

LAVITRA, T., RASOLOFORININA, R., JANGOUX, M. & EECKHAUT, I. 2009b. Problems related to the farming of *Holothuria scabra* (Jaëger, 1833). — *Beche-de-mer Information Bulletin*, **29**: 20-30.

LAVITRA, T., RASOLOFORININA, R. & EECKHAUT, I. 2010. The effect of sediment quality and stocking density on survival and growth of the sea cucumber *Holothuria scabra* reared in nursery ponds and sea pens. — *Western Indian Ocean Journal of Marine Sciences*, **9**:153-164.

LEONET, A., RASOLOFORININA, R., WATTIEZ, R., JANGOUX, M. & EECKHAUT, I. 2009. A new method to induce ovocyte maturation in holothuroids (Echinodermata). — *Invertebrate Reproduction and Development*, **53**: 13-21.

MACKNIGHT, G. G. 1976. The voyage to Marege. Macassan trepangers in northern Australia. — Melbourne, Melbourne University Press.

PERON, F. & FREYCINET, L. 1816. Voyage de découvertes aux Terres australes (vol. 2). — Paris, Imprimerie Royale.

PETIT, G. 1930. L'industrie des pêches à Madagascar. — Paris, Société d'Edition géographique, maritime et coloniale.

PURCELL, S. W., LOVATELLI, A., VASCONCELLOS, M. & YE, Y. 2010. Managing sea-cucumber fisheries with an ecosystem approach. — *FAO Fisheries and Aquacultural Technical Paper*, **520**, 157 pp.

RASOLOFORINA, R. 2004. Reproduction et développement de l'holothurie comestible *Holothuria scabra* (Jaëger, 1833). — Thèse de doctorat, Université Libre de Bruxelles, 176 pp.

RASOLOFORINA, R. & JANGOUX, M. 2005. Apparition et développement des éléments squelettiques chez les larves et les juvéniles épibiontes de *Holothuria scabra*. — *Beche-de-mer Information Bulletin*, **22**: 6-10.

RASOLOFONIRINA, R., VAITILINGON, D., EECKHAUT, I. & JANGOUX, M. 2005. Reproductive cycle of edible echinoderms from the south-western Indian Ocean. — *Western Indian Ocean Journal of Marine Sciences*, **4**: 61-75.

RUFFEZ, J. 2008. Diving for holothurians in Vietnam: A human and environmental disaster. — *Beche-de-mer Information Bulletin*, **28**: 42-45.

SOROKIN, Y. I. 1993. Coral reef ecology. — *Ecological Studies*, **102**, 465 pp.

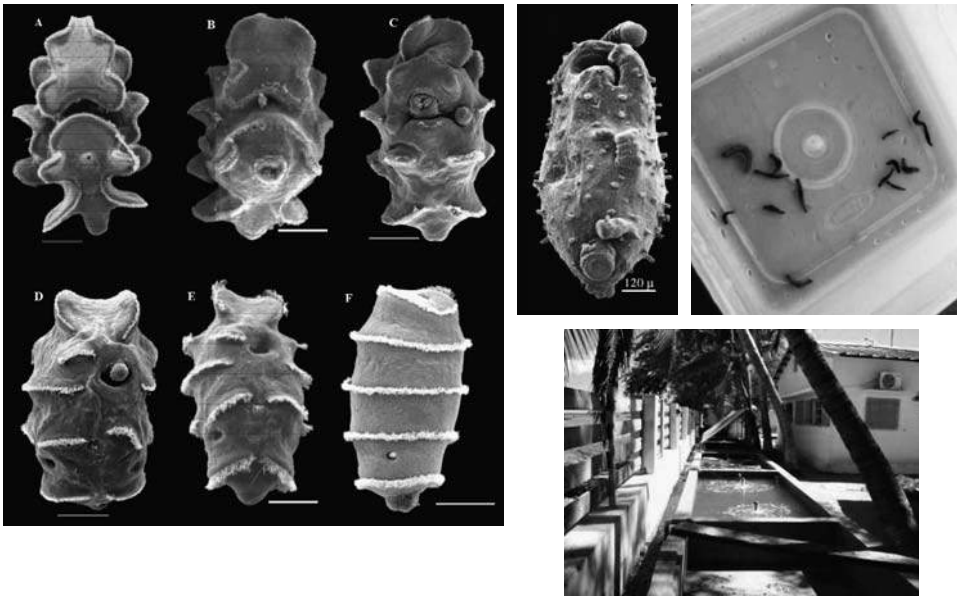
South Pacific Commission 1994. Sea cucumbers and beche-de-mer of the tropical pacific. A handbook for fishers. — *SPC Handbook*, **18**, 51 pp. (Noumea, New Caledonia).

XILIN, S. 2004. The progress and prospects of studies on artificial propagation and culture of the sea cucumber, *Apostichopus japonicus*. — *FAO Fisheries Technical Paper*, **436**: 273-276.

PLANCHE I

L'écloserie de Tuléar

L'écloserie (de gauche à droite et de haut en bas): le bâtiment, les cuves d'élevage larvaire, les aquariums de géniteurs, les cultures d'algues phytoplanctoniques.



Les élevages (de gauche à droite et de haut en bas): de l'auricularia à la doliolaria (A à F), un post-métamorphique, des juvéniles destinés à la ferme (L = 2 cm), les bassins expérimentaux.

PLANCHE II

La ferme de Belaza

La ferme de Belaza (de gauche à droite et de haut en bas): le panneau de bord de piste, le dortoir, l'éolienne et la maison d'habitation.

La ferme de Belaza (de gauche à droite et de haut en bas): les bassins en béton et leur production (L = 5-7 cm), les enclos en mer et leur production (L = 13-16 cm).

Bull. Séanc. Acad. R. Sci. Outre-Mer
Meded. Zitt. K. Acad. Overzeese Wet.
57 (2-4 – 2011): 323-332

Is it Important to Study Tropical African Bird Species?*

by

Michel LOUETTE**

KEYWORDS. — Ornithological Study; Africa; Multidisciplinary Research; Socio-economic Importance.

SUMMARY. — Birdwatching is an important component of ecotourism, an economically-growing activity worldwide. The results of modern multidisciplinary ornithological research, combining range modelling, phylogeny, functional morphology and ecology, can contribute to the documentation, general interest and local participation, three conditions needed to stimulate ecotourism, also in Africa. As an example of my personal research to elucidate biological aspects, Frances' Sparrowhawk *Accipiter francesiae* will be treated. This species lives only in Madagascar and in parts of the Comoro archipelago. Any birdwatcher is highly interested to observe this remarkable species himself in the field and can contribute to science.

TREFWOORDEN. — Vogelstudie; Afrika; Multidisciplinair onderzoek; Socio-economisch belang.

SAMENVATTING. — *Is het belangrijk tropische Afrikaanse vogelsoorten te bestuderen? — Birdwatching*, een belangrijke component van het ecotoerisme, is wereldwijd van groeiend economisch belang. De resultaten van het moderne multidisciplinaire ornithologisch onderzoek op gebied van areaal-modelling, fylogenie, functionele morfologie en ecologie kunnen bijdragen tot de documentatie, algemene interesse en lokale betrokkenheid, drie randvoorwaarden om ecotoerisme te stimuleren, ook in Afrika. Als voorbeeld van eigen onderzoek in die disciplines wordt één enkele vogelsoort besproken, namelijk de Madagascarshikra *Accipiter francesiae* (die ook op de Comoren-archipel voorkomt), waarbij onvermoede biologische aspecten aan het licht komen. De *birdwatcher* is erin geïnteresseerd dergelijke boeiende vogelsoorten met eigen ogen in de natuur gade te kunnen slaan en kan wetenschappelijke gegevens vergaren.

MOTS-CLES. — Etude ornithologique; Afrique; Recherche multidisciplinaire; Importance socio-économique

RESUME. — *Est-il important d'étudier des espèces d'oiseaux tropicaux africains?* — Le *birdwatching,* composante importante de l'écotourisme, est d'un intérêt économique croissant dans le monde entier. Les résultats de la recherche ornithologique multidisciplinaire moderne concernant les modèles de distribution, la phylogénie, la morphologie fonctionnelle et l'écologie peuvent contribuer à la documentation, à l'intérêt général et à

* Paper presented at the meeting of the Section of Natural and Medical Sciences held on 24 May 2011. Text received on 2 September 2011.

** Member of the Academy; Head of Department African Zoology, Royal Museum for Central Africa, Leuvensestw. 13, B-3080 Tervuren (Belgium).

l'implication locale, trois conditions connexes pour stimuler l'écotourisme, aussi en Afrique. A titre d'exemple de notre recherche personnelle dans ces disciplines, une seule espèce d'oiseau sera traitée, l'Epervier de Frances, *Accipiter francesiae* (qui existe à Madagascar et aussi sur l'archipel des Comores), afin de mettre en lumière des aspects biologiques insoupçonnés. Le *birdwatcher* est très intéressé de pouvoir observer de ses propres yeux ces oiseaux fascinants et peut ainsi apporter sa contribution à la science.

Introduction

The "father of ornithology", Ulysses ALDROVANDI (1599), explicitly mentioned the joy of watching birds. But it was especially in the second half of the twentieth century that interest in wildlife grew, thanks to increased leisure time and growth in concern about the environment. Most birds are well documented in books and multimedia and attract attention, which, in turn, stimulates the interested persons to visit biologically important (and accessible) sites in many countries. The identification of birds in the field also greatly improved by the appearance of so-called field guides over the last decades.

Nowadays, the number of birdwatchers is impressive. For the UK, DICKIE *et al*. (2006) mentioned that 2,850,000 people went birdwatching (in their own country); CARVER (2009) gave the figure of 48,000,000 birdwatchers in the USA in 2009. He concluded that the socio-economic interest of birdwatching was appreciable; according to his report, these birdwatchers contribute more than $ 36,000,000,000 a year to the country's economy. This figure concerns domestic revenue only.

Non-residential birdwatching, a component of ecotourism, is also developing steadily. The resulting economic (and social) benefits are important for Third-World countries. It is not exaggerated to use the term "ecotourism industry" (bird guides, drivers, lodging and catering, etc.). A specialized literature tackles pros and cons of ecotourism in development (TAPPER 2006).

In Africa, birdwatching potential is high in countries with long bird lists or a high endemism rate (such as South Africa, Kenya, Ethiopia), but there is also a birdwatching potential for areas with biologically interesting and peculiar birds, such as islands (HEINZEL & HALL 2000). Here, I will deal with the Comoro islands, a circum-African archipelago in the western Indian Ocean (fig. 1).

Birdwatching, Conservation and Science

Research, ecology, economy and ecotourism have multiple links (see reviews in SEKERCIOGLU 2002, ZAHEDI 2004).

Ecotourism development has to consider long-term issues, not in the least conservation *in situ*. SEKERCIOGLU (2002) stated that birdwatchers (the largest

group among ecotourists) contributed much to community-based conservation. In a case study from Africa, NAIDOO & ADAMOWICZ (2005) compared the costs and benefits of maintaining avian biodiversity in a rainforest reserve in Uganda and found that "biodiversity markets" could play a positive role in tropical conservation strategies. Charismatic "flagship" bird species (together with local community involvement) are important predictors of sustainability in ecotourism (KRUGER 2005).

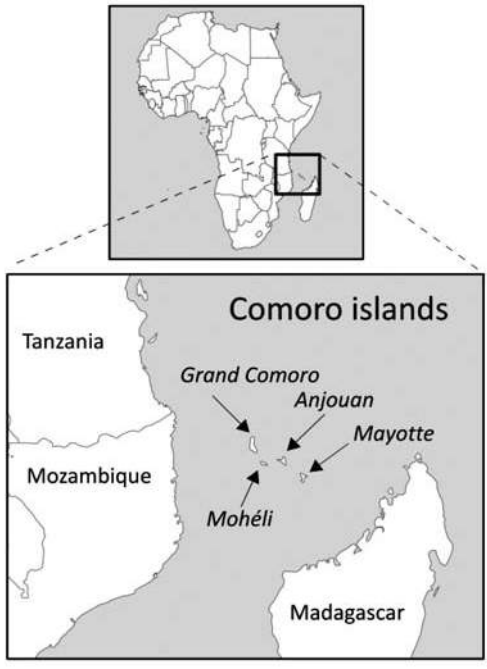


Fig. 1. — The position of the Comoro islands in the western Indian Ocean.

Science can make good use of birdwatchers' activities: in many countries the public participate in the gathering of scientific data; as an example I mention a scheme named "Citizen Science" introduced by Cornell University (USA), which proves highly successful: *e.g.* more than sixty scientific papers have used Cornell citizen-science data since 1997 (example: http://www.birds.cornell.edu/ consulted on 23 August 2011). The data gathered by birdwatchers help improve the knowledge of the biology of many tropical birds (which, in general, are still poorly known, due to lack of field workers and logistical difficulties); in Africa, these data are used for "atlasing" in several countries (http://www.ei-tz.com/files/TanzaniaBirdAtlas.pdf, consulted on 23 August 2011). Many birdwatchers testify that atlasing became, for them, a more rewarding form of their hobby because it had a clear and a larger purpose. Both the concept and the activities

of the atlas helped them to see birds and their hobby in the context of broader ecological issues (HARRISON *et al*. 2008).

Conversely, the scientist provides bird identification material, bird lists and taxonomical papers to the birdwatchers. It must be admitted that until now the majority of birdwatchers have been interested in making a life list, *i.e*. the taxonomic aspect of biology is the most rewarding for them. They also preferably use the phylogenetic species concept, which "upgrades" many taxa formerly classified as subspecies to the species rank (MOSS 2005).

I here advocate the publishing of preliminary studies on the biology of some African birds by the scientist in order to capture the attention of birdwatchers. Hopefully, they will go out to look for birds with a particular biology or morphology (*e.g*. on islands), make their observations available and ultimately contribute to a better knowledge of biodiversity.

Methods, Results and Discussion

Since raptors are birdwatchers' favourites, I have chosen as subject Frances' Sparrowhawk *Accipiter francesiae* Smith, 1834, an example of multidisciplinary research from my own published work on Africa. Frances' Sparrowhawk is a resident small raptorial bird, occurring on western Indian Ocean islands, with distinct subspecies, as follows:

— Madagascar: *A. f. francesiae* Smith, 1834;
— Grand Comoro: *A. f. griveaudi* Benson, 1960;
— Anjouan: *A. f. pusillus* Gurney, 1875;
— Mayotte: *A. f. brutus* Schlegel, 1866.

Four aspects of the biology of this species were studied on the Comoro islands: distribution, ecological parameters (habitat selection, density), phylogeography and functional morphology (proportions, plumages).

DISTRIBUTION

For each Comoro taxon a distribution map was produced (LOUETTE *et al*. 2008, for the three western islands and unpublished, for Mayotte) (fig. 2). The method of atlasing and ecological envelopes was applied, using on the one hand field observations, and on the other hand modelling with GIS data on altitude, forest cover, rainfall, distance to roads, villages, … In sum:

— Grand Comoro: the bird is restricted to the rainforest belt on the flanks of mount Karthala, the highest southern volcano, descending to the wet coastal area near in the south west. It is curiously absent from La Grille, the northern volcano.

— Mohéli: absent.
— Anjouan: rather widespread.
— Mayotte: widespread, common in the humid northwest, scarce in the east, absent from islets.

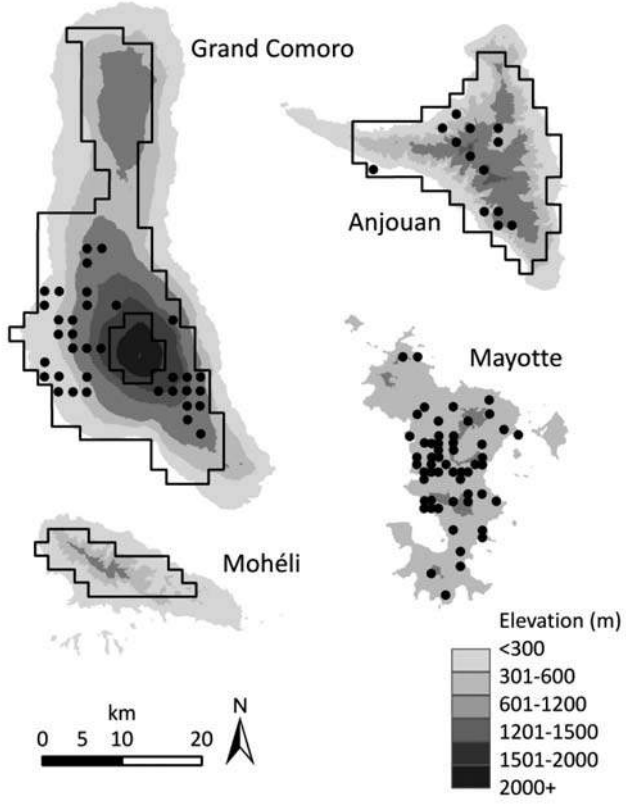


Fig. 2. — Presence of Frances's Sparrowhawk on the Comoro islands. For the three western islands an ecological envelope was drawn, showing the suitability of the habitat on Mohéli and in the north of Grand Comoro where the bird is presently absent.

No explanation could be found as to its absence from La Grille and Mohéli. Only the result of haphazard colonization or the small size of Mohéli island could be put forward and, similarly, the small size of the forest on La Grille, which is separated by drier vegetation from mount Karthala (less than 10 km distance only, however).

The altitudinal profile shows that the bird is a generalist in altitude, being absent only from the very high altitudes on Grand Comoro (mount Karthala rises

to over 2,300 m), with as a hypothetical reason the absence of reptiles (its main prey) at high altitudes.

Ecological Parameters

The subspecies show remarkable differences with respect to habitat preference and population densities, the aspects of which were studied during numerous field trips (Herremans *et al*. 2001, 2011; Louette *et al*. 2008).

On Madagascar, it occurs "in various original forest types and degraded woodlands". On Mayotte, it prefers degraded habitats and attains locally very high breeding densities in the agricultural landscapes, whereas on Grand Comoro it is restricted to forest. On Anjouan, due to the heavy degradation of the original vegetation, it is difficult to say which habitat it prefers, but all recent observations are from the central part of the island, a zone with mixed vegetation and great relief.

The species is common on Madagascar, occurring throughout, but it is scarce in the xeric south. Whereas on Mayotte it is numerous, on less than 350 km^2 (Stevens & Louette 1999), the Grand Comoro bird is restricted to an area of *ca*. 400 km^2, and here it reaches only *ca*. 10 % of the density in prime habitat on Mayotte (fig. 3). The Anjouan subspecies is rare in an area of *ca*. 200 km^2; at one time it was even thought that it was close to extinction, but there are signs of recent recovery. It is possible that these differences in numbers between the islands are due to differences in the level of human persecution and not necessarily to intrinsic differences between the taxa.

The species commonly uses exotic trees in open positions in the canopy for nest building on Mayotte; here some nests are maintained after young fledge, quite likely as territorial advertisement. A new nest is sometimes built immediately after fledging of the young, although it will not be used for breeding then! In contrast, on Grand Comoro, the only two nests ever found were built in closed forest, and no nest has ever been found on Anjouan, which no doubt indicates that all nests are built in forest on those two islands.

Phylogeography

In order to learn about relationships and reconstruct historical events, a molecular analysis, based on the mitochondrial cytochrome c oxidase subunit I (COI) gene, was made. The Madagascar taxon appears well differentiated from the Comoro ones and these are less differentiated (Louette *et al*. 2011). Yet even though the genetic differences are very small, each subspecies corresponds to one or more unique mitochondrial haplotypes and none of the haplotypes is shared between subspecies. Surprisingly, the two well-studied populations (Mayotte and Grand Comoro), resident on small oceanic islands, show some within-island molecular variation, notwithstanding rather small population sizes. Besides, we have only found two haplotypes on Madagascar, despite the larger geographical sampling.

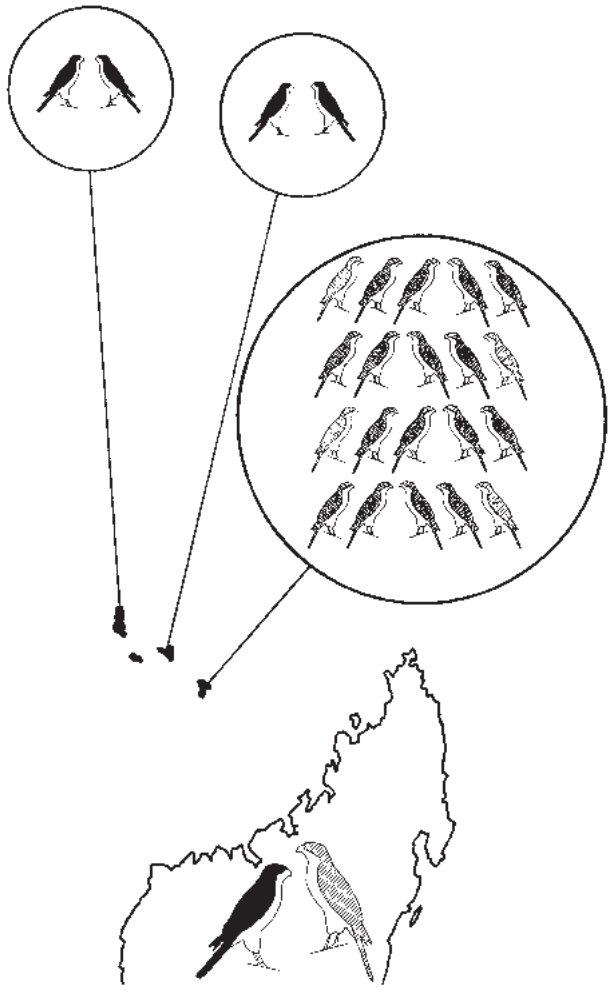


Fig. 3. — Simplified male (looking towards the right) and female (looking towards the left) plumages of the different subspecies and relative abundance (on the Comoro islands only) of Frances's Sparrowhawk.

The small genetic differences suggest a relatively recent colonization of the Comoro islands. Furthermore, the molecular pattern indicates that these islands were colonized within the same historical timeframe; considering the age of the archipelago (*ca*. 3,900,000 year), it must have been relatively recent.

The limited variation in the COI gene does not allow speculation on the exact colonization route or divergence times, although the low variation suggests a recent split between subspecies.

There are other questions to be answered: "What is the relationship between *A. francesiae* and other *Accipiter* species?" and "How were these western Indian Ocean islands colonized by this taxon?".

Interestingly, in analyses of *Accipiter* data sets (containing many species, including the vast majority of the African representatives – BREMAN *et al*. 2013), the Chinese Goshawk *Accipiter soloensis* Horsfield, 1821 from Asia appears to be the closest living relative. It is therefore a possible scenario that the ancestor of *A. soloensis*, which occurs on migration in South-East Asia, made an overshoot migration to Madagascar in the distant past and may have settled after loss of migratory behaviour.

FUNCTIONAL MORPHOLOGY

In contrast to the limited molecular differentiation, the subspecies differ markedly in morphology. After measuring specimens in museums and captured birds in the field, proportions were calculated. Assuming the Comoro populations of *Accipiter francesiae* are derived from Madagascar, they acquired a longer middle toe, relative to tarsus length: 0.52 for Comoro birds, compared to 0.44 for Madagascar birds. These are values for reptile eaters, but evolving towards those for bird eaters (the foot apparatus of a mainly reptile-eating *Accipiter* species has the peculiarity of a short middle toe; WATTEL 1973). These figures are still very much within the "normal" values for reptile eaters (HERREMANS *et al*. 2011). Bill length has also somewhat increased after the colonization process. Bill length, relative to wing length: 0.091 for Comoro birds, compared to 0.087 for Madagascar birds. A long bill is a specialization for forest habitat (WATTEL 1973).

Special attention was given to the colouration and pattern of plumages (see fig. 3). Sexes on Madagascar are well differentiated: adult males are dark grey above; the underside is white and thinly barred rufous to grey-brown on breast and upper flanks. Adult females are larger and browner above than males, with broader and much more profuse barring below. The sexual dimorphism in plumage pattern is much less pronounced in the three Comorian subspecies. On Grand Comoro and Anjouan *A. francesiae* is morphologically similar to males of the Madagascar subspecies, in both sexes. On Mayotte, both sexes resemble the female of the Madagascar subspecies (HERREMANS *et al*. 2001). There are also remarkable differences in juvenile plumage amongst the islands. All these plumages no doubt have a function; hypotheses on this were proposed elsewhere (LOUETTE 2000).

Conclusion of the Case Study

The distribution of Frances's Sparrowhawk is puzzling: modelling failed to reveal why this bird is absent from the north of Grand Comoro. The absence on

Mohéli could be explained by vicissitudes of colonization (or perhaps by the insufficient size of this island). The high density and visibility on Mayotte are striking, especially in contrast to the scarceness and restriction to forest on the two neighbouring islands. Phylogeography shows that Comoro populations are closely related (stemming most likely from one colonization in Madagascar), although they are morphologically so different. Morphological variation among these populations is indeed peculiar: the small island populations have all evolved from a typical reptile-eating to a more generalist feeding apparatus and a seemingly "forest" adaptation in bill length; plumages, however, are strikingly different with masculine tendency on two Comoro islands and feminine tendency on the other. It would be premature to correlate population density with these plumage characteristics: much more fieldwork is needed, and citizen science could very well contribute to this study.

The case study gives the perfect example of discrepancy between molecular and ecological evolution of insular populations, and thus indicates opportunities for interesting and conservation-oriented birdwatching. Field observations by birdwatchers could give better information on *e.g.* distribution and density, food, position of nests, conflicts between pairs and between adults and immatures. All these data are needed to allow interpretation of this remarkable case of biodiversity.

ACKNOWLEDGEMENTS

The survey on the Comoro islands was funded from various sources (*Commission de l'Océan Indien*, Royal Museum for Central Africa (own funding), and the Belgian Fund for Scientific Research). Fieldwork on Grand Comoro, Mohéli and Anjouan was performed in cooperation with the *Centre National de Documentation et de Recherche des Comores*; on Mayotte it was facilitated by the *Services des Eaux et Forêts*. The molecular part of the research was carried out by Floris Breman of the Joint Experimental Molecular Unit, funded by the Belgian Science Policy Office. Feathers of museum specimens, supplemented by fresh tissue, were used for the molecular analysis. Some samples were legally obtained from correspondents listed in LOUETTE *et al.* (2011). Danny Meirte assembled the distribution data. Ruth Swetnam and Alain Reygel drew the figures.

REFERENCES

ALDROVANDI, U. 1599. Ornithologiae hoc est de avibus historiae. Libri XII. — Bologna, Franciscum de Franciscis Senensem, 892 pp.

BREMAN, F. C., JORDAENS, K., SONET, G., NAGY, Z. T., VAN HOUDT, J. & LOUETTE, M. 2013. DNA barcoding and evolutionary relationships in *Accipiter* Brisson, 1760 (Aves, Falconiformes: Accipitridae), with a focus on African and Eurasian representatives. — *Journal of Ornithology*, **154**: 265-287.

CARVER, E. 2009. Birding in the United States: A Demographic and Economic Analysis. Addendum to the 2006 National Survey of Fishing, Hunting and Wildlife-associated

Recreation. — Washington, United States Department of the Interior, Fish and Wildlife Service, 16 pp.

DICKIE, I., HUGHES, J. & ESTEBAN, A. 2006. Watched Like Never Before … the local economic benefits of spectacular bird species. — Sandy, Royal Society for the Protection of Birds, 63 pp.

HARRISON, J. A., UNDERHILL, L. G. & BARNARD, P. 2008. The seminal legacy of the Southern African Bird Atlas Project. — *S. Afr. J. Sci.,* **104** (3-4): 82-84.

HEINZEL, H. & HALL, B. 2000. Galapagos diary: a complete guide to the archipelago's birdlife. — London, Christopher Helm, 272 pp.

HERREMANS, M., LOUETTE, M. & STEVENS, J. 2001. Biology of Frances's Sparrowhawk *Accipiter francesiae* on the Comoro Islands. — *Ostrich*, **72** (1-2): 1-9. Errata: *Ostrich*, **72** (3-4): 158.

HERREMANS, M., LOUETTE, M., STEVENS, J. & MEIRTE, D. 2011. Record breeding densities of Frances's Sparrowhawk *Accipiter francesiae*, and effects on bird communities in the Comoros. — *Phelsuma*, **19**: 1-26.

KRUGER, O. 2005. The role of ecotourism in conservation: panacea or Pandora's box? — *Biodiversity and Conservation*, **14**: 579-600.

LOUETTE, M. 2000. Evolutionary exposition from plumage pattern in African Accipiter (Proceedings Ninth Pan-African Ornithological Congress). — *Ostrich*, **71** (1-2): 45-50.

LOUETTE, M., ABDEREMANE, H., YAHAYA, I. & MEIRTE, D. (in coll. with CAEL, G., DOULTON, H., MARSH, C., MEGANCK, B. & MONTICELLI, D.) 2008. Atlas des oiseaux nicheurs de la Grande Comore, de Mohéli et d'Anjouan. — Tervuren, Royal Museum for Central Africa, *Studies in Afrotropical Zoology*, 240 pp.

LOUETTE, M., HERREMANS, M., NAGY, Z. T., RENE DE ROLAND, L.-A., JORDAENS, K., VAN HOUDT, J., SONET, G. & BREMAN, F. C. 2011. Frances's Sparrowhawk *Accipiter francesiae* (Aves: Accipitridae) radiation on the Comoro Islands. — *Bonner Zoologische Monographien*, **57**: 117-131.

MOSS, S. 2005. Everything you always wanted to know about birds… but were afraid to ask! — London, Christopher Helm, 192 pp.

NAIDOO, R. & ADAMOWICZ, W. L. 2005. Economic benefits of biodiversity exceed costs of conservation at an African rainforest reserve. — *Proceedings National Academy of Science*, **102** (46): 16712-16716.

SEKERCIOGLU, C. H. 2002. Impacts of birdwatching on human and avian communities. — *Environmental Conservation*, **29** (3): 282-289.

STEVENS, J. & LOUETTE, M. 1999. Land bird abundance and conservation of biodiversity on the tropical island of Mayotte (Indian Ocean). — *Alauda*, **67** (2): 123-139.

TAPPER, R. 2006. Wildlife Watching and Tourism: A study on the benefits and risks of a fast growing tourism activity and its impacts on species. — Bonn, United Nations, Convention on Migratory Species Secretariat, 68 pp.

WATTEL, J. 1973. Geographical differentiation in the genus *Accipiter*. — *Publications of the Nuttall Ornithological Club*, **13**: 1-231.

ZAHEDI, S. 2004. Ecological understanding: a prerequisite of sustainable ecotourism. — *J. Humanities*, **11** (1): 61-67.

Bull. Séanc. Acad. R. Sci. Outre-Mer
Meded. Zitt. K. Acad. Overzeese Wet.
57 (2-4 – 2011): 333-353

Health and Diet of Ancient Easter Islanders: Contribution of Palaeopathology, Dental Microwear and Stable Isotopes*

by

Caroline POLET**

KEYWORDS. — Easter Island; Skeletons; Health; Diet.

SUMMARY. — This paper relates to the study of the health and diet of ancient Easter Islanders. It is based on human skeletons discovered between 1934 and 2009. We have studied skeletal markers that revealed poor living conditions during growth (stress indicators) and recorded the presence of infectious diseases. The dietary reconstitution is based on dental microwear and the analysis of carbon and nitrogen stable isotopes. Our study indicates relatively good health and food conditions during childhood. However, we have found cases of infectious diseases that probably followed contact with Europeans or Americans. The dental microwear pattern is due to the dominant part of the tubers. The stable isotopes show that, on average, a little more than one third of their dietary proteins came from the sea.

MOTS-CLES. — Ile de Pâques; Squelettes; Etat sanitaire; Régime alimentaire.

RESUME. — *Etat sanitaire et régime alimentaire des anciens Pascuans: apport de la paléopathologie, de la micro-usure dentaire et des isotopes stables*. — Cette communication traite de l'étude de l'état sanitaire et du régime alimentaire des anciens habitants de l'île de Pâques. Notre matériel se compose de squelettes humains découverts entre 1934 et 2009. Nous avons étudié des marqueurs squelettiques indiquant de mauvaises conditions de vie pendant la croissance (indicateurs de stress) et relevé la présence de maladies infectieuses. Les reconstitutions alimentaires sont basées sur la micro-usure dentaire et l'analyse des isotopes stables du carbone et de l'azote. Notre étude révèle un état de santé et de nutrition relativement satisfaisant durant l'enfance. Nous avons toutefois mis en évidence des cas de maladies infectieuses faisant probablement suite aux contacts avec les Européens ou les Américains. Le *pattern* de micro-usure dentaire résulte de la part dominante des tubercules. Les isotopes stables montrent qu'en moyenne, un peu plus d'un tiers de leurs protéines alimentaires était d'origine marine.

TREFWOORDEN. — Paaseiland; Skeletten; Gezondheid; Dieet.

SAMENVATTING. — *Gezondheidstoestand en dieet van de oude bewoners van het Paaseiland: bijdrage van paleopathologie, microslijtage van de tanden en stabiele isotopen*. — Dit werk handelt over de studie van de gezondheidstoestand en het dieet van de

* Paper presented at the meeting of the Section of Natural and Medical Sciences held on 22 February 2011. Publication decision taken on 22 November 2011. Final text received on 1 February 2012.

** Direction Earth and History of Life, Royal Belgian Institute of Natural Sciences, rue Vautier 29, B-1000 Brussels (Belgium).

oude bewoners van het Paaseiland. Ons materiaal bestaat uit menselijke skeletten ontdekt tussen 1934 en 2009. We hebben pathologische skeletachtige kenmerken bestudeerd die de slechte levensomstandigheden aantonen gedurende de groei (stressindicatoren) en de aanwezigheid van infectieziekten vastgesteld. De wedersamenstelling van de voedingsgewoonten zijn gebaseerd op de studie van microslijtage van de tanden en de analyse van stabiele kool- en stikstofisotopen. Onze studie onthult een relatief bevredigende gezondheids- en voedingtoestand tijdens de kindertijd. We hebben evenwel de aandacht gevestigd op gevallen van infectieziekten die waarschijnlijk het gevolg zijn van contact met de Europeanen of de Amerikanen. Het patroon van de microslijtage is het gevolg van het overwegend gebruik van wortelknollen in de voeding. Stabiele isotopen tonen aan dat gemiddeld iets meer dan een derde van hun eiwitbehoefte van mariene oorsprong was.

1. Introduction

Easter Island (or *Rapa Nui*) is the most isolated inhabited island of the Pacific (fig. 1). It is located at 27º09'30" S and 109º26'14" W — 3,600 km from the Chilean coasts and 4,200 km from Tahiti. Its closest populated neighbour is Pitcairn Island, 2,075 km to the west. Easter Island has a volcanic origin and a land area of 160.5 km^2 (FISHER & LOVE 1993).

According to some authors, the initial human settlement of Easter Island would have taken place between the 8th and the 10th century AD (BAHN 1993). For others, it would have occurred more recently and would date back to the 12th century (HUNT & LIPO 2006). Anthropological (TURNER & SCOTT 1977, GILL & OWSLEY 1993), palaeogenetic (HAGELBERG 1994), ethnographic (METRAUX 1971) and linguistic (DU FEU & FISCHER 1993) research showed that Easter Islanders would have had a Polynesian origin.

The population of the island started to grow until reaching, according to KIRCH (1984), nine thousand islanders in 1550. A demographic decline began in about 1650 and was accompanied by great upheavals in the social organization as well as in the religious and funerary practices. This may have been related to the disappearance of available resources. The palynological (FLENLEY & KING 1984) and anthracological (ORLIAC & ORLIAC 1998) analyses show that the island definitely had, until the early 17th century, a forest cover where palm trees dominated. When the European navigators visited the island in the 18th century (the Dutch explorer Jacob Roggeveen was the first European to discover the island in 1722 on Easter Day, hence its name), Easter islanders were estimated to be no more than one thousand or two thousand individuals and the forests had completely disappeared. According to some authors (KIRCH 1984, DIAMOND 2005), and mainly on the basis of oral tradition (narratives collected in the 20th c.) and on the emaciated wooden anthropomorphic statues (*moai kava kava*), this deforestation would then have been followed by intertribal wars, famines and even cannibalism.

Thereafter, two tragic episodes continued to decimate the population (LAVACHERY 1935, FISCHER 2005). Between December 1862 and March 1863, Peruvian

slave traders captured approximately one thousand four hundred natives (men, women and children) to work in farms and to harvest the guano primarily on Chincha Islands, Peru (MAUDE 1981). More than 90 % of them perished following the bad working conditions, maltreatment and diseases. In August 1863, international protests put an end to the slave trade and the survivors, carrying smallpox and tuberculosis, were repatriated to the island. An epidemic of smallpox then decimated over a thousand islanders. Then, in 1868, Dutrou-Bornier, a French adventurer, settled down in the island and created a reign of terror. In 1873, missionaries invited all the inhabitants to leave the island to live in the Gambier Islands and Tahiti. Only a hundred and eleven natives requisitioned as labour force by the tyrant remained on the island (METRAUX 1941). Dutrou-Bornier was assassinated in 1876. In 1888, the island was annexed to Chile and was then exploited from 1897 onwards by a Chilean businessman. In 1903, the lands were rented to a Scottish sheep-breeding company. Until 1954, the small Polynesian island was no more than a large farm managed by this company and the Rapanui people were gathered in a single village: Hanga Roa (FISCHER 2005).

The absence of written archives and the disappearance of the majority of the ancestral culture holders during the slave raids and the epidemics unfortunately led to the loss of most of the information relating to the history of the island and its traditions. The teeth and human bones consequently constitute the main source of direct information on the lifestyle of ancient Easter Islanders.

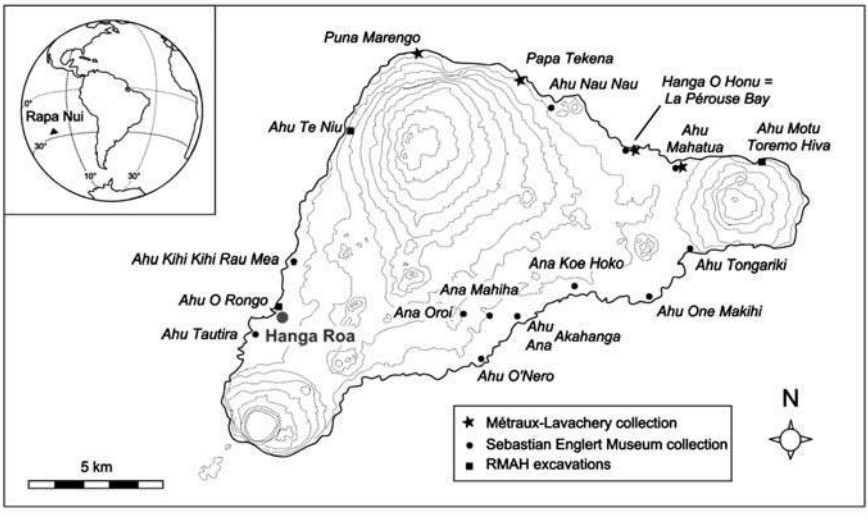


Fig. 1. — Location of Easter Island and the different sites studied (RMAH = Royal Museums of Art and History).

Until now, anthropological studies have mainly attempted to define the ethnic origin of the settlement (see higher), determine the degree of endogamy and/or exogamy between the different "tribes" of the island (STEPHAN 1999) and evaluate the impact of European contact (interbreeding, infectious and traumatic pathology) (OWSLEY *et al*. 1994). Paradoxically, the diet and general health status of the ancient population were barely studied by anthropobiologists. In fact, only two papers relate to these topics through the study of dental caries (OWSLEY *et al*. 1983, 1985).

This paper aims to document both themes by the study of the palaeopathology, dental microwear and stable isotopes.

2. Material

The archaeological surveys undertaken as from the end of the 19th century on Easter Island allowed the discovery of the remains of several hundreds of individuals of which often, unfortunately, only the skulls were taken. The majority were buried in monuments (*ahu*). In the ancient period (13-15th centuries), the dead were generally incinerated and their ashes gathered in stone-lined cists located at the rear of the *ahu* (AYRES & SALEEBY 2000, HUYGE *et al*. 2002, POLET 2003). After the deforestation, the progressive abandonment of the giant statues (*moai*) cult and their overthrow, Easter Islanders continued to bury their dead in the *ahu* but, this time, mostly in niches dug in the platform or under lying *moai* (SEELENFREUND 2000). In addition, there are also burials in caves that seem to have taken place after the discovery of the island by the Europeans (SHAW 2000). Some of them contained individuals who died during the great epidemics of the 19th century.

The chronological attribution of the skeletons, however, is problematic as most of the monuments were used over long periods. Moreover, dating was mainly carried out on obsidian artefacts (SEELENFREUND 2000, SHAW 2000) but rarely directly on human remains. Diachronic studies thus cannot currently be considered.

The samples studied come from eighteen sites mainly dated between the 17th and the 19th century (fig. 1; tab. 1). They are composed of:

— Skulls and long bones brought back to Europe in 1935 by A. Métraux and H. Lavachery (LAVACHERY 1935). They come from the north of the island and belong to the collections of the Royal Belgian Institute of Natural Sciences (RBINS).
— Skeletons exhumed at the end of the 1970s by G. Gill (GILL & OWSLEY 1993). They belong to the collections of the Father Sebastián Englert Anthropological Museum of Easter Island, which holds the majority of the anthropological material recently excavated.

— Fragmentary human remains collected in 1996 by C. M. Stevenson and S. Haoa from cult and settlement sites at La Pérouse Bay (STEVENSON & HAOA 1998). They are housed at the Museum Sebastián Englert.
— Skeletons discovered recently by N. Cauwe and D. Huyge of the Royal Museums of Art and History (RMAH) (HUYGE & CAUWE 2002, CAUWE *et al*. 2006, CAUWE 2011). They are housed at the Sebastián Englert Museum (except for the individual from Ahu Motu Toremo Hiva, which was reburied according to the will of the local authorities).

Table 1

Composition of the samples studied for stress indicators, dental microwear and stable isotopes (G = Gill, LM = Lavachery and Métraux, SH = Stevenson and Haoa, CH = Cauwe and Huyge)

	Site	excavated by	Antiquity	N microwear	N stress indicators	N stable isotopes
Ahu	Nau Nau	G	end 17th-19th c.	28	41	
	Tautira	G	?	1		
	Tongariki	G	?	4		
	Kihi Kihi Rau Mea	G	early 17th c.	1	14	3
	O'Nero	G	end 17th-19th c.	2	12	1
	Akahanga	G	?	5	8	
	One Makihi	G	?	2	3	1
	Mahatua	G	?	6		4
	Hanga O Onu = La Pérouse Bay	LM	19th c.?	3		1
	Papa Tekena	LM	19th c.?	1		1
	O Rongo	CH	end 13th – early 14th c.	2		
	Motu Toremo Hiva	CH	end 19th – early 20th c.	1		
Cave	Akahanga	G	18th-19th c.	1	4	1
	Koe Hoko	G	18th-19th c.	2	8	1
	Mahiha	G	18th-19th c.	3	6	1
	Oroi	G	18th-19th c.	6	17	
Other	Puna Marengo	LM	19th c.?	2		
	La Pérouse	SH	1700-1850	1		
TOTAL				**71**	**125**	**14**

3. Methods

Health has been studied through the recording of infectious diseases and stress indicators. Diet has been reconstructed using dental microwear and stable isotope analyses.

3.1. Skeletal Pathology

The majority of infectious diseases do not leave any traces on the skeletons and, when they do, it is frequently in a generalized and non-specific way. Moreover, often only severe or advanced stages will leave sequels. Some diseases, however, can cause specific modifications of the skeleton and thus be identified in the archaeological record. The most studied are tuberculosis, leprosy and syphilis (Ortner 2008, Polet 2011). Tuberculosis leaves characteristic traces on vertebrae. Leprosy is characterized by damage to the bones of the face, fingers and toes. Syphilis tends to destroy the skull vault and the tibiae.

Easter Island skeletal samples have been examined macroscopically and pathological changes have been recorded.

To get a glimpse of the general health status of ancient Easter Islanders, we have studied two skeletal markers revealing bad living conditions during growth (stress indicators): dental enamel hypoplasia and *cribra orbitalia*.

Dental enamel hypoplasia consists of localized defects (fig. 2) generally in the form of horizontal depressions due to a temporary disturbance in amelogenesis (Goodman & Rose 1990). In most cases, hypoplasias originate from a problem of malnutrition and/or health (high fever or infection). The formation of a defect requires at least several weeks of stress. As enamel does not remodel once it is formed, hypoplasias are permanent markers left on the tooth crown. We recorded the presence of hypoplasia on the deciduous and permanent incisors and canines (Polet 2006a).

Cribra orbitalia is a porotic lesion in the bony orbital roof (fig. 3). It has long been strictly associated with iron-deficiency anemia (Stuart-MacAdam 1992) but recent work shows that it can also be related to a vitamin-B_{12}-deficient diet [1]*, scurvy or chronic infections (Walker *et al*. 2009, Oxenham & Cavill 2010). We recorded the presence of *cribra orbitalia* on individuals presenting at least one complete orbital roof (Polet 2006a).

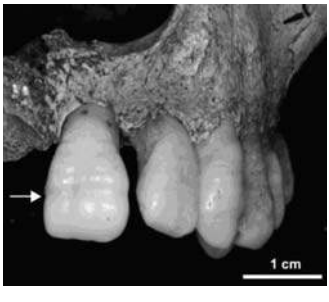


Fig. 2. — Enamel hypoplasia in a child of approximately twelve years from Ahu O Nero.

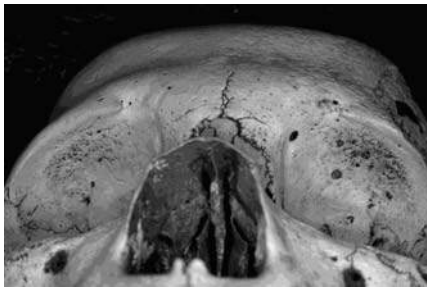


Fig. 3. — *Cribra orbitalia* in a young woman from Oroi cave.

* Numbers in brackets [ ] refer to the notes, p. 349.

3.2. Dental Microwear

Since the end of the 1970s, dental microwear is a field of research that has been integrated in the dietary reconstitutions of ancient populations (Teaford 1994). The density, dimensions and orientation of these microstructures are a function of the type of food as well as of its preparation (Molleson *et al*. 1993, Lalueza *et al*. 1996). On the vestibular surface of the teeth, the vertical and long striations would be caused by meat chewed quickly, while the short horizontal and oblique striations would result from crushing harder (more abrasive) vegetal food. Vegetarians also show more striations than carnivores.

We examined the vestibular surface of the first and second permanent molars with scanning electron microscopy at 178 X magnification (Philips SEM 515 of the RBINS) (Polet *et al*. 2008). The number of striations, their length and their orientation were recorded in a circular area of 300μm diameter (fig. 4) using the software Microware 4.02 of Ungar (1995) [2].

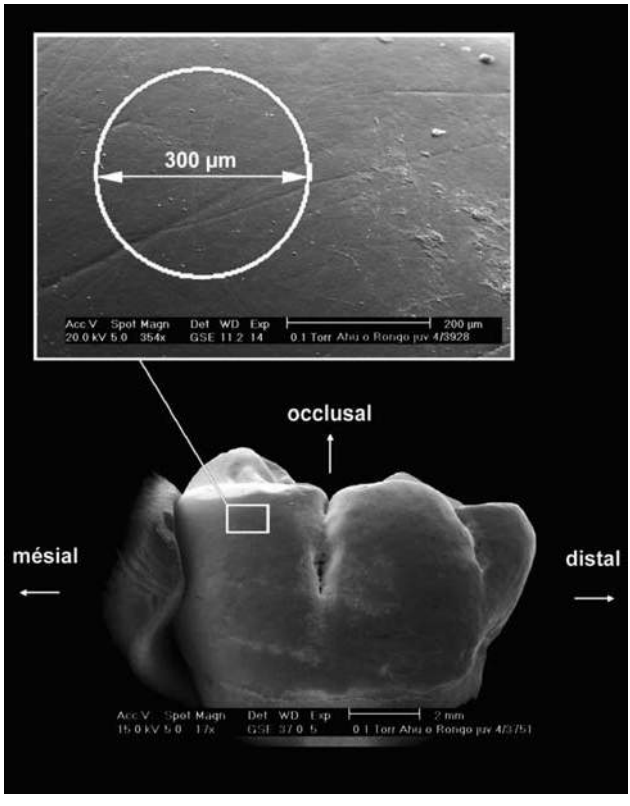


Fig. 4. — Positive replica of a molar from *ahu O Rongo* seen from its buccal side. The selected zone (rectangle) is located on the mesio-buccal cusp near the occlusal surface. Microwear was recorded in a circular area of 300 μm diameter.

3.3. Carbon and Nitrogen Stable Isotope Analyses

Carbon and nitrogen stable isotope analyses have proved to be efficient methods for reconstructing palaeodiets (Tykot 2004, Bocherens & Drucker 2005). They are based on the fact that the differences in chemical composition between different categories of food are reflected in the bones or teeth of the consumer (in other words: "you are what you eat"). They give a direct measure of long-term diets on the individual level and consequently enable associations to be highlighted between diet and certain attributes such as social status, age or sex (Polet 2008).

C and N isotopes are chiefly measured in bone (and dentine) collagen, the main component of their organic fraction. Results are expressed as isotopic ratios (= ratio of abundance of the heavy to light isotope) relative to an international standard. They are reported as delta (δ) notation in units per mil (‰). δ is calculated in the following way for carbon and nitrogen stable isotopes:

$$\delta^{13}C\ (‰) = [\ (^{13}C/^{12}C)\ \text{sample} / (^{13}C/^{12}C)\ \text{standard} - 1\ ] \times 1000$$

$$\delta^{15}N\ (‰) = [\ (^{15}N/^{14}N)\ \text{sample} / (^{15}N/^{14}N)\ \text{standard} - 1\ ] \times 1000$$

δ is positive if the sample is enriched in heavy isotopes compared to the standard; a negative δ indicates the opposite.

For carbon isotopes, the internationally-defined standard is V-PDB (for Vienna Pee Dee Belemnite). The nitrogen isotopes are reported relative to AIR (for atmospheric air).

We sampled 200-300 mg of compact bone with a drill. Collagen was extracted by acidic demineralization followed by a step of contaminants removal (Bocherens *et al*. 1991). The carbon and nitrogen isotopic compositions were measured with the Finnigan MAT 252 mass spectrometer of the University of Tübingen, Germany.

4. Results and Discussion

4.1. Skeletal Pathology

There is currently no study giving the prevalence of infectious diseases in ancient Easters Islanders. This is probably due to the lack of a large-scale study and to the fact that pathological diagnoses are uncertain as most individuals are incomplete (many are only represented by one skull) and fragmented.

We present here two pathological examples we have studied: an individual that might have suffered from leprosy and another from syphilis.

The probable case of leprosy comes from Ahu Motu Toremo Hiva, a site excavated by the RMAH in 2004 (Cauwe *et al*. 2006). The skeleton was buried in a peculiar position: in ventral *decubitus*, face against the ground. The individual would be a Polynesian male who probably reached forty years (Polet 2006b). Radiocarbon dating shows that he died at the end of the 19th or at the beginning of the 20th century. Several osseous pathologies can be observed (fig. 5):

— A resorption of the anterior nasal spine and the maxillary alveolar process with the loss of the left upper central incisor;
— An osteolytic remodelling of the proximal foot phalanges;
— A proximal extension of the distal articulation of the middle phalanx of the left little finger that could result from a chronic hyperflexion of the concerned finger;
— An enlargement of the nutrient foramens of hands and feet bones.

These symptoms indicate that the individual could have suffered from an early stage from the lepromatous form of leprosy. The extraction and amplification of *Mycobacterium leprae* DNA from the bones of this individual should make it possible to confirm this hypothesis. According to historical sources, the first proven case of leprosy on Easter Island dates back to 1888. The disease seems to have been brought from French Polynesia (Fischer 2005, p. 151). It quickly became endemic in the indigenous population, affecting approximately 7 % of the inhabitants. Leprosy was finally eradicated in the 1980s. The individual from Ahu Motu Toremo Hiva could be one of the first lepers of Easter Island. It is also the first probable case of leprosy diagnosed on a Rapanui skeleton.

The supposed case of syphilis comes from Ahu Te Niu, a site excavated by the RMAH in 2008 and 2009 (Cauwe 2011). The pathological bones consist of nineteen fragments of a skull vault (fig. 6). Stratigraphically, they should be later than the 17th century although no direct dating has yet been done. The outer table of the skull presents a sclerotic remodelling with circumvallate cavitations and radial scars very similar to the evolutionary stages published by Hackett (1976). The inner table is not involved. These observations suggest tertiary syphilis. Complementary analyses are necessary in order to confirm this diagnosis. Symptoms of syphilis have been briefly described by Owsley *et al*. (1994) on three adults and two children from Easter Island (congenital syphilis). For one of the adults, the diagnosis was confirmed by the extraction of *Treponema pallidum* DNA (Kolman *et al*. 1999).

No enamel hypoplasia has been observed in the seven deciduous dentitions of Easter Island but this pathology concerns 18.0 % of the permanent teeth of Rapanui (tab. 2). On the island of Guam however, 12.7 % (17/134) of the individuals display this stress indicator on their primary teeth (Stodder 1997). *Cribra orbitalia* concerns 12.7 % of our sample (tab. 2).

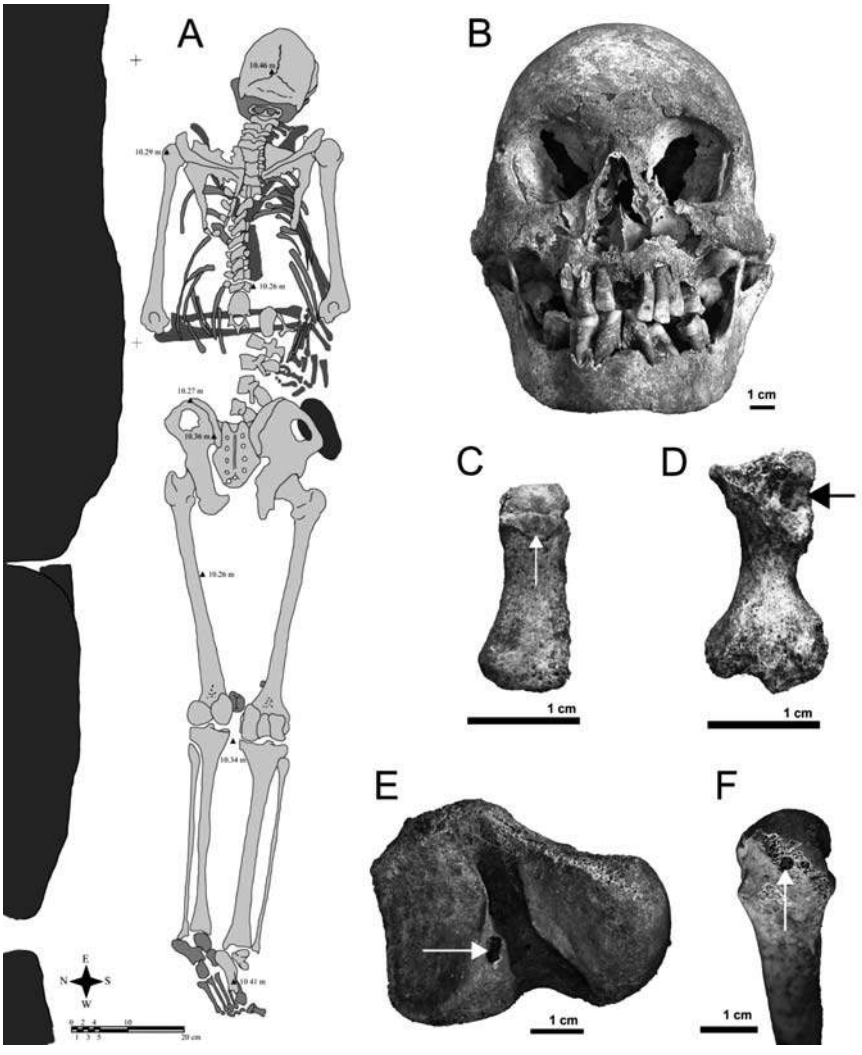


Fig. 5. — Individual from Ahu Motu Toremo Hiva probably suffering from leprosy. A. Skeleton *in situ* (drawing: N. Cauwe, RMAH). B. Skull with resorption of the anterior nasal spine and of the alveolar process of the maxilla with the loss of the left upper central incisor. C. Proximal extension of the distal articulation of the middle phalanx of the left little finger (→). D. Osteolytic remodelling of the diaphysis of the fifth proximal phalanx of the left foot (→). E. Enlarged nutrient foramen on the left talus (→). F. Enlarged nutrient foramen on the head of the left metacarpal II (→).

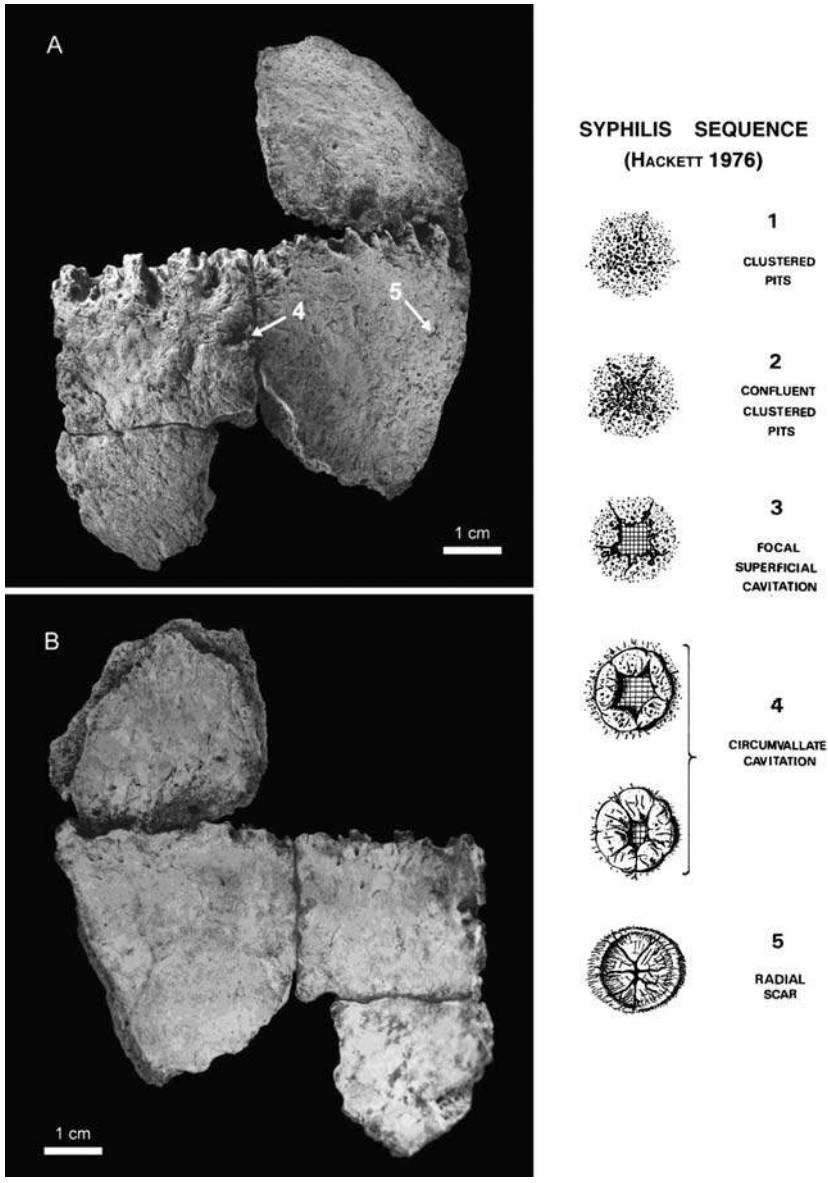


Fig. 6. — Fragments of skull vault of an individual buried at Ahu Te Niu and displaying symptoms evocative of syphilis. A. Outer table characterized by a sclerotic remodelling with lesions looking like the stages 4 and 5 of HACKETT (1976). B. Inner table.

The percentage of the Rapanui adults and children with enamel hypoplasia and the percentage of *cribra orbitalia* are in the range of variation of other historic and prehistoric [3] Pacific samples (POLET 2006a) (fig. 7). These are, however, much lower than European medieval populations from the 6th to the 15th century AD (POLET 2006a).

Table 2

Frequencies of enamel hypoplasia (on permanent teeth) and *cribra orbitalia* in Easter Islanders

	Freq. enamel hypoplasia			**Freq. *Cribra orbitalia***	
	Absolute	**Relative (%)**		**Absolute**	**Relative (%)**
> 20 years	6/31	19.4	> 20 years	3/51	5.9
13-20 years	1/8	12.5	< 20 years	6/21	28.6
Male	1/19	5.3	Male	1/28	3.6
Female	4/11	36.4	Female	5/25	20.0
Total	7/39	18.0	**Total**	9/71	12.7

Within the Rapanui sample, women show significantly higher hypoplasia frequencies than men (tab. 2). This leads to the assumption of a preferential investment in boys (GUATELLI-STEINBERG & LUKACS 1999) as the tooth crown records stress events that occurred during its formation, *i. e.* chidhood.

The percentage of *cribra orbitalia* is higher in children than in adults (tab. 2), as in many other populations (POLET & ORBAN 2001, p. 120; PIETRUSEWSKY *et al.* 1997). This result could be explained by the healing and disappearance of the lesions with age.

4.2. DENTAL MICROWEAR

In the sampled circular area, the total number of microscratches of Easter Islanders varies between 21 and 119 with an average of 53.9 features (or 77 scratches/mm^2). Their average length is 50.9 μm and they display a high proportion of horizontal and horizontal-oblique orientations (fig. 8).

If one refers to studies carried out on individuals of known diet (LALUEZA *et al.* 1996), the amount, length and orientation of these scratches indicate a low abrasive vegetable food prevalence. This result can be related to the dominance of sweet potato (*Ipomoea batatas*) in their daily meals as is stated by historical (POLLOCK 1993, FLENLEY 1993), ethnographical (ROUTLEDGE 1919, METRAUX 1971) and archaeobotanical (FLENLEY 1993, CUMMINGS 1998) data. The high percentages of caries recorded by OWSLEY *et al.* (1983, 1985) confirm this hypothesis because sweet potato and other tubers eaten by

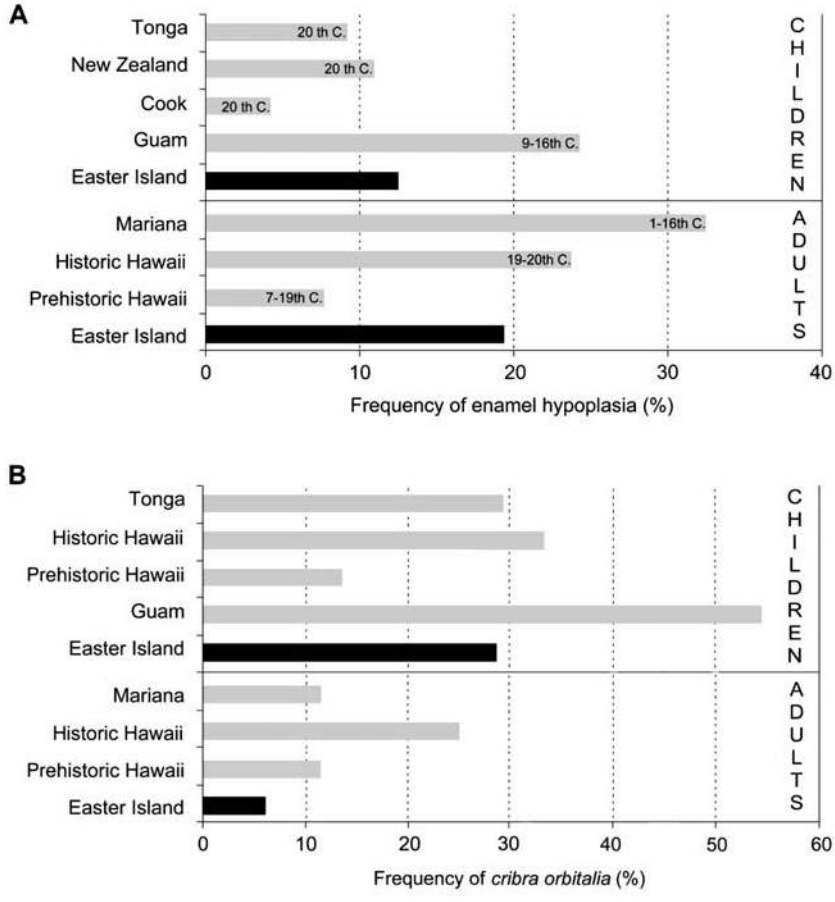


Fig. 7. — A. Frequencies of enamel hypoplasia on permanent teeth in the Easter Island sample compared to those collected in seven archaeological and extant Polynesian samples (references are in POLET 2006a). B. Frequencies of *cribra orbitalia* in the Easter Island sample compared to those collected in five archaeological Polynesian samples (references are in POLET 2006a).

Rapanui (taro, yam and arrow-root) are rich in starches and highly cariogenic (LINGSTROM *et al*. 2000).

There is unfortunately no dental microwear study of other Polynesian populations. We thus decided to compare our group with samples studied by GARCIA-MARTIN (2000). These are individuals from Belgium belonging to the collections of the RBINS: Neolithics from the Meuse Basin (end of the 5th millennium – first half of the 3rd millennium BC), Mediaeval individuals from the Dunes Abbey of Coxyde (12th-15th c.) and from Ciply and Torgny (6th-7th c.). Compared to these samples, Easter Islanders display in fact a small total number of

striations (fig. 9). Furthermore, multivariate statistical analyses based on the length and orientation of the scratches reveal that the microwear pattern of Easter Islanders presents the most similarities with that of the Cistercians of Coxyde (POLET *et al*. 2008) where marine fish consumption is attested. This ichtyophagy is confirmed by the marine faunal remains (STEADMAN *et al*. 1994, AYRES *et al*. 2000) and by the fishing implements (LAVACHERY 1935, AYRES 1985) discovered in Easter Island archaeological sites.

Within our adult sample, we did not observe any sex or age-related differences in microwear pattern (POLET *et al*. 2008). It indicated that these two parameters did not determine a preferential access to the various foodstuffs once adulthood is reached.

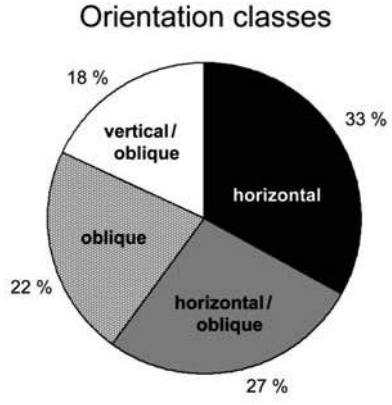


Fig. 8. — Distribution (pie-chart) of the Easter Islanders micro-striations in four orientation classes (horizontal, horizontal / oblique, oblique and vertical / oblique).

4.3. CARBON AND NITROGEN STABLE ISOTOPE ANALYSES

We present here preliminary results for fifteen Rapanui individuals. Their isotopic ratios are plotted in figure 10 and compared to data of animals with known feeding strategies. The Easter Island humans are located between the values of the terrestrial and the marine reference ecosystems. To estimate the proportion of marine food in their diet, we applied the linear mixing model of MAYS (1997) based on the carbon isotopes. In this model, an entirely terrestrial diet leads to a value of – 21.5 ‰ and a wholly marine-based one to – 12 ‰. Except for one man from Ahu O'Nero who dispays a $\delta^{13}C$ signature of – 20 ‰ and who would have only consumed 15.8 % of marine products, the marine proportion of Easter Islanders varied between 29.5 and 49.5 %, with an average of 35.8 % [4]. It would be nevertheless interesting to analyse animal remains coming from archaeological sites of Easter Island in order to establish a local faunal reference frame.

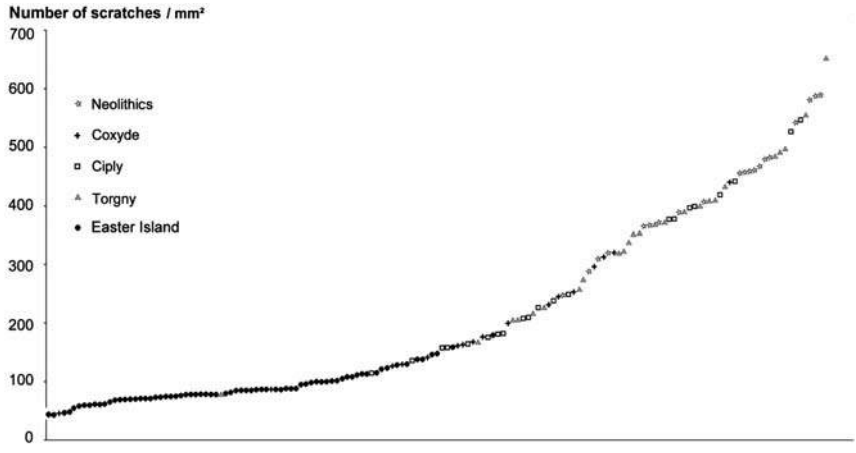


Fig. 9. — Distribution of the seventy-one Easter Islanders and of the individuals of four comparative samples from Belgium (Neolithic individuals of the Meuse Basin, Merovingian individuals from Ciply and Torgny, monks from the Dunes Abbey of Coxyde (Low Middle Ages)) for the total number of striations. The individuals are sorted in ascending order by their total number of striations.

5. Conclusion

This study provides information on health and dietary habits of ancient Easter Islanders.

Stress indicators show relatively good health conditions during childhood. Infantile malnutrition was far from being severe as opposed to the catastrophist theories (chaos, wars and famines following deforestation) popularized by DIAMOND (2005, pp. 79-119). The palaeopathologic study reveals, nevertheless, new cases of infectious diseases probably resulting from contact with Europeans or Americans. Enamel hypoplasia suggests gender disparities in the access to basic resources resulting from a preferential investment in boys.

Dental microwear evidences the dominant part of the tubers, which was their staple food. The preliminary stable isotope analysis shows that, on average, a little more than one third of their proteins came from the sea.

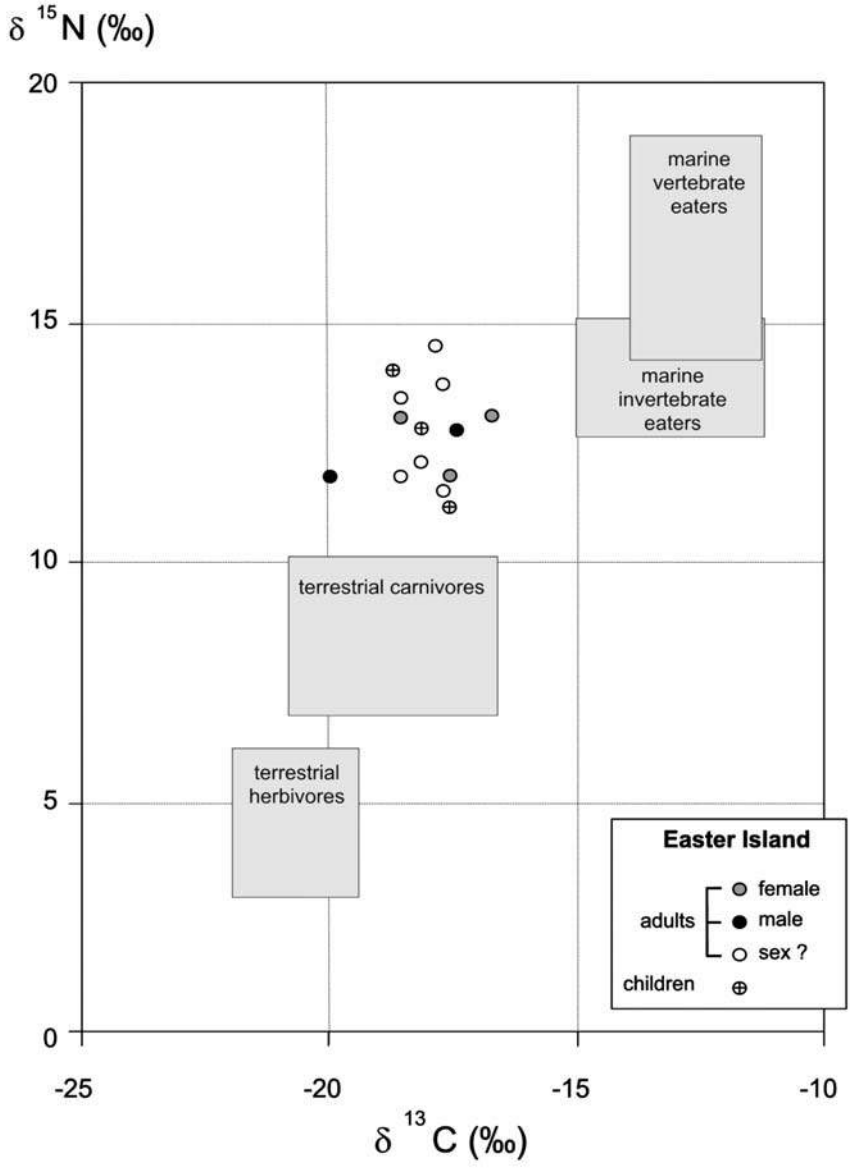


Fig. 10. — Bivariate plot of $\delta^{15}N$ and $\delta^{13}C$ values from animals of known feeding strategies (data from SCHOENINGER & DENIRO 1984) and fourteen Easter Islanders.

ACKNOWLEDGEMENTS

The Belgian Federal Science Policy financially supported the Belgian expeditions to Easter Island. I am most indebted to Francisco Torres Hochstetter, director of the Anthropological Museum Sebastián Englert (Easter Island) for giving me access to the anthropological collections. I thank Nicolas Cauwe (RMAH) and Dirk Huyge (RMAH) for showing me Easter Island and for inviting me to take part in their archaeological expeditions. Julien Cillis (RBINS) produced the SEM photographs. The analyses of stable carbon and nitrogen isotopes were performed by mass spectrometry in the *Institut für Geowissenschaften*, *Eberhard-Karls Universität Tübingen* (Germany) under the supervision of Hervé Bocherens. My thanks go also to Eric Dewamme (RBINS) for his photographs of the skeletons. I am especially thankful to Rosine Orban (RBINS) and Serge Lemaitre (ULB) for helpful discussions on drafts of the manuscript. I have appreciated the help of Claire Bellier (*Musée du Malgré-Tout*) and Tara Chapman (ULB) for the correction of my English.

NOTES

[1] The primary sources of this vitamin B12 are meat, poultry, (shell)fish, milk and eggs.
[2] This program can be downloaded at the following internet address: http://comp.uark.edu/~pungar/software.htm.
[3] Prehistoric here means prior to the first contacts with Europeans.
[4] The actual proportion of marine food in their diet must have been rather lower since collagen is preferentially produced from dietary proteins (AMBROSE & NORR 1993).

REFERENCES

AMBROSE, S. H. & NORR, L. 1993. Experimental evidence for the relationship of the carbon isotope ratios of whole diet and dietary protein to those of bone collagen and carbonate. — *In*: LAMBERT, J.B. & GRUPE, G. (Eds.), Prehistoric Human Bone: Archaeology at the Molecular Level. New York, Springer-Verlag, pp. 1-37

AYRES, W. S. 1985. Easter Island subsistence. — *Journal de la Société des Océanistes,* **80**: 103-124.

AYRES, W. S. & SALEEBY, B. 2000. Analysis of cremations from Ahu Ko Te Riku. — *In*: STEVENSON, C. M. & AYRES, W. S. (Eds.), Easter Island Archaeology: Research on Early Rapanui Culture. Los Osos (California), Easter Island Foundation, Bearsville Press, pp. 125-131.

AYRES, W. S., SALEEBY, B. & LEVY, C. 2000. Late Prehistoric-Early Historic Easter Island subsistence patterns. — *In*: STEVENSON, C. M. & AYRES, W. S. (Eds.), Easter Island Archaeology: Research on Early Rapanui Culture. Los Osos (California), Easter Island Foundation, Bearsville Press, pp. 191-203.

BAHN, P. G. 1993. The history of human settlement on Rapanui. — *In*: FISCHER, S. R. (Ed.), Contributions to the History of Rapanui in memory of William T. Mulloy (*Oxbow Monograph*, **32**). Oxford, Oxbow Books, pp. 53-55.

BOCHERENS, H. & DRUCKER, D. 2005. Biogéochimie isotopique et reconstitution de l'alimentation des humains anciens et des hominidés fossiles. — *In*: DUTOUR, O., HUBLIN, J.-J. & VANDERMEERSCH, B. (Eds.), Paléoanthropologie. Paris, CTHS, pp. 343-361.

BOCHERENS, H., FIZET, M., MARIOTTI, A., LANGE-BADRE, B., VANDERMEERSCH, B., BOREL, J.-P. & BELLON, G. 1991. Isotopic biogeochemistry (^{13}C, ^{15}N) of fossil vertebrate collagen: Application to the study of a past food web including Neanderthal Man. — *Journal of Human Evolution*, **20**: 481-492.

CAUWE, N. 2011. Ile de Pâques. Le grand tabou. — Louvain-la-Neuve, Versant-Sud, 165 pp.

CAUWE, N., HUYGE, D., DE MEULEMEESTER, J., DE DAPPER, M., CLAES, W., COUPE, D. & DE POORTER, A. 2006. Ahu Motu Toremo Hiva. Vie et mort de monuments cultuels sur 1'île de Pâques. — *Anthropologica et Præhistorica,* **117**: 89-114.

CUMMINGS, L. S. 1998. A review of recent pollen and phytolith studies from various contexts on Easter Island. — *In*: STEVENSON, C. M., LEE, G. & MORIN, F. J. (Eds.), Easter Island in Pacific context (South Seas Symposium: Proceedings of the Fourth International Conference on Easter Island and East Polynesia). Los Osos (California), The Easter Island Foundation, Bearsville and Cloud Mountain Presses, pp. 100-106.

DIAMOND, J. 2005. Collapse: How societies choose to fail or succeed. — New York, Penguin Books, 575 pp.

DU FEU, V. M. & FISCHER, S. R. 1993. The Rapanui language. — *In*: FISCHER, S. R. (Ed.), Contributions to the History of Rapanui in memory of William T. Mulloy (*Oxbow Monograph*, **32**). Oxford, Oxbow Books, pp. 165-168.

FISCHER, S. R. 2005. Island at the end of the world: The turbulent history of Easter Island. — London, Reaktion, 304 pp.

FISCHER, S. R. & LOVE, C. M. 1993. Rapanui: the geological parameters. — *In*: FISCHER, S. R. (Ed.), Contributions to the History of Rapanui in memory of William T. Mulloy (*Oxbow Monograph*, **32**). Oxford, Oxbow Books, pp. 1-6.

FLENLEY, J. R. 1993. The present flora of Easter Island and its origins. — *In*: FISCHER, S. R. (Ed.), Contributions to the History of Rapanui in memory of William T. Mulloy (*Oxbow Monograph*, **32**). Oxford, Oxbow Books, pp. 7-15.

FLENLEY, J. R. & KING, S. M. 1984. Late quaternary pollen records from Easter Island. — *Nature*, **307**: 47-50.

GARCIA-MARTIN, C. 2000. Reconstitution du régime alimentaire par l'étude des microtraces d'usure dentaire. — Université Libre de Bruxelles, European Master of Anthropology, 131 pp.

GILL, G. W. & OWSLEY, D. W. 1993. Human osteology of Rapanui. — *In*: FISCHER, S. R. (Ed.), Contributions to the History of Rapanui in memory of William T. Mulloy (*Oxbow Monograph*, **32**). Oxford, Oxbow Books, pp. 56-62.

GOODMAN, A. H. & ROSE, J. C. 1990. Assessment of systemic physiological perturbations from dental enamel hypoplasias and associated histological structures. — *Yearbook of physical Anthropology*, **33**: 59-110.

GUATELLI-STEINBERG, D. & LUKACS, J. R. 1999. Interpreting sex differences in enamel hypoplasia in human and non-human primates: Developmental, environmental, and cultural considerations. — *Yearbook of Physical Anthropology*, **42**: 73-126.

HACKETT, C. 1976. Diagnostic criteria of syphilis, yaws and treponarid (treponematosis) and of some other diseases in dry bone (for use in osteo-archaeology). — *Sitzungsberichte der Heidelberger Akademie der Wissenschaften, Mathematisch-Naturwissenschaftliche*, **3**: 351-470.

HAGELBERG, E., QUEVEDO, S., TURBON, D. & CLEGG, J. B. 1994. DNA from ancient Easter Islanders. — *Nature*, **369**: 25-26.

HUYGE, D. & CAUWE, N. (in coll. with FORMENT, F. & HAOA, S.) 2002. The Ahu o Rongo Project: Archaeological Research on Rapa Nui. — *Rapa Nui Journal,* **16** (1): 11-16.

HUNT, T. L. & LIPO, C. P. 2006. Late Colonization of Easter Island. — *Science*, **311**: 1603-1606.

KIRCH, P. 1984. The evolution of Polynesian chiefdoms. — Cambridge, Cambrige University Press, XII + 314 pp.

KOLMAN, C. J., CENTURION-LARA, A., LUKEHART, S. A., OWSLEY, D. W. & TUROSS, N. 1999. Identification of *Treponema pallidum* subspecies *pallidum* in a 200-year-old skeletal specimen. — *The Journal of Infectious Diseases*, **180**: 2060-2063.

LALUEZA, C., PEREZ-PEREZ, A. & TURBON, D. 1996. Dietary inferences through buccal microwear analysis of middle and upper Pleistocene human fossils. — *American Journal of Physical Anthropology,* **100**: 367-387.

LAVACHERY, H. 1935. La mission franco-belge dans l'île de Pâques (juillet 1934-avril 1935). — *Bulletin de la Société royale belge d'Anthropologie et de Préhistoire*, **50**: 228-264.

LINGSTROM, P., VAN HOUTE, J. & KASHKET, S. 2000. Food starches and dental caries. — *Critical Reviews in Oral Biology and Medicine,* **11** (3): 366-380.

MAUDE, H. E. 1981. Slavers in Paradise. The Peruvianan labour Trade in Polynesia, 1862-1864. — Stanford, Stanford University Press / Canberra, Australian University, 244 pp.

MAYS, S. A. 1997. Carbon stable isotope ratios in mediaeval and later human skeletons from Northern England. — *Journal of Archaeological Science,* **24**: 561-567.

METRAUX, A. 1941. L'île de Pâques. — Paris, Gallimard, coll. l'Espèce humaine, 195 pp.

METRAUX, A. 1971. Ethnology of Easter Island. — Honolulu (Hawaii), Bernice P. Bishop Museum, 432 pp. + 7 pl. (2nd ed.).

MOLLESON, T., JONES, K. & JONES, S. 1993. Dietary change and the effects of food preparation on microwear patterns in the Late Neolithic of Abu Hureyra, Northern Syria. — *Journal of Human Evolution,* **24**: 455-468.

ORLIAC, C. & ORLIAC, M. 1998. The disappearance of Easter Island's forest: Over-exploitation or climatic catastrophe? — *In*: STEVENSON, C. M., LEE, G. & MORIN, F. J. (Eds.), Easter Island in Pacific context (South Seas Symposium: Proceedings of the Fourth International Conference on Easter Island and East Polynesia). Los Osos (California), The Easter Island Foundation, Bearsville and Cloud Mountain Presses, pp. 129-134.

ORTNER, D. J. 2008. Differential diagnosis of skeletal lesions in infectious disease. — *In*: PINHASI, R. & MAYS, S. (Eds.), Advances in human paleopathology. Chichester (England), John Wiley & Sons Ltd., pp. 191-215.

OWSLEY, D. W., MILES, A.-M. & GILL, G. W. 1983. Caries frequency in deciduous dentitions of protohistoric Easter Islanders. — *Bulletin of the Indo-Pacific Prehistory Association,* **4**: 143-148.

OWSLEY, D. W., MILES, A.-M. & GILL, G. W. 1985. Carious lesions in permanent dentitions of protohistoric Easter Islanders. — *The Journal of the Polynesian Society,* **94** (4): 415-422.

OWSLEY, D. W., GILL, G. W. & OUSLEY, S. D. 1994. Biological effects of European contact on Easter Island. — *In*: LARSEN, C. S. & MILNER, G. R. (Eds.), In the wake of contact. Biological responses to conquest. New York, Wiley-Liss, pp. 161-177.

OXENHAM, M. F. & CAVILL, I. 2010. Porotic hyperostosis and *cribra orbitalia*: The erythropoietic response to iron-deficiency anaemia. — *Anthropological Science*, **118** (3): 199-200.

PIETRUSEWSKY, M., DOUGLAS, M. T. & IKEHARA-QUEBRAL, R. M. 1997. An assessment of health and disease in the prehistoric inhabitants of the Mariana Islands. — *American Journal of Physical Anthropology*, **104**: 315-342.

POLET, C. 2003. Study of human remains discovered in 2001 at Ahu 'o Rongo, Rapa Nui. — *Rapa Nui Journal,* **17** (2): 114-118.

POLET, C. 2006a. Indicateurs de stress dans un échantillon d'anciens Pascuans. — *Antropo,* **11**: 261-270.

POLET, C. 2006b. Ostéobiographie du squelette d'Ahu Motu Toremo Hiva (île de Pâques, Chili). — *Anthropologica et Præhistorica,* **117**: 115-133.

POLET, C. 2008. Apport des isotopes stables à la paléo-anthropologie. — *In*: CHARLIER, P. (éd.), Ostéo-archéologie et techniques médico-légales: tendances et perspectives. Pour un «Manuel pratique de paléopathologie humaine». Paris, De Boccard, pp. 151-163.

POLET, C. 2011. Pathologies traumatiques et infectieuses observées sur le squelette. — *In*: BEAUTHIER, J.-P. (éd.), Traité de médecine légale. Bruxelles, De Boeck, pp. 485-523.

POLET, C. & ORBAN, R. 2001. Les dents et les ossements humains. Que mangeait-on au Moyen Age? (*Typologie des sources du Moyen Age occidental*, **84**). — Turnhout, Brepols, 183 pp.

POLET, C., BOURDON, C., VERCAUTEREN, M. & SLACHMUYLDER, J.-L. 2008. Apport de la micro-usure dentaire à la reconstitution du régime alimentaire des anciens Pascuans. — *Bulletins et Mémoires de la Société d'Anthropologie de Paris*, N.S., **20** (3-4): 165-187.

POLLOCK, N. J. 1993. Traditional foods of Rapanui. — *In*: FISCHER, S. R. (Ed.), Contributions to the History of Rapanui in memory of William T. Mulloy (*Oxbow Monograph*, **32**). Oxford, Oxbow Books, pp. 153-157.

ROUTLEDGE, K. 1919. The mystery of Easter Island. — Kemton (Illinois, USA), Adventures Unlimited Press, 404 pp.

SCHOENINGER, M. & DENIRO, M. 1984. Nitrogen and carbon isotopic composition of bone collagen from marine and terrestrial animals. — *Geochimica et Cosmochimica Acta,* **48**: 625-639.

SEELENFREUND, A. 2000. Easter Island burial practices. — *In*: STEVENSON, C. M. & AYRES, W. S. (Eds.), Easter Island Archaeology: Research on Early Rapanui Culture. Los Osos (California), Easter Island Foundation, Bearsville Press, pp. 81-102.

SHAW, L. C. 2000. Human burials in the coastal caves of Easter Island. — *In*: STEVENSON, C. M. & AYRES, W. S. (Eds.), Easter Island Archaeology: Research on Early Rapanui Culture. Los Osos (California), Easter Island Foundation, Bearsville Press, pp. 125-131.

STEADMAN, D. W., CASANOVA, P. V. & FERRANDO, C. C. 1994. Stratigraphy, chronology and cultural context of an early faunal assemblage from Easter Island. — *Asian Perspectives,* **33** (1): 79-96.

STEPHAN, V. H. 1999. Craniometric variation and homogeneity in prehistoric Rapa Nui (Easter Island) regional populations. — *American Journal of Physical Anthropology*, **110**: 407-419.

STEVENSON, C. & HAOA, S. 1998. Prehistoric gardening systems and agricultural intensification in the La Perouse area of Easter Island. — *In*: STEVENSON, C. M., LEE, G. & MORIN, F. J. (Eds.), Easter Island in Pacific context (South Seas Symposium: Proceedings of the Fourth International Conference on Easter Island and East Polynesia). Los Osos (California), The Easter Island Foundation, Bearsville and Cloud Mountain Presses, pp. 205-213.

STODDER, A. L. 1997. Subadult stress, morbidity, and longevity in Latte Period populations on Guam, Mariana Islands. — *American Journal of Physical Anthropology*, **104**: 363-380.

STUART-MACADAM, P. 1992. Porotic hyperostosis: A new perspective. — *American Journal of physical Anthropology*, **87**: 39-47.

TEAFORD, M. F. 1994. Dental microwear and dental function. — *Evolutionary Anthropology,* **3** (1): 17-30.

TURNER, C. G. & SCOTT, G. R. 1977. Dentition of Easter Islanders. — *In*: DAHLBERG, A. & GRABER, T. M. (Eds.), *Orofacial growth and development*. The Hague, Mouton publishers, pp. 229-249.

TYKOT, R. H. 2004. Stable Isotopes and Diet: You Are What You Eat. — *In*: MARTINI, M., MILAZZO, M. & PIACENTINI, M. (Eds.), Physics Methods in Archaeometry (Proceedings of the International School of Physics "Enrico Fermi" Course CLIV). Bologna, Società Italiana di Fisica, pp. 433-444.

UNGAR, P. S. 1995. A semiautomated image analysis procedure for the quantification of dental microwear II. — *Scanning,* **17**: 57-59.

WALKER, P. L., BATHURST, R. R., RICHMAN, R., GJERDRUM, T. & ANDRUSHKO, V. A. 2009. The causes of porotic hyperostosis and cribra orbitalia: A reappraisal of the iron-deficiency-anemia hypothesis. — *American Journal of Physical Anthropology*, **139** (2): 109-125.

Bull. Séanc. Acad. R. Sci. Outre-Mer
Meded. Zitt. K. Acad. Overzeese Wet.
57 (2-4 – 2011): 355-373

L'Himalaya, un laboratoire à ciel ouvert pour géomorphologues*

par

Monique FORT**

MOTS-CLES. — Himalaya; Collision intracontinentale; Risques naturels; Changement climatique.

RESUME. — L'Himalaya, chaîne de montagnes la plus haute de la Terre, est le résultat de la collision toujours active des plaques Inde et Asie. Les fronts de chevauchement, de plus en plus élevés vers le nord, alternent avec des bassins intramontagnards. Les taux élevés de surrection de la chaîne, l'activité sismique ainsi que les précipitations extrêmes de la mousson sont autant de facteurs qui provoquent l'incision des rivières et le déclenchement de glissements de terrain, principale source de sédiments et cause potentielle de blocages et d'inondations catastrophiques dans les vallées. Au cours des dernières décennies, croissance démographique et développement des infrastructures ont accru l'impact des risques naturels. De plus, l'évolution récente du climat et le recul des glaciers du Haut-Himalaya pourraient indirectement menacer les ressources en eau de l'ensemble de la chaîne et de son piémont.

TREFWOORDEN. — Himalaya; Intracontinentale botsing; Natuurlijke risico's; Klimaatverandering.

SAMENVATTING. — *De Himalaya, een openluchtlaboratorium voor geomorfologen.* — De Himalaya, het hoogste reliëf op Aarde, is het resultaat van de botsing tussen Indië en Azië, twee continentale tektonische platen die nog steeds actief bewegen. Overschuivingsfronten vormen bergketens die afwisselen met intramontane bekkens. De rivieren snijden zich sterk in ten gevolge van verschillende factoren: de hoge snelheid waarmee de bergketens opgeheven worden, de hoge seismische activiteit en de extreme neerslagdebieten van de moesson. Aardverschuivingen, het resultaat van deze sterke rivierinsnijding, zijn de voornaamste sedimentbron; ze kunnen de dalbodems afdammen en zo catastrofale overstromingen veroorzaken. De explosieve bevolkingsgroei en de infrastructurele ontwikkeling van de laatste decennia hebben de impact van natuurlijke risico's sterk verhoogd. Daarenboven kan de recente klimaatverandering en het terugtrekken van de gletsjers in de Hoge Himalaya indirect de beschikbaarheid van water in de gehele bergketen en het heuvelland aan de voet ervan bedreigen.

KEYWORDS. — Himalaya; Intracontinental Collision; Natural Hazards; Climatic Change.

SUMMARY. — *The Himalayas: An Outdoor Laboratory for Geomorphologists.* — The Himalayas, the highest relief on Earth, is a product of the ongoing collision between

---

* Communication présentée à la séance commune des trois Classes tenue le 7 juin 2011. Décision de publication prise le 27 mars 2012. Texte définitif reçu le 3 mai 2012.

** Prof. Université Paris Diderot, Sorbonne Paris Cité, UMR 8586 PRODIG, C.P. 7001 (GHSS), bât. ODG, rue A. Einstein, F-75205 Paris Cedex 13 (France).

India and Asia. Thrust ridges, higher and higher when going northward, alternate with intramontane basins. High uplift rates, seismic activity and extreme monsoon rainfall are so many factors causing river incision and landsliding, a major source of sediment and the potential cause of valley blockage and catastrophic flooding. Over the last decades, population growth and infrastructure development have increased the impact of natural hazards. Moreover, recent trends in climate could indirectly threaten glaciation in the Greater Himalaya, and possibly water resources throughout the whole range and its piedmont.

Introduction

L'Himalaya constitue les plus hauts reliefs de la Terre. L'ampleur des dénivellations, l'étagement des milieux bioclimatiques, la magnitude et la rapidité des processus naturels en œuvre, font de cette chaîne de montagnes un laboratoire à ciel ouvert exceptionnel, qui permet de comprendre le fonctionnement des autres systèmes montagneux. Montagne tropicale, l'Himalaya accueille de fortes densités de population. Au cours des dernières décennies, l'urbanisation et le développement des infrastructures liés à la croissance démographique ont accru la vulnérabilité aux risques naturels, tandis que l'évolution récente du climat et, dans une moindre mesure, le recul des glaciers pourraient indirectement menacer l'accès des populations à la ressource en eau.

Notre propos est d'insister d'abord sur l'apport de l'Himalaya à la connaissance de la géomorphologie d'une chaîne de montagnes, en particulier sur les mécanismes de formation des reliefs, liés à la collision des plaques Inde et Asie. Nous évoquerons ensuite, dans un contexte bioclimatique dominé par la mousson, les interactions entre forces internes et externes sur le développement de risques naturels, tels que les glissements de terrain, les inondations ou les séismes. Enfin, dans un monde moderne en pleine mutation, il conviendra de s'interroger sur les menaces spécifiques que fait peser le changement global sur cette montagne densément peuplée, menaces qui pourraient remettre en cause le développement économique et la qualité des conditions de vie des populations montagnardes.

Une chaîne de montagnes géodynamiquement active

L'Himalaya est le résultat de la collision des plaques Inde et Asie, qui se poursuit depuis près de cinquante millions d'années. La convergence de ces deux plaques, à un rythme de l'ordre de 5 cm/an, est un processus toujours actif, qui entraîne la déformation de la plaque indienne en grandes lames — ou nappes — de croûte continentale, progressivement mises en place du nord vers le sud, et ce depuis environ vingt millions d'années (MOLNAR & TAPPONNIER 1975, VALDIYA 1998). La superposition de ces nappes, qui s'ancrent en profondeur au

niveau d'un grand plan de décollement (le MHT, ou grand chevauchement himalayen), a conduit à un épaississement de la croûte (près de deux fois celle de la croûte indienne, avec une racine à près de 75 km de profondeur) qui, par simple effet isostatique «passif», suffirait à expliquer l'ampleur des reliefs ainsi créés (fig. 1; BOLLINGER *et al*. 2004). Néanmoins, la convergence entretenue des deux plaques et la compression qui en résulte redressent peu à peu les plans de chevauchement (DELCAILLAU 1992), créant ainsi des zones de soulèvement «actif» de l'édifice himalayen, d'autant plus important que l'on se déplace vers le nord, vers la zone la plus interne de la montagne. Cette dynamique permet d'expliquer les traits caractéristiques des reliefs himalayens, constitués d'unités de relief parallèles s'étirant sur près de 2 500 km d'est en ouest.

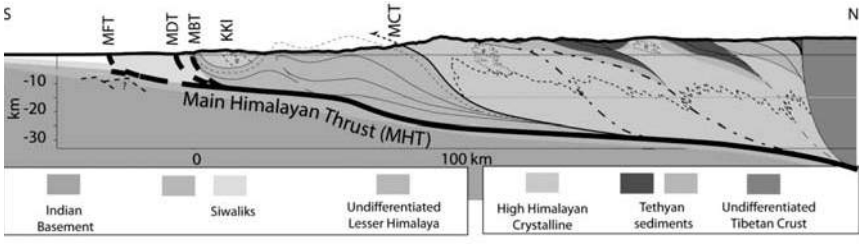


Fig. 1. — Coupe géologique de la chaîne himalayenne au niveau de Kathmandou (Népal) et ses principales unités morphostructurales: la plaine du Terai, au sud du Chevauchement Frontal Principal (MFT); les collines des Siwaliks entre le MFT et le Chevauchement Bordier Principal (MBT) avec d'autres chevauchements intermédiaires, tel le Chevauchement Principal des Duns (MDT); le Mahabharat Lekh (Bas-Himalaya), puis le Pahar sont bordés au nord par le Chevauchement Central Principal (MCT), que domine le Haut-Himalaya (d'après BOLLINGER *et al*. 2004).

L'édifice himalayen est en fait une alternance de chaînons montagneux liés aux fronts de chevauchement, séparés par des bassins intramontagnards de revers dans lesquels les dépôts piégés permettent de retracer les modalités d'évolution des formes de relief au cours des périodes récentes, en particulier sous l'influence de la tectonique et du climat (FORT 1993, 2011b). Le long de la transversale de l'Himalaya central, au Népal, se succèdent du sud vers le nord les unités suivantes: le piémont du Terai, construit depuis près de quinze millions d'années par les divagations des rivières himalayennes, puis les collines des Siwaliks ou *Churia Hills*, zone de tectonique très active, qui se soulève à un rythme moyen de 8 mm/an (fig. 2). Ces collines, longues crêtes étroites et dissymétriques (leur front raide est tourné vers le sud) séparées par des bassins allongés ou «duns», sont dominées au nord par un premier front montagneux, celui du Bas-Himalaya ou Chaîne Bordière (Mahabharat Lekh au Népal, Pir Panjal au Cachemire); limitée à la base par le Chevauchement Bordier (MBT), cette unité s'élève à plus de 3 000 m et peut même atteindre près de 5 000 m au Cachemire. Les terrains, essentiellement d'âge précambrien (plus de six cent millions d'années), sont de nature variée (calcaires, granites intrusifs notamment), avec une prédominance

Fig. 2. — Les formations molassiques des Siwaliks, anciens dépôts de piémonts aujourd'hui déformés (plongement vers le nord) par la convergence Inde-Asie et intégrés à l'édifice montagneux (© M. Fort, 1978).

de terrains schisteux dans la partie supérieure; leur faible résistance à l'érosion explique le développement, au nord de ces moyennes montagnes, d'une zone relativement déprimée ou «Pahar», très peuplée, où se succède une série de bassins de confluences fluviales (Pokhara) ou d'anciennes cuvettes lacustres perchées d'âge plio-quaternaire (Kathmandou, Cachemire). Le fond plat de ces bassins offrit aux premières sociétés de bonnes conditions de développement de la riziculture, dont l'espace est aujourd'hui concurrencé par la progression incontrôlée de l'urbanisation. Plus au nord, ces bassins sont bordés par un front montagneux vigoureux, celui du Haut-Himalaya, limité à la base par le Chevauchement Central. Cette zone de cisaillement majeur, très déformée, met en contact les schistes du Bas-Himalaya avec les unités cristallines du Haut-Himalaya, à leur tour surmontées par des formations sédimentaires plus ou moins métamorphisées au niveau de la Faille Nord-Himalayenne. L'ensemble, qui représente près de quinze kilomètres de croûte basculée vers le nord, sous-tend les sommets englacés de l'Himalaya («Demeure des neiges» en sanskrit) qui, à plusieurs reprises, dépassent l'altitude mythique de 8 000 m, avec des parois rocheuses matérialisant de façon spectaculaire l'épaississement de la bordure nord de la croûte indienne après sa collision avec l'Asie (fig. 3). Au nord de la Haute Chaîne, les altitudes décroissent relativement (6 000-6 500 m) mais les pentes, taillées dans les formations sédimentaires «tibétaines» plissées, du cambrien à l'éocène (de cinq cent quarante à cinquante millions d'années), demeurent raides

et fortement marquées par l'aridité et le froid. La population est plus clairsemée, pratiquant une activité agropastorale, faite de migrations entre le village, autour duquel se concentrent les champs irrigués, et les alpages d'altitude (ovins et yacks), tandis qu'en hiver, les hommes descendent jusque dans les plaines indiennes échanger leurs produits avec ceux de la zone tropicale.

Fig. 3. — La Haute Chaîne himalayenne et la face ouest de l'Annapurna I (8 072 m) dominent la vallée de la Kali Gandaki, qui s'écoule à 2 200 m d'altitude. On notera la forte inclinaison des structures vers le nord (gauche de la photo) et le passage progressif des terrains cristallins du Haut-Himalaya aux sédiments faiblement métamorphisés des unités «tibétaines». La masse boisée dans le centre inférieur de la photo correspond à un mégaglissement préhistorique qui continue de bloquer durablement l'érosion régressive de la Kali Gandaki vers le nord (© M. Fort, 1978).

Les risques naturels en Himalaya

Au cours des dernières décennies, la croissance démographique et le développement des infrastructures ont accru la vulnérabilité des sociétés aux risques naturels. Plusieurs facteurs concourent à rendre cette montagne particulièrement sensible aux aléas naturels: les forts taux de surrection de la chaîne, l'activité sismique ainsi que les précipitations extrêmes de la mousson engendrent un système particulièrement actif, se traduisant par une incision rapide des rivières et une forte connectivité entre le chenal et la base des versants. Il n'est donc pas étonnant que ces conditions d'instabilité géodynamique chronique entraînent à la fois une forte mobilité des versants et le développement de crues souvent catastrophiques.

Le risque sismique

L'aléa sismique fait partie intégrante de l'édification de la chaîne himalayenne et traduit la déformation inéluctable de l'écorce de la plaque indienne en réponse au rapprochement de cette dernière vers le nord (Cattin & Avouac 2000). En fait, il existe une importante micro-séismicité assez largement répandue au sud de la Haute Chaîne himalayenne, mais ces petits tremblements de terre, qui ne sont pas ressentis par les hommes, n'ont pas de conséquences directes perceptibles, si ce n'est de favoriser localement la fissuration des roches et à terme de les fragiliser. En revanche, l'Himalaya peut être affecté de grands séismes très destructeurs. L'un des plus récents est celui du Cachemire (magnitude de moment $M_w = 7{,}6$), qui a fait près de quatre-vingt mille morts et plus de cent vingt mille blessés. D'autres grands séismes ont frappé la chaîne au cours du dernier siècle (1905: Kangra, $M_w = 7{,}8$, près de vingt mille morts; 1934: Bihar Népal, $M_w = 8{,}1$, quinze mille morts et près de quatre-vingt-dix mille sinistrés; 1950: Assam, $M_w > 8{,}4$, nombre exact de victimes inconnu, mais destructions sur près de 50 000 km^2). Tous correspondent au jeu des chevauchements vers le sud lié à la convergence Inde-Eurasie (Bilham 1995). Ces séismes, et d'autres de magnitude plus faible ($M_w \geq 5$), restent une menace constante pour les populations himalayennes. La distribution de la séismicité enregistrée au Népal depuis plus de vingt ans (Sapkota 2011) montre que les séismes sont particulièrement fréquents au sud de la Haute Chaîne (fig. 4). Dans cette zone de 100 à 150 km de large, délimitée approximativement au nord par une altitude de 3 500 m, s'accumule en profondeur un maximum de contraintes, là où le MHT se raidit et bloque, avant que l'énergie accumulée pendant deux ou trois siècles ne soit brutalement relâchée (Bollinger *et al*. 2004).

Or c'est dans cette zone sud-himalayenne, qui inclut les moyennes montagnes, les collines des Siwaliks et le piémont, que les densités de population sont les plus élevées (> 200 habitants/km^2). Du fait de l'exode rural des dernières décennies, les villes des bassins intérieurs du Pahar (Kathmandou, Pokhara, Srinagar) et du piémont himalayen, particulièrement vulnérables, risquent de subir les plus grosses pertes matérielles et humaines. En effet, la sismologie historique et les progrès récents en géophysique ont montré que sur le front himalayen, les séismes de $M_w > 8$ avaient une probabilité d'occurrence forte sur des périodes durant de cent cinquante à deux cents ans, alternant avec des périodes de calme sismique relatif (faible sismicité) qui pouvaient durer de cinq cents à six cents ans (Sapkota 2011). La partie centrale de la chaîne himalayenne est l'une des zones les plus susceptibles de connaître un fort séisme au cours du siècle à venir. La menace est diffuse, mais lorsqu'elle se concrétisera, elle affectera sans discrimination zones rurales et urbanisées. C'est dans ces dernières que la situation peut devenir instantanément catastrophique, du fait des concentrations de population, de la mauvaise qualité générale des constructions, de la rupture de tous les réseaux de communication et de transport, et de l'incapacité matérielle et humaine à faire face à un afflux de blessés. La vallée de Kathmandou (> 2,5 millions d'habitants; fig. 5), qui a été fortement affectée en 1934 par le séisme du Bihar, n'est pas à

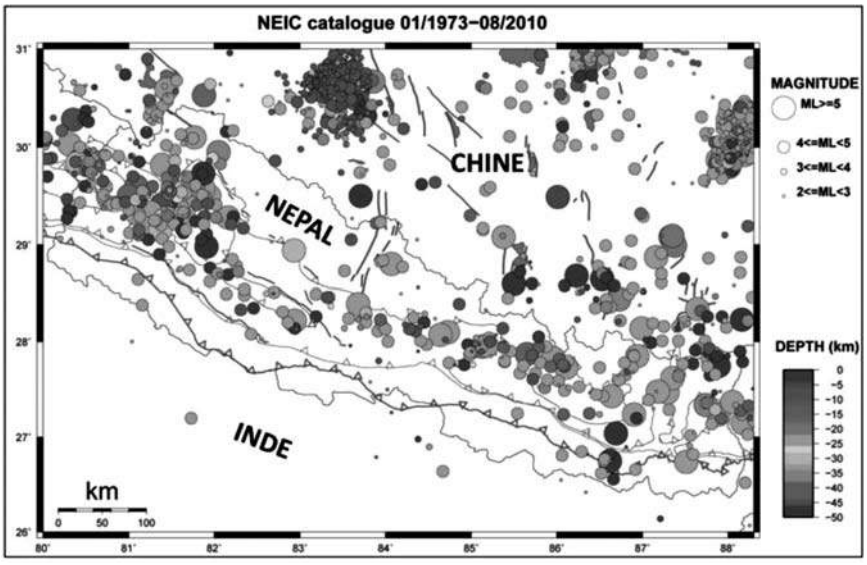


Fig. 4. — Carte de sismicité du Népal fournie par le catalogue du *National Earthquake Information Center* américain (téléséismes). On notera une concentration des séismes au nord et au-dessus des deux principaux chevauchements, bordier et central respectivement (d'après SAPKOTA 2011).

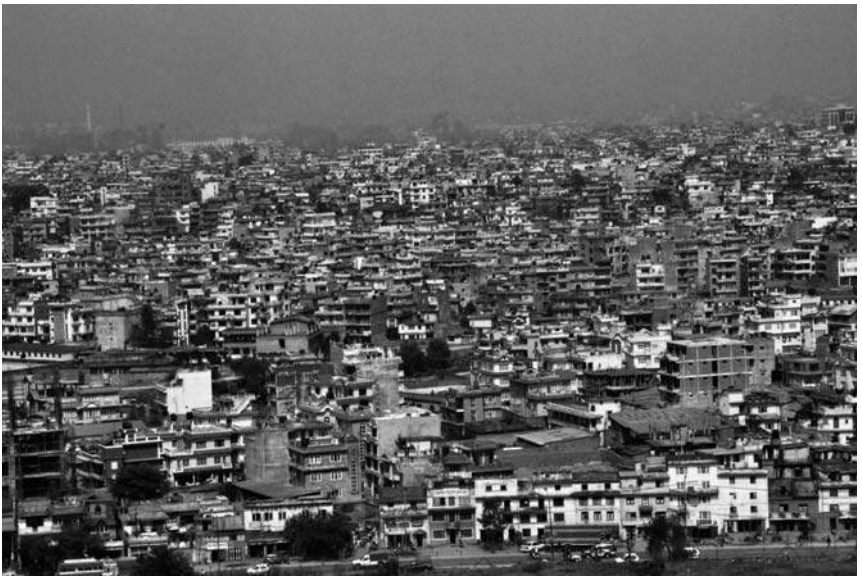


Fig. 5. — La vallée de Kathmandou (> 2,5 millions d'habitants) est sous la menace d'un séisme majeur, dont les impacts seraient aggravés par le sous-sol constitué d'anciens sédiments lacustres. L'urbanisation accélérée et anarchique de la capitale du Népal, au cours des deux dernières décennies, a considérablement accru la vulnérabilité des populations (© M. Fort, 2010).

l'abri d'un nouveau grand séisme (BILHAM & WALLACE 2005, SAPKOTA 2011): celui ci sera d'autant plus destructeur que le sous-sol est constitué d'anciens sédiments lacustres, propices à l'amplification des vibrations telluriques.

LES MOUVEMENTS DE TERRAIN

Les mouvements de terrain sont présents dans toutes les montagnes du monde, et *a fortiori* en Himalaya. En premier lieu, les amplitudes de relief très élevées et les fortes pentes favorisent toute forme d'instabilité dès que l'on dépasse un certain angle d'équilibre (32° ± 2°); or l'incision active des rivières en réponse à la surrection himalayenne entretient un raidissement, donc un déséquilibre permanent à la base des versants. L'autre facteur prédisposant est la nature plus ou moins résistante des terrains. Certaines roches sont massives (comme les gneiss ou les granites du Haut-Himalaya). D'autres comme les schistes, qui prédominent dans le Bas-Himalaya où l'occupation humaine est la plus dense, sont en revanche susceptibles de se gorger d'humidité, de fluer ou de glisser sur la pente, donnant lieu à des mouvements de terrain qui peuvent affecter tout ou partie d'un versant. Enfin, certains versants sont recouverts d'un épais manteau de débris hérités d'anciens glissements de terrain (fig. 6): l'hétérogénéité de tels matériaux les rend particulièrement instables et propices à des relais de processus (glissements purs, glissements par coulées, ravinements et laves torrentielles).

A plus de 90 %, les instabilités des versants himalayens sont déclenchées suite à une saturation hydrique des terrains liée aux fortes précipitations de mousson (BRUNSDEN *et al*. 1981, DAHAL & HASEGAWA 2008); au niveau du front de la Haute Chaîne, on peut même dépasser 5 000 mm/an (flanc sud des Annapurnas). La pression interstitielle de l'eau, qui occupe tous les pores du matériau, l'alourdit, augmente la composante gravitaire et provoque ainsi la rupture et la mise en mouvement de la couverture meuble du versant. Le montant de précipitation nécessaire au déclenchement du mouvement reste un sujet de discussion, car il est difficile d'isoler ce paramètre des autres facteurs favorables (exposition et valeur de la pente, nature des minéraux phylliteux, densité de fracturation des roches, ampleur et morphologie générale du versant, …). Trois paramètres sont particulièrement importants: le seuil de précipitation, le cumul et l'historique des pluies. Lors de la séquence pluvieuse, le seuil de précipitation susceptible de déclencher des mouvements de terrain varie selon les événements observés: de 100 mm à 260 mm/24h (STARKEL 1976, FROEHLICH & STARKEL 1987, DAHAL *et al*. 2006). Par ailleurs et selon les mêmes auteurs, un cumul de pluie de > 350 mm en trois jours serait suffisant pour déclencher les glissements. Enfin, la combinaison de pluies journalières d'au moins 144 mm et de pluies antérieures, cumulées sur plusieurs jours voire plusieurs mois (DAHAL & HASEGAWA 2008, GABET *et al*. 2004), augmentera la pression hydrostatique des terrains jusqu'au point de rupture. Il n'est donc pas étonnant de constater que c'est surtout en fin de période de mousson, lorsque les terrains sont saturés, que se produisent préférentiellement

les mouvements de terrain (CARSON 1985), ce qui n'exclut évidemment pas l'occurrence d'événements extrêmes isolés, par exemple lors des orages printaniers.

Le deuxième facteur déclenchant est la séismicité, avec des conséquences morpho-hydrologiques qui peuvent être particulièrement dramatiques. Des centaines de glissements de terrain se sont produits à la suite des séismes du Cachemire (2005) et du Sichuan (2008), y compris sur des versants couverts de forêts, mais bien peu parmi ces glissements ont excédé un volume de 10^6 m^3. Pourtant, des villages ont été emportés, les réseaux de communication détruits, créant une situation de désorganisation telle que l'accès aux sinistrés a été rendu très difficile. En Himalaya, les mouvements de terrain les plus volumineux ($> 10^9$ m^3), pour la plupart d'âge préhistorique, sont de type avalanche rocheuse et ont pu être déclenchés par des tremblements de terre, comme cela a été suggéré au Népal dans le bassin de Pokhara (FORT 1987) ou sur les contreforts du Dhaulagiri (FORT 2000) ou de l'Annapurna (FORT 2011a). Même si leurs effets (blocage de vallées, réorganisation du réseau hydrographique) se font encore sentir plusieurs milliers d'années après, le rôle de ces mégaséismes destructeurs ($M_w \geq 7{,}5$; d'après KEEFER 1994) n'a pourtant rien de comparable en termes de fréquence avec la périodicité annuelle de la mousson, et il est de fait souvent difficile d'établir une corrélation nette entre séismicité moyenne et déclenchement de mouvements de terrain. Dans la majorité des cas ($M_w < 5$), les séismes doivent plutôt être considérés comme des facteurs préparatoires (fissuration des roches), favorisant l'infiltration des eaux et les ruptures brutales de versants lors des moussons suivantes.

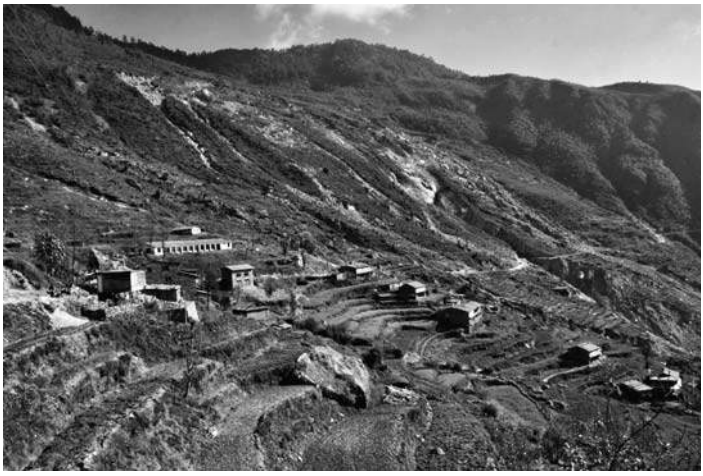


Fig. 6. — Mouvement de terrain actif de Ramche (vallée de la Trisuli), affectant d'anciens dépôts de versants glissés (*cf.* les gros blocs qui parsèment les pentes, comme au premier plan). Ce secteur, particulièrement dynamique, menace la nouvelle route (à mi-pente du versant) destinée à développer les échanges directs entre la Chine, Kathmandou et le sud du Népal. Les longues balafres d'incision torrentielles, fonctionnelles lors de chaque mousson, causent fréquemment des interruptions de circulation de plusieurs jours (© M. Fort, 2010).

Un troisième facteur déclenchant est de plus en plus invoqué pour les zones de haute montagne. La diminution de volume des glaciers himalayens, et l'amincissement des langues en particulier, fait disparaître la fonction de «contrefort» que les glaces exerçaient à la base des versants raidis, et crée donc un relâchement des contraintes qui peut engendrer une réaction «paraglaciaire». Celle-ci se traduit par une recrudescence de vastes écroulements pouvant affecter toute une paroi de montagne (EVANS & CLAGUE 1994). Au Pakistan, près de trois cents mouvements géants ont été inventoriés, dont la cause est généralement attribuée au double effet du retrait des glaces et de la séismicité, également forte dans ce secteur de «syntaxe» himalayenne (HEWITT 2009). Enfin, la remontée de l'isotherme 0° C en altitude peut aussi provoquer la fusion du pergélisol rocheux et l'occurrence d'écroulements rocheux, comme cela a été récemment mis en évidence dans les Alpes (RAVANEL & DELINE 2010). Mais la faible occupation humaine des hautes vallées amène, de fait, à considérer les précipitations de mousson comme le facteur déclenchant des mouvements de terrain le plus dangereux.

LES RISQUES D'INONDATION

Les inondations constituent une autre menace qui pèse fortement sur les vallées himalayennes et leur piémont. Les inondations ne doivent pas être confondues avec les crues, montées saisonnières et prévisibles des eaux liées aux variations annuelles du bilan hydrologique (fonte des glaces et des neiges, pluies de mousson). Quand il y a inondation, la rivière sort de son chenal brutalement, pour occuper un espace qui d'ordinaire est hors d'eau. Plusieurs situations peuvent se présenter, selon la morphologie de la vallée et du lit de la rivière, selon l'existence ou non de glaciers en amont des vallées.

Dans les hautes vallées, le recul marqué de la plupart des glaciers (DYURGEROV & MEIER 2005, BOLCH *et al*. 2011) se traduit par le développement, de plus en plus rapide, de lacs proglaciaires en arrière des moraines frontales (BAJRACHARYA & MOOL 2009). Le phénomène est particulièrement spectaculaire dans la partie orientale de l'Himalaya où les vallées intérieures, situées à plus de 4 000 m d'altitude, sont occupées par des langues glaciaires à faible pente longitudinale. Plusieurs milliers de ces lacs ont ainsi été répertoriés, et certains d'entre eux inspirent de vives inquiétudes du fait de la fragilité apparente de leur barrage morainique. Dans un passé récent, plusieurs crues catastrophiques se sont produites par rupture de ces moraines, tant sur le versant sud (zone de l'Everest, du Bhoutan, zone du Mustang) que sur le versant nord-tibétain, causant de très graves dégâts sur plusieurs dizaines de kilomètres en aval (VUICHARD & ZIMMERMANN 1987, BOLCH *et al*. 2008). La surveillance de ces lacs, qu'autorise maintenant la répétitivité des images satellitaires, permet de suivre chaque année l'augmentation de leur surface et, le cas échéant, de mettre en œuvre des mesures de drainage d'urgence pour protéger les villages situés en contrebas.

Plus en aval dans les vallées, la succession de gorges profondes alternant avec des élargissements plus ou moins marqués se traduit par des phénomènes de réactions en chaîne particulièrement dévastateurs. Une onde de crue, lorsqu'elle se propage, se traduit par une montée d'eau dans les gorges tandis qu'au niveau de chaque élargissement, la rivière «respire» et s'étale, engendrant une forte érosion des berges au détriment de secteurs de terrasses habitées ou cultivées (fig. 7). Ces excès sont très fréquemment provoqués par l'injection brutale dans le lit de la rivière de débris qui non seulement augmentent le volume du flot, mais accroissent aussi son pouvoir destructeur. Ces débris peuvent être apportés par des torrents affluents, sous forme de laves torrentielles (fig. 8), ou par des glissements de terrain qui, s'ils sont suffisamment volumineux, peuvent aller jusqu'à bloquer la vallée (fig. 9). Se forme alors un lac en amont, qui peut submerger des zones habitées (FORT *et al*. 2010, FORT & COSSART 2011). Si le barrage cède brutalement, l'onde de crue dévastatrice déferle alors sur plusieurs kilomètres ou dizaines de kilomètres en aval de la vallée, onde qui peut à son tour déclencher de nouveaux glissements de terrain, lesquels créent de nouveaux barrages, etc. Même s'il s'agit souvent de lacs éphémères, les dégâts peuvent être importants. Le développement récent d'infrastructures routières, qui suivent de préférence les fonds de vallée, révèle souvent une méconnaissance de ce type de risque par les ingénieurs. De même, les ponts qui enjambent les affluents sont rarement calibrés pour laisser passer des laves torrentielles, d'où l'endommagement possible de telles structures, aux conséquences catastrophiques (ADHIKARY & KOSHIMIZU 2005, FORT *et al*. 2010).

Fig. 7. — Erosion de berge (> 20 m de hauteur) dans la moyenne vallée de la Kali Gandaki. Un glissement de terrain a partiellement obstrué la vallée en amont, repoussant la rivière sur la rive opposée. Plusieurs centaines d'hectares de terres ont ainsi été emportées, ainsi que quelques têtes de bétail. Quelques semaines après l'événement (septembre 1999), la rivière a réintégré son chenal principal, à droite de la photo (© M. Fort, 2000).

Fig. 8. — Lave torrentielle, déclenchée lors d'un très gros orage printanier au sud du massif du Dhaulagiri. L'abondante charge solide (plus de 50 %), constituée d'un mélange de boue, de fragments rocheux et de blocs pouvant excéder le mètre cube de volume, a été injectée dans le lit torrentiel par de nombreux petits glissements qui se sont déclenchés en amont du bassin-versant en réponse à l'intensité des précipitations (© M. Fort, 1974).

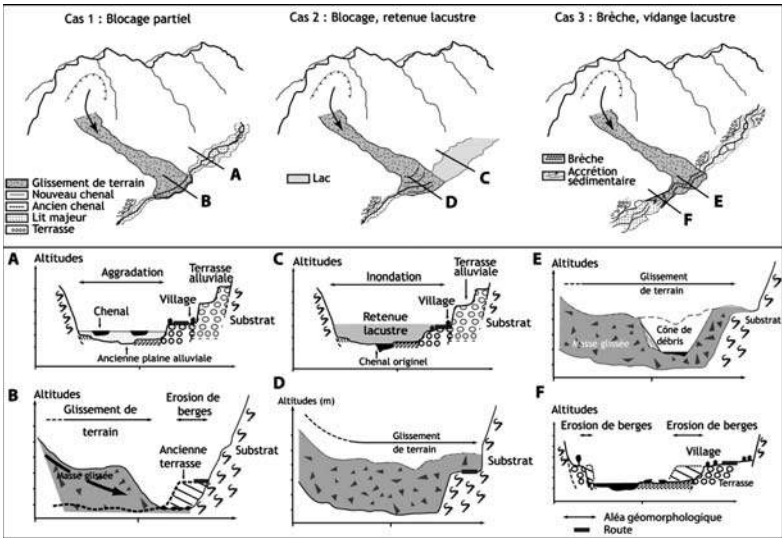


Fig. 9. — Différentes situations engendrées par l'obstruction partielle ou totale d'une vallée par un glissement de terrain. Le blocage partiel (cas 1) dévie le tracé de la rivière et provoque une érosion de la rive opposée. Le blocage total de la vallée induit la formation d'un lac en amont (cas 2) et la submersion possible du fond de vallée (y compris terrasse et village), tandis que la rupture du barrage (cas 3) peut entraîner un lâcher d'eau brutal en aval, des sapements latéraux et donc la disparition par érosion de terrasses de culture, voire d'habitations (d'après FORT & COSSART 2011).

Enfin, au débouché du piémont himalayen, les rivières ont construit des mégacônes; elles ne sont plus confinées et peuvent brutalement changer de tracé selon un processus appelé «avulsion». En 1993, la Bagmati (rivière qui draine le bassin de Kathmandou) a causé des inondations catastrophiques, faisant plus de mille victimes dans le piémont du Terai: en quelques jours, le débit de la rivière est passé de 16 à 11 700 m^3/s, détruisant sur son passage plusieurs villages et un barrage destiné à l'irrigation (FORT 1997). En août 2008, l'un des plus gros affluents du Gange, la Sapt Kosi, qui draine tout l'est du Népal (flanc sud et ouest du massif de l'Everest; bassin-versant de près de 60 000 km^2), est sorti de son lit à l'apex de son cône, s'ouvrant un nouveau chenal quelque 60 km à l'est du précédent, balayant sur plus de 2 000 km^2 zones habitées et cultivées en faisant plus de deux mille victimes (CHAKRABORTY *et al*. 2010). Cet événement, qui semble avoir surpris les gestionnaires, n'est en fait qu'un instantané des processus d'inondation et de divagation des rivières himalayennes qui, depuis plus de dix-huit millions d'années, se sont répétés à de multiples reprises pour façonner le piémont himalayen avant que ces dépôts (molasses) ne soient à leur tour déformés par les forces de convergence entre Inde et Asie et progressivement incorporés à l'édifice montagneux.

Quelles perspectives pour l'avenir?

Les dynamiques géomorphologiques sont omniprésentes dans la montagne himalayenne. Les populations montagnardes l'ont souvent appris à leurs dépens: glissements de terrain, crues torrentielles, avalanches, séismes, ces phénomènes sont souvent connus, sinon compris, donnant souvent lieu à des explications surnaturelles. Au Népal, on constate depuis plusieurs décennies une évolution faite de paradoxes. L'accès à l'éducation éloigne progressivement les jeunes montagnards du mode de vie pénible de leurs parents, harassés par la mise en culture de champs en terrasses sur des pentes vertigineuses (fig. 10). Faute de maintenance, les terrasses s'écroulent, et l'on constate une recrudescence de l'érosion sur ces pentes laissées à l'abandon (KHANAL & WATANABE 2006). Les jeunes éduqués peuplent désormais les villes dont l'emprise ne cesse d'augmenter au détriment des périmètres cultivés. Par contraste, l'aspiration au développement et le souci de désenclaver les vallées intérieures amènent de plus en plus les communautés villageoises à construire des routes carrossables qui les relient aux grands axes asphaltés et permettent l'intensification des échanges entre centres urbains et ruraux, qui à leur tour se transforment progressivement en petits centres urbains ou *bazaar*. Ces nouvelles dynamiques territoriales peuvent cependant à tout moment être remises en cause par les interruptions de trafic ou de réseau liées à des catastrophes qui ne sont donc plus uniquement naturelles. En effet, les nouvelles concentrations de population dans des zones potentiellement à risque augmentent considérablement la vulnérabilité générale, ce d'autant plus que les autorités responsables ne sont ni préparées ni en mesure de gérer des situations de crise.

Fig. 10. — Versant entièrement façonné en terrasse de cultures, flanc nord du Shivapuri Lekh (nord du bassin de Kathmandou). Les seuls bosquets de forêt correspondent à des bois sacrés (© M. Fort, 1979).

Outre ces phénomènes de déprise rurale et de néo-urbanisation incontrôlée, plusieurs sources d'inquiétude viennent assombrir le futur: la crainte des bouleversements engendrés par le changement climatique sur les risques naturels mais surtout sur la ressource en eau et, par voie de conséquence, sur la sécurité alimentaire de plus d'un milliard d'hommes qui, grâce aux eaux himalayennes, peuvent accroître leur production agricole par des périmètres irrigués. Nous avons déjà évoqué plus haut le risque de rupture de lacs glaciaires, directement lié à la fonte accélérée des glaces himalayennes. Un paragraphe contenu dans le quatrième rapport du GIEC, ou Groupe Intergouvernemental d'Experts sur le Climat (CRUZ *et al*. 2007), a malencontreusement suggéré que l'Himalaya serait complètement déglacé vers 2035 et que l'eau viendrait à manquer dans les rivières (COGLEY *et al*. 2010). Certes, le GIEC a depuis démenti l'information, mais il n'en reste pas moins que la question se pose des variations du débit des rivières himalayennes au cours des prochaines décennies. De nombreuses études semblent montrer que les eaux issues de la fonte des glaciers ne représentent en fait qu'une faible part

du débit des rivières, de l'ordre de 4-10 %, alors que ce sont les pluies de mousson qui assurent l'essentiel (deux tiers) de ce débit (ALFORD & ARMSTRONG 2010, THAYYEN & GERGAN 2010). Les apports de la fusion nivale printanière représenteraient quant à eux un tiers du débit (BOOKHAGEN & BURBANK 2010). Ces données s'appuient sur les modèles climatiques existants et sur l'évaluation de l'extension et du volume du couvert neigeux et/ou des glaces à partir d'analyses d'images satellitaires, auxquelles sont appliquées des fonctions de transfert pour en déduire le débit des rivières (BOLCH *et al*. 2012). Les résultats de ces études sont loin d'être toujours convergents, leur marge d'incertitude reste importante, et la saisonnalité tout comme la position géographique au sein de la chaîne ne sont pas toujours bien prises en compte pour chacune des régions considérées. De forts contrastes existent entre l'est, où la mousson est très abondante, et l'ouest de l'Himalaya, qui reçoit davantage de précipitations hivernales. Actuellement, et si l'on fait abstraction des fortes pertes par évaporation, les eaux de fonte glaciaire et nivale contribuent majoritairement au débit de l'Indus. Pour le Brahmapoutre en revanche, elles ne représenteraient plus que 27 % (IMMERZEEL *et al*. 2010). Les simulations faites selon différents scenarii climatiques montrent que la baisse de la contribution des eaux glacio-nivales serait partiellement compensée par une élévation des précipitations, même si les auteurs de telles études reconnaissent qu'il est très difficile de simuler le montant moyen des précipitations de mousson et leur variabilité interannuelle (IMMERZEEL *et al*. 2010). En particulier dans le Brahmapoutre inférieur, l'évolution risque d'aller vers un renforcement des valeurs d'étiage pendant la saison sèche, et des pics de crue et de la fréquence des inondations pendant la mousson (GAIN *et al*. 2011). Dans tous les cas, et malgré le degré d'incertitude sur l'avenir, les autorités publiques devraient dès maintenant prendre les mesures nécessaires pour parer à une augmentation des situations extrêmes (déficit d'eau accru en saison sèche, intensification des précipitations en période de mousson) qui, compte tenu de l'évolution démographique et indépendamment de l'évolution climatique réelle, ne pourra aller qu'en s'aggravant et peser sur la qualité de vie de plus d'un sixième de la population mondiale.

Conclusions

Archétype d'une chaîne de collision intracontinentale, l'Himalaya est aussi le château d'eau de l'Asie. Si la tectonique est à l'origine de la création de ses reliefs vigoureux, c'est l'interaction de celle-ci avec les composantes de l'érosion (précipitations de mousson, action des glaciers quaternaires, incision fluviale) qui donne à cette chaîne de montagnes tout son caractère: pentes vertigineuses, contrastes entre gorges profondes et bassins perchés, risques naturels récurrents (séismes, glissements de terrain, inondations) dont la magnitude peut atteindre des niveaux exceptionnels. L'Himalaya, au contact des

hautes terres centre-asiatiques et de l'Inde tropicale, fut de tout temps parcouru par des populations à la recherche de complémentarités de ressources entre ces milieux si différents, et aujourd'hui par des touristes et alpinistes attirés par les plus hauts sommets de la planète. La démographie et le développement économique des régions himalayennes, la construction de routes et le développement de villes de plus en plus denses, rendent les menaces liées à la sismicité et au changement climatique plus prégnantes que jamais. Même si les modèles actuels proposent des scenarii où les marges d'erreur restent non négligeables, il apparaît acquis que l'accès à la ressource en eau deviendra dans ces régions le problème majeur des années à venir et que, de façon plus difficilement prévisible, le flanc sud himalayen risque d'être à nouveau affecté par d'autres grands séismes très destructeurs. La montagne himalayenne est un organisme vivant, animé par des forces constructrices et destructrices; pour des générations d'hommes et de femmes qui vivent sur ses flancs, qui la vénèrent et la redoutent tout à la fois, la «Demeure des neiges» reste à jamais une source d'inspiration et une mère nourricière.

REMERCIEMENTS

Je tiens à exprimer ma reconnaissance à Laurent Bollinger (CEA-DASE, Bruyères-le-Châtel) et à Soma Nath Sapkota (directeur *National Seismological Centre*, Népal, Kathmandou), qui m'ont communiqué des documents personnels et m'ont donné l'autorisation de les reproduire. Tout au long de mes longues missions, Man Bahadur Mangar fut un compagnon indéfectible sans lequel je n'aurais jamais pu mener à bien mes recherches. Tous mes remerciements vont aux membres de l'Académie Royale des Sciences d'Outre-Mer, en particulier à Mme Danielle Swinne, sa secrétaire perpétuelle, et à M. André Ozer, pour leur aimable invitation.

BIBLIOGRAPHIE

ADHIKARY, D. P. & KOSHIMIZU, S. 2005. Debris flow disaster at Larcha, upper Bhotekoshi valley, Central Nepal. — *The Island Arc*, **14**: 410-423.

ALFORD, D. & ARMSTRONG, R. 2010. The role of glaciers in stream flow from the Nepal Himalaya. — *The Cryosphere Discussion*, **4**: 469-494.

BAJRACHARYA, S. & MOOL, P. 2009. Glaciers, glacial lakes and glacial lake outburst floods in the Mount Everest region, Nepal. — *Annals of Glaciology*, **50** (53): 81-86.

BILHAM, R. 1995. Location and magnitude of the 1833 Nepal Earthquake and its relation to the rupture zones of contiguous great Himalayan earthquakes. — *Current Science*, **69**: 101-128.

BILHAM, R. & WALLACE, K. 2005. Future Mw > 8 earthquakes in the Himalaya: Implications from the 26 Dec. 2004 Mw = 9.0 earthquake on India's eastern plate margin. — *Geol. Surv. India Spec. Publ.*, **85**: 1-14.

BOLCH, T., PIECZONKA, T., & BENN, D. I. 2011. Multi-decadal mass loss of glaciers in the Everest area (Nepal Himalaya) derived from stereo imagery. — *The Cryosphere*, **5**: 349-358.

BOLCH, T., BUCHROITHNER, M. F., PETERS, J., BAESSLER, M. & BAJRACHARYA, S. 2008. Identification of glacier motion and potentially dangerous glacial lakes in the Mt. Everest région/Nepal using spaceborne imagery. — *Natural Hazards Earth System SCIENCES*, **8**: 1329-1340.

BOLCH, T., KULKARNI, A., KAAB, A., HUGGEL, C., PAUL, F., COGLEY, J. G., FREY, H., KARGEL, J. S., FUJITA, K., SCHEEL, M., BAJRACHARYA, S. & STOFFEL, M. 2012. The State and Fate of Himalayan Glaciers. — *Science*, **336**: 310-314.

BOLLINGER, L., AVOUAC, J.-P., CATTIN, R. & PANDEY, M. R. 2004. Stress build-up in the Himalaya. — *Journal of Geophysical Research*, **109** (B11405, doi: 10.1029/2003JB002911).

BOOKHAGEN, B. & BURBANK, D. W. 2010. Towards a complete Himalayan hydrological budget: The spatiotemporal distribution of snowmelt and rainfall and their impact on river discharge. — *Journal of Geophysical Research*, **115** (FO3019, doi:10.1029/2009JF001426, 2010).

BRUNSDEN, D., JONES, D. K. G., DOORNKAMP, J. C. & MARTIN, R. P. 1981. The geomorphological character of part of the Low Himalaya of Eastern Nepal. — *Zeitschrift für Geomorphologie*, **37** (Supplementband N. F.): 25-72.

CARSON, B. 1985. Erosion and sedimentation processes in the Nepal Himalaya. — Kathmandu (Nepal), ICIMOD Occasional Paper n° 1, 39 pp.

CATTIN, T. & AVOUAC, J. P. 2000. Modeling mountain building and the seismic cycle in the Himalaya of Nepal. — *Journal of Geophysical Research*, **105**: 13389-13407.

CHAKRABORTY, T., KAR, R., GHOSH, P. & BASU, S. 2010. Kosi megafan: Historical records, geomorphology and the recent avulsion of the Kosi River. — *Quaternary International*, **227** (2): 143-160.

COGLEY, J. G., KARGEL, J. S., KASER, G. & VAN DER VEEN, C. J. 2010. Tracking the source of glacier misinformation. — *Science*, **327**: 522.

CRUZ, R. V., HARASAWA, H., LAL, M., WU, S., ANOKHIN, Y., PUNSALMAA, B., HONDA, Y., JAFARI, M., LI, C. & HUU NINH, N. 2007. Asia. — *In*: PARRY, M. L., CANZIANI, O. F., PALUTIKOF, J. P., VAN DER LINDEN, P. J. & HANSON, C. E. (Eds.), Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge, Cambridge University Press, pp. 469-506.

DAHAL, R. K. & HASEGAWA, S. 2008. Representative rainfall thresholds for landslides in the Nepal Himalaya. — *Geomorphology*, **100**: 429-443.

DAHAL, R. K., HASEGAWA, S., YAMANAKA, M., BHANDARY, N. P. & YATABE, R. 2006. Role of monsoon rainfall on landsliding in Nepal. — *In*: Proc. Intern. Symposium on Landslide Hazards in Orogenic Zone from the Himalaya to Island Arc in Asia, 1-4: 111-118.

DELCAILLAU, B. 1992. Les Siwaliks de l'Himalaya du Népal oriental. — CNRS, Mémoires et Documents de Géographie, 205 pp.

DYURGEROV, M. & MEIER, M. F. 2005. Glaciers and the changing earth system. A 2004 snapshot. — Boulder (Co), University of Colorado, Arctic and Alpine Research, Occasional Paper 58, 118 pp.

EVANS, S. G. & CLAGUE, J. J. 1994. Recent climatic change and catastrophic geomorphic processes in mountain environments. — *Geomorphology*, **10**: 107-128.

FORT, M. 1987. Sporadic morphogenesis in a continental subduction setting: An example from the Annapurna Range, Nepal Himalaya. — *Zeitschrift für Geomorphologie*, **63** (Supplementband N. F.): 9-36.

FORT, M. 1993. Géomorphologie d'une chaîne de collision intra-continentale: l'Himalaya Central, transversale des Annapurnas. — Thèse d'Etat, Université Paris 7, 702 pp. + 2 cartes hors-texte.

FORT, M. 1997. Développement et aléas naturels en Himalaya du Népal: la crue de juillet 1993, bassin versant de la Bagmati. — *Géomorphologie: Relief, Processus, Environnement*, **3** (1): 43-58.

FORT, M. 2000. Glaciers and mass wasting processes: Their influence on the shaping of the Kali Gandaki valley (Higher Himalaya of Nepal). — *Quaternary International*, **65/66**: 101-119.

FORT, M. 2011a. Two large late Quaternary rock slope failures and their geomorphic significance, Annapurna Himalayas (Nepal). — *Geografia Fisica e Dinamica Quaternaria*, **34** (1): 5-16.

FORT, M. 2011b. The Himalayas: From mountain building to landform evolution in a changing world. — *Geographia Polonica*, **84** (2): 15-37.

FORT, M. & COSSART, E. 2011. Aléas naturels et menaces sur les axes de communication en Himalaya du Népal: la vallée de la moyenne Kali Gandaki. — *Bull. de l'Assoc. de Géographes Français*, **1**: 35-45

FORT, M., COSSART, E. & ARNAUD-FASSETTA, G. 2010. Hillslope-channel coupling in the Nepal Himalayas and threat to man-made structures: The middle Kali Gandaki valley. — *Geomorphology*, **124** (3-4): 178-199.

FROEHLICH, W. & STARKEL, L. 1987. Normal and extreme monsoon rains – their role in the shaping of the Darjeeling Himalaya. — *Studia Geomorphologica Carpatho-Balcanica*, **21**: 129-160.

GABET, E. J., BURBANK, D. W., PUTKONEN, J. K., PRATT-SITAULA, B. A. & OJHA, T. 2004. Rainfall thresholds for landsliding in the Himalayas of Nepal. — *Geomorphology*, **63** (3-4): 131-143.

GAIN, A. K., IMMERZEEL, W. W., SPERNA WEILAND, F. C. & BIERKENS, M. F. P. 2011. Impact of climate change on the Stream flow of the lower Brahmaputra: Trends in high and low flows based on discharge-weighted ensemble modelling. — *Hydrological Earth System Science*, **15**: 1537-1545.

HEWITT, K. 2009. Catastrophic rock slope failures and late Quaternary developments in the Nanga Parbat-Haramosh Massif, Upper Indus basin, northern Pakistan. — *Quaternary Science Reviews*, **28**: 1055-1069.

IMMERZEEL, W. W., VAN BEEK, L. P. H. & BIERKENS, M. F. P. 2010. Climate change will affect the Asian water towers. — *Science*, **328**: 1382-1385.

KEEFER, D. K. 1994. The importance of earthquake-induced landslides to long-term slope erosion and slope-failure hazards in seismically active regions. — *Geomorphology*, **10**: 265-284.

KHANAL, N. R. & WATANABE, T. 2006. Abandonment of Agricultural Land and its Consequences: A Case Study in the Sikles Area, Gandaki Basin, Nepal Himalaya. — *Mountain Research and Development*, **26** (1): 32-40.

MOLNAR, P. & TAPPONNIER, P. 1975. Cenozoic tectonics of Asia: Effects of a continental collision. — *Science*, **189**: 419-426.

RAVANEL, L. & DELINE, P. 2010. Climate influence on rockfalls in high-Alpine steep rockwalls: The north side of the *Aiguilles de Chamonix* (Mont Blanc massif) since the end of the 'Little Ice Age'. — *The Holocene*, **21** (2): 357-365.

SAPKOTA, S. N. 2011. Rupture de surface du séisme de Bihar-Népal 1934: implications pour l'aléa sismique en Himalaya du Népal. — Université Paris-Diderot, Institut de Physique du Globe de Paris, Thèse de Doctorat, 291 pp.

STARKEL, L. 1976. The role of extreme (catastrophic) meteorological events in the contemporary evolution of slopes. — *In*: DERBYSHIRE, E. (Ed.), Geomorphology and climate. Chichester, J. Wiley, pp. 203-241.

THAYYEN, R. J. & GERGAN, J. T. 2010. Role of glaciers in watershed hydrology: ''Himalayan catchment'' perspective. — *The Cryosphere*, **4** (1): 115-128.

VALDIYA, K. S. 1998. Dynamic Himalaya. — India, University Press (Hyderabad), 178 pp.

VUICHARD, D. & ZIMMERMANN, M. 1987. The 1985 catastrophic drainage of a moraine-dammed lake, Khumbu Himal, Nepal. Causes and consequences. — *Mountain Research and Development*, **7** (2): 91-110.

Bull. Séanc. Acad. R. Sci. Outre-Mer
Meded. Zitt. K. Acad. Overzeese Wet.
57 (2-4 – 2011): 375-387

The Struggle against Tsetse Flies and Animal Trypanosomiasis in Africa*

by

Stanny GEERTS**

KEYWORDS. — Trypanosomiasis; Africa; Review; Tsetse Flies; Eradication.

SUMMARY. — An overview is given of the current techniques to control tsetse flies and animal trypanosomiasis. Two main players are currently involved in the control of African trypanosomiasis: the Programme Against African Trypanosomiasis (PAAT) and the Pan-African Tsetse and Trypanosomiasis Eradication Campaign (PATTEC). The role and the objectives of both programmes are critically analysed. The scientific community is very sceptical about the feasibility of an eradication programme of tsetse flies for the following reasons: 1. biological, geographical and environmental factors; 2. institutional weaknesses and logistic constraints; 3. the failure of many eradication projects in the past; and 4. the fact that there are other priorities in sustainable rural development.

TREFWOORDEN. — Trypanosomiase; Afrika; *Review*; Tseetseevliegen; Eradicatie.

SAMENVATTING. — *De strijd tegen de tseetseevlieg en dierlijke trypanosomiase in Afrika*. — Een overzicht wordt gegeven van de huidige methoden om tseetseevliegen en trypanosomiase te controleren. Momenteel zijn er twee belangrijke spelers actief op het vlak van de controle van Afrikaanse trypanosomiase: het Programma tegen Afrikaanse Trypanosomiase (PAAT) en de Pan-Afrikaanse Tseetsee en Trypanosomiase Eradicatie Campagne (PATTEC). De rol en de objectieven van beide programma's worden kritisch doorgelicht. De wetenschappelijke wereld staat zeer sceptisch tegenover de haalbaarheid van een eradicatiecampagne van tseetseevliegen omwille van de volgende redenen: 1. biologische, geografische en milieu factoren; 2. institutionele zwakte en logistieke problemen; 3. de mislukking van vele eradicatieprojecten in het verleden; en 4. het feit dat er veel andere prioriteiten zijn op het vlak van duurzame plattelandsontwikkeling.

MOTS-CLES. — Trypanosomiase; Afrique; Inventaire; Mouches tsé-tsé; Eradication.

RESUME. — *La lutte contre la mouche tsé-tsé et la trypanosomiase animale en Afrique*. — Les différentes techniques de lutte contre les glossines et la trypanosomiase sont ici passées en revue. Deux acteurs importants sont actuellement impliqués dans le contrôle de la trypanosomiase: le Programme contre la Trypanosomiase africaine (PAAT) et la Campagne panafricaine d'Eradication des Mouches tsé-tsé et de la Trypanosomiase (PATTEC). Le rôle et les objectifs des deux programmes sont analysés de façon critique. Le

---

* Lecture given at the Academic Opening Session held on 6 October 2011 and dedicated to the memory of Prof. Peter Van den Bossche († 11 November 2010), member of the Academy. Text received on 11 May 2012.

** Member of the Academy; Institute of Tropical Medicine, Nationalestraat 155, B-2000 Antwerp (Belgium).

monde scientifique reste très sceptique quant à la faisabilité d'une campagne d'éradication des glossines pour les raisons suivantes: 1. facteurs biologiques, géographiques et environnementaux; 2. faiblesse institutionnelle et problèmes logistiques; 3. l'échec de nombreux projets d'éradication dans le passé; et 4. l'existence d'autres priorités dans le domaine du développement rural durable.

Introduction

Trypanosomiasis remains a major constraint to the development of livestock in sub-Saharan Africa. Thirty-seven countries are affected covering an area of about nine million km^2. It is estimated that about fifty million cattle are exposed to the disease and that thirty-five million doses of trypanocides are used per year (MATTIOLI *et al*. 2004). The direct and indirect annual losses are estimated at US$ 4.5 billion (HURSEY 2001). Due to environmental changes (*i.a*. land-use changes due to the increasing population and deforestation) the epidemiology of animal trypanosomiasis is changing (VAN DEN BOSSCHE 2001, VAN DEN BOSSCHE *et al*. 2010). Because of the gradual encroachment of people and cattle, the latter are playing an increasing role as blood source for tsetse flies. This results in a change from a dominant sylvatic to a domestic cycle and it has been nicely shown that bovine trypanosomes in the latter cycle are less virulent and have less impact on production (MASUMU *et al*. 2006, VAN DEN BOSSCHE *et al*. 2011). However, although the pathogenicity of trypanosomes in certain endemic areas might decrease, this is not everywhere the case and livestock owners very often consider trypanosomiasis as one of the most important disease problems. Human African Trypanosomiasis (HAT) will not be dealt with in this review. Contrary to animal trypanosomiasis HAT occurs in certain foci. Most of these foci are well known nowadays and important progress has been made to map them in detail (SIMARRO *et al*. 2010). Furthermore, the number of new cases of sleeping sickness for the first time decreased under ten thousand in 2009 (compared to thirty thousand in 1999), which gives some hope that the elimination of this disease is in sight (SIMARRO *et al*. 2011). Elimination of disease, however, should not be confounded with eradication (MOLYNEUX *et al*. 2004). Disease elimination means the reduction to zero of the incidence of a specified disease in a defined geographical area as a result of deliberate efforts. It precedes elimination of infection which is the reduction to zero of the incidence of infection caused by a specified agent in a certain area. Eradication is defined as the permanent reduction to zero of the worldwide incidence of infection by a specific agent (MOLYNEUX *et al*. 2004).

The purpose of this review is:

— To give a brief overview of the current techniques to control tsetse flies and animal trypanosomiasis;
— To critically analyse the role and the objectives of the two main players involved in the control of African trypanosomiasis: the Programme Against

African Trypanosomiasis (PAAT) and the Pan-African Tsetse and Trypanosomiasis Eradication Campaign (PATTEC).

Current Methods to Control Animal Trypanosomiasis

The control of trypanosomiasis in livestock can be directed against the parasite, the vector or can also involve the host (tab. 1).

Table 1

Current techniques to control animal trypanosomiasis

Target	Technique
Vector	• Insecticides o Ground or aerial spraying o Pour-on o Netting • Screens and traps • SIT (Sterile Insect Technique)
Trypanosome	• Chemotherapy • Chemoprophylaxis
Host	• Management • Trypanotolerant breeds

Methods to Control the Vector

Tsetse flies are the main vectors of animal trypanosomiasis, but some trypanosomes can also be transmitted mechanically by biting flies such as tabanids and *Stomoxys* spp. Large areas can be cleared from tsetse flies by using ground and/or aerial spraying of insecticides.

Ground spraying uses residual insecticides (*e.g.* DDT, dieldrin, endosulfan) which target the tsetse resting sites. Because of the negative effects on the environment these persistent insecticides are more and more replaced by the less toxic synthetic pyrethroids. These products are also used for aerial spraying with fixed wing aircrafts, *i.e.* the "Sequential Aerosol Technique" (SAT). SAT has been used successfully in several African countries, *i.a.* Botswana, where the Okavango delta was cleared from tsetse flies without any negative impact on the environment (Kgori *et al.* 2006). Insecticides can also be applied on live animals by spraying or "pour-on". Nowadays, many African farmers use pour-on insecticides because they can be easily and rapidly applied without any sophisticated equipment. Furthermore, the insecticides kill also biting flies and ticks resulting in less nuisance for the animals and higher productivity (Leak *et al.* 1995).

Applications can be restricted to the preferred biting sites of tsetse flies allowing a reduction of up to 90 % of the amount of insecticide needed (TORR *et al*. 2007). Consequently, this kind of treatment reduces the cost to less than 1 US$ per head of cattle per year (TORR *et al*. 2005). In case of zero grazing animals insecticide-impregnated mosquito nets (about one metre high) have been used successfully around the stable in order to protect the cattle against tsetse flies (BAUER *et al*. 2005).

A large variety of traps and targets (impregnated with pyrethroid insecticides) have been developed to attract and kill tsetse flies. Especially for the savannah tsetse species the efficacy of these traps/targets can be improved by using odour attractants (such as octenol and phenols) (GREEN 1994). At a density of one to four targets per km^2 certain tsetse fly populations can be suppressed to low numbers in a short time period. Although this technology is not sophisticated and environment friendly, it is labour-intensive and too expensive for most African peasants (VALE & TORR 2004).

The "Sterile Insect Technique" (SIT) consists of the release of irradiated sterile male flies at a proportion of at least ten sterile to one wild male so that they are able to compete with the wild male flies. When a sterile male mates with a virgin female fly, this results in no offspring because female tsetse usually mate only once in their life (FELDMAN 2004). SIT is often needed for the final eradication of tsetse flies. It is a very expensive technique because mass-rearing of tsetse flies is necessary to provide huge amounts of sterile males which have to be released (preferably aerially) on a weekly basis for a period of fifteen to eighteen months. SIT is only effective when the population density of the target flies is very low, which implies prior suppression of the flies using other techniques. An example of success of SIT was the eradication of *Glossina austeni* from the island of Unguja, Zanzibar (VREYSEN *et al*. 2000). Unfortunately, with the exception of Zanzibar, there are very few success stories of the use of SIT to eradicate tsetse flies. Although Unguja is a small island infested with only one tsetse species *G. austeni*, it took several years and many millions of dollars to get rid of the flies. Contrary to the theoretical 10:1 ratio of sterile males to wild males, a ratio of more than 100:1 was needed on Unguja. This can be explained by the fact that — contrary to the common belief — some tsetse flies mate more than once (BONOMI *et al*. 2011, ROGERS & RANDOLPH 2002). This implies that huge tsetse breeding units have to be built in order to produce the large amounts required of sterile flies.

It is generally agreed that SIT makes only sense as part of "Area-Wide Integrated Pest Management" (AW-IPM) of tsetse. The AW-IPM approach aims at the sustainable removal of an entire tsetse fly population within a delimited geographical area and uses a combination of various techniques including SIT if necessary (FELDMAN 2004). The estimated costs of various methods to control tsetse flies are summarized in table 2. They depend heavily on the terrain conditions and on the final objective (control or eradication).

Table 2

Estimated costs of tsetse eradication or control

Technique	Costs (US$) per km^2	Objective and location
Ground spraying	265-315	Eradication (Zimbabwe, Zambia)
Targets	220-290	Flat terrain
Aerial spraying	345-535	Various locations
Cattle treatment	50-120	Pour-on, 15 cattle/km^2
	60	Pour-on, 44 cattle/km^2
Linear km of barrier using targets		Zimbabwe, Zambia
• Barrier establishment	2,000	
• Annual barrier maintenance	1,600	
Aerial spraying (SAT)	265-275	Eradication (Botswana)
Sterile Insect Technique (SIT)	800	Eradication (eastern Africa)
	250-400	Eradication (West Africa)
Low-density monopyramidal traps	26	Annual cost of control (Ivory Coast)

Source: SHAW 2003.

METHODS TO CONTROL THE PARASITE

A limited number of drugs are available to treat animal trypanosomiasis. For the treatment of cattle three products have been on the market for more than fifty years. Diminazene aceturate has curative properties whereas isometamidium chloride and the homidium salts (ethidium and novidium) have both curative and prophylactic activities. Although ethidium is mutagenic and should be withdrawn from the market, it is still widely used in East Africa (GEERTS *et al*. 2010).

Currently, the treatment of affected animals with trypanocidal drugs still remains the most frequently applied measure to control trypanosomiasis. Treatment is mainly carried out by the livestock owners themselves without any supervision by veterinary personnel. It has been observed that underdosing occurs very frequently, which is an important risk factor for the development of drug resistance (DELESPAUX *et al*. 2002). Trypanocidal drug resistance is increasingly reported all over Africa and is now present in twenty-one sub-Saharan countries (CHITANGA *et al*. 2011, GEERTS *et al*. 2010). However, farmers continue to use the drugs because alternative products are not available. Fortunately, it has been observed on several occasions that — even when drug resistance is present at high levels — treatment remains beneficial and allows the animal to survive and to be productive (CHITANGA *et al*. 2011, DELESPAUX *et al*. 2010, GEERTS & HOLMES 1998).

HOST MANAGEMENT

Most livestock owners in Africa know very well the sites where tsetse flies are present. They are quite often able to manage their herds and flocks in such a way as to avoid contact with the bites of the flies. However, especially in the dry

season when there is a lack of grass, the farmers are forced to bring their herds to wetter places with more grass but often also infested with tsetse flies.

Trypanotolerance is another host-related characteristic of some livestock breeds allowing them to survive, reproduce and remain productive under trypanosomiasis risk without the aid of trypanocidal drugs (D'IETEREN *et al*. 1998). The use of trypanotolerant breeds is a highly sustainable approach to control trypanosomiasis in low or medium tsetse-infested regions. Unfortunately, only about 6 % of the current cattle population in West and Central Africa consists of Ndama, Baoule and other trypanotolerant breeds. Trypanotolerant Djallonke sheep and West-African dwarf goats account for 32 and 47 %, respectively of the sheep and goat population in West and Central Africa (GEERTS *et al*. 2009). In East and southern Africa there are even much smaller numbers of trypanotolerant livestock breeds.

PAAT and PATTEC: Main Players in the Field of Trypanosomiasis

There are two important players in the field of tsetse and trypanosomiasis (T&T): the Programme Against African Trypanosomiasis (PAAT) and the Pan-African Tsetse and Trypanosomiasis Eradication Campaign (PATTEC). PAAT was launched in 1997 and is a joint programme of the FAO, WHO, OIE and the Inter-African Bureau for Agriculture (IBAR) of the African Union (http://www.fao.org/paat). Its objectives are: coordination and optimization of research and control activities, normative and standardization activities, technical and scientific publications, capacity building and the support to trypanosomiasis endemic countries. PAAT has acted as the international forum for all those working on tsetse and trypanosomiasis. Its regular meetings, where issues could be debated freely and solutions found, have underpinned the global effort to deal with this disease, its vector and their role in perpetuating poverty in Africa. PAAT is unique in bringing together three UN agencies as well as the African Union (FAO 2008). Recently, an external evaluation team made a whole list of recommendations to further improve the functioning of PAAT (DARGIE *et al*. 2010). Inter alia the following three important weaknesses were identified:

— The emphasis given by PAAT in recent years on "area-wide" approaches to T&T management and on the technologies (primarily SIT and more recently SAT) considered necessary for undertaking interventions over large areas needs to be balanced by the provision of updated advice and capacity building on policies, strategies and technologies appropriate for small-scale/community-based interventions. Notwithstanding the importance of "area-wide" principles and of related technologies, the reality on the ground at present is that the depth of knowledge (including *e.g*. the vulnerability to reinvasion of areas identified for interventions), and scale of operations and of financial and other resources

required to implement these principles and technologies successfully are beyond the means of many affected countries, donors and certainly livestock owners.

— Although substantial efforts have been made by both the PAAT Secretariat and the PAAT Chairman to reach agreement with the PATTEC Coordination Office on principles for identifying priority areas for intervention and the respective roles and responsibilities of PAAT and PATTEC in assisting countries and the donor community in developing and implementing "bankable projects", the reality is that this PAAT-PATTEC "harmonization process" does not work "in practice". Urgent action is needed to ensure the active participation of both PATTEC and IBAR in the PAAT Secretariat and activities.

— Although PAAT has generated extremely valuable and much-needed normative outputs for technical and policy decision-making, it is not sufficiently engaged in assisting countries to generate outcomes at field level. Therefore, a FAO-PAAT livestock officer needs to be based in Africa in order to provide technical support to T&T-affected countries for planning and implementing integrated field interventions as well as wider animal disease control packages, and for closer and more effective working relationships with PATTEC, AU/IBAR, IAEA, WHO and others (DARGIE *et al*. 2010). In the meantime this officer is in place and is based at the FAO regional office in Accra, Ghana.

The other major actor in the field of T&T is the "Pan-African Tsetse and Trypanosomiasis Eradication Campaign" (PATTEC), which was launched in 2000 by a declaration of the African Heads of State to render Africa free of tsetse flies (http://www.africa-union.org/Structure_of_the_Commission/depPattec.htm). It is a project of the AU-IBAR. The PATTEC plan of action seeks to apply area-wide principles to eliminate each pocket of tsetse infestation at a time; thus, creating a series of tsetse-free zones that can eventually be linked over a much larger area. The techniques available for use in reducing the tsetse population, including odour-baited traps and insecticide-treated targets, pour-ons and ultra-low volume aerial spraying of insecticide, will be used singly or in combination, and supplemented with SIT to ensure total elimination of the target tsetse population (KABAYO 2002). The field activities started in 2006 in six countries, three in West Africa (Mali, Burkina Faso and Ghana) and three in East Africa (Uganda, Kenya and Ethiopia). A budget of US$ 80 million was foreseen for a period of six years (until end 2011). Most of the funding came from the African Development Bank (AfDB; soft loan and grant for 80 and 5 % of the budget, respectively) whereas the governments of the countries involved contributed 15 % of the budget required. Although an independent evaluation of the PATTEC programme has not yet been carried out, it appears that up to now only very slight progress has been made towards the objectives of PATTEC. In most of the six countries the baseline data have been collected, but few areas have

been cleared from tsetse flies. A lack of regional collaboration was reported among the three countries in East Africa and among the three countries in West Africa. Furthermore, there was a lack of skilled personnel at all levels in the six countries and in Ethiopia serious problems occurred in starting up the tsetse breeding colonies needed for the SIT (PAAT 2008). The original budget had to be revised because too much funding was foreseen for SIT and insufficient money for tsetse suppression activities. At the end of 2011 it was evident that the performance of the PATTEC programme in the six countries was very unequal. In some countries fairly good progress has been realized whereas other countries are far behind schedule. Given the mediocre results of the overall programme there are strong indications that the AfDB will not continue to finance the next phases of the PATTEC. However, because of the good results during the first phase in Ghana the government has decided to continue funding from own resources (Mahama 2012, pers. comm.). It remains to be seen whether other governments will follow the example of Ghana or whether the PATTEC will slowly fade away once the AfDB funds have been completely spent. The aforegoing observations confirm that the scientific community was right when it expressed already ten years ago its scepticism about the feasibility of the PATTEC programme (ROGERS & RANDOLPH 2002, DFID 2003).

Eradication of Tsetse Flies

There are several reasons why the eradication of tsetse flies is not feasible, nor desirable (tab. 3).

Table 3

Reasons why the eradication of tsetse flies is not feasible, nor desirable (modified from DFID 2003, ROGERS & RANDOLPH 2002)

• Biological, geographical and environmental factors
• Institutional weaknesses and logistic constraints
• Historical reasons
• Other priorities in rural development

BIOLOGICAL, GEOGRAPHICAL AND ENVIRONMENTAL FACTORS

There are thirty-one different *Glossina* species in sub-Saharan Africa. Each species has its specific habits and all are very resilient because of the relatively long lifespan of the females, the good pupal survival and the wide variety of hosts for feeding. Nine million km^2 of the African continent are tsetse-infested, covering thirty-seven countries among which twenty-eight belong to the less developed countries, which implies that complete eradication is a huge and

unrealistic task even in the long term. Furthermore, tsetse eradication does not automatically imply trypanosomiasis eradication. *Trypanosoma evansi* is a parasite which is only transmitted by biting flies. *T. vivax* and *T. congolense* are parasites which are commonly transmitted by tsetse flies, but which can also be transmitted mechanically (Desquesnes *et al.* 2003a,b). Several reports were published about the persistence of *T. vivax* in regions without any tsetse flies (Cherenet 2006, Sinshaw *et al.* 2006). This is not surprising since we know that *T. vivax* in South America was imported from Africa and succeeded in adapting itself to a life cycle without tsetse flies (Jones & Davila 2001). And finally, a large-scale eradication campaign will have a negative impact on the environment for two reasons: increased pollution (huge amounts of insecticide will be needed to suppress the tsetse populations in vast areas) and loss of biodiversity.

In terms of conservation of biological diversity tsetse flies have the same intrinsic value as other species. Tsetse flies are unique elements of the biological diversity because they have an unusual combination of life history traits (strictly haematophagous, viviparous, low reproduction rate). Countries which have signed the International Convention on Biological Diversity should not accept the eradication of tsetse flies in protected areas (game reserves, national parks). Since South Africa has signed this convention, the biodiversity Division of KwaZulu-Natal Wildlife has refused to support the control or eradication of tsetse flies inside protected areas in KwaZulu-Natal (Armstrong 2003). Although several tsetse-infested African countries have ratified this convention (http://www.cbd.int/convention/parties/list/), this has not hindered the African Heads of State to sign the PATTEC declaration.

Institutional Weaknesses and Logistic Constraints

Livestock and veterinary departments including tsetse control services in many African countries are often marginalized and have limited resources. Since tsetse-infested areas are often remote and quite inaccessible, this implies that a well-maintained car park is necessary to reach these localities, which is often not the case. Furthermore, area-wide approaches as proposed by PATTEC are large-scale operations, which pose logistic constraints that surpass their capacity. Moreover, the biggest problem may be the lack of reliable tsetse distribution maps. The currently available tsetse prediction maps at the continental level are to a large extent based on the data collected in the 1970s by Ford & Katondo (1977). There is an urgent need to collect more recent and accurate data (Cecchi *et al.* 2011).

Historical Reasons

Although there are a few examples of successful tsetse elimination projects (*i.a.* Unguju island, Vreysen *et al.* 2000; Okavango delta, Kgori *et al.* 2006), most large-scale eradication projects have failed. Despite the injection of

enormous amounts of money by the Cameroonian government and several international organizations between 1976 and 1994 to clear tsetse flies from the Adamaoua plateau in Cameroon, the project was not successful (MAMOUDOU *et al*. 2009). Similarly, the Regional Tsetse and Trypanosomiasis Control Project (RTTCP, 1986-2000), mainly funded by the European Union whose original objective was to eradicate tsetse flies from Zambia, Zimbabwe, Malawi and Mozambique, was quite rapidly forced to adapt its goal to control instead of eradication. Reinvasion of cleared areas was a recurrent problem in all large-scale eradication projects. In three of the four projects in which SIT has been tried out in Africa (Tanzania, Nigeria and Burkina Faso) tsetse populations are on their way back to former levels (DFID 2003). It is believed that barriers using traps and targets to protect cleared areas against tsetse reinvasion are not very effective (mainly because of lack of adequate maintenance). Many government-run vector suppression schemes were successful in the short term, but failed because budgets for insecticide were cut, or because traps and targets disappeared or disintegrated through poor maintenance (ROGERS & RANDOLPH 2002).

OTHER PRIORITIES IN RURAL DEVELOPMENT

It is estimated that the eradication of *Glossina* spp. from the African continent will cost US$ 20 billion (DFID 2003). With limited resources available for poverty reduction and rural development it can be questioned whether this money could be better spent on meeting basic needs such as the provision of drinking water, primary health care, primary education and improved animal health and production. The provision of clean drinking water in the villages will help reduce the incidence of sleeping sickness because women do not have to go any longer to the riverside, which are often tsetse-infested. In the field of animal health there are other important livestock diseases besides trypanosomiasis such as contagious bovine pleuropneumonia, goat plague (PPR) and many others.

Conclusion

Instead of aiming at the eradication of T&T, it makes much more sense to focus on enhanced and extended control at farm level for the following reasons:

— Due to the gradual encroachment of people and cattle there is a shift from the dominant sylvatic cycle to the domestic cycle of animal trypanosomiasis. In the latter cycle trypanosomes are less virulent. Consequently, cattle are able to live with tsetse flies and livestock owners can live with the disease without too heavy reliance on drugs (VAN DEN BOSSCHE *et al*. 2010).
— Control of T&T at farm level is a bottom-up, demand-led approach in which the farmers and not the government do the work and bear the costs (DFID 2003).

— Simulation models show that the human population growth will cause a decline of savannah and forest tsetse flies and that by 2040 some species in these groups may even approach extinction in eastern and southern Africa (REID *et al*. 2000).
— Failure of eradication is much more serious than failure of control because failure to eradicate has no fallback position. Whereas 50 % of success in a control scheme might still be cost-beneficial, 50 % success of an eradication scheme is meaningless (ROGERS & RANDOLPH 2002).

ACKNOWLEDGEMENTS

Redgi De Deken (ITM, Antwerp) is gratefully acknowledged for the critical and thoughtful review of the manuscript.

REFERENCES

ARMSTRONG, A. J. 2003. KZN Wildlife's stance on tsetse fly control and eradication in KwaZulu-Natal. — *In*: Newsletter on Integrated Control of Pathogenic Trypanosomes and their Vectors, No. 7, pp. 36-37.

BAUER, B., GITAU, D., OLOO, F. P. & KARANJA, S. M. 2005. Evaluation of a preliminary title to protect zero-grazed dairy cattle with insecticide-treated mosquito netting in Western Kenya. — *Trop. Anim. Health Prod*., **38**: 31-36.

BONOMI, A., BASSETTI, F., GABRIELI, P., BEADELL, J., FALCHETTO, M., SCOLARI, F., GOMULSKI, L. M., REGAZZINI, E., OUMA, J. O., CACCONE, A., OKEDI, L. M., ATTARDO, G. M., GUGLIELMINO, C. R., AKSOY, S. & MALACRIDA, A. R. 2011. Polyandry is a common event in wild populations of the tsetse fly *Glossina fuscipes fuscipes* and may impact population reduction measures. — *PloS Negl. Trop. Dis*., **5** (6): e1190 (doi: 10.1371/journal.pntd.0001190).

CECCHI, G., PAONE, M., FELDMANN, U., VREYSEN, M. & MATTIOLI, R. 2011. Developing continental maps of *Glossina* species. — *In*: 31st Meeting of the International Scientific Council for Trypanosomiasis Research and Control (ISCTRC), Bamako, Mali. AU-IBAR (African Union – Interafrican Bureau for Animal Resources).

CHERENET, T. 2006. A comparative longitudinal study of bovine trypanosomiasis in tsetse-free and tsetse-infested zones of the Amhara Region, northwest Ethiopia. — *Vet. Parasitol*., **140**: 251-258.

CHITANGA, S., MARCOTTY, T., NAMANGALA, B., VAN DEN BOSSCHE, P., VAN DEN ABBEELE, J. & DELESPAUX, V. 2011. High Prevalence of Drug Resistance in Animal Trypanosomes without a History of Drug Exposure. — *PLoS Negl. Trop. Dis*., **5** (12): e1454 (doi: 10.1371/journal.pntd.0001454).

DARGIE, J., VAN DEN BOSSCHE, P. & DIALL, O. 2010. External evaluation of the Programme against African Trypanosomiasis (PAAT). —*Tsetse Tryp. Info*., **33** (1): 2-20.

DELESPAUX, V., GEERTS, S., BRANDT, J., ELYN, R. & EISLER, M. C. 2002. Monitoring the correct use of isometamidium by farmers and veterinary assistants in Eastern Province of Zambia using isometamidium-ELISA. — *Vet. Parasitol*., **110**: 117-122.

DELESPAUX, V., VITOULEY, H. S., MARCOTTY, T., SPEYBROECK, N., BERKVENS, D., ROY, K., GEERTS, S. & VAN DEN BOSSCHE, P. 2010. Chemosensitization of *Trypanosoma congolense* strains resistant to isometamidium chloride by tetracycline and fluoroquinolone. — *PLoS Neglect. Trop. Dis.*, **4**: e828 (doi: 10.1371/journal.pntd.0000828).

DESQUESNES, M. & DIA, M. L. 2003a. Mechanical transmission of *Trypanosoma congolense* in cattle by the African tabanid Atylotus agrestis. — *Exp. Parasitol.*, **105**: 226-231.

DESQUESNES, M. & DIA, M. L. 2003b. *Trypanosoma vivax*: Mechanical transmission in cattle by one of the most common African tabanids, Atylotus agrestis. — *Exp. Parasitol.*, **103**: 35-43.

DFID 2003. Tsetse control: The next 100 years. Report of a meeting organised by the DFID Animal Health Programme (Edinburgh, 9-10 September, 2002). — London, DFID, 50 pp.

D'IETEREN, G. D. M., AUTHIE, E., WISSOCQ, N. & MURRAY, M. 1998. Trypanotolerance, an option for sustainable livestock production in areas at risk from trypanosomiasis. — *Rev. Sci. Tech. Off. Int. Epizoot.*, **17**: 154-175.

FAO 2008. On target against poverty. The programme against African trypanosomiasis 1997-2007. — Rome, FAO, 12 pp.

FELDMAN, U. 2004. The sterile insect technique as a component of area-wide integrated pest management of tsetse. — *In*: MAUDLIN, I., HOLMES, P. H. & MILES, M. A. (Eds.), The trypanosomiases. Oxfordshire, CABI Publishing, pp. 565-582.

FORD, J. & KATONDO, K. M. 1977. Maps of tsetse flies (*Glossina*) distribution in Africa, 1973 according to sub-generic groups on scale of 1:5 000 000. **—** *Bull. Anim. Health Prod. Afr.*, **24**: 187-193.

GEERTS, S. & HOLMES, P. H. 1998. Drug management and parasite resistance in bovine trypanosomiasis in Africa. — Rome, FAO, PAAT Techn. Sci. Series, No. 1, 31 pp.

GEERTS, S., OSAER, S., GOOSSENS, B. & FAYE, D. 2009.Trypanotolerance in small ruminants of sub-Saharan Africa. — *Trends Parasitol.*, **25**: 132-138.

GEERTS, S., DELESPAUX, V. & VAN DEN BOSSCHE, P. 2010. Drug resistance in trypanosomes of livestock: A worrying issue. — *Meded. Zitt. K. Acad. Overzeese Wet.*, **55** (2):177-184.

GREEN, C. H. 1994. Bait methods for tsetse fly control. — *Adv. Parasitol.*, **34**: 229-291.

HURSEY, B. S. 2001. The programme against African trypanosomiasis: Aims, objectives and achievements. — *Parasitol. Today*, **17**: 2-3.

JONES, T. W. & DAVILA, A. M. R. 2001. *Trypanosoma vivax* – out of Africa. — *Trends Parasitol.*, **17**: 99-101.

KABAYO, J. P. 2002. Aiming to eliminate tsetse from Africa. — *Trends Parasitol.*, **18**: 473-475.

KGORI, P. M., MODO, S. & TORR, S. J. 2006. The use of aerial spraying to eliminate tsetse from the Okavango Delta of Botswana. — *Acta Trop.*, **99**: 184-199.

LEAK, S. G. A., MULATU, W., ROWLANDS, G. J. & D'IETEREN, G. D. M. 1995. A trial of a cypermethrin 'pour-on' insecticide to control *Glossina pallipes*, *G. fuscipes fuscipes* and *G. morsitans submorsitans* (Diptera: Glossinidae) in south-west Ethiopia. — *Bull. Entomol. Res.*, **85**: 241-251.

MAMOUDOU, A., ZOLI, A., VAN DEN BOSSCHE, P., DELESPAUX, V. & GEERTS, S. 2009. Half a century of tsetse and trypanosomosis control on the Adamaoua plateau in Cameroon. — *Rev. Elev. Méd. Vét. Pays trop.*, **62**: 33-38.

MASUMU, J., MARCOTTY, T., GEYSEN, D., GEERTS, S., VERCRUYSSE, J., DORNY, P. & VAN DEN BOSSCHE, P. 2006. Comparison of the virulence of *Trypanosoma congolense*

strains isolated from cattle in a trypanosomiasis endemic area of eastern Zambia. — *Int. J. Parasitol.*, **36**: 497-501.

MATTIOLI, R., FELDMANN, U., HENDRICKX, G., WINT, W., JANNIN, J. & SLINGENBERGH, J. 2004. Tsetse and trypanosomiasis intervention policies supporting sustainable animal agricultural development. — *J. Food Agr. Environ.*, **2**: 310-314.

MOLYNEUX, D. H., HOPKINS, D. R. & ZAGARIA, N. 2004. Disease eradication, elimination and control: The need for accurate and consistent usage. — *Trends Parasitol.*, **20**: 347-351.

PAAT 2008. Report of the 14th PAAT advisory group co-ordinators meeting (Kampala, Uganda, 14-15 October). — Rome, FAO, 18 pp.

REID, R. S., KRUSKA, R. L., DEICHMANN, U., THORNTON, P. K. & LEAK, S. G. A. 2000. Human population growth and the extinction of the tsetse fly. — *Agr. Ecosyst. Environ.*, **77** (3): 227-236.

ROGERS, D. J. & RANDOLPH, S. E. 2002. A response to the aim of eradicating tsetse from Africa. — *Trends Parasitol.*, **18**: 534-536.

SHAW, A. 2003. Economic guidelines for strategic planning of tsetse and trypanosomiasis control in West Africa. — Rome, FAO, PAAT Sci. Techn. Ser., 5, 75 pp.

SIMARRO, P. P., CECCHI, G., PAONE, M., FRANCO, J. R., DIARRA, A., RUIZ, J. A., FEVRE, E. M., COURTIN, F., MATTIOLI, R. C. & JANNIN, J. G. 2010. The Atlas of human African trypanosomiasis: A contribution to global mapping of neglected tropical diseases. — *Int. J. Health Geographics*, **9** (doi: 10.1186/1476-072X-9-57).

SIMARRO, P. P., DIARRA A., RUIZ POSTIGO, J. A., FRANCO, J. R. & JANNIN, J. G. 2011. The Human African Trypanosomiasis Control and Surveillance Programme of the World Health Organization 2000-2009: The Way Forward. — *PLoS Negl. Trop. Dis.*, **5** (2): e1007 (doi: 10.1371/journal.pntd.0001007).

SINSHAW, A., ABEBE, B., DESQUESNES, M. & YONI, W. 2006. Biting flies and *Trypanosoma vivax* infection in three highland districts bordering lake Tana, Ethiopia. — *Vet. Parasitol.*, **142**: 35-46.

TORR, S. J., HARGROVE, J. W. & VALE, G. A. 2005. Towards a rational policy for dealing with tsetse. — *Trends Parasitol.*, **21**: 537-541.

TORR, S. J., MAUDLIN, I. & VALE, G. A. 2007. Less is more: Restricted application of insecticide to cattle to improve the cost and efficacy of tsetse control. — *Med. Vet. Entomol.*, **21**: 53-64.

VALE, G. A. & TORR, S. J. 2004. Development of bait technology to control tsetse. — *In*: MAUDLIN, I., HOLMES, P. H. & MILES, M. A. (Eds.), The trypanosomiases. Oxfordshire, CABI Publishing, pp. 509-524.

VAN DEN BOSSCHE, P. 2001. Some general aspects of the distribution and epidemiology of bovine trypanosomiasis in southern Africa. — *Int. J. Parasitol.*, **31**: 591-597.

VAN DEN BOSSCHE, P., DE LA ROCQUE, S., HENDRICKX, G. & BOUYER, J. 2010. A changing environment and the epidemiology of livestock trypanosomiasis. — *Trends Parasitol.*, **26**: 236-243.

VAN DEN BOSSCHE, P., CHITANGA, S., MASUMU, J., MARCOTTY, T. & DELESPAUX, V. 2011. Virulence in *Trypanosoma congolense* Savannah subgroup. A comparison between strains and transmission cycles. — *Paras. Immunol.*, **33**: 456-460.

VREYSEN, M. J. B., SALEH, K. M., ALI, M. Y., ABDULLA, A. M., ZHU, Z.-R., JUMA, K. G., DYCK, V. A., MSANGI, A. R., MKONYI, P. A. & FELDMANN, H. U. 2000. *Glossina austeni* (Diptera: Glossinidae) eradicated on the island of Unguja, Zanzibar, using the sterile insect technique. — *J. Econ. Entomol.*, **93**: 123-135.

Classe des Sciences techniques

Klasse voor Technische Wetenschappen

Bull. Séanc. Acad. R. Sci. Outre-Mer
Meded. Zitt. K. Acad. Overzeese Wet.
57 (2-4 – 2011): 391-408

Climate-related Information in Labrador/Nunatsiavut: Evidence from Moravian Missionary Journals*

by

Gaston R. DEMARÉE ** & Astrid E. J. OGILVIE***

Light for the dreary vales
Of ice-bound Labrador!
Where the frost-king breathes on the slippery sails
Till the mariner wakes no more,
Lift high the lamp that never fails
To that dark and sterile shore.

"LET THERE BE LIGHT". A Mission Hymn.
Lydia Howard Sigourney (1837), p. 204

KEYWORDS. — Labrador/Nunatsiavut; Moravian Missionary Journals; Climate-related Information.

SUMMARY. — After reconnaissance voyages, the Moravian Brethren established their first missionary station on the Labrador/Nunatsiavut coast in August 1771 at a location named by them as Nain. At that time, the Labrador coast belonged formally to England. The Moravian missionaries remained in contact with England by means of an annual ship voyage. Information from the missionary stations and during the annual travel was published in the Moravian missionary journals in England and on the continent. Climate-related information has been gathered from these journals. A selection of the descriptions of weather and climate together with the impacts on the native Inuit and the missionary families is given. This information, combined with the extant early quantitative climatological records, provides an excellent overview of Labrador's climate and environment for the centennial period 1771-1880s.

TREFWOORDEN. — Labrador/Nunatsiavut; Moravische missietijdschriften; Klimaatgebonden informatie.

SAMENVATTING. — *Klimaat-gebonden informatie in Labrador/Nunatsiavut: evidentie uit de Moravische missietijdschriften*. — Na verkenningsreizen vestigden de Moravische Broeders hun eerste missiepost op de kust van Labrador/Nunatsiavut in augustus 1771 op een plaats die door hen Nain werd genoemd. In die tijd behoorde de Labrador kust formeel

* Paper presented at the joint meeting of the three Sections held on 23 January 2010. Text received on 10 January 2012.

** Member of the Academy; Royal Meteorological Institute of Belgium, Ringlaan 3, B-1180 Brussels (Belgium).

*** Center for International Climate and Environmental Research, Gaustadalléen 21, N-0349 Oslo (Norway).

tot Engeland. De Moravische missionarissen bleven in contact met Engeland door middel van de jaarlijkse scheepsreis van de missieboot. Informatie vanuit de missieposten en over de jaarlijkse scheepsreis werd gepubliceerd in Moravische missietijdschriften in Engeland en op het continent. Klimaat-gebonden informatie uit deze tijdschriften werd verzameld. Een selectie van klimaat- en weersbeschrijvingen samen met hun impact op de oorspronkelijke Inuit bewoners en de families van de missionarissen wordt gegeven. Deze informatie, in combinatie met de overgebleven vroege kwantitatieve klimaat gegevens, geeft een uitstekend overzicht van het klimaat van Labrador over de honderdjarige periode 1771-1880.

MOTS-CLES. — Labrador/Nunatsiavut; Revues missionnaires de l'Unité des Frères; Données climatiques.

RESUME. — *Données climatiques au Labrador/Nunatsiavut: témoignage des revues missionnaires de l'Unité des Frères*. — Au terme de voyages de reconnaissance, les missionnaires de l'Unité des Frères établirent leur premier poste sur la côte du Labrador en août 1771 à un endroit baptisé par eux Nain. A l'époque, la côte du Labrador appartenait officiellement à l'Angleterre. Les missionnaires restèrent en contact avec l'Angleterre grâce à un voyage maritime annuel. Les revues missionnaires anglaises et continentales publiaient des informations provenant des postes missionnaires. Des données climatiques ont été récoltées et une sélection de descriptions du temps et du climat avec leur impact sur la population Inuit et les familles missionnaires est proposée. Ces informations, combinées avec les séries climatologiques subsistantes, donnent un excellent aperçu du climat du Labrador pour la période centennale 1771-1880.

Introduction

The Moravian Brethren, also known in England as the *Unitas Fratrum*, in Germany as *Evangelische Brüder-Unität* or *Herrnhuter Brüdergemeine*, and in French-speaking Switzerland as *Unité des Frères,* are protestant Christians whose pre-Reformation origins date back to the Bohemian reformer Jan Hus (*ca.* 1369 – July 1415). An interesting aside is that one of his most famous followers, Ján Amos Komenský (Jan Amos Comenius, 1592-1670), may be considered to be the father of modern education and also served as bishop of the Unity of the Brethren. After the virtual extinction of the movement, Bohemian survivors of the Counter-Reformation persecution migrated in the early 1700s to Saxony where they found refuge. Count Nicolaus Ludwig von Zinzendorf und Pottendorf permitted them to build the village of Herrnhut on a corner of his estate of Berthelsdorf. Through the influence of Count Zinzendof a vast programme of missions was launched including: the Danish West Indies (1732), Greenland (1733), Surinam (1735), South Africa (1737), and British West Indies (1754-1777).

An initial journey to the Labrador coast in 1752 was an attempt to establish a missionary post at Nisbet Harbour (near present-day Hopedale) but failed due to hostilities with the native peoples. Subsequently, three exploratory missions were made to the Labrador coast in the years 1764, 1765 and 1770. Then in August

1771 the Moravians established their first missionary post at Nain on the one hundred thousand acres of land that had been granted to them by Commodore Hugh Palliser, the British Governor of Newfoundland. The missionaries continued to explore the Labrador coast in order to find suitable places for further mission stations (fig. 1). The station Okak (spelled 'Okkak' until 1854) was opened in 1776 and a third post at Hopedale (in German 'Hoffenthal' or 'Hoffental') in 1782. Nearly another fifty years passed before Hebron, north of Okak, was opened. Later on, further missionary stations were established at Zoar in 1865 (located between Nain and Hopedale), at Ramah in 1871, and at Makkovik in 1895, and finally at Killinek, near Cape Chudley (the northern tip of Labrador), in 1904.

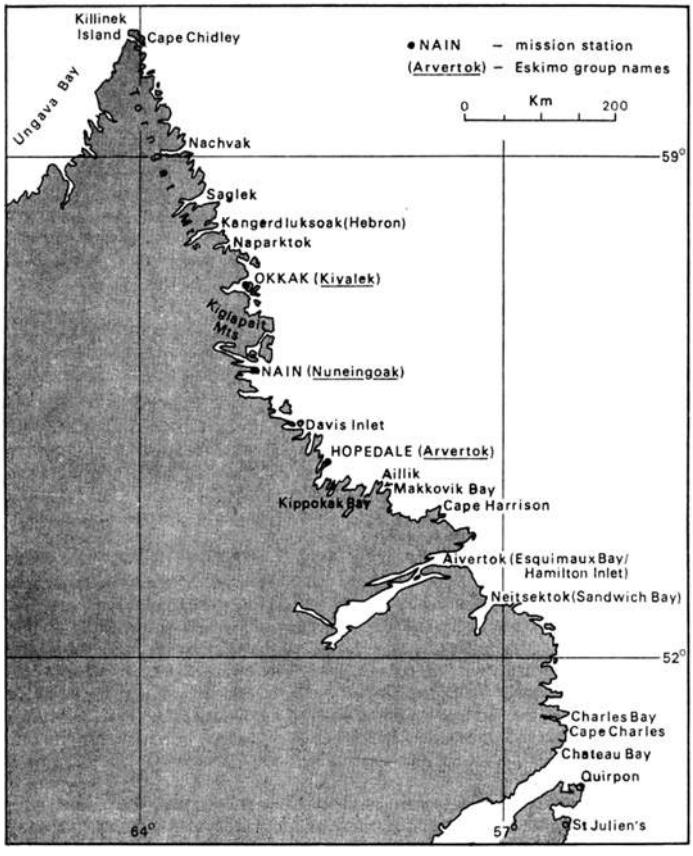


Fig. 1. — Geographical location of the Moravian stations in Labrador/Nunatsiavut (from HILLER 1971).

Moravian Missionary Journals

In the late eighteenth century, and in the early part of the nineteenth, missionary journals (called *Missionsblätter* in German) began to be published. These journals mainly served as a communication between, on the one hand, the flock of the Moravian communities in Europe and, on the other, their sympathizers with the missionary families in the far-away mission stations. The journals had the primary purpose of informing the readers concerning the advances of the missionary work among the 'heathen'. The Moravian communities in Europe organized specific activities for the benefit of the missions and to support the overseas missionary work. The collected goods and funds were shipped with the missionary vessel on its yearly journey to the Labrador coast. One drawback of the information from the missionary journals is that the voice of the native peoples of Labrador is very faint. Indeed their contributions, if present, are merely related to religious affairs and are, of course, filtered by the missionaries.

In general, the information in the journals was relatively broad and stress was laid upon the harsh conditions in which the missionaries had to work. For Labrador, this included information on the extreme climate and environment. Particular information on the so-called "externals" (in contrast to the "internals" or religious aspects) of the Inuit people was given. The well-being of the Inuit in the stations was an important element. This well-being could be challenged by the prevalence of diseases and epidemics and lack of foodstuffs which could potentially lead to famine. Therefore, the fishing, hunting and seal-catching activities of the Inuit are considered of great importance and are described in detail. The interest of the general European public in the nineteenth century also included wider topics such as the state of the country, climate, weather, geography and environmental conditions, as very little information was available for Labrador.

The missionary diaries were brought to Europe by means of the Moravian vessel that visited the Labrador stations in the summer of each year (fig. 2). For this reason, the information is organized in "ship-years". This means roughly July of one year to August or September of the next. The exact date on which this period began or ended was variable depending on many conditions, among them drift ice and meteorological conditions encountered when crossing the Atlantic Ocean.

The following missionary journals were consulted for climate-related information for the centennial period 1771-1880s:

— *Periodical Accounts* related to the Missions of the Church of the United Brethren (1790-1889 and 1890-1930) at London, abbreviated as (P.A.);
— *Missions-Blatt aus der Brüdergemeine* (1837-1939), at Herrnhut, Germany, abbreviated as (M.B.B.);
— *Nachrichten aus der Brüder-Gemeine* (1817-1894) at Gnadau, Germany, abbreviated as (N.B.G.);

— *Calwer Missionsblatt* (1828-1918) at Calw, Germany, abbreviated as (C.M.B.);
— *Journal de l'Unité des Frères* (1835-1938) at different locations in French-speaking Switzerland, abbreviated as (J.U.F.).

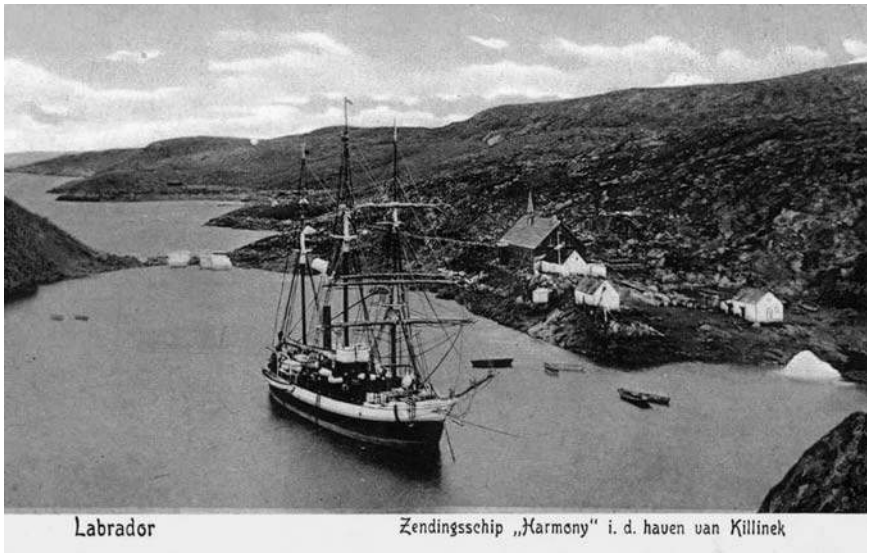


Fig. 2. — The missionary ship 'The Harmony' in the harbour of Killinek, Labrador.

Instrumental Meteorological Observations in Labrador

The climate-related documentary information in the sources described here complements the quite fragmented instrumental meteorological observations published in nineteenth scientific journals (DEMAREE & OGILVIE 2008, tab. 4). These instrumental meteorological observations can be subdivided into four different time spans:

— The earliest or the *Ancien Régime* observations. These observations cover approximately the period 1771 to the late 1780s. Manuscripts of the observations are located at the Moravian Archives in Herrnhut and London, at the Archives of the Royal Society in London, or were in possession of Cleveland Abbe in the USA in 1873 (DEMAREE & OGILVIE 2008, tabs. 1 and 2). DE LA TROBE (1779-1781) published two extracts of meteorological observations at Nain and Okak in the *Philosophical Transactions of the Royal Society in London*. Another printed source is the extracts published in the *Wittenbergsches Wochenblatt* by Johann Daniel Titius (DEMAREE *et al*. 1998; DEMAREE & OGILVIE 2008, tab. 3).

— The nineteenth-century observations and interactions with European scientists. It is most probable that the instruments of the first time span were still used in Labrador as individual readings appear in the missionary journals. Fragmented information was published in several scientific journals but, at present, no systematic records are available. For this time period collaboration with several European scientists, for example, Alfred Gautier (1793-1881) in Geneva and Johan von Lamont (1805-1879) in Munich, was established through the channels of the Moravian communities in Europe.
— A third time span corresponds with the establishing of the Meteorological Service of Canada in 1871 and the First International Polar Year 1882-1883. The German Polar Commission took advantage of the Moravian missions in Labrador and dispatched the physicist Dr Karl Richard Koch (1852-1924) to instruct the missionaries on how to carry out quantitative meteorological observations. The observations were forwarded to and partly published by the *Deutsche Seewarte* or the German Naval Observatory in Hamburg.
— In the prelude to the Second World War, for clear strategic reasons the Canadian authorities took over the meteorological observations. In this connection it is interesting to note that a German U-boat erected the fully-automated weather station *Kurt* in October 1943 close to Cape Chidley for the purpose of weather forecasting.

Climate-related Information from the Moravian Missionary Journals

The climate-related information from the Moravian missionary journals may be subdivided into different categories. Thus, for example, it can take the form of: *i*) specific climatological information and information dealing with climate and climatic changes; *ii*) information on the occurrence of drift ice during the annual travel of the missionary ship in the summer; *iii*) geophysical observations; *iv*) plant phenological observations in the mission gardens; *v*) prevailing health conditions and the occurrence of epidemics and epizootics. In the following, a few examples of climate-related information will be shown illustrating the possibility of obtaining a more detailed picture of the weather and climate of the Labrador coast in the period 1771-1880s.

The Climate of Labrador and Climatological Information

The missionary Johannes Körner at Hopedale, Labrador, wrote on 1 September 1831 to a friend in Württemberg thanking him for the gifts that had been sent: "The dried plumbs that you sent us two years ago have been very useful to us as our garden harvest turned out to be very meagre. The present year of

1831 won't become better as until now the summer has remained mostly cold, and heavy storms and frosts reigned in June and July. In May 1831, the snow still lay 10 feet thick in front of our house".

He continued giving a description of the Labrador climate and, as an example, the weather in the year 1790:

> The cold in Labrador is very severe, more severe than in the more northerly situated Greenland. The rum freezes in the air like water; strong spirit becomes thick like oil. In the houses of the missionaries that are heated by means of large iron stoves, the windows and even the walls are covered with ice, so that the bedclothes freeze to the walls. On a journey in the month of February, the eyelids of the Europeans dressed in furs froze together, so that they had to tear them apart, and had constantly to rub them so that they didn't close again. In the year 1790, the snow still lay in June, 20 feet thick, and it was only with great effort that there was success, after many attempts, in growing some garden fruits, sugar peas, beets and potatoes. In 1791, at the end of May the snow pack was still 10 feet thick and the missionaries sowed their garden on the 24th of June. Two days later everything was again covered with snow. The few summer months are sometimes warmer than at home in Germany. The air is then filled with insects whose bites often cause ulcers (*C.M.B.*, 1831).

In 1830, the station of Hebron — then the most northerly station — was established. The missionary August Freitag described its climate in private correspondence in 1833:

> Hebron may be a very healthy place for young persons, blessed with sound constitutions, the air being clear, and unwholesome vapours unknown; but for persons advanced in life, or such as are hectic or consumptive, the climate is too severe, the atmosphere being too rare, and the cold much too intense. During the winter 1832-1833, the thermometer [1]* has been at –40° C. You speak of trees; but you are not to suppose that there are any to be seen in this neighbourhood. Even brush-wood is much less frequent on this part of the coast than in Greenland. Yet I have observed, here and there, a few birch and alder bushes, and willows of two kinds. The birch appears to thrive the least in the neighbourhood of the sea; it seldom attains the height of a foot; but the diminutive branches become so interwoven into one another, that it would be difficult for a bird to build her nest among them. The willows flourish best; some of them grow to the height of four or five feet. Mineral productions are not to be found in great variety (*P.A.*, vol. XII).
>
> In the middle of October 1817 most of the Eskimos at the station of Okak returned from their outlying places, improved their winter dwellings, and moved into them in a hurry, as the cold increased so that the bays around us froze up before the end of the month. On the 30th October 1817, the ice was already so fast that the Eskimos could go to hunt on it without hesitation. But the seal catch with nets was unfortunately once more prevented by this early ice. In January 1818 the

* Numbers in brackets [ ] refer to the notes, pp. 406-407.

cold increased to –36° C and became more severe due to the strong westerly wind (*N.B.G.*, 1820).

At the mission station Nain, the sea froze up on the 30th November 1844 and on 1st December, the cold rose to –30° C and in mid-January 1845 to –37° C. April 1845 was very sweet and warm for here, but in May and a part of June 1845 we had genuine winter. The snow was not significant; it had already thawed. On 30th June 1845 we had open water again. For seven full months we had not seen any other water than that which was carried into the kitchen. It is truly refreshing to see the blue sea water again after such a long time (*C.M.B.*, 1845).

At Nain, the winter, 1863-1864, was marked by an unusually scanty fall of snow. The bay was covered with ice at the end of November 1863, and the cold continued in an equal degree of severity during the following months, reaching its climax on 16th February when the thermometer showed –33.3° C. The month of May 1864 brought us a succession of fine warm days, which were followed by a return of the cold season in June. Since the ice left the bay, at the end of June, we have had some very warm summer weather. On the 29th June, the thermometer stood at 26.1° C. The season has been marked by drought in an unprecedented degree; our watercourse has been quite dry for a time, and the necessary supply of water, for all purposes, had to be fetched from the other side of the bay (*P.A.*, vol. XXV).

The missionary Carl Gottlieb Kretschmer wrote in a letter dated 4 June 1885 on the summer in Labrador and concurred hereby with the general belief in a colder climate in the northern regions:

The scientists have claimed that the North Pole gets colder and we are inclined to prove them right. Three weeks ago the winter came again. On the 9th May 1885, by a lot of effort we succeeded in putting some little plants in their beds but a cold of –8° C, accompanied by a glacial wind, has brought us snow and ice again. On the 1st of June, some good and warm sunshine caused our small stream to thaw and we hastened to plant our potatoes. Alas! *Ajornapok*, it is impossible. Today, it snows like in the month of December and all gardening work has stopped. Truly, we are in the country of the seals but not of gardening! Over the last 30 years we have never been so much delayed as this time. On the 9th of June 1885, we could finally plough. My colleague Haugk, equipped with warm fur gloves, has planted a few hundreds of potatoes. However, today everything is white from the snow that has fallen without interruption since yesterday evening! We are reduced again to useless laments. On the 28th June 1885, as the month of June approached its end, the calendar tells us that we are in the summer; we could have believed it yesterday, a pleasant day, 19.5° C warm, but today it is cold again. The mosquitoes, hardly appeared, were in haste to disappear. One needs to cover the potatoes in the night (*J.U.F.*, 1887).

Occurrence of Drift Ice on the Labrador Coast

The occurrence of drift ice along the Labrador coast was one of the main constraints regarding the safe arrival of the annual missionary vessel reaching

the stations. The presence of the ice could make the journey dangerous and could potentially delay the arrival of the ships. The year 1816, known famously as 'the Year without Summer', is well known for its vast amounts of drift ice along the Labrador coast (HARINGTON 1992, NEWELL 1992, HILL 1999). It is generally agreed that the unusual cold and rainy climatic anomaly of this year occurred because of the highly explosive volcanic eruption of Mount Tambora on the island of Sumbawa, Indonesia, on 5 April 1815. Furthermore, the year 1816 was in the middle of the Dalton period, a period of low solar activity.

However, the year before (1815) also presented severe drift-ice conditions: "On the 19th July 1815, the Lord unexpectedly led the missionary vessel *Jemima* hither in safety, through the drift-ice which had for a long time encircled our coast" (*P.A.*, vol. VI). It may be concluded that the set of the three consecutive years 1815, 1816 and 1817 are years of medium or high drift-ice conditions near the Labrador coast.

The recording of the complete absence of drift ice is also of great interest climatically: "To our great delight no drift-ice was found**.** On the 30th of July 1842, in the early morning, we saw the first land, although it was very foggy, and in the evening we reached the entry to Hopedale" (*C.M.B.*, 1852).

Brother Johannes Körner wrote on his travel to Labrador: "On the 20th June 1829, we sailed from Stromness, Orkney Islands and had favourable wind and the best weather until 9th July when we caught sight of ice for the first time. On the 12th July the skipper took the courage to enter the ice, and to see if it was possible to advance. The ice in which we were seemed to be the Labrador ice as it wasn't very thick and firm. On the 13th we saw an unbelievably large amount of ice around us. From the 14th till the 17th we passed partly in the ice, partly out of the ice. On the 17th, for the first time, we cast anchor to the ice for which one selects firm and large ice fields. Our ship occasionally suffered heavy pushes from the ice, and the sailors had a hard time for a few hours. On the 31st we neared our Hopedale while we had most to fight with the ice" (*C.M.B.*, 1830).

In the biography of Brother August Freitag, the difficulties encountered with drift ice are remembered as follows: "On the 13th July 1831, on the moment we thought to be near the coast of Labrador, we met drift-ice that our sailors had already suspected because of the drop in temperature. The fog completely hid watch the horizon when the seamen on suddenly shouted "ice in front" and actually, through gaps in the fog, it didn't take a long time to see rising above the water ice needles and peculiar forms. For a fortnight it was impossible to find a passage through the ice that was heaping up more and more. On the 24th July 1831, on a Sunday, there was a moment when we hoped we would be able to pass and we saw the coast, but an adverse wind, and the reappearing of the fog made this hope vanish rapidly. Finally, on the 28th July 1831, a favourable wind rose, the ice being split and having even disappeared. Finally on the 69th day of our journey we reached the harbour of Hebron" (*J.U.F.*, 1868).

Geophysical Information

In Iceland, the Lakagígar volcanic eruption, also named in Icelandic the Skaftáreldar, the River Skaftá Fires, one of the largest fissure eruptions to have occurred in historical times burst out at Whitsun, June 8th, 1783, and lasted until February 1784. The eruption was followed by the appearance of a fog over a large part of the northern hemisphere which was named the "Great Dry Fog" (STOTHERS 1996, DEMAREE & OGILVIE 2001). It was known from Moravian sources of information that the missionaries in Labrador had observed a peat-smelling smoky atmosphere in July 1783. This information was published in the *Wittenbergisches Wochenblatt* by Johann Daniel Titius (DEMAREE *et al*. 1998). The daily weather observations carried out by the Moravian missionaries at the three stations in Labrador in the early period and located at the Archives of the Royal Society, London (DEMAREE & OGILVIE 2009, tab. 2), mention this fog as follows:

> Nain: This month of July 1783, I observed something that I never observed before, *vz*. that the whole air looked like as if it was filled with smoke or a thin fog. This kind of weather I will call smoky. The Sun never shone clearly enough [2] that one could candle a pipe by it. The 2nd of July 1783 was observed as smoky, the 4th, 5th, 7th, 10th, and 11th as misty, the 3rd, 12th, 13th and 14th was observed a 'miste', the 16th as hazy, on the 17th, 21st and 22nd a haze was observed and from the 23rd to the 31st of July 1783 the condition is described as 'quite thick smoky'.
>
> Okkak: Thursday 3 July 1783 "For several days thick smook fly throw the Air as from a great fire we so hope the Ukas [?] set some great woods on fire. They do so sometimes".
> July 22, 23, 24, 25 and 26: "Smoke and Sun Shine"
> July 29: "The Air full of smoke for 5 weeks past"
> July 31: "Thick smoke and Sun Shine".
>
> Hoffenthal: June 1783: "Great fog sequence"
> 23 June: "very much mist"
> 28 June: "much mist. A little sunshine through the mist"
> 10 July: "Clear sunshine, no clouds, but much smook on the land, a very high sea, much cloudy"
> 11 July: "small rain and mist on the hills".

Similar appearances were observed in July 1821 but cannot be ascribed to a known historical volcano eruption (SIMKIN & SIEBERT 1994). In this context it is of interest to note that the last eruption of the Eyjafjallajökull in Iceland, before the one of 2010, started in December 1821 and lasted until January 1823. Regarding the year 1821 an account from Nain reads: "About the middle of July 1821, a dark, smoky vapor, and something like ashes, filled the atmosphere" (*P.A.*, vol. VIII).

Also, from Okak:

> In the night of the 1st of July, 1821, it froze so strongly at Okak that in many places the ice was half an inch thick as a result of which the plants in the garden, in particular the potatoes, suffered much. On the contrary, on the 6th, it was 10° to 19° C. The air was very hazy and smelled like peat. On the next day, the *Höhenrauch* became so thick that we had to put the light on in the room at half past seven. This darkness lasted for 2 hours. As we had no calendar we didn't know if on that day there was a solar eclipse [3] (*N.B.G.*, 1822).

As noted, it is not possible at present to ascribe an historical volcano eruption for these observations. However, the use of the German term *Höhenrauch* may refer to the Great Dry Fog of the year 1783 or to *Moorrauch* or *Moordampf* (FINKE 1820) in the first quarter of the nineteenth century in Lower Germany (a phenomenon witnessed and related to peat burning in the areas of Westphalia). It is also possible that large area inland fires were responsible for.

As regards a "cold fog" mentioned in Labrador in 1884 it may be questioned as to whether this was due to the eruption of the volcano Krakatau, Indonesia, on 27 August 1883. "The winter 1883-1884 has been very severe in Labrador. One had hoped for a nice summer in 1884 but a cold fog has enveloped the coast almost daily" (*J.U.F.*, 1884).

The Labrador missionaries (as well as their Greenland colleagues) also observed a few earthquakes in their missionary posts. From Nain, on 12 August 1809 an account reads: "On January 21st, 1809, and for some days after, we perceived some shocks of earthquakes, which seemed to be felt, as far as we could learn, all down the coast" (*P.A.*, vol. IV). Also, "On the 2nd of June 1838, an earthquake was felt at Nain and strongly shook the house of the missionaries without, however, damaging it" (*J.U.F.*, 1839).

A list of the earthquakes mentioned in the missionary journals is given in table 1.

Table 1

List of earthquakes observed in Labrador at the stations of the Moravian Brethren in the time frame 1770-1880

Date	Station(s)	Source(s)	Brief Description
21 Jan. 1809	Nain	*P.A.*, IV	Some shocks of earthquakes felt all down the coast.
30 Nov. 1836	Hopedale, Nain	*P.A.*, XIV N.B.G., XX	Smart shock of an earthquake. Strong noise of the air with strong movement of the earth.
2 June 1838	Nain [4]	*J.U.F.*, 1839 *N.B.G.*, 22	Earthquake strongly shook the house. Earthquake making the house move.
26 May 1839	Nain	*P.A.*, XV	Slight shock of an earthquake. Plates reared against wall vibration.
12 Jan. 1857	Okak, Hebron	*P.A.*, XXII	Earthquake felt by the Eskimos. Smart shock of earthquake felt by the Eskimos.

This list completes the work carried out by ADAMS & STAVELEY (1985) and STAVELEY *et al*. (1986). Indeed the two earthquakes of 2 June 1838 and 26 May 1839, the first one referenced in the continental missionary journals and the second one from the *P.A*., vol. XV, complete the picture.

Plant Phenological Observations

The German missionaries in Labrador almost certainly had some experience in plant cultivation, coming as they did from areas with an agricultural tradition. Certainly, their garden produce was a first-hand necessity for surviving the long winter. They attributed the absence of scurvy in the missionary family to the consumption in the winter of vegetables from their gardens. The severe climatic conditions of Labrador are the factors which constrain the produce of missionary gardens, indeed spring and summer weather situation is conditional on raising good garden produce.

When founding a new station like that of Hebron in 1830, the missionaries spent considerable manpower in preparing the garden: "My colleague, Brother Freytag, and myself [Ferdinand Kruth] had much pleasure in the spring of this year, in the laying out of a garden, which we have called Elim [5]. It is situated on the margin of our rivulet called the *Neiss* [6], and is surrounded by a wooden paling. Although our Elim cannot boast of any palm-trees, it stands like an Eden [7], in the midst of the rugged vale; and every time that we have wandered forth to it during the summer evenings, to enjoy a social cup of coffee or tea, we have admired it afresh, and felt thankful to the Giver of all Good for this pleasant retreat" (*P.A*., vol. XIII).

Early botanical material provided by the missionaries Benjamin Gottlieb Kohlmeister (1756-1844) and Johann Georg Herzberg (1792-1864) was published by PURSH (1814) and by Ernst Heinrich Friedrich Meyer (1791-1858) (MEYER 1830). Ritter von Schranck described a few plants from Labrador while von Schreber, President of the Royal Bavarian Botanical Society in Regensburg, also received a parcel from "a certain Kohlmeister" with plants from Labrador (VON SCHRANCK 1818). The missionary Carl Gottfried Albrecht (1800-1888) was in contact with the botanist Ernst Gottlieb von Steudel (1783-1856) who lived in Esslingen, Baden-Württemberg. Albrecht forwarded to him botanical material from Hopedale between 1846 and 1848 (CAYOUETTE & DARBYSHIRE 1994).

Botanical knowledge of the missionaries was part of a three-partner process involving the Labrador Inuits, the missionaries and the botanical networks in Europe. On the one hand, the agricultural craftsmanship may have impressed the natives and contributed to their conversion while on the other hand ties with natural history networks in their homelands, Saxony, Bavaria and Baden-Württemberg, may have provided institutional and political supports to the mission (BRAVO 2007). It lasted long before the Inuit took over the agricultural habits of

cultivating a garden: "We rejoiced to see, that our Esquimaux are more and more disposed to lay out gardens, and attend to their cultivation" (*P.A.*, vol. XV, 1839). The Moravian bishop Levin Theodore Reichel (1812-1878) provided, after his visitation in the year 1861, a list of a hundred and seventy plants from Labrador which were known to the missionaries (REICHEL 1863).

The harvest of missionary gardens was carried out in September or early October generally after the missionary ship had already left the stations. Therefore, the reports on the harvest and missionary gardens refer to the past ship-year.

> In the beginning of October 1818 we were occupied at Okak to collect our garden fruits which, beyond expectations, turned out well. This was particularly the case with the potatoes, which could remain in the ground four months and didn't suffer once in that time at the leaves from the frost, a rare example here (*N.B.G.*, 1820).

> The whole spring was cold; and the whole May of 1836 through was like a real winter, only a few days with thaws. June had snow and fog, July rain and fog; only with August did summer weather come so that also the trees became green. The state of the gardens is very regrettable which is no wonder (*C.M.B.*, 1836).

> The winter 1856-1857 was not cold, only once did the thermometer go as low as –33° C, but was full of snow, and the spring wet, and this humid weather continued till the beginning of July 1857, since when we only had warm weather so that we may expect a good harvest in the garden (*M.B.G.*, 1858).

Epidemics and Epizootics

The Labrador Inuits did not have natural immunity to the typical illnesses prevalent in Europe so that in cases of prevailing epidemics a part of the population invariably died. In general, according to the Missionaries' view, the origin of the disease was said to be brought from the Southlanders and then spread by Inuits from station to station.

> At Hopedale, in the autumn of 1806, after the Esquimaux had removed into their winter-houses, a malignant disorder broke out amongst them, resembling both the small-pox and the measles, which caused to some much and to others less pain and suffering. Old Thomas, formerly known by the name of Kapik, was most severely attacked by it, as the eruption in his face struck inward, and turned into a kind of scrofula [8], by which one of his upper jaw-bones was eaten away. (*P.A.*, vol. IV).

> On the 21st August 1821, on the *Clinker* sloop of war Captain William Martin arrived at Nain, from Okak. The benevolent captain offered to have the Esquimaux children inoculated with the cow-pox, but we had several reasons for declining his kind offer (*P.A.*, vol. VIII).

Smallpox was brought to Canada in the 17th century and because the natives were totally devoid of immunity, they were ravaged by the disease (FENN

2001). After Edward Jenner's (1749-1823) experiments in 1796, inoculation against smallpox had become a popular preventive method in Europe. Vaccination — a more effective and less dangerous technique — was introduced into North America by the Reverend John Clinch (1748/49-1819). Clinch was a medical missionary for the Church of England at Trinity, then the second-largest settlement in Newfoundland and had been a classmate of Edward Jenner. However, the widespread use of vaccination, advocated by public-health leaders, met with much resistance by anti-vaccinationists. Nevertheless, many colonists and American natives became vaccinated. It is not mentioned why the Moravian missionaries objected to the suggestion of the inoculation of the Inuit children.

> In the month of September 1827, an infectious epidemic arose among our Eskimos. This illness started with a violent catarrh that attacked the breast and mainly the neck, and which caused much suffocation. One noticed moreover several symptoms of putrid fever. The number of ill persons increased so much that we feared to run out of medicines. Our hall was full of Eskimos who came, evening and morning, to look for medicines. At the end of the month, the number of ill persons increased to 175. It pleased God to call to him by this illness six adults and six children in the time of one month (extraits des *Journaux de l'Eglise de l'Unité des Frères*, 1837).

> The feelings of solemnity were kept alive and intensified throughout the months of February and March 1864, by the prevalence of sickness with a degree of mortality, which has never been known before at this place. An epidemic, which at first appeared nothing worse than an ordinary catarrh, assumed an inflammatory character, fixing itself on the chest and lungs; it spread to such an extent, that not a single individual of the community remained unaffected by it. The circumstance that so many were attacked at the same time increased the general distress, as the possibility of rendering mutual assistance was greatly diminished, and there were none left to provide the needful supply of food and fuel. All day long our Mission-house was never without some person or persons who came for medicine or food, themselves often so ill that no doctor would have sanctioned their leaving their beds. But the missionary brethren were themselves suffering from symptoms of the same disease, so that it was for a time impossible to visit the huts of the poor Esquimaux; we did all that lay in our power to supply the poor people with soup and dried fruit, as well as medicine. In spite of all our endeavours, the disease, favoured by the poverty and want of proper attention and accommodation on the part of the natives, proved fatal in many cases. In the short space of a month twenty-one persons died, of whom one-third were children. On March 8th, 1864, fifteen corpses were buried at the same time (*P.A.*, vol. XXV).

> Okak, September 8th, 1869: "The epidemic [summer and autumn of 1868] had scarcely left us, when another made its appearance among the children, which proved fatal in several instances. Of those who were not carried off by its attacks, not a few remained partially lame in the lower extremities; some recovered sufficiently

> to be able to walk about, others continued incapable of walking or standing and we entertain little hope of their eventual recovery. The brother on whom the duty of doctor devolved had a heavy time of it, as he had continually to visit the sick, or give medicine to the poor people who crowded our mission-house" (*P.A.*, vol. XXVII).

> The Brethren & Sisters Schött, Schneider and Dam from Okak, Report from the mission conference, 8th September 1869: "At the departure of the ship *Harmony* last year still raged here an infectious disease, yes it was still rising and brought us with the poor staff of our station many serious difficulties. Hardly was this illness decreasing or an epidemic broke out among the children by which the entire number of them was seized. When some deaths followed, the Eskimos and we became really scared. But the Lord heard our sighs and begging and made the fast dying stop. With many patients it took a long time before they recovered, some of them have such a slackness of the limbs so that up to now they cannot use them completely, and several remained even completely lame. In the course of the year again 30 deaths happened" (*M.B.B.*, 1870, pp. 7-10).

According to these descriptions, the epidemics might have been poliomyelitis (polio) or infantile paralysis. This illness was first described by the German physician Jacob Heine (1800-1879) in 1840 while its epidemic character was recognized by the Swedish physician Karl Oskar Medin (1847-1927). This illness remained endemic until the 1880s when localized major epidemics started to occur in Europe, notably in Sweden, Norway, Germany, Lower Austria and Vienna, northern Italy, France, and in London and Saint Petersburg (MacMurchy 1912). In the US epidemics began to occur like in Vermont with one hundred and thirty-two cases and eighteen deaths, and approximately two thousand five hundred cases and one hundred and twenty-five deaths in New York in 1907. In June 1916, a large epidemic broke out with over twenty-seven thousand cases and six thousand deaths in the United States, with over two thousand deaths in New York City alone. From 1916 onward, a polio epidemic appeared each summer in at least one part of the United States (MacMurchy 1912, Trevelyan *et al.* 2005). The situation of poliomyelitis in Canada was similar to the one in the United States (Barreto *et al.* 2006). If the epidemics that occurred in 1868-1869 along the Labrador coast could be truly interpreted as poliomyelitis, it would be one of the very early outbreaks of the illness in Canada, and in the New World.

Also epidemic diseases or epizootics were witnessed among the sledge dogs of the Inuits.

> Later, a severe and maybe a never at this level seen disaster was endured by our poor Eskimos, by which in February an epizootic among the dogs broke out, by which little by little more than 100 animals were taken away. Also 20 dogs belonging to the mission were killed by this epizootic. This is a great loss for those poor Eskimos in the long wintertime (*M.B.B.*, 1860).

Conclusions

The continental and English missionary journals of the Moravian Brethren contain a wealth of climate-related information on Labrador/Nunatsiavut. A brief selection of the descriptions of weather and climate together with the impacts on the native Inuits, the Inuit society and the missionary families is given for the centennial period 1771-1880s. This information, combined with the extant early quantitative climatological records (DEMAREE & OGILVIE 2008), provides an excellent overview of Labrador's climate and environment.

In particular, the statements on the occurrence of drift ice along the Labrador coast and the narratives of the difficulties of the mission ships to reach the harbours of the mission posts are good indicators of the climatic evolution in the given time frame. The set of the three consecutive years 1815, 1816 (= the Year without Summer) and 1817 are years of medium or high drift-ice conditions near the Labrador coast. The climate picture is completed by descriptions of the winter climate as experienced by the missionary families. Furthermore, the produce of missionary gardens, which is essential for their survival under the harsh climatic conditions, is heavily dependent on weather and climate.

Geophysical phenomena are particularly stressed as information concerning earthquakes and volcano eruptions experienced by the missionaries in that remote location fully help to document the worldwide geophysical history. In that context, two hitherto unknown earthquakes — 2 June 1838 and 26 May 1839 — are listed and complete the knowledge on historical seismicity of Labrador. The observation in the three missionary posts of the 'dry fog' weather conditions due to the Icelandic Lakagígar volcano eruption of 1783-1784 yields further evidence of the northern hemispheric coverage of the event.

It is shown that the Moravian missionaries adopted the attitude of anti-vaccinationists on the occasion of the visit of the *Clinker* in 1829. It is further hypothesized that the descriptions of the epidemics occurring at the missionary station of Okak in 1868-1869 might be a very early outbreak of poliomyelitis (polio) or infantile paralysis in Canada. This would possibly complete the polio epidemics history in Canada.

NOTES

[1] All temperature observations expressed in degrees Fahrenheit or Réaumur in the missionary journals have been converted to Celsius by the author.

[2] The original manuscript text is kept at the Archives of the Royal Society in London.

[3] A solar eclipse was visible in Labrador on Aug. 27, 1821 (see NASA Eclipse Web Site, Five Millennium Canon of Solar Eclipses by Espenak and Meeus).

[4] See also the earthquake of the San Francisco peninsula, California, in June 1838, measuring a magnitude of 6.8, and the southern Illinois earthquake on June 9, 1838.

[5] Elim was one of the places where the Israelites camped following their Exodus from Egypt. It is referenced in Exodus 15.27 and Numbers 33.9 as a place where "there were twelve wells of water, and seventy date palms", and that the Israelites "camped there near the water".
[6] The (Lusatian) Neisse is a river in the Czech Republic and along the Polish-German border, in total 252 km long. It is a left tributary of the Oder River.
[7] The Garden of Eden is described in the Book of Genesis as being the place where the first man, Adam, and his wife, Eve, lived after they were created by God. Literally, the Bible speaks about a garden *in* Eden (Gen. 2:8).
[8] Scrofula is any one of a variety of skin diseases; in particular, a form of tuberculosis, affecting the lymph nodes of the neck.

REFERENCES

ADAMS, J. & STAVELEY, M. 1985. Historical Seismicity of Newfoundland. — Ottawa, Seismological Service of Canada / Service séismologique du Canada, 73 pp. [http://earthquakescanada.nrcan.gc.ca/histor/20theme/1929/StavelyAdamsSeismicityNewfoundlandEPBOF85-22.pdf]

BARRETO, L., VAN EXAN, R. & RUTTY, C. J. 2006. Polio vaccine development in Canada: Contributions to global polio eradication. — *Biologicals*, **34**: 91-101.

BRAVO, M. 2007. Mission Gardens: Natural History and Global Expansion, 1720-1820. — *In*: SCHIEBINGER, L. & SWAN, C. (Eds.), Colonial Botany: Science, Commerce, and Politics. University of Pennsylvania Press, pp. 49-65 (2nd ed.).

CAYOUETTE, J. & DARBYSHIRE, S. J. 1994. Taxa described by Steudel from the Labrador plants collected by the Moravian missionary Albrecht and distributed by Hohenacker. — *Taxon*, **43** (2): 169-180.

DE LA TROBE 1779-1781. Extract of Two Meteorological Journals of the Weather, observed at Nain, in 57° North Latitude, and at Okak, in 57° 30', North Latitude, both on the Coast of Labrador. Communicated by Mr. De la Trobe to the President, and by him to the Society. — *Philosophical Transactions, of the Royal Society of London*, **LXIX** (I): 657-658; **LXXI** (I): 197-198.

DEMAREE, G. R. & OGILVIE, A. 2001. *Bons Baisers d'Islande*: Climatic, Environmental and Human Dimensions Impacts of the Lakigígar Eruption (1783-1784) in Iceland. — *In*: JONES, P. D., OGILVIE, A. E. J., DAVIES, T. D. & BRIFFA, K. R. (Eds.), History and Climate: Memories of the Future? New York, Kluwer Academic / Plenum Publishers, pp. 219-246.

DEMAREE, G. R. & OGILVIE, A. E. J. 2008. The Moravian missionaries at the Labrador coast and their centuries-long contribution to instrumental meteorological observations. — *Climatic Change*, **91**: 423-450.

DEMAREE, G. R., OGILVIE, A. E. J. & ZHANG DE'ER 1998. Comment on Stothers, R. B. "The Great Dry Fog of 1783": Further Documentary Evidence of Northern Hemispheric Coverage of the Great Dry Fog of 1783. — *Climatic Change*, **39**: 727-730.

FENN, E. 2001. *Pox Americana*. The Great Smallpox Epidemic of 1775-82. — New York, Hill and Wang, 370 pp.

FINKE, L. L. 1820. Naturhistorische Bemerkungen, betreffend eine auf vieljaerige meteorologische Beobachtungen sich stuetzende Beschreibung des Moordampfes in

Westphalen und seine nachtheiligen Einfluesse auf dortige Witterung. — Hannover, Hahn, 96 pp.

GIRARDIN, B. 1982. Périodiques missionnaires protestants romands, 1819-1981. Répertoire bibliographique. — *Mitteilungen der Basler Afrika Bibliographien*, **25**, 29 pp.

GOSLING, W. G. 1910. Labrador: Its Discovery, Exploration, and Development. — London, Alston Rivers Ldt., 574 pp.

HARINGTON, C. R. (Ed.) 1992. The Year without a Summer? World Climate in 1816. — Ottawa, Canadian Museum of Nature, 576 pp.

HILL, B. 1999. Historical Record of sea ice and iceberg distribution around Nfld and Labrador, 1810-1958 WCRP No. 108 or WMO/TD No. 949, April/99, ACSYS. — *In*: Proceedings Workshop on Sea Ice Charts of the Arctic (Seattle, WA AU 5-7, 1998).

HILLER, J. 1971. The Moravians in Labrador 1771-1805. — *The Polar Record*, **15** (99): 839-854.

KOCH, K. R. 1884. Die Küste Labradors und ihre Bewohner. — *Deutsche Geographische Blätter*, **VII** (2): 151-163.

MACMURCHY, H. 1912. Paralysis: The New Epidemic. — Toronto (Canada), Maclean's (November), p. 110.

MEYER, E. H. F. 1830. De plantis labradoricis libri tres. — *Lipsiae, Sumtibus Leopoldi Vossii*, **XXII**, 218 pp.

NEWELL, J. P. 1992. The Climate of the Labrador Sea in the Spring and Summer of 1816, and Comparisons with Modern Analogues. — *In*: HARINGTON, C. R. (Ed.), The Year Without a Summer? World Climate in 1816. Ottawa, Canadian Museum of Nature, pp. 245-254.

PURSH, F. 1814. *Flora Americae Septentrionalis*: or, A Systematic Arrangement and Description of the Plants of North America. Containing, besides what have been described by preceding authors, many new and rare species, collected during twelve years travels and residence in that country. — London, White, Cochrance, and Co.

REICHEL, L. T. 1863. Labrador, Bemerkungen über Land und Leute. — Mittheilungen aus Justus Perthe's Geographischer Anstalt über wichtige neue Erforschungen auf dem Gesammtgebiete der Geographie von Dr. A. Petermann, **IV**: 121-127 + 2 maps.

SIGOURNEY, L. H. 1837. Zinzendorff, and other Poems. — New York, Leavit, Lord & Co.; Boston, Crocker & Brewster, 300 pp. (2nd ed.).

SIMKIN, T. & SIEBERT, L. 1994. Volcanoes of the World. A Regional Directory, Gazetteer, and Chronology of Volcanism during the Last 10,000 Years. — Tucson (Arizona), Geoscience Press Inc. (in coll. with the Smitsonian Institution), 349 pp.

STAVELEY, M., ROLLMANN, H., RODGERS, A., CHISHOLM, J. & MURPHY, J. 1986. Historical Seismicity of Newfoundland. Phase 2: Contract Report to Canada Department of Energy, Mines and Resources, Earth Physics Branch, Division of Seismicity and Geomagnetism. — Ottawa (Ontario), Canada Department of Supply and Services, Contract No. OST85-00313, March 1986, 52 pp.

STOTHERS, R. B. 1996. The great dry fog of 1783. — *Climatic Change*, **32**: 79-89.

TREVELYAN, B., SMALLMAN-RAYNOR, M. & CLIFF, A. D. 2005. The Spatial Dynamics of Poliomyelitis in the United States: From Epidemic Emergence to Vaccine-induced Retreat, 1910-1971. — *Ann. Assoc. Am. Geogr.*, **95** (2): 269-293.

VON SCHRANCK, R. 1818. Aufzählung einiger Pflanzen aus Labrador, mit Anmerkungen. Denkschriften der königlich-baierischen Botanischen Gesellschaft in Regensburg. — *Zweite Abtheilung*, pp. 1-30.

Bull. Séanc. Acad. R. Sci. Outre-Mer
Meded. Zitt. K. Acad. Overzeese Wet.
57 (2-4 – 2011): 409-425

An Overview of Recent Natural Disasters in South America*

by

Lucí Hidalgo NUNES**

KEYWORDS. — Natural Disasters; South America; Urban Centres; Globalization.

SUMMARY. — The present study evaluated temporal and spatial trends of natural disasters in South America, such as earthquakes, volcanic eruptions, floods and landslides. Floods are the most common disasters and affect more people, but earthquakes cause more deaths and damages. Brazil, Colombia and Peru are the countries that register more disasters. From the 1960s there is an increase of catastrophes in general, especially hydrometeorological disasters, which is common to all South-American nations. During this period urbanization grew explosively and disorderly in the area and the insertion of the economies of South-American countries in a globalized market became larger, which brought in turn substantial changes in the environment and contributed to the growth of both the susceptibility of places and the vulnerability of population.

MOTS-CLES. — Catastrophes naturelles; Amérique du Sud; Centres urbains; Mondialisation.

RESUME. — *Tour d'horizon des récentes catastrophes naturelles en Amérique du Sud.* — La présente étude constitue une évaluation des tendances temporelles et spatiales des catastrophes naturelles en Amérique du Sud, telles que séismes, éruptions volcaniques, inondations et glissements de terrain. Les inondations sont les catastrophes les plus courantes et qui affectent le plus de monde, tandis que les tremblements de terre provoquent un plus grand nombre de décès et de dommages. Le Brésil, la Colombie et le Pérou sont les pays enregistrant le plus de catastrophes. Depuis les années 1960, on constate une augmentation des catastrophes en général, en particulier les catastrophes hydrométéorologiques, phénomène commun à toutes les nations d'Amérique du Sud. Au cours de cette période, l'urbanisation du territoire a progressé de manière explosive et anarchique et l'intégration des économies des pays sud-américains dans un marché mondialisé s'est accrue, ce qui a amené à son tour des changements substantiels dans l'environnement et contribué à la croissance de la susceptibilité des lieux et de la vulnérabilité de la population.

1. Introduction

Even though events such as earthquakes, volcanic eruptions, floods, landslides are natural occurrences, these phenomena have strongly impacted the whole world. They have affected an increasing number of people and caused damage that is hardly

* Paper presented at the meeting of the Section of Technical Sciences held on 24 November 2011. Text received on 18 April 2012.

** Member of the Academy; Department of Geography, State University of Campinas, rua João P. Calógeras 51, Cidade Universitária, CP 6512, CEP 13.083-970, Campinas – SP (Brazil).

overcome, making, on the one hand, humans incapable of living in their own environment, no matter if it is the mainstay of all their activities, and, on the other hand, the role played by humans in the generation of natural catastrophes increasingly significant, as KUNKEL *et al*. (1999) and ARAKI & NUNES (2008) attested.

The overcoming of natural tragedies is directly linked to the vulnerability of the population, which reveals how much a social system is (not) able to face/overcome the adverse effects of the exposition of individuals/social groups to unexpected changes, causing ruptures in their ways of living (NUNES 2009). Thus, the consequences of phenomena of equal physical magnitude can be very distinct according to the degree of articulation of the afflicted population. For example, the earthquake that affected Chile in March 2010 was much more intense than that recorded in Haiti in January the same year. Nevertheless, the impacts of the latter were incomparably greater: it caused about two hundred thirty thousand casualties and more than one million homeless (CAMELBEECK *et al*. 2010) and shows that the Haitians' vulnerability is much greater than the Chileans' when it comes to earthquakes — physical phenomena that are part of the natural dynamics of both countries. The earthquake followed by tsunami and nuclear contamination (technological disaster) that affected Japan in March 2011 clearly shows that no nation, even if it is one of the most developed countries in the world, is thoroughly prepared to face natural disasters.

Human intervention in the environment increases the risk of natural disasters, which is particularly preoccupying in urban centres. They constitute the most conspicuous form of transformation of the natural landscape because of the substantial change in the production flows, the population mobility and in the dynamics of physical processes.

If the large urban agglomerations are loci for opportunity and innovation, deterioration of physical components, pollution at all levels and degrees, deforesting and population concentration are more incisive in them, which contributes to the increase of natural disasters in number, severity and types.

In South-American countries the urbanization process has not only been very fast but also profoundly deleterious to the environment, which is a contributing factor to the generation of natural disasters. In this sense, CLARKE *et al*. (2000) stated that in Latin America and the Caribbean the fundamental development problems are those that contribute to the vulnerability of their populations in face of natural disasters: fast and unregulated urbanization, persistence of poverty, environmental degradation caused by bad handling of natural resources, inefficient public policies and infrastructural problems.

Like urbanization, globalization process is another striking feature of the contemporary world, which increasingly widens the relationships between spaces because their capacity to individually overcome challenges, such as economic crises, is limited, leading decisions to be supranational. However, globalization also strengthens competitiveness and rivalry between these spaces, so that the ability to adapt to new demands and necessities is a relevant criterion to establish the role of each centre in the productivity model.

Urbanization and globalization are intimately linked processes and cause outstanding socio-economic, cultural, environmental and political transformations, seen as highly attractive under the prism of their apparent benefits in the regional and national integration. But these processes bring enormous uncertainties in the urban space, having in mind that the capacity of anticipating, analysing and improving land use and integrating these spaces are reduced with the speed of their modifications, increasingly subservient to the logic that respond to the supranational demands and therefore with no commitment to the physical and social processes which take place at a local scale or living space. Such facts can even compromise the functions that contributed to make the space attractive, in special concerning some places and a certain sector of the population.

ALEXANDER (2006) pointed out that if on the one hand the involvement at a global level is deepened and becomes more complex, on the other hand there is a clear, concomitant fragmentation that takes place in relation to global security strategies.

Many South-American cities lie on areas prone to disasters of geological nature, such as earthquakes and volcanism, and of hydrometeorological nature, such as floods, but the growth and the search for more competitiveness in the international market have very strongly contributed to the physical growth of the cities, mostly in areas endangered by floods and mass movements.

In this study the disasters are divided into three major groups: geophysical — such as volcanic eruptions, tsunamis, earthquakes — hydrometeorological — floods, droughts, humid mass movements, temperature extremes, fires and storms — and biological — insect infestations and epidemics. Considering that natural geophysical disasters are less predictable than hydrometeorological catastrophes, one would expect that a higher degree of predictability would help minimize the latter, but this is in general not verified. Moreover, the human role in the three types of disasters is notorious in making them increasingly hazardous, because even a minor physical event, when affecting a large number of people — especially when they are not properly articulated — can lead to negative consequences that may not have any relationship with the physical magnitude of the triggering phenomenon.

2. South America

2.1. PHYSICAL SCENARIO

The following countries constitute South America: Argentina, Bolivia, Brazil, Chile, Colombia, Ecuador, Guyana, Paraguay, Peru, Uruguay, Suriname, Venezuela, and the French Guiana, which is an overseas department of France (fig. 1). South America is approximately 17,800,000 km^2 or 12 % of Earth's surface, stretching out from latitude 12° N to 55° S, totalling 7,400 km. Because of its size and geographical position different climatic regimes and a complex morphology characterize the area, with volcanoes to the west and highlands,

plateaus and plains of varied forms and sizes. The biodiversity is very rich, with habitats varying from exuberant tropical forests to deserts; as a consequence, the fauna is equally very varied.

Western South America is prone to geophysical disasters, because it is under the influence of active tectonic margins and volcanoes. In these localities the deposition of volcanic material in valleys was fundamental to the establishment of communities because of the fertility of the soils. But at the same time, these populations have been exposed to risk.

The climatic characteristics contribute to make the advent of disasters common in South-American countries. Most of the land is in the tropical area, where the solar radiation is high during the whole year, with less seasonal differences when compared to other climatic regimes and few alterations in the photoperiod. Much more than temperature or other climate element, it is the rainfall that governs the biological productivity of the system, with substantial differences in terms of volume and distribution, being one extreme the north of South America — where a super-humid climate predominates — and the other extreme the west of the continent — where deserts exist.

The regional circulation reflects the presence of anticyclone and cyclone centres and neighbouring oceanic conditions that influence the penetration of tropical and polar systems, as well as the position of the Intertropical Convergence Zone and the South Atlantic and South Pacific Convergence Zones.

In several slope sectors the high energy and permanent humidity induce the occurrence of landslides, and the climatic complexity favours severe storms in many localities and, as consequence, floods — common phenomena to all South-American countries. The drought effects are even more severe, considering the increasing demand for water by human activities. They are strengthened by the recurrence of certain phenomena that reflect the atmosphere-ocean interaction, such as El Niño — which promotes strong arid conditions in the northeast and north of Brazil and consequently forest fires, in contrast to torrential rainfall recorded in coastal areas of Ecuador and Peru, and in the north of Argentina, Uruguay, Paraguay and southern Brazil (Nunes 2012).

The Amazonian Basin stands out as a very large area of land drained by the Amazon River and tributaries, with considerable biodiversity and potentiality, but in which long arid periods are sometimes recorded, as well as floods affecting Amazonian settlements and cities.

In the proximity of the major rivers, such as the Amazon, Paraná and Orinoco, lie sedimentary deltas, mangroves, bays, coves and coastal depressions. These areas have been occupied by settlements, exposing the populations at permanent risk.

The Pacific and Atlantic coasts present conspicuous physical diversity, with sandy beaches, cliffs, reefs, coral reefs, mangroves and in the southernmost part, glaciers, with all these environments presenting different degrees of degradation.

Fig. 1. — South America, physical map (*Source*: SIMIELLI 2009).

2.2. Socio-Economic Aspects

The increasing globalization of the international economy has imposed substantial changes in the spatial structure of the South-American production, with the industrial decentralization and direction of farming activities to the world trade, which has forced the dislocation of industrial, farming, employment centres and people throughout the territory.

The South-American population increased from 112,393,000 in 1950 to 392,553,000 in 2010 (http://esa.un.org/unpd/wpp/unpp/p2k0data.asp), from which approximately three quarters live in urban areas. Such fact causes increasing stress to large centres such as São Paulo, Buenos Aires, Lima and Santiago, and to emerging centres, with increasing demand for food and water, not to mention the deterioration of the space that provides the physical support to these agglomerations.

From the economic point of view, the neoliberal policy adopted by many South-American countries has caused recession for decades on, having negative effects, for example, in basic public services. Besides, South America has undergone political destabilization and economic crises for the last decades, which has increased the internal and external debts and caused stagnation of the macroeconomic and social indicators.

Concerning the countries, the political organization of the space has crystallized the socio-economic differences, resulting in a chaotic and fast growth of the urban centres and expansion of settlements for low-income populations. In general, this increase took place marginally to legal patterns of land use, with major deficiencies in basic infrastructure, forcing the dislocation of the population farther away, to where the public apparatus is better equipped (job offers, health, education, leisure, …). As transportation means have expanded at less than urban agglomerations, the transfer of people is one of the most serious problems of the urban centres. The economic growth of several South-American countries has caused the expansion of the middle class, so much so that the number of private automobiles has increased at alarming rates, causing enormous traffic jams and uncontrolled atmospheric pollution, which are worse when high-pressure systems prevail, which make the dispersion of pollutants difficult.

Following the world tendency to build regional economic blocks in order to increase competitiveness in face of a globalized market, the regional integration has been a goal to the American continent, despite the advances and retreats. However, the efficacy of certain organizations such as Mercosul, Alca or the Pacto Andino, which were created to confront other markets, has been low, as a consequence of troubled times in the international economy, weaknesses in regional pacts, institutional shortcomings, very different economic powers, and lack of cohesion and loyalty among the countries.

Foreign investments have taken place in some countries, such as Brazil, Argentina and Chile, even resenting from weaker investments during recession. Quite often the South-American markets profit more or lose less than the multinational headquarters. The automotive industry, for example, has presented returns in countries like Brazil, contrasting with a much more modest, when non-existent, profitability in the headquarters.

Investments are, however, unequally distributed in Latin America, and therefore globalization strongly contributes in widening regional differences. As part of this process, there is the traditional migration of people from all countries to the United States. According to an evaluation made by the United Nations Alliance of Civilizations (www.unaoc.org/ibis/worldwide/south-america/), Argentina and Venezuela were the main destinies of immigrants from South-American countries, especially from Bolivia, Chile, Paraguay and Uruguay. Brazil has also received large numbers of Bolivians, Paraguayans and Peruvians, but according to the same source, there are more immigrants from other regions than from Latin-American countries.

It is undeniable that significant improvements have occurred in South-American countries in many areas, such as education, GDP and longevity. Notwithstanding, as a serious contrast, natural disasters have also increased in number. If on the one hand disasters are part of the evolutionary history of both landscape and populations, on the other hand they have extensively impacted their economic development.

3. Natural Disasters in South America

Natural disasters conjugate a physical component, which is the triggering element (*e.g.* earthquakes, storms, volcanic eruptions, and hurricanes) and a social component, which refers to their effects on the population. The natural disasters recorded in South America are not just a problem related to nature per se, but to the relationship between the natural environment and the (dis)organization and (disruption/)structuring of the society in the territory. Thus, they are not merely conjunctural or exceptional, because they reflect options of how the society is organized in the physical substrate and development processes. These options merely aim at responding to external demands and do not take into account the socio-environmental costs that such transformations cause in the space. The large economic and human losses result from their vulnerability, fruit of lack of planning and of proper policies (Nunes 2009), which make South-American countries extremely dependent on the international support when the catastrophes are recorded.

The explosive growth of South-American cities in the last three decades generated serious problems that remain unsolved, such as traffic jams, lack of

housing, generation of slums in badly-equipped peripheries, and conspicuous transformations in the atmosphere, such as pollution, acid rain and heat islands, leading to more floods and landslides. Equally, there is an increase in the distribution patterns of disease-transmitting vectors and other illnesses related to increasing pollution.

The exceptional South America's ecological diversity, with multiple ecosystems, biomes and landscapes, has transformed this rich region in a provider for natural resources, aspect that antagonistically occupies the central role for environmental problems experienced there. This fact goes back to the beginning of the European colonization, but if the economic model has clearly changed along the centuries, the role of South America in the world system remained the same, maintaining the status quo instead of promoting development for the improvement of its people as a whole.

The historical dimension is of paramount importance to the understanding of the ecological and socio-economic degradation scenario of Latin America. Its colonial past and more recently its development model based on extractivism has brought, among other deleterious consequences, an increase of the susceptibility in many areas and the vulnerability of the population.

Natural disasters represent enormous costs to the economy of the affected countries, the negative consequences lasting for a long time after the event, compromising GDP and refraining the economic development. The environmental and social costs, which are more difficult to evaluate, are equally substantial. Social losses are much more dramatic when it comes to homeless and casualties.

The following information includes number of disasters, of affected, of casualties and economic losses during the last years in South-American countries. The source is Em-Dat (Emergency Events Database), which integrates in a sole database the occurrences in the whole world, enabling the study of temporal and spatial trends related to disasters. In order to an occurrence to be incorporated in this database, it has has to comply with at least one of the following criteria: ten or more casualties, a hundred or more affected, declaration of state of emergency or call for international assistance (GUHA-SAPIR *et al.* 2010). The information on disasters in South America started to be fed in the Em-Dat database in 1904 with an occurrence in Ecuador, and continued until the end of 2011.

Table 1, which presents a general scenario of the natural disasters in South America, shows that between 1904 and 2011, nine hundred and sixty-six natural disasters were recorded, seven hundred and thirty-five of which of hydrometeorological nature. The most common events were floods and earthquakes corresponding to more than 55 % of the calamitous occurrences in South America. Droughts and floods were phenomena that affected the largest number of people in the period. On the other hand, earthquakes caused the largest number of casualties — fact that stands out because not all countries in South America record seismic activities. They also caused the greatest losses and are followed by floods.

Table 1 also shows that the numbers associated with natural disasters in Latin America during the 1904-2011 period were alarming: the catastrophes affected almost a hundred and forty million people and caused more than two hundred and sixty thousand casualties. Although the economic losses were high, it is possible that the information is related to direct losses only. But large-scale disasters can partially or totally paralyze economic activities for a long time, and in extreme cases, make them impossible.

Table 1

Natural geophysical, biological and hydrometeorological disasters in Latin America (1904-2011)

	Events	**%**	**Affected**	**%**	**Killed**	**%**	**Damages (000US$)**	**%**
Seismic activity	124	12.8	14,418,280	10.3	155,791	59.6	40,088,886	45.3
Volcano	33	3.4	740,971	0.5	22,942	8.8	1,175,975	1.3
Epidemic	71	7.3	1,736,618	1.2	15,158	5.8	0	0.0
Insect infestation	3	0.3	2	0.0	0	0.0	104	0.1
Droughts	53	5.5	56,892,403	40.8	36	0.0	10,412,600	11.8
Extreme temperature	42	4.3	3,252,429	2.3	1,819	0.7	2,170,000	2.5
Floods	413	42.8	55,194,744	39.6	46,705	17.9	30,894,174	34.9
Mass movement dry	6	0.6	2,25	0.0	2,307	0.9	200	0.2
Mass movement wet	122	12.6	5,258,001	3.8	14,838	5.7	1,707,754	1.9
Storm	73	7.6	1,523,082	1.1	1,745	0.7	1,060,850	1.2
Wildfire	26	2.7	298,2	0.2	54	0.0	682	0.8
Total	966		139,318,978		261,395		88,496,239	
Total hydro-meteorological	735		122,421,109		67,504		47,127,378	

Source: EM-Dat. Organized by the author.

Considering hydrometeorological disasters only, floods and humid mass movements (which in South America are referred to as landslides) were the most frequent and caused most of the casualties. Largest numbers of affected and greatest losses were associated with floods and droughts.

The situation is different according to the country, as shown in table 2: considering the number of occurrences that led to casualties, affected and economic losses by the three natural disaster groups (geophysical, hydrometeorological and biological) discriminated per country, it can be seen that geophysical phenomena are dominant on the Pacific coast. However, as the hydrometeorological disasters affect all countries, the record of an occurrence of this nature tends to be more constantly associated with casualties, affected and economic losses. It is important to note that despite the fact that droughts have caused fewer casualties, their impact was enormous.

Table 2

Impacts caused by the different natural disaster groups per South-American country (1904-2011)

	Geophysical			Biological			Hydrometeorological		
	Deaths	**Affected**	**Damages**	**Deaths**	**Affected**	**Damages**	**Deaths**	**Affected**	**Damages**
Argentina	2	0	0	1	0	0	7	10	10
Bolivia	1	0	0	2	0	0	7	10	10
Brazil	0	0	0	1	0	0	9	10	10
Chile	9	4	7	0	0	0	1	6	3
Colombia	6	1	6	1	0	1	3	9	3
Ecuador	3	2	3	3	0	0	4	8	7
Guyana	0	0	0	0	0	0	2	6	5
Paraguay	0	0	0	3	1	0	7	9	10
Peru	3	3	4	3	0	0	4	7	6
Suriname	0	0	0	0	0	0	2	3	1
Uruguay	0	0	0	0	0	0	10	10	5
Venezuela	3	1	4	1	1	0	6	8	6

Source: EM-Dat. Organized by the author.

On the basis of hydrometeorological disasters only in the 1904-2011 period, which summed seven hundred and thirty-five events (*cf.* tab. 1) and affected all countries, figure 2 presents the number of events per country, stressing out Brazil (24.4 % of the records), Colombia (16.1 %) and Peru (12.7 %). The fact that regarding Brazil the contribution is almost exclusively from hydrometeorological events (there was one record of epidemic), the great impact caused by the records of this nature is even more evident for this country.

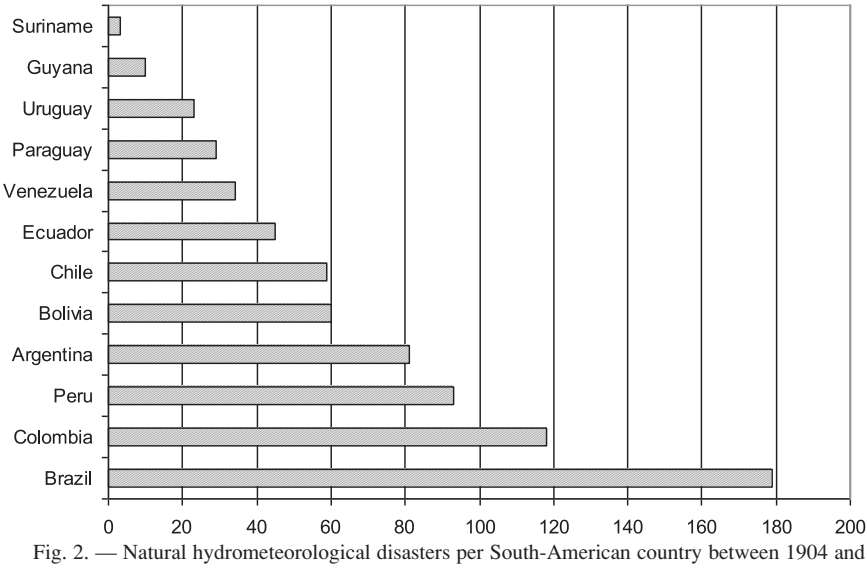


Fig. 2. — Natural hydrometeorological disasters per South-American country between 1904 and 2011 (*Source*: EM-Dat. Organized by the author).

Complementarily, table 3 shows the ten major occurrences of natural disasters in South America according to the number of casualties, affected and economic losses in the 1904-2011 period. Considering that the most perverse effect of catastrophes is the number of casualties, the geophysical disasters have had an outstanding role in the great tragedies that occurred in South America (ten out of eight). The worst of all took place in Peru: on 31st May 1970 an earthquake caused more than sixty-six thousand casualties and affected more than 3.2 million people. Despite causing considerable losses, such phenomenon occupies the thirtieth position in the ranking for general loss in South America. For comparison, the ten disasters that caused the largest number of casualties in each country were computed, totalling 235,909. Compared to the weight of the ten major tragedies that caused 203,594 deaths, the latter contributed with 86.3 % of the total casualties.

Table 3

Ten major natural disasters in South America in relation to the number of casualties, affected and economic losses (1904-2011)

		Disaster	**# Killed**		**Disaster**	**Total # Affected**		**Disaster**	**Damage (000 US$)**
1	Peru	Earthquake	66,794	Brazil	Drought	20,000,000	Chile	Earthquake	30,000,000
2	Chile	Earthquake	30,000	Brazil	Drought	10,000,000	Venezuela	Flood	3,160,000
3	Venezuela	Flood	30,000	Brazil	Drought	10,000,000	Brazil	Drought	2,300,000
4	Colombia	Volcano	21,800	Argentina	Flood	5830000	Colombia	Earthquake	1,857,366
5	Chile	Earthquake	20,000	Colombia	Flood	5,105,000	Brazil	Drought	1,650,000
6	Argentina	Earthquake	10,000	Brazil	Drought	5,000,000	Chile	Earthquake	1,500,000
7	Peru	Epidemic	8,000	Argentina	Flood	4,600,000	Ecuador	Earthquake	1,500,000
8	Chile	Earthquake	6,000	Brazil	Mass movement wet	4,000,000	Argentina	Flood	1,300,000
9	Ecuador	Earthquake	6,000	Peru	Earthquake	3,216,240	Argentina	Flood	1,100,000
10	Ecuador	Earthquake	5,000	Brazil	Flood	3,020,734	Argentina	Flood	1,028,210

Source: EM-Dat. Organized by the author.

Together with the number of casualties, the total of affected constitutes a central parameter for the configuration of a great tragedy, but the situation is very distinct, because the hydrometeorological events were the ones that caused the largest number of affected: nine out of ten, six of which having taken place in Brazil, including the greatest three. One only (the greatest) affected twenty million people in this country. As for the casualties, the ten major occurrences regarding the affected per country were computed and the ten major events as a whole responded for 57.7 % of the cases.

Both geophysical (four out of ten) and hydrometeorological (six out of ten) phenomena promoted immense economic losses, mostly because of the recent earthquake in Chile (February 27th, 2010) that caused estimated losses of US$ thirty million, much higher than the others. The ten major losses in South America responded for 63.6 % of the total ten, being the highest economic losses of each country.

Considering only the greatest natural disaster in each South-American country (thus taking as a parameter the number of casualties), and also based on the Em-Dat database, in five countries the greatest tragedy was of geophysical nature (Argentina, Chile, Colombia, Ecuador and Peru); in five of them, of hydrometeorological character (Guyana, Paraguay, Suriname, Uruguay and Venezuela), and in two of them, epidemic (Bolivia and Brazil).

Figure 3 presents the number of natural disasters by type in South America per decade, between 1904 and 2009 (1900s: 1904-1909, 1910s: 1910-1919, and so forth). From the 1960s on, the number of occurrences has significantly increased and concomitantly the contribution of hydrometeorological disasters is much more substantial.

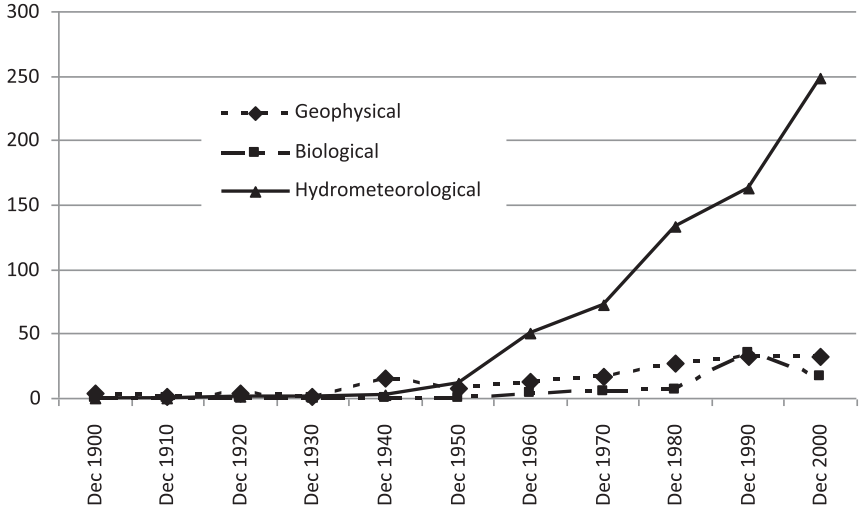


Fig. 3. — Record of natural disasters in South America per decade (*Source*: Em-Dat (events per decade) and Population Division, Population Estimates and Projections Section. Organized by the author).

Figures 4, 5, 6 and 7 compare in percentage the population increase in relation to the number of events, casualties, affected and losses, respectively between the 1950s to 2010 (six hundred and eighty-seven records of natural disasters). The information on the population was obtained from the database maintained by the Population Division, Population Estimates and Projections Section, subordinated

to the Department of Economic and Social Affairs, a United Nations body that presents uniform information in this period on South-American countries (<http://esa.un.org/unpd/wpp/unpp/p2k0data.asp>). Figure 4 shows that in the last three decades the number of disasters disproportionately increased in relation to population, which indicates, among other aspects, the growth of both susceptibility of the localities and vulnerability of the population.

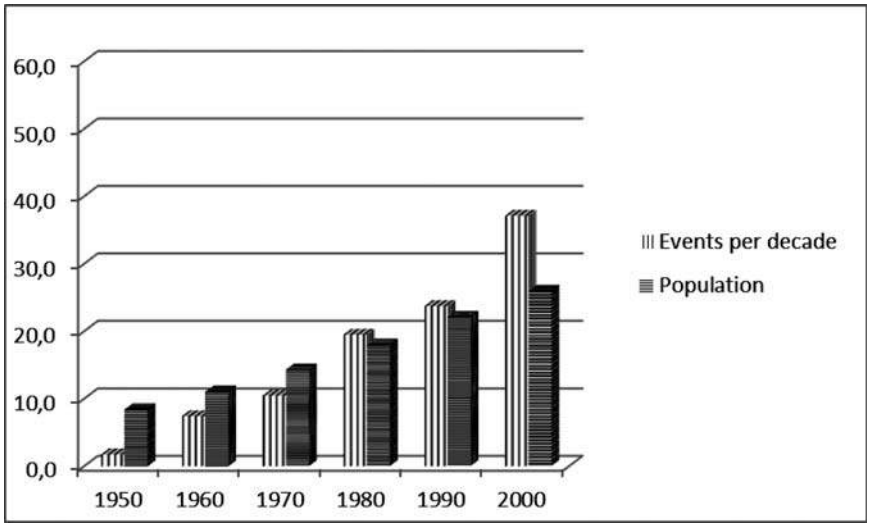


Fig. 4. — Comparison between population increase and the number of events in South America per decade (*Source*: Em-Dat (events per decade) and Population Division, Population Estimates and Projections Section. Organized by the author).

Although figure 5 does not show a clear temporal pattern, it is interesting to note that in the 1990s, the proportional increase in casualties was higher than the population increase, which reports to a particular catastrophic occurrence that Em-Dat classified as flood — although it was indeed mud flow — on 20th December 1999 in Venezuela, with estimated thirty thousand casualties. Two other disasters were very severe in this decade: a tropical cyclone in March 1997 that affected Peru and caused five hundred and eighteen casualties, and a humid mass movement, on 20th February 1997, killing three hundred people. It is worth remembering that the United Nations, in its 42nd General Assembly on 11th December 1987, declared that decade as the International Decade for Natural Disaster Reduction, but it was very tragic for South America.

Also in figure 6, which compares population increase and the number of affected by natural disasters in South America along six decades, there is no temporal pattern between the variables. In this case the 1970s and 1980s show a proportional increase in the number of affected relatively to the population increase. In special the 1980s stand out because of a very large number of

affected. Although the last two decades experimented a decline in the number of affected per natural catastrophe, it is still very large.

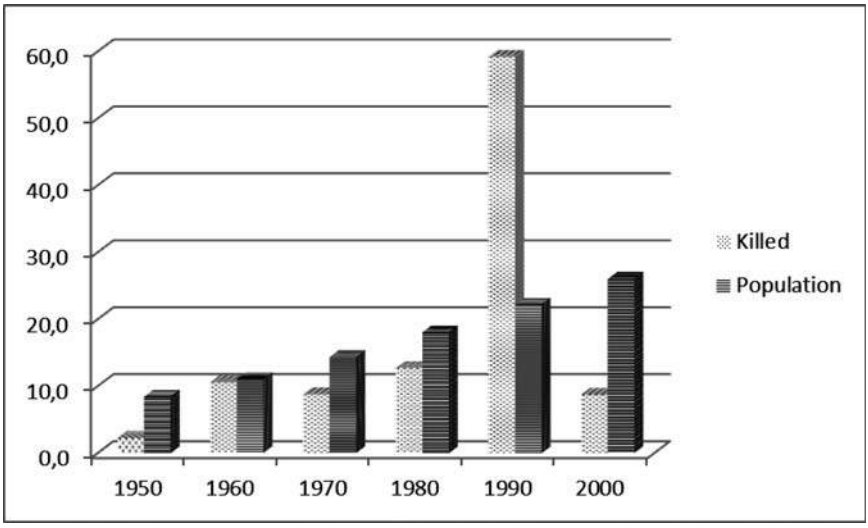


Fig. 5. — Comparison between population increase and the number of casualties in South America per decade (%) (*Source*: Em-Dat (events per decade) and Population Division, Population Estimates and Projections Section. Organized by the author)

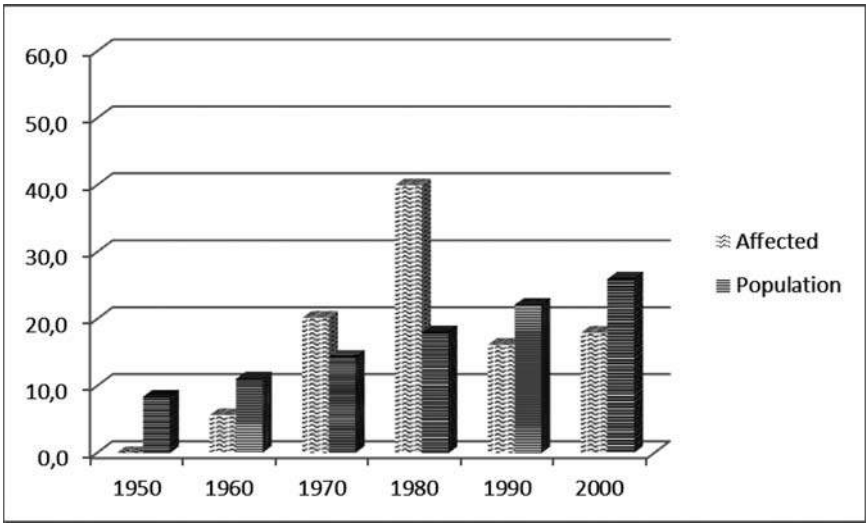


Fig. 6. — Comparison between population increase and number of affected by disasters in South America per decade (*Source*: Em-Dat (events per decade) and Population Division, Population Estimates and Projections Section. Organized by the author).

Figure 7 reveals that whereas in the three initial decades the losses increased at a lower rate than the population increase, from 1980 on the losses became more conspicuous but declined. The largest number of losses took place in the 1980s, concomitantly with the record of the largest number of affected.

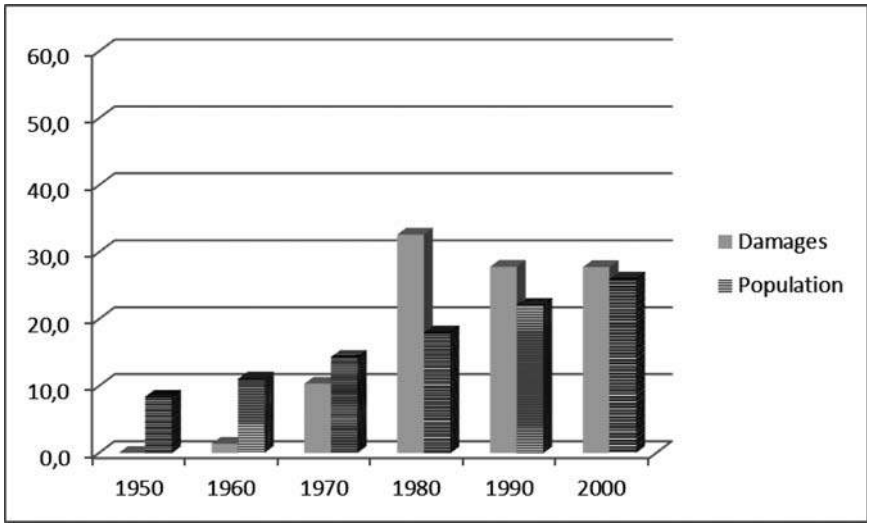


Fig. 7. — Comparison between population increase and economic losses in South America per decade (*Source*: Em-Dat (events per decade) and Population Division, Population Estimates and Projections Section. Organized by the author).

4. Final Remarks: Facing Natural Disasters in South America

In January 2011, after a long sequence of rainfalls, which were concentrated in the end of the period, the mountainous region of Rio de Janeiro State underwent one of the worst natural tragedies that ever occurred in Brazil, with widespread mud flows and floods. The catastrophe caused almost a thousand deaths, missing, hundreds of homeless and very significant economic losses. In the balance of the greatest tragedies of 2011 (Cred Crunch 27, 2012) it was ranked in the third position in relation to the number of casualties and placed Brazil in the tenth position in terms of absolute economic losses. A few months later, in April 2012, a new catastrophe took place in the same area, with casualties, homeless and economic losses.

In February 2010, five hundred and sixty-two people died in Chile due to a strong earthquake that once more affected the Chilean coast. That year Chile was

the country that had the greatest economic losses caused by natural disasters: USD thirty billion (Cred Crunch 23, 2011).

These regrettable facts are no news; rather, they attest that certain areas are susceptible to physical occurrences that strongly affect the population, and thus configure natural disasters. They also show that the tragedy is the edge of a continuous and silent process that is not taken into account until a new calamity devastates the same area. It has become obvious that in both countries preventive measures and better preparation at the time of the deflagration of disasters were lacking, which exposed in full their fragility in face of natural phenomena (intense rainfall and earthquakes) that ended as great tragedies. Brazil and Chile are particularly emblematic, having in mind that these countries intend to consolidate their position as regional powers and gain international visibility. However, recent calamities, such as the heat wave that affected several European countries in the summer of 2003 and caused more than seventy thousand deaths, the Katrina hurricane in August 2005 in the United States, and the earthquake and tsunami in Japan in 2011, show that no country is actually prepared, no matter at what level. Nevertheless, this is more preoccupying in relation to countries where socio-environmental transformations are huge and fast, such as in South America.

It is practically inevitable to live under no risk, which underlines the necessity to develop and/or improve the capacity to live with it (Nunes 2009). It is indispensable that South America gets out of the vicious circle destruction-reconstruction and approaches the causes of its high vulnerability, anticipating the tragedies in such a way that their impact is minimized. There is therefore the necessity of implementing emergency plans, aiming at minimizing the consequences of events that can trigger disasters in urban centres, with emphasis on preventive rather than emergency actions.

At scientific level, the evaluation of natural disasters focuses on the interaction between nature and society, and thus must draw upon theory, methods and research findings from distinct domains of science. But the integration of theory and methods of different areas is not an easy task: analyses focused on the physical components contrast strongly with more socially-focused studies, as each one has its own scientific style, language and differing standards of performance, replicability, uncertainty, and significance (Kates 1985). Still, it is paramount to establish a unified conceptual framework within which social and natural scientists can work together.

Another vital aspect is related to the involvement of the populations with potential of being affected: it is necessary to evaluate the perception of risk and the effects of the social organization on the environment, with measures that reflect interconnection of scales, with problems faced beyond the local and measures taken beyond the immediate.

REFERENCES

ALEXANDER, D. 2006. Globalization of disaster: Trends: Problems and dilemmas. — *Journal of International Affairs,* **59**: 1-22.

ARAKI, R. & NUNES, L. H. 2008. Vulnerability Associated with Precipitation and Anthropogenic Factors – Guarujá City (São Paulo, Brazil) from 1965 to 2001. — *Terrae-Geoscience, Geography, Environment*, **3**: 40-45.

CAMELBEECK, T., VAN CAMP, M. & SABBE, A. 2010. Haiti – all the ingredients for a major disaster. — *Bull. Séanc. Acad. R. Sci. Outre-Mer*, **56** (4):485-495.

CLARKE, C., CHARVERIAT, C. & MORA, S. 2000. Facing the challenge of natural disasters in Latin America and the Caribbean: An IDB action plan. Available at: http://idbdocs.iadb.org/wsdocs/getdocument.aspx?docnum=823495

Cred Crunch 23. Natural Disasters in 2010, 2011, 2 pp.

Cred Crunch 27. Natural Disasters in 2011, 2011, 2 pp.

Emergency Events Database (Em-Dat). Centre of Research of Epidemiology of Disasters – CRED. Available at: http//www.emdat.be/

GUHA-SAPIR, D., VOS, F. & BELOW, R. 2010. Annual Disaster Statistical Review, 2010 – The numbers and trends. Available at: http://www.emdat.be/explanatory-notes

KATES, R. W. 1985. The interaction of climate and society. — *In*: KATES, R. W., AUSUBEL, J. H. & BERBERIAN, M. (Eds.), Climate impact assessment: Studies of interaction of climate and society (Scope 27). Available at: www.icsu-scope.org/download/scope27/chapter01.html

KUNKEL, K. E., PIELKE Jr., R. A. & CHAGNON, S. A. 1999. Temporal fluctuations in weather and climate extremes that cause economic and human health impacts: A review. — *Bulletin of the American Meteorological Society*, **80**: 1077-1098.

NUNES, L. H. 2009. Mudanças climáticas, extremos atmosféricos e padrões de risco a desastres hidrometeorológicos. — *In*: HOGAN, D. J. & MARANDOLA Jr., E. J. (Eds.), População e mudança climática – dimensões humanas das mudanças ambientais globais. Campinas, NEPO, pp. 53-73.

NUNES, L. H. 2012. Tropical and subtropical climate characteristics. — *In*: BILIBIO, C., HENSEL, O., SELBACH, J. F. & LEITE, J. R. S. A. (Orgs.), Sustainable water management in the tropics and subtropics. Universität Kassel, pp. 1057-1076.

SIMIELLI, M. H. R. 2009. Geoatlas. — São Paulo, Editora Atica, 168 pp.

United Nations Alliance of Civilizations. Integration Building Inclusive Societies. Available at www.unaoc.org/ibis/worldwide/south-america/ (consulted in March 2012).

United Nations. World Population Prospects. The 2010 Revision. Available at: http://esa.un.org/unpd/wpp/unpp/p2k0data.asp (consulted in March 2012).