A SUCCESS STORY IN DANISH DEVELOPMENT AID

– DBL (1964-2012)

Editors: Annette Olsen, Niels Ørnbjerg, Klaus Winkel

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1. udgave 2013

Omslag: Annette Olsen
Sats: SL grafik, Frederiksberg (www.slgrafik.dk)
Tryk: Narayana Press, Gylling (www.narayana.dk)

ISBN 978-87-7611-562-3

Photos were provided by former and present staff members Jens Byskov, Solveig Danielsen, Peter Furu, Maria Vang Johansen, Thomas K. Kristensen, Henry Madsen, Pascal Magnussen, Peter Nejsum, Annette Olsen, Erling Møller Pedersen, Claus Reimert, Paul Erik Simonsen, Anne-Sofie Steensgaard (maps), Hanne Strandgaard, Birgitte Jyding Vennervald and Jens Aagaard-Hansen. Also collaborators Gautam Biswas, Andrew Seidu Korkor, Faustin Lekule, Kabemba Evans Mwape, Harriet Namwanje and Ambrose Onapa (map) provided photos.

In addition, a few photos from the archives of DBL, where the photographer is unknown, are included.

A succes story
in Danish Development Aid

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Preface

This book describes aspects of the history, performance and lessons learned of an institution that was established in 1964 under the name Danish Bilharziasis Laboratory (DBL). The name was later changed to DBL – Institute for Health Research and Development to embrace its broader public health profile. When DBL merged into the University of Copenhagen in 2007, the name changed again to DBL – Centre for Health Research and Development.

In an earlier book published in 2004, DBL's first 40 years of existence were thoroughly described to mark this anniversary. When quantifying the results, we have therefore, in this book, paid particular attention to achievements since 2004, while the historic and scientific chapters sometimes go back to the beginning. Obviously, it is not possible to cover everything DBL did, but we have asked our colleagues to give representative examples and to focus on the stories that they found most illustrative, interesting or successful during their working years at DBL.

The chapters are thus written by different authors and can be read independently from each other. As editors, we have made no attempt to harmonise the different approaches taken in the individual chapters. We consider such diversity as indicative of the particular strengths that made DBL a success. The good stories are supplemented with some appendices summarising key output parameters such as PhD and Master studies and publications of different kinds since 2004.

We thank our colleagues for taking time to write their stories and science journalist Michael de Laine for thoroughly editing our English language.

Annette Olsen, Niels Ørnbjerg, Klaus Winkel

1. Introduction

BY NIELS ØRNBJERG

Areas of work

The DBL-Centre for Health Research and Development was established in 1964 as a private foundation under the name Danish Bilharziasis Laboratory (DBL). With effect from 1 January 2007, the centre was integrated into the University of Copenhagen.

Throughout its life, the institution was involved with the control of poverty related diseases, such as schistosomiasis, malaria, lymphatic filariasis, intestinal helminthiasis, cysticercosis and infections caused by Guinea worm and fish-borne flukes. Geographically, this has occurred in many countries in Africa and in a few countries in southeast Asia.

Such diseases are of major public health concern because of their high morbidity and their negative effect on school attendance, cognitive development and growth. From an initial narrow focus on the snail-borne disease schistosomiasis, DBL developed over the years into an institution addressing health research and development more broadly as a contribution to achieving the health-related Millennium Development Goals.

An appropriation in the annual finance act, including a performance contract with the Ministry of Foreign Affairs and its development-aid programme, Danida, has been the crucial core funding for DBL at all times.

High-impact contribution

As documented through repeated international reviews and evaluations, DBL has made a relevant, effective and efficient high-impact contribution to health development through its coherent research, capacity building and knowledge-management programmes.

In close collaboration and in an equal partnership with its many partners, DBL has been instrumental in generating new knowledge through research; in translating and communicating research for input to policies, strategies and practices; in building human, managerial, organisational and social capital to carry out and use research in controlling diseases; in building research centres and supporting individual researchers of excellence; and in training cadres of disease-control personnel and planners, enabling nationwide parasite control programmes to be rolled out in many countries in Africa.

Change in Danida policies and strategies

Danida's policies and strategies have changed dramatically over recent years in terms of supporting research for development. Although external funding has always supplemented Danida's funding of DBL, a serious change happened in 2002. From this year, funding from Danida gradually decreased and the demand for more external funding to support the activities of DBL correspondingly increased. Danida's funding of DBL came to a final conclusion at the end of 2012. DBL as an institution funded by development aid money thus ceased to exist.

Although many elements of the DBL programme will be carried on by former DBL staff now employed at the University of Copenhagen and elsewhere, an era has come to an end.

DBL book

With this book, DBL wishes to present a brief outline of this era. We will describe DBL's history and we will document its activities, outputs and impact. It is obviously not possible to cover everything DBL did. But the intention is, by presenting some representative examples, to provide a picture of the challenges in research for development and in capacity building, of DBL's outputs and impact and thus of an institution that made a difference.

The examples span from snails and mosquitoes over domestic animals to man; from the freshwater environment to health systems; from molecular biology to health impact assessments and medical anthropology; and from research over capacity building to knowledge management. Many disciplines and approaches are presented. They all share the common goal of improving health and livelihood among marginalised population groups in the least-developed countries.

Sincere thanks go to…

A sincere thanks go to present and former DBL staff, European, American and Danish collaborators, and not least to institutions and individual staff at DBL's network of collaborating institutions and networks in Africa and Asia. It has been a privilege to work together in our shared wish to assist in improving health in developing countries. Despite the challenge of finding the necessary funding, DBL staff are determined to continue the collaboration with the starting point in their employment at the Faculty of Health and Medical Sciences at the University of Copenhagen.

Sincere thanks go to Danida for its collaboration over the years. Danida's support has allowed DBL to perform well in the interest of improved health in developing countries. The University of Copenhagen is also thanked for efforts to integrate DBL. We will have to face the fact that universities have difficulties in fully integrating an institution like DBL with its focus on "service provision" to developing countries.

DBL has documented its activities throughout its life. Annual reports have thus

been published and a 40th anniversary publication was published in 2004 (ISBN 87-91521-00-9).

DBL hopes that its approach, as characterised by development relevance, equity, accountability, partnership, empowerment, stewardship and gender equality, will become essential core values on which new programmes will be built. DBL is doing whatever possible to ensure that future programmes will learn from DBL's comprehensive experience. The publication of this book is an element of such efforts.

2. Danida's support for health research for development

BY KLAUS WINKEL

DBL as one of the 'Projects in Denmark'

DBL has always been Danida's flagship when it comes to supporting health research for development. It has been most encouraging to follow the development of DBL itself since I first attended DBL board meetings in 1978-80 as acting observer and later as a member nominated by Danida.

Danida (initially its predecessor, the Secretariat for Technical Assistance) has supported development research almost from its start 50 years ago, but the allocations were modest during the first few years. Special support was given to three research institutions in Denmark, later to fall into the category 'Projects in Denmark'.

All of them were the result of the work of outstanding and high-profiled scientists – in the case of DBL it was Dr Georg Mandahl-Barth. Having been established in 1964, DBL got its first general budget support, DKK 75,000, from Danish aid funding in 1968. That was a relatively significant amount considering that the Council for Development Research (CDR) in the same year had at its disposal just DKK 300,000, and that most research grants from CDR around that time amounted to DKK 10,000-30,000 per year.

The first major project grant

For several years very few of the grants were in support of health research, but in 1971 DBL landed its first major project grant from CDR, DKK 72,000, to finance trials with the biological control of snails transmitting schistosomiasis in Egypt and Tanzania.

The number of health research projects grew steadily and came to represent 20-25% of allocations under CDR. There were good reasons for this. The main function of research is to get more out of available resources, and the most important resource is people. Health research that will assist in releasing people's full potential is therefore a powerful means to increase a nation's productive capacity and combat its poverty.

More support to partners in developing countries

Research got a boost at Danida with the establishment of a department for evaluation and research in 1986. One year later, an internal working group started to analyse needs and potentials for an expanded Danida effort in the field of research. Its report formed the basis of a major conference in 1988, which demonstrated that the Danish

research community was keen to play a more active role as a resource base for Danish development assistance. It was realised that Danida's support of research had almost exclusively financed the work of the Danish researchers; the time had now come to acknowledge, support and reward the research partners in developing countries and their institutions. Enhancing local research capacities would represent a valuable form of development aid for many reasons: it would increase a country's ability to make use of the immense global knowledge pool, to find solutions to specific, local problems, to keep good brains in the country, and to ensure that training at its universities achieved quality as well as relevance to local conditions. Also, a good local research capacity would increase the benefits of Danish researchers when co-operating with the local research capacities.

ENRECA was born

Against this background, Danida decided to establish a programme for research assistance. It differed from what CDR had been doing for years – its primary objective was not to support research as such, i.e. to generate new knowledge, but to strengthen partner institutions in developing countries through collaborative research.

At a meeting at DBL, where we had gathered a good number of Danish researchers to discuss the programme, one of the participants suggested calling the programme ENRECA: Enhancement of Research Capacity in Developing Countries. It is surprising what a good name can do. In no time, ENRECA had become a household word in the international aid community dealing with research, and people generally thought it to be much larger than it actually was. An annual amount of DKK 10 million had been set aside for the first years, but within 10 years the amount had increased to DKK 60 million.

Increasing funds for health research

When the programme was advertised it met with an enthusiastic response. The big attraction was that, from the beginning, it was announced that a successful project could expect support for up to 12 years. The first project became active in 1990. Throughout ENRECA's 20-year life, health research projects were the most important part of the programme by far, with more than twice as many projects as the number two field, agriculture.

This was partly the result of a special allocation for health research that added DKK 5 million a year to ENRECA's budget for a five-year period starting in 1992. The basis for this expansion was an analysis, carried out by Jens Aagaard Hansen from DBL, of the potential for greater involvement of the Danish health research community in capacity building. This new money supported three projects, including the large KEDAHR (Kenyan-Danish Health Research) project with Kenya, where DBL was the primary Danish partner.

In addition, the special allocation permitted a doubling of the ENRECA staff, with the employment of Bente Ilsøe, and provided finance for the ENRECA health research network. After the ENRECA programme as such came to an end in 2009, the name survived for another four years in that network, which for 20 years had made an essential contribution to informing and mobilising Danish health researchers for work on third-world health problems.

Who should pay for the activities in Denmark?

As mentioned above, DBL fell into the category termed by Danida 'Projects in Denmark', which has also included research institutions on seed pathology and forest seeds. Over the years, Danida and its board discussed whether it was proper to support activities located in Denmark when the aid funds were meant to further development in poor countries. Those of us who were in favour of supporting projects in Denmark argued that it was necessary to nourish Danish resources that were required to provide development assistance of good quality.

In certain cases, this aim could best be pursued by having centres of excellence concentrating on important third-world challenges. Competences could be built up in such centres over the years, and one important way to do this was to provide a relevant working place in Denmark for researchers who worked alternately in Denmark and in partner countries.

Certain skills, such as research capacity building in poor countries, were so special that they would be hard to come by unless provided by institutions such as those in question. This has been clearly demonstrated by DBL, which has spearheaded research capacity building from its early days and thus a long time before the ENRECA programme put the subject on the Danish aid agenda.

The argument against supporting projects in Denmark was that funding for maintaining and developing competences in Denmark, whether they are third-world relevant or not, should come from other parts of the state budget. However, other ministries have looked to the sizeable aid allocations and have generally not been prepared to spend their own money on activities not directly benefitting Danes. There has also been uneasiness in Danida about having a direct responsibility for institutions, no matter whether they are abroad or in Denmark.

New Danida strategy for development cooperation

Recently, Danida has adopted a new strategy for Denmark's participation in international development co-operation. The guiding theme in the strategy is that the co-operation must be based on the "rights" of people in partner countries.

Among these is the right to good health. This noble aim will surely not be achieved without heavy investments in research into poor people's health problems, and most of this research will have to be done in the poor countries. So, the case for supporting

local health research capacities remains as strong as ever. Thanks to the work over the years of DBL and a few other institutions, a resource base has been built up that will enable Denmark to continue to play a significant role in this important area. My expectation is that the demand for such services will grow in the years to come.

It remains to be seen to what extent Danida will comply with this demand. Reading the new strategy suggests that it will take an extra effort from the stakeholders in Denmark and partner countries to get Danida on board in any substantive way. You have to look carefully to find the few lines (in a strategy of 38 pages) about research capacity development and the creation of new knowledge.

Most developing countries – also in Africa – are approaching a situation where money is not the primary constraint in development. Prices of their raw materials are skyrocketing and almost every year sees yet another African country entering the ranks of oil exporters. More than ever before the quality of the institutions will decide the pace of progress.

As has been argued above, this also applies to the research institutions. Relations between north and south will be changing along with the shifting of needs away from financial support. We are probably approaching an era where "assistance" will be increasingly replaced by co-operation on much more equal terms. Collaborative research – as it has been practiced by DBL and other Danish health research institutions for many years – has been close to this ideal. As DBL ceases to exist as an institution, it leaves a legacy of competence that is likely to become increasingly relevant.

3. The early history of the Danish Bilharziasis Laboratory

BY FLEMMING FRANDSEN

Inauguration of DBL

On 20 November 1964, the snail aquarium room in the newly built Danish Bilharziasis Laboratory (DBL) was packed with notabilities, who were gathered for the official inauguration of DBL. Knud Højgaard, engineer, Dr Pierre Dorolle, the deputy director general of the World Health Organization (WHO), and representatives of the Danish Ministry of the Interior had arranged the inauguration. Many prominent persons with interests in tropical diseases and development assistance participated, including the USA's ambassador, K. E. White; Carl Iversen, rector of the University of Copenhagen; professor Ragnar Spärck of the University of Copenhagen; Aa. Østergaard, the mayor of Gentofte; and O. V. Bornemann, the director of the Danish Red Cross.

At the inauguration, speeches were given by Knud Højgaard; Dr Johannes Frandsen, the chairman of the DBL board of directors; and Dr Georg Mandahl-Barth, DBL's general manager.

From the inauguration of DBL in 1964.

Establishment of Denmark's Aquarium

The establishment of DBL was closely linked to that of Denmark's Aquarium. The building of Denmark's Aquarium in the Charlottenlund Forest north of Copenhagen was made possible when Knud Højgaard donated DKK 1 million in 1935 for its establishment. The aquarium was inaugurated in 1939 with Knud Højgaard's son, mag. scient. Mogens Højgaard, as director, and with mag.scient. Georg Mandahl-Barth as inspector.

Georg Mandahl-Barth was given the daily administrative and scientific leadership of the aquarium because of his huge experience with freshwater biology, while Mogens Højgaard was a specialist in the behaviour of birds. With the Second World War approaching, the aquarium faced severe challenges during its early years of existence, such as delivery of fish from the tropics and limitations in energy supply. This meant that Georg Mandahl-Barth, while inspector, had good opportunities to continue his research interests in molluscs, i.e. mussels and especially snails from freshwater and land.

During one of his several travels to Madeira, Mogens Højgaard had collected a considerable collection of snails. In the war years, Georg Mandahl-Barth researched these snails and his work was summarised as a doctoral dissertation handed in to the University of Copenhagen. Communications problems during the early post-war years meant that Georg Mandahl-Barth was awarded his doctorate in 1951 on the basis of his thesis, "Systematische Unterschungen Über die Heliciden – Fauna von Madeira", but without a public defence.

Georg Mandahl-Barth's early career

A career in the natural sciences was not an obvious choice at the beginning. Georg Mandahl-Barth began studying classical languages at the University of Copenhagen, but shifted soon to zoology; specialising in molluscs (snails and mussels). He graduated in 1936. He was a very promising young researcher and was expected to take up a position as curator at the Zoological Museum. However, personal relationships also played an important role in those days when vacant positions were to be filled in and a senior colleague bypassed him. Georg Mandahl-Barth decided to leave the university and was offered the position as inspector at Denmark's Aquarium by his former fellow student, Mogens Højgaard.

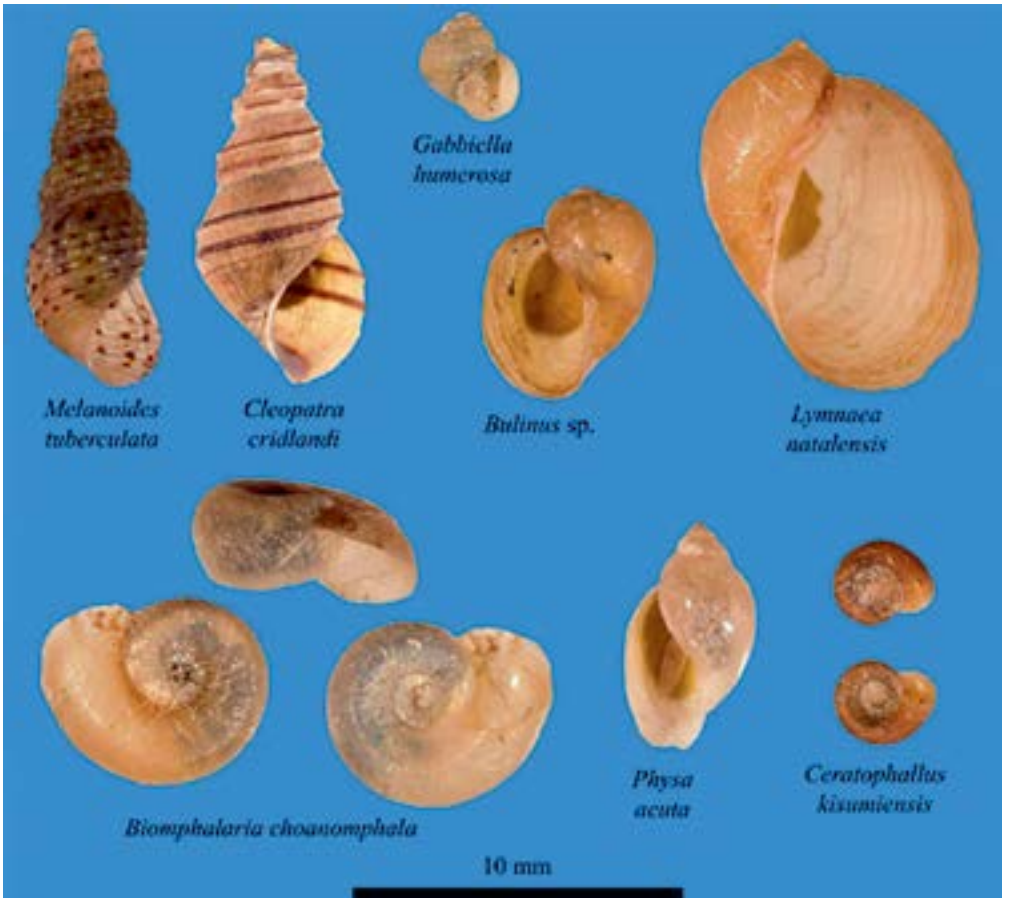
There is no doubt that the university lost a brilliant researcher who would have been a great capacity within research in malacology. Instead Georg Mandahl-Barth managed to manifest himself and his research internationally through collaboration with the World Health Organization (WHO). Georg Mandahl-Barth never forgot that he was bypassed for the position at the Zoological Museum. He ignored the place until 1973, where he was asked by the museum to sort and register the famous Forsskål collection of molluscs collected during the expedition to Arabia headed by Carsten

Niebuhr in the period 1761-67. Forsskål died of malaria in 1763 before he was able to do the work himself.

World Health Organization called for assistance

During the late 1940s and early 1950s, the WHO decided to address the control of major tropical diseases, including bilharziasis (schistosomiasis) in Africa, the Middle East, southeast Asia and south America. Because of the lack of safe and efficient drugs, early control efforts addressed the snails serving as intermediate hosts of the bilharziasis infection. The fact that the biology and taxonomy of the intermediate snail hosts was only known superficially at that time constituted a major problem for the control efforts.

Georg Mandahl-Barth was recognised for his expertise on snail systematics due to his work on the snails from Madeira, and he accepted an offer from the WHO to become a paid consultant to work with the snails, which are intermediate hosts for the schistosomes *Schistosoma haematobium*, *S. mansoni*, *S. intercalatum* and *S. bovis*.



Snail shells from Lake Victoria, Kenya.

Systematics of freshwater intermediate host snails from Africa

Georg Mandahl-Barth's studies were based on snail samples collected from many localities in Africa. The snails were gathered by members of his extended network of colleagues and sent to Charlottenlund. Central to this network was a group of young British researchers who spent a couple of weeks with Georg Mandahl-Barth in preparation for their research stays in Africa. Among these were W.J. McClelland, Fergus McCullough, Peter Jordan, Gerald Webbe, Robert F. Sturrock, David Brown and A. Davis, all of whom later became prominent contributors to the understanding of the epidemiology and control of schistosomiasis.

Georg Mandahl-Barth dissected, measured and analysed thousands of snails. Using selected anatomical characteristics of the radula, the size of reproductive organs and the shape of the shells, Georg Mandahl-Barth succeeded in organising the snail hosts into two distinct genera, *Bulinus* and *Biomphalaria*, each with a reasonable number of species. This was a major achievement. The WHO published the results in 1958 as a classical monograph of *Bulinus* and *Biomphalaria*. Other publications followed. Already in 1952, WHO recognised his work and established the "WHO Snail Identification Centre, Charlottenlund" at Denmark's Aquarium.

DBL on the drawing board

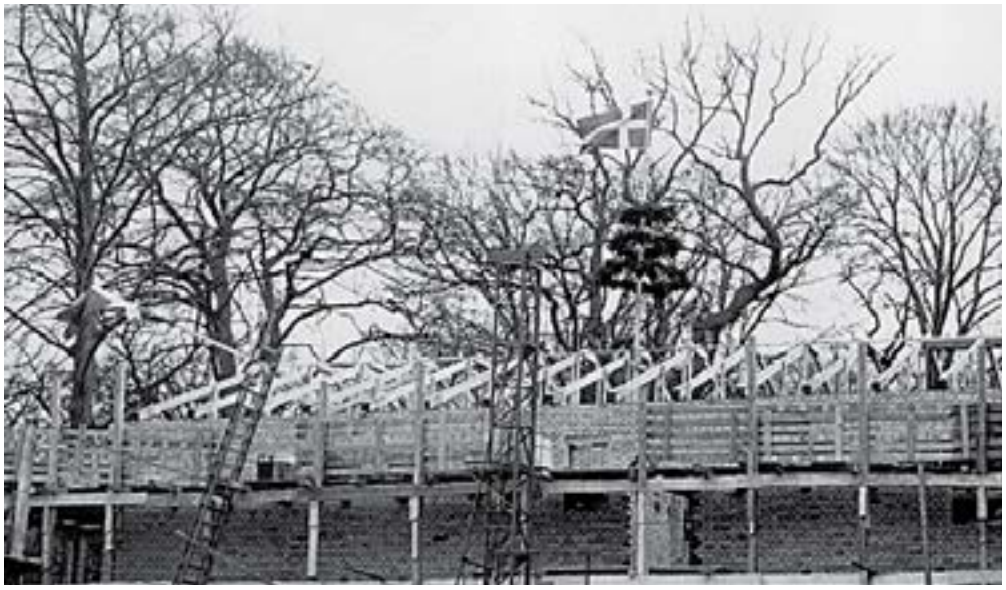
Ten years later, in 1962, a committee was formed to look into the establishment of a laboratory dealing with the systematics of schistosomes and their intermediate hosts, and with biological control. The committee consisted of Jonas Bruun, a Supreme Court lawyer; chief medical officer Dr Johannes Frandsen; director H. Hoffmann; Knud Højgaard; engineer P. Kern-Jespersen; and Ragnar Spärck. F. Nielsen, a head of department at the Ministry of the Interior, and Dr Georg Mandahl-Barth were attached the committee. The work of this committee resulted in an agreement to establish a laboratory to do research by every available method in the biology of schistosomiasis with regard to the prevention of the disease. The instrument of foundation was prepared in agreement between Knud Højgaard, Georg Mandahl-Barth, and Jonas Bruun, who was the lawyer of both the company Højgaard & Schultz and the Knud Højgaard Foundation.

Knud Højgaard had followed Georg Mandahl-Barth's work on molluscs with great interest. In recognition of the great support given to Mogens Højgaard by Georg Mandahl-Barth in running Denmark's Aquarium, Knud Højgaard donated DKK 0.9 million in 1964 for DBL's building. As mentioned by the donor at the inauguration, Georg Mandahl-Barth was thereby able to invest all his time in his hobby, namely African freshwater snails.

The DBL building

DBL's domicile was constructed just behind Denmark's Aquarium on a piece of "pro-

tected" land rented for a period of 100 years. Even in the early 1960s it was possible to persuade ministries and government officials to support activities that actually contravened existing rules and regulations. The building was designed by Carl Oluf Gjerløv-Knudsen, who had also designed Denmark's Aquarium, and who – together with e.g. Steen Eiler Rasmussen and Arne Jacobsen – was central to the development of functionalism in Denmark. Fine examples of this specific type of architecture are the entire Bellevue area along the Sound north of Copenhagen. The buildings that formerly housed Denmark's Aquarium and DBL constitute the southernmost part of this architecturally very exciting area.



Ceremony for raising the roof-tree at DBL's premises.

The interior of the building was adapted to meet Georg Mandahl-Barth's personal wishes for his future home and work space. A main block housed his first-floor flat, with a library, offices and snail collection on the ground floor. A side wing housed laboratories, offices, facilities for keeping small animals and a major central snail-keeping room designed as a greenhouse with a spectacular view of Charlottenlund Forest.

These facilities allowed experimental work, which further enhanced the understanding of the biology of the snail hosts and the parasites. During a major re-construction in 1990, the main block underwent great changes and the side wing was replaced by a new larger two-storey building.

DBL's early staff

What would be the most appropriate name for an institution in the temperate north

that would work with a disease from the tropics? Should it be 'Institute for Snail Fever' or 'Danish Bilharziasis Laboratory'? The latter was agreed upon, with the addition of the subtitle "WHO Snail Identification Centre". The rather isolated position away from the University of Copenhagen and other research institutions dealing with medicine and zoology has been both a strength and a weakness of DBL throughout its life.

Georg Mandahl-Barth was the natural leader of DBL. In addition, the staff plan included another full-time scientific staff member and a part-time secretary, and technical and animal-keeper positions. Being a snail specialist himself, Georg Mandahl-Barth looked for a parasitologist in his network to supplement him and to enable the entire schistosomiasis life cycle to be addressed.

There were several qualified candidates, but especially two persons had collaborated with Georg Mandahl-Barth for several years. Cai Cridland was a Danish-English researcher with a background as a technician. Georg Mandahl-Barth first met Cai Cridland in Jinja, Uganda, during his first visit to Africa in the early 1950s. Cai Cridland had fish research as his starting point but developed later a keen interest in snails and parasites.

Another candidate for the position was Fergus McCullough, who at that time was stationed in Ghana, but had also spent several years in Mwanza, Tanzania. Fergus McCullough had comprehensive research experience with a PhD on *Fasciola hepatica*, the liver fluke of cattle. Cai Cridland was appointed to the position. This choice was probably made for personal and economic reasons. Fergus McCullough was without doubt more qualified, but Cai Cridland and Georg Mandahl-Barth had a good relationship through their collaboration in Uganda and Carl Cridland's salary demand was lower than Fergus McCullough's. Finally, it was an advantage that Ellinor Cridland, Cai Cridland's wife, could be employed as part-time secretary.

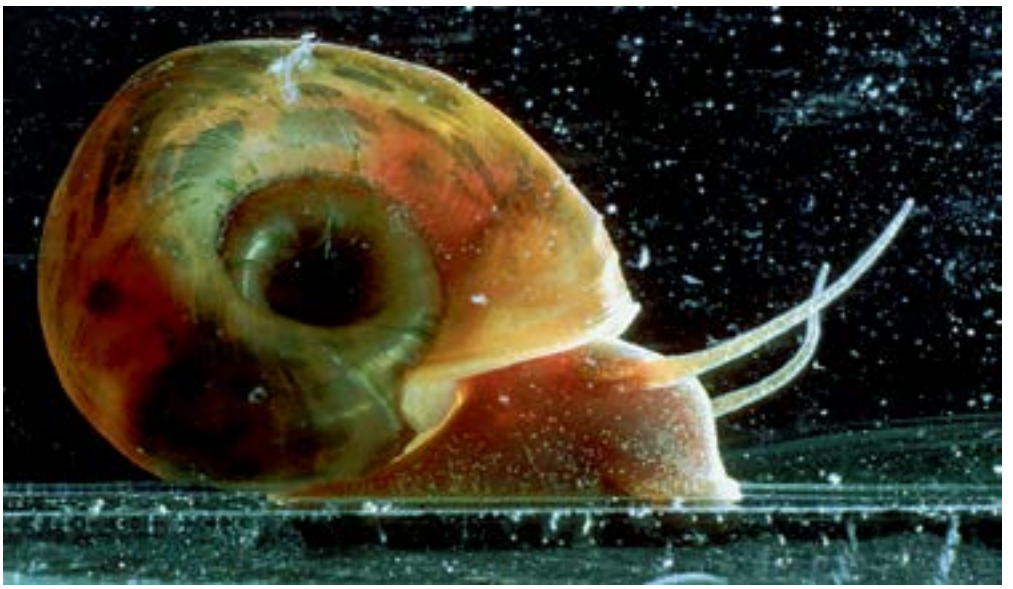
Funding in the early years

The first major challenge for Georg Mandahl-Barth was to secure funding for DBL's activities. The Knud Højgaard Foundation had financed the building but, as a matter of principle, would not support its daily operations.

The WHO, the National Institutes of Health, Bethesda, Maryland, USA, and the Danish Ministry of the Interior covered the initial running expenses. From 1968, funds were provided by the Secretariat for Technical Assistance (later Danida) for a period of three years.

The annual budget at the start in 1964 was DKK 0.2 mill. Funds were provided partly to allow DBL to fulfil its role as a "WHO Snail Identification Centre" and partly to follow up Georg Mandahl-Barth's ground-breaking idea of using the American snail *Helisoma duryi* as a biological control agent. The idea was based on the observations of Denmark's Aquarium that the schistosomiasis snail hosts apparently disappeared when *H. duryi* was introduced to the aquarium. At the same time, *H. duryi* is

not a snail host for schistosomiasis. In other words, *H. duryi* was supposed to be able to suppress the intermediate snail hosts and thereby control schistosomiasis. This was a potentially sound ecological approach explored during a period where there were no safe and efficient drugs for treating schistosomiasis.



Helisoma duryi, a possible biological control agent.

The next generation of staff members

Georg Mandahl-Barth and Cai Cridland both grew older and a plan for a generation shift was already laid in 1970. This included the addition of new, young and recently graduated scientific staff members who had been mentored by Georg Mandahl-Barth and Cai Cridland and who could continue building up experience with work on the schistosome parasite and its snail host.

New staff included cand.scient. Gudrun Wium-Andersen and cand.scient. Ole Rasmussen. Gudrun Wium-Andersen had worked with Danish marine snails (*Littorina*) under the supervision of professor Bent Christensen, applying new experimental methods such as electrophoresis. She was positioned to take over from Georg Mandahl-Barth on his work with the African snails. Ole Rasmussen had worked with *Fasciola hepatica* and its snail host *Lymnaea truncatula* under the supervision of Holger Madsen, a fellow student of Georg Mandahl-Barth. Ole Rasmussen was employed as parasitologist.

Much earlier than planned, Cai Cridland left DBL in 1971 together with his wife, Ellinor. They found Denmark too cold after their many years in Africa and left for Spain to start their retirement. At very short notice, I was appointed to take over Cai

Cridland's position as parasitologist at DBL because of my background as a specialist in parasites in amphibians, studies I had performed under the supervision of Holger Madsen.

A distinguished award and dissemination to the public

In 1975, Georg Mandahl-Barth was awarded the Novo Prize of DKK 100,000, a huge amount at that time. In addition to his research, Georg Mandahl-Barth was also interested in disseminating knowledge about nature to a broader audience and was in that respect ahead of his time. Through the Politiken publishing house he issued a series of small handbooks as introductions for the general public's interests in nature. His research was also transformed into practical guidelines for the identification of snails in various parts of Africa.

Early developments from research to capacity building

DBL was established as a research institute with a narrow mandate to study the snail hosts for schistosomiasis. Valuable contributions to initiate the control of schistosomiasis were made through the clarification of the systematics and taxonomy of the snail hosts. As a "WHO Snail Identification Centre", DBL collaborated with similar centres in Egypt, South Africa, the Philippines and England in supporting the WHO in its efforts to control schistosomiasis. However, with time, a need arose to adjust DBL's profile with a broader approach to research and capacity building for controlling schistosomiasis.

In 1967, a four-week course was held at DBL with the title: "WHO Training Course in Malacology". Seven participants, mainly from Africa, followed the course. Teachers were Georg Mandahl-Barth and Cai Cridland, together with two other specialists from the British Museum. A second course with the same title and duration followed in 1972. This time 12 participants from Asia and Africa joined the course and the teaching was taken care of exclusively by DBL staff. In 1976, the first three-month course in schistosomiasis was taught to three students from Zambia followed by two annual courses each for 12 students.

This development was handed over to me when I succeeded Georg Mandahl-Barth as DBL's director in 1978. Together with the staff, I further developed and implemented the considerable number of field courses, which were held in Africa from 1985 and onwards. In a constructive dialogue with Danida, the basis was created for the future development of DBL into a leading international institution for research, capacity building and knowledge-management in relation to control of schistosomiasis and other neglected tropical diseases.

4. An overview of DBL

BY NIELS ØRNBJERG

Establishment and early history

The Danish Bilharziasis Laboratory (DBL) was established in 1964 with, according to its charter, the aim "to contribute to the solution of the serious human and social problems caused by the disease schistosomiasis (bilharzia) especially for the populations of Africa and Asia". The idea behind establishing a laboratory in Denmark devoted to the study of schistosomiasis was conceived by Georg Mandahl-Barth, at that time inspector of Denmark's Aquarium. Georg Mandahl-Barth was a snail specialist and was asked by the World Health Organization (WHO) as early as in 1952 to establish a "WHO Snail Identification Centre". This centre was later incorporated into DBL. The establishment and early history of DBL are described in more detail in Chapter 3.

Organisational status

DBL was established as a private foundation under the governance of a board of directors. To a large extent it was managed as a government research institution with reference to Danish International Development Assistance (Danida), under the Ministry of Foreign Affairs of Denmark, and with close links to the universities. DBL became officially associated with the Faculty of Science at the University of Copenhagen (KU) in 1991 and with the Royal Danish Veterinary and Agricultural University (KVL) in 2000. Adjunct professorships and external lectureships for DBL staff provided the basis for close and productive collaboration.

The issue of DBL as an independent institution was addressed many times over the years. However, all government research institutions were integrated into the universities in 2007, and DBL followed suit. Thus, in 2007, DBL gave up its status as an independent, private foundation to merge as the DBL-Centre for Health Research and Development into the Faculty of Life Sciences (LIFE, formerly KVL) at the University of Copenhagen. DBL moved physically from its original location in Charlottenlund, north of Copenhagen, to the Frederiksberg campus of LIFE in 2008.

In 2009, DBL merged with the Section for Parasitology at KU's Department of Veterinary Disease Biology to form the Section for Parasitology, Health and Development. The Department of Veterinary Disease Biology, and thereby DBL, was integrated into the new Faculty of Health and Medical Sciences at KU in January 2012.

Throughout its life, DBL has been a central player in international health both nationally and internationally. This has been nourished through DBL's hosting of several

WHO Collaborating Centres, and through DBL's membership of Danish networks such as the Danish Research Network for International Health (ENRECA Health), the Danish Water Forum (DWF) and the Danish Development Research Network (DDRN). DBL became a member of the Copenhagen School of Global Health in 2008. Thus, DBL's work has been well anchored both nationally and internationally.

The building at the Frederiksberg campus, KU, where DBL was hosted from 2008.

Funding

From 1968, a series of performance contracts with Danida, lasting from one to five years, has provided the core financial basis for DBL's operations. The performance contracts were gradually reduced from 2002 and were finally phased out at the end of 2012.

Danida's provision of core funding for DBL has been based on a series of independent reviews and evaluations, all confirming that Danida's investment in DBL was well placed. Reviews and evaluations of DBL were conducted in 1976, 1987, 1992, 1996, 2002 and 2007, and DBL was also included in other evaluations covering Danida's support of research more generally. Throughout its existence, DBL was judged to be an outstanding international institution for building research and disease control capacity in developing countries. All assessments concluded that DBL did quality work in areas of public health that were important to developing countries, and which gave credit to Danida and Denmark. Danida's continued support of DBL over many years

was thus well documented through detailed analysis of relevance, output and impact.

Over the years, DBL has received significant funding from a number of other organisations. This include the Bill and Melinda Gates Foundation, National Institutes of Health, the Rockefeller Foundation, the V. Kann Rasmussen Foundation, programmes under the European Commission, the Consultative Research Committee for Development Research (FFU), Danida's Programme for Enhancement of Research Capacity in Developing Countries (ENRECA), and the Wellcome Trust Foundation. Various Danish research councils have also provided financial support.

The Knud Højgaard Foundation deserves special attention as a key supporter throughout DBL's existence. This foundation financed the construction of the laboratory in 1964 and several later reconstructions, and supported many projects. A major donation was granted for the establishment of the Mandahl-Barth Research Centre for Biodiversity and Health in Developing Countries. Most recently, the Knud Højgaard Foundation financed laboratory renovations when DBL moved to the LIFE campus in 2008.

Board of directors and staff

As an independent organisation until 2007, DBL was led by a board of directors. Chairmen of the board of directors were Johannes Frandsen (1964-1968), professor Erik Husfeldt (1968-1981), Supreme Court lawyer Carl Tjur (1981-1997), professor Flemming Frandsen (1998-2001) and Nils Strandberg Pedersen, president of the State Serum Institute (2002-2007). Danida had observer status on DBL's board of directors from 1976 to 1986, being represented by Erno Olsen (1976-1981), Finn Jønck (1981-1983), Ole Lønsmann Poulsen (1984), Michael Sternberg (1985) and Torben Brylle (1986). Klaus Winkel became a close ally of DBL already in 1976 as he represented Erno Olsen at many meetings.

Danida became a full member of the DBL board of directors in 1987 with Kirsten Wiinblad (1987-1993), Lisbeth Strøjer Kappell (1993-1995), Klaus Winkel (1996-2001), Ib Petersen (2002-2004) and Anne Birgitte Hansen (2004), all serving as deputy chairman. A Technical Advisory Services staff member additionally represented Danida from 1991: Søren Wium-Andersen (1991-1996), Henning Jensen (1996-1997), Pia Rockhold (1998-2004) and Henning Nøhr (2004-2005).

Reflecting the wish of a reduced "ownership" of DBL, Danida left the board of directors in 2005. Until the merger of DBL with the university, Danida was represented on the board of directors with observer status by a member of the Technical Advisory Services: Henning Nøhr followed by Esben Sønderstrup. DBL staff also contributed constructively to the work of DBL's board of directors.

DBL directors were Georg Mandahl-Barth (1964-1978), Flemming Frandsen (1978-1988) and Niels Ørnbjerg (1988-2012).

Throughout its life, DBL has had the privilege of being served by a committed,

dedicated, and competent scientific, administrative and technical staff. Disciplines included malacology, parasitology, entomology, epidemiology, medical anthropology, public health, environmental health and community health. Project staff and PhD students always supplemented permanent staff.

Most administrative staff were incorporated into the central administration at LIFE in 2008. As a consequence of the gradual phasing out of the performance contract, DBL suffered a significant loss of permanent staff over recent years. However, the majority of these staff members found new positions very relevant to health research and development. Other staff entered a well-deserved retirement, some were secured permanent employment with the university and others remained employed through external funding. Although the DBL era has come to a close, most of its former staff will continue their committed work and involvement with international health. A full list of DBL staff members from 2004 and onwards is found in Appendix 1.

The then present director of DBL (Georg Mandahl-Barth, upper row to the right) and two future directors (Flemming Frandsen, lower row in the middle and Niels Ørnbjerg, lower row to the right), 1976.

Collaboration in the south

DBL's network of collaborating institutions and networks in developing countries have consistently remained DBL's particular strength. Equal and balanced partnerships with these collaborators have always been a cornerstone and a key value in DBL's work. While the focus has mainly been on Africa, some strategically selected institutions and networks in Asia were also included.

Almost every project implemented by DBL over the years has been anchored in an institution or network in a developing country. In 1979, the Division of Vector Borne Diseases (DVBD) at the Ministry of Health, Kenya, became the first of DBL's many key collaborating institutions. Many of these partners have grown in strength to become national centres of excellence in research and control of neglected tropical diseases (NTDs). Some key collaborating institutions during recent years were the University of Nairobi Institute for Tropical and Infectious Diseases (UNITID); the CIAM-Public Health Research and Development Centre, The Gambia (CIAM); the Vector Control Division (VCD) of the Ministry of Health, Uganda; the Primary Health Care Institute (PHCI), Iringa, Tanzania; and the Institute of Gender and African Studies at the University of Nairobi, Kenya. Networks supported by DBL in recent years were the Cysticercosis Working Group in Eastern and Southern Africa (CWGESA), the Southern Africa Climate Change Network (SACCNet), and the Regional Network for Research, Surveillance and Control of Asian Schistosomiasis (RNAS+). The collaboration with CWGESA is described in Chapter 17.

Collaboration in the north

Collaboration has been close with many partners in the north, including universities in Denmark. The first Master of Science thesis by a student from the University of Copenhagen conducted at DBL was defended in 1975. From the 1980s, DBL's contribution to training and supervision at Master and PhD levels in parasitology and related fields became very comprehensive. DBL's collaboration with Ecology and Evolution at KU's Department of Biology was of central importance here. DBL's involvement in training at BSc and MSc courses has grown stronger following its merger into the University of Copenhagen. A list of Master and PhD project completions anchored in DBL and registered at Danish universities since 2004 is found in Appendix 4.

Participants at the research methodology course in 2006 experiencing snow.

The organisation's research collaboration developed towards the end of 1980s and into the 1990s. DBL became a prominent member of the KVL-anchored Danish Centre for Experimental Parasitology (CEP), while close collaboration on plant molluscicides was established with the Royal Danish School of Pharmacy (now School of Pharmaceutical Sciences, KU). Fruitful early collaboration was also established with Laboratory for Medical Allergology at the Copenhagen University Hospital and with the Institute of Anthropology at the University of Copenhagen.

DBL's network of collaborating institutions in Denmark expanded markedly with the Kenyan-Danish Health Research Project (KEDAHR). This project involved DBL, KU's Institute of Anthropology, the Department of Human Nutrition at KVL, the Danish National Institute for Educational Research, and the Danish University of Education. The Research Centre for Environmental and Health Education at the Danish University of Education became a central collaborator on health education research in Kenya.

Research and capacity building collaboration also became close with colleagues at the Centre for Medical Parasitology (CMP) and other units at KU's Department of International Health, Immunology and Microbiology (ISIM). Huge numbers of PhD students have been jointly supervised, and collaboration has been close on various research projects. These include ongoing projects funded by FFU (ADMER, ChildMed and FILICORESA), and the MIP, ACT and MCDC malaria projects (see below for the full titles of projects) funded by major international donors such as the Wellcome Trust and the Bill and Melinda Gates Foundation. A close collaboration has also developed recently with the new Danida-supported initiative Building Stronger Universities in Developing Countries (BSU). Following the integration of DBL into the Department of Veterinary Disease Biology, close research collaboration especially within veterinary medicine and zoonotic diseases has also been established within the department. DBL has through its active role in numerous Danish networks and societies of relevance for international health contributed markedly to coordination and advocacy.

DBL has also had a tradition of working closely with institutions in the north outside Denmark. Such close collaboration was pushed by the EU programmes requiring multiple EU partners and by DBL being a very attractive partner due to its huge experience with research collaboration with institutions in the south. In addition to the malaria projects mentioned above, major projects with multiple northern partners comprised the now-completed MUSTSchistUKEMA, CONTRAST and REACT projects and the ongoing SCORE, SchistoVac, FGS, ICONZ and ADVANZ projects.

These collaborative links to other institutions in the north have played a key role for all DBL's major research achievements as regards both quantity and quality. DBL's research outputs have been impressive.

Organising faeces samples before making Kato-Katz slides in the SCORE project.

DBL as a World Health Organization Collaborating Centre

DBL has been a key collaborator with the WHO in NTDs. Many activities have been implemented with reference to DBL as a WHO Collaborating Centre. DBL was appointed a WHO Collaborating Centre for Snail Identification in 1975, a WHO Collaborating Centre for Snail Identification and Applied Malacology in 1980, a WHO Collaborating Centre for Applied Medical Malacology and Schistosomiasis Control in 1988, and a WHO Collaborating Centre for Integrated Helminth Control in 2004.

Furthermore, DBL was designated as a Joint WHO/FAO/UNEP/UNCHS Collaborating Centre for Disease Vector Control in Sustainable Development in 1991. In recognition of its increasingly broader mandate, DBL was re-designated as a WHO Collaborating Centre for Health and Environment in Sustainable Development in 2003.

As a consequence of DBL's closure, these two collaborating centres were closed at the end of 2012. Future collaboration with WHO will without doubt continue on a more individual basis and within the framework of the still-active WHO Collaborating Centre for Research and Training on Neglected and other Parasitic Zoonoses hosted at KU's Section for Parasitology, Health and Development. The WHO-anchored UNDP/World Bank/WHO Special Programme for Research and Training in Tropical Diseases (TDR) has also been a key DBL collaborator for many years.

Profile of work and its development

For the first ten years of its existence, DBL was primarily involved with research on snail taxonomy and biological snail control. Courses in malacology were conducted

in 1967 and again in 1972, and the first students from the University of Copenhagen started their thesis research at DBL as described. Courses on schistosomiasis and its control were started at DBL in 1976 and the first such course in Africa was held in 1985 in Kenya. A broader schistosomiasis research agenda was also gradually adapted. The profile of DBL at the time was that of an institution dealing with research on malacological and parasitological aspects of schistosomiasis and with capacity building for schistosomiasis control.

DBL subsequently took up a much broader profile based on a review conducted in 1987. New staff with a broader public health expertise were employed. Thus, from the early 1990s, DBL's research and teaching agendas took an increasingly inter-sectoral and multi-disciplinary perspective. The focus was on selected NTDs such as schistosomiasis, filariasis, malaria, intestinal worm and Guinea worm infections and related health problems. However, broader and less disease-specific aspects of medical anthropology, environmental health and health systems and services were also addressed. All activities were well-anchored at partner institutions in the south with the aim of supporting their institutional sustainability and to promote local ownership.

Beginning as an institution with a narrow focus on malacology and biological aspects of schistosomiasis, DBL thus developed into a broad cross-disciplinary and inter-sectoral institution that duly reflected a wider public health context. Under the headings of **research**, **capacity building** and **knowledge management**, DBL has in its work contributed significantly to improved health in developing countries.

Newly emerged mosquitos on the walls of a pit latrine in northwest Uganda.

Aim of DBL's research programme

DBL's research programme has from the beginning focused on applied research with the overall aim of improving health in developing countries. DBL has attempted to achieve this goal by performing research that generated new knowledge or contributed to the development of methods, tools and approaches for use in interventions to reduce disease problems.

In its implementation, the programme has provided an understanding of key environmental and social determinants of health, and has contributed to the knowledge base behind the development of strategies for improved human health and for strengthening health systems and services.

Key attention has always been given to scientific quality, ethical standards, development relevance and usability for solving identified problems, all with a focus on southern priorities. With a starting point in the NTD agenda, research areas addressed were chosen with reference to national and international priorities and in close collaboration with the partners in the south.

Examples of DBL research projects and programmes are described in other chapters of this book. An overview of DBL's research programme until 2004 was provided in the 40th anniversary publication (ISBN 87-91521-00-9). That publication also includes a list of key publications up to 2004. Research publications from the period 2004 to 2012 are listed in Appendix 2.

Research in the early years

DBL's research initially addressed snail taxonomy, snail-schistosome relationships and biological control using the competitor snail *Helisoma*. Field trials with *Helisoma* were conducted in Tanzania from 1971 to 1974.

Studies on the ecology of larval schistosomes and other trematodes were later added to the research agenda, as were experimental studies on host-parasite relationships in schistosome and other fluke infections in the mammalian hosts. Different animal/parasite models were used. The issues of hybridisation between species of *Schistosoma*, and the use of plant molluscicides in snail control were also addressed. These studies were conducted in the laboratory in Charlottenlund.

However, emphasis was increasingly given to studies in Africa on the epidemiology of bovine and human schistosomiasis. Studies were thus conducted in the early 1980s on the transmission of bovine schistosomiasis in Iringa, Tanzania, and on snail ecology and biological snail control in the Gezira and Rahad Irrigation Schemes in the Sudan. These malacological studies were extended by studies in Lake Kariba, Zimbabwe.

Studies were also conducted on the transmission of human schistosomiasis in the Sudan and Nigeria and on morbidity due to intestinal schistosomiasis in Kenyan children. Studies on snail taxonomy continued throughout.

Removal of aquatic plants from irrigation canals exposes the workers to the risk of getting schistosomiasis.

Research programme expansion

With a continued focus on individual diseases, but with an increasing reflection on health and human well-being, DBL's research programme expanded markedly in the late 1980s.

Dracunculiasis (Guinea worm disease) research was initiated in 1989, focusing on chemotherapy and other control means, immunology and disease perceptions. Plant molluscicide research was extended with field studies in Zimbabwe and Nigeria, while studies of snail ecology and control continued in the Sudan, Kenya and Zimbabwe. Transmission of human schistosomiasis was studied in the Sudan, Ghana, Nigeria, Liberia and Uganda.

Lymphatic filariasis research began in 1990 with studies of transmission and immuno-epidemiology in Kenya, Tanzania, Nigeria and Ghana. A series of studies of immunology and morbidity in human schistosomiasis, including nutritional aspects, was initiated in the Sudan, Kenya and Zimbabwe. Studies of intestinal helminth infections, including hookworm, were also added.

At DBL, experimental studies of schistosomiasis in ruminants and studies of intestinal fluke infections using murine animal models were given great emphasis. These studies were followed by comprehensive studies of the *Schistosoma japonicum*/pig model. Snail taxonomy research was extended to include *Oncomelania*, the intermediate snail host for Asian schistosomiasis.

Malaria field research with a focus on its vectors was initiated in 1991. The first such project dealt with mosquito blood meal identification, mosquito repellents, larval control based on *Bacillus sphaericus*, and the use of geographical information systems (GIS) in the mapping of mosquito distribution in Pakistan.

Research focusing on disease control

From the beginning of the 1990s, DBL's research agenda focused increasingly on disease control, and malaria became increasingly central. Malaria studies focused on malaria in pregnancy, while transmission studies addressed the spatial epidemiology in The Gambia, the effect of environmental change on transmission in the Usambari Mountains in Tanzania and mosquito population dynamics and control in Mozambique.

Other projects initiated during the early 1990s comprised operational research on school-based control programmes of urinary schistosomiasis and intestinal helminthiasis, the use of bed nets and chemotherapy in lymphatic filariasis control, and community-based control of dracunculiasis. Studies addressing various aspects of chemotherapy-based control of malaria, schistosomiasis and intestinal helminth infections were also given high priority.

Taking finger prick blood for testing of lymphatic filariasis, Uganda.

Broadening the research profile further

The addition of new staff with expertise in medical anthropology, public health and health systems and services allowed a further development of the research agenda to become increasingly integrated, cross-disciplinary and inter-sectoral in its approach.

The first project on medical anthropology dealt with local perceptions of illness among the Bissa in Burkina Faso, while later studies, among other topics, dealt with orphans, especially in Kenya. Health education research was also comprehensive. The health systems research was concerned with improving effectiveness, efficiency and quality of the health systems and services in Kenya, Tanzania, Zambia and Mozambique.

New diseases added to the disease portfolio during recent years comprised the neglected zoonotic diseases (NZDs), with an emphasis on cysticercosis. From the point of view of expanding into an overall 'one health' approach, projects on aspects of plant health were also included.

Research was implemented under the overall headings of disease mechanisms (to understand and measure disease processes); health determinants (to understand factors that affect public health) and health interventions (to develop and test new tools and methods for improving public health).

Research workshops addressing proposal development and the planning, implementation, monitoring, reporting and evaluation of projects have remained core elements of DBL's research programme in order to glue together the often multi-centre projects with many partners in the north and the south.

Participants at the Regional Network for Research, Surveillance and Control of Asian Schistosomiasis (RNAS+) workshop at DBL, Charlottenlund.

Research capacity building

DBL's research programme has always had major elements of research capacity build-

ing. An important part of the research programme has thus centred on PhD projects for staff from collaborating institutions in the south.

DBL has put emphasis on developing capacity for control, monitoring and evaluation of NTDs, and has engaged in strengthening the capacity for health research at key collaborating institutions and networks in partner countries.

Such capacity-development activities have been guided by institutional needs assessment and development plans, strategic partnerships and long-term collaborative agreements. DBL has also been a central player in the efforts to build a Danish research and knowledge base within international health. For further details, see Chapter 5.

What is knowledge management?

WHO defines knowledge management as the use of technology to enable people to create, capture, store, retrieve, use and share knowledge. Knowledge management can provide an effective and efficient way of organising what is known and then using this in a variety of capacities to improve public health services. DBL has put great emphasis on supporting knowledge management activities and processes in the context of health, environment and sustainable development.

DBL's overall role in knowledge management

DBL worked both nationally and internationally. DBL played an active role as a facilitator and promoter of networking, of research into action, of research-based decision making, of the provision of research-based technical and advisory services, and of research policy framework setting. Internationally and nationally, all activities were well-anchored in nationally driven processes. DBL's efforts are documented through the list of selected DBL knowledge management papers found in Appendix 3.

International processes

DBL has been an active player on the international scene in its support of the work of many international organisations and programmes. DBL's research-based knowledge has assisted organisations like the International Union for Conservation of Nature (IUCN), WHO, the Global Programme to Eliminate Filariasis (GPELF), TDR and the Council on Health Research for Development (COHRED) in their work. Support of WHO's work on development of strategies and policies on NTD control has been comprehensive. Such contributions have commonly been based on DBL staff membership of different committees and task forces, on meeting participation, on DBL's role as a WHO collaborating centre, and on the preparation of research-based analysis of for example the role of vector control in filariasis control, morbidity parameters in schistosomiasis, social determinants of health, the role of drug combinations in helminth control, social science aspects of schistosomiasis control, and biodiversity of molluscs in different African regions. DBL´s support of COHRED's promotion of

the role of civil society organisations (CSO) in research for health also deserves to be highlighted, and the collaboration with WHO's Water, Sanitation and Health Unit on health impact assessment (HIA) has been constructive. The same has been the case with collaboration conducted under the Global Network of GeoSpatial Health (GnosisGIS). The impact of some of these activities is exemplified in Chapter 21. Many consultancies have also been conducted, for example for the International Commission on Certification of Eradication of Drancunculiasis, COHRED, the World Bank, TDR and WHO on for example HIA, disease control, testing of bed nets and research priority setting.

Regional and national processes

DBL's support of regional and national knowledge management processes has also been comprehensive. Much attention has been given to HIA policy processes in Vietnam, Cambodia and PDR Laos (Chapter 18), to national research agenda policy setting processes in Kenya, The Gambia and Zambia, to 'research into practice' promoting processes in many countries in Africa, and to the advocacy for and development of national disease control programmes. In most recent years, great attention was given to control of cysticercosis with anchorage in the work of the DBL-supported Cysticercosis Working Group on Eastern and Southern Africa (Chapter 17).

Danish processes

Recent years' support of the work by Danida in knowledge management included a preparedness service for avian flu, consultancies in relation to the tsunami disaster in Indonesia and in relation to health research policies in Bhutan, staff memberships of different task forces and working groups, and meeting participation on behalf of Danida. DBL staff also very actively commented on various drafts of Danida policy and working papers.

Abbreviations

ACT = Artemisinin combination therapy consortium
ADMER = Prudent use of antibiotics for treatment of bacterial infections in Ghana
ADVANZ = Advocacy for neglected zoonotic diseases
ChildMed = Quality medicine use for children in Uganda
CONTRAST= A multi-disciplinary alliance to optimise schistosomiasis control and transmission surveillance in sub-Saharan Africa
FGS = Improved diagnosis and prevention of female genital schistosomiasis
FILICORESA = Filariasis control operational research in eastern and southern Africa
ICONZ = Integrated control of neglected zoonoses: Improving human health and animal production through scientific innovation and public engagement
MCDC = Malaria capacity development consortium
MIP = Malaria in pregnancy consortium
MUSTSchistUKEMA = Multi-disciplinary studies of human schistosomiasis in Uganda, Kenya and Mali: new perspectives on morbidity treatment and control

REACT = Strengthening fairness and accountability in priority setting for improving equity and access to quality health care at district level in Tanzania, Kenya and Zambia
SchistoVac = The targeted development of a new generation vaccine for schistosomiasis
SCORE = Schistosomiasis consortium for operational research & evaluation

5. Capacity development for health and health research

BY NIELS ØRNBJERG AND PETER FURU

Two of DBL's key missions

Throughout its existence, DBL has focused on two key capacity-development dimensions. On the one hand, DBL has put emphasis on developing capacity for control, monitoring and evaluation of neglected tropical diseases (NTDs); and on the other hand, DBL has engaged in strengthening the capacity for health research at key collaborating institutions and networks in partner countries. The capacity-building efforts were always anchored in DBL's operational research programme. This addressed health in the context of sustainable development and poverty alleviation.

Such capacity-development activities have been guided by institutional needs assessments and development plans, strategic partnerships and long-term collaborative agreements. DBL has also been a central player in the efforts to build up a Danish research and knowledge base in global health.

Building capacity for disease control

During DBL's early years, attention was primarily paid to the development of capacity among African scientists and health-workers for snail identification and for control of schistosomiasis. Training courses were well attended in both Charlottenlund and different African countries. During the 1990s, these courses developed gradually towards capacity building for control of malaria, lymphatic filariasis, Guinea worm disease, intestinal helminth infections, and integrated control of NTDs, as well as health impact assessment (HIA).

A World Health Organization (WHO)/DBL course on malaria and major tropical diseases and their control was held in Tanzania in 1992, 1994 and 1996. From 1992 to 1997 a new, problem-based learning course on health opportunities in water resources development was developed and pilot-tested in five African, central American and Asian countries as a joint activity between DBL, WHO, the London University Centre for Higher Education Studies and the Liverpool School of Tropical Medicine. DBL courses and workshops on lymphatic filariasis epidemiology and control were held regularly in Tanzania and Ghana from 1990 to 1999. Emphasis was also given to building capacity for Guinea worm control in Ghana.

The capacity developed through participation of one health sector staff member in an NTD control course has provided a unique starting point for the many national

NTD control programmes that are now ongoing in many countries in Africa. Most recently, staff trained by DBL were instrumental at a time when Kenya developed its national strategy and action plan for NTD control in 2011.

Building capacity for control of individual NTDs has been an ongoing priority. Recent years have witnessed an emphasis on neglected zoonotic diseases (NZDs) and on diagnosing NTDs.

Fieldwork during a schistosomiasis course, Machakos, Kenya, 1985.

Capacity building for improved health beyond individual disease control took up a more central role during recent years. Capacity strengthening on HIA was given high priority in the southeast Asian region in collaboration with WHO through work in Laos, Vietnam and Cambodia (see Chapter 18 for details). Other more generic capac-

ity-building activities included capacity for district-based health priority settings in different countries in east Africa. Furthermore, capacity for monitoring and evaluating disease control programmes more broadly were enhanced through training activities in The Gambia, for example.

However, with time, attention was also increasingly given to building capacity for health research and to build institutional capacity. The latter was found to be essential if sustainable solutions were to be developed.

Course on lymphatic filariasis, Tanga, Tanzania, 1991.

Building capacity for health research

Experience gained in the early days made DBL realise that building capacity for health research is a prerequisite for developing a lasting research tradition and for ensuring that decision-making in health systems will be informed by new knowledge generated in the research processes.

Thus, in the early 1990s, DBL extended its past support of individual PhD students into a comprehensive research school with many students and with a comprehensive programme of PhD courses and workshops, some generic and some more topic-specific:

- research methodology
- research management
- data analysis and statistics
- geographical information systems
- epidemiology

- quantitative research methods
- qualitative research methods
- health systems research
- diagnostic and laboratory techniques
- malacology and snail ecology
- ecosystem health
- mosquito ecology and vector control
- research ethics

All courses and workshops, initially with the exception of the four-month research methodology course (see below), were held at partner institutions in the south. Many of these courses have now become fully institutionalised at the partner institutions. In addition, PhD student registration has increasingly been done at local universities in the south, and staff from DBL and from the collaborating institutions have always shared supervisory responsibility. The research school activities have always been well integrated into DBL's research programme. A total of 50 students from developing countries graduated from the DBL Research School during the period 2004 to 2012 (see Appendix 4a). Of these, 19 were registered at a university in their home country.

To ensure sufficient and qualified recruitment to the PhD programme and to develop research capacity more broadly, DBL supported thesis research for 51 African master's degree students registered at universities in their home countries during the period 2004-2012 (see Appendix 4b).

Course in the use of the statistical programme STATA, Nairobi, Kenya.

The crown jewel among DBL courses

In 1993, DBL conducted the first of a long series of the four-month research methodology course – a training programme for scholars from developing countries about to embark on their PhD studies. The course combined a taught part lasting 2½ months with a proposal-writing part of 1½ months. This course provided the participants with basic knowledge and skills on health research programme planning, implementation and reporting. Scientific as well as managerial, logistic and ethical challenges associated with research were among the topics covered by the course. The course has been an extremely successful starting point for many African PhD students. Many of the research methodology courses held at collaborating institutions in Africa with greater or lesser involvement of DBL build on modules from this crown jewel course.

The DBL research school concept has been very successful (see also Chapter 21), and the approach has gradually been taken up by other international and national programmes, including the new Danida-funded project Building Stronger Universities in Developing Countries (BSU).

Group work at the research methodology course at DBL, Denmark, 2008.

Building capacity for health research into practice

Bringing research down from the ivory tower is essential for giving research for health a role in fighting diseases and for ensuring better health for vulnerable communities. In the 2000s, DBL developed a new branch of research capacity building, namely short courses training health staff in basic research methodology in order for them to plan and conduct simple research projects focusing on issues of specific relevance to their work ('research methodology light'). A number of such short courses were held

as consultancies for Danida for health staff in Bhutan and at district level in the Coast and North Eastern provinces of Kenya.

To support the transformation of research into practice and vice versa, i.e. bridging the well-recognised "know-do" gap, DBL broadened its capacity-building approach to include district health personnel and health decision-makers through research into practice (RintoP) workshops in, for example, Kenya and Uganda. Here, the aim was not to transform the participants into researchers, but to enable the health providers at different levels to become equal and competent partners in research priority-setting processes, in research programme planning, and in dissemination and not least utilisation of research findings.

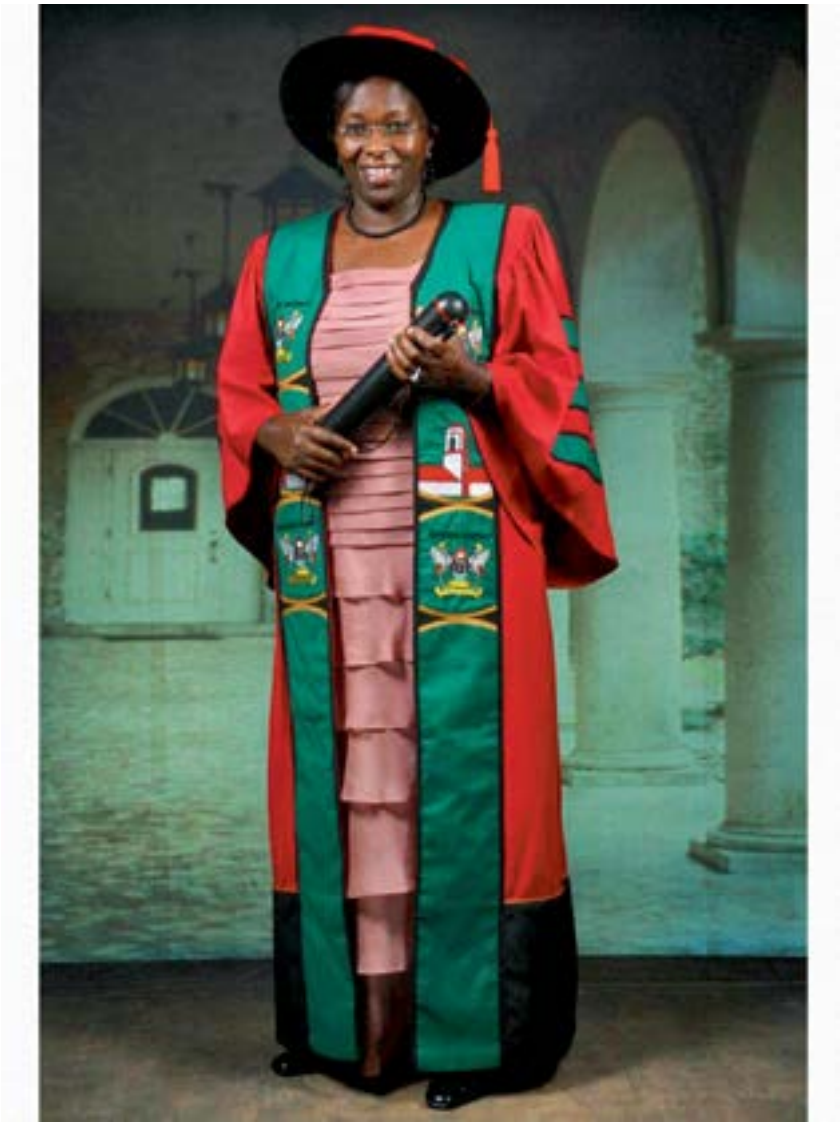
Overall, researchers need competent counterparts at all levels of the health system in order to achieve an increase impact and relevance of their research. Other activities along the same line included workshops to train researchers in writing policy briefs in, for example, Uganda and Kenya to ensure proper dissemination of key research findings to various user groups.

Participants with DBL facilitators in a proposal-writing workshop in Bhutan in 2005.

Institutional capacity development

As mentioned, building individual capacity for research and disease control will not

lead to lasting developments unless appropriately anchored in well-functioning institutions and networks. From the late 1990s, DBL therefore paid increased attention to its contribution to develop institutional capacities more broadly.



Dr Edridah Tukahebwa after the successful defence of her PhD at Makerere University, Kampala, Uganda.

DBL has supported key collaborating institutions and networks in their development of strategies and action plans; infrastructures, such as geographical information systems, and laboratory and library facilities have been improved. In addition, capacities for financial, human resources and research management have been built up through

courses, workshops and on-the-job training. In addition, collaborating universities and institutions have been assisted in the development of courses and educational programmes. One example of such a major effort, namely that of the CIAM-Public Health Research and Development Centre (CIAM) in The Gambia, is described in more detail in Chapter 19.

Institutional and other capacity development work has been anchored in projects such as the EU-funded Prepare-PhD project and the Danida-funded BSU project. The Prepare-PhD project addressed PhD programme capacity building at veterinary and agricultural faculties at universities in Kenya, Tanzania and Uganda, while BSU aims at building such programmes at health faculties at universities in Ghana, Zanzibar and Tanzania. During the most recent years, DBL has supported BSU's portfolio of activities building such broader competences at universities in Ghana and Tanzania.

Without doubt, DBL has contributed markedly to building regional and national research, education and knowledge centres of excellence in many African countries.

Capacity building in the north

In the European context, DBL has strengthened capacity for health research for development through support of PhD, MSc and BSc research projects for northern students and through contributions as teachers and examiners at PhD and master's degree courses at Danish universities. A total of 13 northern PhD and 41 MSc project completions have been anchored at DBL in the period 2004 to 2012 (see Appendices 4c and 4d). Many prominent present members of the Danish research for development community have been trained by DBL.

6. No impact without good governance and efficient administrative support

BY CHRISTIAN GREGART AND KIRSTEN GRØNLUND ANDERSEN

A need for good administrative support

DBL and its collaborating institutions and networks are knowledge-management organisations with aims to conduct research, build capacity, transform research findings into applicable knowledge and support implementation of other health-promoting activities. Enthusiastic and competent researchers, advisers, teachers and students are essential to achieve these aims. However, of equal importance is an effective and efficient administrative support system.

The co-ordination management team at DBL

DBL has from the beginning been privileged to have a committed, professional and user-oriented administrative staff. With the increase in research staff, and as Africa was increasingly included as part of DBL's place of work, the administrative staff was expanded from one secretary to a group of administrative staff members. These were organised in the co-ordination management team (CMT). The CMT embraced a variety of characteristics necessary to support the scientific staff in their various activities. The team managed human, information, project and financial resources. Financial management included budgeting, accounting and reporting, while information management ranged from library services over web mastering, translation and editing of reports to annual reporting to Danida and other donors and organisations.

In a culture of highly specialised individuals, the CMT provided the framework for DBL's daily operations – including not least DBL's interaction with collaborating institutions and networks. The CMT provided good governance and nourished the culture needed to ensure DBL ran smoothly; it organised available resources and it steered DBL's adherence to procedures, guidelines, standards and other formalised processes. The CMT worked with open communication and in full transparency and contributed to achieving DBL's objectives.

Managing south-north collaboration

DBL's close collaboration with partners in Africa required particular administrative knowledge, experience and competences. A profound understanding of how to perform on the interface between different cultures and administrative traditions was also an absolute necessity. These skills were available at DBL throughout its life and

facilitated smooth running of projects and programmes. Not only did these competences support DBL internally, they also gradually became an inseparable part of DBL's aim to build institutional capacity among its partners. DBL has thus aimed at capacity building not just in scientific terms but also with the administrators at the partner institutions and networks. This built on the conviction that administrative capacity is a clear prerequisite for sustainable institutional development. An institutional framework must be in place with clear lines of command, with access to the right information at the right time, and with capacity to handle both human and financial resources. DBL was very active in building such capacities at the partner institutions.

DBL has adhered fully to the administrative procedures, rules and regulations applying to government research institutions and Danida, and has always focused on appropriate control mechanisms that ensured financial transparency. However, the CMT managed to navigate the sometimes-bureaucratic waters smoothly to allow easy running of activities. Flexibility and mutual understanding paved the way.

DBL was thus an attractive collaborator for both Danish and other partners not only because of its capacities within research and capacity building, but also because of its vast experience in the administration of north-south collaborative activities. DBL and its southern partners were often organising courses and workshops on request from other major donors and organisations that recognised DBL's competences and capacities.

Approach taken

Compared with most other units in the world of science and research, DBL was quick to understand that the synergy from close collaboration between science and administration is an indispensable element of institutional capacity building. Involving the administration in project work from the early stages of a project builds trust and a sense of joint movement towards a common goal. That administrative staff could play a significant role in project work was an eye-opener for the partners. The importance of showing that here was actually an institution that practised what it preached, could not and cannot be overestimated.

Organised courses and workshops

Courses and workshops held in Africa have always been central elements of the DBL programme. To arrange a one-week meeting in e.g. Mombasa for 50 researchers from three different continents and from ten different countries in Africa was a major administrative challenge. But the CMT managed everything from the initial invitation to the final check-in before departure from Kenya. In the early days, it was like a caravan ferrying everything from bales of tissue paper, printing cartridges and copying machines to extension cables, pens and pencils. However, as capacity increased in

the administrative units of the southern partners, the DBL administrators gradually withdrew to rely on their counterparts to organise and report.

The presence of the administrative staff gave the researchers free hands to fulfil their commitments, while the CMT and southern colleagues sorted out all the practical issues. Examples are helping a participant stranded somewhere because bureaucracy had held up a bank transfer, or arranging a visit to a primary school with hundreds of children; such a visit became more festive when 50 soccer balls and skipping ropes for the children were released. Endless negotiations with hotel managers and bus companies, changes to travel documents and constant follow-ups made sure everything ran according to plan.

The approach towards collaborating institutions was always that of an equal partnership and shared responsibility. The added value of building durable links and mutual respect was a marker for the CMT's relationships across Africa throughout DBL's existence.

Financial management

The financial front has been slightly more complex as donor regulations differ and are not always clear and straightforward. Financial management has been a crucial part of project management. The CMT had a permanent and important role in informing partners of the detailed rules and administrative procedures and regulations they had to adhere to. The CMT closely assisted and facilitated various administrative activities in close collaboration with the partners, ensuring best use of financial resources when executing the planned activities. Sharing information on how to submit proper project accounts in due time is an absolute must, and DBL has on several occasions held training courses in financial management. This has given the African controllers valuable tools to handle European and other donors' reporting requirements.

Due to strong financial management, accounts and financial reports have been submitted on time, leaving the donors satisfied and confident that their funding was handled appropriately.

Human resources management

The number of African students who visited DBL in Denmark is too high to count. Some came as course participants, while others came as individual PhD students. The CMT made the visiting students feel welcome, and sorted out all practical and logistic issues in a close and constructive collaboration with the Danida Fellowship Centre (DFC). The students were nursed and introduced to European culture and concepts. The CMT was very visible to these students, some of whom had never been outside their own country. Many of the former students are now prominent members of their colleges and universities in Africa, but they continued to come 'home' to DBL and DFC when given the opportunity.

From paper to the Internet

Access to information is essential and DBL gave much attention to information management. DBL's library service underwent a major revolution. From assisting in finding books and journals on the many metres of shelves in our physical library, the librarian participated in different DBL courses teaching students how to search for literature on the Internet. DBL also supported partner institutions with computers and subscriptions to e.g. Hinari, which enabled the institutions to gain access to one of the world's largest collections of biomedical and health literature.

The future

DBL has now merged with University of Copenhagen (KU). As a consequence, most CMT responsibilities have been gradually handed over to more central administrative levels at the university. With the final closure of DBL, the CMT ceases to exist. A pool of valuable know-how on working in an African setting with different stakeholders, taking into consideration the cultural differences and challenges in the context of the African reality, is spread, if not lost. This represents a major challenge for building durable north-south collaboration between University of Copenhagen and its partners in the south, based on trust and a shared responsibility.

Key CMT approaches and values should somehow be maintained at the university. KU should develop administrative procedures, guidelines and standards and, not least, effective and efficient support structures to actively support collaboration with partner institutions in developing countries. This will release the researchers' energy to focus on their main tasks and to maintain their interests in working in and with developing countries.

The new Danida-supported initiative Building Stronger Universities in Developing Countries is now following DBL's emphasis on building institutional capacity. This project recognises, as DBL did, that strong administrative support units are a prerequisite for strong universities, and that a smoothly run administration lets researchers, tutors and students concentrate on and enhance their performance. Under this umbrella, good use is made of DBL's managerial competences in the collaboration with universities in Tanzania and Ghana.

7. Research on schistosomiasis – providing the evidence and tools for disease control

BY BIRGITTE J. VENNERVALD AND PASCAL MAGNUSSEN

Bilharzia

A nine-year-old African boy is rushing to school. He likes going to school, but he is often absent and has difficulties in sitting listening to the teacher in class because he frequently feels like he has to pee and therefore rushes out to the toilet. His urine has recently turned red and he knows that this is a sign of bilharzia. His grandmother has told him that this is a sign that he is growing up to become a man, but the teacher in school has explained that it is bilharzia and that you get the disease from swimming in the river. This young boy is not alone; more than 90% of the children in his school, including his own brothers and sisters, have blood in their urine and are in need of treatment.

The infection

Schistosomiasis or bilharzia is an important poverty-related health problem, especially in sub-Saharan Africa, and it is among the most prevalent and important of the neglected tropical diseases (NTDs). It is caused by an infection with trematodes (flatworms) and people get infected through contact with freshwater where intermediate host snails are found (see also Chapter 8). This can happen when people are performing their daily household activities (washing, collecting water) or various occupational activities (fishing, digging sand, working in irrigated rice fields), as well as several other activities involving contact with water. For children, playing in water constitutes an important and often intensive form of water contact.

Infected snails release a larval stage of the schistosome, a cercaria, and infection occurs when the cercariae penetrate the intact skin of a person. The schistosome larvae will now find their way to a blood vessel and within five to ten weeks mature into adult worms. The adult worms live for many years in the blood vessels of the uro-genital tract (*Schistosoma haematobium*) or the intestine (*S. mansoni*), and as children get older they accumulate more and more worms. This results in the typical age-intensity of infection relationship observed in schistosomiasis, where infection levels increase steadily during childhood to reach a peak around puberty. Thus school-aged children are often the segment of the population with the heaviest burden of infection.

Schistosoma spp. worm pair. The female worm is situated in the ventral canal of the male.

The disease

The adult female worm produces eggs that are excreted from the body with urine or stool. However, not all eggs are excreted; some are trapped inside the body in the tissue of the urine bladder or intestines, as well as in the liver. The immune system reacts against the eggs and this is what causes the disease manifestations seen in schistosomiasis.

Uro-genital schistosomiasis may result in blood in the urine, dysuria, inflammatory changes in the urinary bladder wall and hydronephrosis. Furthermore, inflammatory genital lesions may be found in both men and women affecting their reproductive health. The lesions are also suspected of making the individual more susceptible to HIV. The most severe consequences of chronic uro-genital schistosomiasis is kidney failure after destruction of the kidney by hydronephrosis or cancer (squamous cell carcinoma) of the urinary bladder caused by many years of chronic bladder wall inflammation.

In intestinal schistosomiasis, eggs deposited in the liver mainly cause the symptoms and disease manifestations. In children, this can result in severely enlarged livers and spleens (hepato-splenomegaly). In older teenagers and adults, especially those living in areas with high transmission, a characteristic form of peri-fibrosis of the liver may develop. In severe cases, this can be accompanied by portal hypertension. The most severe consequence of chronic intestinal schistosomiasis is portal hypertension with massive spleen enlargement and oesophageal varices. When people die from schistosomiasis, it is from massive acute bleeding from ruptured varices.

Schistosomiasis research at DBL

Schistosomiasis epidemiology and control was the raison d'etre for the initiation of the Danish Bilharziasis Laboratory (DBL) in 1964 and it has remained one of the core research areas over the years. During this period we have seen the decline and fall of snail control. This strategy was replaced by an emphasis on control of morbidity through chemotherapy, especially in sub-Saharan Africa, where transmission was intense and schistosomiasis-related disease rampant. The focus on disease control called for increased knowledge about disease mechanisms, tools for disease assessment and knowledge about the effects of treatment on disease. In the following we will present some examples of research in these three areas.

Extensive water contact.

Studies of disease mechanisms

The organ-specific changes seen in schistosomiasis are directly linked to inflammatory responses against the parasite eggs that are deposited in the tissue. This results in an inflammatory tissue reaction, a granuloma, around the egg. The granuloma consists of a number of immune cells such as lymphocytes, macrophages and an abundance of eosinophil granulocytes – the hallmark of a schistosome egg granuloma. In most people, the granulomatous response is tightly regulated with a down-modulation of the inflammatory response in chronic infections; but in some individuals this regulation fails, resulting in marked inflammation and disease. The main aim of our research on disease mechanisms has been to improve knowledge – of the immune responses involved in schistosomiasis morbidity, of the effect of co-infection with malaria on schistosomiasis-related inflammation, and of the role of the eosinophil granulocyte in the tissue inflammation in schistosomiasis.

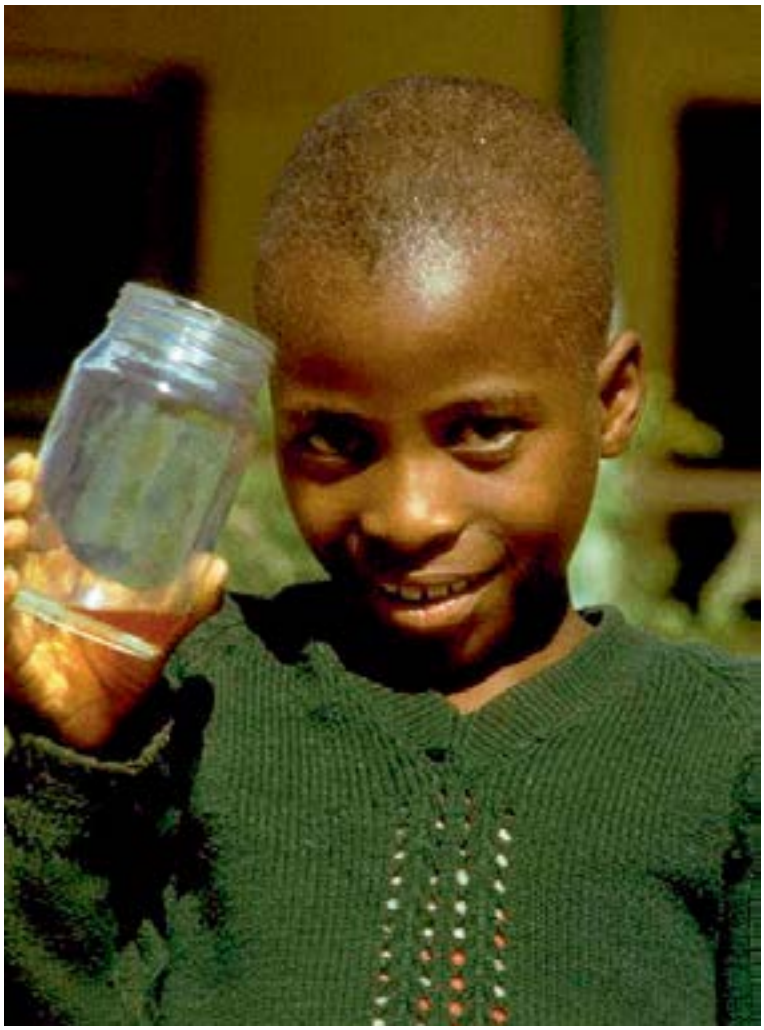
Together with colleagues from Kenya, Uganda, Mali, the UK and the Netherlands we have carried out longitudinal immuno-epidemiological studies in *S. mansoni* endemic areas in Kenya and Uganda and *S. haematobium* endemic areas in Mali. Among other parameters, these studies have analysed plasma cytokine levels, cytokine responses in whole blood-cell cultures in relation to age, gender, infection status and level, clinical morbidity and the effect of treatment with praziquantel. As an example, studies from Kenya have investigated the disease mechanisms behind chronic enlargement of the liver and spleen (hepato-splenomegaly), which is commonly seen in sub-Saharan Africa, particularly among school-aged children. This can be caused by long-term exposure to malaria, or by *S. mansoni*. Our studies indicate that childhood hepato-splenomegaly is associated with a pro-inflammatory response. This is in contrast to the pro-fibrotic Th2 response that is associated with peri-portal fibrosis. The pro-inflammatory response is also associated with chronic exposure to malaria infections, and there is evidence of exacerbation of organ enlargement when co-exposure to malaria and schistosomiasis occurs. Overall, the results suggest that *S. mansoni* infection may enhance the underlying inflammatory reaction. Chronic exposure to *S. mansoni* and *Plasmodium falciparum* can therefore have a synergistic effect on childhood morbidity.

Assessment of morbidity – tools and evidence

With a focus on controlling disease caused by schistosomiasis, it became important to know the level of morbidity in affected populations and to be able to measure the impact of treatment directly on schistosomiasis-related disease. The infection gives rise to overt signs and symptoms, especially in heavily infected people, and these signs have been used as simple diagnostic indicators of infection. An example of this is blood in the urine. Blood in the urine detected by a haemastix is a very good indicator of *S. haematobium* infection in children, as shown in a study from Pangani; but it is much less specific and less useful in an adult population, and it does not indicate the severity of organ-related changes. In the 1980s, ultrasonography was used for the first time in a *S. haematobium* field study to detect changes in the urinary bladder and kidney and peri-portal fibrosis of the liver in *S. mansoni*. It soon became evident that there was a need for standardisation of the ultrasound examinations and WHO hosted a series of workshops, which resulted in standardised classifications for ultrasound examinations in schistosomiasis. This provided a much-needed morbidity assessment research tool and a 'gold standard' against which alternative and simpler morbidity assessment tools and markers could be evaluated.

Longitudinal post-treatment follow-up studies using ultrasonography have been conducted in *S. haematobium* endemic communities and among schoolchildren in Tanzania, Kenya, Mali, Mozambique and Madagascar. These studies have shown that the severity of urinary tract morbidity is closely correlated with intensity of infection

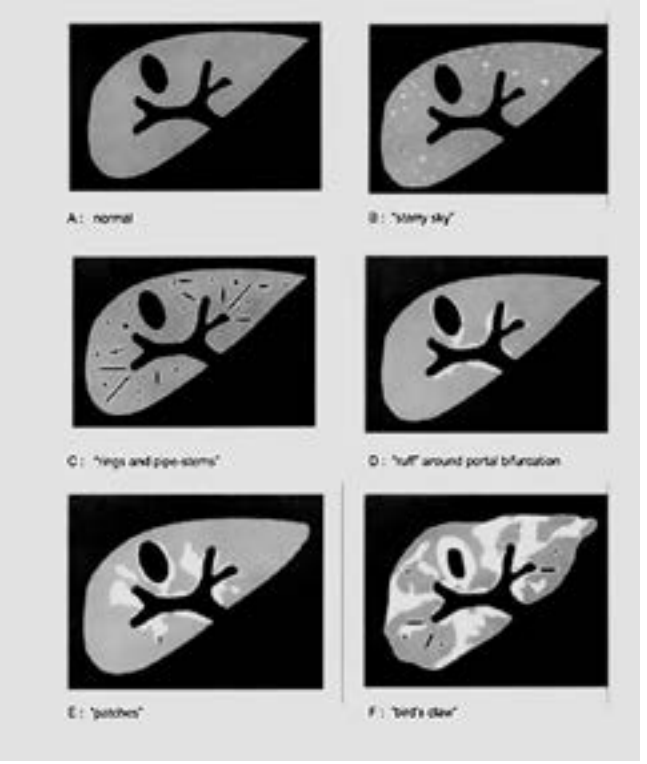
and that bladder and to some extent also kidney morbidity resolves within six months post-treatment despite rapid re-infection with *S. haematobium*. Furthermore, when children get re-infected there is a much slower re-appearance of urinary tract morbidity despite high levels of infection.



Small schoolboy presenting his bloody urine in Pangani, Tanzania.

As previously mentioned, a key finding in *S. haematobium* infections is the accumulation of eosinophils around the eggs in the bladder tissue. This results in high numbers of eosinophils in the urine of infected persons. Since the eosinophil granulocyte is involved in the tissue inflammatory process in the airways in asthma, it was suggested that the degree of eosinophils in the urine was associated with the level of tissue inflammation and hence the degree of morbidity. This hypothesis was proposed in 1988. A highly sensitive Elisa assay was developed for detection of the eosinophil

granule protein, ECP (eosinophil cationic protein), and subsequently a small pilot study in Kenya was performed, which clearly demonstrated that ECP could indeed be measured in urine as a marker for eosinophils in the urine and that the levels correlated with levels of infection and morbidity. This was the start of very fruitful research collaboration, primarily funded by EU research funds, on the use of ECP in urine as a non-invasive tool for assessment of morbidity in *S. haematobium* infection. Longitudinal post-treatment studies have demonstrated that the level of ECP in the urine is a valuable marker for urinary bladder inflammation with the potential to reveal signs of early inflammation. Furthermore, it may have a potential use in the diagnosis of genital lesions caused by *S. haematobium*. In a community-based longitudinal study from Uganda, ECP was measured in stool samples and significantly increased levels of faecal ECP were found in individuals infected with *S. mansoni* compared with the levels found in non-infected people. In addition, the level of ECP decreased significantly after treatment with praziquantel, which removed the parasites.



Standardised classifications for ultrasound examinations in schistosomiasis. Image patterns in the liver parenchyma, observed by ultrasonography.[1]

1 From "A Practical Guide to the Standardized Use of Ultrasonography for the Assessment of Schistosomiasis-related Morbidity", Second International Workshop October 22 - 26, 1996, Niamey, Niger

Training African ultrasonographers

As indicated above, ultrasound examination has been very useful as a research tool and the community-based epidemiological studies have provided us with knowledge about the relationship between organ-related pathology, such as fibrosis of the liver as well as disease of the urinary bladder and kidneys, and various infection parameters.

Furthermore, it has been possible to examine the effect of treatment on morbidity. The technique is non-invasive and is well received by endemic populations, but it requires well-trained staff to perform the examinations. Through our large collaborative field projects we have had an extensive exchange of trained African ultrasonographers between African partner countries. These experts have assisted in on-site training of new ultrasonographers, and over the years DBL has assisted in building a capacity for performing ultrasonography in schistosomiasis research and control. This local capacity has been successfully used in several countries in relation to monitoring the effect of schistosomiasis control programmes.

Examination of morbidity with ultrasound.

The impact of treatment on schistosomiasis morbidity

As described above, the tissue inflammation caused by the schistosome eggs is the cornerstone in the development of morbidity. After treatment, the proportion of people who no longer excrete eggs is often less than 75%; the more intense the trans-

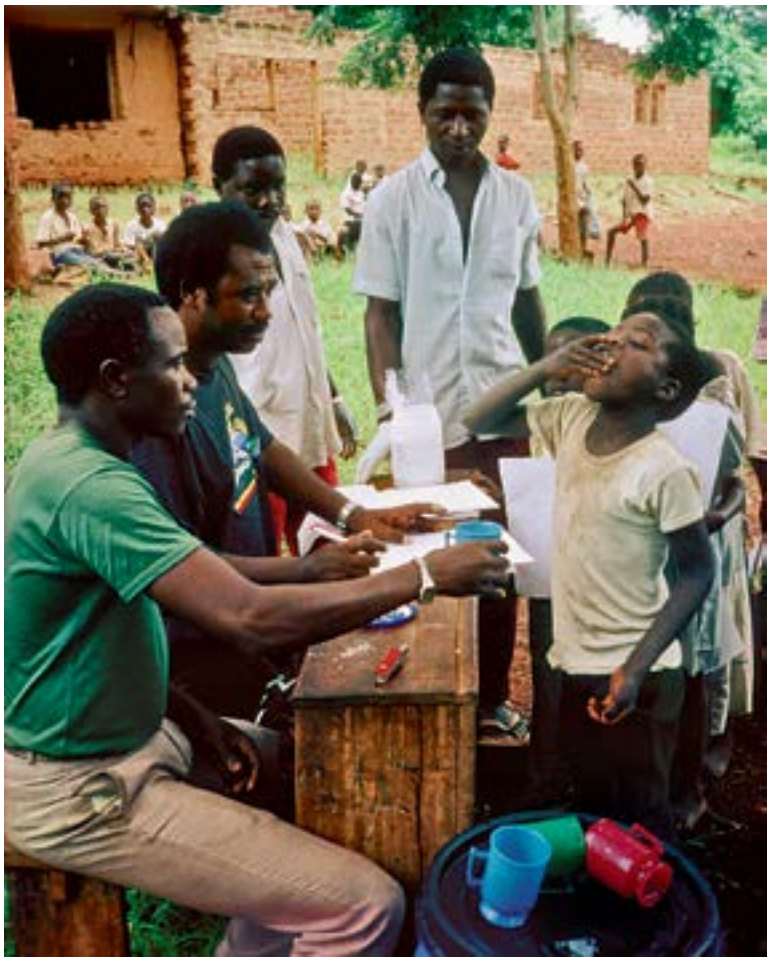
mission, the lower the cure rate. Since schistosome eggs persisting in the tissue may sustain the tissue inflammation, an improved cure rate with fewer eggs remaining might result in less inflammation and thus less morbidity. This hypothesis prompted us to conduct intervention studies where different strategies for treatment were tested.

One approach was to try to improve the cure rate by treating twice with praziquantel, two weeks apart. Praziquantel has an effect on mature but not immature worms, and the two-week period before the second treatment would allow immature worms to mature and become susceptible to the drug. This strategy has been tested in *S. haematobium* endemic areas in Tanzania and Mali and in a *S. mansoni* endemic area in Uganda. Although no significant difference could be observed in the overall cure rates of *S. haematobium* infection between the two treatment regimens, the effect of the double treatment was a significant reduction in infection intensity as well as micro-haematuria up to 18 months post-treatment, which may have a great impact in reducing subtle morbidity. The results for *S. mansoni* suggest that a second dose of praziquantel improves the cure rate and reduces *S. mansoni* infection intensity. However, there is no added effect on the reduction of *S. mansoni* re-infection levels by administering two doses of praziquantel.

A second approach was to time the administration of praziquantel treatment in relation to the annual transmission pattern. The hypothesis behind this approach is that treatment delivered at the beginning of the low transmission season will result in higher cure rates. This was tested in a study of two cohorts of schoolchildren from Mozambique infected with *S. haematobium*; they received praziquantel in the high and the low transmission season, respectively. The study demonstrated convincingly that, in areas with a seasonal transmission pattern, the effect of praziquantel can be enhanced if treatment takes place during the low transmission season.

Schistosomiasis morbidity workshops

Together with its Kenyan collaborators DBL has organised bi-annual research workshops on schistosomiasis morbidity. The first was held in 1995 and the latest in 2008. These workshops have been a very important forum for exchanging research results and they have provided opportunities for young African researchers to meet leading European and American scientists working in the area. Furthermore, they have brought researchers working on schistosomiasis immunology and pathogenesis in experimental mouse models together with scientists working on morbidity in human schistosomiasis through epidemiological field studies and operational research in relation to control. An important outcome of the meetings has been the establishment of several EU research consortia that have subsequently managed to secure research funding from the EU.



Treatment of schoolchildren with praziquantel against schistosomiasis in Tanzania.

Achievements and future perspectives

As will be evident from the description above, the research conducted by scientists at DBL together with our African and European partners has been instrumental in generating new important knowledge concerning the epidemiology of schistosomiasis, disease mechanisms and the impact of treatment on the disease. Furthermore, we have contributed significantly in standardisation and field adaptation of existing morbidity assessment tools, as well as in the development of new tools and markers.

Overall, 15 PhD students and several MSc and MD students have conducted research projects within the areas of schistosomiasis epidemiology and morbidity. Many of these former PhD students are now employed at various African universities or at Ministry of Health institutions, and many are involved in international research consortia.

The focus in schistosomiasis control has now shifted from control of morbidity as

the primary aim to mass drug administration (MDA) programmes with the ultimate goal of eliminating schistosomiasis. This paradigm shift will unfortunately sustain schistosomiasis control as a vertical programme, detached from other activities in existing health systems and outside the normal priority setting process. Aiming at elimination will inevitably include setting up very comprehensive and resource-demanding surveillance systems instead of providing simple point-of-care diagnostics and treatment at health facility level to follow up on a short-term (five-year) focused and intensive treatment programme supported by health education.

The research and capacity building activities of DBL have over time provided new insights and knowledge that can be used in practice to improve control programmes so they are evidence-based and tailored to the local context. Furthermore, the human resources to undertake this change of concept have been trained and are available, and we hope this will impact on schistosomiasis control in the future.

As we continue getting more knowledge and new tools, these need to be considered in the context of control. Currently, the first phase 3 clinical trial of a schistosomiasis vaccine is being conducted in Senegal. The toolbox of tomorrow may include a vaccine and the next generation of young African schistosomiasis researchers will be the ones to secure the research-based evidence of how best to use novel means of control in view of the local setting to ensure that no child or adult suffers from severe schistosomiasis-related disease in the future.

8. The role of snails in schistosomiasis research – from taxonomy to forecasting disease outbreaks

BY THOMAS K. KRISTENSEN, HENRY MADSEN AND ANNA-SOFIE STENSGAARD

It all began with snails

In the middle of last century it was the general idea that conquering bilharzia, now called schistosomiasis or snail fever, required control or elimination of the snails involved in transmitting the disease. One of the main reasons for this was that no safe drugs for medical treatment of infected people were available at that time.

This led, in the early 1950s, the World Health Organization (WHO) to request the world's leading expert on freshwater snails, Dr Georg Mandahl-Barth, to act as a consultant for WHO on African freshwater snails, specifically those that act as intermediate hosts for schistosomiasis. This later led to the establishment of the Danish Bilharziasis Laboratory (DBL), a fascinating story that can be read in Chapter 3.

During his studies, which continued until his retirement in 1978 as DBL's director, Georg Mandahl-Barth resolved some of the major problems in identifying the snails and he established one of the largest collections of African freshwater snails in the world. This collection made it possible to produce a number of regional identification keys for freshwater snails, and these keys became an important tool for people working with the disease in Africa. This was a major breakthrough in schistosomiasis control at that time.

DBL field guides to freshwater snails.

Molecular methods for identification of snails

Georg Mandahl-Barth did a great job, as many new research projects accumulated knowledge about transmission and disease control during the following years. However, numerous new problems areas were identified. For example, it became evident that some snail species could not be distinguished based on morphology and anatomy alone. Hence, it was clear that more advanced biochemical and molecular methods had to be introduced in order to identify snail species.

Electrophoretic methods, morphometrics and molecular studies were introduced by several DBL staff members, leading to significant scientific publications and making DBL one of the leading centres for research on schistosome intermediate host snails. The identification keys were, however, still useful and were continually updated as new information became available. Hundreds of African health workers and young researchers have been trained in snail identification on courses in English or French.

Shells of *Bulinus* snails

Snail ecology

A profound knowledge of snail ecology and the ecological mechanisms affecting transmission can play an important role in integrated control of schistosomiasis and other snail-borne diseases. Information regarding the distribution patterns and population dynamics of the snail hosts, as well as an understanding of factors affecting these, are central in this respect. Several studies of this kind have been conducted by

malacologists from DBL, both in natural and in man-made habitats in many African countries as well as in Asia.

Man-made and natural habitats

For schistosomiasis, man-made habitats, such as irrigation schemes, dams and aquaculture installations, often become important sites for transmission. This is often linked to inadequate water management and system maintenance, resulting in water stagnation and vegetation growth, which, combined with high human population densities, a lack of sanitation facilities and no domestic water supply, provides the background for intensive transmission. DBL staff have been involved in several studies of the consequences of dam and irrigation constructions focusing on snail ecology and transmission.

Natural habitats can equally well play a role in schistosome transmission. Thus, in Lake Malawi, schistosome transmission was established along open shorelines, at least in the southern part of the lake, during the late 1980s, and this seems to be linked to over-fishing in the near-shore areas of the lake. While several cichlid species living in this habitat are known to feed on snails (molluscivorous), the fish density has declined. DBL was involved in these studies in Malawi, advising and training local researchers and health workers.

Extensive human water contact in an irrigation canal in Mali; a favourite habitat for snails.

Biological snail control

The strategy for schistosomiasis control has changed considerably over the years. As mentioned above, early emphasis was on controlling the intermediate host snails,

partly because no good drugs for treating infections in people were available. With the appearance of praziquantel, emphasis was moved to treatment of infected people and snail control became almost neglected by many control programmes.

However, a great deal of research by DBL has been done on the competition between *Helisoma duryi*, a planorbid snail species originating from Florida, USA, and schistosome intermediate hosts. This work was to a large extent laboratory-based.

The studies of *H. duryi* were discontinued because the outcome of experimental introductions in the field had shown little promise and because it was becoming increasingly unlikely that permissions would be granted to make further introductions due to concerns about unforeseen effects on local biodiversity.

Focus on biological control then shifted to using indigenous molluscivorous fish and environmental management for snail control.

Forecasting disease outbreaks

Most recently, the results and experiences obtained through nearly 50 years of research in snail taxonomy and ecology have made it possible to forecast disease outbreaks and optimise disease surveillance and control strategies through spatial analysis utilising biological data, geographical information systems (GIS) and remotely-sensed data.

Having access to comprehensive data on snail and disease distribution, DBL started to bring this data together in complex models in order to see which environmental changes, including climate change, would affect schistosomiasis and also to predict where snails and schistosomes could exist in areas not actually surveyed.

For this modelling, GIS (and remote sensing) were introduced, leading to studies of the relationship between biodiversity and disease (ecohealth), and the Mandahl-Barth Research Centre for Biodiversity and Health, with special attention to developing countries, was established. Significant results have been obtained in this field. It has been shown how freshwater snail diversity seems to have an impact on the distribution of schistosomiasis in Uganda (Figure 1).

Models have also been developed to predict distribution in 2080 of *Biomphalaria pfeifferi,* the main intermediate host for intestinal schistosomiasis in Africa, as affected by the likely climate change (Figure 2). Other studies have presented models showing the highest risk area for intestinal schistosomiasis in Zimbabwe, based on collections of *Biomphalaria* snails and disease prevalence data (Figure 3).

Impact of snail research

The work on snails has had a large impact on disease control during the last five decades. Publishing easy-to-use field guides for health workers gave a breakthrough in epidemiological and control work by enhancing the capability among health workers and scientists to identify the intermediate host snails correctly. Many MSc and PhD students have been trained in malacology in very diverse fields.

Important alternative control measures like biological control have been developed, and the improved knowledge of snail ecology has made it possible to map and model the distribution of intermediate host snails and diseases. All this has had a significant impact on disease control in endemic countries, giving us improved knowledge of risk areas now and in the future.

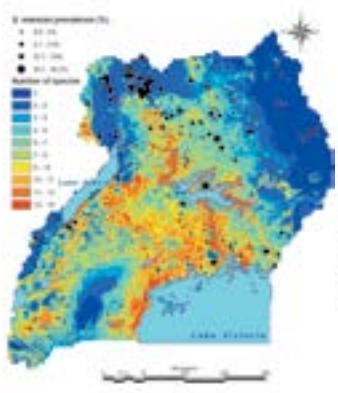


Figure 1. Relationship between snail diversity and intestinal schistosomiasis in Uganda based on ecological niche modelling.

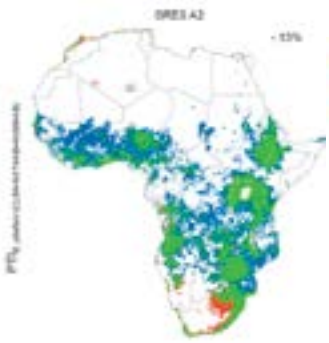


Figure 2. Calculated distribution of the snail *Biomphalaria pfeifferi* in 2080, following climate change; green = no change; red = expanding; blue = contracting.

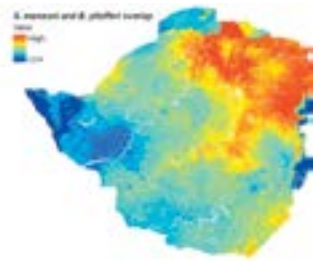


Figure 3. Risk areas for intestinal schistosomiasis in Zimbabwe, based on ecological niche modelling; red = high risk; blue = low risk.

Future perspectives

Despite many decades of research in disease prevalence and the distribution of intermediate host snails and control, there are still questions to be addressed. This is necessary in order to optimise control in the future and maybe even have a chance to eradicate certain diseases, including schistosomiasis.

Classical data on disease distribution and the distribution of intermediate host snails in combination with geospatial tools will be used to reach the optimal disease control or even disease elimination.

In recent years, little attention has been given to research in intermediate hosts snails, and schistosomiasis has been controlled by mass drug-administration campaigns among people in endemic countries. But this year, 2012, WHO declared that the goal is now the elimination of schistosomiasis. Elimination will bring the snail work back in focus because the detailed transmission aspects, including the intermediate host snails, will be crucial if elimination is to be possible in the near future.

9. The laboratory facility at DBL

BY BIRGITTE J. VENNERVALD, SUSANNE KRONBORG AND THOMAS K. KRISTENSEN

How it all began

DBL has hosted a laboratory facility since the start in 1964. At the beginning, the laboratory consisted of aquaria with freshwater snails and these were used for the courses giving the participants hands-on lessons in snail taxonomy and dissection. When the scope of the courses was broadened to include parasitology, the snails in the aquaria got a new role as intermediate hosts for the parasites, and the life cycle for *Schistosoma mansoni* was established in the laboratory with mice as the final hosts. This life cycle is still kept in the laboratory and is used for research purposes but also for providing parasite material to be used in diagnostic immunofluorescence tests for human schistosomiasis.

Aquaria in the laboratory with *Biomphalaria glabrata* snails, one of the intermediate host species for schistosomiasis.

The parasites

Over the years, DBL has kept not only *S. mansoni* but also the much more demanding terminal-spined schistosomes such as *S. haematobium, S. intercalatum* and *S. bovis*, as well as zoonotic *S. japonicum*. The latter two were used for experimental infection

of goats and pigs, respectively. These experiments were conducted in close collaboration with colleagues from the Danish Centre for Experimental Parasitology (CEP), a centre that was the predecessor of the Section for Parasitology at the University of Copenhagen's Department of Veterinary Disease Biology; it was also the section with which DBL merged in 2009. Together, CEP and DBL scientists developed new experimental parasitological methods. These include a method for finding and counting *S. japonicum* eggs in faeces, an expertise in how to infect not only mice but also larger animals with schistosomes, and how to perfuse the worms out of the intestines of the infected animals. The latter can be an arduous undertaking with a fully-grown Danish pig, as anyone can imagine.

Pig being experimentally infected with *Schistosoma japonicum*

The role of the snails in DBL's research portfolio has been described in Chapter 8. However, it also deserves mention that, over the years, several other parasites and vectors have been kept in the laboratory, such as a *Brugia phangi* (filaria) in a life cycle involving gerbils and mosquitoes, and several different trematode worms such as *Echinostoma caproni*, *Faciola hepatica* and *Haplorchis pumilio*, all of which have snails as intermediate hosts. Furthermore, a number of different haemoprotozoans such as *Babesia microti, Plasmodium yoelii, P. berghei* and *Trypanosoma brucei* have been passed through mice and used for experiments investigating the host-parasite interaction and impact on disease in mice co-infected with helminths and blood protozoa. It is worth noting that these experiments in mice were conducted long before it became fashionable to discuss and investigate the importance and impact of e.g. schistosomiasis and malaria co-infections in people (see also Chapter 7).

Several of the chapters in this book describe research results and training activities, which would not have been possible without a well-functioning laboratory and dedicated, well-trained technical staff with 'green fingers' and a clear notion of 'how

you make your snails, mosquitoes and parasites happy' in the laboratory environment. It should be noted, however, that this description is in no way exhaustive, since there are many other examples of good laboratory-based research that could have been mentioned; for those interested in reading more about this, we refer to the list of publications (Appendix 2).

Experimental parasitology

The experimental laboratory work has contributed to the general understanding of parasite and snail biology and has generated new knowledge regarding what happens to the host during an experimental parasite infection. Regardless of whether it concerns the parasite, the host-parasite relationship or the vector, the information gained from the laboratory can prove to be extremely valuable when the scientist is later faced with the much more complex situation at the field site, where transmission of infection takes place. At the field site, the interaction between parasites, people and vectors is influenced by many different factors, the majority of which are beyond our control. Furthermore, the possibility of being able to test laboratory findings in natural settings or to take questions arising from the field work and try to answer them through well-designed laboratory experiments is of the utmost importance if we want to increase our understanding of the complex biology of parasites and vectors.

Students from the course 'Human Parasitology' follow demonstrations in the laboratory at DBL, 2012.

The laboratory at DBL – new technology

Although we could generate a wealth of important information from traditional

experimental parasitology, it became clear that the scientific development in water-related vector-borne diseases and parasitology required us to update our laboratory methods and tools in order to keep us in the scientific forefront. Furthermore, it was seen as a necessary move in our efforts towards research capacity building in Africa. The next generation of African scientists needed to work with state-of-the-art scientific methods if they were to generate new knowledge about disease mechanisms, diagnosis, host-parasite relationships and vector biology. At the same time, this would assist in enhancing their competitiveness in the international scientific community.

Immunological techniques

In the late 1980s we introduced the first immunological techniques. This required laboratory facilities with e.g. equipment for immuno-electrophoresis, Elisa assays and cell culture facilities for cellular immunology. Several African PhD students came to DBL with the aim of working in the immunology laboratory with samples and material collected during their PhD fieldwork, and we had several students working on schistosomiasis and filariasis immunology.

As an example, immuno-epidemiological field studies have been carried out in filariasis (*Wuchereria bancrofti*) endemic communities. These studies have analysed the human immune responses in filariasis, including filarial specific antibody responses in relation to various parameters such as age, gender, infection status, clinical disease and transmission intensity. This generated new knowledge about the determinants of immunological responses in endemic populations and indicated that antibody responses may be useful markers not just for infection and disease but also for assessing changes in the level of exposure to control programmes for lymphatic filariasis. Furthermore, the role of cellular immune responses has been analysed in relation to the development of chronic disease manifestations.

Another area of research has been human schistosomiasis, where immuno-epidemiological studies have looked at specific antibody responses against schistosome eggs and worm antigen. These responses have been analysed in relation to age and infection level and the results have indicated that some of the antibody responses against worm antigen increase with age and seem to correlate with resistance to re-infection. Circulating anodic antigen (CAA) has been measured in people of different age groups infected with *S. haematobium*; this used a simplified version of the magnetic bead antigen-capture enzyme-linked immunoassay (MBAC-EIA). It was shown that there was an overall positive correlation between *S. haematobium* egg excretion and CAA levels.

Several projects have investigated the inflammatory response in the urinary tract by assessing the level of the eosinophil granule protein, ECP (eosinophil cationic protein) in urine by an Elisa assay. The level of ECP in urine has been analysed in relation to infection level and urinary tract pathology as detected by ultrasonography (see also

Chapter 7). The local inflammatory response in the urinary tract has also been assessed by measurement of cytokines, such as IL-6, IL-10, IFN-γ and TNF-α in urine.

Later, many of these young scientists continued their work in their own institutions, often attached to projects funded by the EU and in collaboration with a network of European and African scientists.

Screening of blood for microfilariae during the night. Tanga Region, Tanzania.

Molecular biology

In the 1970s and 1980s, DBL presented significant results using electrophoretic methods in studies of the intermediate snail host species *Biomphalaria* and *Bulinus*. Contrary to the previous studies based on morphology, the isoenzyme studies based on electrophoretic methods gave possibilities for revealing knowledge of genetic differences between and within snail species. This even made it possible to describe new species based on electrophoretic data only. This was a milestone, but also very controversial. Today it is generally accepted scientifically.

In the middle of 1990s it was clear that the way forward in overcoming shortcomings in taxonomy based on morphology and to some extent isoenzyme studies was to turn to molecular studies based on RNA and/or DNA. Thermo-cycle machines (PCR machines) were installed at the DBL laboratory and new PCR-based techniques were introduced. Random amplified polymorphic DNA (RAPD) was employed, making it possible to differentiate between closely related *Biomphalaria* snails in Egypt. This

was followed by restriction fragment length polymorphism (PCR-RFLP) as a technique to reveal the taxonomy of closely-related *Bulinus* species in Kenya.

Being able to study snail genetics at DNA level was a stepping-stone to studies of the sequences of the snail genome and thus of the phylogeny of the snails. In 2002 a sequencing machine was funded by the V. Kann Rasmussen Foundation for studies of DNA sequences in intermediate host snails and this was the start of a decade of successful phylogenetic studies of African freshwater snails. As an example, DBL has shown remarkable results in revealing the phylogeny of the genera of *Biomphalaria* and *Bulinus* snails, and this has improved our knowledge of the relationships between the snails and their parasites.

Based on these advanced methods and the high technical quality of the molecular laboratory at DBL, several master's degree and PhD students from developing countries and from Denmark have carried out their studies and performed their experimental work using DBL's molecular biology facilities.

Training and technology transfer

Throughout the years, technology transfer to African partners has been a crucial output from the activities in the laboratory. This has been in the format of short on-demand courses, for example in how to keep parasites and snails in the laboratory, but also in the form of workshops concerned with the transfer of technology such as assays for measuring markers of infection or disease in serum or urine.

One example is the workshop on methods in relation to assessing circulating schistosome antigens, which was held at the Blair Research Institute in Harare, Zimbabwe, in 1998. This workshop was conducted at a time when detection of circulating schistosome antigens in serum and urine had shown very promising results as a tool for diagnosis and epidemiological research. The workshop enabled African scientists to continue working with the assay, and a scientist from Zimbabwe turned the assay into a field-applicable method by using magnetic beads coupled to monoclonal antibodies instead of the conventional Elisa-based assay. This allowed testing of samples to be performed directly in the field.

Another example is a workshop on theoretical and practical aspects of the Elisa assay detecting granule proteins from eosinophil granulocytes such as ECP in urine and stool samples. The workshop was conducted at Institut National de Recherches en Santé Publique (INRSP) in Bamako, Mali, in 2008 by a DBL scientist and technician together with our senior Malian research partner, and involved training young Malian researchers. This activity was implemented in relation to an EU-funded project and was an important component in transferring the technology because it enabled the Malian scientists to measure ECP in the urine and stool samples collected in the EU project.

The training workshops have often been linked to externally financed projects,

such as EU projects, and the knowledge and technology transferred has later been used in new projects often involving the next generation of African PhD students.

Workshop on theoretical and practical aspects of the Elisa assay at INRSP, Bamako, Mali.

Conclusion

Significant advances have been made in our understanding of parasite and vector biology, taxonomy of snails, the immuno-epidemiology of filariasis and schistosomiasis and the various factors that may influence morbidity in these infections. This has been achieved through laboratory-based research, but often in combination with field-based studies.

We are now in an era where enormous amounts of data are being generated from genomic, transcriptomic, proteomic and metabonomic studies of various parasite infections. However, it is important to note that the interpretation of these data rely on a basic understanding of parasite biology. This is a challenging task for the young African scientists now entering the scene. Furthermore, it should be kept in mind that good laboratory-based research is vital for generating the knowledge needed for evidence-based and sustainable control measures and requires a critical mass of researchers with a range of expertise from basic parasite and vector biology to public-health interventions.

10. Treatment against schistosomiasis now includes toddlers, but …

BY MARIA VANG JOHANSEN AND ANNETTE OLSEN

Obviously diseased, but formerly denied treatment

The two small Laotian children in the picture are obviously infected with schistosomiasis, a disease that gradually destroys their internal organs. Treatment with praziquantel will kill the worms and, although the children probably will get re-infected with the same disease after a short while, annual or semi-annual treatment will ensure that damage to the organs does not develop to a serious stage. This is good, but the problem in the past has been that these two children and millions of others of the same age and with the same condition were not treated. How come?

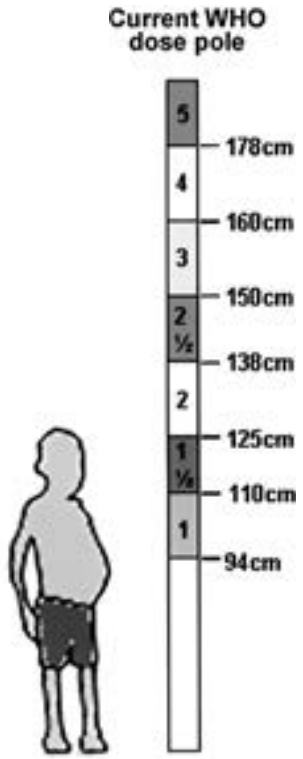
Two small Laotian girls with ascites due to schistosomiasis.

Pregnant women treated, but not small children

With the introduction of praziquantel as the drug of choice for treating human schistosomiasis, pregnant women and children under five were left out, as no clinical studies had yet been performed to clear the drug for these groups. After 25 years, in 2003, the World Health Organization (WHO) released the drug for treating pregnant and lactating women, after a review of all pregnant women who had been inadvertently treated with praziquantel reported no severe adverse events following treatment.

Children, however, remained untreated, as information on the safety of praziquantel in this age group was still lacking. Furthermore, it was found that it was difficult for children to swallow the very big tablets, and paediatric formulations such as syrup or water-dispersible tablets were not readily available. A last argument was that it was impractical to dose children using a dose pole (see below), because the pole only works from patient height of 94 cm and above.

A dose pole indicates the number of tablets a person with a certain height should receive, and uses height as a proxy for weight. The thought behind this invention is that scales break easily, are costly and generally are considered impractical in a control-programme setting.



The poles are marked to show the correct number of praziquantel tablets, to the nearest half tablet, that should be given for each child, depending on the child's height. An infected person should be given praziquantel with a dose of 40 mg/kg body weight (WHO.int).

Is the infection important?

The main route of infection with schistosomes is through exposure of the skin to fresh water infested with the parasite. Hence, the child might get infected as soon as it is exposed to contaminated water. Many studies have shown that schistosomiasis in younger children is much more common and more serious than previously thought, with clinical symptoms like diarrhoea, abdominal pain, anaemia and anorexia.

Thus, children as young as four months have been found infected, and in several countries the prevalence of infection may exceed 50% in preschool-age children. In addition, more than half of the infected ones may show some kind of pathology as shown in Mali.[2]

Studies have also shown that children with schistosomiasis have a poorer growth rate compared to children without the infection. Considering the relative high growth rate in infants and young children compared to older children, the consequences of leaving this age group untreated would be significant. Furthermore, repeated treatment with praziquantel might increase the level of resistance to re-infection.

The ethical issues

The consequences for young children of early exposure to schistosomiasis have received almost no attention, but it has been shown in animal models that 'time of first exposure' is an essential parameter for infection establishment and disease progression.

Excluding a group or community who obviously would benefit from being included is a key research ethical problem. Equity requires that no group of persons should be deprived of a fair share of the benefit. In this case, children under five were kept excluded. In research ethical terms this is a very clear example of serious class injustice.

Arguing for treatment

The exclusion of children under five from praziquantel treatment was challenged by DBL and collaborators in 2007, as children did indeed get infected with schistosomes, suffered from schistosomiasis, and had poor health outcome as a consequence of the infections.

Supported by experts from Uganda, Mali and the Chinese National Schistosomiasis Control Program, where no child was left untreated if diagnosed, it was argued that since praziquantel is the safest anthelmintic on the market and children older than one year were given other anthelmintic tablets, they should not be denied praziquantel tablets. The problem with inappropriately-designed dose poles was not a convincing argument to deny children under five their right to treatment.

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2 Report of a meeting to review the results of studies on the treatment of schistosomiasis in preschool-age children (2011). Geneva, 13-14 September 2010 (WHO/HTM//NTD/PCT/2011.7)

Small child with considerable water contact in the Selingue dam area, 140 km from Bamako, Mali.

Providing the evidence

It was crucial to investigate whether praziquantel is safe to use in preschool-age children and this was done in a DBL-supported study in Uganda in 2008. Children in this age group with intestinal schistosomiasis were treated with the recommended dose and followed for seven days to determine the safety. Many symptoms were reported before treatment, supporting the already-known experience that the disease may cause a lot of symptoms.

Very few mild adverse drug reactions were recorded after treatment and all were reported on the treatment day within 15 minutes of treatment and had cleared by the end of the day. No serious adverse events were reported or observed after treatment. It was concluded that praziquantel was well tolerated in small children in the study area.

Lack of a suitable formulation

WHO also acknowledged the challenge and took a leading role in implementing further studies, collecting data and holding a meeting in 2010 for reviewing the evidence.

Some concerns still exist about the lack of a paediatric formulation of praziquantel. In the Ugandan study described above, mothers administered the tablets; the children swallowed the divided tablets, chewed them or took them crushed with juice, but in general many children do not like the very bad taste (and smell) of the drug.

In Egypt, a syrup formulation of the drug developed for younger school-aged children had been available for some time, but it has a limited durability and UNICEF

argues strongly against syrup because the costs of transporting the added water will increase the overall costs compared to transporting tablets.

Because of this, the WHO meeting recommended that a water-dispersible tablet should be developed. A new initiative involving the pharmaceutical companies in collaboration with researchers and programme managers will work to develop new formulations such as a smaller tablet that is more easily swallowed by children. Whether this will result in development of water-dispersible tablets and/or a camouflage of the awful taste (and smell) in the smaller tablets is not known.

A preschool-age child plays with older siblings in a river in northern Uganda.

Finally including the preschool-age children

The future now looks much brighter for the two Laotian girls with respect to treatment of schistosomiasis, as the WHO report recommended that administering praziquantel to preschool-age children should be offered through the regular health services and by inclusion in other public health interventions such as the Expanded Programme on Immunisation activities, Mother and Child Days, and Child Health Days.

In the control programmes, however, there is still the possibility that a school-age girl will not be treated together with her schoolfellows because she is shorter than 94 cm. The extension of the lower limit of the dose pole to 60 cm, as suggested by British and Ugandan researchers, could be a solution to this problem, but only if this pole gets a wide distribution in endemic areas.

11. Research and capacity-building for lymphatic filariasis control

BY PAUL E. SIMONSEN AND ERLING M. PEDERSEN

The infection and the disease

Lymphatic filariasis (LF), also known as elephantiasis, is a disfiguring and disabling disease caused by infection with a mosquito-transmitted parasitic worm. It is widespread and a major public health problem in many developing countries with a warm and humid climate and it is among the most prevalent of the so-called neglected tropical diseases (NTDs). More than 50 million people are affected in sub-Saharan Africa, where the causative agent is *Wuchereria bancrofti*.

The adult filarial worms live in lymphatic vessels. The larvae (called microfilariae) circulate in the blood, waiting to be picked up by blood-sucking mosquito vectors. After a period of development in the vector, the mature larvae are ready to infect a new person when the vector takes another blood meal.

Many infected individuals develop overt body deformities (e.g. hydrocele, lymphoedema and elephantiasis) that, in addition to physical distress, may have serious social and psychological consequences. Even individuals with no obvious visible manifestations can have marked changes of the lymphatics, and many suffer from recurrent painful attacks of filarial fever.

Increased awareness of LF

The occurrence of LF in poor rural populations, combined with the inconvenience of diagnostic tests and a lack of effective means for treating the infection and managing the disease manifestations, limited the interest of health workers in LF in the past, and no large-scale control programmes were implemented. This situation has dramatically changed in recent years due to increased awareness of the burden of suffering imposed by the disease on endemic populations, and to advances made in development of new tools and measures for control.

A Global Programme to Eliminate Lymphatic Filariasis (GPELF) has been established, with an anchorage at the World Health Organization (WHO), and has been a driving force in mobilising resources and developing strategies for global control. Field research and training activities in LF, carried out by DBL in close collaboration with local African partner institutions, have played a significant role in this promising development.

Elephantiasis of left leg and foot. Tanga region, Tanzania.

The focus of LF activities

Right from the beginning in the early 1990s, the LF programme at DBL focused on a combination of research and capacity-building in endemic African countries. Research projects were often accompanied by, or fully carried out as, MSc and PhD studies under supervision of DBL staff.

Alongside these studies, a number of international field courses and workshops have been implemented. The courses, all held in Tanzania, aimed at training young scientists from endemic African countries to carry out basic field research on LF. In addition to providing essential theory, they included hands-on laboratory training and field surveys for human infection, clinical manifestations, vectors and transmission in endemic villages near the course venue. The workshops aimed at gathering researchers from LF endemic African countries, for exchange of ideas and presentation and discussion of research findings.

Almost all the research has been carried out with a focus on its usefulness for controlling LF, through provision of a better understanding of the epidemiology and/or through development and assessment of new control-relevant tools and strategies.

Demonstration of hygiene measures for alleviating manifestations of elephantiasis. Bagamoyo, Tanzania.

Research on LF epidemiology

Epidemiological investigations carried out in Kenya, Tanzania, Ghana, Uganda and Malawi have documented the patterns of infection and clinical disease in communities with different levels of endemicity and with various environmental and transmission characteristics. In this respect, the commonly observed marked variation in human infection and disease prevalence, even between communities located relatively close to each other, has been shown to have its primary basis in different vector densities (and thereby transmission intensities) resulting from local variation in the quality of habitats for vector proliferation.

Cross-sectional and long-term follow-up surveys in endemic communities have revealed that no simple relationship exists between infection and chronic disease. Thus, no association was found in endemic populations between microfilaraemia (presence of microfilariae) and chronic disease manifestations; and hydrocele development in males did not appear to be related to their microfilaria status earlier in life.

Follow-up studies moreover suggested that re-infection commonly takes place, and that, once infected, an individual has a higher chance of being re-infected. A plausible explanation for this phenomenon could be that initial infections induce immune tolerance to the parasites. It was also noted in some communities that young children with microfilaraemic mothers had a higher chance of being microfilaraemic than those with amicrofilaraemic mothers, whereas no association was seen to the infection status of the fathers. This may suggest that infected pregnant mothers can confer some degree of immune tolerance to their foetus. More recent research has suggested that human genetic factors may also play an important role for susceptibility to *W. bancrofti* infection.

Immuno-epidemiological research

Immuno-epidemiological studies have been carried out in endemic communities to better understand the role of the host immune system in regulating infection and disease processes. Using both cross-sectional and longitudinal approaches, studies analysed antibody and cellular response patterns in relation to age, gender, infection status, clinical disease and transmission intensity.

The measured responses appeared mainly to reflect the infection status and no clear indications of their involvement in resistance development or pathogenesis was found. However, studies that more specifically analysed antibodies reacting to the microfilarial surface-sheath suggested that these antibodies may play an important role in the regulation of host microfilaraemia.

Occult infections in children in particular

The performance of new diagnostic tests based on detection of circulating filarial antigens (CFA) and antibodies to the recombinant antigen Bm14, and on the use of ultrasonography to detect adult live worms in the tissues, has been field-tested in a number of research projects, and their usefulness for different purposes has been evaluated. Field application of the tests for CFA in several endemic populations has demonstrated that many microfilariae-negative individuals are in fact infection-positive, implicating that many more individuals are infected than was hitherto known.

This was found to be particularly pronounced for the child population, where such occult infections may lay the foundation for lymphatic damage and disease development later in life. The findings therefore point to the importance of including young children in control programmes despite the frequent absence of microfilariae in them.

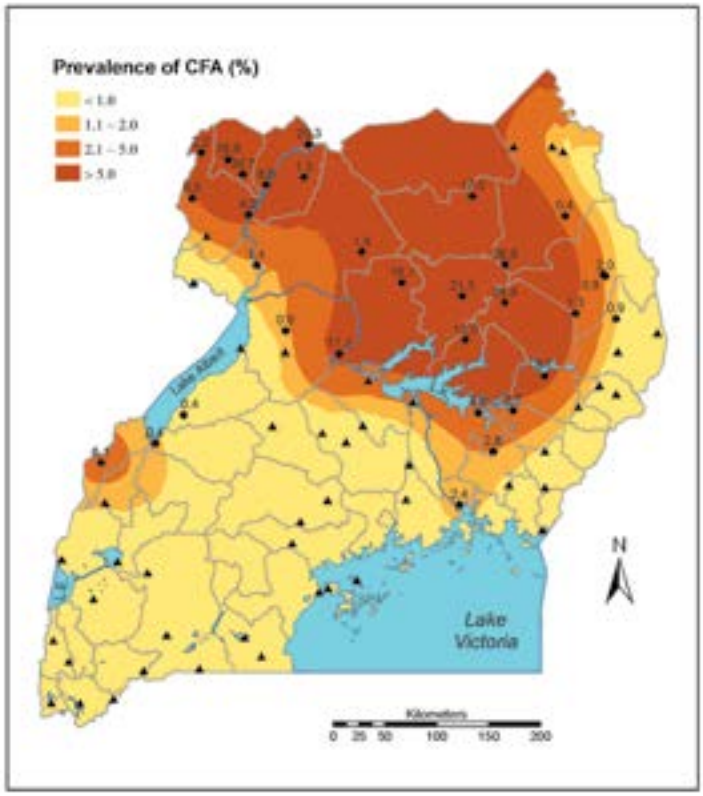
Screening of schoolchildren for circulating filarial antigens. Tanga region, Tanzania.

Treatment of LF decreases HIV load

Potential interactions between LF and HIV have also been investigated, and the effect of LF treatment on these interactions assessed. A positive cross-sectional relation between HIV and LF was observed among adults in an endemic area of Tanzania, but no clear evidence for immunological interactions was obtained. However, treatment of HIV-positive LF patients with the anti-filarial drug diethylcarbamazine (DEC) resulted in a significant decrease in HIV load and an increase in CD4%, suggesting that control of LF with this drug may also have a beneficial effect on the HIV epidemic in areas where these two infections co-exist.

Research on measures for LF control

Geographical mapping of disease distribution is an important pre-requisite for planning control. Combining CFA screening of schoolchildren with geographical information system (GIS) data made it possible to map the distribution of LF in Uganda, and thereby provided an important background for planning and implementing the Ugandan national LF control programme. The distribution of infections with *Mansonella perstans*, a little-known but widespread filarial parasite in Africa, was similarly mapped in Uganda. GIS methodology was later used to analyse risk predictors and geographical patterns of co-endemicity of LF and malaria in Uganda.



Mapping the geographical distribution of lymphatic filariasis in Uganda.

Drug trials

Major research efforts have focused on field trials to assess the efficacy of various anthelminthic drugs (DEC, ivermectin, albendazole) and combinations of these drugs on LF infection and disease, and on the effectiveness of mass-delivery strategies for control.

Long-term studies were carried out in Tanzania to compare the efficacy of spaced and low dosages of DEC and DEC-medicated salt, and the cost-effectiveness of the various strategies. Results were promising in that all the tested alternative strategies were more effective and acceptable to those treated than the previously used more-intensive regimens of DEC. A study assessing the tolerability of DEC-medicated salt in onchocerciasis patients showed only minor adverse reactions in the patients, which did not interfere with their daily activities. Another study found that the efficacy of DEC treatment on intestinal worms was low.

Following the recommendation by GPELF to use the ivermectin/albendazole drug combination for control of LF in African countries co-endemic for onchocerciasis (to avoid DEC-related side-effects), the efficacy of this regimen was assessed through blind tests in community trials in Ghana as well as in schoolchildren in Tanzania.

Although the combination treatment was effective in decreasing microfilaraemias, the findings questioned the added value of albendazole for LF treatment compared to ivermectin alone.

The efficacy of ivermectin and albendazole alone and in combination on *M. perstans* infections was assessed in Uganda, but none of the regimens showed a significant treatment effect on this parasite.

Use of bed nets

LF infection, disease and specific antibody response patterns were analysed and compared in a high- and a low-endemicity community in Tanzania and Kenya, respectively, to assess the relationship between these parameters and community transmission intensity.

The impact of mass treatment on human infection and transmission was also investigated in these two settings, and results pointed to the importance of using vector control as an additional measure to reduce the number of years required before reaching the threshold for transmission interruption. The usefulness of bed nets in this respect was successfully assessed in Kenya. It was shown that bed nets reduced the transmission very effectively, also in areas where the vector was the insecticide-resistant *Culex quinquefasciatus*, by diverting it to bird feeding.

Child sleeping under bed net.

DBL activities in the era of LF control

Research and training by DBL and others stimulated a growing interest in and awareness of the public health importance of LF. This culminated with a World Health Assembly resolution calling on member states to initiate steps to eliminate LF as a public health problem. In response, WHO launched GPELF in 2000. Since then, large-scale national programmes for control of LF have been initiated with assistance of GPELF in most endemic countries. These include major DBL partner countries such as Tanzania, Kenya, Uganda, Malawi and Ghana, where mass drug administration (MDA) has subsequently reduced LF prevalence and transmission.

In response to these developments, the focus of DBL research on LF has changed. Thus, in later years, attention has particularly focused on applied research addressing issues of immediate interest and support to ongoing control, with activities carried out in close collaboration with national control programmes.

Examination of mosquito vectors for filarial infection.Tanga, Tanzania.

A long-term project in the Tanga region of Tanzania is monitoring the effect of the national LF control programme on transmission and human infection. In addition to much useful information for the programme, this project has provided interesting insights into the dynamics of vector mosquitoes of importance for transmission of

both LF and malaria (a dramatic decline in density of *Anopheles sp.* mosquitoes and a change in species composition during the past decade).

It has also pointed to the importance of increasing MDA compliance and supplementing the MDA with other measures in order to reach the programme goal of elimination within reasonable time. Other ongoing studies investigate the epidemiology and control of urban LF, as well as factors influencing the compliance to MDA in both rural and urban areas.

Immense progress has been made in terms of awareness creation and mobilisation of resources for LF control in the health sector of endemic countries during recent years, and major efforts are invested both nationally and internationally to control and eliminate LF as a public health problem. As programmes move on, new and unexpected challenges are met that need scientific assessment. In this respect, the valuable DBL competences on basic and applied LF field research and capacity-building have an important role to play on the path towards reaching a successful elimination of this dreadful disease.

12. Research on intestinal worms – providing the evidence for optimising control

BY ANNETTE OLSEN AND PASCAL MAGNUSSEN

Offering treatment closer to home

The young mother in a rural area of Zambia is aware that she should take both of her children under the age of five years to the health facility during Child Health Week to receive drugs against worms, but the health facility is a five-kilometre walk from her house and carrying them both is simply not possible. She decides to take the youngest child (who is one year old), who still lacks a number of vaccinations. The older one, three years old, is fully vaccinated, so he has to stay home with his older siblings and thereby miss treatment.

An alternative to this unfortunate situation is to offer health services closer to the homes of the user – the community-directed treatment approach (ComDT). In a village with ComDT, treatment against intestinal worms is taken care of by a drug distributor selected by the community. The community has also decided how to collect and store the drug and that the drug distribution should be done house-to-house and not at a central distribution point. This approach has been successfully implemented for control of onchocerciasis (river blindness), and for increasing coverage of malarial treatment, vitamin A supplements and use of insecticide-treated bed nets.

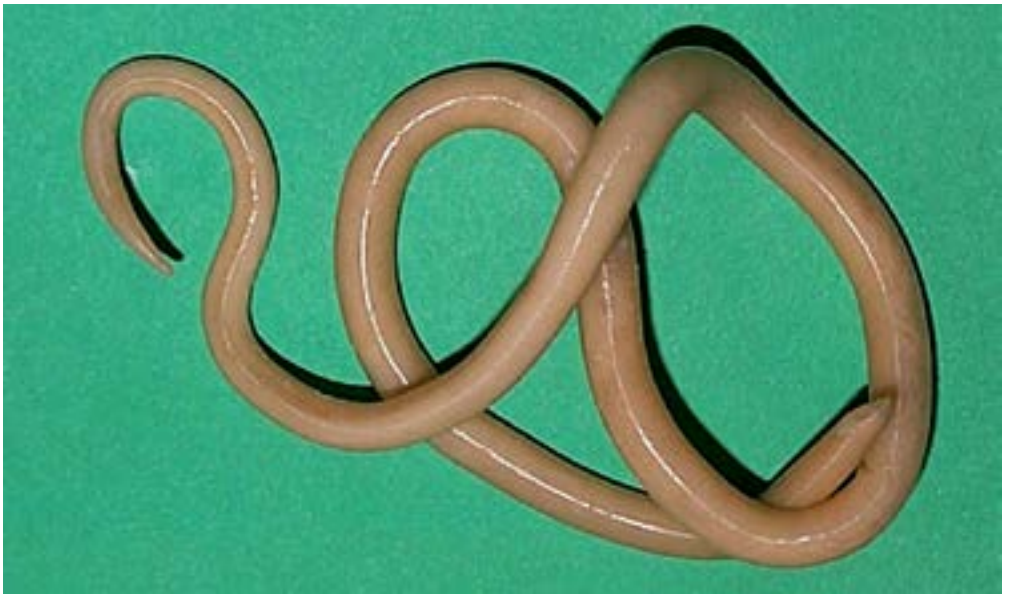
Adding treatment against worms to the duties of the drug distributor means that more under-five children will be treated. As a consequence, the number of children with worms decreases and fewer of them will become stunted, anaemic and develop reduced learning ability.

Providing the evidence

The above is just one example of research implemented by DBL and collaborators with the aim of providing evidence for optimising the control of worms; more examples will follow below. Control of intestinal worms (also called soil-transmitted helminths) is in some countries dealt with through antenatal care and through care for under-five children, as in the Zambian example above.

However, in many other countries, intestinal worms are dealt with as a kind of positive by-product of the two major vertical control programmes, namely the Schistosomiasis Control Programme and the Global Programme to Eliminate Lymphatic

Filariasis. While the latter targets the whole population with the exceptions of children below a body weight of 15 kg and pregnant women, the former focuses on school-based treatment.



The most common of the intestinal worms is the large roundworm *(Ascaris lumbricoides)*, which inhabits the small intestine. The worm may reach a length of 40 cm.

Choosing the right drug against worms

One example of DBL-supported research on school-based treatment approaches for intestinal worm control was performed in Kenya looking at the outcome of a two-year programme for control of schistosomiasis and intestinal worms. After one year of treatment with levamisole against the intestinal worms, this drug showed absolutely no effect on infections with hookworm (*Necator americanus*) and whipworm (*Trichuris trichiura*). No children were cured and their worm burdens were unchanged. When this was realised, levamisole was replaced with albendazole, which was believed to be more efficient. This was true, although the result was not impressive.

Half of the children were cured from hookworm infections, while only one-quarter got rid of their whipworms. The worm loads in the infected children, however, were halved for both infections. As a consequence, the Kenyan programme abandoned the use of levamisole.

'One drug treats all' – or does it?

Both in the vertical control programmes mentioned above and in health-facility-based de-worming campaigns, all intestinal worms (roundworm, whipworm and

hookworm) are nowadays treated with either albendazole or mebendazole in one dose only. It is convenient, cheap and must secure high compliance, as it is obvious that the programme will lose a lot of people if they are asked to come for treatment more than once.

This is the mantra of those implementing the control programmes, but in real life the situation is more complicated, as shown in a study in Uganda. Although effective against roundworms, the drugs were less effective against hookworm and absolutely problematic against whipworms. Thus, in some places, like in southwestern Uganda, schoolchildren must accept that they harbour whipworms and receive treatment against them with no obvious effect. In the study, only a small number of the schoolchildren were completely cured for the infection and only a minor reduction in worm loads was achieved.

The obvious solution to this is to find new combinations of 'old' well-known drugs or accept that treatment has to be repeated and delivered over two or three days. Surprisingly, a combination of the two commonly used benzimidazoles, albendazole and mebendazole, showed promising results against whipworm in the Uganda study. Another way to tackle this difficult infection is using the ComDT approach, where delivery of repeated doses will not be a complicated situation.

Schoolchildren lining up for school-based treatment in Mwanza, Tanzania.

A safe drug cocktail for children

As mentioned above, one-time treatment is believed to increase treatment coverage and cost-effectiveness compared to treatment over several days. In areas where lym-

phatic filariasis, schistosomiasis and intestinal worms co-exist, at least two visits have been necessary to treat individuals for all the infections.

This is because it has not been clear whether it was safe to give the different drugs simultaneously to the individual. The population was thus firstly treated with ivermectin and albendazole against lymphatic filariasis and intestinal worms, and then praziquantel was given one week later to treat schistosomiasis.

This is obviously not very efficient, and now it is evident from a DBL-supported study in Uganda that it is safe for children to receive ivermectin, albendazole and praziquantel at the same time. The study was published in 2011, but the policy has already been changed in Uganda and one of the trips to the endemic areas can be dropped.

Schoolchildren in northern Uganda getting a snack and a drink before taking the drug cocktail.

Combating anaemia in pregnant women

In another area of Uganda, a pregnant woman drags herself to the market to sell vegetables from her garden. She is pale and immensely tired. She is severely anaemic due to a combination of factors. Besides the low iron content in her food and a number of other infections she also harbours hookworm, which attaches to the tissue of the intestine and feeds on her blood.

The Global Programme to Eliminate Lymphatic Filariasis (described in Chapter

11) provides treatment with ivermectin and albendazole, where the latter is effective against hookworm; but pregnant women are excluded from this treatment because of uncertainty of the safety of giving the drug combination to this group.

Consequently, many women refuse to reveal that they are pregnant in order to get the drug for de-worming purposes. However, the first step has been taken to avoid this – in a study in Uganda, no women reported severe adverse events after administration of the drug combination during the second trimester of pregnancy. Combating anaemia in pregnant women is important as anaemia in the mother is a major cause of maternal mortality and low child birth weight, and this again is the most important risk factor for infant death.

Achievements

Overall, one MSc and 13 PhD students have undertaken research in aspects of intestinal worm infections and a high number of workshops and meetings have been held to create awareness and discuss relevant operational research topics.

Former DBL-supported students are now employed in positions where they have an impact on research and control of intestinal worms; as university researchers, dedicated control programme employees or in high-level positions in Ministry of Health and Ministry of Education.

13. Malaria research and control capacity building

BY PASCAL MAGNUSSEN

Malaria in DBL's portfolio

Malaria remains a major public health problem and even today, where malaria incidence is going down in many endemic areas and mortality is being reduced, malaria disables and kills more people than any other disease. More than 90% of all malaria transmission occurs in sub-Saharan Africa. During the period 1950-1960, malaria control campaigns focused mainly on mosquito (vector) control, and the infection was actually considered one of the most neglected of tropical parasite infections, especially in Africa south of Sahara.

As the interest in malaria control had its international comeback in the late 1980s with increasing advocacy, co-ordination and funding (the Global Fund to fight AIDS, Tuberculosis and Malaria), basic as well as operational research got renewed momentum. This change led to a decision in early 1991 to include malaria in the portfolio of the Danish Bilharziasis Laboratory (DBL) and the infection was included in DBL's training and research programme with the initial focus on transmission and vector aspects.

A multi-disciplinary malaria group was created in 1995 with a particular emphasis on control interventions directed towards pregnant women, children under the age of five and school-aged children. Studies of malaria vectors and their control continued and institutional and individual capacity-building for malaria control played a prominent role.

Early malaria research

In the early 1990s, DBL staff were involved in malaria training courses, sponsored by the World Health Organization (WHO), on malaria transmission, infection, disease and control. DBL participated in the entomology modules and practicals, and also in added modules on other DBL target diseases: lymphatic filariasis, schistosomiasis, intestinal helminthiasis and Guinea worm disease.

Early PhD studies in Tanzania and The Gambia looked into transmission dynamics across altitude and the effect of closeness of human habitation to breeding sites on morbidity and mortality. It was found that small-scale variations in malaria-specific knowledge at community level influenced the appropriate use of anti-malarial meas-

ures. Spatial and temporal studies of malaria vectors and transmission risk in Kenya followed.

Focus on mosquitoes

In a collaborative project between Denmark and Mozambique (the Mozambican-Danish Rural Malaria Initiative (MOZDAN)) funded by the Danish Consultative Research Committee for Development Research (FFU), the relationship between exposure to infectious mosquitoes and the development of disease in humans was investigated, and an attempt to set up community-directed sustainable village malaria clinics was investigated. Mosquitoes' mating behaviour was also at the forefront of investigations aiming at following the impact of introducing sterile mosquito males as a possible future intervention to reduced mosquito populations. 'The tent is the trap' explored new ways of catching mosquitoes and innovative uses of screening material were developed and tested (picture).

Impregnated mosquito nets on doors kill mosquitoes when these leave the house during daytime.

DBL entomologists conducted regular malaria entomology courses in Tanzania to train an upcoming generation of young and dedicated malaria entomologists. Malaria transmission in many endemic areas now shows significant reduction in entomological inoculation rate (EIR) and reduced morbidity. Therefore, the value of entomological studies becomes increasingly important in sustaining obtained results and informing about the concept of malaria elimination in selected areas.

Pregnant women at Antenatal Care (ANC) in Uganda.

Malaria control: the vulnerable groups at the forefront

A public health approach to malaria control was established to focus on research capacity-building within institutions and for individuals at PhD and postdoc level. As described in the 40th anniversary publication, the 2004 focus was on PhD students doing research on high-risk groups, especially pregnant women and children less than five years of age and younger schoolchildren. These are the groups that suffer the major impact of malaria infection in terms of morbidity, mortality and development potential. A number of studies were conducted in Uganda, Kenya, Tanzania, Mozambique, Burkina Faso and Ghana. Work on promoting malaria interventions to pregnant women at different levels of transmission led to new ideas on delivery of intermittent preventive treatments in pregnancy (IPTp). A traditional 'one size fits all' solution was found to be not cost effective in low-transmission mountainous areas. Barriers to IPTp delivery and acceptance were explored and led to insight in the importance of health provider-client communication for uptake of malaria-preventive interventions among pregnant women in Ghana.

The era of research consortia

Initially, funding came from the performance contract with Danida, but increasingly funding came from Danida/FFU and international donors. Some of the Danida-fund-

ed projects were the Kenyan-Danish Health Research (KEDAHR) and MOZDAN projects, but for the last approximately 12 years the main funding for malaria research at DBL has come from the EU, the Bill and Melinda Gates Foundation, the European and Developing Countries Clinical Trials Partnership (EDCTP) and the Wellcome Trust. Through generous resources, funding has been awarded to research- and capacity-building consortia.

Consortia such as the Artemisinin Combination Therapy Consortium (ACT), Malaria in Pregnancy Consortium (MIP) and the Gates Malaria Partnership (GMP) have been able to bring together the best research environments and groups in a comprehensive and joint effort in providing the evidence to bring about a needed policy change, and at the same time nursing a new generation of young and enthusiastic researchers.

Traditional birth attendant with newborn in Ghana.

Successful centres

In the GMP, DBL staff members were heavily involved in creating and supporting malaria centres in Malawi, The Gambia and Tanzania. The aim of these centres was to support the national malaria control programmes by providing capacity and expertise to implement operational research and evaluation of implemented interventions. This was research needed to guide the way forward for those involved in the programmes.

Of these three centres, those in Malawi and The Gambia were the most successful. The Gambian centre became an independent sustainable non-governmental organisation (NGO), which now acts as a consultant to the national malaria control programme and the Ministry of Health (see also Chapter 19).

With the inception of the Malaria Capacity Development Consortium (MCDC), the next logical step after GMP was taken to develop capacity at university level to develop proper PhD infrastructures at selected southern universities (Makerere University, Uganda; College of Medicine, Blantyre, Malawi; Kilimanjaro Christian Medical Centre (KCMC), Tanzania; University of Dakar, Senegal; and Kwame Nkrumah University of Science and Technology (KNUST), Kumasi, Ghana).

Successful students

This effort combined continuous support for PhD students from the GMP who competed for re-entry grants, senior research awards and initiative awards. Out of the five successful GMP PhD students anchored in DBL, two students successfully competed for re-entry grants and three students received several initiative awards that support their future research careers.

All students still benefit from a personal development programme and are being mentored by internationally renowned senior researchers sharing their network with the young scientists. There has also been substantial technology transfer in relation to these programmes.

Private licensed drug shop in Uganda.

Recent malaria research

Other projects dealt with interactions between malaria and schistosomiasis/intestinal helminthiasis, trying to measure whether the host response changes when one or more parasites in a multi-infected host are removed by treatments. Research on the impact of treating schoolchildren with artemisinin combination treatment for urinary schistosomiasis is ongoing in Ghana.

The effect on malaria management at health facilities following the introduction of rapid diagnostic tests (RDT) in health facilities was examined in Uganda. This was in order to provide evidence that could be used to inform the policy change process about the introduction of RDTs at health facilities at country level. Introduction of RDT at community level and from private drug shops has led to improved coverage with appropriate, accessible, acceptable and affordable malaria treatment.

Petty trader with mosquito bed nets in Uganda.

Achievements and future perspectives

Overall, 17 PhD and several MSc students have undertaken malaria-related research either funded by DBL or ACT, GMP or MCDC. Senior researchers at DBL have conducted research as principal investigators (PI) or co-PIs with southern partner PIs. As mentioned above, several of these students have been able to competitively attract international funding for postdoc research and for their research work beyond their postdoc.

Others have senior positions in national malaria control programmes, have obtained high-level jobs in the Ministry of Health or are researchers at national univer-

sities or national research institutes e.g. the National Institute for Medical Research in Tanzania and the Centre de Recherche de Santé Publique, Burkina Faso.

The results of the malaria work undertaken by DBL staff and northern and southern partners over the years have to a large extent increased the capacity for malaria research in a number of African countries. The challenge is now to sustain the achievements and support the successful young researchers in establishing malaria research programmes at their home institutions.

Future applications for international funding should focus on supporting a successful researcher as PI surrounded by a new generation of PhD and MSc students. The role of the northern partner should be increasingly supportive, advisory and providing mentorship for the new programmes.

14. Anthropology and cross-disciplinarity at DBL

BY JENS AAGAARD-HANSEN; ERICK NYAMBEDHA; SIMIYU WANDIBBA AND ISAAC NYAMONGO

There is more to health than parasites

In 1998, Achieng' left her local primary school in rural western Kenya. At that time she was 14 years old and attended class 3. She and her siblings lived with her paternal grandmother, and she stayed at home because she needed to take care of one of her younger siblings. Their parents were still alive, but had divorced some time previously. The mother had left and the father moved around in order to find work. Things changed when the paternal grandfather died.

According to local custom, the death put the grandmother in an 'unclean' ritual state (*kwer*), which made it impossible for her to take care of the baby boy because direct contact could inflict the serious condition, *chira*, eventually leading to illness and death. Achieng' therefore needed to stay at home and take care of her younger brother. Only later, when their mother was brought back by the authorities by force, could the necessary rituals be performed, so the grandmother could resume caring for the child and Achieng' could go back to school the following year. This account exemplifies the unique dimension that anthropology brings into research on illness and well-being.

Anthropology at DBL

The Danish Bilharziasis Laboratory (DBL) introduced anthropology in early 1993 as part of a general expansion of its staff and the scope of its research portfolio. The rationale was that, however important insights into biological processes of disease transmission and pharmaceuticals for treatment are in the control of the parasitic diseases in their own right, successful disease control also needs to take socio-cultural factors into consideration. This became the start of 17 years of social science and cross-disciplinary research at DBL. The process started as part of the preparations for the KEDAHR (Kenyan-Danish Health Research) project, one of the first projects supported by the programme Enhancement of Research Capacity in Developing Countries (ENRECA), when the close link between DBL and Kenyan anthropologists was forged – a link that has persisted and grown stronger till today.

Research themes related to core DBL diseases

A major part of the anthropological studies at DBL addressed 'classical' medical an-

thropological issues in relation to the main DBL diseases. Studies thus focused on perceptions and practices in relation to schistosomiasis, filariasis, malaria and intestinal helminthiasis, as well as other diseases of relevance to sub-Saharan Africa, such as diarrheal diseases, and reproductive health. Over the years, these studies provided important insights into local perspectives of illness explanatory models, including causality, pathogenesis and prognosis, as well as availability of the many different options for health care – many of which were based on traditional rather than biomedical principles.

Many disease-control programmes such as deworming interventions took place in primary schools; consequently, many anthropological studies were also conducted in schools. As health education is a key element of disease control, many studies explored existing and innovative ways of conveying relevant knowledge and skills and engaging pupils actively in the processes. For instance, studies explored the potential of children as health change agents in schools and the local community in western Kenya.

Traditional healers sacrifice a chicken. People's lives often comprise elements that are quite different from biomedical rationality.

Nutrition from a social-cultural perspective

The anthropologists also studied themes that were more indirectly related to the core DBL diseases. As a consequence of the KEDAHR project, in which micronutrient deficiencies played an important role, a number of Kenyan anthropology studies looked

at nutrition from a socio-cultural perspective. For instance, research was conducted on traditional vegetables in western Kenya, which unveiled a rich traditional knowledge base that was about to die out because only the elders of the community preserved it. As a result of these studies, this traditional knowledge was recycled to the younger generation via local schools and to the community in general. The studies involved botanists and nutritionists as well as anthropologists, and involved taxonomy, laboratory investigations of the nutrients and qualitative methods. In addition, primary school children played an active role in cultivating the traditional vegetables in school gardens and data collection on their drought and pest resistance. The results were widely published through peer-reviewed journals about traditional vegetables of the Luo, the dominant ethnic group in the project area. Several studies on socio-cultural aspects of food security and breastfeeding were also conducted.

Most of the Kenyan research has been conducted among the Luo in western Kenya. In order to ensure that the various research findings are given practical application, the researchers have established links to the Luo Council of Elders.

Soil eating and veterinary medical anthropology

As a direct consequence of the disciplines working together side by side, new and innovative research ideas emerged. Anecdotal reports of soil eating as a phenomenon among children and women in sub-Saharan Africa have circulated for many years. The researchers involved in the KEDAHR project implemented a large, cross-disciplinary project on soil eating, combining anthropological, parasitological and nutritional aspects in what was probably one of the most successfully integrated research projects of the DBL portfolio.

In addition, DBL staff took the initiative to launch ethno-veterinary medicine (or veterinary medical anthropology) as a research topic. It started by convening a workshop at DBL in 1994 to establish a Danish network of interested veterinary doctors and anthropologists. At a later stage, studies were conducted on the topic among the Luo in western Kenya, and three scientific articles were published.

Project meeting with the class involved in the school-based cultivation of traditional Luo vegetables.

Orphans due to HIV/AIDS

In addition, a number of broad, contextualising research themes were explored. In the late 1990s, the consequences of the rampant HIV/AIDS epidemic became apparent in terms of mortality in the adult segment of the population, which led in turn to a rapid increase in the number of orphans and vulnerable children. This became a significant research theme, especially in Kenya, resulting not only in many theses and scientific articles, but also in many examples of direct dissemination to policy levels nationally and internationally. In the same vein, long-term studies of the dropout from primary schools in western Kenya were conducted.

Children in focus

Many of the parasitic diseases such as schistosomiasis, malaria and intestinal helminthiasis affect children in particular. Consequently, many of the DBL-based anthropological studies had a child focus addressing questions such as: What does the daily

life of African children look like from their own perspective? Which of their activities may expose them to diseases? To what extent are they themselves actively involved in seeking treatment? How do the health problems facing adults impact on the lives of African children? And can children realistically play a role as health change agents in their schools, homes and communities? The initial story of Achieng' is an example of how socio-cultural factors may influence children's lives.

Herbal medicine plays a major role among the Luo, and research has shown that children often play an active and independent role in treatment-seeking practices.

Based on this core focus, DBL took the initiative to establish a child anthropology network in Denmark, where anthropologists studying children met and discussed

topics of relevance with international resource persons during a series of meetings and seminars. In the early 2000s, when Danida developed child-centred policies and guidelines, DBL availed this expertise through a representative on an associated expert committee.

Building anthropological research capacity

DBL's double aim of combining useful and state-of-the-art research with research capacity strengthening was also reflected in anthropology. As a consequence, dozens of African and European anthropologists were trained over the years, leading to numerous PhD and master's degree theses based on fieldwork mainly in Kenya and Tanzania, but also in Ghana, Uganda, Malawi, Mali, Zambia and Zimbabwe. Over the years, close to 50 masters students and 15 PhD students got degrees related to the various DBL activities, and even more students benefitted from the facilitation of short-term study visits.

Especially in Kenya, and to a certain extent Tanzania, this has led to the establishment of strong centres of expertise in relation to anthropology. In Kenya these activities have been centred on a very strong axis of collaboration between the Institute of Anthropology, Gender and African Studies (previously the Institute of African Studies) at the University of Nairobi and in later years the Department of Sociology and Anthropology at Maseno University, Kenya.

Among these students, there is an equal gender distribution and more than half are African students. The Nyang'oma Research Training Site (NRTS), situated on the Kenyan shores of Lake Victoria, played a key role in these activities. This rural research facility, which was initiated in 1995 and is still operational, provides basic facilities of equipment, bicycles, well-trained field assistants, office and accommodation space and, most importantly, a close link to the local population, which makes it easy for new students to work effectively.

In addition to the training of individuals, there were also elements of institutional research capacity strengthening. Thus, DBL played a key role in the introduction of childhood studies as focus areas at the Institute of Anthropology, Gender and African Studies, and the library facilities were also significantly strengthened. Later on in the 2000s, the Department of Sociology and Anthropology at Maseno University received institutional capacity support based on a structured needs assessment approach. This included provision of equipment and books, scholarships, training courses and managerial training. Also, the National Institute for Medical Research (NIMR) in Mwanza, Tanzania, and Kenyatta University, Kenya, benefitted from DBL social science support.

Cross-disciplinarity as part of DBL's educational programme

In the research methodology courses, also described in Chapter 5, it became one of

the key principles that the course participants should be exposed to the benefits and challenges of cross-disciplinarity. In the 'research methodology light' courses, health staff were trained in basic research methodology, in order for them to plan and conduct simple research projects focusing on issues of specific relevance to their work. As the pertinent research questions called for both qualitative and quantitative methods, the cross-disciplinary nature of these courses was essential to their success.

A number of short courses were held as consultancies for Danida for health staff in Bhutan and at district level in Coast and North Eastern provinces of Kenya. One concrete outcome of the last-mentioned course was that DBL facilitated the planning of an evaluation of mobile nomad clinics in Kenya's North Eastern province. The clinic concept aimed at increasing access to health services among nomadic populations by designing mobile clinics that travelled among various locations on a regular basis. Using mixed methods, the evaluation documented the success of this approach based on patient satisfaction and health performance indicators, as well as from a health economic perspective.

Training and planning session with senior health staff in North Eastern province, Kenya, discussing the evaluation of the mobile nomad clinics.

Cross-disciplinary potentials and challenges

Before 1993, DBL's academic staff encompassed natural science, medicine and veterinary medicine with an emphasis on biology. The inclusion of anthropology meant

the introduction of qualitative methods and new research paradigms based on the traditions of the social sciences and humanities. This entailed a process of mutual learning and exploration of mutual interests between DBL researchers of different backgrounds. Especially the Kenyan-based KEDAHR project became the breeding ground for exploring the best ways of collaborating across disciplines.

The accumulated experiences in relation to cross-disciplinarity also led to reflections of a more general nature. Why should one engage in such research at all? What are the main challenges when different methods and paradigms meet? And which are the main contextual factors that influence (and usually inhibit) cross-disciplinary work? These discussions have led to a series of generic, scientific publications addressing the various aspects, including differences in research ethical codes and challenges in relation to evaluation of cross-disciplinary research quality.

Conclusion

The decision in 1993 to make anthropology part of the DBL programme was visionary. The integration went relatively smoothly and significant results were achieved, though there were also lost opportunities for even more cross-disciplinary collaboration internally and externally. What gives hope for the future beyond DBL is the fact that strong centres of applied medical anthropology have been established and that many DBL scholars have been exposed to the potential of cross-disciplinarity over the years. These centres and researchers constitute a strong basis for future growth in the field of anthropology and cross-disciplinary research.

15. Including plant health in the 'one health' concept – in theory and in Uganda

BY SOLVEIG DANIELSEN

The 'one health' concept has largely been defined around zoonotic diseases and the sharing of infrastructure and capacities of human and animal health systems. Veterinary public health is an essential part of public health and includes various types of co-operation between the sectors and disciplines that link the health triad, people-animals-environment.

Yet agriculture is missing in the equation. Many human and animal health problems are caused or worsened by hunger, malnutrition and poor quality of food and feed. Looking beyond the zoonoses, it is clear that human and animal health are closely connected to plant health for at least four reasons: *Food security* – enough food at the right time to feed people; *Food safety* – plant products free from mycotoxins, pesticide residues and human disease contaminants; *Feed security* – enough feed at the right time to feed animals; and *Livelihoods* – agriculture is the world's most important enterprise and is fundamental for economic growth in developing countries. Agriculture means crops. Plant health is essential if the crop yields are to be sufficient and of the right quality.

Health systems for plants

Unlike in human and animal health, where delivery of health services is regarded as central, the world of plant health tends to focus more on specific crops, pests and technologies than on delivery systems for 'plant healthcare'. In 2003, to make up for the apparent gaps in plant health service delivery, the Global Plant Clinic of CABI (a not-for-profit science-based development and information organisation) started to experiment with community-based plant clinics in Bolivia as a way to improve plant health services for farmers. Bangladesh, Uganda and Nicaragua followed in 2005.

Soon after plant clinics were initiated in Nicaragua, a network of national organisations working in plant health made further improvements. Enabled by support from Danida's Agricultural Sector Programme as the overall 'umbrella', a formal system, though very incipient, was set up to support the plant clinics and connect them with diagnostic laboratories, regulatory bodies, agro-input supply and research institutions. The 'plant health system' concept was born.

A broadened 'one health' concept

The emergence of the 'plant health system' approach paved the way for discussions within DBL on expanding the 'one health' concept to include plant health. The plant clinics had shown their worth, not only in improving plant health services to farmers, but also in promoting joint plant-animal service delivery. In Nicaragua and Bangladesh some plant clinics started to give advice on animal health as well in response to the farmers' demands. For many extension workers this combination is straightforward, since they already give advice on a range of topics concerning agriculture and livestock.

Figure 1 illustrates how joint service delivery and cross-sectoral learning (blue lines) are envisaged to interact and deliver plant, animal and human health outcomes (green lines).

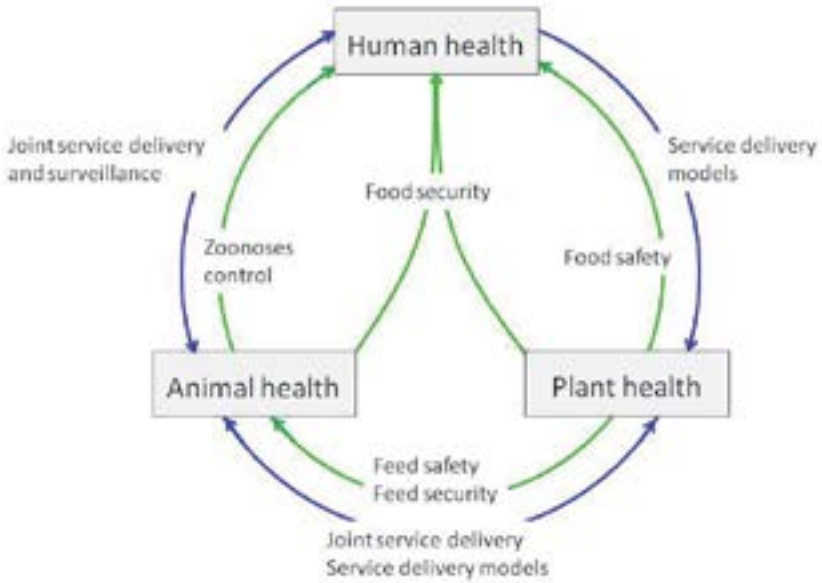


Figure 1. A broadened 'one health' concept. The arrows indicate contribution pathways; the green lines represent outcomes and the blue lines represent service delivery models and mechanisms.

The broadened 'one health' concept model is based on a number of assumptions about interactions and contributions that remain to be tested. Human and animal health systems have been subject to decades of research, so a lot is known about determinants of health, service delivery and health system design and performance. All this is pretty new in plant health.

From concept to reality

Uganda was the first country where plant health system research was to be carried out. It seemed to be the right place to start this new field of study, as Uganda had

been experimenting with plant clinics since 2006 and recently included plant clinics in government policy to improve farmer services and disease surveillance. Danida funded a two-year research project, "Plant health systems in Uganda – A novel approach to plant healthcare", which was carried out in 2010 and 2011 in collaboration between DBL, Makerere University, Uganda, and CABI.

There were basically two things we wanted to do. First, to develop a useful framework to analyse the performance of plant clinics, and second, to find out what 'system factors' influence clinic performance.

As point of departure we used the health system framework of the World Health Organization (WHO), which is based on six building blocks and illustrates how health outcomes are delivered. We assumed that the basic building blocks would be the same for plant health systems, though with small adjustments. We modified the framework to fit the purpose of measuring clinic performance (Figure 2). Two of the performance indicators, coverage and quality of (plant) healthcare, were derived directly from human health, while the third indicator, regularity/timeliness, was used as a proxy for access, another performance indicator commonly used in human health. This seemed to be a reasonable choice, since early field observations had indicated a correlation between the two.

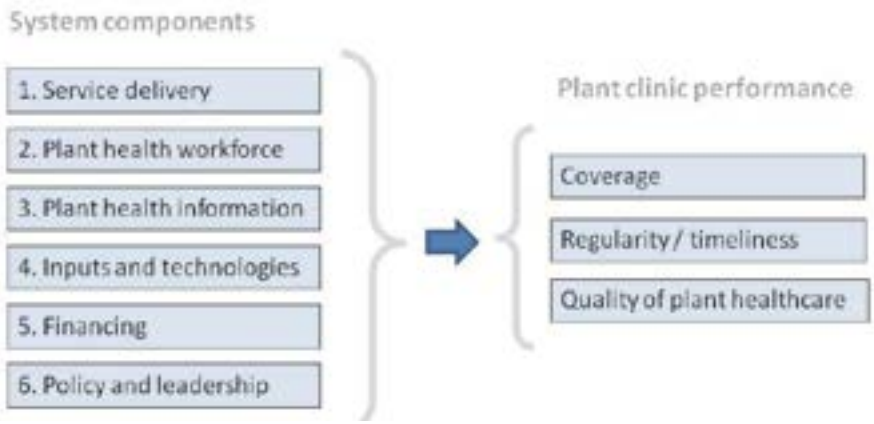


Figure 2. Plant health system analytical framework (modified from WHO, 2007).

Delivering plant healthcare

The plant health system approach draws heavily on principles from human healthcare, using plant clinics as primary healthcare providers to local farmers. These clinics are simple plant health facilities operated by 'plant doctors' and assisted by 'plant nurses' or 'nursing aids'. In most cases, the plant doctors are local extension workers from either government extensions or non-governmental organisations (NGOs).

Most plant clinics in Uganda are set up to operate once every two weeks from a public venue, typically a market-place. The clinics are mobile facilities with tables and

chairs, a banner, a clinic record, a prescription pad, photo sheets and fact sheets, some pamphlets on specific diseases and sometimes fresh samples of diseased plants. Some plant clinics have a small display or outlet of agro-inputs, such as seeds and pesticides. If there is a budget for it, the event is publicised in advance, for example by radio.

Farmers are invited to bring in sick plant samples and ask about any plant health problem. If possible, they receive a diagnosis and a written recommendation on what to do (Figure 3). In case the plant doctor cannot identify the problem, ideally he or she refers the sample to a diagnostic laboratory or in some other way consults an expert.

Figure 3. Primary healthcare for plants. The Soroti Catholic Diocese Integrated Development Organisation (SOCADIDO), a local NGO, runs the plant clinic at Katine market (Soroti, Uganda). The client is first registered by a nursing aid, then the plant doctor attends her.

Promising results

During the project period, plant clinics expanded to 13 districts, and more districts began to show an interest in joining the initiative. Many agreed that the plant clinics could do things that no other extension method could. The systematic collection of farmer demand and information about the pest status in the field was unique. The plant clinics also proved that they were able to cover a large geographic area, thus expanding the reach of existing extension services (Figure 4).

The plant clinics received queries from more than 2,000 clients from over 800 villages during the study period. More than 50 crops with dozens of problems were attended to. Cassava brown streak disease, banana bacterial wilt, groundnut rosette, orange leaf miner and a fungal disease in orange were the most commonly recorded diseases. These are all diseases that pose a serious threat to the food security and livelihoods of Ugandan smallholders.

Momentum for change

The plant clinics were seen as a new and promising way to provide timely advisory services to farmers who had been left in the hands of destiny to cope with rampant plant diseases. There was a growing commitment among implementers and policymakers to expand and consolidate these services. The focus slowly shifted towards viewing the clinics as part of a wider 'plant health system', where plant clinics, diagnostic laboratories, disease surveillance, research and input supply were better connected than had hitherto been the case.

The ministry allocated funds to train more plant doctors and provide technical support and supervision to the plant clinics. And Makerere University established a plant health systems committee to coordinate training and diagnostic support.

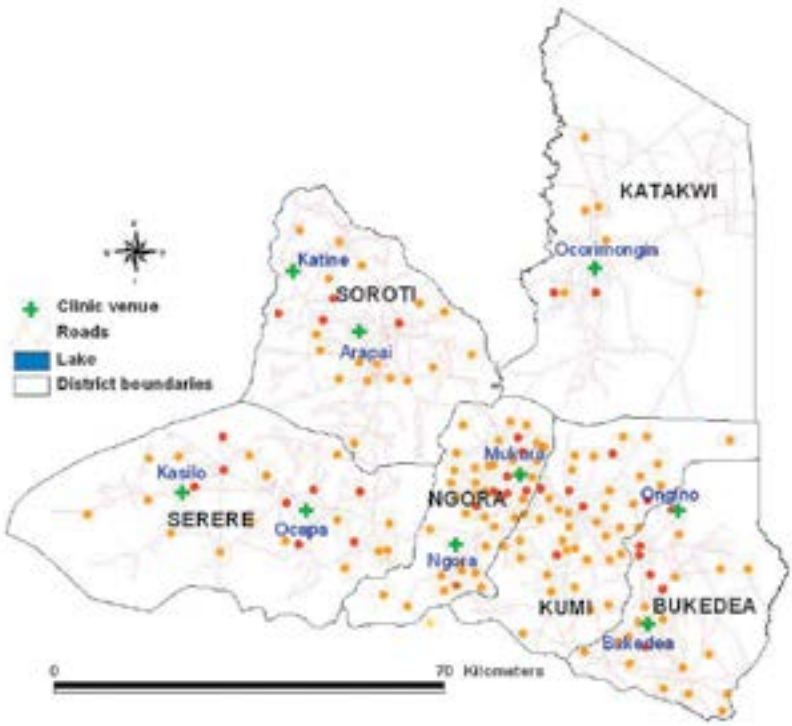


Figure 4. Coverage. Plant clinic catchment areas for nine plant clinics in the Teso region. Each dot represents a parish (total: 190 parishes). Half of the clinic users came from the parishes marked with red dots.Remaining challenges

It was nonetheless evident that the plant clinic initiative expanded in a loose and unregulated way. It was not always clear who was leading the activities and providing the overall leadership needed to guarantee that basic standards and procedures were in place and followed up. Many of the observed clinic weaknesses were products of missing co-ordination, follow-ups and communication.

Although the plant clinics had become part of government policy and the districts showed increasing interest, there were some structural barriers that made it difficult for the districts to institutionalise the plant clinics and for the ministry to play its leading role.

There was a mismatch between institutional mandates and allocated resources. The ministry and local governments have the legal mandate, but few resources, to regulate pests and diseases. On the other hand, the government extension services were designed to address specific commodities chosen by the farmers, not plant health at large. The plant clinics were 'orphans' within the system.

Plant clinic performance during the project period was also affected by a protracted phase of uncertainty about their future. Local government activities in general were heavily constrained by a district reform, electoral campaigns and the prolonged initiation of the second phase of the national agricultural advisory services programme. Staff scarcity, work overload, unplanned activities and inadequate funds for clinic operations also limited plant clinic execution.

The future of the Ugandan plant health system

The agricultural policies in Uganda support plant clinics and this is a major step forward. However, the existing governance structures, institutional mandates and resources make it difficult to institutionalise the mixed-mandated clinics. Finding a solid institutional base for the 'orphaned' clinics will be a major challenge.

The health system framework

We found that many factors influenced the performance of plant health clinics in Uganda, from practical, everyday concerns of clinic staff to the policy framework that shapes public sector activities and relationships with the NGOs and private sectors.

Using a plant health system framework derived from human health to analyse events enabled us to organise the issues and identify key features that affect plant clinics and their surroundings. The initial results were encouraging since the framework gave a structure for analysing human behaviour and outcomes and for identifying what interventions are needed to improve performance.

The preliminary results helped us to understand what works and why. In general, we found a good correlation between plant health system attributes and clinic performance, which will help guide future research.

Visions for the 'one health' concept

The project was anchored in the vision of a broadened 'one health' concept that includes animal, human and plant health. The vision is still viable, but its translation into reality remains a challenging process. Disciplines need to work together and learn from each other. And as shown in this study, the systems approach allows disciplines to create a common starting point for a much-needed joint process towards improved living conditions.

Food safety, food security and animal and human health are inter-dependent. Why not address related challenges from a shared system perspective? Why do we need parallel systems if they basically build on identical core elements? There are lots of synergies to be harvested and lessons to be learned across sectors. We know that it will not be easy. But with continuous reflections and emergence of evidence the vision will stay alive.

16. From 180,000 to zero cases in 23 years – eradication of Guinea worm disease from Ghana?

BY ANNETTE OLSEN AND PASCAL MAGNUSSEN

The starting point

The little girl hobbles towards the rainwater pond in the village of Jantong in Ghana's Northern Region. A blister formed on her left foot during the night and she has an extreme burning feeling in the affected area. Dipping her foot in the pond water relieves the painful sensation; at the same time the blister bursts and the end of a long white worm emerges from the open blister and expels thousands of baby larvae.

She knows this 'NYAASI' from many earlier experiences; in western medicine it is called dracunculiasis or Guinea worm disease, and it is due to an infection with the parasitic worm *Dracunculus medinensis*.

Young girl from Jantong infected with many Guinea worms at the same time. She has been absent from school for several weeks due to her inability to walk. Secondary infections have occurred in some of the wounds (1991).

Guinea worm disease

Dracunculus medinensis is an ancient parasite. It is believed to be the 'fiery serpent' mentioned in the Bible, and the parasite has been found calcified in Egyptian mummies.

The mature female worm, which can be as long as 80 cm, emerges through the skin from any part of the body, but most often from the foot or lower leg. The worm expels its larvae in freshwater; the larvae are eaten by small water fleas and end in humans when people drink water containing infested fleas. Although most individuals only have one Guinea worm at a time, some are infected with many.

The only way to treat the disease is to roll the emerged part of the worm around a stick and carefully withdraw the worm. The worm is attached to the connective tissue and is not easily removed. It takes weeks, sometimes months, to remove the worm completely, rolling it bit by bit on a daily basis. Winding the worm onto a stick has been suggested as the origin of the rod of Asclepius, which is the symbol of medicine today.

Start of the effort to eradicate the disease

In 1986, the World Health Assembly called for global eradication of Guinea worm disease and at approximately the same time Dr Sam Bugri participated in a course at the Danish Bilharziasis Laboratory (DBL) on the epidemiology and control of schistosomiasis. As Regional Director of Health Services in Ghana's Northern Region, he was worried about the many cases of Guinea worm in the region.

We joined forces and after some years of work, Danida accepted in 1988 a project with the aim of supporting the Ghana Guinea Worm Eradication Programme (GGWEP) in the Northern Region. At the same time, a national case search conducted in Ghana in 1988-89 found 179,556 cases throughout the country, more than half of them occurring in the Northern Region.

The Ghana Guinea Worm Eradication Programme

The GGWEP was constructed as a hierarchical system of coordinators, from the national coordinator to regional, district and zonal coordinators. The last link in this chain was the village volunteer selected in every village by the villagers themselves. Reporting of Guinea worm cases (surveillance) went from the village to the national level, while training went in the opposite direction.

Thus, in the village, the village volunteer went from house to house in order to trace every Guinea worm in the village and at the same time taught the villagers about the disease and how they could avoid getting it. Furthermore, the volunteer offered them cloth filters, which they could buy cheaply. The main message to the villagers was that they should always filter their drinking water and that they should avoid contaminating the common water source with larvae from the Guinea worm.

Village volunteer selling cloth filters to villagers while giving health education at the same time (Slide from the MOH/DBL Guinea Worm Project slide series, 1991).

The Danish-Ghanaian collaboration

The Danish-Ghanaian project called MOH/DBL Guinea Worm Project was based in Tamale, the regional capital of the Northern Region, and supported the national programme in different ways. A Danish project officer was based in Tamale. One of the buildings at the hospital was renovated and used as base for the project; project cars were purchased for the region, motorcycles for the district coordinators and bicycles for zonal coordinators and village volunteers.

The project assisted in data collection and analysis, and slide series, films and posters were developed to support health education activities. T-shirts were designed and provided to volunteers, so that they were easily recognised in their communities, and training sessions for volunteers were supported. Some operational research was also conducted in the project, such as studies of the (lack of) efficacy of ivermectin against Guinea worm disease, determination of species of water fleas responsible for transmission, and studies of the usefulness of an alternative nylon filter for filtering drinking water.

Three PhD students were fully or partially supported by the project, while two students did their MPhil studies under the project. The research from these and from collaboration between senior scientists at DBL and Ghana resulted in 30 studies and 15 publications in peer-reviewed scientific journals.

The project continuously evaluated the progress of the programme and suggested improvements. One example was adding a female village volunteer to the already existing male volunteer in each village. This made sense because the responsibility of drinking water in the families often lies on the female head of the household.

Achievements during the collaboration

In 1998-99, Danida decided to end the support of the project at a time when approximately 2,000 cases were left in Northern Region (Figure 1).

Of course, the GGWEP continued its work, realising that the last part of the eradication would be the most difficult part.

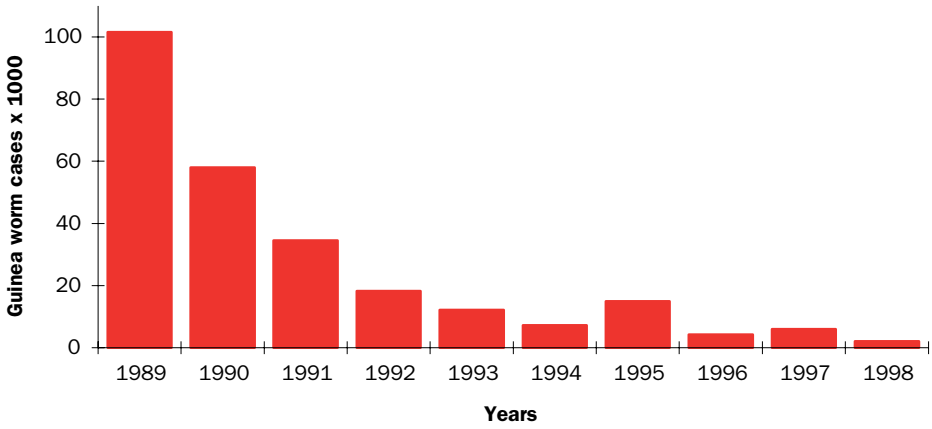


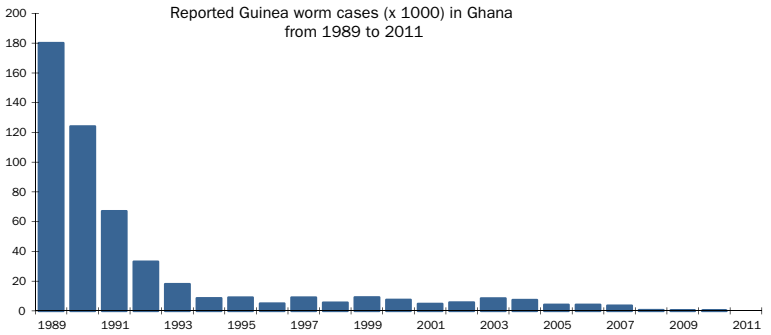
Figure 1: Reported Guindea worm cases in Northern Region, Ghana (1989-1998).

The last mile of the eradication programme

Ghana has continued the eradication efforts since 1999, intensifying some of the measures already in place, such as a reward system that paid for every reported Guinea worm case, and measures inhibiting the contamination of the water source through 'case containment'. Aspects of 'case containment' included immersion of the affected limb in a water container resulting in larvae being thrown on the ground instead of in the water source, and Guinea worm ulcers being bandaged with the same result, namely that larvae were removed from possible transmission.

New measures were also introduced, such as cutting out worms (although this was abandoned in 2007), and paid pond guards who were responsible for preventing infected people contaminating the village water source.

During the last 15 years, there has been a steady although slow decline in Guinea worm cases in the whole of Ghana, and in May 2010 the assumed last indigenous case was reported.



Reported Guinea worm cases from 1989 to 2011 (above) and the assumed last Ghanaian with an indigenous Guinea worm case and her worm (right) (Diari Diari, Savelugu-Nanton district, Northern Region).

External evaluation

This prompted the Ministry of Health in Ghana to ask the World Health Organization (WHO) to conduct an independent evaluation of the GGWEP with the aim of preparing the country for certification documenting that the transmission of the disease had been interrupted. This evaluation was done, in November 2011, by an external team who visited 10 regions, 37 districts and 127 communities/villages, and interviewed a total of 1,159 individuals (see map).

The main finding of the visit was that, although the surveillance of Guinea worm diseases was now generally passive and largely depended on reports generated by community-based volunteers, this documentation was often inadequate. Elderly people knew of Guinea worm disease, but this was not the case for younger people for obvious reasons. The team found posters about the disease and posters advertising the cash-reward scheme for reporting 'worms' in only one-fifth of the visited communities. In addition, approximately half of the communities visited were still using unsafe water sources.

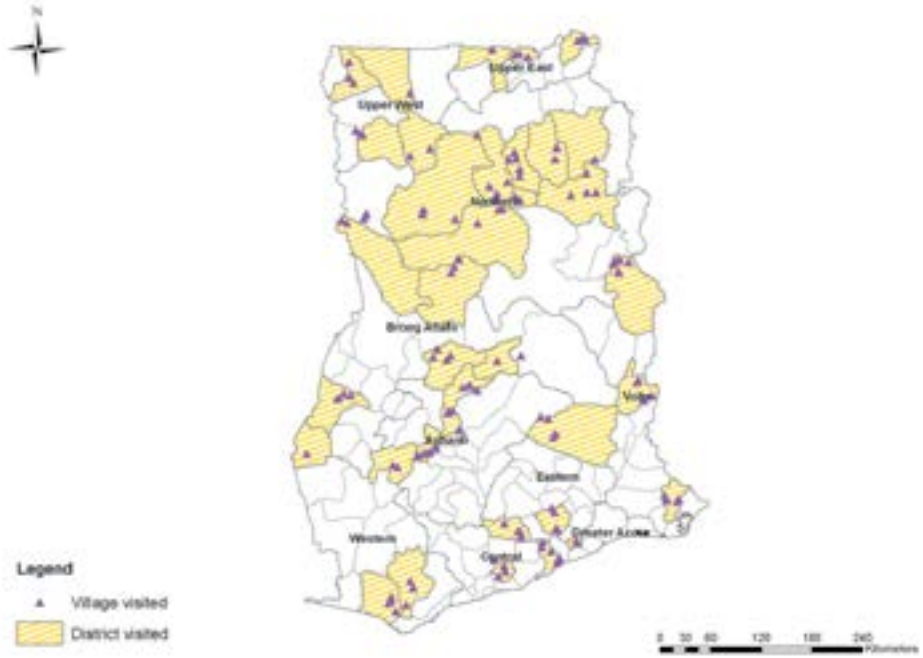
The team concluded that there was no evidence of active Guinea worm cases in the localities surveyed, but that surveillance, documentation and investigation of recent rumours should be improved to obtain the highly-valued certification document. However, the target was expected to be within reach.

Will Guinea worm disease be the next to go?

The first national Guinea worm coordinator, Dr Sam Bugri, is now the national chairman of the Guinea Worm Certification Committee, and DBL has a seat on the International Commission for the Certification of Dracunculiasis Eradication. The circle is closed, and Ghana will without doubt put a lot of effort in achieving the target.

If the world successfully eradicates this disease, it will be the second only after smallpox. The main difference between the two diseases is that there was an effective vaccine against smallpox, which assisted in the eradication effort, while the main measure in the fight against Guinea worm disease is changing human behaviour.

Guinea worm disease is not a killer, but the consequences for the subsistence economy of an affected village and the human suffering are huge. In Ghana, the next generations after the Guinea worm infected girl from Jantong will not know what 'NYAASI' is and they will no longer have to stay home from school for weeks during the period of high transmission or abandon their fields during the planting season because of painful ulcers on their feet or legs.



Map from 'Report of the independent evaluation of the Ghana Guinea Worm Eradication Programme, 2-16 November 2011', World Health Organization, Geneva (WHO/HTM/NTD/PCT/2012.5)

Interview of community health worker for Guinea worm disease, assisted by the district coordinator, during the external evaluation in 2011.

17. The Cysticercosis Working Group of Eastern and Southern Africa (CWGESA)

- A successful network putting *Taenia solium* cysticercosis in sub-Saharan Africa on the international health agenda

BY MARIA VANG JOHANSEN AND SAMSON MUKARATIRWA

People, pigs, poverty and porcine cysticercosis

Poverty and ignorance have been recognised as the main reasons why cysticercosis is an emerging zoonosis in eastern and southern Africa today. The last two decades have witnessed a marked increase in pig-keeping and pork consumption in this region, particularly among rural and peri-urban smallholder farmers, who can improve household income by selling pigs to the rapidly expanding urban markets.

Pigs have an exceptional ability to produce high-quality protein from low-quality feed and reproduce remarkably rapidly on little land. However, poor pig husbandry practices combined with inadequate sanitation, lack of meat inspection, ignorance, and poor human and animal disease control have led to an increase in the incidence of *Taenia solium* cysticercosis.

Porcine cysticercosis – a neglected emerging zoonosis in sub-Saharan Africa

The pork tapeworm, *T. solium,* is a parasite transmitted between humans and pigs. People become infected with the adult tapeworm (taeniosis) by eating infected raw or

undercooked pork. Eggs of the tapeworm pass out with the infected person's stool and can be ingested by free-roaming pigs if people defecate outdoors.

The larval form of the parasite develops in pigs (cysticercosis) with hundreds to thousands of small cysts forming in their muscles, heart and brain, making the pork unfit for human consumption and posing a serious constraint for marketing pigs and pork (picture).

People can also become infected by ingesting *T. solium* eggs either from direct contact with a human tapeworm carrier or from contaminated food or water. Once humans have ingested eggs, the larval stages often develop in the brain, causing a condition called neurocysticercosis, which can cause severe headaches, epileptic seizures and sometimes death.

Neurocysticercosis is one of the common causes of epilepsy, which renders people incapacitated and unproductive. Prevention of diseases related to pork tapeworm can be achieved by providing knowledge and means of effective sanitation; provision of clean water; cooking pork sufficiently to kill cysts; and regular, effective treatment of people against adult tapeworm in rural areas where pigs are reared.

Pork full of *Taenia solium* cysts.

A strong 'one health' network

Porcine cysticercosis is a relatively new disease in sub-Saharan Africa. Before the year 2000, very few reports mentioned the disease, and it received almost no attention. However, through a long-term Danida-funded livestock helminth research project, researchers identified the parasite while doing slaughter-slab surveys. The findings were presented at an annual project meeting and led to several research questions

regarding the parasite, its distribution, abundance, risk factors, and how to control the disease.

At "Human Helminth Infections – Future Research Foci", a meeting financed by DBL and held in Lusaka, Zambia, in 2001, researchers across borders in eastern and southern Africa agreed to form the Cysticercosis Working Group in Eastern and Southern Africa (CWGESA), a network to coordinate and promote research, control and prevention of the parasite. Soon after, the first official meeting of the CWGESA was held in December 2001 in Dar es Salaam, and, in 2002, CWGESA was established as a non-governmental organisation (NGO). The aim of CWGESA was to promote communication, collaboration and co-ordination of integrated research and control activities to combat *T. solium* cysticercosis/taeniosis.

More specifically, the network agreed to:

- Develop and implement appropriate and sustainable surveillance, prevention and control programmes for cysticercosis/taeniosis.
- Co-ordinate concerted action at all levels for formulating, implementing and monitoring research and control activities in co-operation with other institutions within and outside the region.
- Solicit technical and financial support for research and other related activities.
- Receive guidance and support from relevant international/regional institutes, agencies and organisations.
- Designate and support regional centres for training and building capacity with regard to research, surveillance, prevention and control of *T. solium* cysticercosis/taeniosis.
- Lobby for legal reforms such as the introduction of national legislation for pork inspection and control.

Over the following years, DBL has been the main financial supporter of the network, but other organisations like the World Health Organization (WHO), the WHO-anchored UNDP/World Bank/WHO Special Programme for Research and Training in Tropical Diseases (TDR), the Wellcome Trust, the Food and Agriculture Organization (FAO), the Izumi Foundation, the World Bank, the Global Alliance for Livestock Veterinary Medicines (GALVmed) and other smaller funding bodies have also contributed to meetings and other activities.

A model south-south network

CWGESA is a success story of a south-south-north network model. It is now recognised internationally, is used as a model for other networks and has managed to represent the region in the advocacy for the emerging problem of *T. solium* cysticercosis in the region.

With a true 'one health' approach, ten member countries form CWGESA today, seven general assemblies have been held as well as eight technical advisory meetings and a major international meeting in Arusha, Tanzania, in 2002. The meeting in Arusha hosted more than one hundred scientists and officials from six continents. Experts presented up-to-date knowledge regarding all aspects of the parasite, and an action plan for combating the disease in sub-Saharan Africa was developed.

The CWGESA secretariat at Sokoine University of Agriculture, Morogoro, Tanzania.

The outcome of the workshop was reported in a special issue of Acta Tropica that was published in 2003. With financial support from DBL, CWGESA opened a web site (www.cwgesa.dk) and established a secretariat at Sokoine University of Agriculture, Morogoro, Tanzania (picture). As CWGESA has its own financial accounts, money transfers between countries and from international donors are much easier and activities are carried out without much delay.

CWGESA made *T. solium* cysticercosis in sub-Saharan Africa visible

CWGESA has put *T. solium* cysticercosis on the international agenda by providing data documenting its emergence in sub-Saharan Africa, demonstrating the lack of knowledge regarding the disease in both humans and pigs. The network is presently working towards providing sustainable, available, acceptable and affordable control and prevention solutions.

CWGESA has been a pioneer regarding inter-disciplinary and inter-sectoral collaboration – a true 'one health' approach. CWGESA has also shown that while coming together is the beginning, staying together is progress, and working together is success.

CWGESA 5th General Assembly, Maputo, Mozambique, 2007. The CWGESA officers, professor Samson Mukaratirwa (chair), professor Faustin Lekule (vice-chair) and Dr Helena Ngowi (secretary) are found in the first row. The meeting was attended by more than 40 people from 18 countries: Angola, Burundi, Democratic Republic of Congo, Kenya, Mozambique, Tanzania, South Africa, Uganda, Zambia and Zimbabwe in the Eastern and Southern Africa (ESA) region, as well as Australia, Austria, Belgium, Burkina Faso, Denmark, France, the UK and the USA.

18. Health impact assessments in the Mekong Basin for promoting health as a cross-cutting issue

BY PETER FURU AND ROBERT BOS

Health and development

Increased agricultural production, expanded energy generation, improved transport and better housing and settlements all contain elements that affect health through environmental and social determinants. Economic progress, strengthened human capital and improved infrastructure generally translate into improved health. Yet all too often there have been unforeseen adverse effects that have hit vulnerable groups in society, reduced their health status and passed hidden costs on to the health sector.

The health sector tends to pay the bill for damage to health unless other sectors take health into account in their development planning. Health is a cross-cutting issue, and development-related health improvements require an inter-sectoral approach.

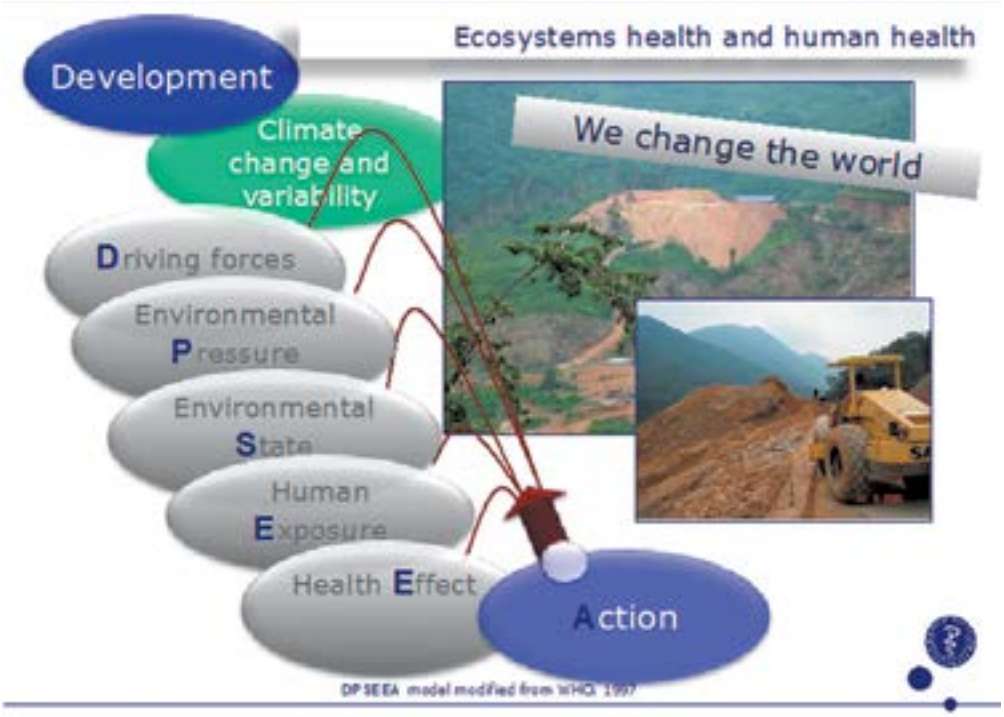
Predicting consequences for health

Health impact assessment (HIA) is a development planning and decision-making tool to predict the consequences for health of new policies and projects. It identifies hazards and risks at an early planning stage, focuses on opportunities to improve health and allows the inclusion of health safeguards and health-promotional measures into project design, management and operation. Thus, it helps to minimise the flow of hidden costs to the health sector. More importantly, it also explicitly recognises that healthy individuals and healthy communities are a critical factor in sustainable development.

HIA is not something a ministry of health can do singlehandedly and in isolation. Firstly, it is not the role of health ministries to carry out HIAs, rather they should take the lead in commissioning and appraising them. Secondly, HIA procedures should be co-ordinated with project feasibility studies and environmental and social impact assessments (EIA and SIA). Overall project planning should ensure that health safeguards are incorporated into project design to eliminate hazard and reduce risks. Strengthened health authorities can then deal with any remaining risks. Ministries of health will also have a regulatory role, ensuring compliance according to agreed specifications, and monitoring the health status of affected communities.

The development of a national HIA capacity requires relevant skills among mid-

dle-level managers in several sectors as a background for inter-sectoral decision-making for health protection and promotion. They should be able to deploy such skills irrespective of their public sector affiliation and professional background. The challenges in the promotion of HIA are not so much technical as they are institutional; individuals in different public sectors must work together, which is an idea that is not part of their professional training and does not flourish in a governance environment based on competition for scarce resources.



HIA recommends actions for adaptation and mitigation of adverse health effects on development.

Start of DBL as an HIA capacity builder

The involvement of DBL with HIA has always been anchored in a close collaboration with the World Health Organization (WHO). It all started in 1989, when DBL's director and staff attended the ninth annual meeting of the joint WHO/FAO/UNEP Panel of Experts on Environmental Management for Vector Control (PEEM). That year's meeting focused its technical discussion on policies and programmes of bilateral and multilateral agencies in support of health in the context of development. Soon after, DBL expressed interest in obtaining a WHO collaborating centre status in the area of health and environment in sustainable development. The formal designation soon followed with PEEM approval of a programme component aimed at HIA capacity building in selected WHO member states.

Health impact assessment courses on three continents

The development and testing of an HIA training package soon followed as a joint effort by DBL, the Liverpool School of Tropical Medicine and the London University Centre for Higher Education Studies, under the umbrella of WHO's Environmental Health Programme.

Over a six-year period, the inter-sectoral HIA course "Health Opportunities in Water Resources Development" was thoroughly tested in five venues on three continents (Zimbabwe, 1992; Ghana, 1994; Tanzania, 1995; Honduras – for five central American countries – 1996; and four states in India – Gujarat, Maharashtra, Rajasthan and Tamil Nadu – in 1997). The definitive course manual was published in 2003.

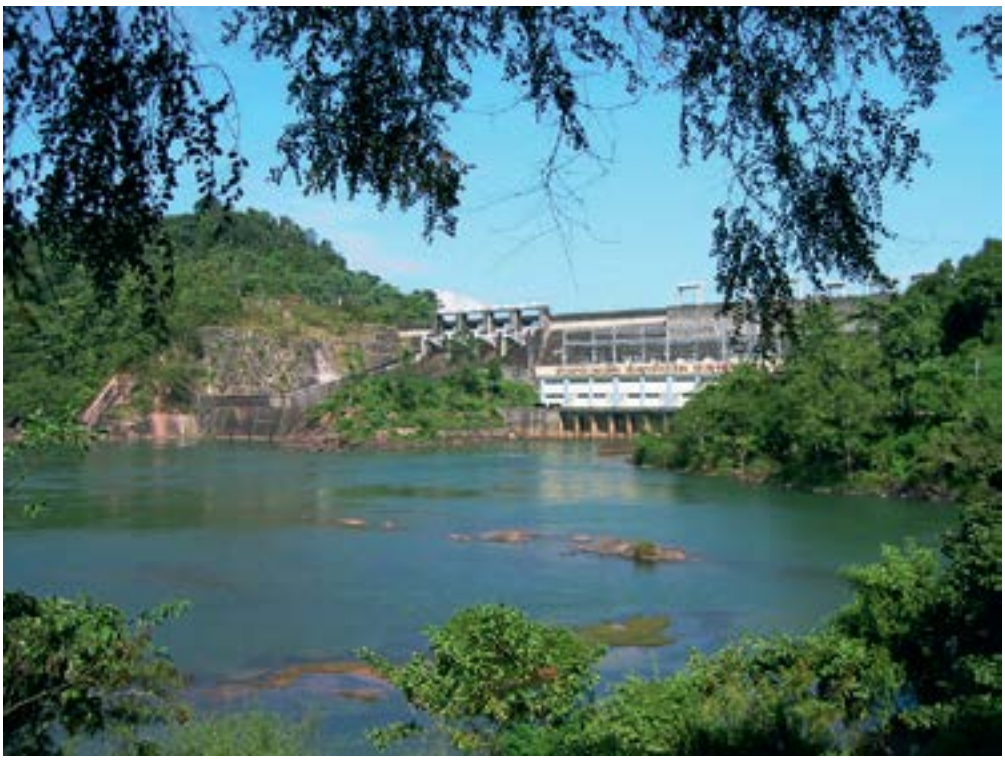
The HIA course manual.

From classroom teaching to e-learning

The main lesson learned from the first course in Zimbabwe was that traditional classroom teaching with passive information transfer did not work to meet the learning objectives. Problem-based learning (PBL) was put at the centre in subsequent courses. In this approach, participants are not lectured by experts on a range of HIA-related topics – the goal is not to turn them into mini-experts in all relevant technical disciplines. Rather, emphasis is given to developing skills to work inter-sectorally, to trust

and rely on the judgment of colleagues in different sectors, and to compromise on a collective way forward. Critical decision-making steps in the HIA process are thereby addressed through PBL. At the end of the course, the participants have gained knowledge about the HIA process, developed skills to jointly carry out the HIA tasks, and established an informal network that runs across the boundaries between public sector institutions.

Recently, considerable resources have been put into the design and content of a new HIA course using a blended learning approach, with an initial face-to-face course module followed by e-learning sessions.



Hydropower development has its pros and cons, including for health.

Laos – the first country with an HIA policy

DBL's active engagement in HIA implementation beyond generic capacity building as such resulted from a request in 2002 by the government of the Lao People's Democratic Republic (Laos) to WHO for technical and capacity-development assistance. This was triggered by the planning and imminent construction of the Nam Theun 2 dam on a Mekong River tributary.

A first step by the Lao Ministry of Health was to establish an HIA task force and, in March 2003, WHO and DBL organised a workshop in Vientiane for task force

members, introducing them to the main HIA concepts, methods and procedures. In October of the same year, the inter-sectoral HIA course "Health Opportunities in Water Resources Development" was held, targeting mid-level professionals from the health and other ministries. The Nam Theun 2 dam project provided the context for the course tasks.

Facilitated by DBL and WHO, a national HIA policy seminar held in December 2004 set in motion a process of HIA policy formulation. Vice-ministers from all relevant ministries gave political backing to the consultative process. The agreed process was co-ordinated by the Ministry of Health with broad stakeholder involvement from all public sectors, and led to a policy draft that went through a political clearing process and was ultimately approved by the Council of Ministers.

The challenge of breaking the wall between sectors – working together on HIA tasks.

In March 2006, the Prime Minister's Office issued an official decree and this concluded the process, marking the first example of an official, national HIA policy. It allowed the establishment of an HIA unit in the Ministry of Health and government engagement in ensuring that health enters the project planning cycle at an early stage. The Minister of Health asked for the preparation of national HIA guidelines to define the detailed procedures for HIAs, describe the regulatory functions and establish cri-

teria for use in screening, scoping and appraisal. Initial work revealed the clear need to harmonise the EIA and HIA processes and procedures. These guidelines have since been finalised, through a process supported by DBL and WHO, for use in day-to-day HIA screening and appraisal activities by the Ministry of Health. Currently, the HIA unit operates mainly as an appraisal mechanism for the health component in EIA reports of development projects.

Sectoral commitment to participation in HIA policy development.

Regional expansion of the HIA capacity development programme

Concurrent with the HIA processes in Laos, requests for HIA capacity development and process facilitation came from the governments of Vietnam and Cambodia. WHO, DBL and a new funding partner – InWEnt (Capacity Building International, Germany) embarked on an expansion of the HIA efforts to these other Mekong countries, applying the lessons learned in Laos.

The Cambodia process

Activities in Cambodia started in 2005 with a national workshop on HIA principles and practices for Ministry of Health staff. It focused on the essential functions of the health sector in support of HIA. The workshop reviewed the country's options for further capacity building and recommended, as a next priority activity, the formulation of a national HIA policy. This would provide the enabling environment for the further development of HIA in the country, in particular through institution building and human resource development. The Cambodian government thereby chose a dif-

ferent sequence of HIA capacity building elements than Laos by developing a policy framework for HIA before fully embarking on training activities.

DBL, InWEnt and WHO supported this recommendation by organising a national seminar for high-level decision-makers from different ministries. This was a solid starting point for the process of national HIA policy development. A national action plan was developed at an inter-sectoral seminar organised by the government of Cambodia in Phnom Penh in 2007. It defined objectives, structures and a road map for a series of activities that would result in a national HIA policy. The HIA process is now part of the activities leading towards a national strategy for environmental health protection and a national environmental health action plan (NEHAP). Currently, the government of Cambodia is finalising the legal procedures towards the official launch of NEHAP with the HIA policy and action plan.

The decentralised approach in Vietnam

Activities in Vietnam started in 2005 with a national workshop on HIA principles and practices for a target group of Ministry of Health staff. The focus of the workshop was on the essential functions of the health sector in support of the HIA process. The workshop recommended training of government officials at sub-national administrative levels – particularly at the provincial level, reflecting the highly decentralised government structure in the country – as the next HIA priority activity. A needs assessment targeted at the provincial level confirmed the overall requirement for comprehensive training in the area of HIA.

A training-of-trainers (ToT) approach was considered appropriate and efficient to create a critical mass of government staff with the required competences at the provincial level. A ToT course was conducted in 2007 and subsequently two provincial courses on inter-sectoral HIA were run under the programme in 2008, testing the ToT approach. Concurrent with the ToT and the pilot courses, a national HIA policy process was set in motion with a view to initiating the formulation of a national HIA policy framework that will support HIA actions at the provincial level.

Overall, the development of HIA in Vietnam has been progressing at a steady pace. The Ministries of Health and Natural Resources and Environment are central to securing sustainable development through the proper use of impact assessments. A new government decree on EIAs, and a new Ministry of Natural Resources and Environment circular guiding this decree, were issued in 2011, strengthening EIAs by including health aspects. These legislative documents emphasise that the EIA report should assess the impacts of a project on communities, including health aspects, as well as propose mitigating measures addressing the negative impacts on community health. This initiative is, however, not expected to constrain the emphasis on parallel development of national guidelines on HIA, expected to be finalised in 2012.

Developing content of the HIA ToT course, Vietnam.

Moving forward

Through training, institution building and policy development, DBL and its partners WHO and InWEnt have planted the first HIA seeds in Laos, Cambodia and Vietnam. HIA is without doubt becoming an important participatory planning tool aimed at safeguarding and promoting human health in the context of development.

However, a major challenge for the countries of the Mekong Basin is keeping this initiative alive for further fruition through the full acknowledgment that health is a cross-cutting issue and that development-related health improvements require an inter-sectoral approach to address the broad health determinants of an environmental and social nature.

The regional efforts and commitments made so far at government level in the DBL partner countries in terms of HIA capacity development witness a willingness to move forward towards sharing the responsibility for health in the context of sectoral development. In the broad context of national governance, the economic rationale will remain the predominant argument in favour of HIA. It must be expected, however, that new Sustainable Development Goals kicking in after 2015 will also address the need for environmental and health impact assessments that form the basis for truly sustainable development.

19. Strengthening knowledge-management systems in The Gambia

BY PAUL BLOCH AND AYO PALMER

Organisational knowledge-management systems

Applied research is designed to solve practical problems rather than acquire knowledge for the sake of knowledge. It is therefore in the interest of applied researchers that knowledge and evidence are used to inform decision- and policy-making processes for human and social development. It is also in the interest of society at large that decision-making is informed by knowledge and evidence rather than by anecdotes, personal interests or preconceived ideas about what works and what does not work. This increases the objectivity of decisions and the trustworthiness of decision-makers.

The enhancement of knowledge-based development depends on the availability of proper organisational knowledge-management systems that are rooted in a variety of mutually dependent characteristics related to 1) organisational governance and culture, 2) organisational resources, 3) formalised processes and 4) technology infrastructure. Strengthening an organisation's knowledge-management system helps the organisation deliver the right information to the right place at the right time. In this way, the organisation may gain respect as a credible stakeholder in development circles and thus be able to influence policy processes for human and social development.

The CIAM-DBL partnership

DBL has supported the strengthening of organisational knowledge-management systems in several partnerships and projects in low-income countries in Africa and Asia. Some of these activities are documented elsewhere in this book. In this chapter, a single case will be presented, namely the knowledge-management partnership between DBL and the CIAM–Public Health Research and Development Centre in The Gambia.

In 2001, the Centre for Innovation Against Malaria (CIAM) was established within the framework of the Gates Malaria Partnership (GMP, see also Chapter 13). GMP was a consortium of nine European and African institutions with expertise in malaria-related capacity building and research. The consortium was awarded a US$40 million grant by the Bill and Melinda Gates Foundation for a five-year programme on malaria-related research, capacity strengthening and knowledge-into-practice activities. CIAM was established as one of four training centres within the capacity

strengthening arm of the GMP. The aim of the centres was to improve the skills, knowledge and attitudes of those involved in malaria advocacy and prevention at national and regional levels. CIAM was supervised by its host institution (the Medical Research Council of The Gambia) and by technical advisers from three European partner institutions, one of which was DBL. Supervision addressed the development, implementation, monitoring and evaluation of innovative capacity building activities and projects within the framework of the partnership.

In 2006, when GMP came to an end, CIAM became a legalised non-governmental organisation (NGO) in The Gambia. This enabled the centre to retain its autonomy, and to define its own programme of work based on its interests, staff competences and emerging local and sub-regional needs. CIAM widened its scope of work to cover public health issues more broadly and therefore changed its name to CIAM – Public Health Research and Development Centre. Emerging from this background and context, CIAM and DBL engaged in a formalised partnership in the period 2006-2010. The partnership addressed health research and development in low-income countries with emphasis on The Gambia and the west Africa region. DBL provided technical (25% of one full-time academic position annually for four years) and financial support for the partnership.

Growth monitoring of infants, The Gambia

Approach taken

The CIAM-DBL partnership was driven by a desire to support local health research and development processes in a sustainable way based on the principles of inclusiveness, local ownership, integration, and capacity strengthening. *Inclusiveness* referred to the need for a broad definition and involvement of stakeholders in health research and development. This included civil society organisations (CSOs), government institutions, academia, politicians/parliamentarians, the media, the private sector, and the public. *Local ownership* referred to the need to respect and build on local aspirations, experience and priorities in defining, planning and implementing partnership activities. *Integration* referred to the need to develop activities around and within the framework of existing structures, traditions, standards and norms, rather than challenging these and the forces behind them. *Capacity strengthening* referred to the need to provide support for individuals and institutions in a way that left behind sufficient capacity in the form of knowledge, skills and infrastructure to continue processes in the long run. The principles of the CIAM-DBL partnership are partly captured by the following quote:

> *"Each country needs to be able to generate knowledge relevant to its own situation, to allow it to determine its particular health problems, appraise the measures available for dealing with them, and choose the actions likely to produce the greatest improvement in health. This should not be seen as the exclusive preserve of universities or research councils, but equally of health/public services, non-governmental organisations, etc."* [3]

The CIAM-DBL partnership addressed five overall areas of collaboration: 1) institutional capacity-strengthening of CIAM, 2) health-sector capacity-building, 3) public health research systems strengthening, 4) research and research dissemination, and 5) international civil society engagement in research for health.

Institutional capacity-strengthening

In an effort to make public health information readily available to the public, the CIAM-DBL partnership funded and established a well-equipped library and documentation centre in the compound of the CIAM building. The centre could be used free of charge by any person or institution interested in public health. It was equipped with computers, printers and Internet access, as well as books, journals and reports related to public health. It also compiled and archived widely dispersed and often unpublished reports of studies done in The Gambia. It subscribed to relevant scientific

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3 Butler P. *Health research for development: the continuing challenge.* A discussion paper. International Conference on Health Research for Development, Bangkok. 10–13 October 2000.

journals and provided quick access to electronic reports and scientific publications. In particular, the Association of Health Journalists was encouraged to use the centre to improve accuracy in reporting on health matters. Monitoring the use of the centre showed that the main users were university students.

The CIAM-DBL partnership also supported formal and informal training, mentoring and supervision of CIAM staff and students operating within the fields of public health, social sciences and epidemiology.

Health-sector capacity-building

Knowledge, skills and experience in monitoring and evaluation (M&E) and operational research methodologies are weak in the public sector in The Gambia. The CIAM-DBL partnership therefore decided to offer capacity-building support to organisations, institutions, professionals and students already involved in (or expecting to become involved in) these disciplines. The first major assignment took place from 2006 to 2008, when CIAM was contracted by the National AIDS Secretariat (NAS) to monitor a HIV/AIDS grant funded by the Global Fund to fight AIDS, Tuberculosis and Malaria. In fulfilling this assignment, the CIAM-DBL partnership designed, introduced and implemented a national HIV/AIDS M&E plan, system and tools on behalf of the NAS. The partnership also developed and implemented a training course in M&E methodology for 22 project managers and technical staff involved in the HIV/AIDS programme.

The Department of Public Health at the University of The Gambia expressed interest in the M&E training course and, in July 2007, the university senate gave the course official accreditation as a certificate course of the university. During this period the course was revised and updated, and in August-September 2008 the university, CIAM and DBL delivered the course jointly for 13 participants from the Ministry of Health and local NGOs.

Following the success achieved with the M&E certificate course, the CIAM-DBL partnership developed a four-week training course in operational research methodology in 2009. This course was also certified by the University of The Gambia and successfully implemented in August and September 2010 for participants from national health programmes and regional health teams.

Public health research systems strengthening

In the past, public health research in The Gambia was erratic and received limited attention by the government. Operational problems within the framework of health programmes were addressed without particular reference to scientific evidence and in-depth understanding of the local context within which these programmes were implemented. Public health research was thus not framed by strategies and planned ahead of time but undertaken in response to immediate needs. This is currently chang-

ing. In the face of increasing international demand from major health programme funders, developing countries, including The Gambia, are now made accountable for investments and requested to document programme deliverables through solid knowledge about key health indicators.

Vaccination of infants, The Gambia

In 2007, in response to this changing situation, the CIAM-DBL partnership engaged in several consultations with governmental and non-governmental organisations about their views and perceptions on implementation barriers and research issues related to major public health challenges in The Gambia. Discussions with selected high-level informants from academic and public health institutions in The Gambia followed these consultations, which addressed a range of issues related to the state of health research in The Gambia and resulted in a proposition by the CIAM-DBL partnership to assist The Gambia's Ministry of Health set up a national health research system.

During this period of time, the Directorate of Planning and Information (DPI) of the Ministry of Health recognised that a national health research system may act as a framework to ensure that health research is needs-driven and that results may be used to inform policy and practice. In August 2007, DPI therefore set up a national

health research system task force that included CIAM and DBL. CIAM was asked to be the secretariat for the task force. The task force finalised the first national policy for health research in August 2008. Subsequently, in 2009, the task force developed the first national health research strategy, which includes the needed structural and procedural changes to cater for a national health research system and the establishment of a national forum for health research. Finally, in October 2010, the Gambian health sector proudly implemented the first national health research conference under the heading "*Research for decision-making and action*". The Medical Research Council of The Gambia, the West African Health Organisation and DBL jointly funded the conference.

Research and research dissemination

Together with local partners, the CIAM-DBL partnership conducted two operational research studies during the period of collaboration. These included 1) an assessment of the efficiency and effectiveness of a pilot programme for delivering intermittent preventive treatment of malaria in pregnancy (IPTp) in two health divisions in The Gambia; the National Malaria Control Programme subsequently used the findings to expand access to IPTp; and 2) a comprehensive national survey of antenatal care (ANC) delivery, coverage and access in The Gambia; the Ministry of Health subsequently used the findings to start an in-service training programme for nurse attendants.

The funding for the research studies came from the CIAM-DBL partnership itself and from external sources such as the Gates Malaria Partnership and the NAS. Findings from the research studies were disseminated at national and international conferences and published in popular formats, scientific reports and international peer-reviewed journals.

International civil society engagement in research for health

An unanticipated outcome of the CIAM-DBL partnership was international networking, facilitated by DBL and partners, between CIAM and NGOs around the world. CIAM is now part of a global network advocating for increased civil society engagement in research for health.

In April 2008, the Council on Health Research for Development (COHRED), DBL and CIAM received funding from the Wellcome Trust to support a consultative process to strengthen the role of civil society organisations in research for health at the international level. The consultative process aimed at increasing the understanding of civil society's role in health research; facilitating learning between north and south; developing a better understanding of relevant experiences in different cultural, political and economic contexts; and designing strategies to increase the involvement of civil society in health research and health research governance. In October 2008,

16 people representing 12 CSOs from Asia, Africa, the Americas and Europe participated in a meeting at DBL, the University of Copenhagen. The main outcome of the meeting was a "*Call for Civil Society Engagement in Research for Health*", which included recommendations and strategies to all relevant actors for involving CSOs in health research and health research governance.

CIAM's director presented this *Call for Civil Society Engagement in Research for Health* in plenum at the Bamako Ministerial Forum on Research for Health, Bamako, Mali, in November 2008. The call was adopted as one of three outputs of the ministerial forum. The discussions in Bamako consolidated the position of CSOs in the international health research agenda and led to wide recognition of the need to engage CSOs more widely in health research. Since the Bamako meeting, CIAM and DBL have participated in other international forums to promote CSO engagement in research for health. In November 2009, CIAM chaired the session on Civil Society in Research for Health during the Global Forum for Health Research meeting in Havana, Cuba.

Conclusion

The CIAM-DBL partnership was driven by a desire to support local health research and development processes in a sustainable way. It was inclusive and participatory in its approach and operated with limited funding and manpower. The partnership provided institutional capacity-strengthening of CIAM and a diversity of technical assistance to national stakeholders. The financial and technical kick-start supported by DBL has ceased and CIAM is now a sustainable research and development organisation capable of attracting its own funding for its public health research and advisory services in The Gambia and elsewhere.

The CIAM-DBL partnership is a good case to illustrate why it is meaningful to apply a broad perspective to health research – a perspective that encompasses all aspects of knowledge-management systems and processes. The scientific community may benefit from applying such a broader perspective because it places the research process in a wider societal context where visions, missions and roles of research and researchers become clearer, and where potentials and roles of non-researchers involved in knowledge-management processes become highly relevant. The researchers may open their eyes and discover that there are real people at the end of the research pathway – people with opinions, competences, desires and needs.

20. Priority-setting in health systems

BY JENS BYSKOV

Why have health systems when effective interventions are known?

A teenage mother lives in a poor sub-Saharan village next to a big lake. The area is known to have malaria transmission all year around, and surveys in nearby villages have shown a high prevalence of intestinal helminthiasis and schistosomiasis. The HIV prevalence in similar rural settings is about 10% in her age group.

She has been losing weight over the last months and now her one-year-old child feels hot and is not eating well. She has tried herbal remedies for both of them for a week but without effect. The family permits her to travel with her child quite some distance to a fairly run down health centre. The queue is long and time for each patient short. Drugs against malaria are prescribed for the child, but are not available at the health centre. The young mother is therefore requested to purchase them from a nearby drug shop. She is also advised to go for voluntary counselling and testing for HIV in another new building on the same premises. She does not go there; it is late and she decides to head for home after purchasing the malaria drugs.

This scenario is common in many settings. Diagnostic tools and effective treatments exist to deal with the health problems encountered by the young mother and her child. However, in real life, the effectiveness at community level is commonly low due to inefficient supply and use. The example is taken from a typical resource-poor setting, but similar challenges can also be found in situations that are richer in resources.

The young mother and her child are the victims. Something needs to be changed. Finding the right solutions means getting the right answers to many questions, such as: Which services should be offered, and what should be done to ensure their use? Are community and provider preferences and efforts known and co-ordinated? Are we really addressing the felt needs of the communities? Do the routine systems adequately monitor and respond to individual disease and group risks?

What are health systems and health systems research?

Health systems include all organisations that influence health, whether they provide health services, address broader conditions for improved health or represent the users and communities that strive for better health. The World Health Organization (WHO) states that, despite strong global consensus on the need to strengthen health systems, there is no established framework for doing so in developing countries, and no agreed

formula to apply. Many health systems simply lack the capacity to measure or understand their own weaknesses and constraints. This effectively leaves policy-makers without scientifically sound ideas of what they can and should actually strengthen. Within such unmapped and misunderstood systems, interventions – even the very simplest – often fail to achieve their goals. This is not necessarily due to any inherent flaw in the intervention itself but rather to the often unpredictable behaviour of the system around it. Every intervention, from the simplest to the most complex, has an effect on the overall system, and the overall system has an effect on every intervention. WHO points out that health systems and subsystems such as a health programme must as a minimum ensure an adequate attention to six core elements: service delivery, health workforce, health information, medicines, financing and governance.

Health systems are embedded in a complex organisational, political and sociocultural context. Health systems research (HSR) is cross-disciplinary and inter-sectoral, with many contributions from political and management sciences. HSR aims to improve the health systems based on the best possible scientific knowledge available and in terms of effectiveness, efficiency, relevance and sustainability of health and health-related actions.

Recently, increased attention has been given to criteria and processes for priority-setting for health in resource-poor communities and to new ways of securing acceptance and support from the affected persons or communities. HSR at DBL gave this issue high priority.

Do the routine systems adequately monitor and respond to individual disease and group risks?

Health systems research at DBL

DBL's focus was initially on control of individual neglected tropical diseases (NTDs). Previously, control programmes addressing these diseases were virtually non-existent due to a lack of tools, methods, policies and strategies. Through its research and capacity building, DBL contributed to the development of such programmes, both nationally and internationally. These were rolled out, initially as vertical programmes addressing individual diseases, but increasingly with greater focus on their integra-

tion. It is now the general consensus that their interaction with and ultimate incorporation into the existing health systems are essential when aiming at sustainability.

DBL's HSR has reflected on these developments. It has addressed needs in relation to controlling individual diseases, but also more general needs in relation to strengthening health systems and services. DBL's broadened public health profile thus includes important elements of HSR. Some of DBL's HSR and capacity-building activities and achievements are described briefly below. The collaborative project with CIAM-Public Health Research and Development Centre in The Gambia is described separately in Chapter 19.

The Kenyan-Danish Health Research project

The multi-institutional research project in Kenya's Bondo district focused on school health, community health and health systems. The overall aim was to improve health service performance. The project came very timely, because it took place during a health service decentralisation reform process. Disease surveillance combined with studies of health service performance and planning led to much-needed evidence for changes of action and prioritisation. The district strategic plan developed for the Bondo district became a model for country-wide district planning.

Capacity building at Tanzania's Primary Health Care Institute

The Primary Health Care Institute (PHCI) in Iringa, Tanzania, is a zonal resource centre under the Ministry of Health. Its mandate is to monitor and support health systems performance, to oversee all training of health workers in the zone and to conduct other training where relevant. PHCI became a feasible entry point for DBL's support of health systems improvement in Tanzania. The collaboration helped PHCI fulfil its objectives related to 1) operational research, 2) collection, documentation and dissemination of health information, and 3) capacity-building at the district level for health care provision. District health authorities and district health management teams in selected districts were the primary beneficiaries. The performance of the district health management systems improved markedly. PHCI was a major partner in the REACT project (see below). PHCI has become a role model for zonal resource centres in Tanzania.

Response to accountable priority-setting for trust in health systems (REACT)

Priority-setting decisions must be made because resources are limited. Such decisions rest on a range of values and criteria. In practice, these are rarely adequately identified or agreed. Policies and plans developed at central levels are mostly based on measured burdens of diseases and on the known cost-effectiveness of different interventions. They frequently aim at quality, equity and efficiency. However, these values compete for the same limited resources, and operational guidance on the necessary

compromises is largely missing. For example, should one more health post be built, should additional staff be added to the existing clinic, or should new disease control campaigns be launched?

Local providers, users and communities have insight and preferences that can lead to the most feasible and acceptable choices. However, this knowledge base is seldom included in the decision-making process. As a consequence, the desired improvements in addressing health needs and demands and in ensuring increased utilisation are commonly not achieved.

The EU-funded REACT project took up the challenge by applying the principles of accountability for reasonableness (AFR) as a concept for legitimate and fair priority-setting. Four guiding conditions prevail in AFR: 1) relevance, 2) publicity, 3) appeal and revision, and 4) enforcement/leadership and public regulation.

Action research bringing the district medical officer and team together with researchers.

REACT was coordinated by DBL, and involved 11 collaborating institutions – seven in the study countries Kenya, Tanzania and Zambia, and four in Belgium, Norway, Sweden and Denmark. Health systems priority-setting was assessed using the AFR concept with an action research approach in one district in each study country. A team consisting of researchers and members of the district health management team

identified gaps in the AFR conditions and ensured that these gaps were addressed in a continuous process, increasingly involving the entire health team and others. This process and its outcomes were also analysed by other researchers.

The acceptability of the AFR concept was high in all districts, and the district leadership found AFR to provide useful additional guidance. Fears that AFR would be seen as a threat to existing power structures did not materialise during introductions of the concept at national and provincial levels, nor with district providers and users. The uptake of AFR was documented through changes in awareness and practice of fairness in a much broader community and stakeholder involvement in priority-setting processes.

Skills for leadership and communication were identified as particularly important to consolidate the AFR approach. The study results show that AFR can be applied to health systems in low-income countries and can contribute to motivation and empowerment of local providers and communities. The REACT actors in Kenya, Zambia and Tanzania continue the application and development of AFR. This promotes an increased focus on AFR as a learning-by-doing democratic health development approach.

AFR in a broader health system perspective

The strategies and methods used in the application of AFR resemble other efforts to support good governance and democratic learning. The four AFR guiding conditions constitute a framework that is easy to survey and they contribute to developing capacity for democratic practice shaped by specific contexts.

The AFR approach re-introduces a stronger consideration of values such as those guiding the original (now termed comprehensive) primary health care (PHC) approach. PHC has its focus on prevention, appropriate technology, inter-sectoral collaboration, community participation and a concern for equity within the context of a systems approach. WHO has recently given PHC and other systems approaches its attention. The further development of the systems approach would benefit tremendously from a process guiding tool such as AFR.

A central element would be a policy decision to promote fairness by supporting and further developing the AFR approach. This could lead to a change in health development paradigms from mainly relying on best possible utilisation of additional funds to a focus on identifying and optimising the use of existing resources. Such a paradigm shift would be important at any level of resource availability, and can be as important in relatively resource-rich countries as in resource-poor developing countries.

The empowerment for more democratic processes has a potential to create a basis for stronger decentralisation and local decision-making. This in turn will make the task of development assistance to the health sector easier. The need for continuous de-

velopment of new and frequently-conflicting priorities at international and national levels may be less necessary, and may be replaced by responsiveness and support of a priority-setting process that has increasingly become a local responsibility. The relevance for and the acceptability among the users will support improved community effectiveness of services and interventions. Furthermore, central levels will remain responsible for monitoring and providing capacity building, innovation, technical guidance and other organisational facilitation.

This DBL-co-ordinated research on priority setting for health has met increased resonance in publications and international fora. A specific panel session was held at the second Global Symposium for Health Systems Research in Beijing in November 2012. DBL has without doubt contributed to democratising decision-making for health and to self-reliance. This is very important from the point of view of achieving long-lasting improvements in health, especially in resource-poor communities.

21. Value for money has been high

BY NIELS ØRNBJERG

Overall impact

Effectiveness, efficiency, relevance, impact and sustainability are the criteria used when assessing the effects of development co-operation. In other words, did DBL deliver what it promised? Can any long-lasting positive effects on research and health development be seen? And can DBL's partners in the south do without DBL in the future? The answer to all three questions is 'yes'. DBL performed well. DBL was reviewed and evaluated repeatedly, and scored high on all criteria. It is beyond doubt that DBL made a relevant, effective and efficient high-impact contribution to sustainable health development, especially in Africa south of the Sahara. It used a coherent research, capacity-building and knowledge-management programme that was implemented in an equal partnership with its many collaborators in the north and the south.

DBL made a difference

DBL was instrumental in generating new knowledge through research, in translating and communicating research to inform policies, strategies and practices, and in building human, managerial, organisational and social capital at key collaborating institutions and networks. Individual researchers and research centres were supported in their progress towards research excellence, and key collaborating institutions and networks now stand strong as national and regional centres of excellence.

In addition, DBL trained a large number of planners and personnel to control neglected tropical diseases (NTDs). This allowed nationwide NTD control programmes to be initiated in many countries in Africa. Thus, in addition to its high scientific merit, with an impressive research productivity and quality, DBL's research also made an impact on health policies, strategies and practices. DBL's capacity-building efforts were comprehensive, not only in terms of the number of students trained, but also in the extent to which knowledge gained was transformed into practice.

DBL made a difference using criteria for effectiveness, efficiency, relevance, impact and sustainability and for national and global efforts to support sustainable health development. This is also reflected in a statement in a recent DBL review: "value for money was high for Danida". Some illustrative examples of such achievements have been provided in the preceding chapters and a short overview is presented in the following.

Tools and methods

Appropriate tools and methods are in great need in both research and control. Together with its partners, DBL contributed to improving disease diagnosis through the development of new versions of techniques for diagnosing intestinal human and animal schistosomiasis; methods for ultrasonographic diagnosis of *Oesophagostomum* infection and urinary and intestinal schistosomiasis were also optimised. To support monitoring of malaria control efforts, a tent trap for catching mosquitoes was developed, and new methods were adapted for indoor residual mosquito spraying in Mozambique. These methods and tools are now widely used. Ongoing urinary schistosomiasis vaccine trials now apply the DBL-developed eosinophilic cationic protein approach to morbidity assessment.

The usefulness of the pig as an experimental model for human intestinal Asian schistosomiasis was fully explored. DBL also contributed to the development of new regimens for treating malaria, filariasis, schistosomiasis, *Oesophagostomum* infection and other intestinal worm infections in trials in Tanzania, Kenya, Ghana and Uganda. A simple and appropriate low-technology method for environmental control of snails in irrigation schemes in Morocco was also developed and is now widely used.

International policies and strategies

DBL research contributed to the knowledge base behind the development of policies and strategies of the World Health Organization (WHO) and other international organisations. This impact reflects the high relevance of the DBL research agenda from a policy- and strategy-development perspective. The results were brought into the decision-making process through their inclusion in broader policy-directed publications and analysis.

DBL contributed to the inclusion of bed nets and new mass-treatment approaches in strategies for filariasis control, and to the need to focus on schools and on preschool children, non-school-attending children and pregnant mothers in de-worming programmes. Other important findings reflected in various strategies include the need for considering the animal reservoir in control of human Asian schistosomiasis, synergistic effects of integrating micronutrient supplements into de-worming programmes, and potential synergistic effects of concurrent schistosomiasis infection on the progression and severity of malaria, tuberculosis and HIV/AIDS.

The cumulative experience of DBL and its partners regarding research on children proved to be very useful in developing strategies and guidelines relating to children, orphaned children and adolescents. New policies on integrated and chemotherapy based strategies for controlling schistosomiasis and intestinal worms reflect clearly on results from DBL's research on schools as health providers and on its research on female genital schistosomiasis. DBL and partners can be credited for the much greater attention now paid internationally to controlling cysticercosis.

DBL was also very instrumental in supporting the international process of giving civil society organisations a role in setting the research agenda. DBL's health system research contributed without doubt to the provision of a credible basis for adopting new international thinking on priority-setting in health according to the principle of accountability for reasonableness, which builds on transparency and sustainability. This principle is increasingly used at district levels in Tanzania, Zambia and Kenya.

Participation of DBL staff on various committees under different international organisations, and staff participation in policy- and strategy-setting processes and fora, have been instrumental in promoting the transformation of DBL research into new policies and strategies. DBL's function as a WHO collaborating centre has also been crucial in this respect.

National policies and strategies

Translating research findings into practice is the most important role of research in development. And the higher the local relevance and level of local ownership, the greater the chances are that the research findings will be used. Throughout its existence, DBL's research agenda has reflected national needs and priorities, and DBL always paid close attention to the dissemination of research findings to disease control managers, policy-makers and politicians with the aim of inducing needed changes. The various means included research and policy briefs, meetings and seminars. This process was made easier by the fact that most projects and students were anchored in Ministry of Health research institutions. It is fully recognised that transforming research findings into policy change at national levels is a complex process, but changes have indeed been observed as a consequence of DBL's research. The following list of examples is far from complete.

Research in Uganda led to changes in malaria intervention among pregnant women, and the DBL-developed standards for clinical and ultrasonographic examination of hepatosplenic schistosomiasis patients were adopted in the Ugandan schistosomiasis and intestinal worm control programme. The recent demonstration of the safety of combining praziquantel, ivermectin and albendazole in one treatment also provided the background for policy change in Uganda. Epidemiological data from Uganda on the distribution of schistosomiasis and filariasis and the demonstration of heavy worm burdens in children under five years of age provided the background for yet another adjustment of the national control programme in Uganda. DBL's research on schools as contributors to improved health feeds into the development of the Kenyan school health programme. Policy and practice on de-worming in South Africa and an increased emphasis on local outreach health services in a district in Mozambique also reflected on DBL research findings. The outcome of an antenatal care project in The Gambia was the initiation of training of nurse attendants to improve their skills in managing labour and delivery.

Results from a DBL project on plant health systems were used by the Ministry of Agriculture as well as civil society organisations and local governments in various districts in Uganda as inputs in their planning processes to implement the government's new development strategy and investment plan.

Policy and strategy implications are also very evident from DBL's involvement in developing inter-sectoral decision-making skills in support of health impact assessments in Vietnam, Cambodia and Laos. Of major importance was DBL's instrumental role in developing national strategies and policies for health research in both The Gambia and Zambia. Similar processes were also nourished in Kenya and Uganda. Focus was on establishing the foundation for an efficient and effective national health research system. This included a legal framework, a robust policy, a coherent strategy and a realistic plan for health research to be used in guiding and regulating system development and implementation processes. The Gambia's experience could well turn it into a role-model for similar processes in other countries.

Building human capacity for research

As an important element of institutional capacity-building, DBL has provided support for many African PhD students. This has had an impressive and long-lasting positive impact on research in developing countries. The brain drain out of the African region has been minimal, many of the graduates are now recognised internationally for their research excellence, and many have been remarkably productive as regards international peer-review publications. DBL has produced many 'stars' who are now outstanding representatives for, and driving forces in, a still stronger African research community.

Most of the graduates now hold central positions in their national research systems with comprehensive international collaboration and funding. Many of them work in areas and positions with clear policy and advocacy implications. Out of the 50 PhD students completing their studies during the period 2004 to 2012, all remained in their home countries or in the African region, filling relevant positions. Once a funder and supervisor, DBL has become an equal collaborator, often on projects headed by the partner in the south.

Some PhD graduates changed focus from research to control. Here they fulfil the role as managers, co-ordinators or key staff in national onchocerciasis, filariasis, schistosomiasis, intestinal worm and malaria control programmes in for example Mozambique, Kenya, Zambia and Uganda. This has played a tremendously important role for bridging the gap between research and practice, and for the facilitation of a knowledge-based approach to controlling neglected tropical diseases. Other graduates now hold top management positions in Africa. Without doubt, DBL has built comprehensive human research capital in Africa that contributes markedly to sustainable research for health development.

DBL also provided support for thesis research for a great number of MSc students at universities in Africa. This has provided the background for strengthening master's degree programmes, for recruiting well-qualified candidates for the PhD programmes, and for increased efficiency and effectiveness in the daily work of the graduates at universities and in ministries in the health and environmental sectors. This also ensures an increased level of knowledge-based decision-making in the interest of sustainable development.

Training staff for disease-control programmes

Over the years, DBL has held courses to train numerous disease control programme staff in controlling schistosomiasis, intestinal worm diseases and filariasis and – in collaboration with WHO – controlling malaria. These cadres of trained staff provided the human backbone in a number of national schistosomiasis, intestinal helminth, filariasis and malaria control programmes being initiated in many countries in Africa. The rolling out of national programmes for controlling NTDs in many countries is thus based on skills and competences built up by DBL in collaboration with its southern partners. The choice of Uganda as the pilot country for controlling neglected tropical diseases was due to the comprehensive research efforts and disease control capacity built up there by DBL and its partners. Similarly, the health impact assessment capacity built up in the Mekong region played a central role in the increased attention paid in that region to health impact assessments in the context of an environmental impact assessment approach to sustainable development.

Building the Danish resource base

Many Danish PhD graduates anchored at DBL took up central positions in a Danish international health context, and many master's degree graduates associated with DBL embarked on PhD studies in international health and related issues. DBL was thus a major contributor to building up the Danish research and resource base in international health.

Institutional capacity development

Over the years, DBL has given increased attention to building up broader institutional capacity of a social and managerial nature. It is thus rightly recognised that sustainable health development requires strong institutions. Some of DBL's key collaborating institutions and networks have undergone major transitions, now reaching the status of national or regional centres of excellence. DBL can partly take the credit for such achievements. Several jointly developed courses in health impact assessments, statistics, mosquito ecology and control, and research methodology have become fully institutionalised at partner institutions, and new master's degree programmes have been established.

Many key DBL collaborating institutions are now recognised as key national players with a great influence on national processes and activities. The Primary Health Care Institute, Iringa, Tanzania, has become a role model for all zonal resource centres in Tanzania, and is increasingly seen as a key component of the structure of the health sector in Tanzania for driving and co-ordinating capacity-building for improved health sector performance at district level. The University of Nairobi Institute for Tropical and Infectious Diseases plays a key role in the Kenyan context for neglected tropical disease research and for driving the process of turning research into practice; and The Gambia's CIAM-Public Health and Development Centre has become a central national stakeholder in public health and development. The Institute for Gender and African Studies at the University of Nairobi has developed into a very strong institution; and the Cysticercosis Working Group in Eastern and Southern Africa has turned into a regional network of excellence. This working group has played a key role in making cysticercosis highly visible on the now-expanded international NTD agenda. The national roles, positions and relevance of these institutions and networks are profound. The capacity building provided by DBL at such institutions in terms of budgeting, accounting, management and financial reporting has played a central role.

Appendix 1

DBL STAFF LIST FROM 2004 TO 2012

Position indicated is that at the end of 2012 or that at the end of employment, unless otherwise indicated. Only staff with employment lasting more than 6 months are listed.

Academic core staff

Bloch, Paul, senior advisor (- May 2010)
Byskov, Jens, senior advisor (part time in 2012)
Charlwood, Derek, senior researcher (August 2005 - December 2010)
Furu, Peter, senior advisor (- August 2012)
Johansen, Maria Vang, professor PMSO
Kristensen, Thomas K., senior researcher
Madsen, Henry, senior researcher (part time in 2012)
Magnussen, Pascal, senior researcher
Olsen, Annette, senior researcher
Pedersen, Erling Møller, senior researcher (- December 2010; emeritus from January 2011)
Simonsen, Paul Erik, senior researcher
Vennervald, Birgitte J., professor
Ørnbjerg, Niels, director
Aagaard- Hansen, Jens, senior researcher (- January 2010)

Academic project staff

Bair, Ivan, project advisor (- November 2004)
Bruun, Birgitte, research assistant (July 2004 - March 2005)
Brå, Uffe Christian (February 2012-)
Danielsen, Solveig, associate professor (January 2010 - April 2012)
Jørgensen, Aslak, post doc (October 2004 - October 2009)
Lukanov, Assia B., project advisor (part-time, January 2008 - April 2010)
Mejer, Helena, post doc (2011 -)
Olsen, Øystein E., project senior advisor (April 2004 - December 2010)
Reimert, Claus, project senior researcher (September 2005 - December 2007)
Rohde, Gitte, project advisor (August 2005 - January 2008)
Saarnak, Christopher Larsen, project advisor (September 2006 -)
Sengupta, Mita, research assistant (January 2008 – September 2008)
Stensgaard, Anna-Sofie, post doc (2011-)

Northern PhD students

Hansen, Kristian Schultz (completed in 2005)
Jørgensen, Aslak (completed in 2004)
Lire, Tore (completed in 2010)
Nielsen, Nina (completed in 2006)
Olsen, Øystein E., (completed in 2010)
Petersen, Ulrik, B., (ongoing)
Prince, Ruth (completed in 2005)

Stensgaard, Anna-Sofie (completed in 2011)
Strandgaard, Hanne (completed in 2006)

Technicians

Clausen, Johan M., laboratory assistant (November 2004 - November 2005)
Dahlsten, Lene, laboratory technician (September 2008 - March 2010)
Groth, J. S., laboratory assistant (- August 2004)
Jensen, Bente L., laboratory technician (- June 2010)
Kronborg, Susanne, laboratory technician (part time in 2012)
Lauritzen, Kirsten, service assistant (January 2006 - December 2010)
Mandahl-Barth, Ulla, technical assistant (- December 2005)
Markussen, M., laboratory assistant (- June 2004)
Søndergård, Jesper, G., laboratory technician (- August 2004)
Vinter, Christina (September 2004 - May 2005)
Wilken, Benedikte L., laboratory technician (- January 2008)

Administrative staff

Andersen, Kirsten Grønlund, programme officer (January 2010 -)
Bagger, Anne, librarian (February 2004 - December 2007)
Gregart, Christian, administrator
Gøtsche, Grete, training co-ordinator (- December 2007)
Hansen, Lea Esbjørn, secretary/finance officer (September 2010 - December 2011)
Haunstrup, Dorte, human resources manager (- December 2007)
Johansen Dorte H., administrator (- July 2004)
Jørgensen, Kirsten, service assistant (March 2006 – July 2007)
Laigaard, Helle, L., student assistant (part-time, January 2009 -)
Larsen, Charlotte W., service assistant (January 2009 - September 2012, part time)
Leisner, Tine, finance officer (- March 2007)
Lykke, Torben, service assistant (September 2005 - August 2008)
Pieters, Alexandra H., programme officer (- December 2007)
Schøler, Helle L., programme officer (- September 2010)
Sefir, Emir, IT system manager (- December 2007)
Svenningsen, Elaine, editorial secretary (- March 2005)
Aaen, Henriette, executive assistant (- January 2007)

Appendix 2

RESEARCH PUBLICATIONS FROM 2004 TO 2012

African schistosomiasis, human aspects

Appleton, C.C., Madsen, H. 2012. Human schistosomiasis in wetlands in southern Africa. Wetlands Ecology and Management, 20, 253–269

Augusto, G., Magnussen, P., Kristensen, T.K., Appleton, C.C., Vennervald, B.J. 2009. The influence of transmission season on parasitological cure rates and intensity of infection after praziquantel treatment of *Schistosoma haematobium* in Mozambique. Parasitology, 136, 1771-1779

Balog, C.I., Hensbergen, P.J., Derks, R., Verweij, J.J., van Dam, G.J., Vennervald, B.J., Deelder, A.M., Mayboroda, O.A. 2009. Novel automated biomarker discovery work flow for urinary peptidomics. Clinical Chemistry, 55, 117-125

Balog, C.I.A., Alexandrov, T., Derks, R.J., Hensbergen, P.J., van Dam, G.J., Tukahebwa, E.M., Kabatereine, N.B., Thiele, H., Vennervald, B.J., Mayboroda, O.A., Deelder, A.M. 2010. The feasibility of MS and advanced data processing for monitoring *Schistosoma mansoni* infection. Proteomics Clinical Application, 4, 499-510

Balog, C.I., Meissner, A., Göraler, S., Bladergroen, M.R., Vennervald, B.J., Mayboroda, O.A., Deelder, A.M. 2011. Metabonomic investigation of human *Schistosoma mansoni* infection. Molecular BioSystems, 7, 1473-80

Booth, M., Vennervald, B.J., Butterworth, A.E., Kariuki, H.C., Amaganga, C., Kimani, G., Kenty, L.C., Mwatha, J., Otedo, A., Ouma, J.H., Dunne, D.W. 2004. Exposure to malaria affects the regression of hepatosplenomegaly after treatment for *Schistosoma mansoni* infection in Kenyan children. BMC Medicine, 2, 36. doi: 10.1186/1741-7015-2-36

Booth, M., Mwatha, J.K., Joseph, S., Jones, F.M., Kabatereine, N.B., Vennervald, B.J., Kadzo, H., Ireri, E., Kazibwe, F., Kemijumbi J., Kimani, G., Kariuki, H.C., Ouma, J.H., Dunne, D.W. 2004. Peri-portal fibrosis in human *Schistosoma mansoni* infection is associated with low IL10, low IFNγ, high TNFά or low RANTES, depending on age and gender. Journal of Immunology, 172, 1295-1303

Booth, M., Vennervald, B.J., Kabatereine, N.B., Kazibwe, F., Ouma, J.H., Kariuki, H.C., Muchiri, E., Kadzo, H., Ireri, E., Dunne, D.W. 2004. Demographic patterns of organ size and periportal fibrosis vary considerably between neighbouring communities in Uganda heavily exposed to *Schistosoma mansoni* infection. Transactions of the Royal Society of Tropical Medicine and Hygiene, 98, 125-136

Booth, M., Vennervald, B.J., Kenty, L.C., Butterworth, A.E., Kariuki, H.C., Kadzo, H., Ireri, E., Amaganga, C., Kimani, G., Mwatha, J.K., Otedo, A., Ouma, J.H., Muchiri, E., Dunne, D.W. 2004. Micro-geographical variation in exposure to *Schistosoma mansoni* and malaria, and exacerbation of splenomegaly in Kenyan school-aged children. BMC Infectious Diseases, 4, 1-11

Booth, M., Shaw, M.A., Carpenter, D., Joseph, S., Kabatereine, N.B., Kariuki, H.C., Mwatha, J.K., Jones, F.M., Vennervald, B.J., Ouma, J.H., Dunne, D.W. 2006. Carriage of *DRB1*13* is associated with increased post treatment IgE levels against *Schistosoma mansoni* antigens and lower long-term reinfection levels. Journal of Immunology, 176, 7112-7118

Dunne, D.W., Vennervald, B.J., Booth, M., Joseph, S., Fitzsimmons, C.M., Cahen, P., Sturrock, R.F., Ouma, J.H., Mwatha, J.K., Kimani, G., Kariuki, H.C., Kazibwe, F., Tukahebwa, E., Kabatereine, N.B. 2006. Applied and basic research on the epidemiology, morbidity, and immunology of schistosomiasis in fishing communities on Lake Albert, Uganda. Transactions of the Royal Society of Tropical Medicine and Hygiene, 100, 216-223

Eriksson, J., Reimert, C.M., Kabatereine, N.B., Kazibwe, F., Ireri, E., Kadzo, H., Eltahiri, H.B., Mohamed, A.O., Vennervald, B.J., Venge, P. 2007. The 434(G>C) polymorphism within the coding sequence of Eosinophil Cationic Protein (ECP) correlates with the natural course of *Schistosoma mansoni* infection. International Journal for Parasitology, 37, 1359-1366

Fitzsimmons, C.M., Joseph, S., Jones, F.M., Reimert, C., Hoffmann, K.F., Kazibwe, F., Kimani, G., Mwatha, J.K., Ouma, J.H., Kariuki, H.C., Vennervald, B.J., Kabatereine, N.B., Dunne, D.W. 2004. Schistosomiasis chemotherapy in Ugandan fishermen: Treatment can cause a rapid increase in Interleukin-5 levels in plasma but decreased levels of eosinophilia and worm-specific Immunoglobin-E. Infection and Immunity, 72, 4023-4030

Fitzsimmons, C.M., McBeath, R., Joseph, S., Jones, F.M., Walter, K., Hoffmann, K.F., Kariuki, H.C., Mwatha, J.K., Kimani, G., Kabatereine, N.B., Vennervald, B.J., Ouma, J.H., Dunne, D.W. 2007. Factors affecting human IgE and IgG responses to allergen-like *Schistosoma mansoni* antigens: Molecular structure and patterns of in vivo exposure. International Archives of Allergy and Immunology 142, 40-50

Joseph, S., Jones, F.M., Fulford, A.J., Kimani, G., Mwatha, J.K., Kamau, T., Kariuki, H.C., Kazibwe, F., Tukahebwa, E., Kabatereine, N.B., Ouma, J.H., Vennervald, B.J., Dunne, D.W. 2004. Increases in human T Helper 2 Cytokine responses to *Schistosoma mansoni* worm and worm-tegument antigens are induced by treatment with praziquantel. Journal of Infectious Diseases, 190, 835-842

Joseph, S., Jones, F.M., Kimani, G., Mwatha, J.K., Kamau, T., Kazibwe, F., Kemijumbi, J., Kabatereine, N.B., Booth, M., Kariuki, H.C., Ouma, J.H., Vennervald, B.J., Dunne, D.W. 2004. Cytokine production in whole blood cultures from a fishing community in an area of high endemicity for *Schistosoma mansoni* in Uganda: the differential effect of parasite worm and egg antigens. Infection and Immunity, 72, 728-734

Kabatereine, N.B., Kemijumbi, J., Ouma, J.H., Sturrock, R.F., Butterworth, A.E., Madsen, H., Ørnbjerg, N., Dunne, D.W., Vennervald, B.J. 2003. Efficacy and side effects of praziquantel treatment in a highly endemic *Schistosoma mansoni* focus at Lake Albert, Uganda. Transactions of the Royal Society of Tropical Medicine and Hygiene, 97, 599-603

Kabatereine, N.B., Kemijumbi, J., Ouma, J.H., Kariuki, H.C., Richter, J., Kadzo, H., Madsen, H., Butterworth, A.E., Ørnbjerg, N.,Vennervald, B.J. 2004. Epidemiology and morbidity of *Schistosoma mansoni* infection in a fishing community along Lake Albert in Uganda. Transactions of the Royal Society of Tropical Medicine and Hygiene, 98, 711-718

Kouriba, B., Traore, H.A., Dabo, A., Sangaré, L., Guindo, H., Keita, A.S., Reimert, C.M., Van Dam, G.J., Deelder, A.M., Doumbo, O., Dessein, A.J. 2005. Urinary disease in two Dogon populations with different exposure to *Schistosoma haematobium* infection: progression of bladder and kidney diseases in children and adults. Journal of Infectious Diseases, 15, 2152-2159

Leutscher, P.D.C., Pedersen, M., Raharisolo, C., Jensen, J.S., Hoffmann, S., Lisse, I., Ostrowski, S.R., Reimert, C.M., Mauclere, P., Ullum, H. 2005. Increased prevalence of leukocytes and elevated cytokine levels in semen from *Schistosoma haematobium*-infected individuals. Journal of Infectious Diseases, 191, 1639-1647

Leutscher, P.D., Ramarokoto, C.E., Hoffmann, S., Jensen, J.S., Ramaniraka, V., Ranndrianasolo, B., Raharisolo, C., Migliani, R., Christensen, N.Ø. 2008. Coexistence of urogenital schistosomiasis and sexually transmitted infection in women and men living in an area where *Schistosoma haematobium* is endemic. Clinical and Infectious Diseases, 47, 775-782

Leutscher, P.D., van Dam, G.T., Reimert, C.M., Ramarakoto, C.E., Deelder, A.M., Ørnbjerg, N. 2008. Eosinophil cationic protein, soluble egg antigen, circulating anodic antigen, and egg excretion in male urogenital schistosomiasis. American Journal of Tropical Medicine and Hygiene, 79, 422-426

Leutscher, P.D., Høst, E., Reimert, C.M. 2009. Semen quality in *Schistosoma haematobium* infected men in Madagascar. Acta Tropica, 30, 41-44

Malenganisho, L.M., Magnussen, P., Friis, H., Siza, J., Kaatano, G., Vennervald, B.J. 2008. *Schistosoma mansoni* morbidity among adults in two villages along Lake Victoria shores in Mwanza District, Tanzania. Transactions of the Royal Society of Tropical Medicine and Hygiene, 102, 532-541

Mentink-Kane, M.M., Cheever, A.W., Thompson, R.W., Hari, D.M., Kabatereine, N.B., Vennervald, B.J., Ouma, J.H., Mwatha, J.K., Jones, F.M., Donaldson, D.D., Grusby, M.J., Dunne, D.W.,Wynn, T.A. 2004. IL-13 receptor a-2 down-modulates granulomatous inflammation and prolongs host survival in schistosomiasis. Proceedings of the National Academy of Sciences of the United States of America, 101, 586-590

Midzi, N., Ndhlovu, P.D., Nyanga, L., Kjetland, E.F., Reimert, C.M., Vennervald, B.J., Gomo, E., Mudenge, G., Friis, H, Gundersen, S., Mduluza, T. 2004. Assessment of eosinophil cationic protein as a possible diagnostic marker for female genital schistosomiasis in women living in a Schistosoma haematobium endemic area. Parasite Immunology, 25, 581-588

Naus, C.W.A., Booth, M., Jones, F.M., Kemijumbi, J., Vennervald, B.J., Kariuki, C.H., Ouma, J.H., Kabatereine, N.B., Dunne, D.W. 2003. The relationship between age, sex, egg-count and specific antibody responses against *Schistosoma mansoni* antigens in a Ugandan fishing community. Tropical Medicine and International Health, 8, 561-568

Naus, C.W.A., Jones, F.M., Satti, M.Z., Joseph, S., Riley, E.M., Kimani, G., Mwatha, J.K., Kariuki, C.H., Ouma, J.H., Kabatereine, N.B., Vennervald, B.J., Dunne, D.W. 2003. Serological responses among individuals in areas where both schistosomiasis and malaria are endemic: cross-reactivity between *Schistosoma mansoni* and *Plasmodium falciparum*. Journal of Infectious Diseases, 187, 1272-1282

Ramarakoto, C.E., Leutscher, P.D., van Dam, G., Christensen, N.Ø. 2008. Ultrasonographical findings in the urogenital organs in women and men infected with *Schistosoma haematobium* in northern Madagascar. Transactions of the Royal Society of Tropical Medicine and Hygiene, 102, 767-773

Reimert, C.M., Fitzsimmons, C.M., Joseph, S., Mwatha, J.K., Jones, F.M., Kimani, G., Hoffmann, K.F., Booth, M., Kabatereine, N.B., Dunne, D.W., Vennervald, B.J. 2006. Eosinophil activity in *Schistosoma mansoni* infections *in vivo* and *in vitro* in relation to plasma cytokine profile pre- and post treatment with praziquantel. Clinical and Vaccine Immunology, 13, 584-593

Reimert, C.M., Tukahebwa, E.M., Kabatereine, N.B., Dunne, D.W., Vennervald, B.J. 2008. Assessment of *Schistosoma mansoni* induced intestinal inflammation by means of eosinophil cationic protein, eosinophil protein X and myeloperoxidase before and after treatment with praziquantel. Acta Tropica, 105, 253-259

Reinstrup, L., Jørgensen, A., Vennervald, B.J., Kristensen, T.K. 2012. DNA extraction from dried *Schistosoma haematobium* eggs isolated on nylon filters. Transactions of the Royal Society for Tropical Medicine and Hygiene, 106, 270- 272

Saathoff, E., Olsen, A., Magnussen, P., Kvalsvig, J.D., Becker, W., Appleton, C.C. 2004. Patterns of *Schistosoma haematobium* infection, impact of praziquantel treatment and re-infection after treatment in a cohort of schoolchildren from rural KwaZulu-Natal/South Africa. BMC Infectious Diseases, 4:40. doi:10.1186/1471-2334-4-40

Sacko, M., Magnussen, P., Traoré, M., Landouré, A., Doucouré, A., Reimert, C.M., Vennervald, B.J. 2009. The effect of single dose versus two doses of praziquantel on *Schistosoma haematobium* infection and pathology among school-aged children in Mali. Parasitology, 136, 1851-1857

Sacko, M., Magnussen, P., Keita, A. D., Traoré, M. S., Landouré, A., Doucouré, A., Madsen, H., Vennervald, B. J. 2011. Impact of *Schistosoma haematobium* infection on urinary tract pathology, nutritional status and anaemia in school-aged children in two different endemic areas of the Niger River Basin, Mali. Acta Tropica, 120, 142-150

Satti, M.Z., Cahen, P., Skov, P.S., Joseph, S., Jones, F.M., Fitzsimmons, C., Hoffmann, K.F., Rei-

mert, C., Kariuki, H.C., Kazibwe, F., Mwatha, J.K., Kimani, G., Vennervald, B.J., Ouma, J.H., Kabatereine, N.B., Dunne, D.W. 2004. Changes in IgE- and Antigen-dependent histamine-release in peripheral blood of *Schistosoma mansoni*-infected Ugandan fishermen after treatment with praziquantel. BMC Immunology, 5, 1-12

Tweyongyere, R., Mawa, P.A., Ngom-Wegi, S., Ndibazza, J., Duong, T., Vennervald, B.J., Dunne, D.W., Katunguka-Rwakishaya, E., Elliott, A.M. 2008. Effect of Praziquantel Treatment during Pregnancy on Cytokine Responses to Schistosome Antigens: Results of a Randomized, Placebo-Controlled Trial. Journal of Infectious Diseases, 198, 1870-1879

Tweyongyere, R., Mawa, P.A., Emojong, N.O., Mpairwe, H., Jones, F.M., Duong, T., Dunne, D.W., Vennervald, B.J., Katunguka-Rwakishaya, E., Elliott, A.M. 2009. Effect of praziquantel treatment of *Schistosoma mansoni* during pregnancy on intensity of infection and antibody responses to schistosome antigens: results of a randomised, placebo-controlled trial. BMC Infectious Diseases, 9: 32. doi: 10.1186/1471-2334-9-32

Tweyongyere, R., Mawa, P.A., Kihembo, M., Jones, F.M., Webb, E.L., Cose, S., Dunne, D.W., Vennervald, B.J., Elliott, A.M. 2011. Effect of praziquantel treatment of *Schistosoma mansoni* during pregnancy on immune responses to schistosome antigens among the offspring: results of a randomised, placebo-controlled trial. BMC Infectious Diseases, 11:234. doi: 10.1186/1471-2334-11-234

Vennervald, B.J., Kenty, L.C., Butterworth, A.E., Kariuki, H.C., Kadzo, H., Ireri, E., Amaganga, C., Kimani, G., Mwatha, J., Otedo, A., Booth, M., Ouma, J.H., Dunne, D.W. 2004. Detailed clinical and ultrasound examination of children and adolescents in a *Schistosoma mansoni* endemic area in Kenya: hepatosplenic disease in the absence of portal fibrosis. Tropical Medicine and International Health, 9, 461-470

Vennervald, B.J., Booth, M., Butterworth, A.E., Kariuki, H.C., Kadzo, H., Ireri, E., Amaganga, C., Kimani, G. Kenty, L.C., Mwatha, J., Ouma, J.H., Dunne, D.W. 2005. Regression of hepatosplenomegaly in Kenyan school-aged children after praziquantel treatment and three years of greatly reduced exposure to *Schistosoma mansoni*. Transactions of the Royal Society of Tropical Medicine and Hygiene, 99, 150-160

Walter, K., Fulford, A.J., McBeath, R., Joseph, S., Jones, F.M., Kariuki, H.C., Mwatha, J.K., Kimani, G., Kabatereine, N.B., Vennervald, B.J., Ouma, J.H., Dunne, D. 2006. Increased human IgE induced by killing *Schistosoma mansoni* in vivo is associated with prethreatment Th2 cytokine responsiveness to worm antigens. Journal of Immunology, 177, 5490-5498

Wilson, S., Vennervald, B.J., Kadzo, H., Ireri, E., Amaganga, C., Booth, M., Kariuki, H.C., Mwatha, J.K., Kimani, G., Ouma, J.H., Muchiri, E., Dunne, D.W. 2007. Hepatosplenomegaly in Kenyan schoolchildren: exacerbation by concurrent chronic exposure to malaria and *Schistosoma mansoni* infection. Tropical Medicine and International Health, 12, 1442-1449

Wilson, S., Jones, F.M., Mwatha, J.K., Kimani, G., Booth, M., Kariuki, H.C., Vennervald, B.J., Ouma, J.H., Muchiri, E., Dunne, D.W. 2009. Hepatosplenomegaly associated with chronic malaria exposure: evidence for a pro-inflammatory mechanism exacerbated by schistosomiasis. Parasite Immunology, 31, 64-71

Wilson, S., Vennervald, B.J, Kadzo, H., Ireri, E., Amaganga, C., Booth, M., Kariuki, H.C., Mwatha, J.K., Kimani, G., Ouma, J.H., Muchiri, E., Dunne, D.W. 2010. Health implications of chronic hepatosplenomegaly in Kenyan school-aged children chronically exposed to malarial infections and *Schistosoma mansoni*. Transactions of the Royal Society of Tropical Medicine and Hygiene, 104, 110-116

Wilson, S., Vennervald, B.J., Dunne, D.W. 2011. Chronic hepatosplenomegaly in African school children: a common but neglected morbidity associated with schistosomiasis and malaria. PLoS Neglected Tropical Diseases, 5 : e1149. doi: 10.1371/journal.pntd.0001149

Helminth zoonoses

Anh, N.T.L., Madsen, H., Thi, T., Hoberg, E., Dalsgaard, A., Murrell, K. 2012. Evaluation of the role of rats as reservoir hosts for fishborne zoonotic trematodes in two endemic northern Vietnam fish farms. Parasitology Research, 111, 1045–1048

Carabin, H., Balolong, E., Joseph, L., McGarvey, S.T., Johansen, M.V., Fernandez, T., Willingham, A.L., Olveda, R. 2005. Estimating sensitivity and specificity of a faecal examination method for *Schistosoma japonicum* infection in cats, dogs, water buffaloes, pigs and rats in Western Samar and Sorsogon Provinces, The Philippines. International Journal for Parasitology, 35, 1517-1524

Cederberg, S., Sikasunge, C.S., Andersson, Å., Johansen, M.V. 2012. *In vitro* efficacy testing of Praziquantel, Ivermectin and Oxfendazole against *Taenia solium* cysts. Journal of Parasitology Research, Article ID 36276. doi: 10.1155/2012/363276

Chi, T.T.K., Murrell, K.D., Madsen, H., Khue, N.V., Dalsgaard, A. 2009. Fishborne zoonotic trematodes in raw fish dishes served in restaurants in Nam Dinh province and Hanoi, Vietnam. Journal of Food Protection, 72, S394-S399

Clausen, J.H., Madsen, H., Murrell, K.D., Van, P.T., Thu, H.N.T., Do, D.T., Thi, L.A.N., Manh, H.N., Dalsgård, A. 2012. Prevention and Control of Fish-borne Zoonotic Trematodes in Fish Nurseries, Vietnam. Emerging Infectious Diseases, 18, 1438-1445

Duenngai, K., Sithithaworn, P., Rudrappa, U.K., Iddya, K., Laha, T., Stensvold, R., Strandgaard, H., Johansen, M.V. 2008. Improvement of polymerase chain reaction for detection of *Opisthorcis viverrini* DNA in human stool samples. Journal of Clinical Microbiology, 46, 366-368

Fitzpatrick, J.M., Johansen, M.V., Johnston, D.A., Dunne, D.W., Hoffmann, K.F. 2004. Gender associated gene expression in two related strains of *Schistosoma japonicum* as revealed by cDNA microarray profiling. Molecular Biochemical Parasitology, 136, 191-209

Iburg, T.M., Karlsson, M., Spång, F., Sikasunge, C.S., Johansen, M.V. 2012. The effect of oxfendazole treatment on muscle pathology in pigs infected with *Taenia solium* cysticercosis. Veterinary Parasitology, 190, 442-446

Joshi, D.D., Maharjan, M., Johansen, M.V., Willingham, A.L., Sharma, M. 2003. Improving meat inspection and control in resource-poor communities: the Nepal example. Acta Tropica, 87, 119-127

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Appendix 3

SELECTED KNOWLEDGE MANAGEMENT PUBLICATIONS FROM 2004 TO 2012

A call for civil society engagement in Research for Health- toward a post-Bamako action plan. Statement developed by the participants of the International Consultation for CSOs Engaged in Research for Health, Copenhagen, Denmark 2008

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World Health Organization. 2009. The role of Polymerase Chain Reaction techniques for assessing lymphatic filariasis transmission. Report of a workshop co-sponsored by the World Health Organization and DBL-Centre for Health Research and Development, University of Copenhagen, November 2006

Zhou, X-N., Shan, Lv., Kristensen, T.K., Bergquist, N.R., Utzinger, J., Malone, J.B. 2009. Spatial epidemiology in zoonotic parasitic diseases: insight gained at the 1st International Symposium on Geospatial Health in Lijiang, China. Parasites and Vectors, 2:10. doi: 10.1186/1756-3305-2-10

Appendix 4a

SOUTH PHD STUDY COMPLETIONS FROM 2004 TO 2012

Agyei-Baffour, P. 2010. Department of Community Health, School of Medical Sciences, College of Health Sciences, Kwame Nhrumah University of Science and Technology, Kumasi, Ghana: Access, use and cost implications for equity of home management of malaria in children under five years in rural Ghana. (Supervisors: E.N.L. Brown and E.Y. Kunfaa, Department of Community Health; K.S. Hansen, Department of Health Services Research, Institute of Public Health, University of Århus, Denmark; P. Magnussen, DBL)

Alusala, D.N. 2003. Division of Vector Borne Diseases (DVBD), Ministry of Health, Kenya (Department of Biology, Faculty of Science, University of Copenhagen): Malaria-vitamin A interactions in pregnancy and infancy: predictors of congenital malaria and effects of maternal vitamin A supplementation on infant malaria parasitaemia and morbidity. (Supervisors: B. Estambale, University of Nairobi, Kenya; J. Ouma, DVBD; H. Friis, Department of Human Nutrition, Royal Veterinary and Agricultural University; P. Magnussen and N. Ørnbjerg, DBL)

Asio, S.M. 2008. Department of Zoology, Makerere University, Kampala, Uganda (Department of Biology, Faculty of Science, University of Copenhagen): Studies on the epidemiology and control *of Mansonella perstans* infections in Uganda. (Supervisors: A.Onapa, Vector Control Division, Ministry of Health, Uganda; P.E. Simonsen, DBL)

Assane, Y.A. 2012. Department of Microbiology, Medical Faculty, Eduardo Mondlane University, Mozambique (Faculty of Health Sciences, University of Pretoria, South Africa): Human *Taenia Solium* Cysticercosis in the District of Angonia, Mozambique: Prevalence Rates and Clinical Aspects. (Supervisors: C. Schutte, Department of Neurology, Steve Biko Academic Hospital, University of Pretoria, South Africa; E. Noormahomed, Department of Microbiology; P. Magnussen, DBL)

Augusto, G. 2007. Institute of National Health, Maputo, Mozambique (School of Biology and Conservation Science, University of Natal, South Africa): Effect of transmission season on the outcome of treatment of urinary schistosomiasis in schoolchildren in Mtola and Maputo. (Supervisors: C. Appleton, School of Biology and Conservation Science; P. Magnussen, B.J. Vennervald and T.K. Kristensen, DBL)

Bam, V.B. 2011. Department of Community Health, School of Medical Sciences, College of Health Sciences, Kwame Nkrumah University of Science and Technology, Kumasi, Ghana: Control of pregnancy-associated malaria through community involvement in rural Ghana. (Supervisors: E.N.L. Brown, Department of Community Health; K. David, Hvidovre Hospital, Denmark; P. Magnussen, DBL)

Batwala, V.K. 2012. School of Public Health, Makerere University, Kampala, Uganda: Parasite-based diagnosis for malaria in Uganda: Feasibility and Cost-effectiveness. (Supervisors: F. Nuwaha, School of Public Health; K.S. Hansen, London School of Hygiene and Tropical Medicine, England; P. Magnussen, DBL)

Coulibaly, S.O. 2007. Laboratoire National de Santé Publique, Ministère de la Santé, Ouagadougou, Burkina Faso (Centre for Medical Parasitology (CMP), Department of International Health, Immunology and Microbiology, University of Copenhagen): Relationships between the use of antimalarial drugs in pregnancy and *Plasmodium falciparum* resistance. (Supervisors: B. Kone, Faculty of Health Sciences, University of Ouagadougou; T. Theander, CMP; P. Magnussen, DBL)

Enosse, S. 2004. National Institute of Health, Ministry of Health, Maputo, Mozambique (Department of Biology, Faculty of Science, University of Copenhagen): Antimalarial drug resistance in southern Mozambique: treatment efficacy and molecular characterization of *Plasmodium*

falciparum resistance to sulfadoxine-pyrimethamine. (Supervisors: R. Thompson, National Institute of Health; A. M. Rønn, Institute of Public Health, University of Copenhagen; P. Magnussen and N. Ørnbjerg, DBL)

Halwindi, H. 2010. Department of Biological Sciences, University of Zambia (Department of Public Health, Faculty of Health Sciences, University of Copenhagen): Community-directed treatment of soil-transmitted helminths in children aged 12 to 59 months of Mazubuka district in Zambia. (Supervisors: S. Siziya and R. Handema, Department of Biological Sciences; D. Meyrowitsch, Department of Public Health; A. Olsen and P. Magnussen, DBL)

Immuong, U. 2008. Department of Epidemiology, Faculty of Public Health, Khon Kaen University, Thailand: Development of Participatory Healthy Public Policy using Health Impact Assessment in the Context of Thai Local Government. (Supervisors: L. Charerntanyarak, Department of Epidemiology; P. Furu, DBL)

Kazibwe, F. 2004. Vector Control Division, Ministry of Health, Uganda (Department of Zoology, Makerere University, Kampala, Uganda): The ecology of *Biomphalaria* species and their role in transmission of *Schistosoma mansoni* at Lake Albert in Western Uganda. (Supervisors: J. Ouma and C. Kariuki, Division of Vector Borne Diseases, Ministry of Health, Kenya; R.F. Sturrock, London School of Hygiene and Tropical Medicine; B. Makanga and R. Akiiki, Department of Zoology; B.J. Vennervald, DBL)

Kinung'hi, S.M. 2011. Mwanza Medical Research Centre, Mwanza, Tanzania (Department of Veterinary Disease Biology, Faculty of Life Sciences, University of Copenhagen): Malaria and Helminth Co-infections in School and Pre-school Children in Magu District, Tanzania. (Supervisors: N.J.S. Lwambo, Mwanza Medical Research Centre; P. Magnussen and B.J. Vennervald, DBL)

Lange, C.N. 2005. National Museums of Kenya, Nairobi, Kenya (Department of Biology, Faculty of Science, University of Copenhagen): Diversity patterns of freshwater gastropods in lake habitats with and without anthropogenic disturbance in Lake Victoria, Kenya. (Supervisors: H. Madsen and T.K. Kristensen, DBL)

Luoba, A.I. 2004. Division of Vector Borne Diseases (DVBD), Ministry of Health, Kenya (Department of Microbiology, University of Nairobi, Kenya): Risk factors for intestinal helminth infection among pregnant and lactating women in Western Kenya with special emphasis on geophagy. (Supervisors: B. Estambale, Department of Microbiology; J. Ouma, DVBD; P.W. Geissler, London School of Hygiene and Tropical Medicine; H. Friis, Institute of Public Health, University of Copenhagen; P. Magnussen, DBL)

Machyo, P. 2006. Institute of African Studies (IAS), University of Nairobi, Kenya: Behaviour change sequencing in the household production of health: a study in the management of child survival in Bondo district of western Kenya. (Supervisors: S. Wandibba, IAS; J. Aagaard-Hansen, DBL)

Makoni, P. 2003. Blair Research Laboratory, Harare, Zimbabwe (Department of Biology, Faculty of Science, University of Copenhagen): Investigations to assess the suitability of *Sargochromis codringtonii* as a biological control agent of intermediate host snails for schistosomiasis. (Supervisors: M. Chimbari, Faculty of Science, University of Zimbabwe; H. Madsen, DBL)

Malenganisho, W.L.M. 2005. Mwanza Medical Research Centre, Mwanza, Tanzania (Department of Biology, Faculty of Science, University of Copenhagen): The role of HIV, micronutrient status and treatment in *Schistosoma mansoni* infection and morbidity: a cohort study among adults of Ukerewe and Mwanza Districts, Tanzania. (Supervisors: N. Lwambo, Mwanza Medical Research Centre; H. Friis, Institute of Public Health, University of Copenhagen; P. Magnussen, B.J. Vennervald and N. Ørnbjerg, DBL)

Maluka, S. 2011. Institute of Development Studies, University of Dar es Salaam, Tanzania (Department of Public Health and Clinical Medicine, Epidemiology, and Global Health, Umeå

University, Sweden): Strengthening Fairness, Transparency and Accountability in Health Care Priority Setting at District Level in Tanzania. (Supervisors: A-K. Hurtig and M.S. Sebastian, Department of Public Health and Clinical Medicine, Epidemiology, and Global Health; P. Kamuzora, Institute of Development Studies, Dar es Salaam, Tanzania); B. Ndawi, Primary Health Care Institute, Iringa, Tanzania; Ø. E. Olsen, Haydom Lutheran Hospital, Mbulu, Tanzania; E. Shayo, National Institute for Medical Research, Tanzania; J. Byskov, DBL)

Mangesho, P. 2011. Amani Medical Research Centre, Muheza, Tanzania (Department of Social Anthropology, University of Cape Town, South Africa): HIV/AIDS, food insecurity and the burden of history : An ethnographic study from North Eastern Tanzania. (Supervisors: S. Levine and F. Ross, Department of Social Anthropology; P. Bloch and J. Byskov, DBL)

Massa, K.M. 2007. School of Environmental Health, Tanga, Tanzania (Department of Biology, Faculty of Science, University of Copenhagen): Control of schistosomiasis and soil-transmitted helminthiasis among school-age children in north-eastern Tanzania. (Supervisors: B. Ndawi, Primary Health Care Institute, Iringa, Tanzania; A. Sheshe, School of Environmental Health, Tanga, Tanzania; R. Ntakamulenga, Vector Control Training Centre, Tanga, Tanzania; A. Olsen, P. Magnussen and N. Ørnbjerg, DBL)

Mbonye, A.K. 2006. Department of Community Health, Ministry of Health, Kampala, Uganda (Department of International Health, Faculty of Health Sciences, University of Copenhagen): A new approach to deliver malaria prevention interventions to pregnant women at a community level in Uganda. (Supervisors: I. Bygbjerg, Department of International Health; K.S. Hansen, Department of Health Services Research, Institute of Public Health, University of Århus; S. Neema, Institute for Social Research, Makerere University, Kampala, Uganda; P. Magnussen, DBL)

Mubyazi, G. 2010. Amani Medical Research Centre, Muheza, Tanzania (Department of International Health, Immunology and Microbiology (ISIM), Faculty of Health Sciences, University of Copenhagen): Economic and other Contextual Determinants of Acceptability and Practicability of Intermittent Preventive Treatment for Malaria during Pregnancy (IPTp) in Tanzania. (Supervisors: I. Bygbjerg, ISIM; K.S. Hansen, Department of Health Services Research, Institute of Public Health, University of Århus, Denmark; P. Bloch, P. Magnussen, J. Byskov and Ø.E. Olsen, DBL)

Mwanga, J.R. 2005. Mwanza Medical Research Centre, Mwanza, Tanzania (Danish University of Education, Copenhagen): Community-Integrated and Action-Oriented Health Education Intervention on Schistosomiasis and Other Illnesses among Children of Primary School-Going Age in Magu District, Tanzania. (Supervisors: B. Bruun Jensen and K. Schnack, Danish University of Education; J. Aagaard-Hansen, DBL)

Nalugwa, A. 2010. Makerere University Institute of Environment and Natural Resources, Kampala, Uganda: Genetic variability, molecular characterisation and distribution of species in the genus *Bulinus* (Gastropoda: Planorbidae) from the Albertine Rift Valley, East Africa. (Supervisors: S. Nyakaana, Makerere University Institute of Environment and Natural Resources; T.K. Kristensen, DBL)

Namwanje, H. 2011. Vector Control Division (VCD), Ministry of Health, Uganda (Department of Veterinary Disease Biology, Faculty of Life Sciences, University of Copenhagen): Safety and efficacy of drug combinations in the treatment of helminth infections in pre-school and school children in Uganda. (Supervisors: N.B. Kabatereine, VCD; A. Olsen, DBL)

Nchito, M. 2004. University Teaching Hospital, Lusaka, Zambia (Department of Biology, Faculty of Science, University of Copenhagen): Effects of iron and multi-micronutrient supplementation on geophagy, *Ascaris lumbricoides* reinfection, iron status and growth among Zambian schoolchildren in Lusaka. (Supervisors: L. Mubita, Department of Biological Sciences, University of Zambia; H. Friis, Department of Epidemiology, Institute of Public Health, University of Copen-

hagen; A. Olsen and N. Ørnbjerg, DBL)

Ndyomugyenyi, L.K. 2009. Uganda AIDS Commission, Kampala, Uganda (Institute for International Health, Immunology and Microbiology (ISIM), Faculty of Health Sciences, University of Copenhagen): Influence of HIV infection on the effectiveness of malaria prevention during pregnancy with emphasis on the effect of chloroquine on HIV viral load in urban Uganda. (Supervisors: T. Theander, ISIM, P. Magnussen, DBL)

Ngowi, H. 2005. Sokoine University of Agriculture (SUA), Morogoro, Tanzania: Effectiveness of health education intervention in reducing the incidence rate of porcine cysticercosis in Mbulu district, Northern Tanzania. (Supervisors: A.A. Kassuku, M.R.S. Mlozi and J.E.D. Mlangwa, SUA; J. Monrad and L. Willingham, Royal Veterinary and Agricultural University, Copenhagen; M. V. Johansen, DBL)

Nguyen, T.L.A. 2009. National Institute of Veterinary Research, Hanoi, Vietnam (Department of Veterinary Disease Biology, Faculty of Life Sciences, University of Copenhagen): Fishborne zoonotic trematodes in domestic animals and their role in the transmission to cultured fish in North Vietnam. (Supervisors: L. To Thu, National Institute of Veterinary Research; S.M. Thamsborg and D. Murrell, Department of Veterinary Disease Biology; M.V. Johansen, DBL)

Njaanake, H.K. 2012. University of Nairobi Institute of Tropical and Infectious Diseases, Nairobi (UNITID), Kenya: Morbidity patterns and spatial distribution of *Schistosoma haematobium* and intestinal helminth infections among children in Tana delta District, Kenya. (Supervisors: B.B.A. Estambale, UNITID; P.E. Simonsen and B.J. Vennervald, DBL)

Nnko, S.E.A. 2008. Mwanza Medical Research Centre, Mwanza, Tanzania (Department of Anthropology, Faculty of Social Sciences, University of Copenhagen): Malaria, Modernity and the State: Ambivalence towards Public Health Interventions in Tanzania. (Supervisors: S.R. Whyte, Department of Anthropology; P.W. Geissler, London School of Hygiene and Tropical Medicine; J. Aagaard-Hansen, DBL)

Ntakamulenga, R.G. N. 2003. Vector Control Training Centre, Tanga, Tanzania (Department of Biology, Faculty of Science, University of Copenhagen): *Ascaris lumbricoides* infection among pre-school children in relation to the children's defecation and excreta disposal behaviour in a rural area of north-eastern Tanzania. (Supervisors: A. Olsen and N. Ørnbjerg, DBL)

Nyamai, R.K. 2010. Department of Educational Foundations, School of Education, Kenyatta University, Nairobi, Kenya (Danish School of Education, University of Århus): Exploiring Teacher Competences and Learner Participation in HIV/AIDS Education through the Application of the Investigations Visions Action and Change (IVAC) Approach - An Action Research of Schools in Mutomo District, Kenya. (Supervisors: E. Otiende, Department of Educational Foundations; V. Simovska, Danish School of Education; J. Aagaard-Hansen, DBL)

Nyambedha, E.O. 2006. Institute of African Studies, University of Nairobi, Kenya (Department of Anthropology, Faculty of Social Sciences, University of Copenhagen): Children and HIV/AIDS- Questioning Vulnerability in Western Kenya. (Supervisors: K. Olvig, Department of Anthropology; J. Aagaard-Hansen, DBL)

Olungah, C. O. 2006. Institute of African Studies (IAS), University of Nairobi, Kenya: The sociocultural context of maternal healthcare in Bondo district, Western Kenya: implications for safe motherhood interventions. (Supervisors: C. Suda, IAS; J. Aagaard-Hansen, DBL)

Onapa, A.W. 2005. Vector Control Division, Ministry of Health, Uganda (Department of Biology, Faculty of Science, University of Copenhagen): Studies on the geographical distribution and epidemiology of lymphatic filariasis in Uganda. (Supervisors: P.E. Simonsen and E.M. Pedersen, DBL)

Pondja, A. 2010. Faculty of Veterinary Medicine, Eduardo Mondlane University, Maputo, Mozambique (Faculty of Veterinary Medicine, Sokoine University of Agriculture, Morogoro, Tanza-

nia): Epidemiology and evaluation of control strategies for porcine cysticercosis in Angonia district, Mozambique. (Supervisors: L. Neves, Faculty of Veterinary Medicine; J. Mlangwa, Faculty of Veterinary Medicine, Sokoine University of Agriculture; M.V. Johansen, DBL)

Range, N.S. 2004. National Institute for Medical Research, Dar es Salaam, Tanzania (Department of Biology, Faculty of Science, University of Copenhagen): The role of micronutrients and co-infections in pulmonary tuberculosis: a randomized, controlled trial in Tanzania. (Supervisors: M. Malacela, National Institute for Medical Research; Å. Bengård Andersen, Copenhagen University Hospital; H. Friis, Department of Epidemiology, Institute of Public Health, University of Copenhagen; P. Magnussen and N. Ørnbjerg, DBL)

Rwegoshora, R.T. 2004. Amani Medical Research Centre, Amani, Tanzania (Department of Biology, Faculty of Science, University of Copenhagen): *Wuchereria bancrofti* in East Africa: patterns of transmission in two communities with different levels of endemicity. (Supervisors: P.E. Simonsen and E.M. Pedersen, DBL)

Sacko, M. 2006. National Institute for Research and Public Health, Bamako, Mali (Department of Biology, Faculty of Science, University of Copenhagen): Assessment of the effect of two different treatment strategies on the morbidity caused by *Schistosoma haematobium* infections among school aged children in the Niger River Basin, Mali. (Supervisors: M. Traore, Ministry of Health, Mali; B.J. Vennervald, P. Magnussen, C. Reimert and N. Ørnbjerg, DBL)

Sikasunge, C.S. 2009. Department of Paraclinical Studies, School of Veterinary Medicine, University of Zambia (Department of Veterinary Disease Biology, Faculty of Life Sciences, University of Copenhagen): Immuno-pathological responses to *Taenia solium* infections in pigs. (Supervisors: I.K. Phiri, Department of Paraclinical Studies; A.L. Willingham and P.S. Leifsson, Department of Veterinary Disease Biology; M.V. Johansen, DBL)

Simoonga, C. 2006. Ministry of Health Planning and Development, Lusaka, Zambia (School of Biological and Conservation Sciences, University of KwaZulu - Natal, South Africa): The spatial epidemiology of schistosomiasis and soil-transmitted helminthiasis in Zambia. (Supervisors: C. Appleton, School of Biological and Conservation Sciences; L. Mubila, Department of Biological Sciences, University of Zambia; T.K. Kristensen and A. Olsen, DBL)

Siwila-Saasa, J. 2011. School of Veterinary Medicine, University of Zambia (Department of Veterinary Disease Biology, Faculty of Life Sciences, University of Copenhagen): Intestinal parasitism with special emphasis on *Cryptosporidium* spp. in children in pre-schools in Kafue district, Zambia. (Supervisors: I.K. Phiri, School of Veterinary Medicine, University of Zambia; H.L. Enemark, Danish Technical University; M.N. Nchito, Ministry of Education, Zambia; A. Olsen, DBL)

Thien, P.C. 2011. Research Institute for Aquaculture no. 2, Ho Chi Minh City, Vietnam (Department of Veterinary Disease Biology, Faculty of Life Sciences, University of Copenhagen): Occurrence and risk factors of fishborne zoonotic trematodes in major freshwater fish species cultures in the Mekong Delta of Vietnam. (Supervisors: A. Dalsgaard and K.D. Murrell, Department of Veterinary Disease Biology; A. Olsen, DBL)

Tukahebwa, E. 2010. Vector Control Division, Ministry of Health, Kampala, Uganda (Institute of Public Health, Makerere University, Uganda): The effect of one versus two praziquantel treatments on *Schistosoma mansoni* morbidity and re-infection in a high transmission focus along Lake Victoria in Uganda. (Supervisors: F. Nuwaha, Institute of Public Health; B.J. Vennervald and P. Magnussen, DBL)

Tweyongyere, R. 2008. Uganda Virus Research Institute, Entebbe Central Diagnostic Laboratory, Kampala, Uganda (Faculty of Veterinary Medicine, Makerere University, Uganda): Effect of praziquantel treatment against *Schistosoma mansoni* during pregnancy on anti-schistosome immune responses in pregnant women and their babies. (Supervisors: E. Katunguka-Rwakishaya, Faculty of Veterinary Medicine; A. M. Elliott, London School of Hygiene and Tropical

Medicine; N. Kabatereine, Vector Control Division, Ministry of Health, Uganda; D.W. Dunne, Department of Pathology, University of Cambridge, England; B. J. Vennervald, DBL)

Wachira, D. 2004. Division of Vector Borne Diseases (DVBD), Ministry of Health, Kenya (Department of Zoology, Kenyatta University, Kenya): Spatial and temporal distribution of malaria vectors and malaria transmission in Bondo District, Kenya. (Supervisors: J. Ouma, DVBD; E.W. Kabiru, Department of Zoology; C. Bøgh and H. Madsen, DBL)

Wang, T. 2005. Anhui Institute of Parasitic Diseases, Anhui, P.R. China (Department of Biology, Faculty of Science, University of Copenhagen): Animal reservoirs for *Schistosoma japonicum* and their contribution to transmission in the Yangtze River Valley, Anhui Province, China. (Supervisors: L. Jiaojiao; Shanghai Institute of Animal Parasitology; Z. Xiaonong, National Institute of Parasitic Diseases; M.V. Johansen and N. Ørnbjerg, DBL)

Ziem, J.B. 2006. University for Development Studies, Tamale, Ghana (University of Leiden, the Netherlands): Controlling human oesophagostomiasis in northern Ghana. (Supervisors: A.M. Polderman, University of Leiden; P. Magnussen and A. Olsen, DBL)

Appendix 4b

SOUTH MASTER STUDY COMPLETIONS FROM 2004 TO 2012

Boa, C.N. 2006. Biology Department, Faculty of Science, Eduardo Mondlane University (EMU), Maputo, Mozambique: Dynamics of *Schistosoma haematobium* in Maputo urban and peri-urban areas, southern Mozambique. (Supervisors: C. Boane, EMU; G. Augusto, National Institute of Health, Ministry of Health, Maputo, Mozambique; DBL focal point: P. Magnussen)

Buce, E. 2008. Department of Intestinal and Vesical Parasitology, National Institute of Health, Ministry of Health, Maputo, Mozambique (Department of Biology, Science Faculty, Eduardo Mondlane University (EMU), Maputo, Mozambique): Evaluation of the prevalence and intensity rate of intestinal parasites in children in school age (6 to 12 years) in the community of Massavase, Administrative post of Lionde. (Supervisors: G. Augusto, Department of Intestinal and Vesical Parasitology; C. Boane, EMU; DBL focal point: P. Magnussen, DBL)

Chichava, O.A. 2006. Biology Department, Faculty of Science, Eduardo Mondlane University (EMU), Maputo, Mozambique: Identification of malaria vectors in Massavase. (Supervisors: N. Cuamba, EMU; J.D. Charlwood, DBL)

Chitongo, P. 2003. Department of Biochemistry, University of Zimbabwe: A study on the role of interleukin-10 and tumour necrosis factor-alpha promoter gene polymorphism in *Plasmodium falciparum* malaria severity. (Supervisors: T. Mduluza and M. Chirara, Department of Biochemistry; DBL focal point: B.J. Vennervald)

Chiundu, M. 2006. Sociology Department, Chancellor College, University of Malawi, Blantyre, Malawi: Assessing effectiveness of drug revolving funds within Mpenda Health Centre catchment area. (Supervisors: G. Malenga, Malaria Alert Centre; P. Bloch, DBL)

Chiweka, N.C. 2012. Sokoine University of Agriculture (SUA), Morogoro, Tanzania: Economic analysis of smallholder pig production in Tanzania: The case of Mbeya and Mbozi districts, Mbeya region. (Supervisors: J. Makindara and J. Mlangwa, SUA; H. Mejer, SPHD)

Cuinhane, C. 2009. Institute of Anthropology, Gender and African Studies (IAGAS), University of Nairobi, Kenya: Community perceptions and practices regarding transmission and management of human and porcine cysticercosis in Angonia rural district, Mozambique. (Supervisors: C. Owuor and I. Nyamongo , IAGAS; M.V. Johansen, DBL)

Dorji, K. 2004. Ministry of Health, Bhutan (Department of International Health, Institute of Pub-

lic Health, Faculty of Health Sciences, University of Copenhagen): Assessing the general nurse mid-wife graduate's perceptions of the training in Royal Institute of Health Sciences and their appropriateness in the work place. (Supervisors: I.U. Netterstrøm, Danish University of Education; J. Aagaard-Hansen, DBL)

Elisante, K.R. 2009. Sokoine University of Agriculture (SUA), Morogoro, Tanzania (Institute of Anthropology, Gender and African studies (IAGAS), University of Nairobi, Kenya): Lay people's knowledge, perception and practices regarding the transmission and management of human and porcine cysticercosis in Mbeya rural district, Tanzania. (Supervisors: C.Owuor and I. Nyamongo, IAGAS; M. Malongo, SUA; M.V. Johansen, DBL)

Fufane, H. 2011. Faculty of Science and Technology, University of Bamako, Mali: Evaluation and validation of morbidity markers (ECP, EPX) in schistosomiasis pre-treatment. (Supervisors: B. Sadio, Faculty of Science and Technology; M. Sacko, National Institute for Research and Public Health, Bamako, Mali; DBL focal point: B.J. Vennervald)

Kagina, M.M. N. 2006. Institute of Tropical Medicine and Infectious Diseases, Jomo Kenyatta University of Agriculture and Technology, Nairobi, Kenya: Investigations towards establishing the predictors of persistent iodine deficiency disorders (IDD) in Nyandurua district, central highlands of Kenya. (Supervisors: D.L. Mwaniki, Kenya Medical Research Institute, Nairobi; DBL focal point: P. Magnussen)

Kambango, A. 2009. Biology Department, Faculty of Science, Eduardo Mondlane University, Maputo, Mozambique: The effect of moonlight on mosquito and people's behaviour. (Supervisors: N. Cuanda and B. Muatinte, Biology Department; J.D. Charlwood, DBL)

Kefi, A.S. 2007. Bunda College of Agriculture, University of Malawi, Lilongwe, Malawi: Size preferences of hatchery bred and wild *Trematocratus placodon* (Pisces: Ciclidae) for *Bulinus* species. (Supervisors: J. Likongwe, Bunda College of Agriculture; J.R. Stauffer, Pennsylvania State University, USA; H. Madsen, DBL)

Konate, O. 2011. Faculty of Science and Technology, University of Bamako, Mali: Evaluation and validation of morbidity markers (ECP, EPX) in schistosomiasis post-treatment. (Supervisors: A. Toure, Faculty of Science and Technology; M. Sacko, National Institute for Research and Public Health, Bamako; DBL focal point: B.J. Vennervald)

Kone, F. 2011. Faculty of Medicine and Pharmacy, University of Bamako, Mali: Efficiency of single dose 40 mg Praziquantel on morbidity caused by *Schistosoma* infection among pre-school children in two endemic settings, Segou region, Mali. (Supervisors: A.D. Keita, Faculty of Medicine and Pharmacy; M. Sacko, National Institute for Research and Public Health, Bamako, Mali; DBL focal point: B.J. Vennervald)

Kubiriza, G.K. 2007. Bunda College of Agriculture, University of Malawi, Lilongwe, Malawi: Influence of temperature on growth, survival and reproduction in *Bulinus nyassanus* (Smith, 1877). (Supervisors: J. Likongwe, Bunda College of Agriculture; J. R. Stauffer, Pennsylvania State University, USA; H. Madsen, DBL)

Lipendele, C.P. 2012. Sokoine University of Agriculture (SUA), Morogoro, Tanzania: Performance of pigs kept under different management systems by small-holder farmers in Mbeya and Mbozi districts, Tanzania. (Supervisors: F. Lekule and D. Mushi, SUA; H. Mejer, SPHD)

Lituri, E. 2008. Department of Intestinal and Vesical Parasitology, National Institute of Health, Ministry of Health, Maputo, Mozambique (Department of Biology, Science Faculty, Eduardo Mondlane University, Maputo, Mozambique): Mapping places of occurrence of schistosomiasis transmission in the districts of Manhica and Marracuene, Province of Maputo, 2006-2007. (Supervisors: G. Augusto, Department of Intestinal and Vesical Parasitology; B. Muatite, Department of Biology; DBL focal point: P. Magnussen)

Lundeba, M. 2005. Department of Aquaculture and Fisheries Sciences, Bunda College of Agri-

culture, University of Malawi, Lilongwe, Malawi: Potential of *Metriaclima lanisticola* (Pisces: Cichlidae) for biological control of schistosome intermediate host snails. (Supervisors: J. S. Likongwe, Department of Aquaculture and Fisheries Sciences; J. Stauffer, Pennsylvania State University, USA; H. Madsen, DBL)

Machado, J. 2006. Biology Department, Faculty of Science, Eduardo Mondlane University, Maputo, Mozambique: Mating and age in anophelines. (Supervisors: N. Cuamba, Biology Department; D.J. Charlwood, DBL)

Makonombera, M.J.R. 2008. Faculty of Science, Chancellor College, University of Malawi, Blantyre, Malawi: Knowledge, Attitudes and Practices (KAP) Regarding Shallow Water Fishing in Relation to Schistosomiasis Control in Chembe Village, Mangoshi District, Malawi. (Supervisors: P. Mvula and S. S. Chiotha, Faculty of Science; P. Bloch, DBL)

Makundi, I.J. 2011. Sokoine University of Agriculture (SUA), Morogoro, Tanzania: Prevalence and related risk factors of porcine cysticercosis and African swine fever in selected urban/periurban areas of Morogoro, Tanzania. (Supervisors: H. Ngowi, SUA; J.P. Nielsen, Faculty of Life Sciences, University of Copenhagen; M.V. Johansen, DBL)

Manaca, N.M. 2006. Biology Department, Faculty of Science, Eduardo Mondlane University, Maputo, Mozambique: Mosquito ecology and taxonomy in Massavase. (Supervisors: N. Cuamba, Biology Department; D.J. Charlwood, DBL)

Mangara, S. 2010. Faculty of Sciences and Technology, University of Bamako, Mali: Urinary and intestinal schistosomiasis in pre-school children in two endemic settings in Mali. (Supervisors: M. Sacko, National Institute for Research and Public Health, Bamako, Mali; T. Kone, Faculty of Sciences and Technology; DBL focal point: B.J. Vennervald)

Manhique, E.A. 2009. Faculty of Veterinary Medicine, Eduardo Mondlane University, Maputo, Mozambique (Faculty of Life Sciences, University of Copenhagen): Assessing risk factors for *Taenia solium* cysticercosis in Inhambane province - Mozambique. (Supervisors: S. Alonso, Faculty of Veterinary Medicine; L. Willingham, SPHD; M.V. Johansen, DBL)

Matwale, G.K. 2005. Vector Control Division, Ministry of Health, Kampala, Uganda (Makerere University, Kampala, Uganda): Vector potential of *Anopheles* species (Diptera: Culicidae) in the transmission of *Plasmodium* in Lukaya Town Council, Masaka District, Uganda. (Supervisors: A. M. Kezimbira and J.J. Lutwama, Makerere University; DBL focal point: E.M. Pedersen)

Mpoya, S. 2011. Department of Medicine, Makerere University, Uganda: Prevalence of schistosomiasis-malaria co-infection and its association with clinical and ultrasonographic characteristics along Lake Albert, Buliisa District, Uganda. (Supervisors: C. Karamagi, Department of Medicine; N.B. Kabatereine and E. Tukahebwa, Vector Control Division, Ministry of Health, Uganda; DBL focal point: B.J. Vennervald, DBL)

Mubita, P. 2008. Department of Biological Sciences, University of Zambia, Lusaka, Zambia: Freshwater snail diversity in relation to schistosomiasis in Lusaka Province, Zambia. (Supervisors: E.M. Chidumayo, Department of Biological Sciences; C. Simoonga, Ministry of Health, Zambia; T.K. Kristensen, DBL)

Muga, G.O. 2006. Institute of African Studies (IAS), University of Nairobi, Kenya: Food security in the households headed by the elderly caretakers in Nyang´oma sublocation, Bondo District of western Kenya. (Supervisors: W. Onyango-Ouma, IAS; J. Aagaard-Hansen, DBL)

Muiruri, S.K. 2004. Division of Vector Borne Diseases, Ministry of Health, Kenya (Jomo Kenyatta University of Agriculture and Technology, Nairobi, Kenya): Determination of predator feeding preference on immature stages of *Anopheles* mosquitoes. (Supervisors: D.W. Wachira, Division of Vector Borne Diseases; DBL focal point: E. M. Pedersen)

Namuraha, H. 2007. Department of Biological Sciences, Faculty of Science, Eduardo Mondlane University, Maputo, Mozambique: Prevalence of malaria and associated risk in a rural area of

southern Mozambique. (Supervisors: S. Enosse and N. Cuamba, National Institute of Health, Maputo; S. Silva, Department of Biological Sciences; J.D. Charlwood, DBL)

Ng'wena, O.N. 2011. Department of Sociology and Anthropology, Maseno University, Kenya: Livelihood strategies for Children Born out of Wedlock in Nyang'oma Division, Bondo district, Kenya. (Supervisors: E Nyambedha and C.O. Ochola, Department of Sociology and Anthropology; DBL focal point: N. Ørnbjerg)

Nhomele, J.L. 2006. Veterinary Faculty, Eduardo Mondlane University, Maputo, Mozambique: Mapping the human blood index (HBI) and mosquito density of malaria vectors in houses according to cattle density. (Supervisors: L. Nevas, Veterinary Faculty; J.D. Charlwood, DBL)

Nyabundi, A.A. 2012. Department of Sociology and Anthropology, Maseno University, Kenya: Health Seeking practices of caregivers for children with perceived malaria related fever in Marera Sub-Location, Kisumu County, Kenya (Supervisors: E. Nyambedha and P. Obonyo, Department of Sociology and Anthropology; DBL focal point: N. Ørnbjerg)

Nyaga, L.N.K. 2005. Institute of African Studies (IAS), University of Nairobi, Kenya. Mothers' perception and management of malaria among young children in Nyang'oma area of Bondo District. (Supervisors: I Nyamongo, IAS; J. Aagaard-Hansen, DBL)

Nyamanga, P.A. 2005. Institute of African Studies (IAS), University of Nairobi, Kenya: Ethnoveterinary perceptions and practices and how they relate to human health care: a case study of Nyang'oma Division, Bondo District, Western Kenya. (Supervisors: C. Suda, IAS; J. Aagaard-Hansen, DBL)

Odek, A. 2005. Division of Vector Borne Diseases, Ministry of Health, Nairobi, Kenya (Department of Biochemistry and Biotechnology, Kenyatta University, Nairobi, Kenya): Assessment of eosinophiluria using eosinophil cationic protein: comparative study in single and mixed *Schistosoma* infections in Kenyan school children. (Supervisors: E.U. Kenya, Department of Biochemistry and Biotechnology; M.T. Mwanje, Division of Vector Borne Diseases, Ministry of Health, Nairobi, Kenya; C. Reimert, DBL)

Okungu, V.R. 2004. Institute of African Studies (IAS), University of Nairobi, Kenya: The Influence of Socio-Cultural and Economic Factors on the Girl Child Education in Nyang'oma sublocation, Bondo District, Kenya. (Supervisors: C. Suda, IAS; J. Aagaard-Hansen, DBL)

Okuther, H.A. 2012. Department of Sociology and Anthropology, Maseno University, Kenya: The role of households in domestic waste management in Nyalenda Slums, Kisumu Municipality, Western Kenya. (Supervisors: E. Nyambedha and B.O. Oindo, Department of Sociology and Anthropology; DBL focal point: N. Ørnbjerg)

Olang'o, C.O. 2008. Institute of Anthropology, Gender and African Studies (IAGAS), University of Nairobi, Kenya: An ethnographic study of home-based care for people living with HIV/AIDS in Nyang'oma, Bondo District in Western Kenya. (Supervisors: I. Nyamongo, IAGAS; J. Aagaard-Hansen, DBL)

Orech, F.O. 2005. Department of Botany, Faculty of Science, Jomo Kenyatta University of Agriculture and Technology, Nairobi, Kenya: The ecobiodiversity and possible toxicity of some traditional leafy vegetables of Nyang'oma, western Kenya. (Supervisors: H. Friis, Department of Epidemiology, University of Copenhagen; J. M Ochora and T. Akeng'a, Department of Botany; J. Aagaard-Hansen, DBL)

Ouma, J.A. 2004. Institute of African Studies (IAS), University of Nairobi, Kenya: Socio-cultural factors that influence child survival in Nyang'oma sub-location, Bondo District. (Supervisors: W. Onyango-Ouma, IAS; J. Aagaard-Hansen, DBL)

Paulino, S.A.D. 2007. Biology Department, Faculty of Science, Eduardo Mondlane University, Maputo, Mozambique: Impact of the use of bed nets on morbidity, prevalence and multiplicity of infection with *Plasmodium falciparum* in Furvela, a rural community in southern Mozambique.

(Supervisors: S. Enosse and N. Cuamba, National Institute of Health, Maputo; J. Saide, Biology Department; J.D. Charlwood, DBL)

Pulaizi, A. 2005. Department of Aquaculture and Fisheries Sciences, Bunda College of Agriculture, University of Malawi, Liilongwe, Malawi: Some life history traits of *Fossorochromis rostratus* (Boulenger 1899) and its potential to control schistosome host snails. (Supervisors: J. Likongwe and E.K.H. Kaunda, Department of Aquaculture and Fisheries Sciences; J. Stauffer; Pennsylvania State University, USA; H. Madsen, DBL)

Sabonete, A. 2008. Department of Intestinal and Vesical Parasitology, National Institute of Health, Ministry of Health, Maputo, Mozambique (Department of Biology, Science Faculty, Eduardo Mondlane University, Maputo, Mozambique): Prevalence, intensity and re-infection rate of intestinal parasites in the urban and sub-urban schools of Maputo (Polana Cimento and Mafalala areas). (Supervisors: G. Augusto, Department of Intestinal and Vesical Parasitology; S. Silva, Department of Biology; DBL focal point: P. Magnussen)

Sambo, P. 2012. Eduardo Mondlane University (EMU), Maputo, Mozambique: Assessment of livelihoods of smallholder pig producers at Angónia district in Tete Province. (Supervisors: A. Pondja and C. Mugoi, EMU; H. Mejer, SPHD)

Tembe, C.G. 2006. Department of Biology, Faculty of Science, Eduardo Mondlane University, Maputo, Mozambique: Dynamics of *Schistosoma haematobium* in Maputo urban and peri-urban areas, southern Mozambique. (Supervisors: C. Boane, Department of Biology; G. Augusto, National Institute of Health; DBL focal point: P. Magnussen, DBL)

Thi Dung, B. 2007. Institute of Ecology and Biological Resources, Hanoi (Department of Veterinary Pathobiology, Faculty of Life Sciences, University of Copenhagen): The role of snails and cercariae in the lifecycle of fishborne zoonotic parasites. (Supervisors: D. Tat, Institute of Ecology and Biological Resources; A. Dalsgaad, Department of Veterinary Pathobiology; H. Madsen and N. Ørnbjerg, DBL)

Traore, A.A. 2010. Faculty of Medicine and Pharmacy, University of Bamako, Mali: Assessment of efficacy and feasibility of single dose praziquantel (syrup and tablet formulation) in treatment of schistosomiasis among pre-school children in two endemic areas in Mali. (Supervisors: M. Sacko, National Institute for Research and Public Health, Bamako, Mali; C.F. Traore, Faculty of Medicine and Pharmacy; DBL focal point: B.J. Vennervald, DBL)

Viegas, S.O. 2006. Biology Department, Faculty of Science, Eduardo Mondlane University, Maputo, Mozambique: Therapeutic efficacy and parasitological response to Chloroquine and Sulfadoxine-pyrimethamine after treatment of *Plasmodium falciparum* non-complicated malaria in children in rural areas of Southern Mozambique. (Supervisors: S. Enosse and N. Cuamba, National Institute of Health, Maputo; J. Saide, Biology Department; J.D. Charlwood, DBL)

Wesangula, E.N. 2009. University of Nairobi Institute for Tropical and Infectious Diseases (UNITID), Nairobi, Kenya: Translating Health Policy into Practice: Successes and Challenges at implementation in Bungoma South District, Western Kenya. (Supervisors: B. Estambale, UNITID; K. Njagi, Ministry of Public Health and Sanitation, Kenya; P. Bloch, DBL)

Appendix 4c

NORTH PHD STUDY COMPLETIONS FROM 2004 TO 2012

Dahl, K. 2006. Danish University of Education: Lærerliv, tilblivelse og pædagogisk praksis i det vestlige Kenya. (Supervisors: B.B. Bruun and K. Schnack, Danish University of Education; DBL focal point: J. Aagaard-Hansen)

Faurby, S. 2009. Department of Biological Sciences, University of Aarhus, Denmark: Geographical variation in invertebrates- from tardigrades to horseshoe crabs. (Supervisors: P. Funch, Department of Biological Sciences; A. Jørgensen, DBL)

Hansen, K.S. 2005. Department of Health Services Research, Institute of Public Health, University of Copenhagen: Using Disability-Adjusted Life Years and Cost-Effectiveness Analysis to Define Priorities for the Public Health Care Sector in Zimbabwe. (Supervisors: H. Keiding, Department of Health Services Research; P. Magnussen and J. Byskov, DBL)

Lier, T. 2010. Department of Microbiology, University of Tromsø, Norway: Molecular diagnosis of low intensity *Schistosoma japonicum* infections. (Supervisors: A. Deelder, Leiden University Medical Centre, The Netherlands; H.H. Haukland and G.S. Simonsen, Department of Microbiology; M. V. Johansen, DBL)

Jørgensen, A., 2004. Department of Biology, Faculty of Natural Sciences, University of Copenhagen: Diversity and phylogeny of African freshwater gastropods with special emphasis upon the molecular phylogeny of "Ancyloplanorbidae" and *Biomphalaria* and snail biodiversity within the Great East African Lakes. (Supervisors: R. Stothard, Natural History Museum, London, England; H. Enghof, Department of Biology; T.K. Kristensen, DBL)

Nielsen, N.O. 2006. Department of Biology, University of Copenhagen: Studies on the interaction between HIV infection, lymphatic filariasis and diethylcarbamazine in Tanga region, Tanzania. (Supervisors: P.E. Simonsen, N. Ørnbjerg and P. Magnussen, DBL; H. Friis, Department of Public Health, University of Copenhagen)

Olsen, Ø.E. 2010. Centre for International Health, University of Bergen, Norway: Barriers to Implementing Emergency Obstetric Care in Northern Tanzania: Balance, Quality and Quantity. (Supervisors O.F. Norheim, Centre for International Health; DBL focal point: J. Byskov)

Prince, R. 2005. Institute of Anthropology, University of Copenhagen: Struggling for Growth in a Time of Loss: Challenges of Relatedness in Western Kenya. (Supervisors: S. Whyte, Institute of Anthropology; J. Aagaard-Hansen, DBL)

Sengupta, M.E. 2012. Department of Veterinary Disease Biology, Faculty of Life Sciences, University of Copenhagen: Sedimentation and resuspension of helminth eggs in water. (Supervisors: A. Dalsgaard and S.M. Thamsborg, Department of Veterinary Disease Biology; A. Olsen, DBL)

Steenhard, N.R. 2003. Danish Centre for Experimental Parasitology (CEP), The Royal Veterinary and Agricultural University, Copenhagen, Denmark: Concurrent infection with intestinal worms and bacteria in man and domestic animals - epidemiological studies in children in Guinea-Bissau and experimental model studies in pigs. (Supervisors: A. Roepstorff, CEP); D.L. Baggensen, State Veterinary Serum Laboratory, Copenhagen; K. Mølbak, State Serum Institute, Copenhagen; N. Ørnbjerg, DBL)

Steensgaard, A-S. 2011. Centre for Macroecology, Evolution and Climate Change, Department of Biology, Faculty of Natural Sciences, University of Copenhagen: The ecology of infectious diseases - patterns, determinants and distribution of parasitic infections in Africa. (Supervisors: C. Rahbek, Centre for Macroecology, Evolution and Climate Change; F. Møhlenberg, DHI-Water and Environment; T.K. Kristensen, DBL)

Strandgård, H. 2006. Department of Biology, Faculty of Sciences, University of Copenhagen: Applied Aspects of Opisthorchiasis Control in Lao PDR. (Supervisors: D. Engels, WHO, Geneva, Switzerland; N. Ørnbjerg and M.V. Johansen, DBL)

Sörén, K. 2009. Department of Biomedical Sciences and Veterinary Public Health, Faculty of Veterinary Medicine and Animal Science, Swedish University of Agricultural Sciences, Uppsala, Sweden: Experimental *Schistosoma bovis* Infections in Goats. Studies on the Host-Parasite Relationship with Special Reference to Immunoregulatory Effects and Immunopathology. (Supervisors: R. Lindberg and M. Hurst, Department of Biomedical Sciences and Veterinary Public Health; J. Monrad, Department of Veterinary Disease Biology, Faculty of Life Sciences, University of Copenhagen; M.V. Johansen DBL)

Appendix 4d

NORTH MASTER STUDY COMPLETIONS FROM 2004 TO 2012

Aimee, M. 2009. Department of Veterinary Disease Biology, Faculty of Life Sciences, University of Copenhagen: Occurrence and viability of fish-borne zoonotic trematode metacercariae in Vietnamese raw fish dishes. (Supervisors: A. Dalsgaard, Department of Veterinary Disease Biology; M.V. Johansen, DBL)

Andersen, L.B. 2010. Institute of Anthropology, Faculty of Social Sciences, University of Copenhagen: Children as Caretakers in Home-based Care. (Supervisor: H. Lucht, Institute of Anthropology; DBL focal point: J. Aagaard-Hansen)

Baum, M. 2005. Institute of Medicine Chemistry, Danish University of Pharmaceutical Sciences: Vurdering af attraktant-egenskab for lavmolekylære stoffer secerneret af potientielle værtssnegle overfor miracidier af parasitten *Schistosoma mansoni.* (Supervisors: P. Mølgård, Institute of Medical Chemistry; H. Madsen, DBL)

Beyer, I. 2012. Department of Veterinary Disease Biology, Faculty of Health and Medical Sciences, University of Copenhagen: Helminths in dog and potential risk factors for transmission in Israel. (Supervisors: G. Baneth, School of Veterinary Medicine, Hebrew University, Israel; M.V. Johansen, DBL)

Braae, U. 2012. Department of Veterinary Disease Biology, Faculty of Health and Medical Sciences, University of Copenhagen: The burden of ectoparasites on swine and farmers practices in relation to the infestations in Mbeya region, Tanzania. (Supervisors: H. Ngowi, Sokoine University of Agriculture, Morogoro, Tanzania; M.V. Johansen, DBL)

Bæk-Sørensen, L. 2007. Institute of Veterinary Pathobiology, Faculty of Life Sciences, University of Copenhagen: Fascioliasis in cattle- Epidemiological studies in Tønder marsken. (Supervisors: S.M. Thamsborg, Institute of Veterinary Pathobiology; T.K. Kristensen, DBL)

Cederberg, S. 2009. Department of Pharmacology and Pharmacotherapy, Faculty of Pharmaceutical Sciences, University of Copenhagen: *In vitro* efficacy testing of three anthelmintics against *Taenia solium* cysts. (Supervisors: Å. Andersson, Department of Pharmacology and Pharmacotherapy; C. Sikasunge, Department of Paraclinical Studies, School of Veterinary Medicine, University of Zambia; M.V. Johansen, DBL)

Damgård Jensen, M. 2008. Institute of Anthropology, Faculty of Social Sciences, University of Copenhagen: Sibling-headed Households. Orphans managing everyday life among the Luo of Western Kenya. (Supervisor: K.F. Olwig, Institute of Anthropology; DBL focal point: J. Aagaard-Hansen)

Enemark, D.N. 2008. Institute of Anthropology, Faculty of Social Sciences, University of Copenhagen: Pursuing Pathways of Possibilities. Agency and Premarital Motherhood in Urban Mali. (Supervisor: T. Gammeltoft, Institute of Anthropology; DBL focal point: J. Aagaard-Hansen)

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