in parasite:host ratio. Although upward and downward incorporation [11] led to different life cycles and parasitic taxa in the oceans, lateral incorporation by originally generalistic parasites, followed by further specialization [12] according to their principal life cycle, is responsible for the huge diversity of parasites of marine fish. This can also explain the coexistence of generalist and specialist parasites within the same taxon. The costs of generalism, in terms of infecting false hosts (one in which the parasite is unable to survive) or casual hosts (one in which the parasite is unable to complete its life cycle) [12], or being outcompeted by specialist parasites, are sufficiently small (even for larger taxa of parasites that infect marine fish) to maintain generalism over evolutionary time. Established generalists can be considered to be the driving force behind the evolution of parasite-species diversity.

An accurate estimate of the increasing number of parasite species will be difficult to determine because the ratio of generalists and specialists is different in each parasite taxon [11]. In addition, after the infection of a new host group, parasites might encounter certain problems that prevent further species radiation or development; for example, new invaders often face competition from established parasites. Various other factors influence the host–parasite relationship, such as the parasite causing disease or the host species facing extinction. However, negative effects are usually moderate and, in fact, most parasites do not cause severe pathology (with multiple infections being common), thus enabling both parasite and host to survive. This balanced relationship has enabled species of parasite that infect marine fish to diversify and increase in number, and these characteristics underlie the concept of cumulative parasite evolution.

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Implications of findings of bibliometric analyses in parasitology

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Although outweighed by chronic conditions such as heart disease, stroke, cancer and diabetes in developed countries, parasitic and tropical diseases remain a major burden of disease and overwhelm medical services and economic resources in developing nations. This is an ongoing problem, despite the success of some programs to reduce the incidence of parasitic diseases such as onchocerciasis [1] in Africa, dracunculosis [2] in Africa and Asia and the global effort for elimination of lymphatic filariasis.

Implications of findings of bibliometric studies in parasitology

Several bibliometric analyses in the fields of parasitology and tropical medicine have been published [3–6], including a study of the origin of 18 110 publications in parasitology between 1995 and 2003. Western Europe, USA, and Latin America and the Caribbean produced 34.8%, 19.9%, and 17.2% of the articles, respectively [3], and both Latin America and the Caribbean and Asia doubled their production of publications during the study period. Interestingly, Oceania ranked first in research productivity in parasitology when adjustments for both the gross national income per capita and population were made. It should be acknowledged that adjustments for spending on health-related research would be more satisfactory but accurate data on this important index are not available for many countries.

The most important finding of this analysis, however, is that both absolute (5.3%) and relative research productivity in parasitology in Africa is low, although it is higher

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compared with the respective figures in cardiology and pulmonary medicine [7,8]. This finding is in contrast to the morbidity and mortality data showing that parasitic diseases are common in Africa. Although the incidence and prevalence of some of the major parasitic diseases have decreased, the mortality and burden of disease expressed in disability adjusted life years caused by the most important parasitic diseases (including malaria and schistosomiasis) remain high in Africa.

The main implication of the results of bibliometric analyses in these fields [3–6] is that more support should be provided by developed countries to the developing areas of the world, especially Africa, for the advancement of local research efforts; a need that is also probably true for other research fields. This support should aim to improve the infrastructure of research in developing countries.

Networks between scientists in developed and developing countries

Scientists in developed areas of the world should try to involve investigators from developing countries by forming well-structured small teams of scientists, paramedics and public-health workers. Networks of scientific institutions and organizations can be set up where they do not exist, and where such networks already operate further appropriate support should be offered through set percent increments, for projects that are already running, from the World Health Organization, private and public funding agencies and non-governmental organizations. The aim would be to set and sustain a scientific 'hub' to establish collaboration on local, national, international and intercontinental levels among scientists from developing and developed countries [9–11]. This could evolve in parallel to projects related to HIV, tuberculosis, malaria, maternity, pediatrics and immunization, thus taking advantage of existing manpower, infrastructure, interdisciplinary scientific expertise and facilities to produce quality research and clinical practice achievements [12]. However, it should be acknowledged that the findings of the bibliometric studies mentioned earlier do not directly lead to conclusions suggesting that scientific networks will solve the problem of disease burden in parasitic and tropical diseases.

The moving force behind these projects is the appropriate and well-balanced allocation of funds. The coordination and collaboration of international, governmental and philanthropic non-governmental organizations throughout the world can instil incentives and help realize disseminated but organized scientific groups. Such groups could comprise small numbers of dedicated, motivated and well-trained personnel in the disciplines of tropical medicine and hygiene, parasitology, laboratory medicine, nursing, midwifery, public health and veterinary medicine. This would, ultimately, form a widespread health service web that can depend on established academic and state-supported reference centers in the developing countries and will serve as a structure for boosting research.

By having on-site problem-oriented research, better training and practice can be provided for African parasitologists and related specialists, who can then offer much-needed know-how and health-service solutions to local populations. This must inevitably involve the collaboration of other civil service departments and their personnel so that they can provide sanitation, a clean water supply and housing, all of which will help to reduce parasitic diseases. The scientific exchange between western researchers in Africa and between African researchers and western institutions should result in directed and well-targeted training and research; the aim being a productive interaction among scientists that will benefit the developing nations. It should be emphasized that a major objective is to have research carried out in Africa by African scientists.

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