

Electron Microscopy in Developing Countries: What can be done to get these countries more involved?

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This article examines why there are so few electron microscopes and electron microscopists in developing countries, even if the need for them is clearly there. Instrument costs and equipment priorities do play, of course, a role, but so do attitudes towards electron microscopic research in developing countries. As someone who has headed an electron microscope unit in a developing country for several years, the author has first-hand experience of the problems that developing nations face when trying to build up and develop electron microscopy. The author discusses these problems and then offers some suggestions on what can be done to boost electron microscopy in developing countries and how to get more scientists of the developing world involved in this field. Ultrastructural investigations are, after all, no less important to the scientific community of developing nations than they are to scientists of the rich nations.

Keywords microscopists; third world; tropics; resources; under-privileged

1. Introductory remarks

In the year 2000 the scientific journal “*Micron*” published a discussion article of mine, titled “Not a tool for the rich alone: developing countries also need EM” [1]. That article, with the permission of the publishers of *Micron*, (Elsevier), with some newer information added, forms the basis for this chapter.

Has much changed for the developing countries with regard to electron microscopy since I left Jamaica in 1995 after having spent 4 years there as the ‘Head of the Electron Microscopy Unit’ and ‘Professor of Experimental Zoology’ at the University of the West Indies? Have matters regarding fine-structural research and electron microscopy in developing countries improved since I published my discussion article in the year 2000? That article generated a meager three responses from researchers in India, Jordania, and Kenya. This in itself could be interpreted as a reflection of the low population density of electron microscopists in developing countries or the non-availability of specialized EM-journals like ‘*Micron*’ in their libraries or simply disinterest in the topic or, worst of all, resignation that an article like mine could not change anything for the better anyway.

Not long ago, I needed to fix some insect material for electron microscopy in Madagascar and not having been able to carry the necessary solutions with me on the plane (or post them), because of restrictions imposed by safety regulations, I approached local scientists in the capital Antananarivo (=Tananarive). Yet, despite the locals’ smiling faces and helpful attitudes, I could not get the essential chemicals to make up the correct fixative solution (glutaraldehyde plus phosphate or Na-cacodylate buffer) and ultimately was not even able to locate a single electron microscope in the country! By comparison, many years before (in 1984) on a brief visit to Iceland, I needed to fix the eyes of some amphipod crustaceans from the Arctic island of Spitzbergen [2] and not knowing anybody in the country, I simply walked into Reykjavik’s Landsspítalinn (i.e., main hospital). Without any difficulty I was introduced to two electron microscopists, who generously handed me what I needed. So, have things really changed for developing countries, since I published my earlier discussion article?

2. Some progress, but problems remain

Some movement, some improvement, is indeed apparent. The 15th International Congress of Electron Microscopy took place in Durban, South Africa and the 17th is scheduled to be hosted by Rio de Janeiro in 2010. Moreover, local as well as international EM-conferences, involving many smaller and not just developing countries, were organized, for example, in La Habana, Cuba (the Inter-American Congress of Electron Microscopy in 2005, which brought together 252 foreign delegates from 20 countries plus 110 Cubans), in Zagreb, Croatia (the 1st Congress of the “Croatian Society for Electron Microscopy” in 1999), and in Prague (the 8th Multinational Congress in Microscopy in 2007), etc. Yet, looking at the webpage of the International Federation of the Societies for Microscopy (www.ifsm.umn.edu/calendar.html), it becomes obvious that smaller and in particular developing countries are still largely underrepresented and seemingly little involved in this field. So, does it matter that participation from developing countries is so limited? And if it does, are there any reasons for it? As someone, who for several years has headed an electron microscopy unit in a tropical, developing country [3] and who has prepared specimens for transmission and scanning electron microscopy under the most trying field conditions [4], allow me to comment on the situation.

First of all, yes, it does matter when three quarter of the participants at international Conferences and meetings come from the technologically advanced, well-developed, rich countries. Gatherings of scientist whose main tools are light and electron microscopes should not be a club for the chosen few, because I think we would all accept that: (a) scientists from developing countries are just as smart as those from the developed world and (b) a considerable portion of the world is made up by developing countries. I am using the term developing countries to contrast these countries from developed, fully industrialized nations in the sense it has been used by other scientists, e.g. Hadlock [5] or Clapp [6] and the ISF on their application forms for research grants.

As scientists we know that there are still exciting discoveries to be made in which all branches of microscopy may be involved and we are all aware of the fact that a great deal of the “raw material” for scientific research, generally, rests in the developing countries, e.g., the well-documented wealth of biodiversity in the tropical regions of the Earth [7 – 10] (Fig. 1). Going there frequently to collect, fix and prepare specimens is usually impossible and where it is possible, it is often unsatisfactory: extra visits have to be scheduled, equipment has to be flown in, visa and other formalities need to be taken care of and there are hassles over hassles. On top of that comes the reputation one can accrue as a “Western scientist” (which must include the “Easterners” from Japan as well), namely that of modern-day-exploiters or science colonialists. Since many a smart brain with much desire for knowledge and learning exists in any of the developing countries, would it not be better for microscopical science, generally, to involve microscopists from the developing countries, listen to their suggestions, get their input, share the workload and yes, their results, too?

So, if we all agree that: (a) the scientific world as a whole would benefit from the ideas and solutions generated by microscopists in the developing nations and (b) there is, in all probability, still more to be discovered in the developing rather than developed countries, why aren't there more microscopists from the developing world at international microscopy meetings or contributing to books like these? A host of reasons can be advanced, with some being easily rectifiable but others more complex. Political reasons, visa-requirements, travel and accommodation costs are often a greater obstacle for travelers from developing countries, although it has to be said that special funds are frequently provided by the conference organizers to assist participants from poorer countries. In 1994 the ICEM-meeting took place in Paris, an expensive place and consequently less than 5% participants from the least developed countries attended the meeting. The 1998 and 2002 venues were Mexico City and Durban (South Africa) and the percentages of participants from developing countries were up considerably, yet still much below that of the delegates from the developed world. I, therefore, believe that the absence of microscopists from the largely tropical regions of the world at scientific meetings, in which microscopy plays a role, has mainly other reasons.

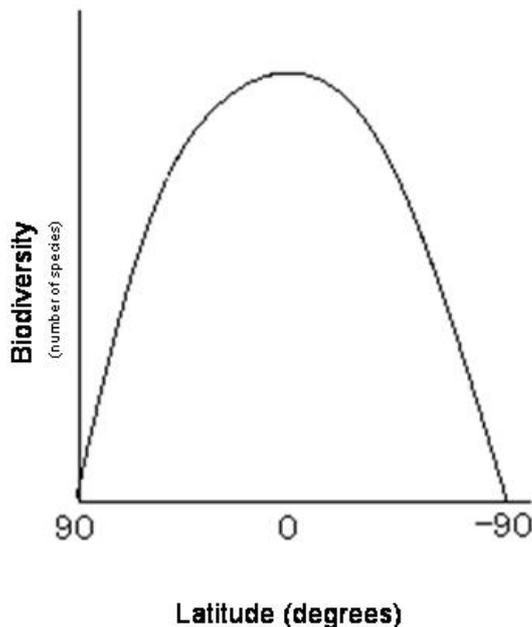


Fig. 1 The latitudinal gradient in species richness with, generally speaking, highest biodiversity at low and smallest biodiversity at high latitudes, has been known for a long time. With few exceptions (e.g., some cold-adapted taxa [10]) it applies to virtually all major groups of plants and animals. Modified after several different authors.

3. Problem definition and identific:

One big reason is the much smaller amount of technologically advanced equipment, which includes electron microscopes, installed in the tropics and, consequently, the overall number of scientists in the developing countries using modern scientific technology such as, for instance, electron microscopy in their research. Another is related to the often seemingly inadequate working conditions. The two go hand in hand, but scientists in the developed world are not entirely without blame. I should like to illustrate my point with some examples. When G. (a friend of mine from Jamaica) received a scholarship to go to Canada, his PhD-supervisor there immediately decided that research involving the electron microscope would not be very suitable for a student from the Caribbean, because as a developing country Jamaica would not need any electron microscopists. I was told a very similar story by a Pakistani, who had been invited to Germany to do his doctorate, but was considered not to be material for the electron microscope. "After all", was the view of his German doctoral supervisor, "we want him to be employable and useful for his home country when he returns". Why this attitude by Westerners that advanced technology, in my example electron microscopy, is of little relevance to scientists from developing countries?

Some of it may stem from persons who have heard horror stories about the terrible working conditions in the labs of the universities of developing countries and from some Westerners who have visited such laboratories for a short while to collect, fix, and prepare their samples. While in charge of the EM-Unit at the University of the West Indies in Jamaica, we have had about eight such visitors from overseas over a period of four years. While some of them certainly did marvel at the local ingenuity that made frontier research possible under sometimes trying conditions, there were others who were less open-minded and flexible. Using recipes and solutions that worked in their own air-conditioned well-equipped laboratories, such persons found it hard to work in the tropics: no high-grade pH-meter, no microgram-scales, poor or no air-condition, lack of fume cupboards, no fresh chemicals, frequently not even reliable electricity, but plenty of humid tropical heat instead. These people may have been in the minority, but they did exist and their conclusion that electron microscopy does not work in developing countries and is not something that scientists from developing countries need to have can hurt the development of science in the very countries we wish to see progress. The truth is, developing countries need advanced technology, they need microscopy in all its modern varieties, they need it badly for a host of reasons.

People who live in tropical, developing countries have different attitudes towards the obstacles they face every day in their research; they do not despair when there is no pH-meter (pH-paper also works quite well and is a lot cheaper) or when the specimen blocks turn out soft because of the high air humidity. The ability to adapt is a huge asset of theirs in science and a talent many of us Westerners appear to have lost. Local scientists need not be meek and subservient to Westerners; on the contrary, they know best how to obtain results under the conditions they are familiar with and, therefore, can frequently serve as effective teachers to those Westerners new to the territory. The locals are used to an unreliable electricity supply, they know that doubly distilled water often does not even reach the purity of simply distilled water in the developed world, they know that a dustfree laboratory work-place is an illusion. BUT under even the most trying conditions it IS possible to adjust and to modify methods, so that in the end a reasonable result can be obtained. Most Westerners do not give the local scientists in developing countries sufficient credit for coming up with their own wonderful solutions to indigenous problems; with patience, ingenuity, dedication and experience they can often find ways to make things work. But why should scientists in developing countries have to work at all with often inferior equipment, when it is plain to everyone that increased technology will bring benefits to even the poorest nations? Discarding the notions then that developing countries do not need advanced technology and that electron microscopy is not possible there, let me now turn to the equipment itself. Why is there so little sophisticated scientific equipment in tropical, developing countries? Because such equipment is so horrendously expensive would be the immediate answer. And, indeed, developing countries are located predominantly at lower latitudes, where -as we have seen earlier (Fig. 1)- biodiversity is highest, but generally speaking the per capita gross national product is lowest [11] (Fig. 2). But while the high cost of the equipment under debate is undoubtedly a factor, one could argue that a lot of other items bought by developing countries are also not exactly cheap. There are clearly other reasons: where there are no users, where there is no local expertise to look after, for instance, an electron microscope, where there is no general awareness in the scientific community and the public of what certain scientific tools like, to stay with our example, electron microscopes could be used for, there is little pressure to obtain and install such sophisticated equipment. If the students from developing countries, who had been trained overseas, had had no chance to familiarize them-selves with the latest techniques, then obviously they will not miss them back in their home countries.

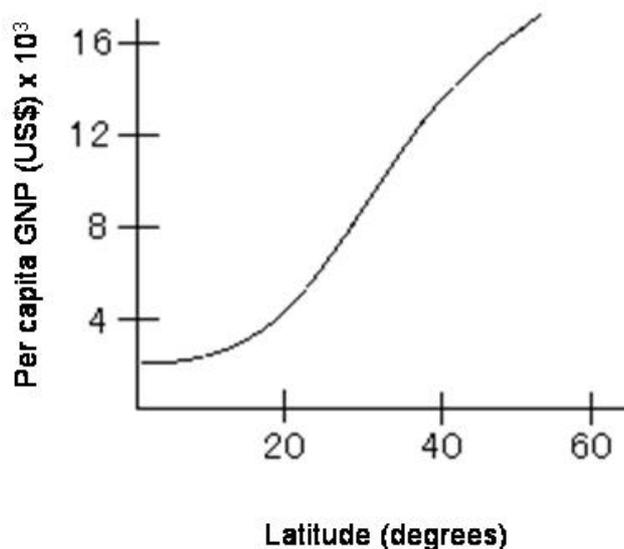


Fig. 2 Longitudinal gradient in the per capita gross national product (GNP) of countries of the world (modified after [11]).

4. Problem solving suggestions

An environment has to exist in which local scientists and university administrators can see the usefulness in investing into, for example, electron microscopy. "We don't have the money" must not be an excuse nor should "We don't have any EM-operators" be one. The only valid argument for not having electron microscopists and other trained scientific personnel in tropical, developing countries would be that they do not need them there. However, that, as I have tried to explain above, based on my own experience in Jamaica and elsewhere in the developing world, is a myth.

When I was the Head of an electron microscopy unit in a developing country, we received a brand new electron microscope as a gift from a developed country. This is certainly one way the number of electron microscopes could be increased in the research institutions of the developing world, but two words of caution here. Firstly, a certain responsibility rests with the donor that the valuable instrument is not put into a vacuum and becomes merely a show-piece for visiting dignitaries: there have to be skilled operators, adequate housing facilities and suitable ancillary equipment available. Secondly, while the receivers of such gifts are usually overjoyed and thankful, their enthusiasm can be dampened when they realize that the precious gift consisted of scientific equipment that was outdated, no longer in the market, and outright unsellable in the countries of the developed world. More sadness creeps in when the receivers realize after the first minor instrument failure that spare parts for the new microscope are no longer available. Yet, even then, skilful local engineers will frequently be able to keep the instrument running.

It would certainly be better if regular free annual servicing and possible repair costs for 10 years accompany the donation of any major equipment item. Further, some form of co-operation and collaboration between donor and recipient organizations following the handing over of the gift could be of-value to both parties. What I am saying is that while I whole heartedly applaud equipment transfer and donations of sophisticated instruments like electron microscopes to developing countries, I do not wish to see redundant equipment forced onto poor developing nations. Advanced technology and gifts can help the science of developing countries, but not if the gifts were motivated by the motto "what is no longer acceptable for us, is still good enough for the scientists of the developing world". In the long run that kind of practice helps neither the donor nor the receiver and can actually turn into feelings of resentment.

This brings me to the end of my brief chapter on the situation of electron microscopy in developing countries. I hope I have been able to show that sophisticated equipment, advanced technology, electron microscopy, etc. in tropical, developing countries do have a place. As a scientist who makes extensive use of electron microscopes in his research, I am convinced that with more electron microscopes and skilled electron microscope operators in the developing countries, considerably greater scientific progress *is* possible than if persons from the developed world made the occasional visit to the tropics to collect, fix, and prepare specimens for study in their home countries.

The world needs the input, the discoveries, the ideas from the scientists of the developing world and to not encourage them to use the technologically most advanced techniques in their own, biologically so very rich countries is nothing more than shortsighted. Am I alone with my opinion? Once again I would be interested to receive feedback from other concerned microscopists (especially those residing and working in developing countries) and would welcome further discussion on this matter.

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