

Borders in science and nations are artificial. Should we have borders within India?

Tamil is an ancient language that has been around for several millennia. Several philosophers have written poetry, which is ancient, but its content remains applicable for all times. One such poem was written by Kaniyan-Poongundranaar during the Tamil Sangam period (Tamil Sangam is comparable to Academic Societies today), which started around 300 BC (https://en.wikipedia.org/wiki/Sangam_period; accessed on 26 January 2017). This poem starts as: ‘யாதும் ஊரே யாவரும் கேளிர்’ (yaadhum oorae, yaavarum kaelir), loosely translated as ‘All towns are our native and all people are our kin’. This is depicted in the United Nations Organization for the profound truth it conveys (https://en.wikipedia.org/wiki/Kaniyan_Pungundranar; accessed on 26 January 2017). The translation given in the Wikipedia page quoted mentions ‘all people are our kin’. This is incorrect and ‘all are our kin’ is the right translation. Kaniyan Poongundranaar did not envision any borders between towns!

I became a physical chemist, bordering physics and chemistry. One of the prominent journals in this field is *Physical Chemistry Chemical Physics (PCCP)*, with which I have been involved for more than a decade. The title of the journal implies that the border between physics and chemistry is thin and either can be the first or last name, for the sub-discipline. More importantly, this journal shows how borders between the nation-states of Europe have become thin. It combines several favourite journals in physical chemistry published in the UK and Europe. Among them are two journals named after two of the greatest scientists of all times, Faraday and Bunsen – *Faraday Transactions*, published in the UK and *Berichte der Bunsengesellschaft für Physikalische Chemie* published in Germany. Brexit may have happened, but I am confident that *PCCP* will continue, at least, during my lifetime. It is published under the aegis of the Royal Society of Chemistry, by the Owner Societies, which have many of the European Chemical Societies as their members.

When I was in high school in the 1970s, I remember learning that chemistry is a study of matter and physics is a study of energy. Of course, Einstein’s famous equation $E = mc^2$ was already known having energy on the

left-hand side and matter (its mass) on the right-hand side. One can translate this equation as physics = chemistry. However, physics and chemistry as individual disciplines still exist and may continue to do so. One subtle difference, that would be lost in this generalization, is that chemists worry more about how atoms combine to form molecules or liquids or solids. They worry about the interactions between them and how they transform from one to another. Study of making and breaking bonds between atoms is indeed chemistry. Though atomic physics and molecular physics exist, there is no atomic chemistry (nuclear chemistry was taught in colleges some time ago). Atoms have to join together for chemistry.

Science, as a pursuit of understanding nature, really cannot have borders. However, it is important to have disciplines, sub-disciplines and sub-sub-disciplines, and for individual researchers, focus on a specific problem in a narrow sub-discipline is needed. Divide and conquer works. One soon realizes that even to solve a specific problem in a narrow field in science, it is important to have contributions from many disciplines. Again, taking a personal example, we have established experimental laboratories in India where we can make the weakest bond, even between inert gases such as argon and neon, and study them with a pulsed nozzle Fourier transform microwave spectrometer. We can also break one of the strongest bonds, the triple bond between two N atoms in N_2 , in a single pulse shock tube. In both laboratories, building the experimental facilities involved knowledge of mechanical engineering, electronics and communication engineering, vacuum techniques, physics, chemistry and, of course, mathematics. One lifetime is not enough to learn all these thoroughly, but even to talk to experts in all these areas one needs to understand these subjects to some extent. It is important to collaborate, and that involves mutual trust and respect. If there is a pyramidal structure, then there is no collaboration. Learning all these subjects is not trivial and may require different skills that a person may not be able to acquire. None of these skills is more important than the others.

Scientists, of course, know the importance of collaboration. Again, taking an example from a field that has

excited me, i.e. the hydrogen bond, one of the most important papers was published recently in *Science*, from China through a collaboration between physicists and chemists (Zhang, J. *et al.*, *Science*, 2013, **342**(6158), 611–614). They could see ‘the hydrogen bond’, when seeing atoms and molecules was thought to be impossible, not so long ago! Readers without access to *Science* are welcome to read a commentary in *Current Science*, available online with free access (Arunan, E., *Curr. Sci.*, 2013, **105**, 895–897). Not surprisingly, other scientists have questioned this claim and that is how science progresses. Naturally, when people collaborate, they can achieve a lot more than what is possible when they work independently. However, not only in science, but also in human relations, mutual trust and respect are important. When that is lost, there will be tension, war, destruction, etc. People should realize that it is better to develop mutual trust and respect and find ways to coexist.

C. V. Raman was born in Thiruvanaikaval in 1888 and went to Visakhapatnam for his schooling and Madras (now Chennai) for his college, all these places located in the Madras Presidency. He moved to Calcutta (now Kolkata) for a Government job, which he quit to join the University of Calcutta in 1917. The rest is history. Thiruvanaikaval is in Tamil Nadu, with Chennai as its capital. Visakhapatnam is now in the recently formed state of Andhra Pradesh. Calcutta was in the Bengal Presidency, which was divided into West Bengal in India and East Bengal in Pakistan, during independence in 1947. East Bengal became an independent nation, i.e. Bangladesh in 1971. Raman became the first Director of the Indian Institute of Science, Bangalore (now Bengaluru) from India. Bengaluru is the capital of Karnataka. One can see that the state borders in British and independent India did not matter much. More interestingly, Jagdish Chandra Bose was born 30 years before Raman in Munshiganj, which was part of the Bengal Presidency under British India, later to be part of Bangladesh. Meghnad Saha was born in Dhaka which had a similar fate as Munshiganj, eventually becoming the capital of Bangladesh!

When one looks at history, it is surprising that there have been no attempts so far to unite the Science societies and academies in south Asia. Certainly, the wars between these nations are nowhere comparable to the World War II, in which Europe was shattered. If nations in Europe can come together and form scientific societies, should we not attempt to do this in South Asia? Perhaps, not yet. India itself has three Academies of Science, seven decades after independence!

There are historic reasons that we have three Academies of Science. One has to learn history, but we cannot let it decide our future. Not surprisingly, there was an attempt to unite the three Academies of Science as early as January 1947, even before India (and Pakistan) became independent. Ramaseshan has given a detailed summary

of the attempts in 1994 in an article in *Current Science* (Ramaseshan, S., *Curr. Sci.*, 1994, **67**, 633–636). A name was also chosen for the unified Academy as well – The United Academy of Science of India. It appears that there was widespread agreement to this merger, but somehow it did not happen. More recently, Desiraju has argued the case for this unification (Desiraju, G. R., *Curr. Sci.*, 2010, **99**, 1510–1512). This would need mutual trust and respect. The recent announcement of an honorarium for scientists who become fellows of a minimum two Academies indicates that we are perhaps short on this.

I must point out that in recent times, the three Academies of Science have begun working together and have identified common causes. One good example is the Science Education Panel which supports academic workshops and summer research fellows from all over India. I cannot think of any reason for the three academies of science not to merge now. For one thing, we will have less number of committees and national meetings.

I recommend an autobiography by Curt Wittig from the University of Southern California, USA (<http://www.curtwittig.com/wp-content/uploads/curt-wittig-autobio.pdf>). It is long, but worth reading. A part of this was published in the *Journal of Physical Chemistry A*, in a *Festschrift* in his honour a few years ago. He has done some remarkable experiments in physical chemistry that have helped in understanding the microscopic details of how chemical reactions take place. From his autobiography, one can learn a few things about the nations and their borders in Europe. The city in which he was born kept changing hands among different countries. His experiences in the Chicago’s southern neighbourhood are unbelievable. It also shows that where one starts in life hardly matters. Given the right opportunities one can excel.

This brings me back to another millennia-old Tamil literature, *Thirukkural* by Thiruvalluvar, who declared ‘பிறப்பொக்கும் எல்லா உயிர்க்கும்’ (Pirappokkum ella uyirkkum), i.e. by birth all lives are equal. This year is 2048 in the Thiruvalluvar calendar, which starts from his birth year. One can compare it with the US Declaration of Independence, which starts as follows: ‘We hold it to be self-evident that all *men* are born equal’. Clearly, the ancient poet’s writing in Tamil was far more progressive than the authors of the Declaration of Independence in the greatest nation of the modern world, 18 centuries later. Is it not time for us academicians in India to let the world know that we understand and agree to this principle?

E. Arunan

Department of Inorganic and Physical Chemistry,
Indian Institute of Science,
Bengaluru 560 012, India
e-mail: arunan@ipc.iisc.ernet.in