Recollections of 50 years of research in biophysics: a matter of hard work and luck

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This Letter is intended to complement an accompanying Letter by Amy Li who completed her PhD in my laboratory and then spent a several years doing cutting edge single-molecule research at the University of Vermont. Hers is a story of the challenges facing a young investigator in the early stages of building a research career in biophysics. She rightly voices concern over the limitation of opportunities compared to the ‘good old days’. Tenure-track positions have indeed largely vaporised. Research funding is increasingly competitive, even if early career candidates do get slightly favourable opportunities with Australia’s National Health & Medical Research funding.

My Letter speaks from the other end of a research career dating back to the 1960s when I began thinking about a research career. In those days, PhD Scholarships were few and were barely enough to live on. One needed to share accommodation with other students or have understanding parents who might tolerate supporting a son (or daughter) on a low income. I chose the former.

I began my research ‘career’ as a Demonstrator in Zoology at the University of Sydney. This job entailed six to seven 3-h classes a week teaching Zoology I. The remaining ‘spare’ time was spent writing 10,000-word research essays, one for each of Lent, Trinity and Michaelmas terms. Today, such a teaching load would seem outrageous, but in those days, it was considered normal. In the mid-1960s, libraries were structures that contained actual books and journals curated by real librarians.

In the Old Medical School, the Medical Librarian knew the Dewey number for nearly every book and research journal, as well as whether it was available and if not, who had it. Clearly, it paid to be nice to the Librarian! Print issues of the latest

journals arrived on the shelves from overseas and were much sought after. Often, there would be a queue to read the latest *Nature* issue, and notes had to be taken in the library since these issues were not allowed to leave the library. There were no photocopiers in those days.

After I made it through the first year of paper-based research, I recall managing to get an interview with the late Professor Charles Birch, an eminent ecologist and charismatic teacher. He told me I had qualified to enrol in a PhD and that it was ‘normal’ for it to take ‘at least seven years’ to complete. He laughed when I told him I wanted to finish in half that time, but he offered me a full-time job as a Teaching Fellow that involved a little less contact teaching and therefore more time for research.

Getting into muscle research was a stroke of luck. All honours students were required to attend Department seminars. I had personally subscribed to *Scientific American* and was fascinated to read an article by H.E. Huxley (1964) where he described how thick filaments, containing the motor protein myosin drive a relative movement between the two sets of filaments, to produce muscle contraction. Soon after, Dr. Darcy Gilmour, a CSIRO scientist of renown who wrote the only two texts on insect biochemistry, gave a seminar. He had the ‘audacity’ to say in public that muscle really had three *sets* of filaments. The textbooks said nothing of this! I tried to raise the details of the Huxley article during question time and was told by Professor Birch, a friend of Darcy’s, that I was to sit down and be quiet while others asked more polite questions.

That encounter led to a CSIRO Summer Scholarship with Darcy during which I repeated the Huxley experiments. Using light microscopy, I extracted single striated muscle myofibrils from the indirect flight muscles from the Queensland fruit fly, from mud crab claw muscle, grasshopper leg muscle and even from rabbit psoas muscles, since this latter source of muscle was what everyone including Dr Huxley worked on. After dissolving these filaments, I saw the myofibrils did not fall apart as expected from the textbooks. By early 1966, I was learning how to do electron microscopy, protein assays and

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measure force and torsional elasticity of single muscle fibres. I even managed to attend an International Conference on Fibrous Proteins at the Australian Academy of Science where I actually met some of the major players in the field of muscle contraction. By the end of three years, I had completed sufficient experiments that Darcy said I could submit my PhD. Six months later in mid-1969, the degree was awarded (dos Remedios 1969).

Darcy told me he wanted me to go work with Dr. Manuel Morales at the University of California San Francisco in the famous Cardiovascular Research Institute. The CVRI was headed by Dr. Juius Comro, a frighteningly imposing man who had written ‘The Book’ on how the lung worked, but it turned out he had a soft heart. Morales also had a fearsome reputation, but Darcy assured me I would be OK. So, in late December 1969, I set off for San Francisco with my wife and 8-week old son on a new adventure. I had 2-years funding for an American Heart Association Career Investigator Fellowship (where Morales was the Career Investigator). My J1 visa did not allow my wife to work, but least they spoke English.

In the second year of my post-doc, I had two strokes of luck. I was given a Visiting Professor job for one semester teaching physiology to pre-med students at the UC Berkeley. It paid very well so now we could afford to live a little and moved closer to UCSF, near the famous Haight Ashbury District. Very groovy. The second lot of luck happened when I applied for, and astonishingly won, the 1972 American Heart Association’s Louis N Katz Prize for Basic Research. It was my first significant publication (dos Remedios et al. 1972). That not only turned hard times into good times, but it also resulted in the offer of a Senior Lectureship in the School of Anatomy at the University of New South Wales. Much later, the publication was included by Mike Ostap and his colleagues (Ostap et al. 2004) in their list of fifty important papers in the history of muscle contraction and myosin motility.

It looked like my research career was beginning to take off. It was awarded multiple, often simultaneous, research grants, at first from the Australian Research Council and subsequently with the National Health and Medical Research Council. My lab initially worked on the molecular structure of the muscle protein, actin. While this globular protein had never been crystallised, we managed to publish the first crystalline structure of actin in the presence of the lanthanide ion gadolinium (dos Remedios and Dickens 1978). It gave us the first glimpse of the actual shape of the actin monomer. Actin has since been crystallised and several high-resolution structures are now available.

A decade later, in 1989, I started a collaboration with Dr. Victor Chang AO at the St. Vincent’s Hospital Heart and Lung Transplant Unit. Tragically, 2 years later, he was shot dead in a failed extortion attempt. Over the following decades, I continued to collect as many explanted failing

human hearts as possible (Trahair et al. 1993), and the work continues today as the Sydney Heart Bank with more than 130 publications. Together with Amy Li and Sean Lal, (dos Remedios et al. 2017), we have collaborated with 89 laboratories in 12 countries to investigate clinically relevant research into why human hearts fail. Many of these papers only required ‘controls’ because their failing hearts were locally collected. Our bank of 120 healthy, non-failing hearts was a ‘gold mine’.

Regarding contributions to science in general, for nine years, I served as the Secretary General of the International Union for Pure & Applied Biophysics (IUPAB). This global body is concerned with promoting biophysics in all countries, particularly in developing nations. For the past 5 years, I edited this Springer-Nature journal, which continues to publish contributions from biophysicists in Latin America, Africa and Asia. With these duties completed, I look forward to getting back to research.

Amy’s *Letter* raised the question of paid parental leave rights. These benefits did not exist in the 1970s, and it is good to see Australia is taking a positive attitude to this important question. The University of Sydney has built in flexibility in accessing either 52 weeks or 104 weeks leave (<https://intranet.sydney.edu.au/employment/leave/parental-leave.html>), including the ability to incorporate annual and long-service leave into paid parental entitlements. It seems to be a good model.

For those like Amy, who are tempted to get post-doctoral experience abroad, the need to return to work is usually a balancing act between maintaining academic productivity and catering to the needs of the new family. The challenge of focusing on complex tasks such as experiments and writing papers for high-quality journals does not fit well with demands such as breastfeeding and keeping junior on a regular schedule. The kind of maternity/paternity leave described at the above website is needed to provide parents with peace of mind, time to recover, time to bond with their babies and a pathway back into research.

Returning to research after maternity leave also requires a plan. Sometimes, this comes in the form of a soft transition, working part time for the first weeks or going back full time but working several days a week from home. In addition to workplace challenges, it is always important to consider childcare options *before* taking maternity leave. Childcare is an essential part of a return to work plan and is notoriously difficult to achieve.

In February 2014, just before I formally retired, I was completely surprised by being voted as one of the 60 most memorable and influential teachers in the history of the University of Sydney (Sydney Alumni Magazine, November 2014). Now, as a Professor Emeritus, I am fortunate to have strong logistic support from my Department. I get financial and administrative support for my research, and I can still

mentor research students. In return, I do some *pro bono* teaching of anatomy to our medical students. It is liberating to be able choose when and how to plan and do research, a luxury I did not have before I ‘retired’.

I hope for a similar happy ending for Amy Li and for all early career scientists.

Compliance with ethical standards

Conflict of interest Cris dos Remedios declares that he has no conflict of interest.

Ethical approval This article does not contain any studies with human participants or animals performed by the author.

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