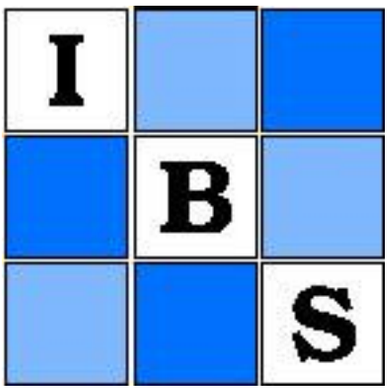

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Evolution and Biometry*

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1. Introduction

Fellow biometricians, other scientists, distinguished visitors, and guests, it is indeed a privilege to welcome you on behalf of IBS to this, our 19th International Conference, in Cape Town, South Africa. Our heartiest thanks go to Tim Dunne, Chair of the Local Organizing Committee, who, together with his Committee and others, has worked hard and long to prepare for this meeting, attending to the myriad of details that inevitably arise. Our thanks go also to the Scientific Program Committee, chaired by Geoff McLachlan; they have ensured that our program is of the highest quality, both scientific and biometric.

Earlier this year, while I was busy interacting with scientists in molecular biology and biological anthropology in Australia, contemplating coming to IBC and to South Africa, dealing with the day-to-day matters that arise in our Society's affairs, and reading some of the early issues of *Biometrics* and the *Biometric Bulletin,* the word evolution kept recurring. Hence, the title of this address, "Evolution and Biometry." The term evolution has many meanings. Two of these are:

(1) any process of development, including formation;
(2) in biology, the continuous adaptation of organisms to the environment by processes of selection, hybridisation, inbreeding, mutation.

Within these two meanings of evolution, there is an enormous number of topics from which to choose. I have selected a few, grouped into three parts. The first part highlights some of the multifaceted aspects of running our Society, concentrating on some of those that have been occupying your Executive over the past couple of years, and also gives some of the recorded historical context. The middle part of this address briefly traces the biometrical influences of three of our Society's founders. Finally, I look at biometry today and suggest some future strategies.

2. Recent Evolution of Our Society

Between the 18th and 19th IBC, our most time-consuming task has been the updating of the Constitution and Bylaws, which were approved early in 1998. The *Proceedings of the First International Biometric Conference* from 1947 (*Biometrics* **3,** pp. 168–192) details the mechanisms of the setting up of our Society and the first Constitution, a concise document suiting a fledgling society. Council Bylaws were approved later in July 1948. Then, every few years thereafter, the *News & Notes* parts of *Biometrics* detailed the various updates (for early changes, see *Biometrics* **5,** p. 180; **8,** p. 392). The step previous to our most recent one in the evolution of our governing documents was the approval in 1984 of the Constitution and Bylaws, described by then President Dagnelie (1984, pp. 1–2) as 'the culmination of a lengthy task' carried out over several years. The same can be said for the 1998 update. Our Bylaws continue to evolve to meet our Society's growing and changing needs. Discussions during this conference will formulate various further changes.

Rockefeller Foundation funding was a common source of support for our Society in the early years, right from the first IBC in 1947 (see early issues of *Biometrics* (*Bulletin*) and Bradley and Anderson, 1996). I am sure that we are all pleased to see the recent initiative by some of our members to obtain funding to support attendees and two special discussion sessions at this conference. Such support is extremely important if we are going to reduce the gap between institutions of "advanced" and "developing" countries (see also Dagnelie, 1998).

Our worldwide news of the past year or so has concentrated on the economic crises, the impacts of which are having extreme effects in many parts of the world. As an international society, these crises affect our members in different ways. This is not a new problem for us. For example, in 1984, Dagnelie tells us the 'general economic crisis which we are going through at present, and also the rise in the value of the dollar [means that] several Regions and National Secretaries have informed us of the difficulties that they have encountered in transferring their subscriptions to the United States.' Looking further back in our records, Bliss (1958) describes the formation of the Indian Region (IR) in 1949 that had to be abandoned due to the rupee being devalued and IR being 'unwilling to raise its dues to cover the devaluation, but in fairness to our other members, the Society could not make an exception.' Doubtless there are other examples of such financial difficulties that have affected our members.

Communication within an international society has never been straightforward, although the nature of the difficulties has changed. Going back to 1949 (*Biometrics* **5,** p. 91), we read that because 'of the long time for ballots to reach members of the Australasian Region, the election of new Council members will be reported in the next issue' of *Biometrics.* Today, electronic communication has removed this difficulty. However, the negative side to speed of communication is a

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deluge of messages. Today we are in the position of having overinformation—too much and of varying bias and quality, dependent on the topic. For simple exchange of information, email and fax generally work well. For many-faceted discussion and decision-making on complex topics, these communication methods are less satisfactory. Unfortunately, many cope by ignoring nearly all messages, others by having an opinion on (nearly) everything. What is clear is that we need to develop better methods of clearly communicating at all levels. It is also appropriate to mention here that rapidly changing dynamics are affecting the process of scholarly communication. Electronic publishing is a process that all members of the scholarly, library, and publishing communities are having to continually re-examine—we as well. However, access to these communication advances depends on economic growth. Of more concern in some parts of the world is the reliability of the communication connections upon which, increasingly, we all are becoming dependent. Political stability is necessary to maintain these connections.

In 1986, then President Freeman (*Biometric Bulletin* **3**(4), pp. 1, 3) discussed communication in a broad sense, and 10 years ago, then President Ellenberg (1988, *Biometric Bulletin* **5**(4), pp. 3–4) noted the 'many committee meetings that occur during the week involving person-to-person contact with committee members who can only see each other once every two years. The culmination . . . is the Council meeting.' The same occurs this week. Council forms the link between you, your region or national group, and the international body. So during this week, make the most of the opportunity to talk with your Council members.

The use of the word "biometry," along with "biometric/s," has been evolving. Dagnelie (1988) explored the roots of the use of these words. Recently, concern has been expressed that these words have gone into popular media use but are now associated with techniques being developed for identification of individuals. This is not in accord with current dictionary use as 'the statistical or quantitative study of biology.' (However, it is noted that 'personal identification' along with 'physical heredity' were both late 19th century interests of Galton; see Porter, 1986). Currently, IBS is requesting 'International Biometric Society' and 'Biometrics' be registered as trademarks in the U.S.

In 1994, then President Billard (1995) and Bradley and Anderson (1996) detailed the evolution of our journal *Biometrics.* To remind you, the journal was originally started (1945) as a publication of the Biometric Section of the American Statistical Association (ASA) and was called *Biometrics Bulletin.* The name change occurred in 1947, the year of the founding of our Society, but responsibility for publication was not transferred from ASA to IBS until September 1950, following 'negotiation' (Bliss 1958, p. 323). Today, we have another quality publication, *JABES, Journal of Agricultural, Biological, and Environmental Statistics.* It is a joint venture between ASA and IBS, the details of which have been requiring much 'negotiation' during this past year.

3. Contributors to Our Early Evolution

Earlier this year (1998) Professor Finney (personal communication) wrote, 'The Society was very much the creation of R. A. Fisher, G. M. Cox, and C. I. Bliss, but of course with much collaboration from other leading figures of the 1940s. I (Finney) was a member from the earliest days. My own Presidency came very soon after the death of Ron Fisher. . . . I was immediately conscious that Gertrude and Chester also were aging and yet had no assured place in the archives of what was now a very vigorous society. I put forward the suggestion that they be created Honorary Life Members. Council rapidly accepted this entirely *ad hoc* resolution' in 1964. Since then, your Council has elected eight Honorary Life Members, the last in 1985. Currently, we have two living Honorary Life Members: David Finney and C. R. Rao. At the banquet this Friday, I will be announcing the election of two new Honorary Life Members for the period covering the past two 2-year periods, Peter Armitage and Pierre Dagnelie.

At the time of honouring Bliss and Cox, Council placed on record special recognition of Sir Ronald Aylmer Fisher (1890–1962). Fisher had been the first President, C. Bliss the first Secretary, and G. Cox the first Editor of *Biometrics.* The following vignettes describe some of their contributions to the statistical/quantitative study of biology, i.e., biometry.

According to Bliss (1962), R. A. Fisher 'created the basis for our Society,' and, moreover, 'growth . . . is indicative of the wide response of biologists, mathematicians and statisticians to Fisher's genius.' Certainly Fisher is regarded by many as the most influential statistician of all ages (Johnson and Kotz 1997). His statistical contributions are currently seeing a resurgence in their re-evaluations (Watson and Welsh 1998 *On Fisher's use of scores*, unpublished manuscript). These contributions can truly be said to be revolutionary in the Thomas Kuhn (1962) sense of a scientific revolution, namely, a paradigm shift. However, Fisher was known more widely during his lifetime as a biological scientist and geneticist. Richard Dawkins' book *The Selfish Gene* described him as 'the greatest biologist of the twentieth century.' In fact, Fisher's interest in statistical problems developed because of his interest in genetics and evolution (Yates 1962). It has been described (Owen 1962) how Mendelism, which was rediscovered when Fisher was about 12 years old, was, as late as 1918, 'still insecure,' particularly because it remained doubtful to what degree the inheritance of quantitative traits, like height, was controlled by genes segregating in Mendelian fashion. In his famous paper on the correlation between relatives, Fisher (1918) settled this debate, although it took many years for the paper's complexity and subtlety to be fully understood. Even today, there are still certain unresolved inconsistencies with some of the theory (Wilson 1998). It is not generally realised that, in this 1918 paper, Fisher also laid the groundwork for analysis of variance.

In his subsequent prolific contributions to our understanding of genetical and evolutionary processes, Fisher showed his clear appreciation that the general validity of Darwin's evolutionary system could only be understood by the application of statistical thinking, namely, by modelling of natural selection operating on variation that arises by the Mendelian mechanism. This basic principle, application of statistical thinking, still holds today, although we are now dealing at the far more complex molecular level.

To Gertrude Cox (1900–1978) is given 'the credit for the Society's vigorous growth and strength, . . . due to (her) vision, energetic dedication and persistence' (*Biometrics* **34,** p. 720). She edited our flagship publication for its first decade and was

our first woman and the Biometric Society's 11th as President. Gertrude Cox was renowned for her abilities as a communicator, especially at the frontier between the mathematical and statistical sciences and the biological sciences. Her writings on experimental design, with applications to agriculture, are models of clarity and precision. It is therefore not surprising that the paper, with which Kotz and Johnson's (1992) volumes *Breakthroughs in Statistics* start, is her 1956 ASA Presidential Address, entitled 'Statistical Frontiers.' This paper summarises the state of statistical sciences, generally, just before the major impact of computer technology on statistical methodology and practice. (Cox, however, could foresee the importance that computers would have; indeed, one of her 'major achievements was the development of strong statistical computing programs' [Anderson, 1997].) In her 1972 *Biometrics* paper reporting on the first 25 years of the IBS, Cox noted the increase in the cooperation between the biometricians and the biologists. Although this cooperation still exists in many biological specialities, we can wonder what Cox would have made of the current tendency in many other biological arenas for biologists to be seeking cooperation mainly from 'information scientists.' I am sure that she would have been using her communication skills to insist that biometricians are also included. Collaboration is a point to which I will return.

Finally, Chester Bliss (1899–1979) is described by Finney (*Biometrics* **20,** p. 667) as 'virtually [the] creator' of the Biometric Society, 'its servant and ambassador in many ways.' As Bliss (1958) describes, part of the evolution of our Society was dissatisfaction with the small place allotted to biometry in the ISI program for 1947. This allocation of a 'small place' in ISI's program is a recurring problem. Bliss was not only our first Secretary for 8 years but was also our eighth President. Moreover, he bequeathed his royalties to the Society, a practice that could be encouraged more! Bliss was described by Cochran (1979, p. 715) as 'a biologist whose statistics throughout his life were largely self-taught.' Those of you currently experiencing a difficult job market can take heart from Bliss's experience: In 1932, during the depression, he was retrenched from the U.S. Department of Agriculture (James 1996). According to Finney (1979), his major research interests were in biological assay, and he became an 'outstanding biometrician under the influence of R. A. Fisher.'

Now is a time to ask ourselves what these three biometricians would make of today's Society. Are we evolving in the right directions? In particular, where are the biologists? What proportion of our membership is biologists? At our conference, what proportion is biologists? This brings me to the final section.

4. Evolutionary Strategies

This section is introduced by recalling a (small) part of South Africa's rich evolutionary history. *Equus Quagga* was an animal having a brownish colouring, with a striped neck and unstriped body. Opinions used to differ as to whether this was a subspecies in the zebra family or more closely related to the horse. It became extinct over 100 years ago, and a rebreeding program has been implemented (see the South African Museum web site). Is there an analogy here for us as biometricians? First, many differ as to whether we are a subspecies of statisticians (or even mathematicians) or if we are more closely related to biologists. Second, although as a society we are not in danger of extinction, some of our members are in institutions that have put biometricians on their "endangered" list. Even as I was preparing this address, I learnt that Wageningen Agricultural University is planning to reduce the role of its biometricians. Why? Currently there is an enormous expansion in the collection and analysis of biological data. If, and I stress IF, we do become extinct, will we be "rebred"? Well, a quote that is attributed to Efron (see Friedman 1997) says 'Statistics has been the most successful information science. Those who ignore statistics are condemned to re-invent it.' The Cochrane Collaboration and the move to evidence-based medicine are to be welcomed; as biometricians, we should be insisting that such approaches are adopted in other parts of biology as well (see Maindonald 1998). Meanwhile, perhaps evolutionary theory (in the biological sense) can help us here: A basic maxim is survival of the fittest. So how can we improve our fitness? Again, it is appropriate to first consult our Society's evolutionary history.

As is well known, part of IBS's evolution is directly traceable to ASA's Biometric Section, which was established in 1938. 'From the start the section (invited) biologists to bring new biometrical problems before the membership' (*Biometrics Bulletin* **1,** p. 2). Their journal, *Biometrics Bulletin,* was 'designed primarily for biologists who see in statistics a potent tool for their work.' Bliss (1958) discusses the 'aggressive policy' the Society had with a wide range of biological societies: 'By the end of 1942, meetings had been arranged with the professional organizations in ecology, public health, cereal chemistry, pharmacology, biological chemistry, horticulture, and entomology, as well as with the Institute of Mathematical Statistics' (IMS). Today, although I am aware of the regular joint meetings both the Eastern North American Region (ENAR) and the Western North American Region (WNAR) have with IMS, I am not aware of many joint meetings with biological societies. I believe that we should be promoting such meetings at the regional and international levels. Although IBS is at the interface, most papers given at our meetings come from the mathematical or statistical side of the divide. I believe we should be encouraging biologists to speak, without fear of unfair criticism by someone 'more concerned with mathematical (or statistical) correctness than biological relevance' (Armitage 1985). For example, we could introduce the idea of guest institutions for IBCs, namely, one or more biological societies could be invited to organize a session. Our recent evolution of the Bylaws has established an Education Committee. The work of this committee can help us here. As Gertrude Cox so aptly summarized: 'What the Biometric Society is like tomorrow depends on the wisdom used today in planning for the future.'

Our journals, *Biometrics* and *JABES,* need have no problems on this score, as papers can go to at least one biological referee. They used to, according to our first editor (Cox 1972). Some biological (including medical) journals now have statistical referees on their panel. What is more disconcerting, however, is that some have removed statisticians from their editorial board, much to the scientific detriment of these publications. However, as we all well know, it is better to collaborate (biologists along with mathematical, statistical, and information scientists) and to maintain this collaboration throughout

the whole project. Too often, though, the statistician is called in too late; as Fisher (1938, Presidential Address to the First Indian Statistical Congress) so aptly said: 'To consult a statistician after an experiment is finished is often merely to ask him to conduct a *post mortem* examination. He can perhaps say what the experiment died of.'

IBS could also be more proactive in many areas. For example, in recognition of the importance of the marine environment, the United Nations declared 1998 the International Year of the Ocean. On their website, I read 'Oceans sustain life on Earth and provide us with many vital resources. They are a source of food, energy, commerce, medicine and recreation. They shape our weather.... In the 21st century, we will look increasingly to the ocean to meet our everyday needs.' Our conferences and our journals have much to say, yet we do not appear to have been participating actively in these conferences.

April 1999 is Mathematics Awareness Month in the United States. The theme is 'Mathematics and Biology.' We could not only participate but also extend the concept to our own region and nation. We need to make the most of all opportunities, particularly those concerning science, in our own local media.

Early issues of *Biometrics* describe the interaction that our Society had with the International Union of Biological Sciences (IUBS), at whose early meetings the Society was both 'represented and vocal' (Bliss, 1958, pp. 319–320). Although we are still a member of that union, our participation in their meetings and activities seems to have waned.

I now return to the evolution of our science, albeit briefly, and base some topical observations on my own research interests, which include evolution (in the biological sense). However, my message holds very widely. I have already mentioned the role that evolution as a topic had in the early days of our Society. Right from the first issue of our journal, the topic was included under the biometrics umbrella. However, the topic is nearly extinct in recent *Biometrics* issues. This is partly due to there being specialist journals devoted to the topic. Yet, reading many of the papers in these journals, you will find that the underlying questions are biometrical and are attacked with extremely powerful algorithmic tools. However, even if the source of the data is mentioned, one often wonders of just what it is a "random" sample. To give one example, a recent paper in the *Journal of Molecular Biology and Evolution* states the source of some chimpanzee data used but without providing evidence that they are a random sample from an identifiable population. More interesting is the statement that 'the human material was from various sources.' I happen to know that the 'various sources' are mainly present and previous staff and students in the lab that produced the results.

Recently, Professor Sir Robert May, Chief Scientist of the U.K., told attendees at the (Australian Academy of Science-sponsored) Conference on Biological Informatics that 'there will be winners, and there will be losers' among nations as the world moves into the next century. He underscored statements that have been made by other international leaders. "The next century will be the 'Age of Biology,' just as this one has been an age of physics and astronomy. Specifically, those countries who best know how to correlate, analyze, and communicate biological information will be in the leading position to achieve economic and scientific advances." Again, note that no mention is made of the problems associated with collection of this information, i.e., its source, let alone how to analize the information if the underlying data are essentially *ad hoc*. This is not a recent problem. Nearly 50 years ago, Cochran (1950) said, 'Sampling theory has advanced to the point where good sampling is relatively simple,' provided the population is well defined and 'satisfactory methods of measurement have been devised. Many problems remain where these conditions are not met, as in ... obtaining information from human populations.' This problem is one that currently is escalating dramatically in this so-called information age. For example, we are witnessing 'the explosive growth of genetic data accumulating in public data centers' (*Science* **272,** p. 1730). A very important question, as these 'real' data sets are being downloaded and analysed is: What, exactly, is the origin of these data? For example, most DNA and other molecular sequences being downloaded are certainly not random. The sequences tend to cluster in the regions where "disease" genes have been proposed based on linkage results. Does this matter? Well, sometimes it does, sometimes it does not. It depends on the circumstances, particularly the questions being asked, and so we cannot be prescriptive. Nevertheless, generally, we need to develop appropriate methods to deal with the way in which the data have been ascertained. A relatively simple example of the difficulty of identifying, and then implementing, an appropriate ascertainment correction is provided by human genetic data where families enter a study population because of having certain affected individuals within them. Now a recent examination of data from the Collaborative Study on the Genetics of Alcoholism (COGA), where ascertainment depended on a phenotype of alcohol dependence, using both multistage and multiple proband criteria, found that limited ascertainment correction increased the strength of evidence for linkage to a particular chromosome compared with no ascertainment correction, but efforts at implementing a more complete correction for ascertainment bias markedly reduced the evidence for linkage (Comuzzie et al. 1998). Such findings raise a number of particular, as well as more general, issues regarding ascertainment bias and its correction for family linkage data, on which there is already a large, although by no means exhaustive, literature (Thompson, 1996).

So, generally speaking, what should we be doing? Holding joint conferences, collaborating with biologists, querying data sources and the relevance of their analyses, and raising our media profile are some of the ways we can maintain our 'fitness' while also seeking out opportunities to increase it.

In conclusion, I have found my time as President both stimulating and challenging—stimulating for the personal contacts with other scientists, challenging because of the need for IBS to evolve in order to meet the current demands of biometry and biometricians. May we all enjoy this week being stimulated by our scientific program and meeting our colleagues from throughout the world and may biometry evolve successfully as we look towards the 21st century.

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