Cytometry PART A
Journal of the International Society for Advancement of Cytometry

ISAC International Society for Advancement of Cytometry

20 Years of the German Society for Cytometry: Past and Future Concepts

THE German Society for Cytometry (Deutsche Gesellschaft für Zytometrie, DGfZ) celebrated its 20th anniversary in 2010. The society was founded 1990 in an effort to strengthen the scientific potential of the cytometry discipline in Germany and to ease research relationships with other European societies and international partners. The society has developed continuing scientific leadership with a high proportion of young scientists from various backgrounds in the awareness of the future challenges and potential of cytometry for the systemic and methodological molecular analysis of heterogeneous cell systems. The 20th annual conference honored the achievements of scientists who developed basic physical and cell biological principles of cytometry in the past and focused on integrated ideas to promote developments further in single-cell analytics (www.dgfz.org). It seems important to recall the foundation of various scientific societies in Europe during the pioneer era of cytometry, which led to the now very successful and internationally interlinked cell based research as well as to new concepts.

Early Cytometry Developments

Following the concept of cellular pathology (Fig. 1a) by Rudolf Virchow (h1), Torbjoern Caspersson (h2) originated cytometry with his work on DNA and protein measurements in single cells by light absorption. Wallace Coulter (h3, h4) started flow cytometry by the development of fast electronic counting and cell sizing instrumentation, while computerized cell and tissue image analysis with the TICAS (h5) system was introduced by George Wied (h6), who like Leo Koss (h7, h8), was conceptually influenced by Karl von Rokitansky and Rudolf Virchow. Leo Koss as well as Myron Melamed and Louis Kamenstky (h9, h10) became oriented toward the combination of flow and optical light absorption parameters, thus generating the first flow cytometer in a modern sense including computer recording and display of results. Zbigniew Darzynkiewicz (h11) and Brian Mayall (h12) worked significant time with Torbjoern Caspersson in Stockholm to focus their cytometric views.

The observed right skew of volume distribution curves for electrically sized erythrocytes of healthy human individuals (h13) polarized the opinions. It was interpreted as a biological phenomenon by Clarence Lushbaugh (h14, h15) at Los Alamos National Laboratories while Gerhard Ruhenstroth-Bauer and Klaus-Dieter Zang at Martinsried as well as Mac Fulwyler (h16) in Los Alamos considered it an artifact. He built the first cell sorter to prove his point. Ruhenstroth-Bauer in turn initiated the construction of own instrumentation (h17) leading to the development of hydrodynamically focused cell transit through the electrical sizing orifice by Reinhard Thom and Volker Kachel (h18). This provided symmetrical volume distribution curves.

Fluorescence measurements by Marvin Van Dilla and Wolfgang Göhde (h19, h20), the construction of the first commercial fluorescence flow cytometer (ICP11 by Phywe AG, Göttingen) by Wolfgang Göhde (h20–h22) and the description of the fluorescence activated cell sorter (FACS) by Len Herzenberg (h23) gave cytometry a wide acceptance in research and led to the commercial use in hospital laboratories by physicians. The upcoming handling of large data sets (e.g., h24 and h25) led to the implementation of bioinformatics in cytometry with Günter Valet being one of the pioneers in this concept (h26).

Early Cytometry Organizations

The fast development of cytometry instrumentation and knowledge stimulated mutual information exchange, resulting in European cytometry conferences (Fig. 1b) initiated by Wolfgang Göhde, while Sandford Cole (h27) organized cytometry conferences for the American Engineering Foundation.

Received 27 June 2011; Revision Received 15 August 2011; Accepted 16 August 2011

Additional Supporting Information may be found in the online version of this article.

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Published online 13 October 2011 in Wiley Online Library (wileyonlinelibrary.com)

DOI: 10.1002/cyto.a.21141

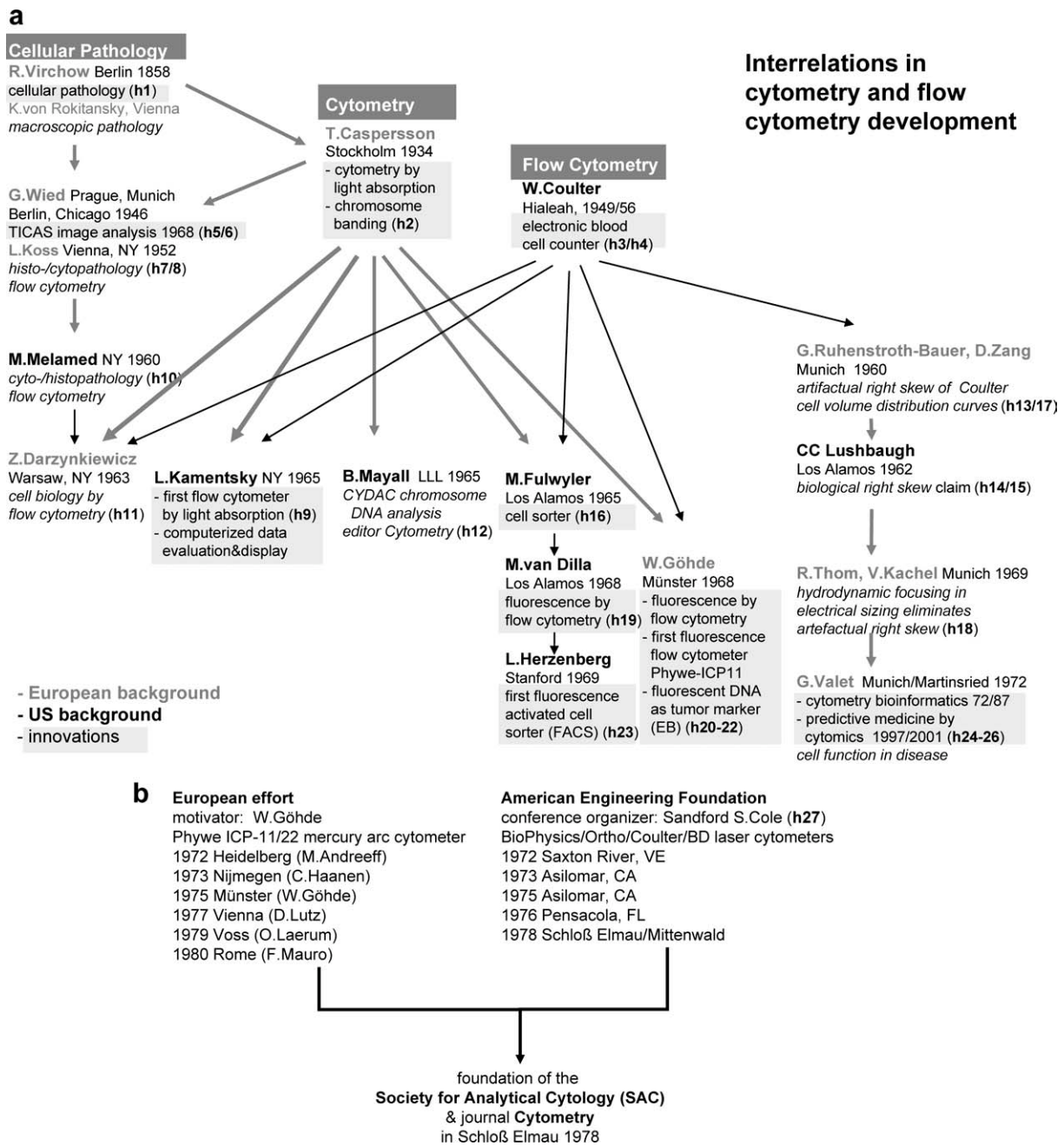

Figure 1. (**a**) Developmental network of early cytometry. Pioneer scientists (with years indicating early contacts) in the field of cytometry, including ground breaking publications in various areas. EB, ethidium bromide. (h1) Virchow R. In: Vorlesungen über Pathologie, Vol. 1. Berlin: August Hirschwald; 1858. (h2) Caspersson TO. Cell growth and cell function. New York: WW Norton; 1950. (h3) Coulter WH. US patent 2,656,658, priority Aug 27, 1949. (h4) Coulter WH. Proc Natl Electron Conf 1956;12:1034–1042. (h5) Wied GL, Bartels PH, Bahr GF, Oldfield DG. Acta Cytol 1968;12:180–204. (h6) Bibbo M, Schneider V, Bedrossian CWM. Diagn Cytopathol 2005;33:359–363. (h7) Koss LG. Acta Cytol 1961;5:309–310. (h8) Koss LG. Acta Cytol 1966;10:145. (h9) Kamentsky LA, Melamed MR, Derman H. Science 1965;150:630–631. (h10) Melamed MR, Koss LG. Med Clin N Am 1966;50:651–666. (h11) Darzynkiewicz Z, Bolund L, Ringertz NR. Exp Cell Res 1969;55:120–123. (h12) Mayall BH. Cytometry 1980;1:1. (h13) Ruhenstroth-Bauer G, Zang D. Blut 1960;6:446–462. (h14) Lushbaugh CC, Maddy JA, Basmann NJ. Blood 1962;20:233–240. (h15) Lushbaugh CC, Basmann NJ, Glascock B. Blood 1962;20:241–248. (h16) Fulwyler MJ. Science 1965;150:910–911. (h17) Valet G. In: Robinson JP, editor. Purdue Cytometry CD Nr.10, 2007; ISBN 978-1-890473-10-5, http://www.classimed.de/martins1.html. (h18) Thom R, Kachel V. Blut 1970;26:48–50. (h19) Van Dilla MA, Mullaney PF, Coulter JR. Annual Report Biological and Medical Research Group H-4, Los Alamos Scientifc Laboratories; 1968. pp 100–105. (h20) Dittrich W, Göhde W. Patent DE 1 815 352, priority Dec 18, 1968. (h21) Dittrich W, Göhde W. Z Naturf 1969;24b:360–361. (h22) Büchner T, Dittrich W, Göhde W. Verh Dtsch Ges Inn Med 1971;77:416–418. (h23) Hulett HR, Bonner WA, Barrett J, Herzenberg LA. Science 1969;166:747–749. (h24) Valet G, Metzger H, Kachel V, Ruhenstroth-Bauer G. Blut 1972;24:42–53. (h25) Ruhenstroth-Bauer G, Valet G, Kachel V, Boss N. Naturwissenschaften 1974;61:260–266. (h26) Valet G. In: Sack U, Tarnok A, Rothe G, editors. Cellular diagnostics, Karger Basel; 2009. pp 29–52. (h27) Mendelsohn ML. Cytometry 1987;8:111–113. (**b**) Organizational time course of European and American developments in cytometry.

With the entire cytometry community counting between 150 and 200 scientists in Europe and in the United States, it was felt that the frequency of the mutually attended meetings was too high and that the development was hampered by an increasingly confusing nomenclature (Impulsfluorometrie, Impulszytophotometrie, Imulsmicrophotometrie, pulse cytophotometry, microflow fluorometry, micro-flow fluorometry, flow microfluorimetry, flow microfluorometry, and flow cytofluorometry) resulting for the period 1969–1976 in 60 mostly German and 44 US electronically searchable publications under the various terms. Flow cytometry as name for the discipline was finally agreed on at the Pensacola 1976 conference and the Society for Analytical Cytology (SAC) with the new journal Cytometry and Brian Mayall as editor (h12) were founded 1978 at the Schloß Elmau conference. This provided a single international cytometry society in conjunction with a focused journal. The decisions were not undisputed amongst European scientists but finally supported by a majority in good faith.

SAC membership rose steadily mainly by US members. Regionalization in conjunction with an association status to SAC [renamed in 1990 to International Society for Analytical Cytology (ISAC) and in 2010 to International Society for the Advancement of Cytometry] was considered a promising concept to positively combine scientific independence with disciplinary progress.

DGfZ

Earlier meetings of interested scientists from various disciplines in Germany had the charm of introducing new procedures and instrumentation in cytometry and supported discussion with experts of operational experience. The organization of local groups in the United States, the foundation of the French [Association de Cytométrie en Flux (ACF) 1981, renamed to Association Française de Cytométrie (AFC) 1994] and Italian [Groupo Italiano di Citometria (GIC) 1982] cytometry societies showed a need for such communication in Europe. Klaus Goerttler in Heidelberg thought that it would be worth a try to bring German cytometry groups together. Günter Valet, Wolfgang Göhde, and Andreas Radbruch advanced therefore the foundation of a German society for cytometry during a brainstorming session in October 1989 at the second Heidelberger Flow Symposium. The majority of the attending scientists voted for the foundation, which had been realized until the third Heidelberg Flow Symposium in October 1990.

The DGfZ has organized since then yearly meetings as well as workshops and courses under various presidents (www.dgfz.org). The main topics changed every year; therefore, a broad scientific community is getting the opportunity to present new ideas and research data with the single cell as the target. The aim of the 20th conference was to start a discussion on how developments in nanotechnology might provide new advantages for single cell analytics. "Cytometry goes Nano" for example meant that scientists are challenged by getting resolution below the micrometer scale within the cell to better understand cellular functions on a well-resolved molecular level. Going "Nano" included, besides the dimension of the object, those of the materials and tools used to perform a more accurate or cheaper analysis of the cells. New nanotechnologies, and the corresponding changes in physical, molecular, and biological characterization of cells, might therefore be a reasonable part of upcoming instrumentation technologies. Setting up a dialogue between nanoscience and cytometry was therefore the first aim of the DGfZ conference in 2010 (see abstracts SI 1). The 20th anniversary meeting on October 2010 under the presidency of Susann Müller was characterized by the stimulating attendance of a majority of young scientists. Their interest in cytometry, the successful work of Attila Tarnok as editor of Cytometry Part A as well as the upcoming ISAC CYTO2012 congress in Leipzig with the background of the Leipzig University including the federal state of Saxonia will provide a stimulating environment for the future.

Future

Regionalization has not been restricted to Europe and generated a high variety of approaches world wide. They are the source of continuing expansion of the cytometry discipline into many areas of cell research, medicine, and various areas of biotechnology and ecology. Beyond the *methodological* impact, it seems important to stress the *systemic potential* of cytometry for the important exploration of the heterogeneity of cell populations (1–4) in the context of wider efforts like predictive medicine by cytomics (5) or cell systems biology, data mining, and mathematic modeling. Such approaches are not only very useful for public health research but also for studying and decoding the impact of the global climate change on various ecosystems. Putting the magnifying glass on the individual cell (and on the single molecules within a cell) will be the future philosophy facilitating knowledge to understand, influence, shape, and protect complex cell systems.

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