



## Crodowaldo Pavan



Campinas, São Paulo, Brazil, 1 Dec. 1919 - São Paulo, Brazil, 3 Apr. 2009

**Nomination** 17/4/1978

**Field** Biology

**Title** Professor Emeritus, Universidade de Sa#o Paulo and Universidade de Campinas-Sa#o Paulo

**Commemoration** – Crodowaldo Pavan was born on 1 December 1919 in Campinas, Brazil. He became member of our Academy in 1978. For the last 31 years of his life he was a very active participant in the activities of the Pontifical Academy of Sciences. Crodowaldo Pavan had Italian roots. In fact, his grandfather had emigrated from Italy to Brazil. The young Crodowaldo Pavan studied natural sciences and he obtained a PhD in Zoology in 1944. Already a year before he finished his PhD studies in Brazil, he had started to work as a zoologist on the genetics of *Drosophila* flies in collaboration with one of the famous *Drosophila* geneticists, Theodosius Dobzhansky, who was working in the USA. These studies concerned animal evolutionary genetics implying the observation of chromosomes in the optical microscope, which revealed specific banding patterns. This was facilitated by giant chromosomes which had been seen with some, but by far not all kinds of flies. In the first decades of the 20th century, cytogenetic studies had suggested that the genetic information is carried in the chromosomes. This stimulated more intensive studies. In the search for appropriate animals for such studies, Crodowaldo Pavan isolated on the coastline near São Paulo different kinds of flies. One of these isolates revealed in the optical microscope to have particularly nice giant chromosomes which facilitated Pavan's research. May I just remind you that in 1944, precisely in the year in which Pavan submitted his PhD thesis, Avery and his collaborators at the Rockefeller University in New York were able to convincingly show that the material basis of genetic information is the nucleic acid DNA, a component of chromosomes. Giant chromosomes can be found in some flies and in a number of other animals, but they are not very widespread. Giant chromosomes display a remarkable banding pattern along the chromosomal filamentous structures. The intensity of these bands depends on the particular tissue under observation. Particularly intensive bands are called puffings (or shortly "puffs"). One had assumed that these tissue-specific variations of band intensities depend on tissue-specific gene activities. It was Crodowaldo Pavan who found in his working with fly chromosomes good experimental evidence for this assumption. He could show (to his own surprise) that puffs contained a high number of DNA copies which cause the high intensity of the bands. Interestingly, puffs cannot only be seen in chromosomes of adult flies but also on larval developmental tissues. This observation facilitated studies of the embryonic development. Upon the publication of his findings Pavan encountered a lot of disbelief in the scientific community. One could not understand that parts of a chromosome become highly amplified when this particular gene activity is needed. But in the long term it turned out that Crodowaldo Pavan was right: puffs contain many DNA copies of the heavily expressed genes and this in a tissue-specific manner. As a young scientist, Crodowaldo Pavan spent several stays in the USA, the first one for his collaboration with Dobzhansky. In the 1960's he spent some time at the Oak Ridge National Laboratory, where he studied the effects of radiation as well as the effects of virus infections on the chromosomal morphology, i.e. the banding pattern and gene expression. Around 1970 he worked for some time in Austin, Texas. From there he returned to Brazil. While his early scientific investigations had been done in São Paulo, his later work was carried out in Campinas. Here he used fruit flies to control agricultural pests, applying his scientific knowledge to the benefit of humanity. This shows his wide interests for both basic and applied scientific research at the frontline of genetics. In his home country Crodowaldo Pavan also collaborated with Johanna Döbereiner, a late member of our Academy. I remember many interesting discussions with them on their experimental results on nitrogen fixation by microorganisms residing in various tissues of agricultural crops such as sugar cane. As a matter of fact, these researchers found out that nitrogen fixation by various kinds of bacteria is much more widespread

in plants than one had assumed before. In general, different nitrogen fixing bacteria can be found as symbionts throughout the plant tissues, at least as long as no (or only small) doses of nitrogen fertilizer are applied. This insight is of high relevance for a sustainable agriculture. Crodowaldo Pavan exerted also activities in science politics in his home country. For some years he was the President of the National Science Council and also of the Brazilian Society for the Advancement of Science. He actively propagated an improvement of the public understanding of science. With his death, our Pontifical Academy of Sciences has lost an active member with an impact on basic scientific knowledge and on the beneficial application of this knowledge, particularly in favor of developing countries and with respect to sustainability of agricultural practices.

Werner Arber

### **Most important awards, prizes and academies**

*Awards:* Brazilian Prize in Genetics (1963); Moinho Santista Prize - Area Biology (1980); Alfred Jurykowski Prize, Brazilian Academy of Medicine (1986). *Academies:* Pontifical Academy of Sciences; Brazilian Academy of Sciences; Third World Academy of Sciences; Academy of Sciences of Lisbon, Portugal; Academy of Sciences of Chile; Academy of Medicine of Sa#o Paulo, Brazil; Istituto Veneto di Scienze, Arti e Lettere; Fisiografica Society of Lund, Sweden; Academy of Letters of Sa#o Paulo, Brazil.

### **Summary of scientific research**

1) Areas of scientific work: Population genetics on tropical species of *Drosophila*; cytogenetics and chromosomal physiology on different species of Sciarids; biology and the biological control of animal pests; *Cochliomya hominivorax* (screwworms), *Dermatobia hominis* (human bot fly), and *Musca domestica* (housefly). Nitrogen-fixing bacteria of non-legume plants. These are bacteria that live inside the body (endophytic) of the plant, some of them being obligatory endophytic and others facultative. These bacteria are very common on many families of plants in Brazil. He hoped to find or create an association between plant and specific nitrogen-fixing bacteria to substitute the use in agricultural practice of artificial nitrogen fertilizers. More recently the study of endosymbiotic bacteria associated to plant seeds and birds' eggs. 2) Other areas of activity. The development of science and technology in Brazil; cooperation in science and technology between countries of the Third World.

### **Main publications**

Dreyfus, A., Nonato, E., Breuer, M.E. and Pavan, C., 'Cromossomos politenicos em va#rios o#rga#os de *Rhynchosciara angelae*', *Rev. Brasileira de Biologia*, 2, pp. 435-57 (1951); Pavan, C., Cordeiro, A.R., Dobzhansky, N. & Th., Malagolowkin, C., Spassy, B. and Wedel, M., 'Concealed genic variability in Brazilian population of *Drosophila willistoni*', *Genetics*, 36, pp. 13-30 (1951); Breuer, M.E. and Pavan, C., 'Behavior of polytene chromosomes of *Rhynchosciara angelae* at different stages of larval development', *Chromosoma*, 7, pp. 371-86 (1955); Pavan, C., 'Nucleic acid metabolism in polytene chromosomes and the problem of differentiation', *Brookhaven Symposia in Biology*, 18, pp. 222-39 (1965); Azeredo-Espin, A.M.L. and Pavan, C., 'Karyotypes and possible regions of origin of three species of *Calliphoridae* (Diptera) recently introduced in Brazil', *Rev. Brasileira de Gene#tica*, 4, pp. 619-38 (1983); Pavan, C., 'Chromosomal changes induced by infective agents Triangle', *Sandoz J. Med. Sci.*, 8, pp. 42-8 (1967); Pavan, C., Biesele, J., Riess, R.W. and Wertz, A.V., 'Changes in the ultrastructure of "Rhynchosciara" cells infected by "Microsporidia"', *Studies on Genetics*, VI, p. 7103 (1971, XIII); Pavan, C., Da Cunha, A.B. and Morsoletto, C., 'Virus-chromosome relationships in cells of "Rhynchosciara" (Diptera, Sciaridae)', *Caryologia*, 24, pp. 371-89 (1971); Pavan, C. and Sanders, P.F., 'Heterochromatin in development of normal and infected cells', *Cell Differentiation* (Munrsgaard-Copenhagen, 1972).