Plant Pathology in the Czech Republic

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Abstract

An outline of past achievements in plant pathology in the CR and main recent problems of Czech plant pathologists are given. A description of the present state in plant pathology in the CR is preceded by data on the structure of CR, on its agriculture, research and development. The outstanding feature of the Czech agriculture is large-scale production. However, the CR still lags behind the EU in yields per hectare. Compared with the EU member states, the CR devotes less money (less then 0.7% of GDP) to research and development (R&D). The trend of state subsidies to R&D in the agriculture sector in current prices is stagnant. It represents an actual decline in the fixed prices. In the Czech Republic, approximately six hundreds persons are professionally engaged in plant health. It represents 6 professionals per 100 hundreds citizens in the CR. Around 160 persons deal with the research and/or teaching of plant pathology. Public service in the field of plant health (advisory work, extension or outreach activities) is one of the weak links in the system of plant health care in the CR. The reason is the lack of commitment for this field of plant health care activity together with absence of sufficient financial support. Minimum requirements for education should be set on advisors and provider of services in the field of plant health at the EU level. In the CR, there exists still some gap in scientific expertise of nematology and integrated pest management. The Czech Lands are proud of the role of some Bohemian and Moravian scientists who have been prominent in the development of plant pathology and related disciplines. These include: AUGUSTUS CARL JOSEPH CORDA and FRANTIŠEK BUBÁK in mycology, GREGOR JOHANN MENDEL in genetics, FRANTIŠEK KRÁL in bacteriology, BOHUMIL NĚMEC and EDUARD BAUDYŠ in plant pathology.

Keywords: Czech agriculture; R&D in the CR; the present state and the past of plant pathology in the Czech Lands; prominent Bohemian and Moravian scientists in plant pathology and related disciplines

It is an honour to speak about plant pathology in the Czech Republic. I decided to try:

- to present some reflections on the status of plant pathology in our country;
- to outline important or remarkable features of plant pathology in the Czech Republic today and in the past;
- to describe the development of research and outreach efforts in plant pathology in the country as they relate to the needs of Czech agriculture;
- to elaborate on our concerns for the future of plant pathology.

A description of the present situation in plant pathology in the Czech Republic should be preceded by some data on the structure of the CR, on its agriculture, research and development.

Czech Republic

The present-day Czech Republic is comprised of three historical provinces: Bohemia, Moravia, and Silesia (known as Lands of the Czech Crown or Czech Lands). In the modern era, i.e. from 1826 to 1918, the Czech kingdom was part of the Habsburg Monarchy. The Czech Republic became a recognized state in 1993, with the dissolution of the 74-year-old republic of Czechoslovakia.

The CR is ranked anywhere from 35th to 45th worldwide according to criteria such as level of national economy, competitiveness, credibility, and other indicators, although in the 1920s and 1930s, most indices of production and living standards placed the former Czechoslovakia in 10th to 15th position in the world.

The gross domestic product (GDP) in the CR recently only slightly exceeded 60% of the EU average, but are still higher than in other Central and East European countries.

Czech agriculture

According to statistical data (Statistical Yearbook of the CR, 2001), of the 7.88 million ha area comprising the CR, 4.28 million ha (or about 55%) are in agriculture. An additional 2 million ha (33%) are in forests and 0.16 million (ca. 2%) are covered by ponds and lakes.

In 2000, the agriculture sector (including forestry and fishing) generated 3.76% of the GDP. In comparison, in the EU, agriculture amounts to only 2% of total GDP (OLESEN & BINDI 2002). The percentage of workers engaged in agriculture has declined from 12% of employees in economically active population in 1989 to ca. 3% in 2000. I the EU, about 5.6% of economically active population is employed in agriculture. Adjusted for inflation, agriculture productivity is increasing. Agricultural labour productivity increased by 17% between 1989 and 2000. Agriculture has become an economic sector with the highest productivity rate in the CR. For the first time since 1990, in 2000 and also in 2001, primary producers in agriculture realized a substantial profit of CZK 3.7 billion. Farmers' incomes represent just 75% of average wages (Report on the state of agriculture of the CR in 2000 – "Green report" 2001).

An outstanding feature of the Czech agriculture is its large-scale production. More than 75% of farm units consist of 500 ha to 3000 ha or more. Current farm ownership is as follows: private citizens (25.8%), cooperatives (29.3%), trading companies (43.7%), state enterprises (1.2%). CR still lags behind the EU in yields per hectare. For example, in 1996–2000 average yields of cereals were 4.11 tones per hectare in the CR, i.e. about 25% less than EU member states.

Average fertilizer use dropped markedly in CR from 234 kg NPK per hectare in 1988 to 67 NPK in 2000. This level of fertilizer is similar to that of the middle 1960s. Pesticide use has decreased from about 2 kg active ingredients per hectares in 1980s to 1 kg/ha in 2000.

The economics of research and development (R&D) in the CR

Compared with the EU member states, the CR devotes less money to research and development (Figure 1) (OECD 2001). Only about one-half as many persons per 1000 inhabitants are involved in R&D in the CR compared with the EU (Figure 2). The other countries of Central and Eastern Europe face similar problems. The total R&D expenditure per employee in the CR is gradually approaching that in the EU (Figure 3).

Judging from proportion of the GDP, the number of persons involved, and few younger people entering research, one may say quite generally that the input in R&D is stagnant (R&D Council of the Government of the CR 1999, 2002).

In the CR, state expenditure allocated to R&D expressed as a proportion of GDP decreased until 1995 followed by a slow climb. The objective of 0.7% of GDP, which the government undertook to achieve already in 1994, continued to be postponed. According to a government declaration the objective of 0.7% of GDP would be achieved at the time of the Czech Republic's admission to the EU (R&D Council of the Government of the CR, 2002).

The trend in state subsidies for R&D is considerably different in particular areas (Figure 4) (R&D

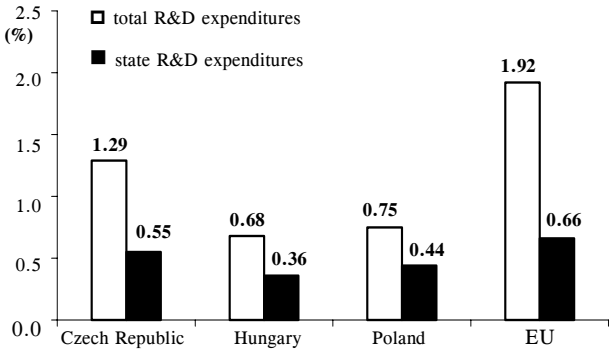


Figure 1. State R&D expenditures (% of GDP) in 1999

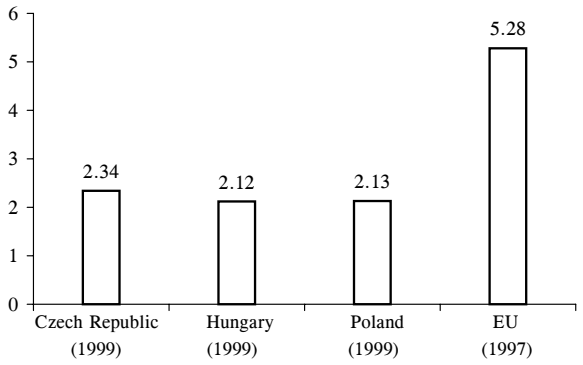


Figure 2. Number of persons employed in R&D adjusted for full-time employment per 1000 inhabitants

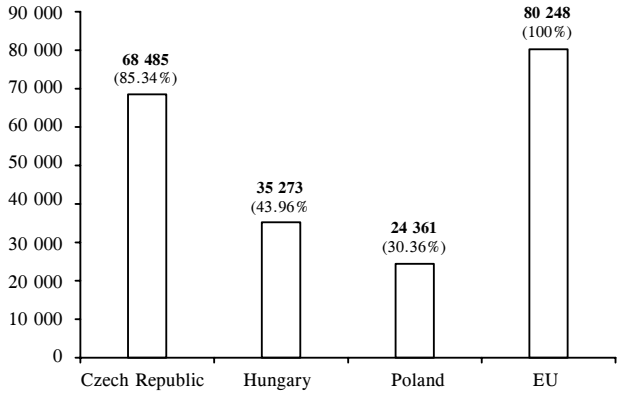


Figure 3. Total R&D expenditures per employee in R&D (in USD per employee – full time equivalent – adjusted at purchasing power parity in 1999)

Council of the Government of the CR 1999, 2002). In current prices, the subsidies administered by Ministry of Agriculture have changed little since 1994. It represents an actual decline in the fixed prices. But on the other hand, remaining agencies, possibly with the exception of Ministry of Health, have experienced a growth. Substantial growth, for example, has occurred in the Ministry of Education, Youth and Sports and the Czech Academy of Sciences. So, the described trend is a troublesome signal for agricultural research institutes.

Some aspects of plant health management and plant pathology in the CR

The number of persons professionally engaged in plant health management is ca. 600. It represents 6 professionals per 100 hundreds citizens in the CR.

All main components of the whole plant health system (namely practical plant protection, research education, inspection, quarantine, certification, registration of plant protection products and applicators, production, processing and distribution of regulated materials) are institutionally and personally more or less secured in the CR. The exception is public service in the field of plant health (advisory work, extension or outreach activities). One of the reasons is that the present-day system of funding research institutes and universities is having a negative impact on applied research, and particularly on outreach activities. The another reason is the lack of commitment for this field of plant health care activity together with absence of sufficient financial support.

There exists still some gap in scientific expertise of nematology and integrated pest management.

About 160 persons are dealing with research and/or teaching of plant pathology. Institutes with research programs in plant pathology are: 2 state agriculture research institutes; 10 private research institutes in which workers are dealing with specific crops; 2 institutes of the Czech Academy of Sciences; 5 state universities.

Another important unit is the national plant protection organization, known as the State Phytosanitary Administration, with main office in Prague and regional and district offices throughout the CR.

The share of the Czech Lands on the development of plant pathology and related disciplines

Many countries have produced key figures in the development of our knowledge of plant diseases. We are proud of the role of some Bohemian and Moravian scientists who have been prominent in the development

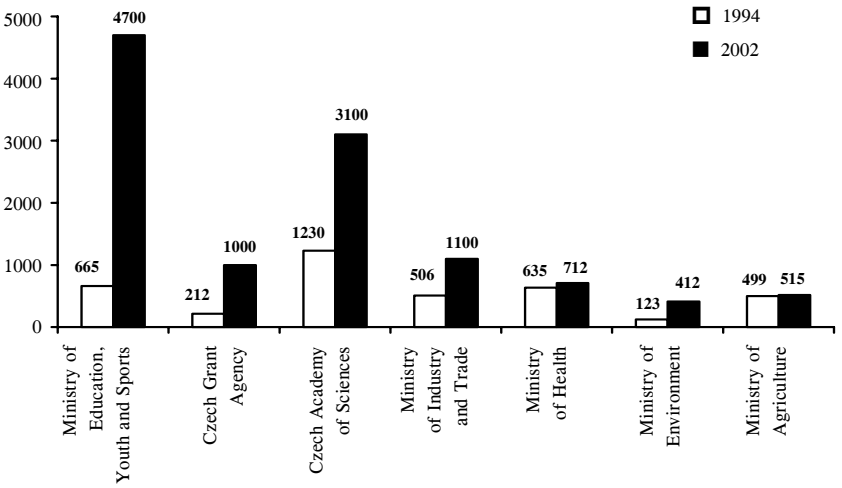


Figure 4. Trend of state subsidies extended to R&D in some selected resorts (in CZK million in current prices – 1994 and 2002)

of plant pathology and related disciplines. These include: AUGUSTUS CARL JOSEPH CORDA and FRANTIŠEK BUBÁK in mycology, GREGOR JOHANN MENDEL in genetics, FRANTIŠEK KRÁL in bacteriology, BOHUMIL NĚMEC and EDUARD BAUDYŠ in general plant pathology.

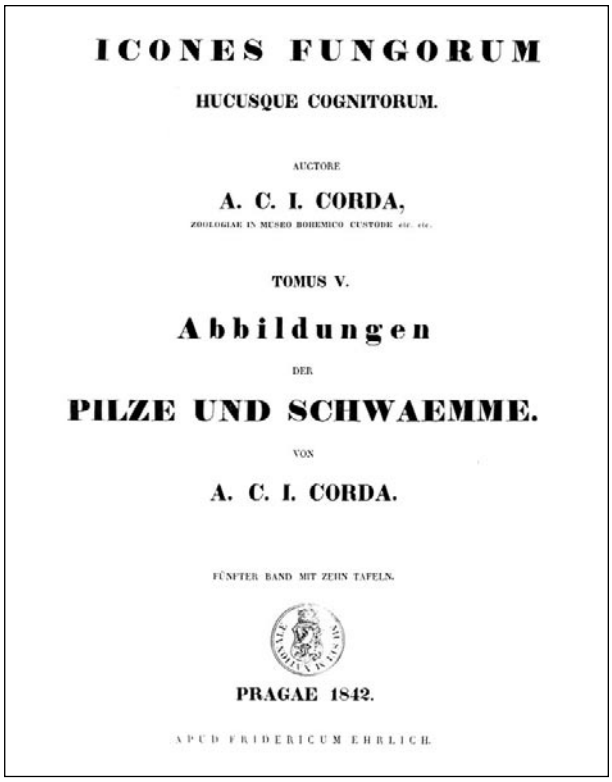
After World War II, the work of Czech and Slovak virologists contributed substantially to the knowledge of virus diseases in Central Europe. Some of the results, such as the original finding of virus diseases of bryophytes and higher fungi and descriptions of new viruses in coniferous trees and cereals, are worthy of mention (BOJŇANSKÝ 1973).

Specific biographical sketches illustrate the contribution of some Bohemian and Moravian scientists to our discipline.

Augustus Carl Joseph Corda and František Bubák

A.C.J. CORDA (1809–1849), a Bohemian botanist and mycologist, was one of the distinguished mycologists of the 19th century. In mycology, the 19th century saw major developments in the knowledge of systematics. Corda's achievements in this field are generally acknowledged.

In the work *Icones fungorum hucusque cognitorum* (6 volumes published in 1837–1854), he described many new genera and species of *Hyphomycetes* and illustrated his work with 954 detailed figures on 71 plates (Figure 5). The plates are uncoloured lithographs by the author. More than one hundred years later, in 1963, the *Icones* was reissued as facsimile (Cramer facsimile Weinheim, Historiae naturalis classica, vol. 23). Later an alphabetical index to the plates was added (STAFLEU & COWAN 1979).


ICONES FUNGORUM

HUCUSQUE COGNITORUM.

AUCTORE

A. C. I. CORDA,

ZOOLOGIAE IN MUSEO BOHEMICO CUSTODE etc. etc.

TOMUS V.

Abbildungen

DER

PILZE UND SCHWAEMME.

VON

A. C. I. CORDA.

FÜNFTER BAND MIT ZEHN TAFELN.

PRAGAE 1842.

APUD FRIDERICUM EHRLICH.

Figure 5. A title page of Corda's chief writing "Icones fungorum ..."

In all Corda described 513 genera of fungi. Many taxa described by Corda are still valid, e.g. *Peronospora, Coniothyrium, Melampsora, Ustilago maydis* etc. In 1847 to 1848 Corda published 7 scientific articles devoted to plant pathogenic fungi (rust and smut fungi and *Cladopsorium herbarum*). Corda's collection, a very important one because it has a great number of type species, is preserved in the National Museum, Mycological Department, Prague. The National Museum in Prague was founded in 1818 and was at first developed as a scientific institution (JANKO & ŠTRBÁŇOVÁ 1988).

FRANTIŠEK BUBÁK (1866–1925) was the founder of the first research department of plant pathology (1889) and the first professor of plant pathology in our country (1901). Therefore, he has been regarded as the father of modern plant pathology in the Czech Lands (KŮDELA 2000).

In his time, Bubák was, together with H. Sydow (1879–1946) of Germany, and F. Petrak (1886–1972) of Moravia, among the foremost European authority in mycology. He published 132 scientific works, mainly about rusts. His studies received wide renown.

Bubák's outstanding herbarium was purchased by Brooklyn Botanical Garden (USA) in 1922. Nowadays, Bubák's herbarium is maintained at the U.S. National Fungus Collection Beltsville, Maryland. It consisted of 33 779 specimens including a number of important exsiccati (21 series). An important part of the collection consisted of 500 type specimens of the species of fungi described by Bubák.

Gregor Johann Mendel

The study of plant pathology requires some understanding of genetic interactions of host and parasites. Due to the discovery of DNA in the 1950s and the introduction of recombinant DNA technology in the 1970s, the 20th century has been stamped as the era of genetics, despite the fact that the father of genetics, Mendel, did his work in the 19th century.

GREGOR JOHANN MENDEL (1822–1884), a Moravo-Silesian botanist and monk, was the first who described chromosomal inheritance based on careful experiments

in 1865. BAFFEN (1905), working with yellow rust, provided the first evidence that resistance to a pathogen may be controlled by a single, Mendelian gene.

It is interesting to examine the economic and social background of Mendel's interest in plant breeding early in the second half of the 19th century. Science was not widely institutionalized in the period so that individual, independent scientists still played an important role in scientific discovery. Scientific endeavours in Moravia had their institutional centre in the Moravo-Silesian Society (MRS) in Brno. At the beginning of the 19th century, the MRS aroused great interest in the problems of the breeding of cultivated plants and farm animals. There is a direct link between the MRS activities and Mendel's work (JANKO & ŠTRBÁŇOVÁ 1988).

In Brno, Moravia, the Museum of Genetics (the only one in the world) has been opened to the public in May of 2002. It is situated where Gregor Mendel lived and worked.

František Král

Culture collections of microorganisms are important not only for preservation of endangered germplasm, but also as principal source of material for research, teaching and development of products on the basis of substances produced by microorganisms.

FRANTIŠEK KRÁL (1846–1911) founded the first culture collection of microorganisms in Prague in 1889. The collection was known under the name Král'sche Samlung von Mikroorganismen (KOCÚR 1990). The next oldest collection – Centraalbureau voor Schimmelcultures – was founded some years later, in 1906 at Baarn, The Netherlands.

Professor Král realized the value of maintaining a collection in one location and began to collect cultures, which he made available for a fee to other workers (GIBBONS 1984). Král obtained cultures for his collection directly from the authors who isolated and published their descriptions (KOCÚR 1990). Král's catalogue of cultures, which appeared in 1900, is the first catalogue of microorganisms to have bee published. Král's catalogue of microorganisms, issued in Prague in 1911 (Figure 6), comprised 910 strains of bacteria, 176 mitosporic fungi (*Hyphomycetes*), 123 yeasts and 10 algae (FASSATIOVÁ 1988). Král also prepared permanent preparations of cultures microorganisms (Figure 7) and sets of slide preparations for teaching purposes (KOCÚR 1990).

After Král's death, the collection was acquired by Professor Ernst Přibram and transferred from Prague to the University of Vienna (Wien) in 1915. Přibram brought part of the collection to Loyola University in Chicago some years before World War II. He was killed in a car accident in 1940 but the fate of his collection is not known. The collection is currently not complete. The cultures left in Wien were destroyed during World War II (GIBBONS 1984). Only 34 exhibits of permanent cultures made in previous Král's bacterial laboratory are preserved in the Naturhistorischen


KRÁL'S BAKTERIOLOGISCHES LABORATORIUM, PRAG
I., KLEINER RING II

DER GEGENWÄRTIGE BESTAND
DER KRÁL'SCHEN SAMMLUNG
VON
MIKROORGANISMEN

MÄRZ 1911

PRAG

Figure 6. A title page of Král's catalogue of microorganisms issued in Prague in 1911 (according to FASSATIOVÁ 1988)

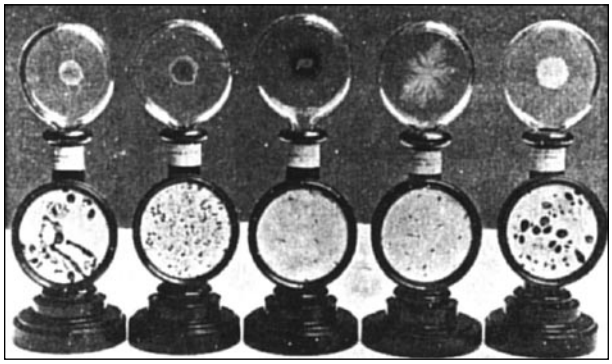


Figure 7. A museum display cultures containing both colonies on agar and microcraphs which F. Král supplied for teaching purposes (according to KOCÚR 1990)

Museum, Wien (FASSATIOVÁ 1988). Some of Král's original subcultures were deposited by several American microbiologists in the American Type Culture Collection (KOCÚR 1990).

The existence of Král's collection in Prague had an influence on the development of phytobacteriology in our country. For example, Jaroslav Peklo from Prague University, did pioneering inoculation experiments with the crown gall bacterium in 1911–1913, using strains of *Agrobacterium tumefaciens*, which were sent to Král's collection by Erwin Frink Smith, USA, father of phytobacteriology, some time around 1907.

Bohumil Němec and Eduard Baudyš

The notion that previous infection leads to changes in host susceptibility and resistance remains as a general concept that deserves an important place in modern thinking about plant disease.

BOHUMIL NĚMEC (1873–1966) was one of three scientists who first presented evidence for induced immunity to bacterial plant diseases, using the model system of *Pseudomonas aeruginosa* (opportunist pathogen both to plants and animals), and *Crassula lactea* (succulent species). The first evidence was presented by Ray and Beauvery in 1902 (see GOODMAN 1980) and the second one by BROWN (1923). Němec conducted his experiments in 1927 and his results were published two years later in Czech with an extensive English summary (NĚMEC 1929).

EDUARD BAUDYŠ (1886–1968) was probably the first scientist to record that mosaic viruses enhance the defence of hosts against a number of different pathogens. He found that sugar beet plants infected with beet mosaic virus were subsequently resistant to both *Cercospora beticola* and rust fungus (*Uromyces betae*). His communication was published in Czech with a German summary in the Journal Ochrana rostlin (Plant Protection) (BAUDYŠ 1929). The article was recorded in Review of Applied Mycology, **10**, 78–79 (1931). In the same year as Baudyš, MCKINNEY (1929) announced that the plant, inoculated with one strain of virus (inducer), would fail to develop the symptoms of a second train (challenger) upon the inoculation of that strain. The third observation was made by THUNG (1931) in studies with isolates of tomato mosaic virus. He confirm McKinney's results, but he also observed that the challenge virus could not be detected upon subinocculation from protected plants to healthy indicator plants (HAMILTON 1980). McKinney published his work in Dutch.

Important events in the history of plant pathology and the whole plant health care system in the Czech Lands

1898 – The adoption of the law (No. 37/1898) valid for Bohemia Crown regarding vineyard protection against *Peronospora viticola*.

1899 – The establishment of the first department devoted to the study of diseases and pests of plants at the Agricultural Research Station in Prague. The station was set up in co-operation with the agricultural education program at the Czech Technical University.

1901–1920 – The establishment of an early professorship in plant pathology at the Agricultural University, Prague (associate professorship in 1901; full professorship in 1920).

1921 – The founding of the journal Ochrana rostlin (Plant Protection). In 1998, the journal began publication in English under the name Plant Protection Science.

1924 – The establishment of the Czechoslovak Agricultural Academy, the association for agricultural sciences, comprising special sections and committee inclusive of the Plant Pathology Commission.

1959–1962 – The publication of the four-volumed textbook (2382 pages) on plant diseases of agricultural crops, Agricultural Plant Pathology (Zemědělská fytopatologie), edited by E. Baudyš, J. Benada and J. Špaček.

1957–1985 – The publication of 7 atlases of diseases and pest injuries of cultivated plants and forest woody species. The atlases were on a crop basis. A hand-painted plate accompanied each brief disease description. Some of the atlases were also published in other countries.

1996 – A law was passed that established minimum qualifications needed for appointment as a plant health management professional in both the public and private sector (KŮDELA 1997). I is important that requirements for plant health management professionals are laid down by the law and not only by lower legal regulations in the CR. This provides the best basis for improving the quality of plant health care in the Czech Lands in the future. These efforts should result in increased prestige of persons and institutes dealing with plant health.

Challenges and potential problems

In the first decade of the 20th century, plant pathologists began to express a desire for their own recognized discipline in line with the general trend in disciplinary specialization in the sciences. The economic importance of plant diseases became the

driving force in plant pathology beginning with the Millardetian period (1883–1906). From that time on, plant pathology focused on the needs of growers.

The future of plant pathology in the CR and other European countries is closely connected with the world-wide future of plant pathology, as well as with the prospect for European agriculture and plant health management. At the beginning of the 21st century, some plant pathologists look to the future with trepidation. What are the reasons for such pessimism? Is the further survival and continued success of plant pathology in jeopardy? In what form will plant pathology survive?

Some possible reasons for anxiety are:

In developed countries, the urban population, that constitutes most of the taxpayers and voters, may not appreciate the need for continual funding of research, teaching and outreach in plant pathology and other plant health disciplines.

Most people outside of agriculture are unaware of the threat of plant disease epidemics. They do not fully realize that an abundant supply of food is, among other things, the result of successfully implemented disease management practices based on sound research. Today, majority of consumers does not know how vegetables and fruit would appear when effective treatment for plants is not available. Nevertheless, if products from crops not treated against pathogens and pest were to be sold, buyers would be few.

Even in countries with prosperous economies, the agriculture research institutes and universities are under great economic pressure because of budget cuts. We view with alarm that in some USA universities the departments of plant pathology were merged with larger units, such as general plant sciences or general biology (SEQUEIRA 2000), applied ecology or environmental science. Plant pathology cannot continue to grow as an independent branch of science while attached to a larger department. However, to my way of thinking, there is nothing to be said against large departments of plant health. I agree with those who say, e.g. WEINHOLD (1996), that strong disciplines are essential to promote the advances in knowledge necessary for devising new approaches to problem solution.

Many careers and professions are frankly more attractive to bright, ambitious young people. At the present moment, these include computer science, business and finance, law, medicine and allied medical fields. Poor funding for agricultural sciences has lead to a tight job market in plant pathology.

From the beginning, plant pathologists have balanced their efforts between helping growers identify and manage disease problems and the more fundamental work needed to understand the biology of the plant disease process. The dilemma that must be addressed is how to establish a balance between disciplinary and problem-solving research and a continuum from achieving fundamental advances in knowledge to the development and implementation of problem-solving approaches (WEINHOLD 1996). The mission-oriented research does not lack scientific rigor.

The present-day system of funding research institutes and universities is having a negative impact on applied research, particularly on outreach activities. However, outreach or extension activity keeps our feet in the furrow and generates grass-root support for our profession, as it was said by J.C. Walker. We need two-way flow of information between the field and the laboratory bench.

Conclusion

If, in the next few decades the prestige of plant pathology in the CR and all over the world is to be strengthened and the systematic effort of plant pathologists result in effective and environmentally friendly control of plant diseases to the benefit of growers and the general public, it is necessary:

- to strive for the formation of a plant health care system in which research, teaching and extension services or private practice for plant protection will be balanced;
- to strengthen the position of public service in the field of plant health (advisory work, extension or outreach activities) by organizing a highly structured interdisciplinary program of training in plant health care for professionals, by declaration of the clear institutional responsibility for public services in the field of plant health care activity and by defining the means for financing such programs;
- to establish minimum requirements for education advisors and providers of services in the field of plant health at the EU level;
- to preserve the integrity of plant pathology as an independent branch of science in spite of the increased tendencies of university or research administrators for the merger of autonomous organizational units of plant pathology with other disciplines. At the same time, it is important to minimize the tendency for plant pathologists to specialize in mycology, virology, bacteriology, molecular biology, and other areas;
- to learn to lobby effectively for applied research for agriculture and public service in the field of plant health and to intensify our connections with

the farming community, to which we owe our existence, using our professional societies including European Foundation for Plant Protection.

Despite the existing problems, we believe that plant pathologists, with physicians and veterinarians, will successfully fulfil their responsibility for addressing the disease problems of higher organisms on earth.

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