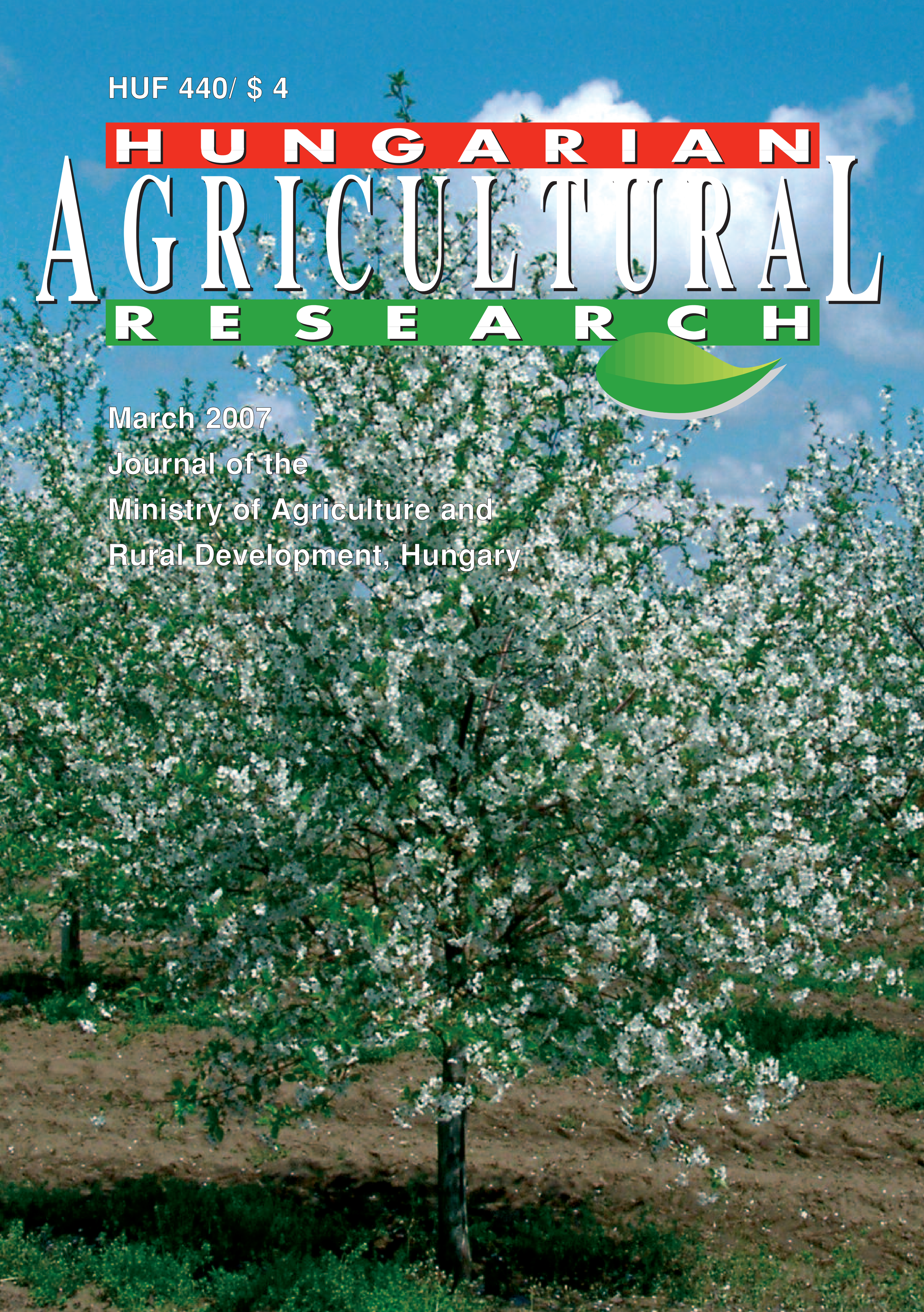
HUF 440/ $ 4

HUNGARIAN AGRICULTURAL RESEARCH

March 2007
Journal of the
Ministry of Agriculture and
Rural Development, Hungary



A Joint IAAE- EAAE Seminar

Agricultural Economics and Transition:

"What was expected, what we observed, the lessons learned."

6th–8th September, 2007
Corvinus University of Budapest, Budapest 1093 Fővám tér 8.

Over fifteen years have elapsed since the transition from the centrally planned economic system began in the early 1990's. During this time agricultural and rural areas of Central and Eastern Europe have undergone profound structural changes with wide variations in the degree of transformation and in the rate of success in creating a competitive market and private ownership based food and agricultural system. By becoming member of the European Union the "transition" in its traditional interpretation has been concluded in eight of the Central European countries and it is close to get completed in the EU candidate countries. The transition to market based agriculture, however, is far from completion in Southern and Eastern Europe and especially in the CIS countries.

The major objective of the seminar is to discuss and draw conclusions on the role of agricultural policy in the transition process in the light of actual progress and current situation in Central and East European countries and in formal Soviet States. In addition the contribution of agricultural economics - both from the West and from the East – as discipline and profession to the transition process in agriculture will be discussed. A specific objective is to identify priorities and means to strengthen the agricultural economics profession in Central and Eastern Europe and determine research and educational priorities for the future.

Topics

1. **The overall transition process: macroeconomic, trade policy and institutional framework**
   + theories and expectations, the reform agenda foreseen by the profession,
   + actual overall progress in transition in the region,
   + underlining factors (e.g. human capital, financial and public institutions) and characteristics of the observed transition processes.

2. **Land privatization and farm restructuring**
   + the reform agenda and proposals,
   + progresses in land privatization and farm restructuring,
   + determinants and differences of outcomes.

3. **Reforms in primary production and in the upstream and downstream sectors**
   + what was expected?
   + changes in productivity and competitiveness
   + dramatic changes in vertical and market relations,
   + critical lessons.

4. **EU accession experiences**
   + a priori impact analysis,
   + observed outcomes so far,
   + results in the lights of predictions: what did we learn?

5. **What was the contribution of the profession?**
   + adequacy of proposals and predictions,
   + where we were right?
   + where we were wrong?
   + was the profession prepared?
   + priorities for the future/in research, training and research and in advocacy.

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Blossoming sour cherry trees
(Photo by Agroinform archive)

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Published by AGROINFORM Publishing
H-1149 BUDAPEST, Angol u. 34. Hungary
www.agroinform.com

Editorial Office
Department of Mechanics and Engineering Design
Szent István University, Gödöllő
H-2103 GÖDÖLLŐ, Hungary

Subscription request should be placed with the Publisher (see above)
Subscription are HUF 1200 (only in Hungary) or
$16 yearly plus $5 (p & p) outside Hungary

HU ISSN 1216-4526

Dezső Surányi[1]

'There is an infinite diversity of sweet and sour cherries in Hungary'

From wild fruit to domesticated variety…

The bird cherry is endemic to Eurasia (to our country, as well), though it is quite rare in South Europe, in the southern part of India and in South-East Asia and is absent in China. It is a species of typical mountain forest ecosystems and birds play an important role in its propagation. There are several known forms of this species and by means of recurrent selection its appearance and quality parameters have been successfully improved. Archaeologists found a great number of wild and semi-domesticated cherries stones in the Swiss pile-dwellings.

The original habitat of the cultivated sweet cherry is difficult to determine since the area of the bird cherry is vast, while that of the sour cherry is difficult to locate because of the small area of similarly uncertain boundaries. The sweet cherry has a remarkably great diversity of forms in Asia Minor. It is probable that the cultivated sweet cherry was selected around Trapezunt (Trabzon). On the other hand, one of the possible birthplaces of the sour cherry and the cultivated varieties is to be sought after where the area of the bird cherry and that of the dwarf cherry (*Cerasus fruticosa*) come together (in the region between the Caspian and the Black Sea). According to an other theory in circulation, the sour cherry is the autotetraploid form of the sweet cherry.

MOHÁCSY – MALIGA (1956) called attention to the fact that the ancient author placed more importance on the wood of the tree than to its fruit (probably, because it was used for furniture and tools). The name 'kerasos' refers probably to the sweet cherry. Otherwise, only semi sour cherries could be thought of, as sour fruits were considered of little value in the antiquity and sour cherries were obtained from gathering, if at all, since people did not give much care to them.

THEOPHRASTUS described the cherry in the following way: 'the cherry-tree is a tree of a peculiar character, and of large size, with a trunk very huge in circumference...its flower is like that of the pear or the medlar...its fruit is red...its tree grows in places like the linden: near brook sides'.

The introduction of cultivated cherries into Italy dates to the period of the war of LUCULLUS against Mithridates (around 64 B.C.). at this time 8 new sweet cherry and 2 sour cherry varieties appeared in Rome which are mentioned by PLINY in his Historia Naturalis. This story was then adopted in The Parallel Lives by Plutarch. 'Before the time that CATULLUS defeated Mithridates there were no cherry-trees in Italy, i.e. prior to the year 680 from the foundation of the City. CATULLUS was the man that first brought this tree out of Pontus and furnished Italy so well with it, that within hundred and twenty years other lands had part thereof, even beyond the ocean'.

The one from *Aprionia* was the reddest, the one from *Lutatia* the blackest and the one from *Caecilia* the roundest. The *Junian* cherry has a pleasant taste and is eaten 'under its tree' because its flesh is so fragile, because does not tolerate transportation. The most appreciated was a Duracine variety which was called *Plinian* cherry in Campania and Lusitanian cherry in Belgium and there was the variety from the riverside of *Rhenus* (Rhine). The colour of the latter is a combination of black, red and green and look as if it was in ripening still. The tree of the *Macedonian* (Cigány, Maraska,) cherry is very small, seldom above three cubits high; the *Chamaecerasus* is a shrub even smaller. (This was cited because these varieties became commonly known in Pannonia, under Celtic-Roman influence.)

The Roman authors were probably wrong as the production of the sweet and sour cherry had already been undertaken in Rome prior to CATULLUS, according to some Etruscan mosaics. In his book VARRO described the method and time of propagation. The sour cherry was long regarded as 'a stepchild', this fact is also confirmed by written documents. What is said by AMMANIUS and SAINT JEROME following the Roman specialist writers is substantially only a repetition of the earlier accounts of PLINY.

The simultaneous discussion of the sweet cherry and the sour

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cherry is also justified by the Roman frescoes discovered in Pompeii as also these images do not permit to decide whether, in fact, they depict sweet or sour cherries.

According to LA BAUME (1961), the sweet cherry was introduced from Western Asia into the Mediterranean by the Romans. VAVILOV locates the area of the two species in this very same place, while ZSUKOVSZKIJ much more to the north into the European-Siberian centre. MÁNDY (1970) in a similar manner regards Asia Minor and the Trans-Caucasus as the primary gene centre of the sweet and sour cherry. It is known from historical-plant geographical data that the sweet and sour cherry were present in the period from 6500 to 2500 in the shrub layer of mixed-oak forests in the Carpathian Basin and the bird cherry occurred together with different tree species. The sour cherry is to be considered endemic partly to this area, partly to the Balkan (WERNECK, 1955 and 1956).

The sweet cherry is already known from the Mesolithic and a number of German, Austrian and national data are available in archeobotanical works. The stones found at the Celtic settlement at Schwäbisch Hall, dating to the Bronze Age, are bigger than the ones known from the Roman period. Also the Austrian Roman era discoveries are very rich: the stones discovered in Nussdorf, Penzerdorf and Linz represent the local sweet cherry variety form of the late Roman period (WERNECK, 1955). According to BERTSCH the domestication of the sweet cherry and the beginning of its cultivation in the valley of the Danube go back to the late Neolithic (P. HARTYÁNYI, 1978).

The Roman legionary camp near Neuss brought to light 64 carbonized sweet cherry stones which were demonstrated by KNÖRZER (1970) to originate from bird cherries gathered (or possibly even cultivated) in the nearby mountains by the Romans. Also the water well discoveries from the Roman period are rich in sweet cherry stones: seeds were found in the soil infilling in Irel, Saalburg, Rottweil and Butzbach and these are remarkably similar to the national bird cherry. In the course of the excavation of the 10^{th}–11^{th} century fortress of Haus-Meer-Niederungsburg, too, seeds were discovered in large number where the sweet cherry stones themselves numbered 1148. The 1012 carbonized sweet cherry stones determined at Neuss are also worthy of attention.

__Figure 1.__ Family tree of C.2493 bird cherry in a homestead school in Hajdúszoboszló (1952)

In the course of the excavations of medieval towns in Bohemia and in Moravia (from the 7th to the 10th century) a great number of sweet cherry stones were discovered coming from fireplaces, garbage pits and tomb fillings.

The Polish seed discoveries are also very rich, though they are a few centuries posterior: e.g. 789 whole and 56 half sour cherry stones were found in Wroclaw, as well as 34 whole and 2 half sweet cherry stones (LECHNICKI, 1955), or 824 sweet and sour cherry stones emerged from under the spades of the excavators in Gdansk, and 130 stones in Szczecin.

According to KOCZTUR, the findings in Tác-Gorsium also contained the mahaleb cherry, along with the sweet cherry. 66 sweet cherry and 100 sour cherry stones were collected from a more recent well at number 8 Dísz square in the 1st district of Budapest and further ones from the well at number 10. 3 dwarf cherry stones were identified from the clay pot discovered in the cellar of the house number 22 Hunyadi street in the 1st district of Budapest, and bird cherry fruits from the 13^{th}–14^{th} century were found in the fortress of Kereki-Fehérkő (P. HÁRTYÁNYI – NOVÁKI – PATAY, 1968).

Old varieties and growing regions

The early occurrence of the sweet and sour cherry is confirmed by charters '…ad ceresnum nigrane', '…ad arborem cheresnafa' (1265), or '…ad arborem cheresne'. The name of the sour cherry is also found in

Figure 2. *Cheese cherry at Csongrád, yellow mahaleb in botanics... (Surányi)*

several documents: '…in quibus crescunt merasa' (1277), '…ad quandam arborem merasii dupplicati' (1392). The varieties *Magyar szívcseresznye* (Hungarian heart cherry) and *Fekete* (Black) or *vadmeggy* (wild sour cherry) are to be considered our eldest varieties. As no precise description of them has survived the names are accompanied by the possibility of uncertainty.

European sweet and sour cherry production, as in Hungary, started to boom in the 16th century. A number of new varieties were bred, described and planted into the orchards. A herbal printed in Mainz does not give a particularly detailed description of the varieties offering only the scant information that there are sour and sweet cherries: 'the sour ones create gases in the stomach and refresh the mouth and the cherry that is either too sweet or too sour is of little value'.

Sweet and sour cherries were divided into four groups in another herbal written in 1569: amarelles, sour cherries, sweet cherries and finally the local varieties and semi sweet cherries. The 16th century saw a boom also in the national production with the beginning of some swapping of varieties between the three parts of the country torn into pieces. In a garden in Wroclaw KONRAD GESNER already saw valuable Hungarian and mid ripening and late ripening sweet cherry trees. TAMÁS NÁDASDY in his letter wrote: 'Of the tiny sweet cherry do not send to me, nor to her majesty the queen, but of the old fruited one when it becomes fully ripe'.

In this period in Hungary, the distinction was made between the red and black sweet cherry. SCHWENKENFELT and BAUHIN in their botanical works also mention the Hungarian sweet cherry varieties which is also utilized by LEROY in writing his works. The sweet cherry variety *Nagy piros ropogós* (Big red crisp) has survived as the ancestor of several local varieties, such as *Korkoványi*, *Korponai*, *Várkonyi*. The letter of the Emperor Maximilian I mentions the sweet cherry *Nagy fekete ropogós* (Big black crisp) as distinct from the variety denominated as *Ölyvedi fekete* which is referred to as *Cerise Coeur Noir* by CHARLES in 1540. BOETHIUS in his report on the liberation of the city Szigetvár wrote that sweet cherries as big as walnuts grew in the county of Baranya.

The sour cherry is known to be the first fruit of the Hungarians which they became familiar with on the steppes in South Russia and in the Ukraine. The tart sour cherry, with hanging twigs, was nearly only an ornamental tree in the orchards; the slender twigs of which were used to form shady tunnels. Cultivated sour cherries became common only in the 18th century in Europe, first the variety Spanish sour cherry (RAPAICS 1940).

MÁTYÁS BÉL summarizes his experiences with the two fruit species in *De re rustica Hungarorum* (1734) 'There is an infinite diversity of sweet and sour cherries in Hungary. They can be divided into garden and wild varieties, each then into sweet and tart ones; existing forms vary from crimson to completely black. Sweet cherry grows very well in Hungary without any efforts... in some places forms forests... one can recommend the sweet cherries from Sopron, Korpona and Kőszeg, but the ones grown elsewhere also deserve praise. The common sour cherry is not demanding in terms of soil and will grow in the poorest one. The Spanish sour cherry is of great esteem.' The description of Lippay in his *Posoni kert* embraces a number of sweet and sour cherry varieties.

'...sour cherry brandies...that make even the mute speak'

(Mór Jókai)

The description of the sweet cherry varieties is as follows. 'The sweet cherry is commonly of two types: grafted and ungrafted. Some of them are big, some of them are medium big and some of them are tiny. As to colours, there are black ones and there are red ones, there are ones white in one half and red in the other half and there are white ones. It is possible to encounter even green ones but I have not seen such yet. Its flavour is nice sweet juicy and a little sour, mainly the grafted black, old and very crispy. The late maturing, mostly the one ripening around the St. Michael's Day, is nice hard, but is medium in size, and looks as if it had flounces around the peduncle (i.e. is stipitate), is rarely seen in our parts. Half of it is white and half is red, is very good sweet and crispy and big. The one that is pure white is very sweet and soft fleshed. The grafted ones are always superior to those grown from the seed. The sour cherry prefers cool or medium places and is not very successful in tolerating extreme heat; nor is very keen on clayey soil, more on one somewhat humid. Medium and flat lands do not produce so big and nice sweet cherries as highlands and hills or the feet of mountains and vineyards'.

As it is known from the book of RAPAICS (1940) there was fierce debate among specialists about the name of the sweet cherry *Glocker óriás* (Glocker giant). SZUBLICS (1841) in his list describes 14 sweet and sour cherry varieties which can be considered to be of national origin. One of them is the *'Baltavári nagy vernyeges porcogós'* which is described by ENTZ (1858) under the name of *Baltavári ökörszem*. PÁL VILLÁSI (1881) mentions another variety by the same name. Since the issue could not be settled in a definitive way, BERECZKI called the *Fekete baltavári* as *Entz fekete cseresznyéje* (Black sweet cherry of Entz) and the red multicolour one *Glocker óriás*.

Figur 3. *Germersdorf giant (Brózik 1998)*

During the last century the light red variety *Nagy hercegnő* was also widespread in cultivation, but gradually the Western varieties became dominant: the *Germersdorfi óriás* and then the *Hedelfingeni*, the *Bopparti* and the *Badacsonyi óriás* found by BELKE TIVADAR in Badacsony. The *Pongrác cseresznye* was discovered in the vineyards of Nagykőrös. The *Disznódi fűszeres* was described by GUSZTÁV RITTER. The *Cserszegi mézes* was made known by PÁL VILLÁSI who selected it on the confines of the city Keszthely.

'Auctors confound the sour cherry tree with the sweet cherry tree, therefore the Germans call the common cherry as sour cherry in some places, and commonly, botanists, too. These are the few black and red ones. 1) *Fekete közönséges* (Black common) tiny or medium big: sour and somewhat sweet, but when it gets very ripe it is sweeter and the shape is round. 2) *Fekete spanyol meggy* (Black Spanish sour cherry), is also round, whit short stem, but is big and some branches are even bigger than *Öreg fekete cseresnye* (Old black sweet cherry), it is sweeter than the others when gets truly ripe. Its flowers tend to grow thickly on the branches as if they were tied to the latter in the manner of a tuft, but not too many fruits will remain on them. 3)

Figure 4. *Spanish sour cherry (Román Pomológia 1965)*

Figure 5. *Pándy meggy (Román Pomológia 1965)*

Vörös közönséges halyag meggy (Red common bell-shaped sour cherry) as some call it, medium large, sweeter than the black, very juicy, tastes like water. 4) *Spanyol halyag meggy* (Spanish bell-shaped sour cherry) which others call as Gundi, not much superior to the közönséges halyag meggy, but is much bigger than that and its stem is shorter, is more sweeter and fleshier. These sour cherry trees are not much different from sweet cherry trees, especially in nature, since, similarly to the latter, they demand a cool place' (LIPPAY).

So far, our historical sour cherry variety with the most valuable quality parameters is the *Pándy,* whose origin is unknown. Still it is certain that it came into being in the Carpathian Basin and probably is the result of mutation. According to DEZSő ANGYAL this variety originates from the orchard of the hussar captain PÁNDY native to the city Debrecen. Already in 1848 the tree was known in various parts of the country. It is also called *Kecskeméti*, *Kőrösi*, *Szentesi meggy*. An oral tradition makes the *Szentesi meggy* derive from Turkish times, according to which in 1662 ACHMET allegedly saved the daughter of GÁSPÁR BATHA the high judge of Szentes and after the big feat the high rank Turkish officer, fallen into love, brought the sour cherry as a gift to Szentes. The first Hungarian woman doctor, VILMA HUGONNAY propagated that the *Pándy meggy* had been born in the orchard of JÓZSEF SZILASSY inhabitant of Pánd and this was the place from where it spread over the country. Nowadays there are only very few sour cherry trees at Pánd, but a lot more in the neighbouring villages.

A few interspecific hybrids of the sweet and sour cherry were also instrumental to the development of the national fruit production, such as the *Hortenzia királynő*, *Eugénia császárnő* and *Châtenay szépe*. Recently, they were still present in the gene bank orchards, the question is how long will we continue to have gene bank orchards. There are sweet-sour cherry candidate varieties among the Maliga hybrids.

The wine regions, as understood nowadays, came into being during the 17th/18th century. The sweet cherry was often planted among vines in mountain vineyards, and in later times the sour cherry in the vineyards on sandy soil. In the past century there was a growing number of *Pándy* sour cherry trees besides the *Cigány meggy* and *Vörös meggy*. To ensure pollination, other sour cherries were planted next to the *Pándy* trees.

There emerged a group of sweet cherry growing regions in the country such as Eger-Gyöngyös, the neighbourhood of Szeged, the region of Buda and the northern shore of Lake Balaton.

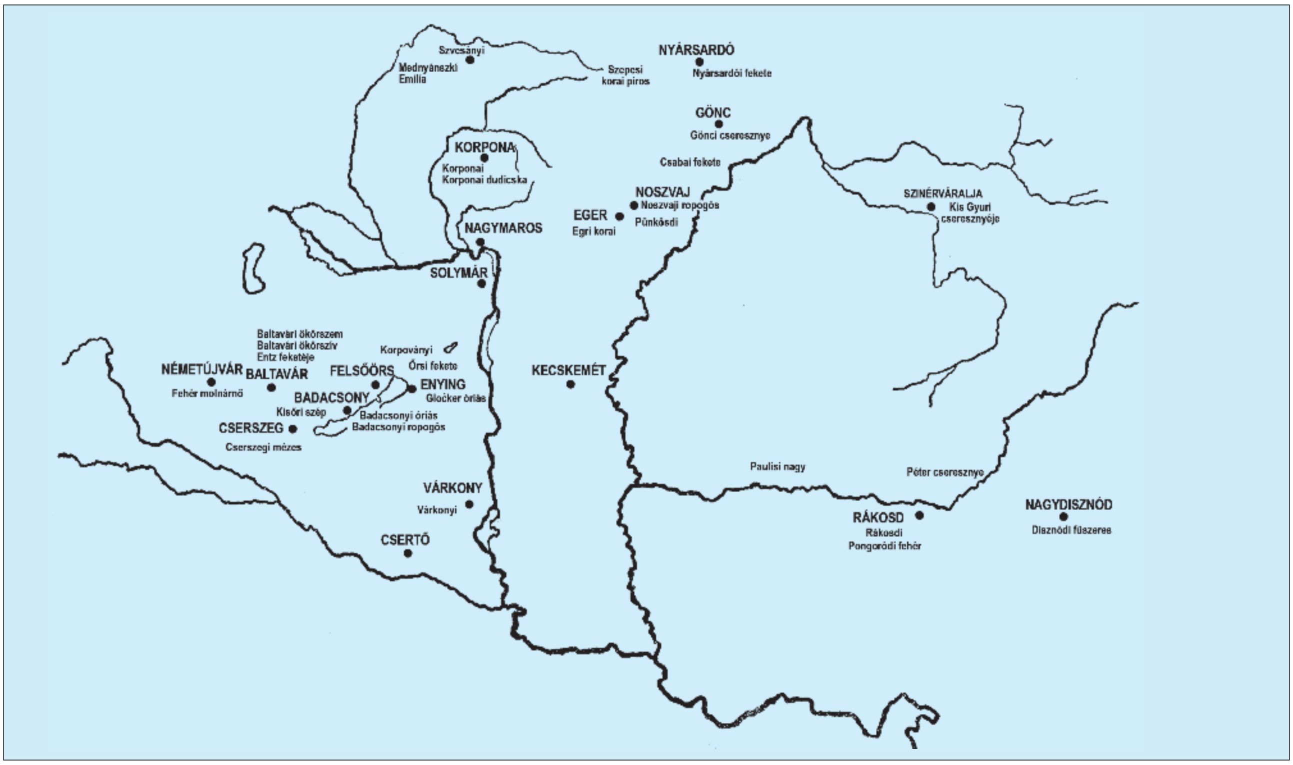

Figure 6. *Place of origin of sweet cherry varieties (Mohácsi-Maliga 1956)*

The regions of Buda, Eger and Kelebia were particularly noted for precocity, since May cherries had and have a very good market.

The traditional growing areas of the sour cherry were concentrated in the region between the rivers Danube and Tisza, in the region of Nyírség and Hajdúság and in the neighbourhood of individual localities. Sour cherry production by peasants (in small orchards) gave usually preference to the *Pándy,* though in the Trans-Danubian and Trans-Tisza Region the tendency was to grow *Cigánymeggy* and *Vörös meggy* trees instead. It is worth to note

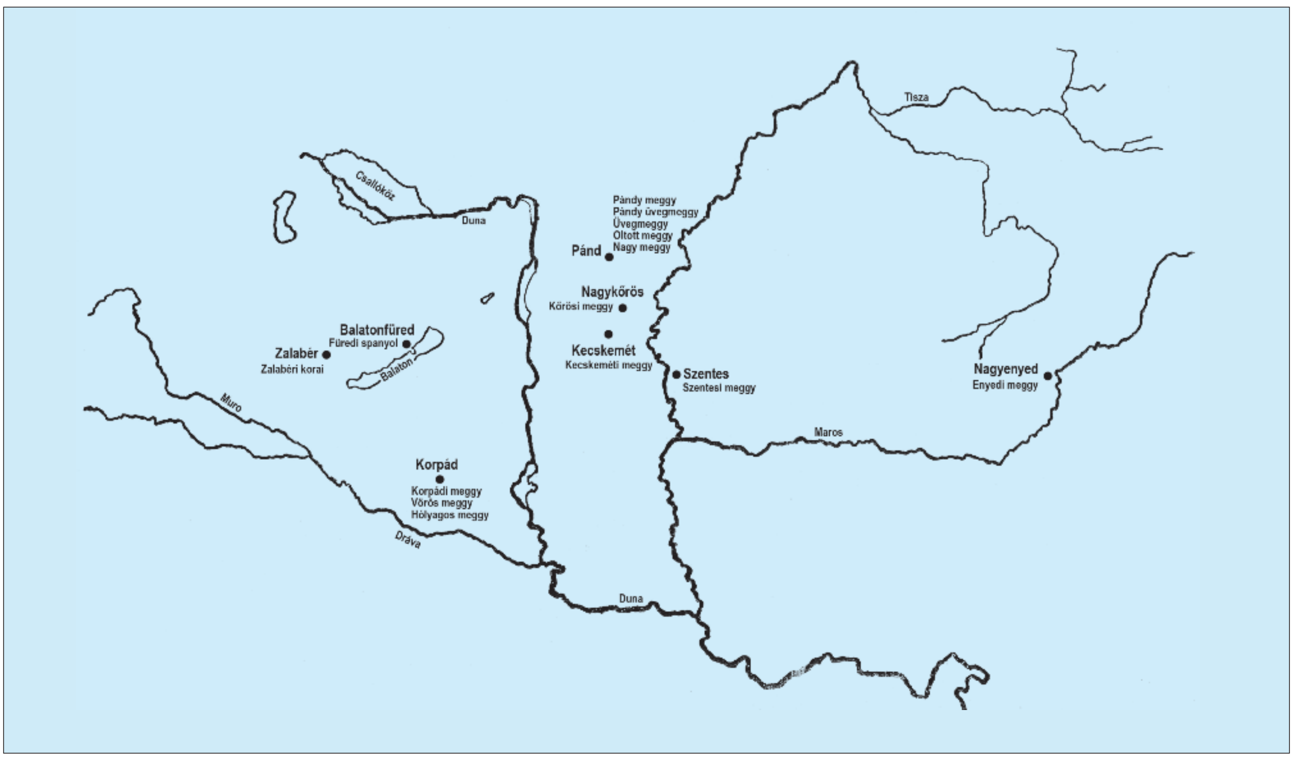

Figure 7. *Place of origin of sour cherry varieties (Mohácsi-Maliga 1956)*

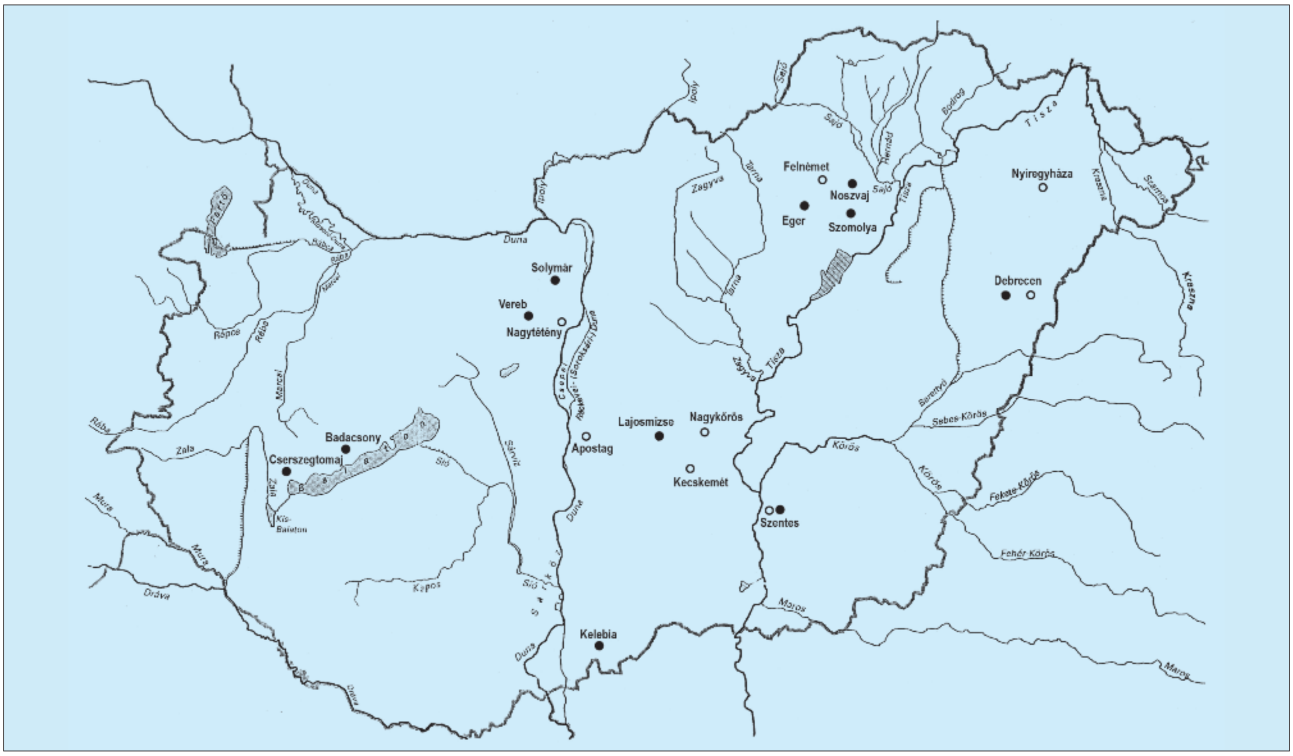

Figure 8. F*amily trees of cherry varieties in the country (Mohácsi-Maliga 1956)*

the sour cherry production in the county Bács-Kiskun (Apostag, Kecel, Kiskőrös, Kecskemét and Izsák), as well as the one on the confines of the cities Cegléd and Nagykőrös and Szentes, Csongrád and Szeged. More recently the *Cigánymeggy* has less frequently been planted for juice purposes than earlier.

The self-pollinated varieties and the hybrids of the Maliga and Brózik produce marketable fruit now. On the other hand, the recurrent waves of Monilia disease, as well as Blumeriella leaf spot and the present form of plantation policy reshape the growing regions.

'...ripe sweet cherry which is sweet and red...'

(Mihály Csokonai Vitéz)

The origins of sweet and sour cherry production in Hungary go back even to times prior to the settlement of the Hungarian tribes. The era of gathering involves the wild forms of both species, but our ancestors entered the era of primitive production as early as the 6th/8th century. Following the influences coming from Italy and from the Balkan (9th/14th century) the German and other West European varieties (after the 16th century) gained an increased role. The Carpathian Basin gave rise to a great number of sweet and sour cherry varieties and methods were developed.

Neither the era of the Turkish occupation nor the subsequent centuries proved deleterious to the

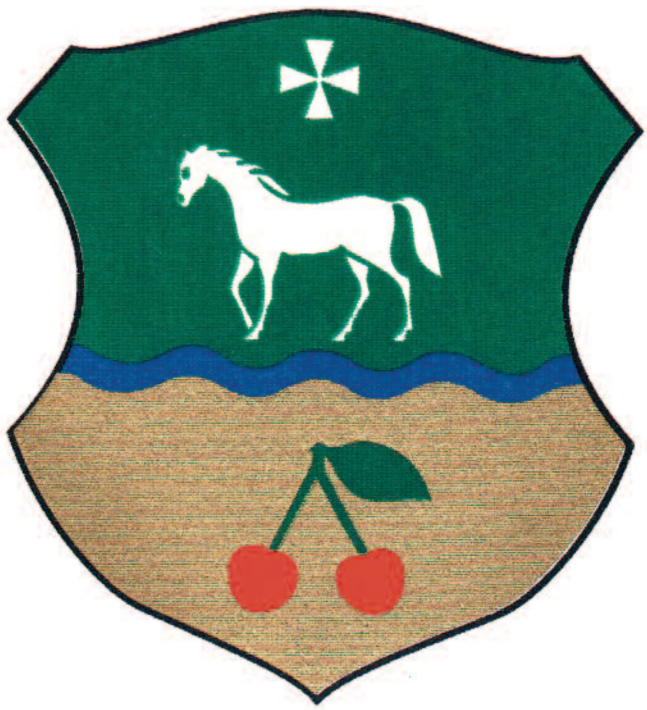

***Figure 9.** The cherry in coat of arms of Nagykörű – Germersdorf giant*

Figure 10. *Pilose sweet cherry (Surányi 1987)*

national sweet and sour cherry culture. The popularity of the sweet and sour cherry is attested by the value of their wood for making furniture and tools, by the use of the bark on the farm and in the household and by the appearance of these fruits in folk art. After 1718 (the Peace Treaty of Pozsarevac) the Habsburgs recruited German, Slovak, Romanian and Serbian colonists to the depopulated parts of the country, among which especially the Germans brought a number of sweet cherry landraces with themselves and the South Serbians some sour cherries, enriching the national culture vegetation.

The activity of *György Petrovay* is an interesting episode of the recent history of the sweet cherry, who at the turn of the 20th century left a valuable variety collection and the cultivation of the sweet cherry to Nagykörű. The traditional approach of the village, the cherry festivals and the coat of arms of the village all conserve the sweet cherry *Germersdorfi*. The pilose sweet cherry is the memory of the early-ripening sweet cherry Kelebiai in the southern region of the Hungarian Great Plain. In the case of the sweet cherry only the Szomolyai group are able to produce root suckers, in the case of the other varieties the common propagation methods are budding and grafting.

For the purpose of forcing St Barbara's Day twigs it was the sweet cherry twigs that were usually cut because the twigs harvested on Dec 4th came to bloom by Christmas at room temperature. This was also a way of crop estimation and was part of the folk culture, similarly to children's hanging sweet or sour cherries over the ears. Previously, it was the sweet cherry that was commonly used for making brandy, nowadays also the sour cherry is ever more frequently used. The products are highly demanded, similarly to the jams and fruit juices made from cherries.

The stipitate fruits of the *Pándy* and its group were defoliated and could be sold only in this form. The reason why the big fruited sour cherries were called *Üveg-meggy (Glass jar cherry)* in old households is that they were preserved as bottled fruit, occasionally were used to put in dumplings. The *Cigánymeggy* and *Vörös-meggy* were preserved stoneless

Figure 11. *Sour cherry brandy – Hungarian made (Balázs 1998)*

(stoned), more recently are deep frozen, but with stones. In the traditional utilization this seed was used for stock, but the varieties capable of producing root suckers were always propagated vegetatively. These species had a therapeutic role, too, the peduncles (stems) were used to make heart tonic. In the centuries before the computer sweet and sour cherry rodlets (dry stalks) had an important role in the teaching of arithmetic.

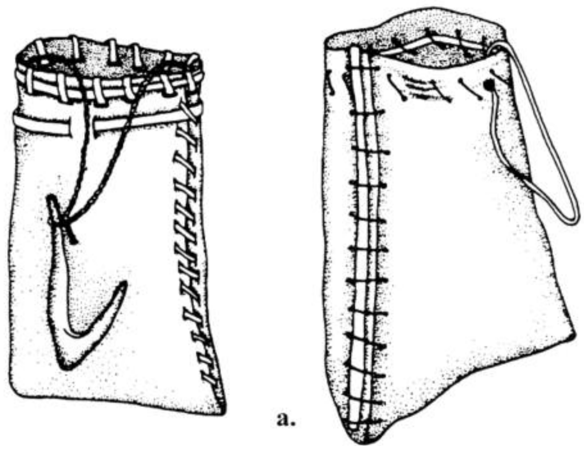

Figure 12. Satchel made of sour cherry tree bark (Surányi 2002)

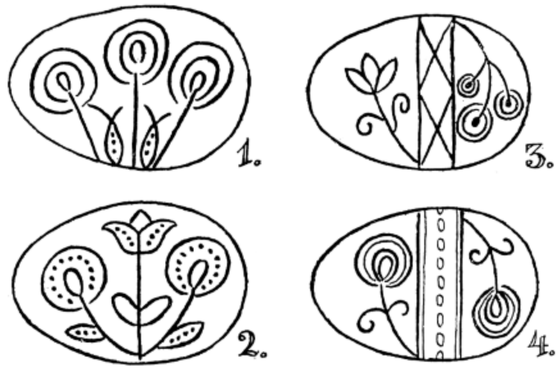

Figure 13. Egg ornamentals with sour cherry branch from Transylvania (Lükö 2001)

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***Table 1.** Traditional cherries in Hungary*

SWEET CHERRY VARIETIES	SOUR CHERRY VARIETIES
Badacsonyi óriás	Arató meggy
Baltavári ökörszem	Cigány meggy
Cserszegi mézes	Csengődi
Disznódi fűszeres	Csukros meggy
Egri korai fekete	Debreceni bőtermő
Fehér cseresznye	Enyedi meggy
Fekete szívcseresznye	Füredi meggy
Germersdorfi óriás	Gálócsi
Glocker óriás	Halyag meggy
Gyöngyösi szívcseresznye	Hartai meggy
Hedelfingeni óriás	Jósika
János cseresznye	Kántorjánosi
Kelebiai korai	Kecskeméti
Kiss Gyuri (Szinyérváralja)	Késői Pándy
Korkoványi	Kisvárdai (HM 101)
Korponai világos	Korai májusi
Magyar szívcseresznye	Korai vörös meggy
Májusi korai	Korpádi
Márki korai	Kőrösi meggy
Nagy fekete ropogós	Latos meggy
Noszvaji ropogós	Ostheimi
Nyársardói	Pándy üvegmeggy
Ölyvedi fekete	Parasztmeggy
Öregszemű fekete	Pipacs meggy
Örsi fekete	Réti sommeggy
Pomázi hosszúszárú	Skublics meggy
Pongorádi	Spanyol meggy (Montmorency)
Pongrác cseresznye	Szakter meggy
Porcogós cseresznye	Szentesi
Rákosdi	Szentlőrinci
Solymári gömbölyű	Szilágyi meggy
Szegedi óriás	Tarka meggy
Szomolyai fekete	Újfehértói fürtös
Várkonyi	Zalabéri meggy

István Szabó[1], Zsolt Szüle[1]

New Trends in the Development of Agricultural Engineering

The XVth CIGR World Congress was held between 3rd and 7th September, in 2006 in Bonn. Nearly 800 delegates offrom 54 countries took part in the Congress; Hungary was represented by a long delegation in the session. The lectures and posters presented lectures and posters provided a comprehensive overview of the circumstances of the agro-technical world and of trends in development and improvements. As the result of those presented in the Congress, as well as the overall research carried out in the theme, a clear view of the development features of the agricultural engineering has been profiled in connection with which the trends and tendencies related to the harvest of cereals, sugar-beet and potato are summed up in this article with special emphases on Hungarian context.

Development possibilities and trends concerning harvest

In this paper an attempt will be made to review development tendencies in the harvest of some arable crops such as green crops (roughage), grains, and tuber crops with special emphases on the Hungarian context. Generally it can be established that both development engineers and manufacturers, according to the demands of practice, consider increases in performance, the reduction of specific energy consumption and an increase in the reliability of machines as the cardinal task, at the same time guaranteeing the unchanged working quality. The working quality manifests itself in the full utilization of the yield of plant value and the entire conservation of the use-value. As in all human or mechanical work, faults and errors occur after all frequently applied IT solutions have to be mentioned in a high place amongst the development tendencies; they facilitate the continuous control of the operation quality and the maximum utilization of the potential performance of the machines. One part of the applied IT solutions assists the machine-operator's work, and reduces the errors of individual origin occurring in the operating to the minimum.

A strong trend has been observable for several years a in the harvesting of *green crops (hay, roughage)* – the wide-spread use of the machines equipped with rotary-drum mower units. The simple mowers and the wind rowers equipped with stem crimpers are mainly constructed with bottom drives and 2- to 6-m working widths. An additional increase of the working width is effected by 'em building' the tractor. A special version of this construction is the self-propelled mower of which working width may be 14 m as well. Windrow tedders, conditioners of similar dimensions belong to the mowers of great working width; these together will be used on the large farms or by contractors.

Indications of an fundamental change in harvest technologies have not been observed as yet. The harvest of hay and the stacking technology – in the countries where it is still applied – will remain essentially on the present level however a slight decrease may be possible. The capacity of self-loading wagons (with pick-up) used here will be the same as that at present – 30 to 50 cubic metres – and they will be equipped with stop-start cutter blades. An important aspect is the increase of the transport travel speed; the objective to be attained is 60 to 80 km/h.

In countries with developed agriculture, technologies based on baling and chopped products will be dominant; a further increase of the performance of the machines can be expected. The principal machines of these technologies show significant development. The engine power of the built-in engines is approaching 750 kW which results in gigantic mass performances. The transport, loading and storing of 200 to 300 t chopped material per hour sconstitutes a very serious logistic task. A new row-independent cutting header was improved. A further increase of the capacity of the forage trailers (chopped-matter wagons) is expected therewith, by improving the carriage construction of the trailers, the transport travel speed may be increased to 60 to 80 km/h. For making fermented roughage, beside the cheap horizontal surface silos, which depends on of the herds sizes, the technology of plastic

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Figure 1. Modern harvester (Claas Lexion 600)

vacuum clamp silo (otherwise silo-plastic-sheet technology) may spread. It would seem that the account of the tower silos constructed of metal or concrete will decrease in the future.

In the baling technology, the further spread of large round and rectangular bales can be expected. The bale sizes – since they have reached the limit of handling – will remain but, regarding the density of bales, a further development can be expected especially concerning the requirements of haylage making, and straw traders. The volume mass used for characterizing the compactness (density) of the bales may reach 250 to 300 kg per cubic metre. As to the roller balers, the constructions with constant and variable compression chambers will remain; an increase can be expected in bale packing (in plastic bags or sheets), and in the single-pass baling together with bale packing. The working travel speed of baling, due to the improvement of the knotter constructions (pneumatic cleaning, good-quality twine, precision manufacturing), may attain even the value of 20 km/h in the case of an excellent soil condition, and on an even surface.

The *harvesting of cereals* will be carried out by combine-harvesters (harvester-thresher machines) in the future as well *(Fig 1.)*. The permanent increase of the performance, instead of the increase of size that characterized the past period, is the result of the completed improvements of the threshing and grain-separating mechanism. The capacity (mass-flow rate or combine output) of 2 to 3 kg/s measured in wheat harvest with the machines manufactured in the 1950s or 60s has increased to the value of 18 to 20 kg/s up to now. At the same time the size of the cutting mechanism increased (to 9 to 10 m), the capacity of the grain tank (to 10 to 12 cubic metres) and, of course, the power of the built-in engine *(Fig. 2)*.

The cutting mechanisms automatically follow the irregularities of soil surface; crop-depending adjusting facilities and constructions appeared. Additionally, the cutting tables with variable-reach or intake-assisting belts which are suitably used, beside cereals, for harvest of rape seed, peas as well as other sensitive crops. A generally used operating facility will be the crop-yield meter assisting the precision management with applying the GPS system or the system of informatics controlling the correspondence of the load with the working travel speed. The devices serving for the steering, the directional stability and the exact selection of pass widths will spread. Machines can be chosen in accordance with the utilization demands of the straw, taking, on the one hand, the construction of the threshing and grain-selecting mechanism (with straw walker or of hybrid design) and, on the other hand, the construction of the straw chopper into consideration.

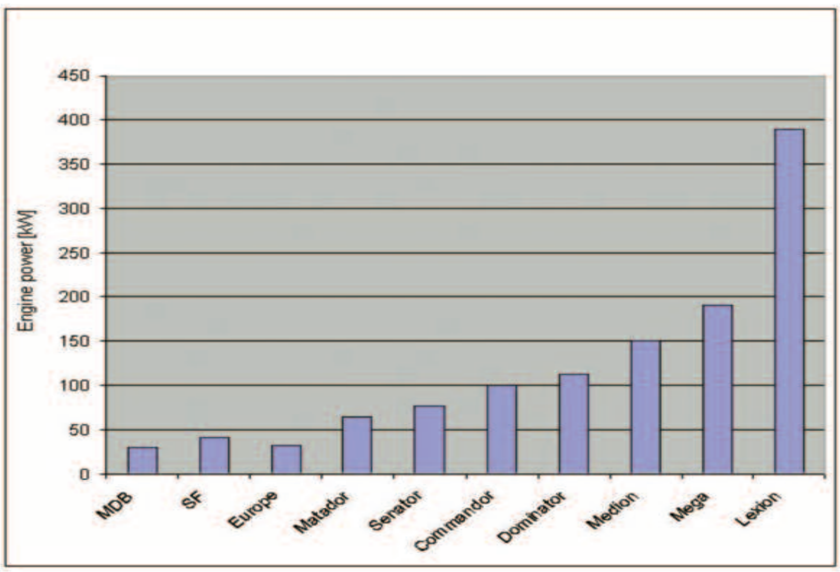

Figure 2. The course of the engine power of the combine-harvesters manufactured by CLAAS

Future *potato harvesters* will be characterized by the improvements for the working quality (first of all for the reduction in the ratio of damages). The velocity of the hydraulically driven delivery-cleaning (soil ridder) elements will be controlled by automatic systems, in accordance with the mass-flow rates. The pressure of the ridge scanning profiled roller will also be regulated that will assist the adjustment to the actual harvest and soil conditions. In the similar way, the digging depth will hydraulically be variable even in the course of operating. In the roller selectors on the harvesters, the distance between the rollers will be adjustable i.e. it will be adjusted to the potato sizes of harvest. On the farms owning large cultivated area, self-propelled 2- to 4-row harvesters will be used partly with mechanical, partly with mechanical-and-manual sorting. These machines will already be equipped with the basic accessories assisting the precision management and the operating (such as the measurement of yield or the row-scanning guiding device).

Figure 3. *4-row potato harvester (Grimme SF 3000)*

The harvest of sugar beet will be carried out by 6-row, mainly self-propelled, bulk-hopper type machines, with few exceptions. The row spacing will be adjustable between 45 and 50 cm; the ratio of the tramline cultivation technology will increase. The topping mechanism of differential height, the lifter-depth control and row scanning guide device will be basic facilities. The demand for the gathering of the sugar-beet tops (crowns with leaves) will remain only in some countries being poor in forage but this will not load or increase the autumn harvest campaign or work peak in the developed countries. The mass measuring and recording instruments will appear on the harvesters, for assisting the precision farming and management and the contractors' accounts. The present tendency shows that the sugar production and the cultivation area of sugar beet is decreasing in Europe that will lead to a decrease in the number of machine manufacturers and the uniformization of the machine fleet. The harvest technology is developing basically by the single-stage method; the improvement of the cleaning (clod and stone separating) efficiency of the harvesters can be expected but there will be still a need of the clamp pick-up cleaner loaders known today. Because of the extremely heavy rolling weight featuring the harvesters with bulk hoppers, other new technical solutions can be expected in the wheel arrangements and the constructions of the rubber tyres.

Figure 4. *Sugar beet harvester in work (ROPA Tiger)*

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Food safety aspects of toxins and adhesins of verotoxigenic and enterohaemorrhagic **Escherichia coli** *(VTEC and EHEC) in farm animals*

Summary

This study briefly reviews our present knowledge on toxins and adhesins, the two main virulence attributes of human-, and animal pathogenic strains of verotoxigenic *E. coli* (VTEC), and gives indications about the possibilities of gene transfer between commensal and pathogenic *E. coli* bacteria leading to development of new VTEC clones. At present it seems that the most widely distributed human pathogenic VTEC clones are the serotype O157:H7 and O157:NM strains most frequently originating from cattle and sheep. However, other animal species and several other types of VTEC/EHEC can be of concern and may cause serious outbreaks. These new types can be developed due to transmitibility of the toxin genes through phages and due to flexibility of the adhesin genes (on the locus of enterocyte effacement =LEE) of the chromosome. In humans, VTEC infection may lead to gastroenteritis with watery to bloody diarrhoea and in severe cases to "haemorrhagic colitis" (HC), and to haemolytic uraemic syndrome (HUS) and death

Transmission of VTEC from animal to man occurs mainly via contaminated food, but contaminated water and environment as well as human to human contact may also be the source of infection. The greatest concern for man are fresh meat (contaminated directly or indirectly during slaughter and/or processing), minced beef and fermented beef products, milk and milk products, fresh fruits and vegetables, herbs and spices. In Hungary the EHEC strains are of relatively less concern. So far only sporadic diseases could be detected in man, and – based on a representative survey on slaughter cattle – a low (2,5%) incidence of VTEC O157 or of other serogroups of VTEC was detected.

Introduction

Toxicity and adhesiveness are the two main virulence attributes of several enteric bacteria pathogenic for animals and man. These virulence properties are responsible for the ability of certain enteric bacteria of animals to become food born pathogens by contaminating food of animal origin. These bacteria are able to cause more or less severe clinical symptoms in farm animals or to maintain a subclinical infection and latent shedding leading to contamination of the environment or directly of raw materials for human consumption *(Fig 1)*. The human health consequences of consumption of such contaminated foods depends on the species-, and on the particular clones of these zoonotic bacteria. In general, the clinical symptoms can be much more severe in man than in the animal of origin. As the presence of these bacteria in food producing animals represent a human health concern (of "zoonotic disease"), the Zoonosis Directive (2003/99 EC) of the European Union is enlisting the four most important food born zoonotic bacteria (*Salmonella*, verotoxigenic *E. coli*, *Campylobacter* and *Listeria*) for constant mandatory monitoring and increased awareness in the EU.

Verotoxigenic E. coli (VTEC)

Among the above food born zoonotic bacteria the verotoxigenic *E. coli* (VTEC) [also named Shiga toxin producing *E. coli* = STEC], are representing a peculiar group of pathogens that may stay hidden amongst the normal intestinal inhabitant *E. coli* bacteria (especially in cattle). The most common O-groups of human and bovine VTEC are O26, O103, O111, O145 and O157. VTEC bacteria can be shed into the environment to contaminate pasture, and milk or processed meat thereby entering into the food chain *(Fig. 1),* and may cause mild to severe intestinal lesions or even fatal disease (Haemolytic Uraemic Syndrome = HUS) especially among children and elderly persons. The outcome of infection in man is dependent – among others - on the toxic and colonizing

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Figure 1. *Grazing cows as a source of faecal contamination of environment (source: Nikoletta Gál, www.google/tehenek)*

(mucosal adhesive) virulence attributes of the infective bacteria. These attributes are directed by genes that can be horizontally transmitted between bacteria and thus, can be acquired by harmless *E. coli* bacteria, contributing to the evolution of new types of enteric (food born) pathogens. Therefore, it is important to understand the food safety aspects based on the nature and genetic background of these virulence factors characteristic to VTEC in animals and man.

Identification of VTEC need to be confirmed by the demonstration of production of the verocytotoxin or by the presence of the gene (*vtx*) encoding it. Therefore in a broad sense, VTEC are *E. coli* strains which possess genes on their chromosome governing verotoxin production. Such genes are carried by lambdoid phages and are transmitted between bacteria by phage transduction. In a more strict sense, VTEC are only able to produce verotoxins and are not inducing specific mucosal AE lesion *(Fig 2A)*. However, several VTEC strains may also acquire genes (additionally to the verotoxin genes), that govern a specific adhesive and microvillous damaging (attaching effacing =AE) activity *(Fig. 2B)*, thereby causing haemorrhagic colitis in human, and therefore called enterohaemorrhagic *E. coli* (EHEC). Such strains are also designated here as VTEC. As these two groups of VTEC are producing diseases with different mucosal pathomorphology and different clinical pictures, the following two sections will deal with these two groups of virulence factors separately.

Toxins of VTEC (Vero-, or Shiga toxins)

Terminology

Verotoxigenic *E. coli* is one of the alternative names for *E. coli* bacteria producing a cytotoxin detectable on Vero (African green monkey kidney) cells -therefore called vero toxins = VT – (Konowalchuk et al., 1977). They share a number of properties with cytotoxins produced by *Shigella dysenteriae* therefore they are also called “Shiga toxin” producing *E. coli* (STEC) (O’Brien et al., 1977). The designation SLT was also applied by us in the Hungarian literature earlier (Nagy and Tóth 1998, and Tóth and Nagy 1998), until the term verotoxin (VT) became more generally accepted in the official documents of the European Union (i.e. 2003/99 EC).

History, origin and mode of action of VT

It has been established that VTEC has elvolved by phage transduction from *Shigella dysenteriae* and different toxin encoding lambdoid phages have been identified (Strockbine et al., 1986). In fact, both *vt1(stx1)* and *vt2 (stx2)* gene carrying phages

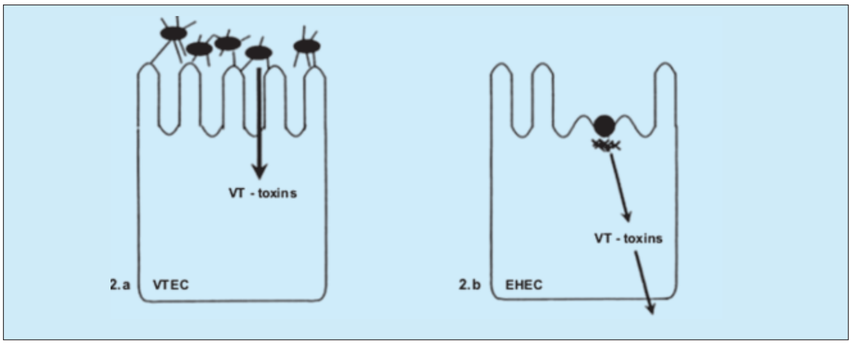

Figure 2A and 2B. *Schematic illustration of pathogenesis and morphology of lesions due to infection of intestinal epithelial cells pathotype VTEC (2A) and EHEC (2B) of Escherichia coli (Nataro and Kaper, 1998., modified)*

have been transduced *in vitro* and *in vivo*. In case of the *stx2* phage, trandsuction from a K12 strain to a porcine EPEC strain was only possible *in vivo* (in ligated pig loops) but not *in vitro*, indicating that efficient mechanisms may help horizontal gene transfer *in vivo* (Tóth et al, 2003) *(Fig. 3)*.

The members of the VT (SLT) toxin family are characterized by the same or similar structure and function. They are composed of one A and five B subunits. The pathomechanisms of these toxins is characterized by a receptor mediated endocytosis of the VT complex, followed by a fusion in lysosomes and release of the enzymatically active fragment A1, which targets the ribosome leading to inhibition of protein synthesis and cell death *(Fig. 4)*. The greatest differences among the individual toxins are in toxicity for animals and different cells. VT2 are more toxic than VT1 and several subtypes of VT2 (-2c, -2d, -2e, -2f, and –2g) may also vary in toxicity a great deal (Scheutz et al., 2001., Garcia-Aljaro et al., 2006). One specific toxin (VT2e), characteristic to the porcine VTEC strains causing oedema disease, which is the only known naturally acquired systemic disease of animals, needs to be mentioned separately. VT2e toxin leaves the intestinal epithelial cells without damage and enters into the blood stream, using receptors on red blood cells (and on leucocytes?) and will be transmitted to the endothelial cells of the small blood vessels to inhibit protein synthesis. This leads endothelial damage, to subsequent perivascular oedema and hyalinisation in several organs, and finally to death. This particular toxin (VT2e) is encoded on the bacterial chromosome (not encoded by phages) and is not harmful for man as it uses globotetraosylceramide (Gb4) instead of Gb3, characteristic to human cells *(Fig. 3)*. Consequently, VT2e toxin does not have a significant food safety aspect.

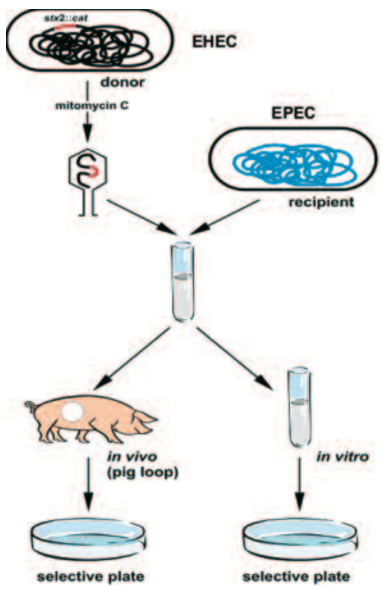

Figure 3. *Schematic representation of experimental phage transfer systems of an stx2 toxin gene from an EHEC strain into a porcine EPEC strain in vivo (pig intestinal loop). In vitro transfer was not successful*

As a result of enteric infection with VTEC strains in man, these – antigenically different – toxins (VT1 and VT2) produce enteric disease (haemorrhagic colitis) and/or systemic disease (haemolytic uraemic syndrome). In calves they produce enteric disease (calf dysentery), while no disease can be described to VTEC infection of adult cattle or small ruminants.

Adhesins of VTEC in animals

As mentioned above, VTEC bacteria in a more strict sense, are able to produce VT, and more or less colonize the intestinal epithelium without producing any morphological damage or lesion (Fig 2A). In spite of research efforts, adhesins that may help colonization by VTEC are largely unknown. The only exception being the porcine VTEC (causing oedema disease), where the characteristic adhesin (F18ab fimbriae) have been identified (Rippinger et al , 1995).

Several of the VTEC bacteria of ruminants and man produce a characteristic attachment and effacement (AE) type of microvillous degeneration and bacterial adhesion *(Fig. 2B)* (as will be described later at the section about enterohaemorrhagic *E. coli* = EHEC). However, there are verotoxin producing E. coli strains which do not have the AE phenotype), therefore do not produce such characteristic lesions but specifically adhere to the intestinal brush border, leaving the microvilli intact *(Fig 2.A)*, (Kaper et al., 1999., Mainil et al., 1999a). In this regard Wieler (1996) demonstrated that bovine VTEC without AE genes were relatively frequent among VT2 strains of calves. He has also demonstrated that many of these strains adhered to cultured Hep2 cells, and they were all negative for boundle forming pili (Bfp) characteristic to initial adhesins of human EPEC. However, it remains an interesting question how these strains could colonize the bovine intestine and continue being shed into the environment, and whether they could really colonize human intestine. At this point it is assumed that most of them can, and therefore these VTEC strains are regarded as potential food born pathogens, which would still need further investigation.

In pigs – at present – the only clinically important VTEC are the ones producing oedema disease. The only known adhesins of the porcine VTEC are the F18 fimbria acting as initial adhesin (as above). Adhesion and colonization mediated by F18 is not causing characteristic damage to the morphology of the intestinal cells (Fig 2A) thereby resembling to the morphology of adhesion by ETEC (Bertschinger et al., 1990; Nagy et al., 1997). Production of F18 fimbriae of porcine VTEC strains are encoded by the large plasmids which seem to represent a heterogenous group of plasmids (Fekete et al., 2002). As mentioned above, porcine VTEC do not have a significant food safety aspect.

At present there are very few data indicating that VTEC strains – in a strict sense - form other animals could colonize-, and could cause zoonotic disease in man. However there are some indications about sporadic infections of man (usually without severe clinical signs) caused by VTEC strains more resembling to bovine VTEC. In general the food safety aspects of VTEC infections from animals can be regarded as relatively low. This lower significance can probably be explained by the lack of adhesive mechanisms of these VTEC strains which would enable them to colonize (and damage) human intestine. The only group of VTEC strains where there is strong evidence for animal strains colonizing human intestine is the group of enterohaemorrhagic *E. coli* (EHEC).

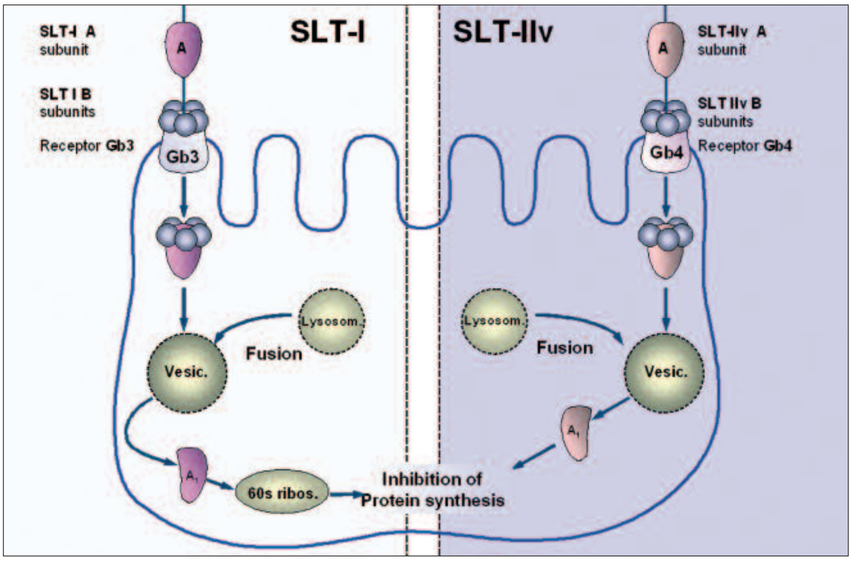

Figure 4. *Mode of action of VTEC1 (SLT-I) and VTEC2 (SLT-II) toxins in intestinal epithelial cells (Nagy and Tóth, 1998, modified)*

Enterohaemorrhagic E. coli (EHEC), and their close relatives

In contrast to porcine VTEC, the enterohaemorrhagic *E. coli* (EHEC), – a specific and interesting group of VTEC – are highly pathogenic for man, and are therefore of great food safety significance. This subgroup of VTEC has a close relative pathogroup among human and animal pathogenic *E. coli* strains called enteropathogenic *Escherichia coli* (EPEC). Our knowledge of adhesive and toxic virulence attributes of EHEC and EPEC have developed almost “hand in hand”. Although EPEC were first described in the 1940’s and 1950’s as the causative agents of infantile diarrhoea, and are still a major cause of enteric infections in the developing world, their virulence attribute have not been really discovered until recently. EPEC do not produce toxins and are not invasive; instead their virulence depends on causing characteristic intestinal histopathology called as attaching and effacing (AE) which can be observed in intestinal samples and in *vitro* samples (Fig 2.B), (Moon et al., 1983; Knutton et al., 1987).

Adhesins of EHEC

The AE phenotype is characteristic to both EHEC and EPEC and can be described by effacement of microvilli and intimate adherence between the bacterium and the epithelial cell membrane *(Fig. 2.B)*. The AE phenotype develops due to the function of specific signalling pathways and the A/E lesions are characterized by localized effacement of the brush border of enterocytes with intimate bacterial attachment and pedestal formation beneath the adherent EHEC and EPEC bacteria due to their adhesin “intimin” encoded by the *eae* gene *(Fig 5)*, (reviewed by Nataro and Kaper, 1998). However, EHEC induced lesions develop in the large intestine. For EHEC adhesion the “intimin” (outer membrane protein of the bacteria) is essential. The *eae* gene of both EHEC and EPEC is located on the middle

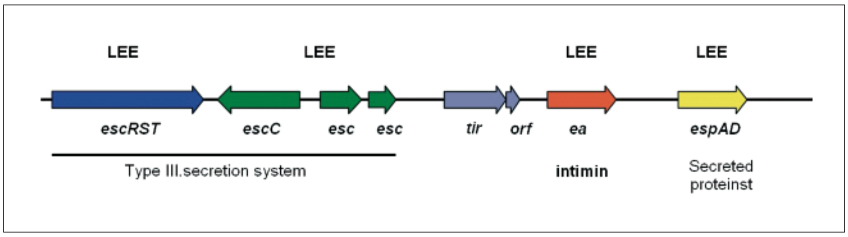

Figure 5. *Attachment effacement (AE) lesion of an intestinal epithelial cell. In the inlet there is a schematic drawing of the typical AE lesion with pedestal formed with actin accumulation underneath EHEC/EPEC bacterium (Nagy and Tóth, 1998, modification M.A.Dow, personal contribution.*

part of a chromosomal pathogenicity island (Locus of Enterocyte Effacement = LEE) (McDaniel et al., 1995). Adhesion and AE lesion of the small and/or large intestinal mucosae develops by EHEC and EPEC using very similar set of genes forming part of a Type III secretion system within the LEE.

Immunological and genetic studies on the LEE revealed the existence of intimin subtypes: α, β, γ, δ, and intimin ε (Oswald et al., 2000). Molecular studies revealed that these intimin types are pathotype (and host species) specific. Intimin α was specifically expressed by human EPEC strains belonging to classical EPEC (Class I) serotypes of O55:H6, O125:H-, O127:H6, O142:H6 and O142:H34 (Adu-Bobie et al., 1998b). Intimin β appears to be the most ubiquitous type. It is associated with EPEC strains belonging to Class II EPEC (O26:H- , O111: H-, O111:H2, O142:H2, O119:H2, O1219:H6, and O128:H2) and EHEC O26:H11. intimin β was also detected in rabbit O15:H-, O26:H11, O103:H2 strains, and this intimin subtype was present in O26:H11 bovine strains, as well. (Oswald, et al., 2000).

Intimin γ is associated mainly with human and bovine VTEC strains including sorbitol fermenting and sorbitol non-fermenting EHEC O157:H7, O157:H- strains, and VTEC strains of serotypes O111:H8, O111:H-, O86:H40, O145: H-. Furthermore, EPEC O55:H-, and O55:H7 strains also harbour *eae* γ gene. intimin δ was associated with human EPEC O86:H34 (Adu-Bobie et al., (1998a). intimin ε was present in human and bovine EHEC strains of serogroups O8, O11, O45, O103, O121 and O165. (Oswald et al., 2000). Beside these main types, further, less frequent types of intimin have been described (Zhang et al., 2002).

These observations, hat different intimin subtypes are associated with different pathogenic clones can explain that these strains colonise different segments of the intestine in different host species. Tzipori et al., (1995) infected pigs with human strains having different types of intimin and demonstrated that the intimin α producing strain caused AE lesions in both the large and the small intestine, while the Intimin γ- producing EHEC strain caused AE lesion only in the large intestine. When the pigs were infected with an *eae* α^+ EHEC recombinant strain AE lesions were observed in both the small and the large intestine (Tzipori et al., 1995).

Interestingly, the EPEC and EHEC bacteria are not only prodeucing their adhesions (intimin) but they also produce the receptor for it (translocated intimin receptor = Tir). The Tir is a bacterial secreted protein that is translocated into the host cell via a type III secretion system and upon entry into the eukaryotic cell it serves as the receptor for the intimin. Initially it was believed that the intimin receptor protein is a mammalian membrane protein that was originally called Hp90 (“host protein”) and that was tyrosine phosphorylated in response to EPEC infection (Rosenshine et al., 1996). The combined interactions between host kinases and EPEC proteins result in additional host signalling events like actin aggregation and polimerization leading to the characteristic cellular pathology (pedestal formation) (Fig. 6). In case of EHEC O157:H7 infection the Tir protein has analoguos fuction, but it is not phosphorylated after tanslocating to the eukaryotic cell (DeVinney et al., 1999).

As mentioned above, the LEE contains two main additional functional clusters : on the right side of the LEE are the *espA, espB., espD, espF* genes, which encode proteins secreted via the type III secretion system, and are necessary for AE phenotype. On the left side of the LEE is a set of genes encoding for type III secretion system itself. These genes share sequence homology with the type III secretion systems of *Yersinia enterocolitica*, *Shigella flexneri* and *Salmonella typhimurium* (reviewed by Mecsas and Strauss, 1996). The type III secretion systems are responsible for secretion and translocation of different virulence determinant proteins like the EspA, -B, -D, -F encoded proteins and Tir protein *(Fig 5).*

Regarding differences between animal and human EHEC McNally and colleagues (2001) observed clear differences in the expression of LEE-encoded factors between O157 strains, with the same *stx*$^+$ *eae*$^+$ genotype, isolated from human disease cases and those isolated from asymptomatic cattle. All strains produced detectable amount of EspD when the strains were grown in tissue culture medium. However, production level of human O157 strains it was an average 90-fold higher than that of the bovine O157 strains. Level of EspD secretion also correlated with the ability to form AE lesions on HeLa cells and with exhibiting a localized adherence phenotype. (McNally et al., 2001). Similar analysis (Kim et al., 1999) revealed the existence of two distinct lineages of *E. coli* O157:H7 in the United States. Human and bovine isolates are non- randomly distributed among EHEC-I class (more pathogenic for humans), and EHEC –II class (that may not readily cause disease or may not be transmitted efficiently to humans from bovine sources). This may reflect a loss of characteristics in this lineage of EHEC-II, that are necessary for virulence in humans, perhaps as a consequence of adaptation to the bovine environment.

Beside the LEE, most of the EHEC strains posses an approx. 60 MDa large virulence plasmid (pO157) that encodes for the enterohaemolysin and promotes the adherence to cultured epithelial cells. According to the present concept (Kaper et al., 1999), the transfer of this plasmid to the O157:H7 *stx*$^+$, *rfb*$^+$ strain was the last step in the clonal evolution of the hypothetized EPEC ancestor strain to develop into a class I. EHEC, pathogenic for man *(Fig. 7)*. Simnilarly, the addition of the EAF plasmid contributed to the evolutionary development of class I. EPEC *(Fig. 7)*.

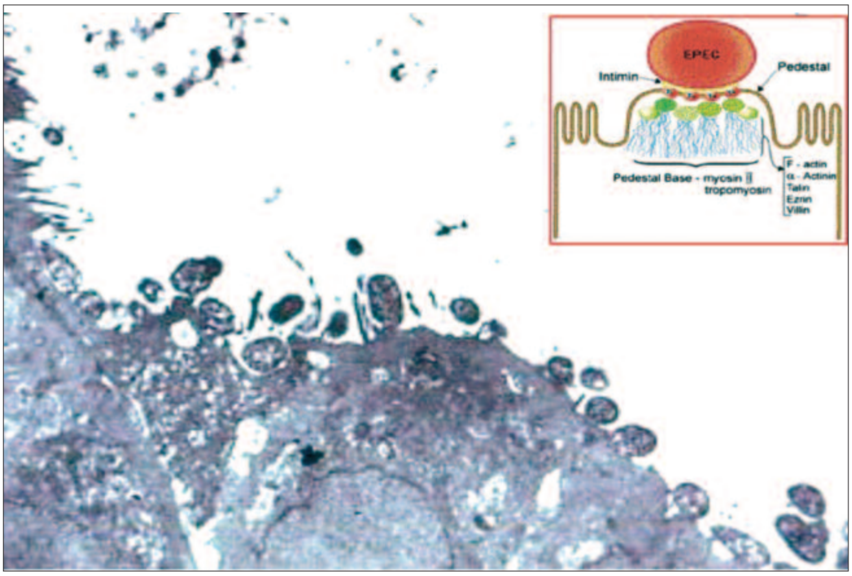

Figure. 6. *Physical map and genetic organization of the LEE (Nataro and Kaper, 1998).*

EHEC in calves

In calves the first description of attachment effacement (AE) lesion due to “atypical *E. coli*” was given in the U.K. by Chanter et al., (1984), in relation to natural cases of “calf dysentery”. The *E. coli* O5 strain produced bloody diarrhea and typical AE lesions in gnotobiotic piglets (Chanter et al., 1986) and it turned out to be verotoxigenic as well. Further observations in the USA indicated that verotoxigenic and AE lesion producing strains of *E. coli* O26 are relatively frequent cause of calf diarrhea (Janke et al., 1990) and such strains have also been detected to cause natural infections in the UK (Gunning et al., 2001). Based on the fact that most of the bovine AE lesion producing strains also produce verotoxins, they could also be named as enterohaemorrhagic-like *E. coli* (or: EHEC-like strains). As it is well known, the classical human EHEC strains (O157:H7 and O157:NM) are frequently carried asymptomatically by calves and older cattle as well as by small ruminants and it is usually among the least frequent serotype occurring in cattle, in contrast to humans where O157 is the leading serogroup of EHEC (reviewed by Dean-Nystrom et al., 1998). The EHEC strains causing bovine diseases (O26, O103, O111, O118 and O157) can also be transmitted to man and thus, these strains have a serious zoonotic potential. So far it seems that several bovine and human strains have beta intimin (supporting the zoonotic significance of bovine EHEC).

Non-verotoxigenig AE producing *E. coli* strains seem to be relatively rare in calves, although they may also produce watery diarrhoea (Pearson et al., 1989), and can be regarded as the bovine EPEC. The intimin type of these bovine EPEC strains is usually also the ß intimin (Oswald et al., 2000). At present there is no solid information available on any additional adhesive factor of bovine EPEC or EHEC strains, although it seems quite likely that there are some peculiarities in the adhesins of these strains as well.

Food safety aspects of VTEC and EHEC

As described in the previous chapters the VTEC serotpyes O157:H7 and O157:NM are the most frequently reported food born VTEC clones, but due to the possibilities for horizontal transfer of toxic and adhesive virulence determinants (*vtx* gene carrying lambdoid phages and the pathogenicty island LEE) other

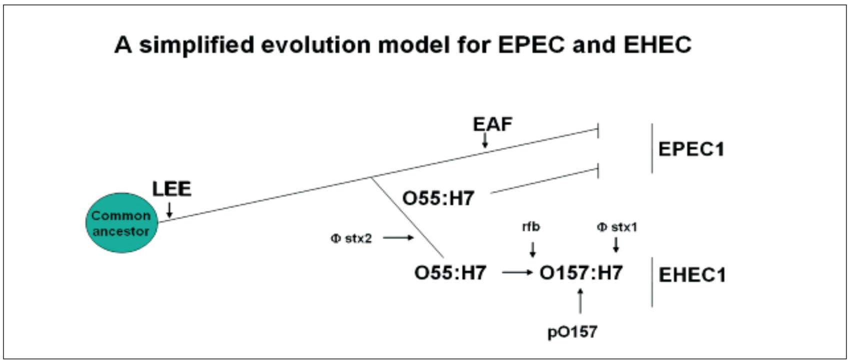

Figure 7. *Clonal evolution of EPEC and EHEC strains, showing the hypothesized ancestor with the LEE pathogenicity island, diverging into an EPEC and an EHEC lineage. In that latter, lineage, the stx phages, the rfb genes (encoding for the O157 lypopolysaccharide) and the the pO157 plasmid were incorporated into the EHEC O157 genome. (Kaper et al., 1999, simlified)*

serogroups (i.e. O26, O103, O111, O113) are also associated with human disease. In overwhelming majority of the cases these have also been proven to be of animal (mostly bovine) origin.

The incidence of VTEC in humans is probably the least comparable between countries. The main reason being the differences in diagnostic methodology. In spite of these difficulties it seems that there are regions (i.e. in Scotland, and US) where there is a higher incidence of VTEC infections of man (approx. 40 cases/ 1 millon inhabitants/year in Scotland). There are also certain trends indicating that in some EU countries (UK, Ireland Sweden) the strains of serogroup O157 prevails, while in other countries (Danemark, The Netherlands), a considerable number of outbreaks are caused by serogroups other than O157. In contrast, in spite of comparable methodology, the Hungarian public health service only finds VTEC in humans sporadically (Milch et al., 1997., Herpay et al., 2003).

The routes and sources of transmission : the routes of transmissions for VTEC are principally: direct contact with infected animals (i.e. petting zoos), person to person transmission, food born-, and waterborn transmission, and environmental infection (i.e. swimming water, or contact with contaminated pastures, camping). These routes also point towards sources and reservoirs of VTEC, in which category the alimentary tract of ruminants (especially cattle) and humans are probably presenting the two main reservoirs. Other animals include sheep, goats (other ruminants), pigeons, poultry, seagulls, pigs and geese. In these sources and reservoirs different monitoring systems in different countries have found a wide range of prevalences. In abbatoir studies in the UK the prevalence of O157 VTEC was 4,7% in the summer (which is season for the highest prevalence) (Chapman et al.,.1997, Tuetenel et al., 2002), and the approximate prevalence of O157 VTEC in beef herds was 25% in Scotland (Synge et al., 2002). Based on a much wider range of survey the International Commission on microbiological Specifications for Foods =ICMSF (2005) gave figures for prevalence for individual cattle from 1,5–28%, and for individual beef from 0,1 – 5%. In Hungary, a recent abbatoir survey with comparable methodology indicated a 2,5% prevalence of O157 VTEC in cattle, which is in good agreement with the findings that only sporadic occurrence of this food born pathogen can be detected in the human population in this country (Tóth et al., 2005).

Survival of VTEC. As O157 VTEC/EHEC bacteria are known to have a low infectious dose (approx 10 bacteria may cause disease in man), it is important to get information about expected survival and/or growth rate under different environmental conditions and during food storage. In general it can be stated that O157 VTEC/EHEC bacteria are more acid tolerant than the most *E. coli* strains, and they survive at least as well as normal *E.coli* in food, or manure or soil, or in other compartments of the environment. Interestingly, acid adaptation (following contact with acid environment) induces increased survival, thermotolerance and resistance to low pH values (pH 4,0). Although there are strain variations between VTEC strains in this respect, there is no evidence that acquisition or loss of virulence factors would influence acid-, or stress tolerance.

As a result of contamination from the above sources of VTEC, the following food commodities can be of greatest concern for man: fresh meat (contaminated directly or indirectly during slaughter and/or processing), minced beef and fermented beef products, milk and cheese and other fermented milk products (yoghurt), fresh fruits and vegetables, herbs and spices. Among all the food of greatest concern are the raw or undercooked beef, and minced meat. These foods are regarded as high risk food for VTEC and should be treated accordingly. In general, microbiological guidelines and corrective actions aimed at reducing faecal contamination along the food chain can contribute to a reduction of food safety risks due to VTEC.

References available at the author.

Zoltán Kertész

Zoltán Kertész was born in Girincs in 1943. He graduated from the Agricultural University Gödöllő as agricultural engineer in 1968, and took the M.Sc. degree in 1971. He received his Ph.D. in biology in 1983, and earned his Academic Doctor degree from the Hungarian Academy of Sciences in 1996. **Dr. Zoltán Kertész's** research activity has deserved international recognition. He is a research professor of the **Cereal Research Non-Profit Company** (earlier **Cereal Research Institute**). Besides being an outstanding wheat breeder, he has contributed a lot to the improvement of research methods. His career as a breeder and co-breeder is highlighted by 56 registered wheat varieties with 33 of them patented, the results of conventional and non-conventional breeding techniques. He is a senior breeder with the aptitude to schedule cultivars. The released wheat cultivars stemming from his breeding efforts are planted on 30% of the domestic wheat growing area. He is the leader of the Wheat Breeding Department, which is actually a team of ten devoted researchers engaged in fundamental and applied researches in wheat. He is tutor, Head of Department and Honorary Professor of Szent István University and University of Szeged, respectively. He is the Managing Editor of Cereal Research Communications, an international quarterly; and the Chairman of HAS Plant Breeding Committee. The Hungarian Grand Prize for Innovation was awarded to Cereal Research Non-Profit Co. in 1998 for the innovative work done by the breeding staff headed by Zoltán Kertész. **Academic Prize** (1989) and the **Prize named after Rudolf Fleischmann** (1997) were granted to Zoltán Kertész for his breeding and research oeuvre.

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