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Brown ring formation and streak mottle, two distinct syndromes in Lilies associated with complex infections of lily symptomless virus and tulip breaking virus

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Abstract

Brown ring formation in bulbs of lilies, particularly of Mid-century hybrids, is described as a newly recognized disease. Symptoms of streak mottle in cultivars of *Lilium speciosum* Thunb., not associated with abnormalities of bulbs, are briefly described with reference to the literature. Sometimes the two syndromes occur in the same crop such as in the Mid-century hybrid 'Enchantment', showing brown ring formation in bulbs and an indistinct mottling in field plants. Severe leaf mottling appears in Mid-century hybrids and *L. speciosum* when plants are forced under glass. In both diseases tulip breaking virus (TBV) was always found to occur in complex with lily symptomless virus (LSV), which was consistently detected in apparently healthy plants of the Mid-century hybrid 'Enchantment' and in several *L. speciosum* cultivars.

The part of TBV involved in the complex diseases described has been demonstrated by serological, electron-microscopical, and inoculation studies with lilies and tulips. LSV was sap-transmitted from lily to tulip but it could not be detected in several randomly taken samples of a dozen field-grown tulip cultivars. Suppression of TBV in plants of 'Enchantment', grown from bulbs with brown ring formation under field conditions, is discussed. TBV was serologically and electron-microscopically detectable only in plants grown under glass. A similar phenomenon was observed in *L. speciosum* cultivars under both conditions.

Introduction

In the Netherlands the acreage of lilies (*Lilium*) increased three times during the last decade. The cultivation of Mid-century hybrids and *L. speciosum* Thunb. cultivars has approximately become half the acreage grown. Two distinct diseases of these *Lilium* spp. i.e. brown ring formation in bulbs and streak mottle on leaves, respectively, cause trouble in the field and during the forcing under glass. The possible association of these diseases with viruses known to occur in lilies was studied.

In America on Easter lilies *L. longiflorum Thunb.*, several viruses and virus diseases have already been described: lily rosette virus (Brierley and Smith, 1945), necrotic fleck and late breaking fleck caused by a complex of lily symptomless virus and cucumber mosaic virus (Brierley and Smith, 1944 a; Allen and Lyons, 1969), lily strong mottle and lily mottle viruses considered as strains of tulip breaking virus (Brierley, 1940; Brierley and Smith, 1944b; 1948), lily curl stripe associated with filamentous virus particles of 640 nm (McWhorter and Allen Jr, 1964; Allen Jr and McWhorter, 1966), lily ringspot virus, presumably a strain of cucumber mosaic virus (Smith, 1950; Brierley, 1962), tobacco ringspot virus (TRSV; Travis and Brierley, 1957), and tobacco rattle virus (TRV; Crogan, cited by McWhorther and Allen Jr, 1964).

From other lily species a few viruses have been reported: lily rosette virus (Brierley and Smith, 1945), lily (*L. speciosum*) fleck virus (McWhorter and Millsap, 1954), lily

streak mottle virus associated with flexuous particles of 750 nm (Elser and Allen Jr, 1968), tulip breaking virus (Yamaguchi, 1964; Van Slogteren and De Vos, 1966), lily mosaic virus associated with filamentous particles of 625–650 nm (Procenko and Schatrowa, 1969), and the incidental *Arabis* mosaic virus (Mowat and Stefanac, 1970).

Recent virus research in the Netherlands has shown that such lily diseases are caused so far by tulip breaking virus (TBV), lily symptomless virus (LSV), cucumber mosaic virus (CMV), and *Arabis* mosaic virus (AMV) (De Vos, 1966; De Vos, 1967; Muller, 1967; Muller 1968; Van Slogteren et al., 1969; Asjes et al., 1970). The present paper is mainly concerned with infections of lily symptomless virus (LSV; R/x: x/8:E/E:S/Ap, Allen Jr, 1972; Carlavirus group) and tulip breaking virus (TBV; x/x:x/x:E/E:S/Ap, Van Slogteren, 1971; Potyvirus group).

Description of the disease syndromes

Brown ring formation in the Mid-century hybrid 'Enchantment'. The colour of diseased *bulbs* varies from brown to nearly white (Fig. 1). Symptoms are not visible on the outer scales in almost apparently healthy bulbs. These bulbs, if peeled down to the centre, can show slightly brown or watery rings on the central scales.

The bulbs of severely diseased plants are smaller (Fig. 1, right) than those of apparently healthy plants. The scales are shorter and the bulb tips sometimes more open. The scales show concentric brown ring spots with a necrotic centre (Fig. 2). The brown ring formation appears on both sides of all scales. They mainly occur on their lower half and sometimes around the scale tip as well. The scale tips may become dark brown as a result of secondary infection by fungi. The virus symptoms also develop on the young stem bulblets on plants in the field.

The symptoms on *plants in the field* are less distinct. Diseased bulbs produce shorter plants (Fig. 3) with a slightly lighter colour. Numerous small, irregularly shaped, light-coloured flecks are visible along the veins. The symptoms may be observed after

Fig. 1. Effect of brown ring formation in the lily Mid-century hybrid 'Enchantment' on bulb size and quality. Right: apparently healthy; middle and left: severely diseased.

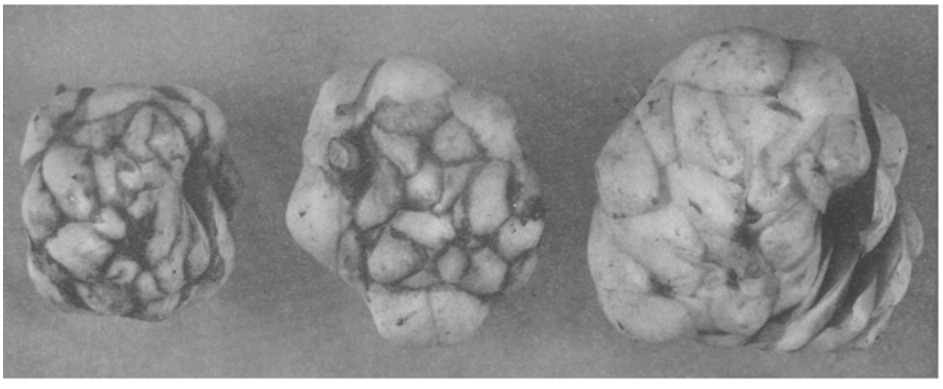

Fig. 1. Invloed van bruinkringerigheid op bolgrootte en -kwaliteit bij de lelie Midcentury-hybride 'Enchantment'. Rechts: ogenschijnlijk gezond; midden en links: ernstig aangetast.

Fig. 2. Brown concentric rings on severely affected bulb scales of the lily 'Enchantment'.

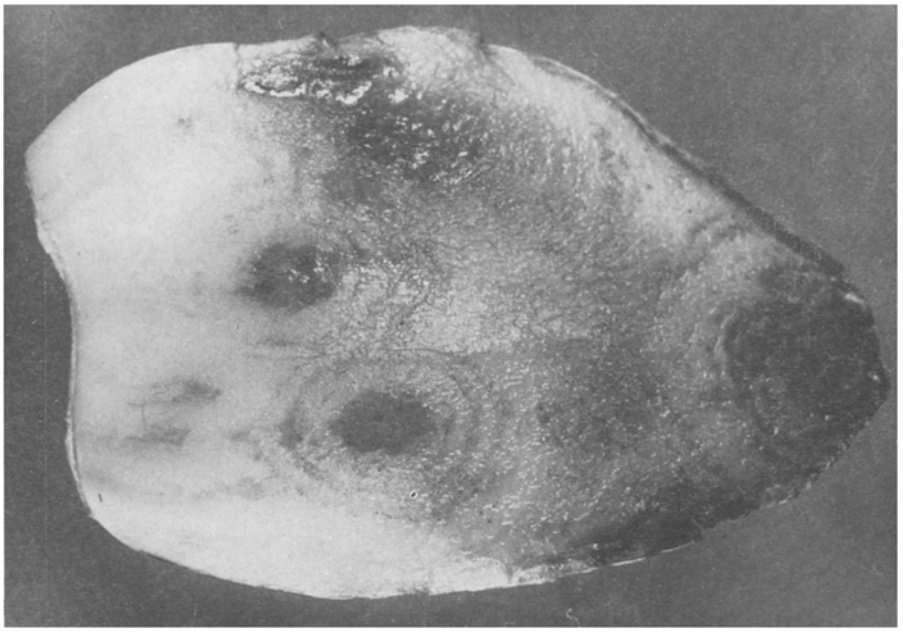

Fig. 2. Bruine concentrische kringen op ernstig aangetaste bolschubben van de lelie 'Enchantment'.

emergence and during and after flowering, but are generally masked in other growing periods. Diseased plants die prematurely, starting at the stem base (Fig. 3).

The symptoms on forced plants are generally more conspicuous than on those in the field. A mottle extending from the veins appears on most of the leaves. The vase-life of cut flowers from diseased forced plants is reduced. The leaves mature earlier and buds and flowers drop precociously, particularly in dark periods of the year when bulbs are forced under glass for flower production.

Streak mottle in L. speciosum cultivars. L. speciosum cultivars do not show symptoms on the bulbs. On the plants in the field mottle symptoms may be conspicuous (Fig. 4) and are persistent from the time of emergence. The mild leaf mottling extends from the veins. Mottling is severe when in the lower leaves chlorotic streaks turn into reddish necrotic flecks all over the leaf. Sometimes flowers are malformed and asymmetric. Then the quality of forced plants may even be worse than in 'Enchantment' plants with brown ring formation.

The symptom expression in *L. speciosum* depends on the cultivar; 'Uchida' is less sensitive to streak mottle than other cultivars. The symptoms described resemble those of mottle and streak mottle reported in the literature (Brierley and Smith, 1944 b; Mowat and Stefanac, 1970).

Materials and methods

Inoculations. The lily and tulip plants were manually inoculated after dusting with

Fig. 3. Brown ring formation disease in the lily 'Enchantment'. Right: apparently healthy; middle: moderately affected; left: severely affected.

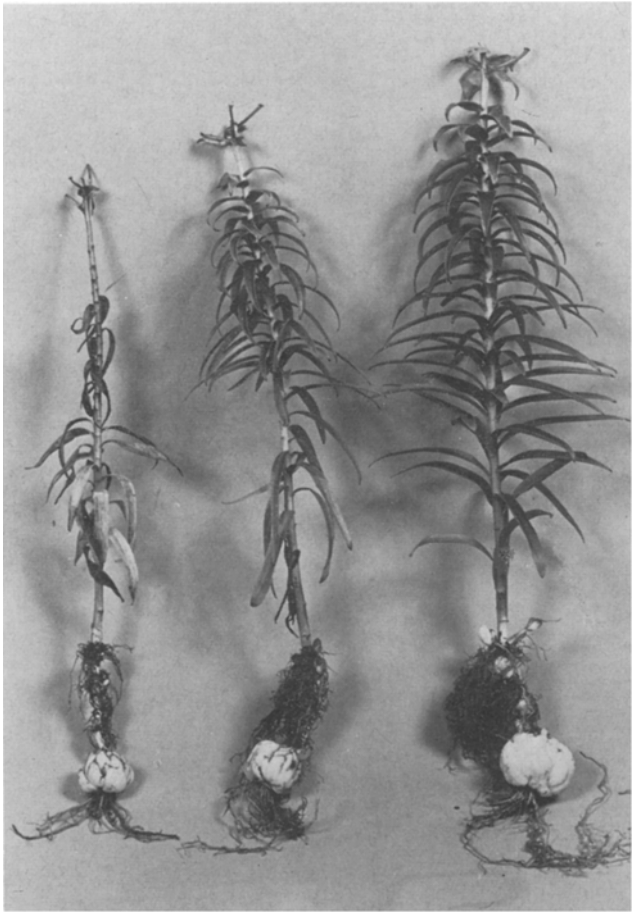

Fig. 3. Bruinkringerigheid in de lelie 'Enchantment'. Rechts: ogenschijnlijk gezond; midden: matig aangetast; links: ernstig aangetast.

carborundum (500), using sap from leaves and petals of tulips and leaves of lilies. Tulip leaves were homogenized with 0.9% NaCl (w/v = 1/3) and lily leaves with phosphate buffer 1/30 M containing 1% Na_2SO_3, henceforth to be called phosphate sulfite buffer (pH 7.5) (w/v = 1/2). For aphid transmission virus-free *Neomyzus circumflexus* Bckt., *Myzus persicae* Sulz. and *Macrosiphum euphorbiae* Thos. were used. The aphids of *N. circumflexus* and *M. persicae* were starved for 3–4 hours, allowed to feed on infected tulips and lilies grown under glass for less than 30 min, transferred to virus-free plants for 30 min and later killed with an insecticide. When using *M. euphorbiae* to test for virus transmission during storage (Smith and Brierley, 1948) tulip leaves with colonies were brought together with brown ring formation diseased lily bulbs and apparently healthy bulbs of tulips and the lily 'Enchantment'.

Fig. 4. Streak mottle in leaves of a *L. speciosum* cultivar. Right: apparently healthy; middle two: mild symptoms; left: severe symptoms.

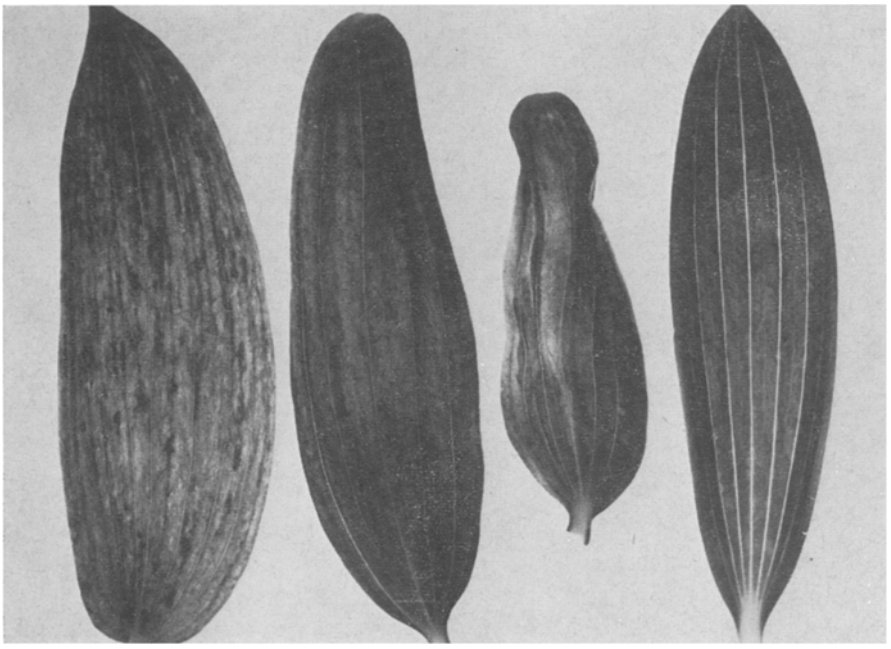

Fig. 4. Streperige vlekkerigheid op bladeren van een cultivar van L. speciosum. Rechts: ogenschijnlijk gezond; middelste twee: milde symptomen; links: ernstige symptomen.

Serology. Leaves of 'Enchantment' and *L. speciosum* cultivars were ground in a mortar in phosphate/sulfite buffer (w/v = 1/2), squeezed through cheese cloth, and centrifuged for 10 min at 1000 *g* in an angle rotor of a Phywé centrifuge before use in microprecipitin tests (Van Slogteren, 1955). Tulip leaves were treated in hot water for 15 min at 50 °C prior to preparation for serological tests (Van Slogteren and De Vos, 1966), after which they were homogenized in saline (w/v = 1/3) and squeezed through cheese cloth. The extract was stirred with 2/3 volumes of saturated ammonium sulfate solution and centrifuged for 15 min at 9,000 *g*. The sediment was resuspended in saline and dialysed overnight against distilled water. Then, 1/10 vol. 8.5% NaCl was added and the suspension centrifuged for 10 min at 1,000 *g* prior to use in serological tests.

Antisera against TBV from tulips were prepared according to Van Slogteren and De Vos (1966). Antisera against the viruses presumed to cause brown ring formation were prepared in June and July with partially purified virus suspensions from 'Enchantment' plants grown under glass. Leaves were homogenized in a Waring Blender with phosphate/sulfite buffer. The extract was centrifuged for 10 min at 1,000 *g*, followed by 5 min at 3,000 *g*. The supernatant was stirred with saturated ammonium-sulfate solution and centrifuged for 15 min at 9,700 *g* in a Sorvall-RC2-B centrifuge. The pellet resuspended in phosphate buffer was made isotonic by adding 1/10 vol. 8.5% NaCl solution and dialysed overnight against distilled water. This suspension was centrifuged for 10 min at 1,000 *g*, and the supernatant centrifuged for 60 min

at 110,000 *g* in a Spinco L-50 ultracentrifuge. The pellet was then resuspended in saline in 1/10 of the volume of the original sap, and this suspension centrifuged for 10 min at 3,000 *g*. The resulting supernatant was mixed with an equal volume of Freund's Bacto adjuvant incomplete. Rabbits were injected intramuscularly with 2 ml in both hindlegs two or three times at intervals of two to three weeks. The animals were bled about two weeks after the last injection. The antisera were absorbed (as/sap = 1/9) with leaf material of seedlings of *L. formosanum* or virus-free *L. tigrinum splendens* and of the tulip cultivar 'Rose Copland', ground in a mortar in phosphate buffer (1/15 M, pH 7.2).

Electron microscopy. Bulbs and leaves of 'Enchantment' with and without brown ring formation, leaves with severe streak mottle of *L. speciosum* 'Favorite', and petals of inoculated plants of *Tulipa* 'Rose Copland' were used for measuring filamentous virus particles. Negative staining in 2% phosphotungstic acid (PTA) at pH 7.2 was accomplished in two ways.

Cut pieces from bulb scales with symptoms were immediately dipped into PTA on carbon-reinforced formvar-coated grids. After about two minutes, excess liquid was removed with a Pasteur pipette.

Parts of leaves were chopped on a glass slide and a few drops of phosphate buffer (0.067 M, pH 7.2) added. An internal length standard (Bos, 1970) was incorporated by adding a piece of *N. tabacum* 'White Burley' infected with tobacco mosaic virus (TMV). The suspension was covered with a second slide and a few drops of the sap were poured into 1.5 ml PTA, after which drops of this mixture were brought onto grids, and left there for two minutes whereupon excess liquid was removed.

The dried preparations were examined without delay with a Philips EM 300 electron microscope. Photographs were made at a magnification of about 11,700 times and the negatives projected at a magnification of about 200,000. The particles were then traced on paper and the measured lengths were grouped into classes of 10 nm. The particle lengths were calculated on the basis of TMV length (300 nm).

Results

Inoculations. Sap inoculations from diseased and apparently healthy lilies onto test plants of *Chenopodium quinoa*, *Nicotiana rustica*, and *N. tabacum* 'White Burley' did not cause symptoms of readily transmissible CMV and AMV, and no infections with TRSV and TRV were observed.

The results of most inoculation experiments with lilies and tulips are shown in Table 1. Current season symptoms were occasionally observed but are not reported.

In tulips mechanically inoculated from apparently healthy lilies (series 1) infection only showed up by fine streaks in the petals (Fig. 5), almost exclusively visible on their outside. These symptoms recurred in progenies. The leaves showed no symptoms. The petal symptoms were associated with LSV, serologically detectable in progeny plants in leaves and petals, but not in plants with current season symptoms.

In tulips infected after sap inoculation from diseased lilies (series 2) the petals showed fine streaks mixed with average break (Fig. 6, right; Van Slogteren, 1971). The leaves showed mild mosaic. LSV was serologically detectable. However, TBV was not detected in forced tulips. In field-grown tulips both viruses were serologically detect-

Table 1. Results of inoculations of plants of the lily Mid-century hybrid 'Enchantment' grown under glass and of *Tulipa* 'Rose Copland'.

Inoculation: object and source	Mode of transmission	Number/ Total number	%	Expression of symptoms	Serological detection	
					LSV	TBV
tulips of 1st progeny with symptoms in petals						
1. from apparently healthy lilies to:						
forced tulips	sap	6/10	60	fine streaks	+	−
field-grown tulips	sap	10/30	33	fine streaks	+	−
2. from diseased lilies to:						
forced tulips	sap	26/34	76	fine streaks and average break*	+	−
field-grown tulips	sap	26/37	70	fine streaks	+	−
				average break	+	+
3. from apparently healthy lilies to:						
forced tulips	aphids	0/10	0	none		
field-grown tulips	aphids	0/16	0	none		
4. from diseased lilies to:						
field-grown tulips	aphids	12/28	43	average break	−	±**
5. from TBV-diseased tulips to:						
healthy tulips	aphids	15/21	71	average break	−	+
brown ring formation in lily bulbs						
6. from TBV-diseased tulips to:						
apparently healthy lilies	sap	0/24	0	none	+	−
	aphids	0/48	0	none	+	−
7. from diseased lilies to:						
apparently healthy lilies	sap	15/24	62	diseased	+	−***
	aphids	0/24	0	none	+	−

* According to Van Slogteren (1971).
** Occasionally detectable.
*** Not detectable.

Tabel 1. Resultaten van inoculaties van planten van de lelie Midcentury-hybride 'Enchantment' geteeld in de kas en van de tulp 'Rose Copland'.

able. Eight of these plants were found to be infected by LSV and TBV. They showed petals with both types of symptoms (Fig. 6, right) and their leaves showed a more severe mosaic (Van Slogteren, 1971). Eighteen plants showed petals with fine streaking associated with LSV only.

Aphid transmission of LSV from apparently healthy lilies to tulips failed (series 3), but led to average break in the petals and mild mosaic in the leaves when diseased lilies were used as a virus source (series 4). LSV was not detected serologically and TBV was occasionally detectable.

TBV was readily transmitted by aphids from tulips to tulips (series 5) as shown by symptoms and serological testing. The virus could not be transmitted by sap or aphids from diseased tulips to apparently healthy lilies (series 6) as indicated by absence of brown ring formation in the bulbs. However, TBV could be rather easily transmitted by sap to apparently healthy lilies, whereas aphid transmission failed (series 7).

Fig. 5. Fine streaks on tulip petals, 'Rose Copland', caused by lily symptomless virus. Right: infected; left: healthy.

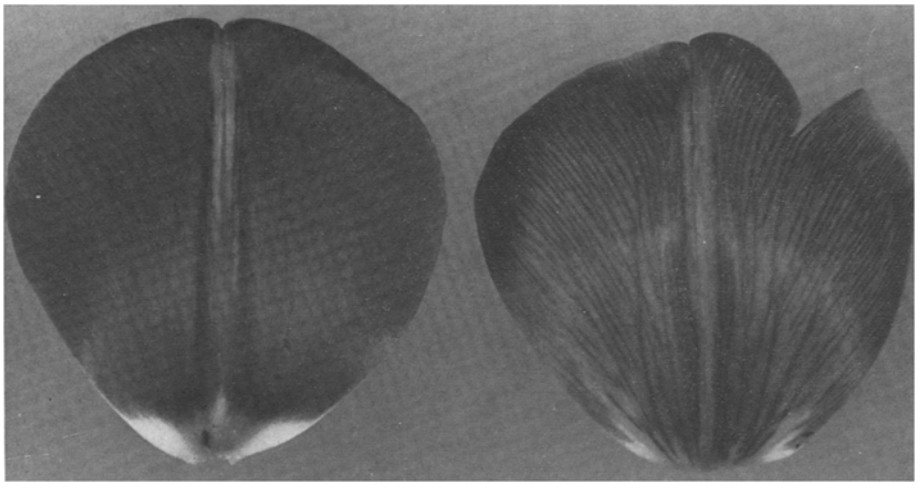

Fig. 5. Fijne strepen in bloembladen van de tulp 'Rose Copland', veroorzaakt door symptoomloos lelievirus. Rechts: geïnfecteerd; links: gezond.

Presumed aphid transmission of viruses by *M. euphorbiae* from lily to tulip and from lily to lily bulbs during storage gave no diseased plants. Experimentally, TBV is transmissible by aphids in tulip bulbs during storage (Asjes, unpublished).

Serology. TBV detection was hazardous in tulips with average break and mild mosaic, although the filamentous particles can be consistently detected with the electron microscope. The presence of LSV in tulips was consistently confirmed serologically except in plants with current season symptoms. Random sampling of several plants of a dozen cultivars of tulips with severe mosaic resulted in serological detection of TBV but not of LSV. Inoculated tulips proved to be susceptible to LSV, but the virus does not seem to occur naturally in field crops.

TBV could be detected in lily 'Enchantment' plants with brown ring formation grown under glass but not in field-grown plants. Detection of TBV in field plants of *L. speciosum* cultivars with severe streak mottle was not possible either, whereas in plants grown under glass the virus was usually indexed. LSV was readily detected in both instances. Random sampling of several stocks of 'Enchantment' and *L. speciosum* cultivars of well-known reputation indicated that crops of these lily species were totally infected with LSV.

The antisera (titres 1280) prepared from diseased lilies after absorption with suspensions of LSV reacted positively with TBV suspensions from tulip, but negatively with sap of diseased leaves of 'Enchantment'. Also, no positive reactions were obtained between this lily sap and TBV-antiserum. The testing was done in August with diseased lilies grown under glass. The positive reactions of the antiserum prepared from diseased lilies with tulip TBV suspensions indicated the presence of a closely related or identical virus. Data obtained by electron microscopy will explain why TBV

Fig. 6. Symptoms of single and complex infections in tulip petals 'Rose Copland'. Right: breaking and fine streaks caused by the complex of TBV and LSV; left: breaking caused by tulip breaking virus.

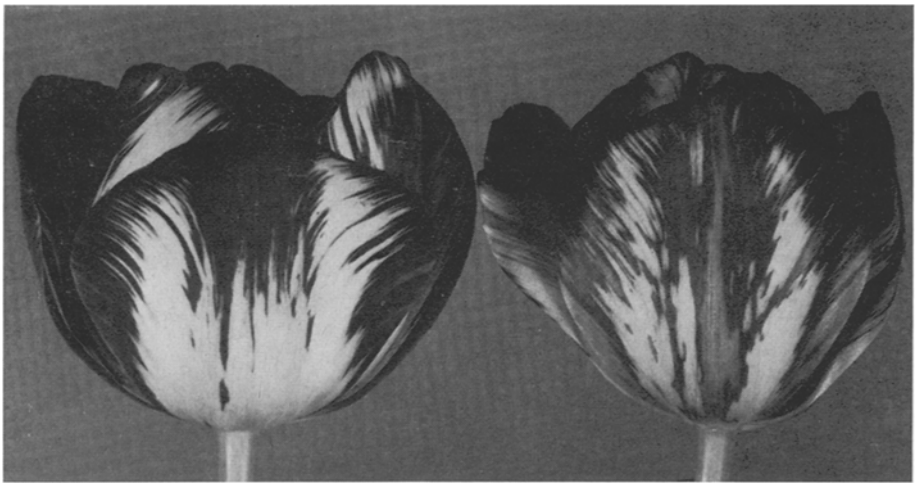

Fig. 6. Symptomen van enkelvoudige en complexe infecties in bloembladen van de tulp 'Rose Copland'. Rechts: breking en fijne streping veroorzaakt door een complex van TBV en LSV; links: breking veroorzaakt door tulpemozaïekvirus.

is difficult to detect serologically in lilies.

The lily symptomless virus in 'Enchantment' was serologically closely related to or identical with the LSV of Easter lilies, *L. longiflorum* Thunb. LSV is serologically distantly related to chrysanthemum virus B (CVB) (Van Slogteren et al., 1969). An antiserum against CVB reacted with sap of apparently healthy 'Enchantment', which suggested a distant serological relationship between LSV and CVB. Reciprocally, an antiserum against LSV and sap of chrysanthemum infected with a strain of CVB reacted negatively, as has also been reported by Allen Jr (1972). However, a positive reaction was obtained between LSV antiserum and a partially purified suspension of CVB concentrated about 10 times (Van Slogteren and De Vos, unpublished).

Electron microscopy. Results of measurements of filamentous virus particles from several virus sources are shown in Table 2.

The peak lengths of the virus particles of LSV ranged between 620 and 645 nm and of TBV between 740 and 755 nm in both lilies and tulips. Both peaks were definitely found in one plant with brown ring formation of lily 'Enchantment' grown under glass, which were measured on the 21st of April. In all other cases with lilies, inclusive *L. speciosum* 'Favorite', TBV could hardly be discerned.

That TBV cannot be detected serologically in leaf sap of diseased field-grown plants of 'Enchantment' early in the lily growing season (middle of July) or in leaves of plants grown under glass (in August or December), may be explained by the very low concentrations of the virus. LSV particles were more abundant in lily plants with complex diseases than in singly infected plants. Also more virus particles were found when streak mottle symptoms were more severe in *L. speciosum* cultivars.

Discussion

The brown ring formation disease of 'Enchantment' bulbs is evidently associated with a complex infection of tulip breaking virus and lily symptomless virus. In no case other viruses, such as CMV, AMV, TRSV and TRV could be detected. TBV was serologically detected in diseased lilies grown under glass and once observed electron-microscopically. An antiserum prepared from such lilies reacted positively against TBV suspensions of tulips. TBV and LSV in inoculated tulips could be distinguished by their symptoms and by serology and electron microscopy. The spread of the disease is above ground (Muller 1967; 1968), and a non-persistent virus was involved as suggested by the results of mineral oil sprays (Asjes, 1972). However, the postulates of Koch have not yet been fulfilled, because inoculations from TBV-infected tulips to apparently healthy lilies failed.

Brown ring formation can be found in bulbs of the original Midcentury clones, e.g. 'Enchantment', 'Harmony', 'Cinnabar', 'Valencia', and 'Joan Evans'. The disease is not observed in 'Tabasco' and 'Destiny', which were seedlings derived by inter-

Table 2. Results of length measurements of filamentous particles.

Virus source	Total number of particles	Peak length(s) (nm)		% particles peak length(s) of total number		Period/ date of measurements
		short	long	short	long	
Lilium Mid-century hybrid 'Enchantment':						
bulb scales with brown ring formation	273	635	740	18	3	December
leaves of an apparently healthy plant grown under glass	283	645		19	0	February
leaves of a plant with brown ring formation grown under glass	199	620	750	24	14	21 April
leaves of a plant with brown ring formation grown under glass	267	630	750	24	1	21 December
leaves of a field-grown plant with brown ring formation	379	645	735	25	2	14 July
L. speciosum 'Favorite':						
leaves of a field-grown plant with severe streak mottle	248	635	755	30	2	14 July
Tulipa 'Rose Copland':						
petals of a 2nd progeny tulip after sap transmission from apparently healthy lilies	188	640		21	0	May
petals of a 1st progeny tulip after aphid transmission from lilies with brown ring formation	138		750	0	28	May
petals of a 1st progeny tulip after aphid transmission from TBV-diseased tulips	45		750	0	31	May

Tabel 2. Resultaten van lengtemetingen van draadvormige virusdeeltjes.

crossing between the original clones or other *Lilium* spp. (De Graaff and Hornback, 1967). Bulbs of a *L. hollandicum* hybrid 'Orange Triumph' may also show the brown ring formation.

Streak mottle on the leaves of *L. speciosum* cultivars obviously also results from complex infections by LSV and TBV as clearly suggested by the serological reactions in leaves of plants grown under glass, and occasionally in field plants. Other viruses, such as CMV, AMV, TRSV, and TRV could not be detected. Electron-microscopically, *L. speciosum* 'Favorite' (Table 2) further pointed to a complex infection similarly occurring in 'Enchantment'. Aphid transmission of TBV to tulips from other *Lilium* spp., with symptoms similar to those in *L. speciosum* described as 'mottle patterns' have been reported (Brierley and Smith, 1944 b; Mowat and Stefanac, 1970). In *L. speciosum* plants with streak mottle, filamentous virus particles of 750 nm were observed by Elser and Allen Jr (1968).

Various types of mottle and mosaic may also be associated with complex infections of LSV and CMV, e.g. necrotic fleck (Brierley and Smith, 1944), or LSV and AMV in *L. tigrinum splendens* (Anonymous, 1971). So far, we have not found lily fleck virus (McWhorter and Millsap, 1954) or lily rosette virus, although the latter has once been reported to occur in Holland (Brierley and Smith, 1945).

In single infections in lilies, e.g. lily Mid-century hybrids, *L. speciosum* cultivars and *L. tigrinum splendens*, LSV does not cause visible symptoms under normal conditions. Complex infections of LSV with TBV are associated with conspicuous symptoms. Under field conditions LSV greatly decreased the concentrations of TBV particles (Table 2). However, TBV does not completely disappear, because plants with conspicuous symptoms will develop from bulbs of 'Enchantment' or of several *L. speciosum* cultivars. This emphasizes that mosaic in lilies may not be exclusively associated with virus particles having the length of LSV only (Procenko and Schatrowa, 1969).

LSV has been reported to occur naturally in tulips (Allen Jr, 1971). The fine streaking of petals in tulips mechanically inoculated with LSV (Fig. 5), are unlike those caused by other viruses infecting tulips (Van Slogteren and Asjes, 1970). LSV was not transmitted by aphids from lilies to tulips, although a non-persistent mode of transmission of *M. persicae* from lilies to lilies has been reported (Mowat and Stefanac, 1970).

A suggested increase of LSV particles in complex diseases such as necrotic fleck in Easter lilies (Civerolo et al., 1968; Allen Jr and Lyons, 1969) also occurs with the brown ring formation in lily bulbs. Electron-microscopically, the same observation was made in field-grown plants of several *L. speciosum* cultivars with streak mottle and severe streak mottle symptoms.

Tulip breaking virus was transmitted by aphids from lilies to tulips but not vice versa. Transmission from tulips to tulips was readily achieved. Mechanical transmission from diseased lilies to tulips resulted in petal symptoms with average break. TBV was serologically detected and the virus particles ranged between 740 and 755 nm which corresponds to a reported modal length (Van Slogteren, 1971). It is evident that in lilies a closely related or identical strain of TBV is a causal virus in complex diseases. The observed non-transmissibility of TBV by aphids from tulips to lilies or from lilies to lilies is puzzling and should be further investigated.

Samenvatting

Bruinkringerigheid en streperige vlekkerigheid, twee verschillende ziektebeelden in lelies bij een complexe infectie met symptoomloos lelievirus en tulpemozaïekvirus

'Bruinkringerigheid' in bollen van Midcentury-hybriden wordt beschreven als een nieuw onderkende virusziekte (Fig. 1, 2 en 3). Streperige vlekkerigheid op bladeren van *L. speciosum* cultivars (Fig. 4), niet tegelijkertijd optredend met bolafwijkingen, wordt in het kort beschreven, en deed zich voor zoals in de literatuur wordt vermeld.

Soms treden de twee syndromen op in hetzelfde gewas zoals in de Midcentury-hybride 'Enchantment', die bruinkringerigheid in bollen laat zien en een onduidelijke vlekkerigheid in veldplanten. Ernstige vlekkerigheid op de bladeren komt naar voren in Midcentury-hybriden en *L. speciosum* wanneer de planten in de kas worden gebroeid.

Bij de beschreven ziekten was het complex van tulpemozaïekvirus (syn.: tulpebloembrekingsvirus; TBV) en symptoomloos lelievirus (LSV) steeds aanwezig. Het laatstgenoemde virus werd steeds aangetoond in ogenschijnlijk gezonde planten van de Midcentury-hybride 'Enchantment' en van verscheidene cultivars van *L. speciosum*.

Het aandeel van het TBV in de beschreven complexe ziekten bleek uit serologisch en elektronenmicroscopisch onderzoek en uit inoculatieproeven met lelies en tulpen (Tabel 1 en 2). LSV werd met sap overgebracht van lelie naar tulp (Fig. 5 en 6). LSV kon niet worden aangetoond in verscheidene willekeurig genomen monsters uit planten met mozaïeksymptomen op de bladeren van een twaalftal te velde geteelde tulpecultivars. In planten met bruinkringerigheid te velde werd een teruglopen van de concentratie van het TBV waargenomen. TBV was serologisch en elektronenmicroscopisch slechts aantoonbaar in lelie-planten die in de kas groeiden. Een overeenkomstig verschijnsel werd waargenomen in *L. speciosum*-cultivars.

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