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Diagnosis of the agromyzids *Liriomyza bryoniae* and *L. trifolii* by means of starch gel electrophoresis

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already been reported by Brennan (1977).

The 900 : 100 mixture of EZ : Ac and ZZ : Ac was successfully used for monitoring *S. vespiformis* in the summer of 1982.

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Ent. exp. & appl. **34** (1983) 205—208. *Ned. Entomol. Ver. Amsterdam*

Steph B. J. MENKEN¹) & Sandrine A. ULENBERG²): *Diagnosis of the agromyzids Liriomyza bryoniae* and *L. trifolii* by means of starch gel electrophoresis.

To enlarge the character set of the species of the family Agromyzidae an electrophoretic study has been done on two species of this family, *Liriomyza trifolii* (Burgess) and *L. bryoniae* (Kaltenbach).

Seventy-five percent of the known 1800 spe-

cies of the Agromyzidae are leaf-miners (Spencer, 1973: 1). Several of these leaf-miners are serious pests and many others are potential agricultural and horticultural pests. The larval mines and adult feeding produce leaf stippling, and cause reduction in crop value. Seedlings often do not survive a *Liriomyza* attack.

L. trifolii and *bryoniae* are amongst the major trouble makers in the Netherlands. *L. trifolii*, an important pest of chrysanthemums and vegetable crops in the USA, was detected for the first time in Europe in 1977. This species is associated with warm areas being centred in Florida in the USA and in Holland it is mainly a problem of glasshouses. *L. trifolii* has been

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TABLE I

Allozyme frequencies at the 7 diagnostic and 2 other polymorphic loci in Liriomyza bryoniae (L.b.) and L. trifolii (L.t.), the numbers of alleles sampled (n) and the heterozygosity per locus (h)

		<i>n</i>						<i>h</i>
<i>Pgm</i>	<i>L.b.</i>	82	.16	—	.65	.11	.07	.535
	<i>L.t.</i>	46	—	1.00	—	—	—	.000
<i>Me</i>	<i>L.b.</i>	76	—	93	100	104		.461
	<i>L.t.</i>	60	.98	.02	.64	.36		.039
<i>Estβ-1</i>	<i>L.b.</i>	32	.13	97	100	101		.557
	<i>L.t.</i>	20	—	1.00	.59	.28		.000
<i>6Pgdh</i>	<i>L.b.</i>	42	.12	96	100	101	104	.211
	<i>L.t.</i>	16	—	—	.88	—	—	.375
<i>Nadh. dh-1</i>	<i>L.b.</i>	34		100		104		.000
	<i>L.t.</i>	20		1.00		—		.000
<i>Ald</i>	<i>L.b.</i>	46		93		100		.000
	<i>L.t.</i>	40		1.00		1.00		.000
<i>Hbdh</i>	<i>L.b.</i>	14		100		105		.000
	<i>L.t.</i>	20		1.00		—		.000
<i>Mdh</i>	<i>L.b.</i>	38		100		106		.000
	<i>L.t.</i>	38		1.00		—		.058
<i>G6pdh</i>	<i>L.b.</i>	28		100		103		.077
	<i>L.t.</i>	6		.96		.04		.000
				1.00		—		

recorded on more than 100 different hosts. In the Netherlands it causes the most serious damage in chrysanthemums and *Gerbera*, but it is steadily increasing its host range to include vegetable crops (Jaarboek Plantenziektenkundige Dienst, 1980: 32, 88–90). *L. bryoniae* occurs exclusively in the Palearctic Region. In the Netherlands it is known of old as a pest of tomato.

The genus *Liriomyza* is a taxonomically difficult group, with several species hardly distinguishable on morphological grounds. Because of its economic importance a good identification is important. Although the larvae and the imagines of *L. bryoniae* and *trifolii* are morphologically distinguishable (Spencer, 1973: 226–229, 209–214), identification of the pupae cannot be given with certainty. Moreover, the threat of introduction of other pest species, closely related to these, makes unambiguous

characterisation extremely valuable.

Enzyme variation has proved to be differential in a number of closely related species (Ayala, 1975; Lakovaara *et al.*, 1976; Menken, 1982) and has therefore been investigated to enlarge the character set of *Liriomyza*.

Materials and Methods. Mass cultures were produced from individuals collected in the field, at the Glasshouse Crops Research and Experimental Station, Naaldwijk, the Netherlands. Individuals analysed electrophoretically originated from the 15–20th generation in *L. trifolii* (reared on aubergine, cucumber and tomato), and from the 30–40th in *L. bryoniae* (reared on tomato).

The *L. trifolii* samples were put together and treated as one, as no significant differences were observed between subsamples.

In total the following numbers of individuals

were analysed: *L. bryoniae* — 9 last-instar larvae, 17 pupae, 28 adult flies and *L. trifolii* — 23 last-instar larvae, no pupae, 18 adult flies.

Specimen preparation and electrophoretic and staining techniques followed Menken (1982). The following 15 proteins were analysed (locus abbreviations in parentheses): α -glycerophosphate dehydrogenase (α -Gpdh-1 and -2, referring to the larval and adult locus respectively), glucose-6-phosphate dehydrogenase (G6pdh), hydroxybutyrate dehydrogenase (Hbdh, only active in larvae, sometimes in pupae), isocitrate dehydrogenase (Idh, activity in adults very low), malate dehydrogenase (Mdh), malic enzyme (Me), NADH dehydrogenase (Nadh.dh-1 and -2), 6-phosphogluconate dehydrogenase (6-Pgdh), catalase (Cat), phosphoglucumutase (Pgm), esterase (Est β -1), aldolase (Ald) and the general protein (Pt-1).

Enzymes are encoded by the same locus in all life stages studied, unless otherwise stated.

Genetic interpretation of the observed variation is inferential.

At each locus the most common electromorph (allozyme) of *L. bryoniae* is arbitrarily designated as 100. All other electromorphs are numbered according to their differences in migration distance from this standard in millimeters (standardisation according to Menken, 1982). Six more enzymes gave no activity at all

or demonstrated uninterpretable patterns (fucose dehydrogenase, alcohol dehydrogenase NAD- and NADP-dependent, glutamic-oxaloacetic transaminase, acid phosphatase and leucine aminopeptidase).

Results and discussion. Table I lists allozyme frequencies at 7 diagnostic loci (a locus is considered diagnostic when it is sufficient to distinguish the taxon from other taxa with 100% probability), viz.: Hbdh, Me, Nadh. dh-1, 6Pgdh, Pgm, Est β -1 and Ald. Also listed is the variability at 2 slightly polymorphic enzyme loci (Mdh and G6pdh), that show a broad overlap in frequencies between the 2 species. The remaining 6 loci are monomorphic in our samples and fixed for the same electromorph in both species, viz.: α Gpdh-1 and -2, Idh, Nadh. dh-2, Cat and Pt-1. Fig. 1 depicts genotypic patterns of the diagnostic loci Me and Pgm. These are superior systems for characterisations of the 2 species as all individuals analysed gave sharp banding patterns.

The total information on allozyme frequencies results in a genetic identity (Nei, 1972) $I = 0.573$ and a genetic distance $D = 0.556 \pm 0.223$. Obviously the 2 species are biochemically quite separate and easily distinguishable.

In *Liriomyza trifolii* no pupae were available for electrophoretic analysis. As larval and adult patterns are the same for 6 out of the 7

Genotypic patterns of malic enzyme (Me, presumably of tetrameric structure) and phosphoglucumutase (Pgm, monomer) in *Liriomyza trifolii* (L.t.) and *L. bryoniae* (L.b.).

diagnostic loci (*Hbdh* was only mainly active in larvae) it can be taken for granted that the same locus is expressed in the pupae. Hence *L. bryoniae* and *trifolii* are easy to discriminate as larvae, pupae and adults.

It is not known at what time the transition of the larval α *Gpdh-1* into the adult form (α *Gpdh-2*) occurs during the pupal stage.

There is a notable difference in heterozygosity value between the 2 species. The mean heterozygosity computed over 15 genetic loci for *L. bryoniae* ($H = 0.123 \pm 0.055$) is 4 times as large as that for *L. trifolii* ($H = 0.031 \pm 0.025$; standard errors of H were calculated from the variance among loci: Nei, 1975). According to the niche-width variation hypothesis (Van Valen, 1965) *L. trifolii* should be as polymorphic as *L. bryoniae* as both species have a comparable host plant range (as a parameter of niche breadth). Conclusions, however, must remain very tentative as we are dealing with the n^{th} laboratory generation and we do not know much of processes that may influence heterozygosity levels, such as bottlenecks, in the cultures.

We will continue our study with the characterisation of other important or potentially important pests within the genus *Liriomyza*.

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D. J. HORN¹): *Selective mortality of parasitoids and predators of Myzus persicae on collards treated with malathion, carbaryl, or Bacillus thuringiensis*

KEY WORDS: *Diaeretiella rapae* — Encyrtidae — Insecticide — Integrated control — Hymenoptera — Pteromalidae — searching behavior — Syrphidae

Densities of phytophagous insects, especially aphids may increase after application of broad spectrum insecticides. Outbreaks of *Myzus persicae* Sulzer (green peach aphid) have followed application of botanical, chlorinated hy-

drocarbon, organophosphate, and carbamate insecticides (Bacon 1960, Pimentel 1961, Ripper 1956). Such outbreaks have been attributed to elimination of predators (Ripper 1956), to increased attractiveness of treated plants (Folsom 1927), to reduced competition and higher host quality after elimination of competitors (Root & Skelsey 1969), or to a combination of these.

Fewer investigators have reported selective effects of insecticides on specific natural enemies. Coats *et al.* (1979) found that Coccinellidae tolerated some pyrethroids, and Lecrone & Smilowitz (1980) noted that *Coleomegilla maculata* (Coccinellidae) was more tolerant of carbaryl, pirimicarb, and methamidiphos than was either *M. persicae* or predaceous Chrysopidae. Ba-Angood & Stewart (1980) found

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