Boll. Ist. Ent. "G. Grandi" Univ. Bologna, 50: 215-231, 1996.

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Comparative Study of Strains of *Phytoseiulus persimilis* Athias-Henriot (Acarina Phytoseiidae).
I. Development and Adult Life. (*)

INTRODUCTION

The predatory mite *Phytoseiulus persimilis* Athias-Henriot (Acarina Phytoseiidae) is an effective biological control agent of the red spider mite *Tetranychus urticae* Koch (Acarina Tetranychidae). In 1990, van Lenteren *et al.* (1992) estimated in ca. 7,000 ha the world-wide use of the mass-reared predators in protected crops. In northern Europe, small-scale releases of *P. persimilis* began in 1968. In Italy, initial biocontrol experiments were carried out in Sicily by Nucifora *et al.* (1983) and Vacante and Nucifora (1987b), using indigenous strains of *P. persimilis*; predatory mites mass-reared in a northern European biofactory were tested from 1985 in Po Valley (Celli *et al.*, 1987).

P. persimilis was first described by Athias-Henriot (1957) collected in nature in Algeria in 1955-1957 on various plants. Dosse (1958) found the species (reported as *P. riegeli*) on a consignment of orchids received in Germany from Chile and distributed the progeny in several European countries (Hussey, 1985). In Italy, Lombardini (1959) was the first to report *P. persimilis* which he found in Sicily on citrus leaves, describing the predator as a new species (*Amblyseius tardi*) until Kennett and Caltagirone (1968) showed the synonymy with *P. persimilis*. Other Italian reports of wild populations followed in Sicily (Ragusa, 1965, 1974, 1977, and 1986; Liotta *et al.*, 1977; Vacante and Nucifora, 1985, 1986, 1987a, and 1987b), in central Italy (McMurtry, 1977) and in Cesena, near the northern Adriatic seaboard (Celli *et al.*, 1988). *P. persimilis* has also been reported in other Mediterranean areas such as southern France (Rambier, 1972),

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(*) Accepted for publication: June 3, 1996.

Greece (Swirsky and Ragusa, 1976 and 1977), Spain (Ferragut *et al.*, 1983; Garcia Marì *et al.*, 1986 and 1987) and as an "imported beneficial" in Lebanon (Dosse, 1967) and Israel (Swirsky and Amitai, 1968).

Several authors have conducted comparative studies on strains of Phytoseiidae. Croft (1971) reported significant differences in the critical photo-phase prior to diapause in four *Typhlodromus occidentalis* Nesbitt strains coming from various geographic areas. McMurtry *et al.* (1976) investigated two *Amblyseius potentillae* (Garman) geographic races finding differences in reproductive diapause induced by photoperiod and in egg-hatching by relative humidity.

Hassan (1982), König and Hassan (1986), Mori and Gotoh (1986), Fournier *et al.* (1987a, 1987b and 1988) compared the pesticide resistance of various strains of *P. persimilis*; Moraes and McMurtry (1985) reported different oviposition rates in strains of different geographic origin. Perring and Lackey (1989) found differences in developmental time and mortality of juvenile stages in response to varying thermo-hygrometric regimes. Sabelis (1985) reported the demographic indexes calculated by Takafuji and Chant (1976) and Badii and McMurtry (1984). These studies proved that differences can be found among strains, therefore justifying comparative studies finalised to select and preserve the most effective strains for the "seasonal inoculative" method. To investigate the performances of indigenous strains could provide a spin off for the biological control particularly in the extremely varying conditions of the Mediterranean protected crops (Benuzzi and Nicoli, 1991).

Galazzi *et al.* (1994) and Galazzi and Nicoli (1994) reported the initial findings of comparative studies on the performances of three strains of *P. persimilis* while Mantovani *et al.* (1994) investigated the possibility of the genetic characterisation of the same strains.

MATERIALS AND METHODS

Origin of the strains. Three laboratory experiments were carried out from August 1992 to March 1993 using different strains: the strain SI was collected in July 1992, in Sicily (Siracusa, ca. 37° N latitude) on strawberry, in an area where mass-reared predatory mites were never released (Antonio Amore, pers. comm.); the strain NE was supplied by a northern-European biofactory (Bunting BC, Colchester, GB), in August 1992, though originally derived from a rearing at the Institute of Horticultural Research (ex-GCRI) in Littlehampton (GB) in the early 1980's, selected for resistance to OP-insecticides and supplemented with material field-collected in California (Clive Stinson, pers. comm.); the strain NI was collected in March 1991, in northern Italy near the Adriatic seaboard (Cesena, ca. 44°N latitude) on strawberry and then mass-reared at the Biolab, Cesena, Italy (Massimo Benuzzi, pers. comm.).

Rearing of the strains and experimental cages. The rearing of the strains (maintaining ca. 500-1,000 individuals each) was carried out in separate climate chambers set up at 20-24°C, RH=80±10% and photoperiod L:D=16:8; the rearing unit was composed of a plastic tray, containing bean leaves infested by

T. urticae; water in the tray prevented the mites from escaping and kept the leaves fresh (Osakabe *et al.*, 1988). The biological parameters were investigated by isolating predators in Plexiglas cylindrical cages (4.0 cm high, 4.0 cm wide and 0.2 cm thick), featuring a cap fitted with a stainless steel mesh disk (2.5 cm diameter, 201 mesh, and 36% air permeability) and lying on a ca. 0.6 cm thick layer of agar gel. At the bottom of each cage was a disk of bean leaf, the abaxial face-upwards.

Experiment 1: Longevity and oviposition. Pairs of newly moulted adults collected during mating were tested in a climate chamber at 25±1°C, RH=80±5% and photoperiod L:D=16:8. Each pair was isolated in a cage with a disk of bean leaf infested *ad libitum* by various stages of *T. urticae*. The cage was placed upside-down on a perforated basket so that the leaf disk was on top and the cap mesh on the bottom. The male was kept in the cage for only the first three days. The number of eggs laid per day was recorded throughout the lifetime of each female. At the beginning of the experiment, the NE, SI and NI strains were reared in the laboratory for ca. 1, 4, and 8 generations, respectively (one generation lasted ca. 10 d in the laboratory rearing).

Experiment 2: Longevity, oviposition, adult predation and sex of the progeny. The experimental units and the collection method of pairs were identical to experiment 1 and again males were kept only for the first three days. Predators were fed only with *T. urticae* eggs (80 eggs per day; <48 h old). The number of eggs laid and the number of the prey eggs consumed were counted daily for each female, subtracting the average male predation. The egg-consumption of males was calculated by isolating 10 individuals per strain during the initial three days of adult life. The progeny of a large part of females was reared separately until the adult age to determine the sex-ratio. At the beginning of the experiment, the NE, SI, and NI strains were reared in the laboratory for ca. 11, 14, and 18 generations, respectively.

Experiment 3: Pre-imaginal development. The survival and developmental times were recorded at 15, 20, 25, 30, and 34±1°C constant temperature, RH=80±5% and photoperiod L:D=16:8. Eggs of *P. persimilis* (<2 hours old) were isolated in experimental units identical to experiments 1 and 2. Only eggs and adult females of *T. urticae* were supplied to avoid the presence of the prey exuviae. The developmental stage of the predators was recorded from two to four times per day. Moults were checked by recording the number of legs (6 for the larva and 8 for protonymph) or the presence of exuviae (protonymph-deutonymph and deutonymph-adult). The sex of all the first generation adults was determined. At the beginning of the experiment, the SI, NE, and NI strains were reared in the laboratory for ca. 23, 20, and 27 generations, respectively.

Statistical analysis. Analysis of variance, followed by Tuckey's test or Kruskall-Wallis' analysis was applied to compare the performances of the adult females and the developmental times; Mann-Whitney U test was applied to compare the developmental times between males and females. The percent data were compared by the Chi-square test. ANCOVA was applied to study the parallelism of the regression lines.

RESULTS

Experiment 1.

Longevity and oviposition. The biological parameters recorded and the comparison of performances are reported in figures I, II, III and in table 1. Figure I indicates a slower decline of female survival in strain SI when compared to strains NE and NI: at day 15, female survival was 53.3% for strain SI, 13.3% for NE, and 23.3% for NI. The daily oviposition is reported in figure II: SI showed an oviposition trend higher than the other two strains. Figure III shows the cumulative percent oviposition: the eggs production of the SI strain was distributed over a longer period: at the 5th day of life, the NE and NI females have just produced over 50% of the total eggs while SI females will exceed 50% only at the 8th day. A longer oviposition period corresponded, for the SI strain, to a longer longevity and a higher number of eggs laid per female (tab. 1): the SI strain was, therefore, characterised by an egg production larger and more extended in time. One SI female laid eggs for up to 19 days of adult life compared to a 16-days maximum for both NE and NI. The peak number of total eggs laid by one female was 95 for SI, 81 for NE, and 78 for NI. SI registered a number of eggs laid per day significantly higher than NE, whereas NI did not differ significantly from the other two strains. Although no significant differences were found in the percentage of egg-laying females, the SI strain showed a significantly higher longevity, oviposition period, and number of eggs laid per female compared to NE and NI (NE and NI did not differ significantly in these parameters). No differences among strains were found in the pre-oviposition period.

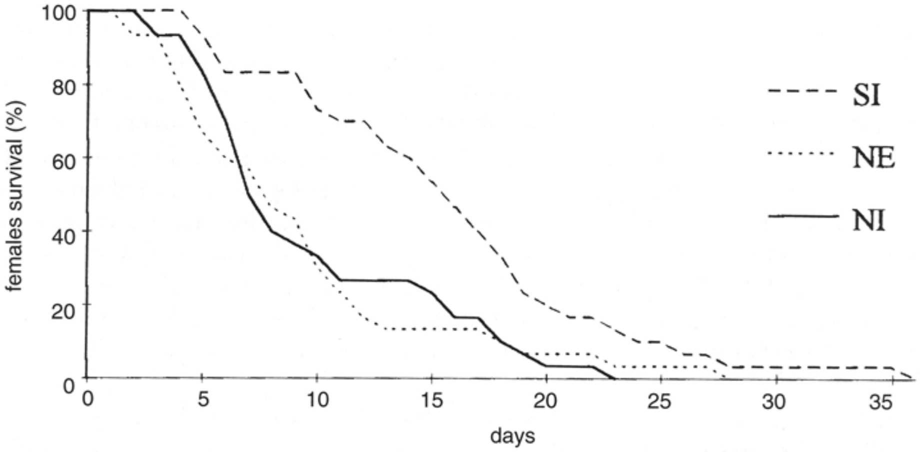

Figure I. Females survival of three *Phytoseiulus persimilis* strains in experiment 1.

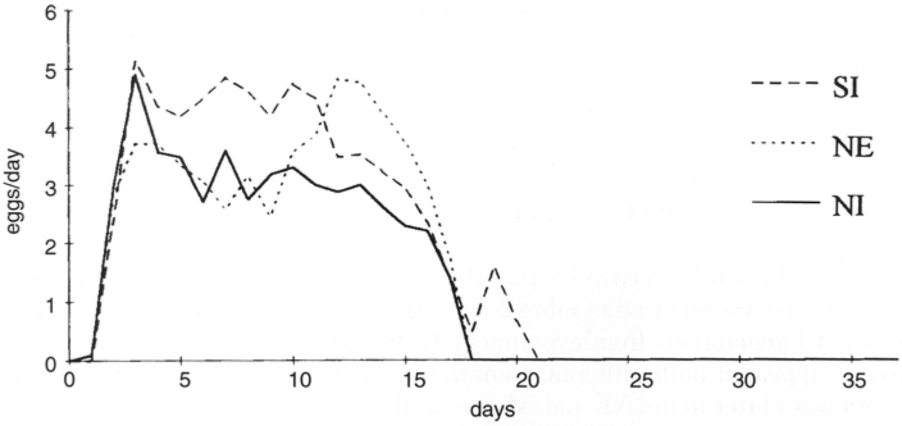

Figure II. Daily oviposition of three *Phytoseiulus persimilis* strains in experiment 1.

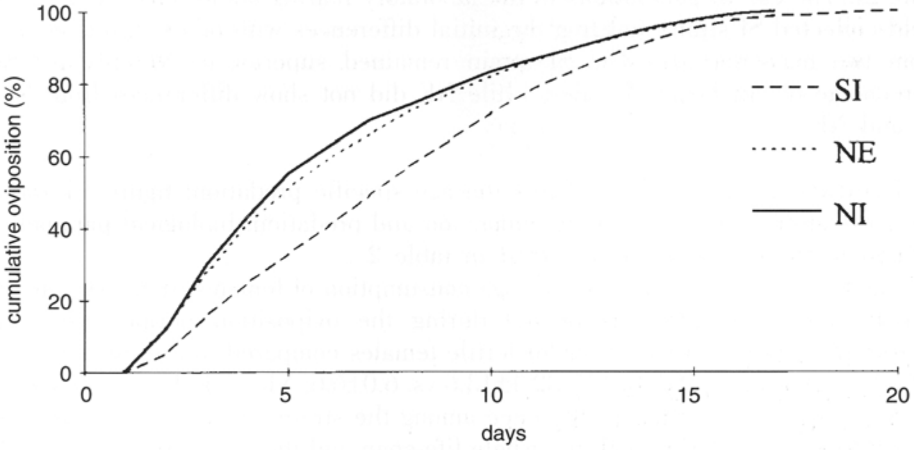

Figure III. Cumulative oviposition of three *Phytoseiulus persimilis* strains in experiment 1.

Table 1 - Experiment 1: biological parameters related to oviposition (means±sd) of three *Phytoseiulus persimilis* strains; different letters indicate significant differences ($p<0.05$).

Strain	SI	NE	NI
N. females tested	30	30	30
N. generations in the laboratory	4	1	8
Egg-laying females (%)	100 ^{a}	93.3 ^{a}	93.3 ^{a}
Longevity (d)	14.9 ± 7.1 ^{a}	8.3 ± 6.0 ^{b}	8.9 ± 5.4 ^{b}
Pre-oviposition period (d)	1.1 ± 0.4 ^{a}	1.1 ± 0.6 ^{a}	1.1 ± 0.6 ^{a}
Oviposition period (d)	11.1 ± 4.9 ^{a}	5.7 ± 4.6 ^{b}	6.4 ± 4.9 ^{b}
Total eggs laid / female	48.0 ± 24.8 ^{a}	22.3 ± 24.0 ^{b}	25.1 ± 21.7 ^{b}
Eggs laid / fertile female	48.0 ± 24.8 ^{a}	23.9 ± 24.1 ^{b}	27.0 ± 21.4 ^{b}
Eggs / day of life *	3.3 ± 1.0 ^{a}	2.2 ± 1.2 ^{b}	2.7 ± 1.3 ^{ab}
Eggs / day of oviposition*	4.2 ± 0.8 ^{a}	3.2 ± 1.3 ^{b}	3.8 ± 1.4 ^{ab}

* Only fertile females were considered.

Experiment 2.

Experiment 1 pointed out the SI strain superiority compared with NE and NI, concerning longevity and oviposition. After ca. 10 generations of laboratory rearing, experiment 2 was carried out to evaluate the female predation and the sex-ratio of the progeny, in addition to longevity and oviposition, following the procedures of the previous experiment. The biological parameters recorded in experiment 2 are reported in figures IV, V, VI, and VII and in tables 2 and 3.

Longevity and oviposition. Biological parameters related to longevity and oviposition are reported in table 2 and figure IV shows the survival of females. After ca. 10 generations from experiment 1, the age specific survival reported in figure IV appeared quite different from the previous one (fig. I): the trend of the SI strain was closer to the NE and NI ones and all of them showed a rapid decline after the peak. In experiment 1, higher performances of strain SI were recorded, but in experiment 2 this strain did not show either longer longevity and oviposition period or a higher number of eggs laid per female compared to the other strains (tab. 2). The ca. 10 generations in the laboratory rearing could have affected the field-collected SI strain, leveling the initial differences with other strains coming from two mass-rearings. The SI strain remained superior to NI only for the percentage of egg-laying females, while NE did not show differences from both SI and NE.

Predation. Figure V concerns the age specific predation; figure VI shows the correlation between the total oviposition and predation; biological parameters related to the predation are reported in table 2 .

Figure V shows the age specific egg consumption of females: in all strains the larger amount of eggs was preyed during the oviposition period and daily consumption of eggs was higher for fertile females compared to the infertile ones (SI=30.7±13.0 vs. 11.9±3.8; NE=32.4±13.6 vs. 6.0±6.6; NI=31.1±13.9 vs. 6.8±6.5).

There was no significant difference among the strains for the total number of eggs preyed, considering both the whole life-span and the oviposition period (tab. 2). The SI strain showed a significantly higher percentage of fertile females compared to NI. No significant difference resulted in the conversion ratio between the consumption of the prey eggs and the amount of eggs laid (only females that laid more than one egg were considered). The predation was positively correlated to the total oviposition (fig. VI) for each strain.

Sex-ratio of the progeny. The age of females was positively correlated with the percentage of females in the vital progeny; this correlation is significant for each *P. persimilis* strain (fig. VII). As reported in table 3, the SI strain showed a higher percentage of females in the vital progeny compared to NE (only females with vital progeny ≥10 were considered), whereas NI did not differ significantly from the other two strains. Nevertheless, no significant difference emerged either in the vital progeny per female or in the female progeny per female of the three strains.

Table 2 - Experiment 2: biological parameters related to oviposition and predation (means±sd) of three *Phytoseiulus persimilis* strains; different letters indicate significant differences ($p<0.05$).

Strain	SI	NE	NI
N. females tested	30	30	30
N. generations in the laboratory	14	11	18
Fertile females (%)	96.7 ^{a}	83.3 ^{ab}	76.6 ^{b}
Longevity (d)	11.8 ± 7.5 ^{a}	9.2 ± 6.2 ^{a}	9.8 ± 7.0 ^{a}
Pre-oviposition period (d)	1.0 ± 0.4 ^{a}	0.7 ± 0.5 ^{a}	1.4 ± 1.2 ^{a}
Oviposition period (d)	8.7 ± 5.5 ^{a}	6.9 ± 6.2 ^{a}	6.3 ± 6.5 ^{a}
Total eggs laid / female	32.8 ± 28.7 ^{a}	26.9 ± 28.5 ^{a}	21.5 ± 28.2 ^{a}
Eggs laid / fertile female	34.0 ± 28.5 ^{a}	32.3 ± 28.3 ^{a}	28.0 ± 30.8 ^{a}
Total eggs consumed / female	297.2±217.3 ^{a}	254.3±217.9 ^{a}	235.9±220.8 ^{a}
Eggs consumed during the oviposition period *	277.5±201.8 ^{a}	272.5±213.2 ^{a}	256.7±224.3 ^{a}
Females laying > 1 egg (%)	96.7 ^{a}	80.0 ^{b}	66.7 ^{c}
Eggs consumed / egg laid**	11.5±6.2 ^{a}	11.5±4.9 ^{a}	14.8±9.2 ^{a}
Eggs consumed in the oviposition period / egg laid**	9.8±3.9 ^{a}	9.7±4.0 ^{a}	11.4±4.6 ^{a}

* Only egg-laying females were considered.

** Only females that laid more than one egg were considered.

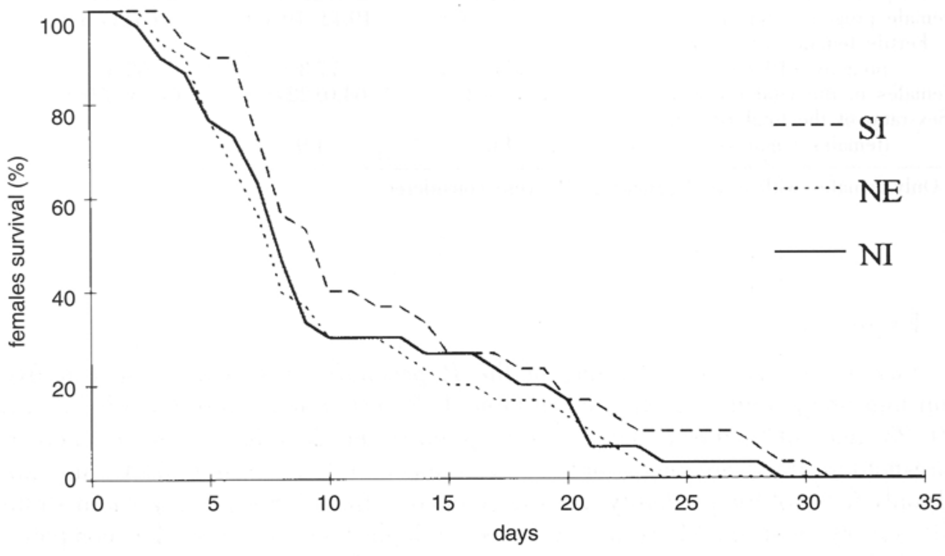

Figure IV. Age specific survival of the *Phytoseiulus persimilis* strains tested in experiment 2.

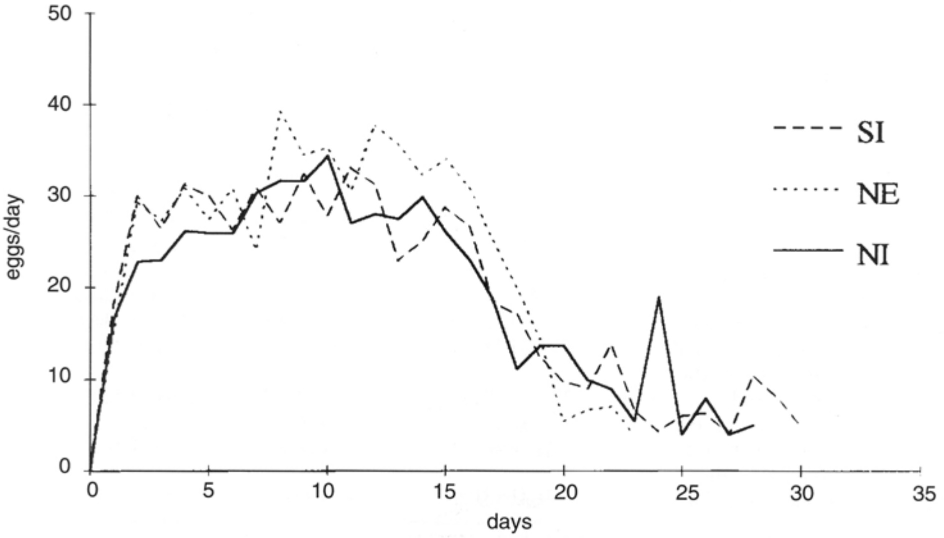

Figure V. Age specific predation, for the females of the *Phytoseiulus persimilis* strains tested in experiment 2.

Table 3 - Experiment 2: biological parameters (means±sd) related to sex-ratio of the vital progeny of the *Phytoseiulus persimilis* strains; different letters indicate significant differences.

Strain	SI	NE	NI
N. fertile females	25	22	24
N. generations in the laboratory	14	11	18
Vital progeny / fertile female	27.0±23.7 [a]	29.1±26.3 [a]	29.3±23.6 [a]
Female progeny / fertile female	22.1±21.3 [a]	19.1± 19.3 [a]	19.5±17.3 [a]
Fertile females with vital progeny ≥10 (%)	68.0 [a]	77.3 [a]	62.5 [a]
Females in the vital progeny (%)*	79.8±8.2 [a]	64.0±22.0 [b]	64.5±17.9 [ab]
Sex-ratio of the total progeny (females / males)	4.6	1.9	2.0

* Only females with a vital progeny ≥10 were considered.

Experiment 3.

Survival. The survival rate of the *P. persimilis* strains developed at five constant temperatures is reported in table 4. No differences were recorded at 15, 20, 25, and 30°C: the mortality was between 0 and 22.7%. The higher thermal threshold for the development of the strains appeared to be close to 34°C: in strain SI, only 6.3% of the predatory mites developed to the adult stage; 34.5% in strain NE and 0% in strain NI. Strain NE showed a higher resistance at 34°C compared to SI and NI, mainly due to the higher survival rate during the moults into deutonymph and adult.

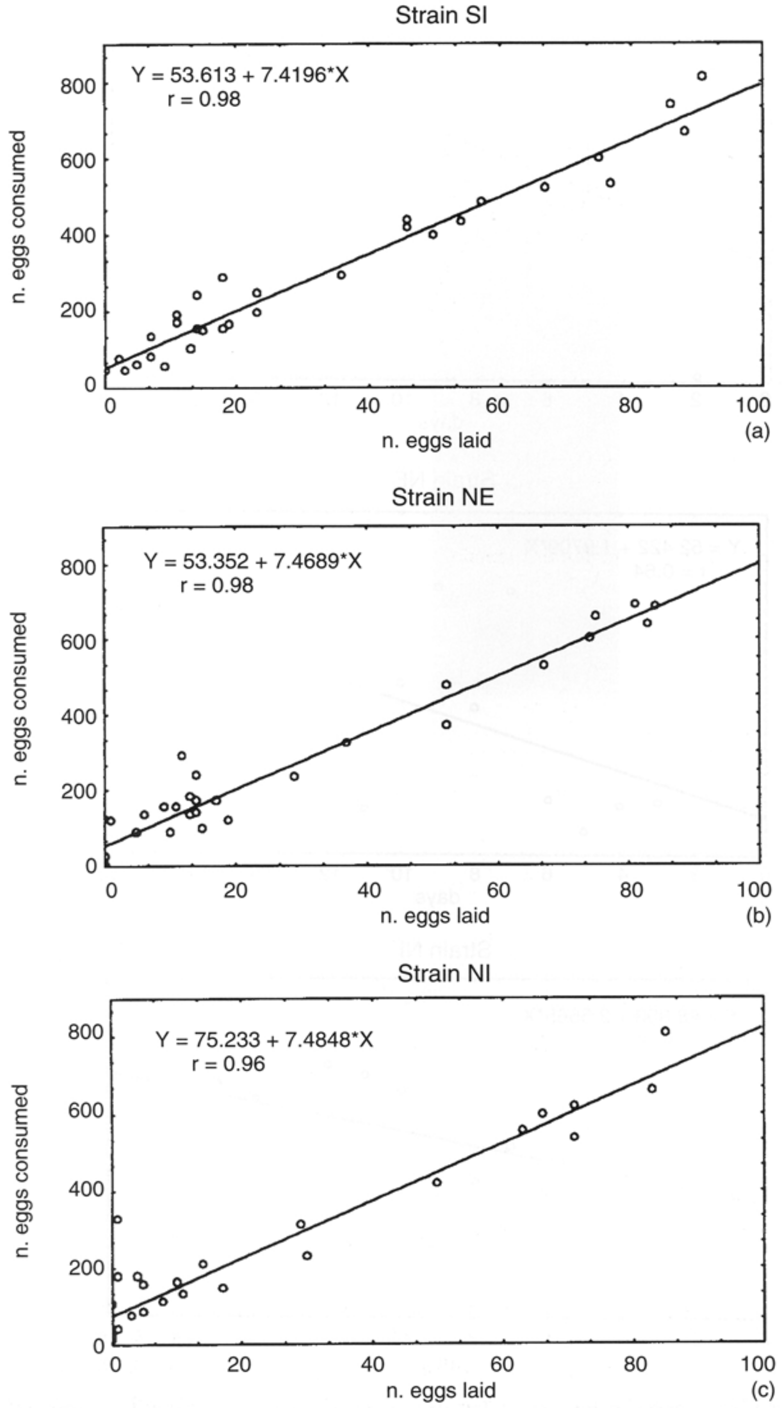

Figure VI. Correlation between the total oviposition and predation of females of the *Phytoseiulus persimilis* strains tested in experiment 2 ($p < 0.01$).

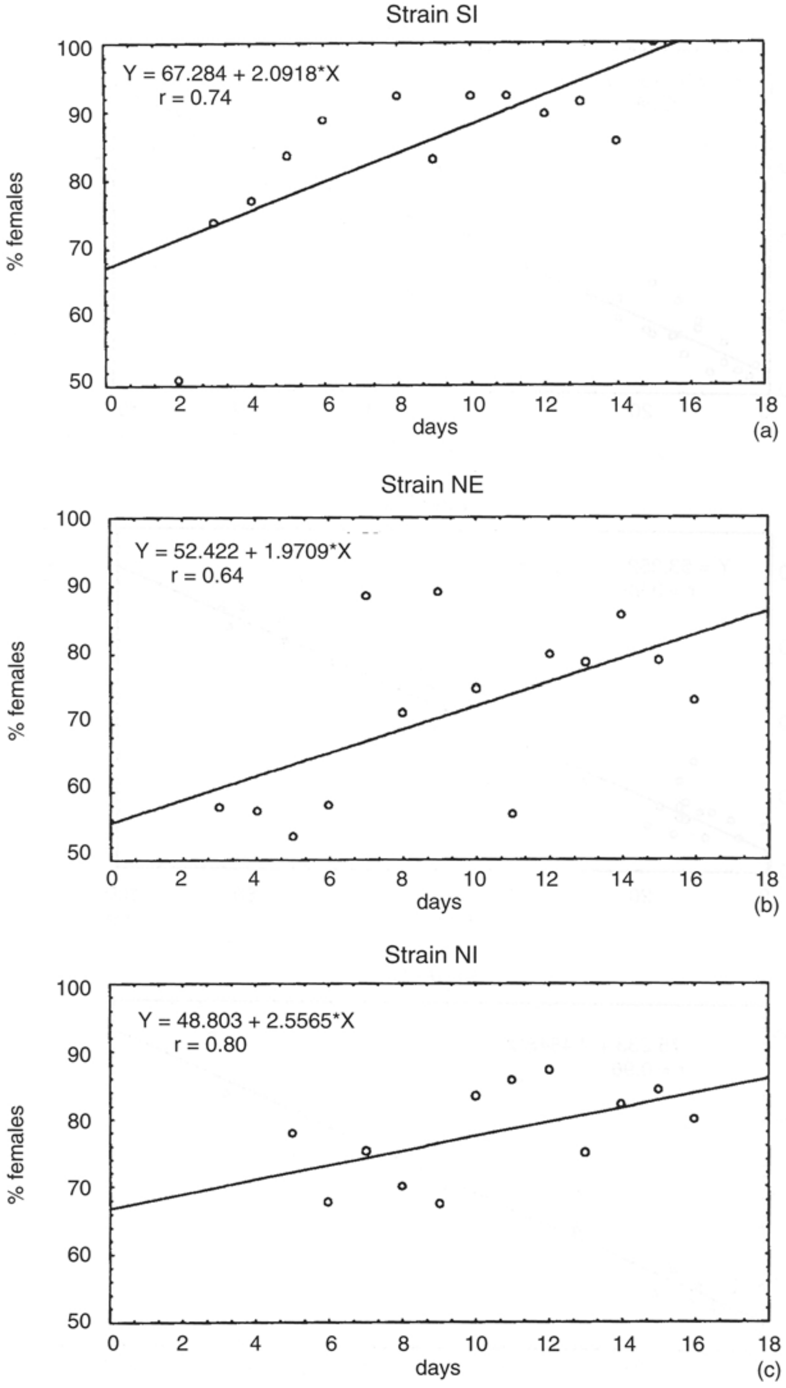

Figure VII. Correlation between the age of females of the *Phytoseiulus persimilis* strains and the percentage of females in the vital progeny ($p<0.01$) in experiment 2 (only females with a total progeny ≥ 10 were considered).

Development. The developmental times were reported considering the predatory mites surviving the previous stage without separating males and females because no significant difference was found between sexes in the total developmental times at the temperatures tested. Some differences were recorded among strains in the development at 20 and 30°C, with SI the slowest strain (tab. 5). The regression lines and the equations of the rate of total development (rate of development = 100 / developmental time in hours) are reported in figure VIII: the regression lines of strains NE and NI were parallel, contrary to SI.

Table 4 - Experiment 3: survival rate of the *Phytoseiulus persimilis* strains at five constant temperatures. Different letters indicate significant differences among strains, at each temperature (p<0.05).

temp. °C		N. eggs	Larva %	Protonymph %	Deutonymph %	Adult %	Total development n.	%	N. females	N. males
15	SI	24	100	95.8	100	100	23	95.8 ^{a}	13	10
	NE	24	100	100	95.8	100	23	95.8 ^{a}	5	18
	NI	20	95.0	100	94.7	100	18	90.0 ^{a}	9	9
20	SI	20	100	100	100	100	20	100 ^{a}	14	6
	NE	25	96.0	100	95.8	100	23	92.0 ^{a}	18	5
	NI	21	100	100	95.2	100	19	90.5 ^{a}	10	9
25	SI	18	94.4	100	100	100	17	94.4 ^{a}	11	6
	NE	20	95.0	100	100	100	19	95.0 ^{a}	9	10
	NI	16	87.5	100	100	100	14	87.5 ^{a}	8	6
30	SI	20	100	100	100	100	20	100 ^{a}	13	7
	NE	16	93.8	100	93.3	100	14	87.5 ^{a}	6	8
	NI	22	100	90.9	85.0	100	17	77.3 ^{a}	8	9
34	SI	16	75.0 ^{a}	91.6 ^{a}	27.23 ^{a}	33.3 ^{ab}	1	6.3 ^{a}	1	0
	NE	29	96.6 ^{a}	96.4 ^{a}	63.0 ^{b}	58.8 ^{a}	10	34.5 ^{b}	5	5
	NI	26	92.3 ^{a}	91.7 ^{a}	27.3 ^{a}	0 ^{b}	0	0 ^{a}	0	0

Table 5 - Experiment 3: developmental times (hours) of the *Phytoseiulus persimilis* strains at five constant temperatures. Different letters indicate significant differences among strains, at each temperature (p<0.05).

temp. °C		N. eggs	Egg	Larva	Protonymph	Deutonymph	Total n. adults	Development hours
15	SI	24	130.5 ± 11.8	40.3 ± 9.7	64.2 ± 12.5	60.2 ± 14.7	23	295.2 ± 15.7 ^{a}
	NE	24	133.3 ± 8.5	34.3 ± 10.7	59.3 ± 11.4	64.5 ± 10.6	23	291.5 ± 15.1 ^{a}
	CE	20	133.4 ± 12.4	39.4 ± 7.0	61.0 ± 9.3	64.7 ± 11.3	18	298.4 ± 23.2 ^{a}
20	SI	20	66.4 ± 7.1	21.7 ± 8.0	32.6 ± 7.4	36.6 ± 7.5	20	157.3 ± 5.7 ^{a}
	NE	25	63.2 ± 4.0	22.8 ± 4.9	28.6 ± 5.9	33.3 ± 8.3	23	148.5 ± 6.9 ^{b}
	CE	21	66.0 ± 5.3	16.2 ± 7.2	30.0 ± 5.7	29.1 ± 8.6	19	141.3 ± 6.6 ^{c}
25	SI	18	42.4 ± 4.3	16.6 ± 5.2	31.8 ± 13.2	18.6 ± 8.0	17	109.5 ± 14.5 ^{a}
	NE	20	44.3 ± 5.3	13.2 ± 4.9	29.9 ± 10.2	21.3 ± 11.0	19	108.9 ± 11.0 ^{a}
	CE	16	46.2 ± 4.9	13.2 ± 4.5	24.5 ± 10.7	24.2 ± 17.1	14	108.1 ± 13.1 ^{a}
30	SI	20	39.5 ± 0.5	14.0 ± 7.4	17.2 ± 6.9	22.5 ± 8.6	20	93.1 ± 10.4 ^{a}
	NE	16	37.5 ± 3.9	9.8 ± 2.3	12.9 ± 6.1	12.8 ± 5.2	14	72.8 ± 7.7 ^{b}
	CE	22	39.0 ± 2.0	9.1 ± 2.6	18.1 ± 4.9	13.8 ± 5.7	17	79.0 ± 3.7 ^{b}
34	SI	16	46.3 ± 12.5	16.0 ± 6.4	13.3 ± 5.0	33.0	1	89.0
	NE	29	33.6 ± 8.1	10.7 ± 2.7	18.3 ± 4.3	24.9 ± 11.2	10	89.0 ± 9.1
	CE	26	59.5 ± 23.0	14.3 ±5.1	19.3 ± 3.9	-	0	-

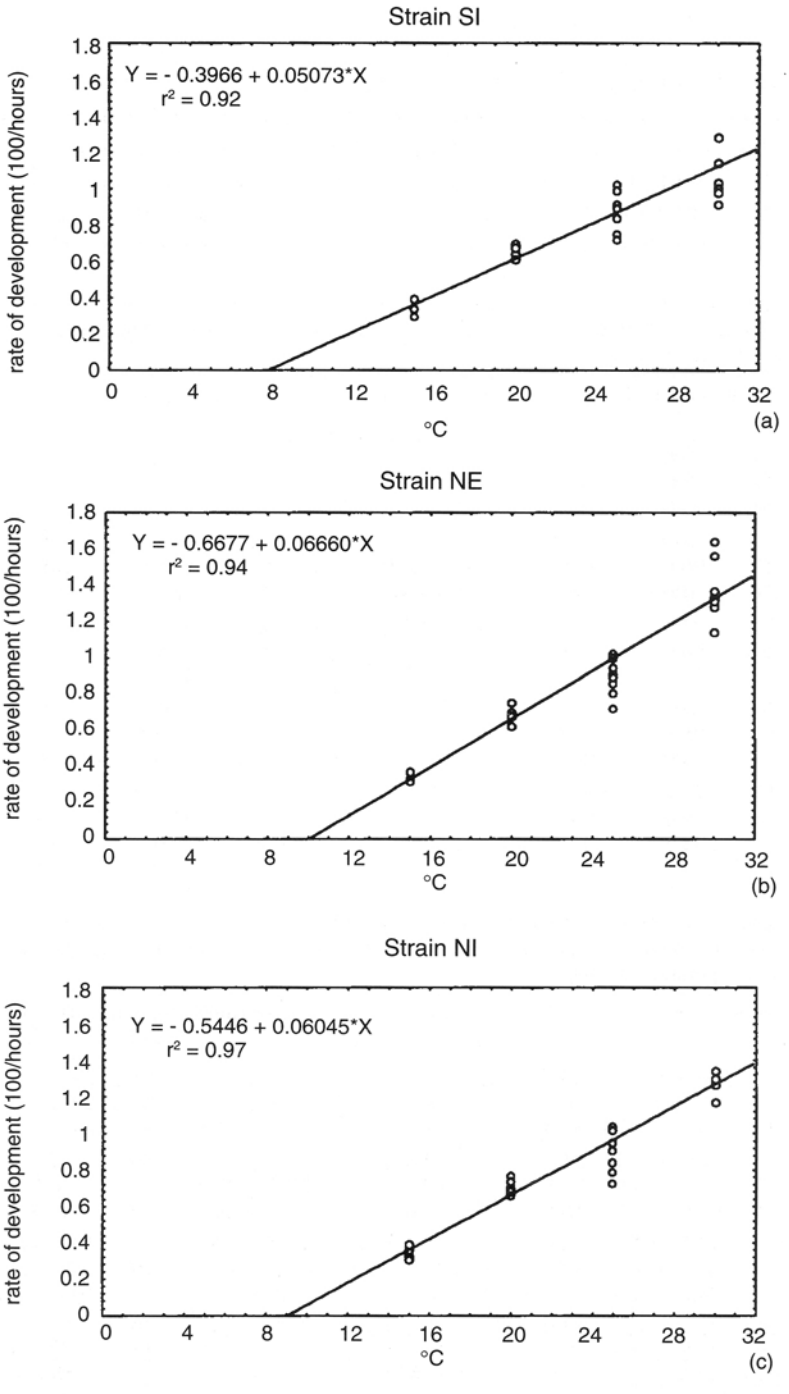

Fig. VIII. Regression lines ($P<0.01$) of the rate of development for the *Phytoseiulus persimilis* strains in experiment 3 (15, 20, 25, and 30±1°C; RH=80±5%; L:D=16:8).

CONCLUSIONS

After a few generations of laboratory rearing (experiment 1), the strain directly collected in the field in Sicily (SI) appeared more suitable for biological control by the inoculative seasonal release method, mainly due to the higher longevity and fecundity of females when compared to the two strains collected in different areas and mass-reared by two biofactories situated in northern Europe (NE) and in northern Italy (NI), respectively. As to the better performances of strain SI, three non-conflicting explanations may be advanced:

1. the strains are genetically different as a consequence of their different geographic origin, as reported by Moraes and McMurtry (1985) and Perring and Lackey (1989), concerning some biological parameters;
2. the relatively constant conditions of mass-rearings induce a selection pressure on the reared strains (as NE and NI), reducing their genetic variability, also due to probable bottle-necks occurring in some phases of the rearing procedures.
3. in some phases of the mass-rearing, very high densities of predators may promote some diseases caused by pathogen microrganisms, as suggested by Steiner (1993) for *P. persimilis* and other predatory mite species.

In experiment 2, carried out after ca.10 generations in the laboratory, all the strains showed analogous performances, with the longevity and fecundity of strain SI similar to the other strains. The only difference recorded was in the higher percentage of fertile females of strain SI compared to strain NI, although the number of female progeny per fertile female was not different. The laboratory rearing procedures, maintaining only small stocks of predators (500-1,000) at the same time, are probably responsible for the fast reduction of the SI fitness. The effect of the mass-rearing procedures, generally maintaining larger amounts of predators at the same time, could be less dramatic and will be discussed in a following publication (Galazzi and Nicoli, in press).

No significant difference among strains was recorded in the total number of preyed eggs and in the conversion ratio between the consumption of the *T. urticae* eggs and the amount of eggs laid by *P. persimilis*. Female predation was positively correlated with the oviposition activity in all strains.

Concerning the development at constant temperature (experiment 3, ca. 19 laboratory generations after experiment 1), no differences were recorded in the survival at 15, 20, 25 and 30°C (from 77.3 to 100%). Some differences were recorded among strains in the developmental time at 20 and 30°C with SI being the slowest one. The temperature of 34°C appears to be close to the higher thermal threshold for all strains, although a higher number of NE predators completed the development compared to SI and NI (34.5%, 6.3% and 0% survival, respectively).

The present study, following those of Moraes and McMurtry (1985) and Perring and Lackey (1989) confirms that significant differences may exist among *P. persimilis* strains, although it should be verified whether and to what extent the differences are due to geographic origin, to the rearing procedures and number of generations in the rearing facilities (both in commercial production and in the laboratory) or to eventual unknown diseases. Ongoing investigations on various *P.*

persimilis strains are designed to determine the effects of selection pressure induced by mass-rearing methods and to study the embryonic development in varying humidity regimes.

Acknowledgements

This publication is part of a research project supported by the European Union (ECLAIR Programme; Contract no. AGRE-CT91-0062).

The authors wish to express their gratitude to Prof. Vincenzo Vacante (University of Tuscia, Viterbo, Italy) for confirming the determination of *Phytoseiulus persimilis*, to Dr. Clive S.A. Stinson (Ciba-Bunting Co., GB), to Dr. Antonio Amore and Dr. Massimo Benuzzi (Biolab-Centrale Ortofrutticola, Italy) for supplying the tested *P. persimilis* strains and the relative information, to Fabrizio Santi, Marco Pozzati and Antonio Vaccari for their technical assistance.

SUMMARY

The biological activity of three *Phytoseiulus persimilis* strains of different origin was investigated in the laboratory. The SI strain was field-collected in Sicily (I), the NE was supplied by Ciba-Bunting BC Co. (GB) and the NI was field-collected in Italy (at Cesena, near to the Adriatic seaboard) and mass-reared by Biolab (I). Newly emerged pairs were isolated and maintained at 25±1°C, RH=80±5%, L:D=16:8 photoperiod and fed on its prey, *Tetranychus urticae* Koch (Acarina Tetranychidae). In experiment 1, carried out after a few generations in the laboratory, SI showed, compared to the other two strains, significantly higher longevity (SI=14.9±7.1; NE=8.3±6.0; NI=8.9±5.4 days; means±sd), oviposition period (SI=11.1±4.9; NE=5.7±4.6; NI=6.4±4.9 days) and total number of eggs laid (SI=48.0±24.8; NE=22.3±24.0; NI=25.1±21.7); moreover, SI registered a significantly higher number of eggs laid per day than NE. No significant difference was recorded in the pre-oviposition period or in the percentage of egg-laying females. Nevertheless, in experiment 2 (ca. 10 generations later), the differences in longevity and fecundity among strains were not confirmed. Moreover, no significant difference was recorded either concerning the consumption of the prey eggs or in the conversion ratio between preyed and laid eggs. A highly significant correlation was found between the number of eggs laid and number of prey eggs consumed, for all strains. The experiment 3 (ca. 19 generations after experiment 1) concerned the pre-imaginal development at 5 constant temperatures (15, 20, 25, 30, and 34±1°C). At 15, 20, 25, and 30±1°C, no significant difference was found in the survival (from 77.3 and 100%), but at 34°C the survival of the NE strain was higher than the other strains (SI=6.3%; NE=34.5%; NI=0%). At 20 and 30°C, differences were found in the developmental times, with the SI strain slower in the development. The possible reasons of the superiority of the SI strain in the experiment 1 were discussed, as well as the possible cause of the quick leveling in the differences after only ca. 10 generations in the laboratory rearing.

Studio comparativo di ceppi di *Phytoseiulus persimilis* Athias-Henriot (Acarina Phytoseiidae).
I. Sviluppo pre-immaginale e vita dell'adulto.

RIASSUNTO

È stata studiata in laboratorio l'attività biologica di tre ceppi di *Phytoseiulus persimilis* di diversa origine. Il ceppo SI è stato raccolto in campo in Sicilia (I), il ceppo NE è stato fornito da Ciba-Bunting BC Co. (GB) e il ceppo NI è stato raccolto in campo nel nord Italia (a Cesena, in prossimità della costa adriatica) e allevato da Biolab-Centrale Ortofrutticola (I). Coppie di adulti neo mutati sono state isolate e mantenute a 25±1°C, UR=80±5%, fotoperiodo L:D=16:8 e alimentate con la preda d'elezione, *Tetranychus urticae* Koch (Acarina Tetranychidae). Nell'esperimento 1, condotto dopo poche generazioni in laboratorio, SI ha mostrato una longevità superiore agli altri due ceppi (SI=14,9±7,1;

NE=8,3±6,0; NI=8,9±5,4 giorni; medie±ds), così come sono risultati superiori il periodo di ovideposizione (SI=11,1±4,9; NE=5,7±4,6; NI=6,4±4,9 giorni), il numero totale di uova deposte (SI=48,0±24,8; NE=22,3±24,0; NI=25,1±21,7); inoltre SI ha mostrato una maggiore ovideposizione giornaliera rispetto a NE. Non sono state invece registrate differenze significative nel periodo di pre-ovideposizione e nella percentuale di femmine ovideponenti. Tuttavia, nell'esperimento 2 (ca. 10 generazioni dopo), le differenze di longevità e ovideposizione tra gli stessi ceppi non sono state confermate. Inoltre non sono emerse differenze nè nel numero di uova di *T. urticae* predate nè nel tasso di conversione tra uova predate e deposte. Per tutti i ceppi è stata dimostrata una correlazione altamente significativa tra uova deposte e uova predate. Nell'esperimento 3 (ca. 19 generazioni dopo l'esperimento 1) è stato indagato lo sviluppo preimmaginale a 5 temperature costanti (15, 20, 25, 30 e 34±1°C). Non sono state rilevate differenze nella sopravvivenza a 15, 20, 25 e 30°C (sempre compresa tra 77,3 e 100%), mentre a 34°C è stata rilevata una sopravvivenza superiore per il ceppo NE (SI=6,3%; NE=34,5%; NI=0%). Differenze nei tempi di sviluppo sono emerse a 20 e 30°C, con valori più elevati per il ceppo SI. Sono state discusse le possibili cause della superiorità del ceppo SI rispetto agli altri due ceppi nell'esperimento 1 e le ragioni che possono aver causato il rapido appiattimento delle differenze dopo solo ca. 10 generazioni di allevamento in laboratorio.

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