Deladenus siricidicola, BEDDING (NEOTYLENCHIDAE) PARASITISM EVALUATION IN ADULT *Sirex noctilio*, FABRICIUS, 1793 (HYMENOPTERA: SIRICIDAE)[1]

FENILI, R.,[2] MENDES, C. J.,[3] MIQUELLUTI, D. J.,[4] MARIANO-DA-SILVA, S.,[5] XAVIER, Y.,[5] RIBAS, H. S.[5] and FURLAN, G.[5]

[1]Convênio Associação Catarinense de Reflorestadores, Centro Agroveterinário, Universidade do Estado de Santa Catarina, CAV/UDESC

[2]Centro Agroveterinário, CAV/UDESC, Av. Luiz de Camões, 2.090, CEP 88520-000, Lages, SC, Brazil

[3]PCC, Papel e Celulose Catarinense

[4]Estatística e Experimentação, Centro Agroveterinário, CAV/UDESC, Av. Luiz de Camões, 2.090, CEP 88520-000, Lages, SC, Brazil

[5]CAV/UDESC

Correspondence to: Samuel Mariano da Silva, Laboratório de Bioquímica, Departamento de Ciências Biológicas, Escola Superior de Agricultura "Luiz de Queiroz", USP, Avenida Pádua Dias, 11, C.P. 09, CEP 13418-900, Piracicaba, SP, Brazil, e-mail: smgsilva@carpa.ciagri.usp.br

Received November 22, 1999 – Accepted January 5, 2000 – Distributed November 30, 2000

ABSTRACT

This work aimed to evaluate the *Deladenus siricidicola,* Bedding (Neotylenchidae) parasitism in adults *Sirex noctilio,* Fabricius, 1793 (Hymenoptera: Siricidae). Timber was sampled by cutting out pieces of 0.80 m in length in *Sirex noctilio* attacked and *Deladenus siricidicola* inoculated *Pinus taeda*. Longs were 15-20 cm in diameter, according to the tree age. Samples were packed in gauze-cages, for daily observations, till *S. noctilio* adults emergence. The emerged insects were transported, in plastic containers to the laboratory, where they were sectioned and dissected under stereoscopic microscopy to observ the nematode occurrence. From the initially proposed ten units, nine of them were evaluated in a total of 1,810 emerged adult insects, being 1,441 males and 369 females. Nematode parasitism was shown in 267 males and 74 females, in a total of 341 infected insects (18.84%).

Key words: *Sirex noctilio*, *Deladenus siricidicola*, parasitism, biological control.

RESUMO

Avaliação do parasitismo de *Deladenus siricidicola,* Bedding (Neotylenchidae) em *Sirex noctilio,* Fabricius, 1793 (Hymenoptera: Siricidae) adultos

O objetivo do presente trabalho foi avaliar o parasitismo do nematóide *Deladenus siricidicola,* Bedding (Neotylenchidae) em adultos de *Sirex noctilio,* Fabricius, 1793 (Hymenoptera: Siricidae). Foram utilizados toretes de 0,80 cm de comprimento, retirados do terço médio de árvores de *Pinus taeda* atacadas por *Sirex noctilio* e inoculadas com *Deladenus siricidicola*. Os toretes possuíam diâmetro entre 15-20 cm, de acordo com a idade das árvores. As amostras foram acondicionadas em gaiolas ou tonéis vedados com tela de nylon e seguros por cintas de borracha, permanecendo em observação diária até a emergência dos insetos adultos. Os insetos foram trasportados em recipientes plásticos para o laboratório, onde foram seccionados e dissecados sob microscópio estereoscópico, para a verificação da ocorrência ou não do nematóide. Foram avaliadas nove das dez unidades inicialmente propostas. Nestas, foram analisados 1.810 insetos adultos, sendo 1.441 machos e 369 fêmeas. O parasitismo pelo nematóide foi verificado em 267 machos e 74 fêmeas, em um total de 341 insetos parasitados, com uma porcentagem de parasitismo de 18,84%.

Palavras-chave: *Sirex noctilio*, *Deladenus siricidicola*, parasitismo, controle biológico.

INTRODUCTION

The woodwasp *Sirex noctilio*, Fabricius, 1793 (Hymenoptera: Siricidae) is native insect in southern Europe, the Near East and North Africa, where it attacks and breeds in the holes of weakened and dying pines. It is not considered as pest in its native habitat. During the early 1900's, *S. noctilio* was detected in New Zealand in imported pine logs from Europe (Cielsa, 1992).

By the end of the Second World War, *S. noctilio* was causing an extensive mortality in New Zealand exotic conifer plantations. Infestations were firstly detected in Tasmania in 1952 and in the Australian Mainland in 1961 (Cielsa, 1992; Eldridge & Taylor, 1989; Taylor, 1981; Zondag & Nuttall, 1977).

More recently, *S. noctilio* was found in South America. Infestations are now known to occur in Argentina, Uruguay, Chile and Brazil, where *Pinus taeda*, a pine tree native to the Southeastern United States, is the principle species affected (Cielsa, 1992). Infestations were detected in Uruguay in 1980. By 1990, plantations of *P. taeda*, *P. elliottii* and *P. pinaster* throughout the country had suffered damage (Rebuffo, 1990). In Brazil, its presence was detected in 1988, attacking *P. taeda* plantations, inicially in Rio Grande do Sul (Iede *et al*., 1988) and later in Santa Catarina (Mendes, 1992).

Sirex wasp attack causes stress and it kills trees by the injection of phytotoxic mucus and spores of the symbiotic pathogenic basidiomycete *Amylostereum areolatum* (Fries) Boidin (commonly known as the sirex fungus) into outer sapwood during ovoposition. This pathogen desiccates the wood, causes white rot, and it is also a source of nutrients for the wasp larvae. Additional degradation in the wood occurs by the larvae tunneling activity and by an attack of secondary decaying fungi which enter via flight holes. In a year the wood will loose its commercial value (Diodato, 1995; Kille *et al*., 1974; Neumann *et al*., 1987).

Its control began in Australia when the nematode *Deladenus siricidicola*, Bedding (Neotylenchidae) and other parasites were introduced (Nuttall, 1980a). *D. siricidicola* nematode, according to the National Sirex Control Strategy in Australia (NSCS, 1991), is known to be the most important parasite for its biological characteristics and by laboratory multiplication facility. The nematode is artificially inoculated in the cuter sapwood of sirex-infested trap trees and significantly suppresses the fecundity of females without impairing their general sexual vigor and competitiveness. The parasitoid can also kill early wasp larvae (Neumann *et al*., 1987; Nuttall, 1980b).

D. siricidicola use and its field artificial inoculation, depends on its parasitism degree (NSCS, 1991) emphasized by the key factors: freeing effectiveness evaluation to its establishment; specific village evaluation to dispersion determination; recommendation to evaluation in adult insects, males and females. The Fundo Nacional de Controle da Vespa-da-madeira (Funcema, 1993) recommendation in Brazil is that in villages where the parasitism level detected is higher than 30%, artificial inoculations should not be made in the following years, and maintaining the forest monitoring.

This work aimed to evaluate the *D. siricidicola* parasitism in adult *S. noctilio*.

MATERIAL AND METHODS

Timber was sampled by cutting out pieces with 0.80 m length, in the tree medium third part (Haugen, 1991), in *S. noctilio* attacked and *D. siricidicola* inoculated trees. Logs were 15-20 cm in diameter, according to the tree age.

Logs were collected in ten geographic units in Santa Catarina State, Brazil, shown in Table 1. In each unit it was sampled four reforestation, removed four trees per reforestation and three logs per tree, to have 480 logs in total. Material was sampled during November of 1995 and February of 1996.

Samples were taken to the Centro de Ciências Agroveterinárias – CAV/UDESC, where some of them were stored in 1.00 × 1.20 m gauze cages and the others in 200 L casks covered with nylon gauzes fixed by elastic rubber girdles.

Daily observation were carried out till adults emergency. The insects were transported in plastic containers to the laboratory, where they were sectioned and dissected under stereoscopic microscopy (40x magnification) to observe nematode occurrence, according to NSCS (1991) and Mendes (1992) methodology. A parasitism value of 30% was used as an efficiency referential (Funcema, 1993).

TABLE 1
Geographic units of material collect.

Unit 01	Irani region municipalities
Unit 02	Campos Novos region municipalities
Unit 03	Campo Belo do Sul, Anita Garibaldi and Lages (Paequerê and BR 116 region)
Unit 04	Correia Pinto, São José do Cerrito and Lages (sede region) region municipalities
Unit 05	São Joaquim and Bom Jardim da Serra municipalities
Unit 06	Bom Retiro (Santa Clara region) and Urubici municipalities
Unit 07	Alfredo Wagner, Imbuia, Leoberto Leal and Bom Retiro (Barbaquá region) municipalities
Unit 08	Otacílio Costa (Fundo do Campo region) and Lages (Bocaina) municipalities
Unit 09	Otacílio Costa and Ponte Alta municipalities
Unit 10	Santa Cecília region municipalities

Results for proportions were statistically analyzed by the Z-test, comparing the region total parasitism percentage per sex to the 30% standard value. Variance analysis was used to analyze the variable infestation for each reforestation region and insect sex following a casual ship delineation in hierarchic model, witch 12 repetitions. Treatment variation stabilization was made according the square root arcsin transformation (Bishop, 1966; Snedecor & Cochran, 1967).

RESULTS AND DISCUSSION

From the initially proposed ten units, nine of them were evaluated in a total of 1,810 emerged adult insects, being 1,441 males and 369 females. Nematode parasitism was shown in 267 males and 74 females, in a total of 341 infected insects (18,84%).

The total parasitism (males and females) and percentage per unit are shown in Table 2.

The low emergence number shown for each unit might be due to the sampling period and the transference to CAV, when many of adult insects were already emerged.

The results obtained in U2, U4, U8 and U10 should be carefully considered due to the low number of observed insects. The resultant rates in U3, U5, U6, U7 and U9 were satisfactory, considering parasitism percentage rates observed in other regions (Mendes, 1992). According to the literature, the nematode applications should be continued, since the parasitism rate was lower then 30%.

After result statistics analysis, was confirmed that in U2, U4, U6 and U10 the parasitism rate was higher then 30% ($p > 0.05$) for both sex. In U3, U5 e U9 it was low then 30% ($p > 0.05$) for both sex. In U7 and U8 it was higher then 30% ($p > 0.05$) for females and lower then 30% ($p > 0.05$) for males.

The observed variation might be the result from stored nematode viability from its production until its field inoculation, the gelatin preparation (used as inoculation vehicle), application mode (application hammer), nematode migration ability in tree, the infection losing of the nematode strain, and climate conditions, as temperature during inoculation.

The averages of nematode parasitism percentages, in *S. noctilio* males and females, in different units and reforestation places, considering all the analyzed repetitions (with or without adult emergence) are shown in Table 3.

The results showed no differences among reforestation averages in U3 and U5. The reforestation with greater parasitism level were P1, P2 and P3. In U6, P3 it was shown the higher parasitism rates. In U7 were P2 and P4, whereas in U9 the greater parasitism rate was P1. Analysis of region averages showed higher parasitism rate in U5, U6 and U7, whereas smaller rates were observed in U3 and U9. Perhaps the same factors above listed influenced this variation.

TABLE 2

Collection realized in November-February (emerged adults and parasitism percentage).

Unity	Adult	M	F	Parasitism		%		Total
	Total			M	F	M	F	Parasitism (%)
U1	1	1	0	0	0	0	0	0
U2	10	5	5	2	2	40.00	40.00	40.00
U3	139	118	21	11	0	09.32	0	7.91
U4	34	21	13	6	2	28.57	15.38	23.53
U5	1,103	942	161	163	30	17.30	18.43	17.49
U6	159	121	38	45	10	37.19	16.31	34.60
U7	212	130	82	25	20	19.23	24.39	21.23
U8	21	16	5	0	4	0	80.00	19.05
U9	112	74	38	11	5	14.86	13.15	14.28
U10	20	14	6	4	1	28.57	16.66	25.00

M = males; F = females.

TABLE 3

Averages of nematode parasitism percentage in *S. noctilio* in units and reforestation places.

	U3	U5	U6	U7	U9
P1	4.98a	25.23a	8.44b	3.04b	16.68a
P2	5.87a	4.60b	1.00b	22.64a	1.00b
P3	1.00a	14.03ab	22.28a	1.00b	–
P4	–	16.84ab	5.26b	16.31a	–
Means	3.95C	15.18A	9.24AB	10.75AB	8.84BC
Coefficient of variation					42.89%

U = unit; P = reforestation place.

Sampling period should be during August and September, for a standard emerged adult collection, avoiding the samples where a great number of adult emergence occurred. In units with low parasitism, it is suggested to review the operation proceedings, meaning the identification of causes and the collection training.

REFERENCES

BISHOP, O. N., 1966, *Statistics for biology*. Boston, Houghton Mifflin Company, 182p.

CIELSA, W. M., 1992, Recent introductions of forest insects and their effects: a worldwide overview. *In*: Conferência Regional da Vespa-da-Madeira *Sirex noctilio* na América do Sul, 1, Vol. I, Florianópolis, 1992. *Anais*. EMBRAPA\CNPFlorestas\FAO-ONU\USFA-Forest Service/FUNCEMA, Florianópolis, pp. 09-21.

DIODATO, M. A., 1995, Controle da vespa-da-madeira. *Ciência Hoje*, *19*(113): 21-24.

ELDRIDGE, R. H. & TAYLOR, E. E., 1989, *Sirex woodwasp: a pest of pine in N.S.W.* Forest Protection Series n. 1. Wood Technology and forest Research Division, Forest Commission of New South Wales, Beecoft, Australia, 5p.

FUNCEMA – Fundo Nacional de combate à vespa-da-madeira, 1993, Reunião Funcema, Comissão Técnica, Avaliação do Programa Nacional e Novos Projetos. Lages, SC, 4p.

HAUGEN, D. A., 1991, Woodship sampling for the nematode *Deladenus siricidicola* and the relationship with the percentage or *Sirex noctilio* infected. *Australian Forest Research, 54*(1/2): 03-08.

IEDE, E. T., PENTEADO, S. R. C. & BISOL, J. C., 1988, *Primeiro registro de ataque de Sirex noctilio em Pinus taeda no Brasil.* Circular Técnica 20. EMBRAPA-CNPF, Colombo, PR, 12p.

KILLE, G. A., BOWLING, P. J., DOLEZAL, J. E. & BIRD, T., 1974, The reaction of *Pinus radiata* twinges to the mucous of *Sirex noctilio* in relation to *Sirex* attack. *Australian Forest Research,* 6(3): 25-34.

MENDES, C. J., 1992, *Manual de controle da vespa-da-madeira*. Associação Catarinense dos Reflorestadores, Florianópolis, SC, 23p.

NSCS – National Sirex Control Strategy, 1991, Operations Worksheets Committee, n. 6. Worksheet, NSCS, 25p.

NEUMANN, F. G., MOREY, J. L. & McKIMM, R. J., 1987, *The Sirex wasp in Victoria*. Bulletin 29. Department of Conservation Forests and Lands, Melbourne, Australia, 41p.

NUTTALL, M. J., 1980a, Insects parasites of *Sirex* (Hymenoptera: Ichneumonidae, Ibaliidae and Orussidae). *Forest and timber insects in New Zealand,* n. 47. Forest Research Institute, Rotorua, New Zealand, 11p.

NUTTALL, M. J., 1980b, *Deladenus siricidicola,* Bedding (Nematoda: Neotylenchidae) nematode parasite of *Sirex*. *Forest and timber insects in New Zealand,* n. 48. Forest Research Institute, Rotorua, New Zealand, 9p.

REBUFFO, S., 1990, *La aviespa de la madera Sirix noctilio en el Uruguay*. Ministerio de Ganaderia, Agricultura y Pesca, Dirección Florestal, República Oriental del Uruguay, 17p.

SNEDECOR, G. W. & COCHRAN, W. G., 1967, *Statistical methods,* 6ª ed., The Iowa State University Press, Iowa, USA, 593p.

TAYLOR, K. L., 1981, The *Sirex* woodwasp: ecology in control of an introduced forest insect. *In*: R. Kitching, & R. Jones (eds.), *The ecological of pests some Australian cases histories.* Melbourne, CSIRO. Chapter 12, pp. 231-248.

ZONDAG, R. & NUTTALL, M. J., 1977, *Sirex noctilio,* Fabricius (Hymenoptera, Siricidae). *Forest and timber insects in New Zealand,* n. 20. Forest Research Institute, Rotorua, New Zealand, 7p.