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SEASONAL SOIL VERTICAL DISTRIBUTION OF *SCHIZOCHELUS SERRATUS* PHIL. (COLEOPTERA, SCARABAEIDAE)

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ABSTRACT

A field experiment was carried out to study the vertical soil distribution of pre imaginal stages of the white grub *Schizochelus serratus.* This species was found deeper into the soil latter in spring and early summer, when the insect was predominantly in the first and second instar larvae. In winter it was found in the upper soil layers. Non feeding third instar larvae and pupae were found deeper than feeding third instar larvae. The possible reasons of the differences on the vertical distribution of *S. serratus* were analyzed.
Key words: *Schizochelus serratus*, Scarabaeidae, soil vertical distribution.

RESUMEN

Se realizó una investigación de campo para estudiar la distribución vertical en el suelo de los estados preimaginales del escarabaeido *S. serratus.* Esta especie fue encontrada más profunda en el suelo en primavera y temprano en el verano, cuando los individuos estaban fundamentalmente en el primer y segundo estadio larval. En invierno las larvas fueron encontradas en las capas superiores del suelo. Formas larvales áfagas y pupas fueron encontradas más profundas en el suelo que larvas de tercer estadio que se encontraban alimentando activamente. Las razones que explicarían la distribución vertical de los distintos estadios preimaginales de *S. serratus,* fueron analizadas.
Palabras clave: *Schizochelus serratus*, Scarabaeidae, distribución vertical.

INTRODUCTION

Studies of vertical and seasonal distribution of soil insects have shown, that they migrate to different soil depths during the year. This behaviour has been found in different insect orders (Cohen,1941; Pinto,1970; Usher,1975; Nadvornyj, 1983, Riis and Esbejerg, 1998) and apparently occurs widely among soil insects. According to Nadvornyj (1971,1983) there are many abiotic and biotic factors that influence vertical migration in the soil such as: soil humidity, soil temperature, soil acidity, soil density, insect stage, moulting and density.

Scarabaeid pre imaginal forms tend to move to the upper layers of soil when feeding, however after completed their feeding phase they moved down to seek pupation sites (East and Pottinger, 1975). In species of other families the vertical distribution of larvae and pupae follow similar pattern. (Hanula, 1993). Physical components of the soil also can affect the vertical distribution of scarab grub species, showing some of them upward movements in response to an increasing soil moisture (East and Pottinger, 1985; Villani and Wright, 1990), on the other and temperature fluctuations had very little impact on the position of some european scarab grubs (Villani and Wright, 1990).

Together with scientific reasons, to know the vertical seasonal soil distribution of an insect could be extremely useful, to implement different

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strategies of control in univoltine or bivoltine species, such as rolling, cultivation, biological or chemical, which have indicated by Steward and Van Toor, (1983); Steward, (1986); Steward *et al.* (1988); Hanula, (1993) and Atkinson and Slay (1994).

This paper reports a field study of the vertical distribution in the soil of *S. serratus*, through out a year.

MATERIALS AND METHODS

The study was conducted at a private farm near Puerto Varas (41° 20' S; 72° 57'W), the site consisted in a pasture in which the dominant plant species were perennial ryegrass (*Lolium perenne* L.) and white clover (*Trifolium repens* L.).

The climatic characteristics of the area during the experimental period were obtained from the Puerto Montt metereological station situated 10km south from the sampled area. The climate of the sampled site is mild and wet, with a mean annual temperature of 11.1° C. The warmest month being February and the coldest, July. The rainfall averages 1996mm, autumn and winter with higher precipitation on average than spring and summer months (Fig. 1). Soil corresponded to Hapludand (Serie Puerto Octay) with 23%organic matter (Mella & Kuhne, 1985)

Soil samples 20x20x20cm in number from 5 to 15 were taken every thirty days from December 1986 until February 1988, at 2 cm layers to the depth of 20 cm.Occasionally during (November and December) the field study samples were taken until 50cm of soil depth, founding larvae only in the first 20cm. The soil from the samples was crumbled and examined thoroughly in the field. The depth at which the specimens were found, was measured with a 0.1cm graduated ruler.

The identification of the different larval instars and pupae of *S. serratus* was done according to Cisternas (1986).

RESULTS AND DISCUSSION

The vertical and seasonal distribution of *S. serratus* is shown in Fig 1 and Table 1. Larvae occurred relatively deep in the soil profile late in spring (November and December) and early summer (January and February), from that period onwards there was a continuous upward movement until the middle of winter (June-July), when there was a change in its behaviour and larvae moved deeper into the soil.

The causes of this upward movement might be the result of the interaction of biotic and abiotic factors. A biotic factor could be related with a change of feeding requirements of sacarabaeid larvae in its development, since Richter (1958) indicated that phytophagous scarabaeid larvae consume principally organic matter during the first and second instar, on the other hand third instar larvae on the other hand consume largely roots and other buried plant material. This change in feeding habits

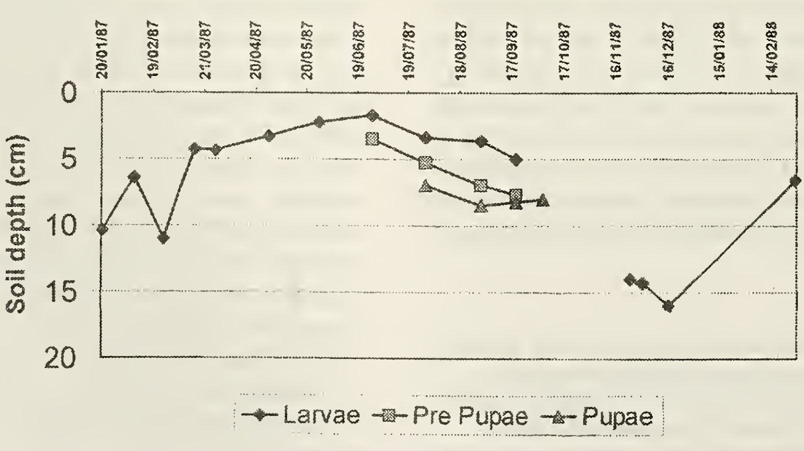

Figure 1. Soil vertical mean distribution of larvae, prepupae and pupae of *S. serratus*.

of scarabaeid larvae through its development, can partially explain the movement from deeper soil layers (10-17cm) in November to February (first and second instar larvae) to the top 5cm layer of soil latter on, where most roots occur in grazed pasture. Studies of the life cycle of *S. serratus* by Cisternas & Carrillo (1989), showed that from the middle of March (1987) and late February (1988) more than 65% of collected larvae were on third instar. The association between root feeding and upward movement in the soil has been reported in scarab larvae by East and Pottinger (1975). The downward movement that occured from the end of July, also should be related with changes in feeding habits of larvae, because in that month many larvae are completing the feeding phase of the third instar and as consequence its requirements for food decline at the end of this phase, then they should tend to move away from feeding resources.

An abiotic factor that possibly influences the upward movement of larvae is a change in the soil humidity. In the study precipitation and temperature (Fig. 2) showed variations through out the year, which produce changes in soil humidity which is higher in autumn and winter and lower in spring and summer. Villani and Wrigth (1990), have found that different species of white grubs moved upward after the addition of moisture in dry soils. Therefore species that are very sensitive even to small humidity variations should be able to occupy layers of soil only when moisture in such places is favourable for the insect, however this response of scarab larvae to water addition occurs only when the humidity of soil was low (East and Pottiger, 1975; Villani and Wright, 1990), situation that did not occurs during the trial. So it is improbable that soil humidity could be the explanation for the change on soil vertical distribution.

Results are showing that different physiological condition of the larvae, migth influence their vertical distribution. In this study the feeding third instar larvae consistently occupy the upper soil layers, than non feeding third instar larvae (pre pupae). (Table 1). This differences should be related with feeding requirements or is the result of searching for optimal conditions of the soil (eg. humidity) for rather non mobile stages. Futhermore pupae (non-mobile form), were found deeper than feeding and non feeding third instar larvae. However the behaviour of non feeding preimaginal forms of carabid species to select deeper soil, to create soil chambers could disengaging themselves from soil properties and then this kind of behaviour to moved down to seek pupation sites which has been reported in scarab larvae (East and Pottinger, 1975), but that is absent in another Coleoptera (Hanula,1993) could be an strategy of scarab non mobile forms living in pasture, to escape from predators living on the soil (eg. birds) (East and Pottinger, 1975).

The rather superficial distribution of the preimaginal stages of this species, could create favourable conditions for the application of cultural (rolling, tillage, etc) and biological measures (nematodes, birds, etc) for the control of *S. serratus.*

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Figure 2. The monthly mean temperature and raifall at Puerto Montt, from January 1987 to February 1988.

TABLE 1.

Soil vertical distribution of pre imaginal stages of *S. serratus*

Date	Mean vertical distribution pre imaginal stage ± DS (cm.)		
	Larvae	Pre pupae	Pupae
20 January 1987	10.4 ± 2.4		
08 February 1987	6.4 ± 0.7		
25 February 1987	11.0 ± 3.4		
15 March 1987	4.3 ± 0.5		
27 March 1987	4.4 ± 0.5		
27 April 1987	3.3 ± 0.5		
27 May 1987	2.2 ± 0.6		
27 June 1987	1.7 ± 0.2	3.5 ± 0.0	
28 July 1987	3.4 ± 0.5	5.3 ± 0.4	7.0 ± 0.0
29 August 1987	3.7 ± 0.5	7.0 ± 1.2	8.5 ± 1.5
19 September 1987	5.0 ± 0.0	7.7 ± 0.7	8.2 ± 1.0
04 October 1987			8.0 ± 0.0
24 November 1987	14.0 ± 2.0		
01 December 1987	14.3 ± 1.3		
16 December 1987	16.0 ± 0.5		
28 February 1988	6.6 ± 1.0		

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