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Biological aspects of the immature stages and seasonal cycle of *Halysidota ruscheweyhi* Dyar (Lepidoptera, Arctiidae) in the south of Uruguay

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The seasonal cycle and the biology of *Halysidota ruscheweyhi* Dyar in the south of Uruguay was studied through field and laboratory observations. This is an univoltine species, although a small percentage of the adults emerged in summer and they would eventually breed a second generation. It winters as pupae, and the adults fly in part of October and in November. The oviposition period lasts from four to five weeks. The eggs are laid on the lower surface of leaves in a number of parallel and contiguous lines. The number of eggs per oviposition varied from 62 to 227, with a mean de 151.5. The larvae emerge in November and they are polyphagous, living on different species of trees and herbaceous plants. They are gregarious during the first two instars. In December, starting from the fourth instar, a percentage of the larvae descend from the trees to live in the ground cover. In this situation, they complete their development in a way similar to that of the larvae that remain in the trees. The larvae went through seven or eight instars, the latter requiring a longer time than the former to pupate. The larvae that were fed on linden leaves (*Tilia moltkei*) showed a greater speed of development than those fed on elm leaves (*Ulmus procera*). In January, the larvae which remained in the trees come down to the ground cover to pupate. The pre-pupal period varied from 2 to 4 days, with a mean of 3.4 days. The pupa is in a cocoon which is located in the dead leaves or under stones or fallen tree trunks. The pupal phase lasted between nine and ten months. Three species of Vespidae and one of Pentatomidae were recognized as natural enemies of *H. ruscheweyhi*, and a second species of bug is mentioned as a probable predator on larvae.

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INTRODUCTIÓN

Among the arctiids fauna in Uruguay, *Halysidota ruscheweyhi* Dyar stands out because it is so widespread in the southern part of the country. Although the adults are little known because of their nocturnal habits, the larvae are common in parks and other areas with many trees. In spite of the fact that they are extremely abundant, the damage that the larvae cause is not extensive. The larvae are commonly known as "kittens", and they are easy to recognize because of their abundant pilosity and bright coloring. At a certain time of the year it is common to see them moving around in the ground cover or suspended in the air on a fine silk thread which hangs from the trees. They have polyphagous habits, they live on elm (*Ulmus* spp.), linden (*Tilia* spp.), white mulberry (*Morus alba*), European ash (*Fraxinus excelsior*), coral tree (*Erythrina crista-galli*), glossy privet (*Ligustrum lucidum*), elm-leaf zelkova (*Zelkova carpinifolia*), tala (*Celtis iguanaea*), weeping willow (*Salix babylonica*) and *Salix humboldtiana*. RIZZO and PUTRUELE (1983) cite other plants that are host to this species.

In the catalogues of Uruguayan Lepidoptera, BIEZANKO *et al.* (1957, 1974, 1978) did not report this arctiids in Uruguay although they did cite a number of species of *Halysidota*. Given that this is the most common species of its genus, it seems reasonable to suppose the fact that it was not included was not due to an oversight but rather to erroneous identification that came about because some of the species are similar to each other, and because there has been confusion in the last few years in the classification of the group. The genus *Halysidota* can be found across North, Central and South America. WATSON (1986) catalogued the neotropical species and he mentioned Argentina and Paraguay as the distribution area of *H. ruscheweyhi*. In spite of its being so common, knowledge about the biology of *H. ruscheweyhi* is scarce; it is limited to works by RIZZO (1981) and RIZZO and PUTRUELE (1983). The purpose of this study is to provide basic data about its life cycle, behavior and seasonal development in the southern part of Uruguay, so as to make a contribution to improving current knowledge about the bionomy of our main species of lepidoptera.

MATERIALS AND METHODS

Rearing in the laboratory: The eggs used in this study were collected in the field from elm and linden trees, and kept until the time of hatching in plastic boxes (18 x 14 x 4 cm) on absorbent paper. Once the larvae emerged, they were kept individually in plastic boxes 80 mm in diameter and 90 mm deep, with absorbent paper covering the floor. The larvae were fed on a diet of young elm (*Ulmus procera*) and linden (*Tilia moltkei*) leaves, which were changed every two or three days during the first four instars, and then daily until pupation. The larvae were observed at intervals of 24 hours to determine the number of instars and their duration. The size of the cephalic capsule was measured from the exuviae, except in the last instar when the larva itself was measured. The larvae pupate inside a cocoon, which is usually found adhering to the walls of the box or on linden or elm leaves. The length and width of the cocoons were measured, and in a series of 20 individuals the pupae were taken out of the cocoons so as to be measured as well. Both the pupae with cocoons and those without were transferred individually to absorbent paper in plastic boxes 65 mm in diameter. They remained under these conditions all winter until the adults emerged the following spring. Rearing were done at a temperature of 23±1 °C, at 70±10% humidity, and with a photoperiod of 16 h of light. To maintain relative humidity, closed glass boxes and a saturated solution of sodium chloride were used (WINSTON and BATES, 1960).

So as to study the behavior of the larvae in the first stages of development, elm and linden twigs with masses of eggs were taken and placed in a glass box with the lower end submerged in water. After a few days, when the leaves started to lose their natural turgidity, the larvae were transferred to a new twig which was set up in the same way. For a number of days, observations were made periodically (every 4 or 6 hours) on this material.

The dimensions of the different stages and the respective durations of the stages are expressed as an average of the observations (X) ± standard error (SE).

Field observation: Field observation was done in parks and rural areas on the outskirts of the city of Montevideo, where there is abundant vegetation suitable for the development of the species. The predominant kinds of trees in the areas of study were elm, ash, linden, eucalyptus, poplar and plane-trees, as well as various kinds of conifers. The observations were made in the period 2000-2003. In those years, *H. ruscheweyhi* were abundant in some areas (e.g. the agronomy faculty park) and this facilitated observation and the collection of data. Follow up in the breeding ground was done with observations every two days from the middle of Septem-

Fig. 1: Adult of *H. ruscheweyhi*

ber until March, on trees where the insect was present and in the ground cover in the areas of study. During the period when adults fly, pre-established sectors of the trees were carefully observed to determine the presence of egg masses Nine unhatched egg masses were marked and were monitored daily until the larvae dispersed. The periodic collection of larvae made it possible to follow the evolution of the populations and the period in which the larvae pupated. The age of the larvae population was calculated through measurement of the width of the cephalic capsule, although in the last few instars this could not be determined with absolute precision, as will be commented on below. The period when adults fly was estimated from direct observation, from captures in light traps, and from specimens reared in the laboratory.

RESULTS AND DISCUSSION

Seasonal cycle

In the south of Uruguay, *H. ruscheweyhi* is an univoltine species, although a small percentage of the population would eventually breed a second generation (Fig. 1). The period of flight of the adults was not determined with precision. However, in the areas studied, adults were observed in the last ten days of October and in November (Fig. 2), and some were captured in light traps during that period. The data on reared specimens agreed with field observations, since the emergence of adults in the laboratory was distributed between 14 October and 23 November. Outside the flight period, a few moths were captured at the end of February in 2001 and 2002. Between 3% and 5% of the pupae kept in the laboratory turned into adults at the end of February. RIZZO and PUTRUELE (1983) noted similar behavior for Castelar although in that case emergence took place at the end of January and the beginning of February. At that time, egg masses were also found in the field, and when they were brought to the laboratory they turned out to be non-viable. Some larvae were observed in the field in March and April, although it is not possible to say whether they managed to complete their development, or if the resultant pupae turned out to be viable.

In the month of October in 2001 and 2002 eggs were not found in the field. The first eggs were found in the first week of November, and the last at the end of that same month. From this it can be concluded that the oviposition period probably lasts 4 to 5 weeks. Similarly, the emergence of larvae occurred in November, since only in that month were larvae neonates found. At the start of December, an egg mass was observed on only one occasion, shortly after the eggs hatched. On the other hand, the larvae from 18 ovipostions that were kept in the laboratory at ambient temperature emerged between two and four days after they were collected in the field Given that some of the egg masses showed incipient embryonic development, it is reasonable to suppose that the hatching of the eggs under natural conditions would occur between five and seven days after oviposition. RIZZO and PUTRUELE (1983) reported that embryonic development lasted between 4 and 8 days, and the most common frequency was five days.

Larvae in the second instar were abundant at the end of November and the beginning of December. Larvae in the third and fourth instar were abundant in the middle of December, while the number larvae in the fifth and sixth instar peaked in the last week of that month. In January, the majority of the larvae were in the last instar, regardless of whether they had developed on trees or in the ground cover. The pupation period began at the end of December and lasted into January, mainly taking place in the second and third week of that month. Due to the fact that pupation is quite synchronized, the number of larvae decreased considerably at the beginning of the fourth week of January, and by the end of the month all had pupated. In the laboratory, similar data to those found in the field were obtained, with a pupation period which lasted from 6 to 18 January. The pupal phase continued until the spring, so its duration was between nine and ten months.

RIZZO and PUTRUELE (1983) concluded that in Castelar *H. ruscheweyhi* is univoltine, with a pupal phase lasting between 285 and 315 days. Other species of *Halysidota* are also univoltine. In North America, *Halysidota tesselaris* and *Halysidota harrisii* exhibit

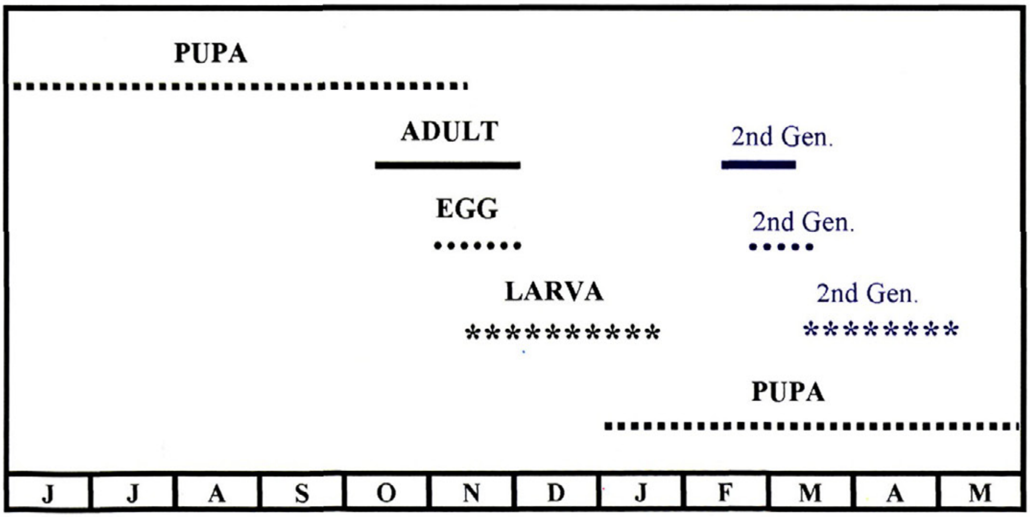

Fig. 2: Life cycle of *H. ruscheweyhi* in the south of Uruguay.

a season cycle with these characteristics, spending the winter in the pupal phase (ANDERSON, 1966 and BAKER, 1972).

Oviposition

H. ruscheweyhi laid its eggs on the foliage of host plants. In all cases studied, they were to be found on the lower surface of leaves. On trees with a wide leaf (e.g. linden) it is common to find them near one of the sides of the foliar lamina. The eggs are laid in a single stratum, in parallel contiguous lines, and they form a compact group. Due to the fact that they are not covered by the abdominal scales of the females they remain exposed. They are sub-spherical, and they measure 0.83±0.00 mm in diameter by 0.75±0.00 mm (n=22) in height. They are of a whitish color, and the chorion is smooth, translucent and brilliant. Some hours before hatching they get darker but they do not lose their characteristic shine. At that time, through the chorion it is possible to see the body of the larva already formed, with the cephalic capsule oriented towards the upper tip. The number of eggs per oviposition varied from 62 to 247 with a mean of 151.5±10.72 (n=21). At the end of embryonic development, the non-viable eggs are recognizable because their whitish coloring had not changed. The number of non-viable eggs in 18 egg masses collected varied from 0 to 14, with a mean of 3.2±1.00 eggs.

Larva

Under laboratory conditions the larvae from the same oviposition emerged simultaneously. In six ovipositions that were observed, the difference between the first and the last emergences varied from two hours forty minutes to three hours thirty minutes. The only time that the emergence of larvae in the field was observed they were also synchronized. On other occasions, the observation of egg masses in which the larvae had only recently emerged would, in the same way, indicate a simultaneous hatching of the eggs. The larvae leave the egg through an irregular orifice which they make in the chorion in the upper lateral position. The duration of the emergence period from the start of the orifice until the larva comes out of the egg varied between 29 and 39 minutes, with a mean of 34.5±1.07 (n=9). In the first two or three minutes after emergence, the larvae made a series of contorted movements, raising both ends of the body while remaining held fast to the substrate using two of the first three pairs of false legs. Straight away they feed on the remains of the chorion.

Larva neonates are 2.3±0.06 mm (n=20) in length. The general color of the body is grayish, and there are dark warts uniformly distributed on the thorax and abdomen, from which black setae come out. The cephalic capsule is black, and the prothoracic shield and thoracic legs are dark. On the second day, the body turns greenish, although the cephalic capsule, prothoracic shield and setae do not change color.

The larvae neonates remain grouped together, forming a single colony. As their first vegetal food they use the leaf which served as a substrate for oviposition. They gnaw at the foliar lamina on either the upper side or the lower without perforating it. Between the third and fifth day it was common for larvae to leave the initial leaf, and they sometimes sub-divided to form two to five groups which occupied different leaves. The colonies normally disperse during the third instar, although it was often possible to find larvae in the second instar that were alone. Under laboratory conditions they likewise remained in colonies until the third instar. RIZZO and PUTRUELE (1983) also reported gregarious behavior until the third instar.

While the larvae were grouped together the moults were synchronized, so all the individuals in the same colony moulted more or less at the same time. During the moulting processes the larvae remained immobile and did not feed for a number of hours, or even for a whole day. After the moult, the exuviae, including the abundant pilosity but not the cephalic capsule, were eaten.

Between the third and fifth instar it was common for the larvae to let themselves down from the trees by a silk thread. In this way the larvae went directly to the ground cover or established themselves on short plants (e.g. glossy privet and coral tree), where they can remain until they finish developing. In the field studies, descents from as high as about eight meters were recorded. When the larvae descend they make contorted movements with their bodies, and it is also common for them to interrupt the descent for a few moments before continuing on down. According to RIZZO and PUTRUELE (1983), once the larvae have come down from the trees they start to look for the same plant or another plant to go up again. Although this behavior was observed in our studies on a number of occasions, most of the larvae remained in the ground cover and did not go up into the trees again. Thus, while some larvae remain in the foliage of the trees until the end of their development, others come down prematurely and undergo a phase on the ground whose duration basically depends on the age they are when they descend. When the larvae are approaching pupation they reach the ground by letting themselves fall from the lower levels of the trees or by coming down the trunks. On no occasion they were observed lowering themselves down by a silk thread.

From the second week of December, a large number of larvae were to be found in the ground cover. On the ground, the main host plants that the larvae used were the red clover (*Trifolium pratense*) and the white clover (*Trifolium repens*); it was even possible to find as many as three or four larvae on the back of a single leaf. Larvae were also found feeding on kikuyu grass (*Pennisetum clandestinum*), although this was only observed on rare occasions. When they were collected from the ground and kept in the laboratory they showed a clear preference for clover rather than kikuyu grass, dallis grass (*Paspalum dilatatum*) or Bermuda grass (*Cynodon dactylon*). Clover was the only food on which they completed their development and pupated. The abundance of larvae which can be seen in the ground cover and their capacity for dispersion leads to suppose that they survive on a greater number of herbaceous plants, which is an aspect which ought to be studied in more detail. It was also not possible to determine the reasons why a percentage of the population of larvae come down from the trees prematurely only to return to them again, or simply remaining in the ground cover.

At its maximum development the larva is 33.3 ± 0.39 mm (n=20) in length (Fig. 3). It has a hypognate head and a cylindrical body with warts from which clumps of secondary setae come out. The cephalic capsule is a dark brown color with a whitish clypeus. The dorsal region of the body is dark, almost black, and the ventral area is grayish. The mesothorax and metathorax have orange markings on the back. The thoracic and abdominal legs are reddish. The spiracles have an elliptical shape and are white. The body is densely covered with black secondary setae, although some individuals have clumps of white setae, particularly on both sides of the abdomen. On the mesothorax and metathorax, and also on the last three abdominal segments, there are clumps of setae which are longer than the others and they are white, except for the pair of central setae of the mesothorax and metathorax, which are orangish yellow.

Under laboratory conditions, larval development was completed in seven or eight instars. Larvae with eight instars made up 41.3% of the total of larvae reared on elm and 48.3% of those reared on linden. Table 1 shows the width of the cephalic capsule for larvae with different numbers of moults. The width of the cephalic capsule was similar for both series in the first instars but differences were observed in the last instars, with lower values when there was one additional moult. The final size of the cephalic capsule was greater in larvae with eight instars than in larvae with seven. In the first five instars there is discontinuity in the size, even taking extreme values into consideration. However, in the last instars there is an overlap between larvae with different numbers of moults, which does not allow the age of the larvae to be known with certainty.

Fig. 3: Mature larva of *H. ruscheweyhi*

Females go through one instar more than males; the percentage of female larvae with eight instars was 62.5%, and only 31.3% had seven instars.

Table 2 shows the duration of the larval stage under laboratory conditions for larvae with different kinds of food and different kinds of development. The larvae fed on linden leaves showed faster development than those fed on elm leaves. Regardless of diet, mean development time was greater in larvae with eight instars than in larvae with seven instars. In both situations, the duration of the first five instars and of the last instar were similar. Consequently, differences in total duration can be explained basically by differences observed during the sixth instar of larvae with seven instars, and during the sixth and seventh instars of larvae with eight instars.

Table 1. **Mean width (mm) of the cephalic capsule for larvae of seven and eight instars of *H. ruscheweyhi* reared in the laboratory**

	Instar 7 (n=25)		Instar 8 (n=18)	
Instar	X±SE	Range	±SE	Range
I	0.50±0.00	0.49- 0.51	0.50±0.00	0.50- 0.51
II	0.76±0.00	0.72- 0.80	0.73±0.01	0.70- 0.77
III	1.21±0.01	1.12- 1.27	1.13±0.01	1.05- 1.20
IV	1.68±0.02	1.42- 1.82	1.59±0.02	1.42- 1.70
V	2.38±0.02	2.15- 2.52	2.16±0.03	1.95- 2.37
VI	3.19±0.03	2.80- 3.50	2.85±0.03	2.60- 3.10
VII	4.03±0.01	3.90- 4.12	3.50±0.04	3.20- 3.80
VIII	—	—	4.22±0.03	4.00- 4.40

Table 2. **Mean duration (days) for larvae of *H. ruscheweyhi* with seven or eight instars, reared under laboratory conditions with linden leaves (*Tilia moltkei*) and elm leaves (*Ulmus procera*)**

Instars	Linden (n=40)				Elm (n=38)			
	7 Instar		8 Instar		7 Instar		8 Instar	
	X±SE	Range	X±SE	Range	X±SE	Range	X±SE	Range
I	4.1±0.07	4-5	4.1±0.07	4-5	4.9±0.10	4-6	5.0±0.00	5
II	3.1±0.07	3-4	3.1±0.07	3-4	4.3±0.16	3-6	4.6±0.14	4-5
III	4.2±0.10	4-5	4.0±0.05	4-5	6.1±0.15	5-7	6.1±0.13	5-7
IV	5.8±0.09	5-6	5.8±0.07	5-6	5.1±0.14	4-6	4.9±0.25	4-6
V	4.6±0.27	4-8	4.2±0.09	4-5	7.0±0.20	5-9	7.2±0.30	6-9
VI	8.1±0.50	4-10	4.7±0.24	3-6	10.5±0.27	9-13	7.7±0.37	7-10
VII	12.0±0.58	10-19	8.3±0.25	6-10	13.8±0.16	13-16	7.2±0.33	4-9
VIII	—	—	12.2±0.38	10-16	—	—	13.5±0.44	11-16
Total	42.0±0.56	38-48	46.5±0.39	44-50	51.7±0.24	50-54	56.1±0.51	53-60

Pre-pupa

This period is considered as being from the moment that the larva begins construction of the cocoon until it transforms into a pupa. Under laboratory conditions the duration of the pre-pupal period varied between two and four days, with a mean of 3.4±0.09 days (n=38). No significant differences between males and females were found in the duration of this stage.

Pupa

The mature larvae pupate inside a silk cocoon to which they add hair from their bodies. The cocoons are to be found in protected places on ground level, like on fallen leaves, between grasses, or under stones or fallen tree trunks. The cocoon is thick, oval and of a black color, sometimes with light colored mixed bristles, and it is 10.9±0.12 mm (10-12) wide and 22.3±0.20 mm (20-25) (n=37) long. The pupa is of an obtect type, robust, with rounded ends, and the widest part is in the middle sector of the pterotheca. Male pupae are 15.9±0.12 mm long and their maximum width is 6.3±0.02 mm (n=20), while female pupae are 16.5±0.10 mm in length and 6.6±0.03 mm wide. The pupa is a reddish brown color, and the reduced cremaster is made up of a series of little hooks. The sexes can be distinguished by observing the distance which separates the genital opening from the anal. In females the distance between the two openings is twice as great as it is in males.

Natural enemies

Certain wasps, *Polybia ignobilis* (Haliday), *Polybia scutellaris* White and *Polistes ferreri* Saussure were observed attacking *H. ruscheweyhi* larvae. These wasps turned out to be very common in the areas of study, and they frequently go into plants in search of prey. The first two species were observed preying on larvae in their first and second instar, while *P. ferreri* was found preying on larvae in the fourth to the sixth instar.

Besides those types, nymphs and adults of two pentatomidae, *Brontocoris tabidus* (Signoret) (=*Podisus nigrolimbatus* (Spinola)) and *Oplomus cruentus* (Burmeister) were frequently found on the trees. Both pentatomids were observed from the beginning of November onwards. They are widespread predators which are common in a variety of ambients, and they mostly attack the larvae of chrysomelids and Lepidoptera. The former of the two species was observed on two occasions feeding on *H. ruscheweyhi* larvae. In both cases these were nymphs in the last instar, which when kept in the laboratory would change into adults on the fourth or fifth day after collection. RUFFINELLI and CARBONELL (1953) mentioned this pentatomid as a predator on *Halysidota* spp. On the other hand, there were no observations of the species feeding on *H. ruscheweyhi*. However, when collected from trees in the presence of this lepidopteron and reared under laboratory conditions, they regularly attacked their larvae, which allows us to suppose that they also act as natural enemies of the species.

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RESUMEN

SCATONI I. B., C. M. BENTANCOURT. 2004. Aspectos biológicos de los estados inmaturos y ciclo estacional de *Halysidota ruscheweyhi* Dyar (Lepidoptera, Arctiidae) en el sur de Uruguay. *Bol. San. Veg. Plagas*, **30**: 3-11.

Se estudió en el sur de Uruguay el ciclo estacional y la biología de *Halysidota ruscheweyhi* Dyar, a través de observaciones de campo y laboratorio. Se trata de una especie univoltina, aunque una pequeña proporción de adultos emerge en verano dando, eventualmente, lugar a una segunda generación. Pasa el invierno como pupa y los adultos vuelan durante parte de octubre y en noviembre. El periodo de puesta dura de cuatro a cinco semanas. Las puestas son depositadas en el envés de las hojas y están formadas por varias hileras de huevos paralelas y contiguas. El número de huevos por puesta varió de 62 a 247 con una media de 151,5. Las larvas emergen en noviembre y son polífagas, viviendo sobre diversas especies de árboles y plantas herbáceas. Son gregarias durante los dos primeros estadios. En diciembre, a partir del cuarto estadio, un porcentaje de larvas descienden de los árboles para vivir sobre el tapiz vegetal. En esta situación completan el desarrollo de manera similar a como lo hacen las que permanecieron sobre los árboles. Las larvas pasaron por siete u ocho estadios, estas últimas requirieron de mayor tiempo que las primera para pupar. Las larvas que fueron alimentadas con hojas de tilo (*Tilia moltkei*) mostraron una mayor velocidad de desarrollo que las alimentadas con hojas de olmo (*Ulmus procera*). Durante enero las larvas que permanecían en los árboles descendieron al tapiz vegetal para pupar. El período de prepupa varió de 2 a 4 días con una media de 3,4 días. Las pupas se encuentran dentro de un capullo, el que se ubica entre la hojarasca o bajo piedras y troncos caídos. La fase pupal duró entre nueve y diez meses. Como enemigos naturales de *H. ruscheweyhi* fueron reconocidas tres especies de Vespidae y una de Pentatomidae, una segunda especie de chinche es mencionada como probable depredadora de larvas.

Palabras clave: Insecta, Arctiidae, biología, Uruguay.

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