

SYSTEMATICS, MORPHOLOGY AND PHYSIOLOGY

Morphology of the Immatures and Biology of *Chinavia longicorialis* (Breddin) (Hemiptera: Pentatomidae)

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Edited by Fernando Barbosa Noll – UNESP

Neotropical Entomology 38(1):074-082 (2009)

Morfologia dos Estágios Imaturos e Biologia de *Chinavia longicorialis* (Breddin) (Hemiptera: Pentatomidae)

RESUMO - *Chinavia longicorialis* (Breddin) é encontrada apenas no Brasil, Argentina e Uruguai, sobre plantas hospedeiras de pelo menos três famílias diferentes. Adultos e ninfas dessa espécie foram coletados no Parque Estadual do Espinilho (Barra do Quaraí, RS) e na região da Serra do Sudeste (Canguçu e Caçapava do Sul, RS) e mantidos sob condições controladas ($24 \pm 1^\circ\text{C}$; UR $70 \pm 10\%$; 12hL:12hE), alimentados com vagens verdes de feijão (*Phaseolus vulgaris* L.). Os ovos e as ninfas de primeiro ínstar de *C. longicorialis* são muito semelhantes àqueles das demais espécies de *Chinavia*; porém apresentando manchas alaranjadas na margem lateral dos segmentos torácicos. As manchas abdominais, a partir do terceiro ínstar, são nitidamente divididas pelas pseudo-suturas do abdome, o que constitui caráter diagnóstico para *C. longicorialis*. Ninfas do terceiro ao quinto ínstar apresentaram formas claras e escuras. Não foi observada sobreposição nas medidas de largura da cabeça entre diferentes estádios. O número de ovos por postura mais freqüente foi 14; sugere-se a adoção da moda como melhor estimativa para o tamanho das posturas em Pentatomidae. A duração média da fase imatura (ovo a adulto) foi de $39,4 \pm 3,20$ dias. A alta mortalidade do segundo ao quinto ínstar (82,4%) e a ausência de desempenho reprodutivo nos adultos da segunda geração de laboratório indicam que vagens de feijão constituem alimento inadequado para a sobrevivência e reprodução de *C. longicorialis*.

PALAVRAS-CHAVE: Percevejo-verde, ovo, ninfa, mortalidade, tempo de desenvolvimento

ABSTRACT - *Chinavia longicorialis* (Breddin) is recorded only in Brazil, Argentina and Uruguay on host plants of at least three different families. Adults and nymphs were reared under standard controlled conditions ($24 \pm 1^\circ\text{C}$; $70 \pm 10\%$ RH; 12hL:12hD), and fed on green beans (*Phaseolus vulgaris* L.). Eggs and first instars of *C. longicorialis* are very similar to those of other species of *Chinavia*; however, the presence of orange maculae at the thoracic pleura is exclusive of first instars of *C. longicorialis*. Third to fifth instars have abdominal maculae divided by pseudo-sutures, a diagnostic feature of *C. longicorialis* nymphs. Light and dark morphs were observed for third, fourth and fifth instars. Head width measurements did not overlap between consecutive instars. The most frequent size of an egg clutch was 14; we suggest the adoption of the mode as the best and useful estimate of the egg clutch size for Pentatomidae. Average duration of the immature stages (egg to adult) was 39.4 ± 3.20 days. The high mortality observed from second to fifth instar (82.4%) and the lack of reproduction of the second generation indicate that green beans are unsuitable to proper development and reproduction of *C. longicorialis* by itself.

KEY WORDS: Green stink bug, egg, nymph, mortality, developmental time

It has been thoroughly recognized that the study of immatures could help to face more properly the taxonomic, ecological and economic problems posed by insects (DeCoursey & Esselbaugh 1962, Brailovsky *et al* 1992, Grimaldi & Engels 2005, Costa *et al* 2006). Consequently,

there is a growing need of research on the morphology and life history of early life stages of these animals.

The genus *Chinavia* Orian is the most speciose in the neotropics, and is included in a common group of medium to large sized pentatomids, usually known as green stink bugs

(Rolston 1983, Panizzi *et al* 2000). *Chinavia* has recognized economic importance, and some species are associated with very important crops (Panizzi *et al* 2000). The morphology of immatures and the life history traits of some species were already described (Grazia *et al* 1982, Hallman *et al* 1992, Avalos & LaPorta 1996, Schwertner *et al* 2002), although most species are known only by their adult morphology.

Chinavia longicorialis (Breddin) is registered in southern Brazil (São Paulo, Paraná, and Rio Grande do Sul states), Argentina and Uruguay, and records include Rosaceae, Rhamnaceae and Smilacaceae as host plants (Link & Grazia 1983, Rolston 1983, Schwertner & Grazia 2007). The objective of this work was to describe the general external morphology of eggs and nymphs of *C. longicorialis*, and to study some life history traits under controlled conditions.

Material and Methods

Nymphs and three adults (Fig 1) (two males and one female) of *C. longicorialis* were collected in the “Parque Estadual do Espinilho” (Barral do Quaraí county, RS, Brazil) and “Serra do Sudeste” (Canguçu and Caçapava do Sul counties, RS, Brazil). Specimens were kept in the laboratory under controlled conditions ($24 \pm 1^\circ\text{C}$; $70 \pm 10\%$

RH and photoperiod of 12h). Eggs and first instars were kept in petri dishes with a moistened cotton pad. From the second instar up to adulthood, the insects were reared in 500 ml plastic pots covered with organdy, and water was supplied in moistened cotton. The rearing containers were replaced whenever necessary to maintain a clean rearing environment.

Green beans were used as food from the second instar to the adult stage, following the rearing recommendations for other *Chinavia* species (LaPorta & Avalos 1993, Avalos & LaPorta 1996). The food and water were replaced every three days.

Measurements and morphological data were obtained from fifteen specimens of each instar and fifteen egg masses maintained in 70% ethanol, but the description of color patterns was carried out *in vivo*. Measurements (mean \pm standard deviation), given in millimeters, were obtained according to Matesco *et al* (2007). Terminology for eggs and nymphs follows Wolf *et al* (2002) and Matesco *et al* (2006, 2007), respectively.

Image of eggs was obtained with a digital camera (Nikon Coolpix® 995) coupled to stereomicroscope. Drawings were elaborated in a camera lucida coupled to a stereomicroscope, lined with black pigment ink pen, digital scanned and colored with Adobe Photoshop® software.



Figs 1-4 *Chinavia longicorialis*. 1, Adult (scale = 2 mm); 2, Eggs; 3, First instar; 4, Second instar (scale = 0.5 mm).

The number of eggs per female, immature development time and mortality, and sex ratio of *C. longicorialis* were studied under laboratory conditions. The number of eggs per female was obtained from four pairs emerged from late nymphs collected in the field. Data on immatures were obtained with daily observations after oviposition. It was calculated the mean and modal number of eggs per egg clutch; number of eggs, and egg clutches per female, as well as the development time and mortality of the eggs and nymphs.

Voucher specimens were deposited at the Entomological Collection of the Department of Zoology, Federal University of Rio Grande do Sul (DZRS).

Results

Egg (Fig 2). Barrel-shaped, operculum round and convex. Height: 1.6 ± 0.17 mm, width: 1.3 ± 0.15 mm. Chorion surface reticulated, light-brown in color. Aero-micropylar processes white, clubbed and oblong, mean number of 56 ± 7 . Once embryo development is advanced, dark red eyes and dark brown *raptor ovis* are visible.

First instar (Fig 3, Tables 1, 2). Body round and strongly convex. General color dark brown to black, except an orange maculae on head and thorax, and a series of white maculae dorsally on the abdomen. Head conical, strongly declivent; tylus round at apex, surpassing juga; juga subtriangular. Eyes narrower than base of tylus; ocelli absent. Head black, except for a wide orange round maculae, extended from the base of head to the posterior margin of mesonotum. Antennae black, except intersegmental orange rings; four-segmented, with few short hairs, denser at segment IV; segment I to III cylindrical, segment IV fusiform. Antennal segment I shortest; segment IV almost as long as II and III combined, these segments sub equal. Rostrum black, surpassing anterior margin of urosternite

III. Thorax mostly black, except for the median and lateral orange maculae. Pro, meso and metapleura black. Legs black, with short hairs, denser and longer at apex of tibiae and tarsi. Tibiae dorsally flattened; tarsi 2-segmented, with a pair of claws and pulvillus. Margins of pro and mesothorax depressed and deflected. Abdomen mostly dark brown, with a series of white maculae. Dorsal and ventral abdominal plates black; lateral plates with a small notch close to the spiracle, ventrally. Dorsal white maculae as follows: one median, rounded and anterior to fore median plate; 1+1 surrounding fore lateral plates; 1+1 rounded maculae, wider than the remaining, lateral to fore median plate (that maculae, in subsequent instars, could be yellowish); 1+1 maculae lateral to second median plate, semicircular and smaller than the previous maculae; and 1+1 lateral to third median plate, with same size and placement of the previous maculae. Abdominal sternites dark-brown. Spiracles on II to VIII abdominal segments, near to anterior margin of lateral plates. From III to VII urosternites, 1+1 trichobothria placed entad an imaginary line across spiracles and near posterior margin of each segment.

Second instar (Fig 4, Tables 1, 2). Body oval and less convex than first instar, with punctures on dorsal head, thorax and abdominal plates; less punctures on thoracic maculae. General color mostly black, except the orange, yellow and white maculae on thorax and abdomen. Head black, median maculae absent; head shape less declivent than in the first instar and truncate at apex; juga and tylus equal in length, the former wider at apex than in the first instar. Eyes almost as wide as base of tylus. Antennae black, except intersegmental light brown rings. Antennal segment I shortest; II and III subequal in length, and combined subequal to IV. Rostrum black, surpassing at least anterior margin of urosternite IV. Thorax mostly black, with orange maculae on lateral margins (visible in dorsal and ventral view): 1+1 rectangular maculae in the prothorax, and 1+1 semicircular ones in the mesothorax. Margins of prothorax and mesothorax depressed, slightly deflected and serrulate. Legs black, tibiae dorsally flattened and ventrally wedge-

Table 1 Morphometric traits of *Chinavia longicorialis* nymphs (n = 15) (mean \pm standard deviation, mm).

Measures	1 st instar	2 nd instar	3 rd instar	4 th instar	5 th instar
TL	2.2 ± 0.13	3.2 ± 0.13	5.1 ± 0.26	6.8 ± 0.39	10.1 ± 0.58
TW	1.3 ± 0.06	2.1 ± 0.13	3.4 ± 0.24	5.0 ± 0.25	7.1 ± 0.35
HL	0.7 ± 0.05	0.8 ± 0.07	1.1 ± 0.06	1.4 ± 0.11	1.9 ± 0.13
ID	0.6 ± 0.03	0.8 ± 0.02	1.1 ± 0.04	1.4 ± 0.05	1.7 ± 0.07
I	0.1 ± 0.02	0.1 ± 0.03	0.2 ± 0.05	0.3 ± 0.04	0.4 ± 0.05
II	0.2 ± 0.02	0.5 ± 0.04	0.8 ± 0.08	1.3 ± 0.11	1.9 ± 0.20
III	0.2 ± 0.02	0.5 ± 0.03	0.7 ± 0.06	1.1 ± 0.07	1.5 ± 0.12
IV	0.5 ± 0.04	0.7 ± 0.05	1.0 ± 0.11	1.2 ± 0.09	1.5 ± 0.13
RL	1.0 ± 0.04	1.8 ± 0.08	2.5 ± 0.22	3.4 ± 0.19	4.3 ± 0.26
PL	0.3 ± 0.01	0.4 ± 0.05	0.6 ± 0.06	1.0 ± 0.06	1.6 ± 0.14
PW	1.1 ± 0.04	1.8 ± 0.05	2.7 ± 0.08	4.3 ± 0.14	6.4 ± 0.32

HL, head length; ID, interocular distance; PL, pronotum length; PW, pronotum width; RL, rostrum length; TL, total length; TW, total width; I, II, III, IV, length of antennal segments.

Table 2 Head width (mm) of *Chinavia longicorialis* nymphs (n = 15).

Instar	Head width	
	Mean \pm SD ¹	Min – Max
1 st	0.80 \pm 0.022	0.76 – 0.84
2 nd	1.14 \pm 0.037	1.08 – 1.20
3 rd	1.56 \pm 0.038	1.48 – 1.60
4 th	2.10 \pm 0.065	2.03 – 2.19
5 th	2.65 \pm 0.120	2.43 – 2.84

¹Standard deviation

shaped. Abdomen dark-brown to black; maculae lateral to fore median plate mostly yellowish, and maculae lateral to second and third median plates absent; some individuals with 1+1 white oval maculae, near to IV and V lateral plates, subdivided by pseudo-sutures. Median abdominal plates black. Ventral abdominal plates IV to VIII smaller than the dorsal ones, and 2+2 trichobothria on urosternites III to VII. One trichobothrium entad the spiracular line and the other along that line. Other characters as described for first instar.

Third instar (Figs 5, 6, Tables 1, 2). **Light morph** (Fig 5). Similar to second instar in body shape. Head mostly greenish; basal portion of head, margins of tylus and juga, and antennae black. Antennal segment I shortest; II and III subequal in length, and combined larger than IV. Rostrum with segments I and II green, segments III and IV black; rostrum surpassing anterior margin of urosternite III. Thorax mostly green, more punctured than second instar; margins of thorax and surrounding area of thoracic maculae black, as well as 1+1 prolonged maculae submedian on pronotum and mesonotum. Legs mostly green, except tibiae and tarsi somewhat dark. Abdomen reddish to brown; lateral plates orange, marginated by black; white oval maculae close to the lateral plates of segments IV to VII and divided by pseudo-sutures always present. Ventrally: head, thorax and abdomen mostly green; orange maculae on thorax and lateral plates present; median plates may be absent. Other characters as described for second instar. **Dark morph** (Fig 6). Similar to second instar in body shape and coloration. Head black. Thorax mostly black, except the lateral orange maculae on the pro and mesothorax; in some individuals, median area of juga and thorax light in color. Legs mostly black; coxae and femora somewhat light in some individuals. Abdomen dark-brown; dorsal abdominal maculae as in the light morph; abdominal venter dark-green. Other characters as described for light morph third instar.

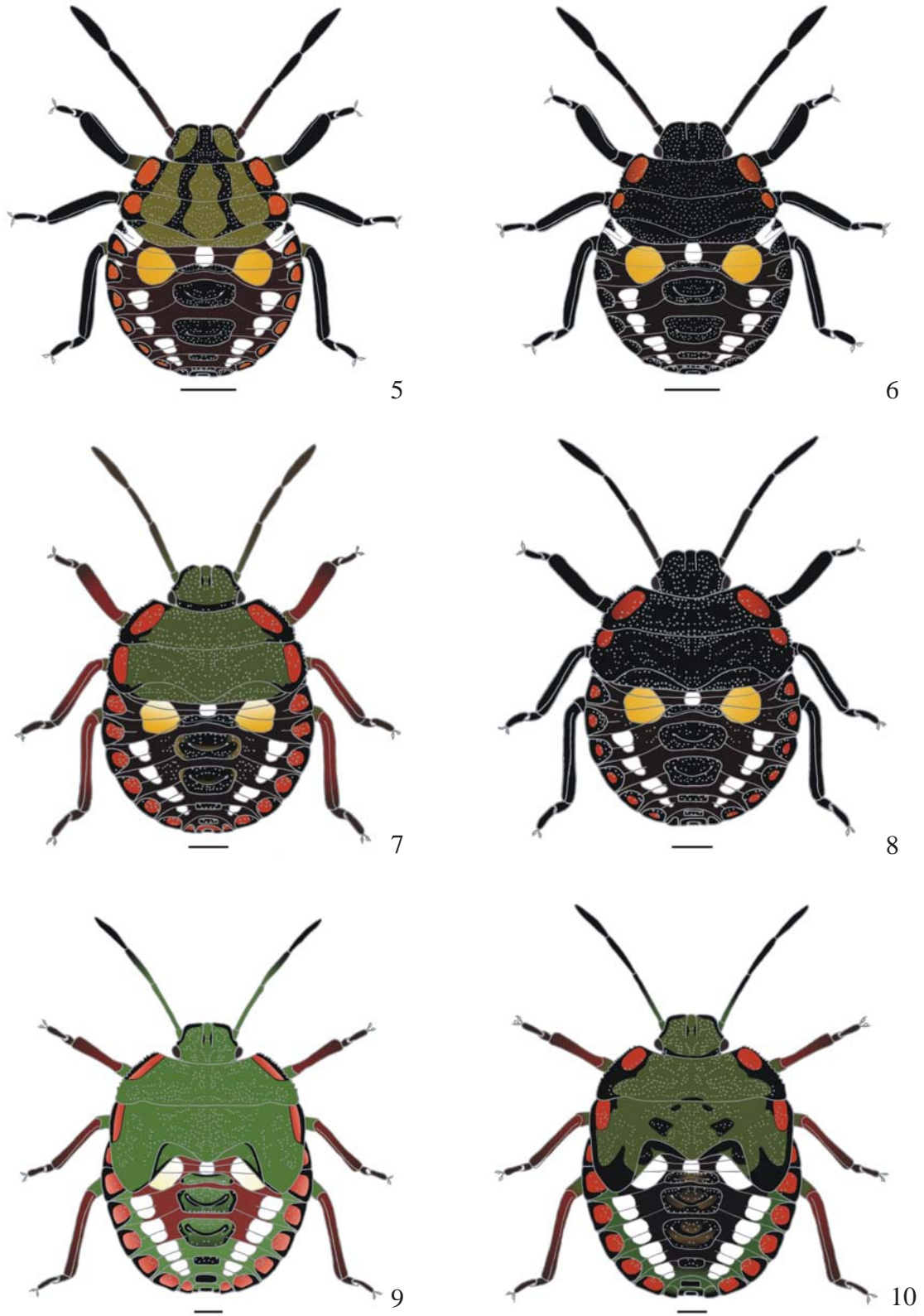
Fourth instar (Figs 7, 8, Tables 1, 2). **Light morph** (Fig 7). Body oval. Head mostly green, marginated by black, and less declivent than in third instar. Antennae mostly dark-brown; segments I and II somewhat green; segment I shortest and II longest; III and IV subequal in length. Rostrum green, surpassing at least anterior margin of urosternite III. Thorax mostly green; some individuals with submedian black maculae as in previous instar, and posterior margin of mesonotum blackish; other individuals black just on

margins of thoracic segments and lateral maculae. Prothorax trapezoidal; mesothorax rectangular, posterior margin wide, “V” shaped, evidencing the scutellum development. Pro- and mesothorax with lateral margins slightly serratulate; maculae of lateral margins of mesothorax subrectangular, larger than in the previous instar. Wing pads slightly developed, reaching posterior margin of metanotum; metanotum almost reaching posterior margin of abdominal segment I. Legs green, except tibiae somewhat reddish, and tarsi dark-brown. Abdomen dark-brown dorsally, with few punctures between median and lateral plates on each segment; abdominal maculae wider than in previous instar, maculae surrounding the first lateral plate hidden by wing pads. Abdominal venter mostly light green, with five median plates in segments IV to VIII; median plates sometimes absent. Other characters as described for third instar. **Dark morph** (Fig 8). Head black. Thorax mostly black, except the orange maculae on lateral margins of pro- and mesothorax. Abdomen dark-brown dorsally, abdominal maculae with the same number, distribution and color as in light morph. Abdominal venter greenish. Other characters as described for third instar.

Fifth instar (Figs 9, 10, Tables 1, 2). **Light morph** (Fig 9). Body oval, mostly green. Head flat and porrect, green; lateral margins of juga narrowly black. Juga and tylus subequal in length; eyes larger than base of tylus, ocellar maculae present. Antennae mostly green, apex of segments III and IV black; segment I shortest and II longest; III and IV subequal in length. Rostrum green, surpassing anterior margin of urosternite III. Thorax mostly green, lateral margins black; 1+1 prolonged red-orange maculae on pronotum and wing pads. Prothorax wider, antero-lateral margins slightly convex; mesothorax more developed, scutellum well delimited. Wing pads well developed, surpassing the middle of abdominal segment III, partially hiding the anterior abdominal maculae. Abdomen mostly green dorsally; area between the anterior three median and lateral plates dark-brown; median plates greenish, marginated by black in some individuals. Abdominal maculae same as in previous instar, abdominal punctures denser; wide maculae close to fore median plate always yellowish; black margin of lateral plates narrow than in the fourth instar, sometimes incomplete. Abdominal venter mostly green, lighter than in previous instar. Other characters as described for fourth instar. **Dark morph** (Fig 10). Head green; basal area and lateral margins of juga and tylus black. Thorax mostly green, with 1+1 rectangular red-orange maculae on basal half of lateral margins of pro- and mesothorax; in black: 1+1 postero-lateral maculae on pronotum, 2+2 submedian maculae on mesonotum and apex of wing pads. Abdomen mostly brown to purple dorsally; area between abdominal white maculae and lateral plates dark-green; median plates black. Other characters as described for the light morph.

Biology. Laboratory-reared females laid 415 eggs in 23 egg masses. Other two egg masses were accompanied: one with six eggs collected in field, and another with 21 eggs obtained from a field-collected female.

On average, each female laid 103.8 ± 91.78 eggs in 5.8 ± 3.86 egg masses. Mean number of eggs per egg clutch was 17.7 ± 7.38 (variation from 5 to 30), and modal number



Figs 5-10 Immatures of *Chinavia longicorialis*. 5, Third instar, light morph; 6, Third instar, dark morph; 7, Fourth instar, light morph; 8, Fourth instar, dark morph; 9, Fifth instar, light morph; 10, Fifth instar, dark morph (scale = 1 mm).

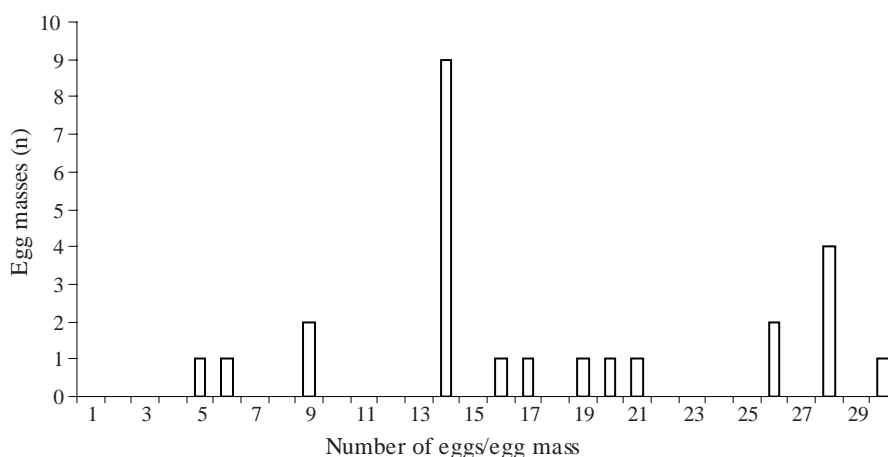


Fig 11 Number frequency of eggs per egg mass of *Chinavia longicorialis* reared with green beans (*P. vulgaris*) ($24 \pm 1^\circ\text{C}$, $70 \pm 10\%$ RH and photoperiod of 12h).

of 14 eggs per egg mass (Fig 11). Sex ratio was 1.3 male: 1 female. Mean development time from egg to adult of *C. longicorialis* was 39.4 ± 3.20 days (Table 3). High mortality was observed from second to fifth instars, reaching 51.1% at the fifth instar (Table 3). A second generation was not obtained under laboratory conditions; although the rearing procedures were repeated with the adults obtained from the first generation, none of the females were observed in copula or displayed any egg laying activity.

Discussion

Morphology of the immatures. Eggs of *C. longicorialis* are similar to those of other *Chinavia* species. They have the same chorion pigmentation and sculpture and a large number of white and clavate aero-micropylar processes (Bundy & McPherson 2000, Schwertner *et al* 2002, Wolf

et al 2002, Matesco *et al* 2006, 2007). These characteristics are unique and allow the identification of the genus in this stage of development.

First instar of *C. longicorialis* follows the observed pattern of *Chinavia* spp.: body coloration predominantly dark; head and thorax with a dorsal median yellow to reddish macula; and abdomen with a series of white to yellowish maculae lateral to the first three median plates (Schwertner *et al* 2002, Matesco *et al* 2006). Only *C. longicorialis*, *Chinavia obstinata* (Stål) and *Chinavia ubica* (Rolston) have the dorsal macula of head and thorax of the first instar orange in color. Nonetheless, *C. obstinata* has white maculae surrounding all abdominal lateral plates, and the maculae lateral to first median plate are yellowish (Matesco *et al* 2003); *C. ubica* has white maculae anteriorly to the first four median plates of abdomen, and small white maculae juxtaposed to the lateral plates of abdominal segments IV and V (Schwertner *et al* 2002). Distribution pattern and coloration of abdominal maculae of the first instar of *C. longicorialis* is similar to *Chinavia impicticornis* (Stål) and *Chinavia pengue* (Rolston). However, *C. impicticornis* first instar has the dorsal macula of the head and thorax yellowish in color, and the white maculae surrounding the first lateral plates are absent (Grazia *et al* 1982); in *C. pengue* first instar, maculae of head and thorax are orange-red, and body size are larger than those nymphs of *C. longicorialis* (Matesco *et al* 2007). The orange maculae on lateral margins of thorax are an exclusive feature of *C. longicorialis* first instar, allowing early recognition of this species.

From the second instar on, nymphs of *Chinavia* have 1+1 maculae on lateral margins of prothorax, which differ in color as compared to other species, being orange in *C. longicorialis*, *C. obstinata* and *Chinavia scutellata* (Distant) (Brailovsky *et al* 1992, Matesco *et al* 2003). In the abdomen, the anterior median white maculae, 1+1 yellowish maculae lateral to first median plate, and 1+1 white maculae surrounding the fore lateral plates are common features of *Chinavia* nymphs in general, present in *Chinavia nigrodorsata* (Breddin), *C. impicticornis*, *C. obstinata* and *C. ubica*, and very likely in

Table 3 Duration (in days) and relative mortality (%) of eggs and nymphs of *Chinavia longicorialis* reared under controlled conditions ($24 \pm 1^\circ\text{C}$, $70 \pm 10\%$ RH and photoperiod of 12 h, with green beans as food)

	Duration (days) (mean \pm SD ¹)	Variation interval (days)	Mortality (%) (mean \pm SD)
Egg	6.7 \pm 0.98	4 – 8	0.9 \pm 3.25
1 st stadium	4.4 \pm 0.63	3 – 11	4.8 \pm 12.10
2 nd stadium	6.6 \pm 1.45	5 – 15	28.7 \pm 20.91
3 rd stadium	5.5 \pm 0.98	3 – 14	28.9 \pm 32.49
4 th stadium	6.8 \pm 1.28	4 – 20	32.3 \pm 17.72
5 th stadium	11.1 \pm 1.83	8 – 20	51.1 \pm 25.39
2 nd stadium to adulthood	28.4 \pm 2.87	24 – 39	82.4 \pm 14.37

¹Standard deviation

Chinavia marginata (Palisot de Beauvois) and *C. scutellata* as well. Immature descriptions and illustrations of the last two species are partial (Brailovsky *et al* 1992), and comparisons with nymphs of other species are difficult. However, only nymphs of *C. longicorialis* have the white maculae lateral to third and fourth median plates present, and the lateral maculae on abdominal segments IV to VII, when present, are divided by the abdominal pseudo-sutures.

From the third instar on, besides the lateral orange maculae on the prothorax, other maculae of same coloration may be present on jugae, lateral margins of mesothorax, and in the middle of each abdominal lateral plate, making easy the recognition of *C. longicorialis* nymphs. Additionally, from this instar on, abdominal white maculae clearly divided by pseudo-sutures are always present, which is the main diagnostic feature of *C. longicorialis* nymphs.

Light and dark morphs were observed from third to fifth instars of *C. longicorialis* (Figs 5-10); the light morph is the most common. Although coloration and distribution patterns of maculae are very similar in light and dark morphs, general body coloration is different: greenish in the former, blackish in the latter. Light and dark morphs occurring from third or, more commonly, fourth instar on, were observed in other species of *Chinavia* and Pentatomidae as well (Brailovsky *et al* 1992, Schwertner *et al* 2002). In *C. ubica*, the balance between color morph types is related to food sources used by nymphs during development (Schwertner *et al* 2002).

The number and distribution of trichobothria in the nymphs of *C. longicorialis* follow the pattern described by Schaefer (1975) for Pentatomoidea, and also have been observed in other species of *Chinavia* (Grazia *et al* 1982, Matesco *et al* 2003, 2007).

Recognition of the five instars of *C. longicorialis* is possible via body size and coloration, as well as the level of development of wing pads and scutellum. Besides these characters, head measurements can help recognizing each instar (Hallman *et al* 1992, Matesco *et al* 2007). In *C. longicorialis*, there was no overlap in the variation intervals of head width among instars (Table 2), this measure can be used as a reliable diagnostic character to recognize instars.

Compared to nymphs of other species of green stink bugs, the light morph of *C. longicorialis* fifth instar is similar to the greenish fifth instar of *Nezara viridula* (Linnaeus) (Pennington 1918, Rizzo 1968). Nonetheless, the overall body coloration and shape, as well as the distribution pattern of abdominal maculae, allow the identification of *C. longicorialis* in the nymphal stage.

Biology. Despite the high standard deviation value, the mean number of eggs and egg clutches per female in *C. longicorialis* were very similar to those found in other *Chinavia* species reared under the same laboratory conditions (Hallman *et al* 1992, LaPorta & Avalos 1993, Avalos & LaPorta 1996). Low mortality during the egg stage (Table 3) indicates a high fertility rate of *C. longicorialis* adults collected in the field.

The mean number of eggs per clutch was 17.7 ± 7.38 ; however, two frequent values were found: 14 and 28 eggs/clutch (Fig 11). Egg masses with 14 eggs or multiples of seven are the common pattern found in several species of *Chinavia* (Miner 1966, Grazia *et al* 1982, Vecchio *et al* 1988,

Javahery 1990, Hallman *et al* 1992, Matesco *et al* 2003, 2007) and other Pentatomidae (Miller 1971, Brailovsky *et al* 1992, Javahery 1994). Pentatomidae usually have seven ovarioles in each ovary (Pendergrast 1957), which seems to be the case of *C. longicorialis* and almost all *Chinavia* species (Miner 1966, Javahery 1990, Hallman *et al* 1992, but see Matesco *et al* 2006 for an exception). Although studies with pentatomids (and other insects that oviposit egg clutches) generally present mean values of eggs per clutch, this measure of central tendency is not the best to represent variables with a modal distribution. Based on the results found here and data from the literature, we suggest the adoption of the mode – the most common value in a sample (Callegari-Jacques 2003) – as the best and useful estimate of the egg clutch size for pentatomids (see below).

Despite the fixed number of ovarioles among pentatomids, the number of eggs per clutch can be strongly influenced by the oviposition strategy of each species (Kiritani & Hokyō 1965, Javahery 1994). The oviposition strategy can be defined as the most frequent number of eggs per clutch (Kiritani & Hokyō 1965), and is relatively constant within stink bugs species (Kiritani & Hokyō 1965, Javahery 1994). According to the oviposition patterns established by Kiritani & Hokyō (1965), *Chinavia* females usually lay eggs soon after choriogenesis (Matesco *et al* 2007), the most common pattern observed in *C. longicorialis* when fed on green beans (egg masses with 14 eggs). However, our results show that females of this species can retain up to two mature eggs per oviduct before oviposition (Fig 11), which could indicate a plastic oviposition pattern.

Mean development time of the egg stage and first instars of *C. longicorialis* (Table 3) were similar to those of *C. nigrodorsata*, *C. marginata* and *C. pengue* reared under similar conditions (Hallman *et al* 1992, Avalos & LaPorta 1996). From the second instar on, quality and quantity of food resources have great influence on immature performance (Slansky & Panizzi 1987, Vecchio & Grazia 1993). Mean developmental time from second to fifth instar in *C. longicorialis* (Table 3) was very similar to other *Chinavia* species under similar conditions (Hallman *et al* 1992, LaPorta & Avalos 1993, Avalos & LaPorta 1996, Matesco *et al* 2007), although these species showed lower mortality. *Chinavia* species reared under relatively low temperatures or different food resources, either wild or cultivated, showed longer developmental times and higher mortality rates from second to fifth instar (Miner 1966, Simmons & Yeorgan 1988, Javahery 1990, Matesco *et al* 2003).

Usually, nymphs of *C. longicorialis* show increasing mortality rates as they grow, with higher values during the fifth instar (Table 3), in which the quality and quantity of food are important due to the storage of nutrients for the final moulting and adult activities, as flight and reproduction (Panizzi & Rossi 1991). Increasing mortality rates during nymphal development were observed in *N. viridula* reared on *Raphanus raphanistrum* L. and *C. obstinata* on mature fruits of passion fruit (*Passiflora alata* Dryander), both considered unsuitable for nymphs of these two species (Panizzi & Saraiva 1993, Matesco *et al* 2003). Other *Chinavia* species also show high mortality during early instars (LaPorta & Avalos 1993, Avalos & LaPorta 1996).

Adult sex ratio observed was close to 1:1, a pattern predicted for pentatomids in general and always verified in similar studies (Mau & Mitchell 1978, Botton *et al* 1996, Martins & Campos 2006, Matesco *et al* 2007).

The reproductive performance of females collected in the field and the developmental time of their offspring under laboratory conditions suggest that green beans may be an appropriate food resource to *C. longicorialis*, as for other *Chinavia* species (Hallman *et al* 1992, LaPorta & Avalos 1993, Avalos & LaPorta 1996, Matesco *et al* 2007). However, the mortality during the nymphal stage was very high (86.2%) when compared to that of other *Chinavia* species fed with the same food (LaPorta & Avalos 1993, Avalos & LaPorta 1996, Matesco *et al* 2007). Additionally, females reared throughout their life cycle under laboratory conditions and fed with green beans as immatures did not reproduce. Although all phytophagous pentatomids are considered potentially polyphagous, they show different performances on different food resources, even among hosts of the same plant family (Panizzi 1997). Some authors emphasize that food suitability can affect the nymphal and adult stages differently (Panizzi & Slansky 1991, Velasco & Walter 1993). In general, *Chinavia* species show preference for legumes (Fabaceae) (Panizzi 1997), but none of the few-recorded hosts of *C. longicorialis* belong to this group of plants. The high mortality observed from second to fifth instar, and the lack of reproductive performance of the second generation lab-reared adults indicate green beans were unsuitable to sustain *C. longicorialis* survival and reproduction by itself across generations.

Since there is no other data available for this green stink bug species on alternative food resources, and host-plant records are scarce, it is difficult to predict if *C. longicorialis* could show a better performance or if the high mortality during the nymphal stage occurs naturally under field conditions. Natural high nymphal mortality was suggested by Panizzi & Rossi (1991) for the pentatomid *Loxa deducta* Walker. Using different legumes as food for nymphs and adults of *N. viridula*, Panizzi & Slansky (1991) showed that, on some plants, long development time caused high mortality, which could be the case for *C. longicorialis* on green beans. Future studies with *Chinavia* species, under laboratory conditions, can help our understanding on the phytophagous habits of stink bugs in general.

Acknowledgments

To Gilson R P Moreira (DZ/UFRGS) and Gilberto S Albuquerque (LEF/UENF) for their valuable contribution to improve this manuscript. To CAPES for the fellowships granted to the authors V C M e C F S and to CNPq for J G fellowship and for financial support (Biodiversidade de Insetos no Rio Grande do Sul, Processo CNPq n° 478787/2001-4) that allowed the collection of the specimens studied.

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Received 13/VIII/07. Accepted 20/XII/08.