Morphological aspects of developmental stages of *Streblote panda* (Lepidoptera: Lasiocampidae)

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Abstract. The external morphology and fine structure, as well as some biometric data, of *Streblote panda* immature stages (Lepidoptera: Lasiocampidae), are reported. The first chaetotaxy study of first instar larvae was made. Also data of egg’s and pupae’s width, length and volume were recorded. Observations on the external morphology were made with the aid of Scanning Electron Microscopy and Stereoscopic Microscope, equipped with digital camera and drawing tube. Precise characteristics described here are expected to provide a wider comparative basis for future descriptions and taxonomical works.


Keywords: *Streblote panda*, morphological aspects, egg, first instar larva chaetotaxy, pupa.

There are thirty one Lasiocampidae species recorded from the Iberian Peninsula, 70.96 % of which live in Andalusia (Gómez-Bustillo & Fernández-Rubio 1978; Vives-Moreno 1994; Fuentes-García 1999). Among these, *Streblote panda* Hübner 1820 is an eremic species that prefers littoral, sandy and open scrub areas. Its distribution ranges from Catalonia to El Algarve (Portugal), with healthy populations in Andalusia, where it can be found in mild areas of the interior provinces, reaching 300–500 m of altitude (Palma et al. 1995; Fuentes-García 1999). The species is well distributed throughout North Africa –91.4 % of all species belonging to this genus is distributed along this continent, where the genus reaches its highest diversity (Holloway 1987; Kroon 1999; Vári et al. 2002; Calvo 2004). Geographically, the nearest species to *S. panda* is *Streblote acaciae* (Klug 1829) which is distributed across North Africa.

Like other species of the genus, *S. panda* is a highly polyphagous insect; it has been considered a local pest of some pomes and lime fruits (Balachowsky 1966), infesting several perennial plants of ornamental and economic interest in Western Andalusia. Its larvae may have an unwanted effect on the plant production when they feed on young growing plants. (Molina 1998; Calvo 2004; Calvo & Molina 2004b).

Due to its consideration as a pest, previous published studies about *S. panda* have been much more ecological and biological, focusing on aspects about insect-plant relationship (Calvo & Molina 2004 a, b; 2005 a, b, c ). Although, our knowledge about morphological aspects of Lasiocampidae immature stages is still scarce in bibliography. Only a few descriptions of preimaginal stages, providing some useful morphological data to identify subfamilies or even species, can be found (Gardner 1941; Peterson 1948; Holloway 1987; Fitzgerald 1995; Lemaire & Minet, 1998). The adult’s external morphology has not been included in this study because faunistic studies have already provided thorough information (Peterson 1966; Gómez-Bustillo & Fernández-Rubio 1978; Huertas Dionisio 1980; Rougeot & Viette 1980; Gómez de Aizpurúa 1988; Bogner 1999).

The aim of this study is a better morphological description of the immature stages of *S. panda*, by reporting the first chaetotaxy study of this species, and as far as we know, of the genus *Streblote*. This kind of morphological study will establish a solid ground...
and will give us the correct tools for the accurate identification of the species required for basic studies of biology, physiology or demography. Besides, it is a valuable tool for developing recommendations regarding pest control, since it has proved harmful for some local crops.

Material and Methods

Insects and samples. Stock cultures of *S. panda* were maintained in our laboratory (Centro “Las Torres-Tomejil”, IFAPA, Seville, Spain). The colony was established in June 2000, from specimens collected in the field as larvae and reared on its own host plant. New wild collected larvae were added to the colony.

![Figure 1](image)

**Figure 1**

Morphological aspect of egg. **a**, View of *S. panda* egg with SEM; **b**, Egg colour pattern; **c**, Reticular pattern of chorion surface; **d**, Polygonal cells and aeropyles; **e**, Micropylar rosette; **f**, Micropylar area and micropylar canals.
to avoid excessive endogamy. Insects were maintained in a growth chamber at 25±1 °C, RH, 70±5 %, and 16:8 L:D.

**Eggs.** A total of 400 eggs were weighted and their length and width measured within 72 hours after they were laid. Their size was estimated by the cubic root of the volume of a regular, prolate, ellipsoid according to the formula: 

\[ \text{Size (mm)} = \left( \frac{1}{6\pi} \times d^2 \times h \right)^{1/3} \]

where ‘d’ is the egg’s diameter, and ‘h’ the egg’s length. The cube root transformation applied to this formula, improves egg size calculations, minimizing errors (García-Barros 2000).

The morphological study of eggs was carried out using Optic Microscope and Scanning Electron Microscope (SEM). We

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**Figure 2**

Larval morphological aspects. **a,** Ventral view of head; **b,** Prolegs; **c,** Antenna; **d,** Labrum; **e,** Maxillary palp and basiconic sensilla; **f,** Labium and spinneret.
used a random subsample of 20 eggs; a group of 10 eggs was kept in 75 % ethanol, for study with Optic Microscope. Another group of 10 eggs was prepared for study with SEM (see protocol below).

**Larvae.** Fifty neonate larvae, randomly selected among several breeds, were freeze killed and maintained at –20°C for immediate observations. A Stereoscopic Microscope (Leica MZ6) equipped with a digital camera (JVC GC-X3) and drawing tube was used in those observations. Twenty-five specimens, from the frozen stock, were rinsed in 1 % NaOH solution during 48 hours. After this, specimens were rinsed in distilled water for 24 hours, and dehydrated in a growing concentration of ethanol (Patin 1964; Houyez & Lecomte 1984). Then, they were mounted on Hoyer medium and observed with an Optic Microscope (Nikon Optihot). Finally, another subsample of twenty-five larvae was prepared for SEM study.

**Pupae.** A total of 167 pupae, 93 males and 74 females were weighted and their length and width measured within the 24 hours after their formation. Samples of 15 pupae per sex were used for Optic and SEM study.

**Sample preparation for SEM.** The study of all immature stages was made using a protocol developed by the University of Seville's Electronic Microscopy Service. The stages were previously fixed with glutaraldehyde [4 %], then were dehydrated with ethanol and acetone, and dried by the critical point method (Balzevs CPD 030). Finally, the larvae were mounted on SEM stubs, sputter coated with gold and examined with Scanning Electron Microscope (PHILIPS XL-30).

**Nomenclature** used to describe eggs and chaetotaxy of first instar larvae follow Hinton (1946; 1981). We used the nomenclature proposed by Mosher (1916) to describe the pupae.

**Results**

**Egg.** The egg showed a mean fresh weight of 2.72±0.35 mg, a height of 1.87±0.01 mm and a width of 1.56±0.01 mm. The size of the eggs was 1.37±0.07 mm.

Its surface is brown spotted; spots are greater and denser on the egg’s poles, scattered and dot shaped in the equatorial area (Fig. 1a and 1b). Central circular spots in the micropylar area are not present in the caudal area. The egg colour and pattern did not change with the larval development.

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**Figure 3**

Chaetotaxy of first instar larva. a, Frontal view of head capsule; b, Dorsal view of head capsule; c, Ocular area; d, Dorsal view of prothorax.
Chorion surface was thick and resistant. Eggs SEM Examination showed a reticulate pattern of slightly depressed polygonal (hexagonal) cells without evident edges (Fig. 1c). Higher magnification revealed that this surface is not smooth and is formed by an intricate pattern of sinuous ridges, with a central circular depression (Fig. 1d). The polygonal cells are outlined by ridges outstanding from the surrounding ridges mainly because of their relatively straight course; they differ little in elevation from the surrounding surface. A circular aeropyle is found in every vertex of polygonal cells (Figs. 1c and 1d). The micropylar area is a little depressed, without aeropyles (Fig. 1e). All examined eggs had 7–9 not perpendicular micropylar channels, and 8 petal-shaped primary cells radiating from the central area. The primary cells are in turn completely surrounded by various series of secondary cells, forming the micropylar rosette (Fig. 1e and 1f).

**Larvae.** The first instar larva of *S. panda* has both primary and secondary setae. Scanning electron microscope has revealed that it is covered with minute, pyriform microtubercles (Fig. 5a, b). The pretarsus has been examined with a microscope has revealed that it is covered with minute, pyriform microtubercles (Fig. 5a, b). The pretarsus is formed by one claw (Fig. 2a). Five pairs of prolegs are formed by one claws (Fig. 2a). Proleg base, with the crochets in mesoseries. Proleg planta is reduced to a lobe at the distal end of the proleg base, with the crochets in mesoseries.

Head hypognathous, with medial epicranial suture little visible. Adfrontal sutures are not easily distinguishable. Head capsule width of 1.04±0.02 mm. Six stemmata, one of them separated from the others, are located in the genal area (Figs. 2a and 3c). Three-segmented antenna; second segment with two elongated tactile setae and 3 basiconic sensillae; the elongated tactile setae prevents the sensilla from contacting the substrate. The third antennal segment is smaller, with 4 sensilla, one of them bisegmented (Fig. 2c). Clypeus and labrum are very evident. Yellowish labrum, deeply notched at its anterior edge, bearing six pairs of setae in its external face (Fig. 2d). Maxilla consisting of cardo and stipe; maxillary palpus with three segments, directed downward; each palpus with 8 basiconic sensillae on its top (Fig. 2e). Only one maxillary lobe (galea), with 2 setae and 7 sensillae; one of them circular, two bisegmented -medial and lateral sensilla basiconica-; another one longer than the rest and three microsetae. Labium with prementum, little sclerotized (Fig. 2f). Postmentum divided in two triangular sclerites. Small spinnerets, formed by fusulinger and fusulus, and directed downward contacting the substrate as the caterpillar moves. Epipharynx cuticle covered with microscopic spines. Labial palpus little visible, dorso-lateral to spinnerets. Mandibles with eight teeth on the edge.

The cuticle of caterpillars bears elongate, dorsal and lateral setae. We have identified several setae groups in the distinct tagmata of first instar larvae. The following groups of setae were identified in the head capsule: anterior group (setae A1, A2, A3, puncture Aa); ocellar group (setae O1, O2, O3, and puncture Oa); subocular group (setae SO1, SO2, SO3); clypeal group (setae C1, C2); lateral group (setae L1 and puncture La); vertical group (setae V1 and V2); genal group (setae G1 and puncture Ga); frontal group (setae F1 and puncture Fa); adfrontal group (setae AF1, AF2 and puncture AFa); posterior group (setae P1, P2, punctures Pb and Pa) (Figs. 2a, 3a, 3b and 3c).

In the anterior area of prothoracic shield we find XD group (setae XD1, XD2, and puncture XDc.). These setae are located in tubercles together with secondary setae, playing a head protection function. The dorsal group was localized in the prothoracic shield posterior area (setae D1, D2, punctures XDb and XDa) (Fig. 3d). Subdorsal group with one seta (SD1), which has a different cuticular structure and thinner, showing a globular form at its insertion base, probably with proprioceptor function (Fig. 3c). Subventral group setae (SV1 and SV2) are localized in two tubercles, with a high number of secondary setae. Microsetae and lateral setae are not visible because of the high quantity of secondary setae.

Identical setal maps for meso and metathorax. Two dorsal tubercles with secondary setae are localized in the anterior area of each segment, all of them have six setae (Fig. 4a). In the lateral area on each segment we localized one tubercle with three setae (SD2, L3 and SD1). Dorsal group (D1 and D2) posterior to dorsal tubercules. Subventral groups (SV1 and SV2) in tubercles with high quantity of secondary setae (Fig. 4b). Urticating retractable organs are visible from second instar. They appear with Scanning Electron Microscope as cuticles differentiation in the first instar (Fig. 5a).

Abdominal segments with two dorsal tubercles localized in their anterior area (Fig. 4c and 4d). Each tubercle with four secondary setae in the first abdominal segment, five setae in the 2nd –7th segment, three in the 8th and six in the 9th (Fig. 4a, 4c and 4d). We localized two small tubercles, lateral and posterior to dorsal tubercles. These tubercles must be the union of dorsal to subdorsal group (D1, D2, SD1 and SD2) (Fig. 4c, 4d and 5b). Subventral group only has one visible seta (SV1). Lateral group (L1 and L2) is localized in tubercles near to spiracle (Fig. 5d).

The chaetotaxy study, from the 2nd to the final instar of *S. panda* larvae, proved virtually impossible due to high density of setae, thus a general description...
Figure 4
Chaetotaxy of first instar larva. a, Lateral view of first instar larva; b, Lateral view of mesothoracic segment; (1) Dorsal tubercle, (2) Setae D1 and D2, (3) Tubercle with SD1, SD2 and L3 setae, (4) Tubercles with setae SV1 and SV2; c, First abdominal segment; (1) Dorsal tubercle, (2) Tubercle with D1, D2, SD1 and SD2 setae, (3) Setae L1 and L2; d, Third abdominal segment; (1) Dorsal tubercle, (2) Tubercle with D1, D2, SD1 and SD2 setae, (3) Setae L1 and L2; e, Lateral view of pupa; f, Dorsal view of pupa; (1) Remains of urticating retractable organs; g, Ventral view of pupa.
of mature larval morphology is given. Brownish-grey head with short setae. Lateral area with longer setae. Violet discontinuous stripe in middorsal area, with two black stripes in subdorsal areas. Each abdominal segment with four orange tubercles. Grey pleural area, with a black pleural stripe in zigzag.

**Pupa.** Obtect type; black colour (Fig 4e, 4f and 4g). The pupae are normally localized in an elongate brown cocoon inside a branch. Head with a pronounced epicranial suture (Fig 4g). Antennae bipectinate. Mandibles next to caudalateral labrum angle, not functional (Fig 4e and 4g). Suture between clypeus and labrum little pronounced. Maxillae and labial palpus present, palpus is localized caudal to labrum (Fig 4g). Eyes with two differential areas; one of them elongated and smoothly surfaced, whereas the other has an elliptic shape and a rough surface (Fig 4e and 4g).

Length of the prothoracic legs is longer than half a wing’s length (Fig 4g). Metathoracic legs are shorter than the wing’s length. Mesothoracic wings cover metathoracic ones (Fig 4e and 4g). Dorsally, we found two tubercles which are the remains of meso and metathoracic urticating retractable organs (Fig. 4f).

Abdomen dorsoconvex, surface covered by short and rough setae, preferentially localized in the posterior area of each segment (Fig. 4e, 4f and 4g). The 5th and the 6th abdominal segments are movable. Anterior area of each abdominal segment bearing little and smooth spines and cuticle invaginations, with circular shape (Fig. 6a). Abdominals segments from the 2nd to the 6th with scars of prolegs. Spiracles localized from the 1st to the 8th abdominal segment (Fig. 4e). The first of them not functional, covered by wings. Cremaster absent. Anal opening situated on the meson, near the caudal margin of the 10th segment. It is slit-like, surrounded on each side by several prominent wrinkles. Male gonopore is situated on the ventro-meson of the 9th abdominal segment (Fig. 6b). It is a slit-like opening.

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**Figure 5**  
Chaetotaxy of first instar larva.  
**a,** Urticating retractable organs;  
**b,** Abdominal tubercles localized lateral and posterior to dorsal tubercle. Union of D1, D2, SD1 and SD2 setae.  
**c,** Seta SD1;  
**d,** Abdominal lateral group and spiracle.
with a distinctly elevated tubercle on each side. In the female there are two slit-like openings, situated on the 8th and the 9th, which are not confluent (Fig. 6c).

Females pupae of *S. panda* are heavier (♀: 2379.13±63.26 mg; ♂: 1317.68±23.86 mg), longer (♀: 35.92±0.30 mm; ♂: 30.57±0.17 mm) and wider (♀: 10.19±0.11 mm; ♂: 8.27±0.05 mm) than males.

**Discussion**

Like other Lasiocampidae species, the egg of *S. panda* is flat type (sensu Hinton 1981; Lemaire & Minet 1998), with a prolate spheroid shape (Fig. 1a). The design of the eggs as well as the general structure of the chorion is similar to other observed and described Lasiocampidae (Peterson 1966; Hinton 1981; Arbogast et al. 1983). The spots present in the eggs (Fig. 1b) are usually found in other Lasiocampidae species, but pattern is distinctive of this species. Egg coloration and ornamentation probably have a disruptive function, breaking its form against the background, protecting the egg from enemies (Hinton 1981).

Egg biometric data agrees with Huertas Dionisio (1980); and they were twice the size of other species like *Eriogaster lanestris* (L. 1758), *E. catax* (L. 1758) or *Malacosoma neustria* (L. 1758) (Ruf 2002). Larger eggs imply a higher quantity of vitellum for early development of caterpillars, resulting in eggs with slower development (Garcia-Barros 2000). That would allow the birth of a bigger larva which, supposedly, will be better suited for feeding on its host plant's tough leaves. *S. panda* eggs size and shape did not show any connection with the female size or the host plant where the female had been fed on (Hinton 1981; Calvo 2004; Calvo & Molina 2005c).

In our study, we have confirmed the presence of secondary setae in the first instar larvae of *S. panda*, aspect already mentioned like general characteristics for the Family Lasiocampidae by Lemaire & Minet (1998). The number of secondary setae experienced a sharp increase from the second stadium, making chaetotaxy study very difficult. No previous data, apart from external description, about chaetotaxy of other species of the same genus or the same subfamily, even the same family have been found (Lemaire & Minet 1998; Bogner 1999; Calvo 2004).

![Figure 6](image)

**Figure 6**

a, Surface of abdominal segments; b, Male gonopore; c, Female gonopore
The head chemoreception system that mediating feeding is a relatively conservative feature of caterpillar morphology. The antennae, the oral chamber, the palpus, the sensilla and setae found on them, showed many similarities with the pattern found in the Tent Caterpillars, Malacosoma disstria Hübner (Fitzgerald 1995). These similarities make us think about the same function, although further research is needed.

Scanning Electron Microscope also revealed that caterpillar’s cuticle was covered by minute, pyriform microtubercles. Fitzgerald (1995) already mentioned these microtubercles containing the dark pigments in charge of cuticle colour. As the caterpillar matures, various colours and designs appear and are arranged in the conspicuous species-specific pattern. Although this particular coloration, like many other species, may change depending on the microenvironment where the larvae develop, due to genetic control, host plant/s, plant’s parts eaten and temperature (Stamp & Wilkens 1993). S. panda larvae developing at lower temperatures, showed a darkening of the general pattern. This colour variability, wide dorsal dark stripe and long lateral setae, contributed to weight gain and prevented the convective heat loss (Calvo 2004).

Mature larvae of S. panda showed external similarities with other genera like Phylloidesma, Gastropacha, Pachypasa and Dendrolimus, all of them with European species (Gómez de Aizpurúa, 2002). The long secondary setae in the subventral groups of meso and metathorax and abdominal L3 group found in this species, forming characteristic projecting lappets (Lemaire & Minet 1998), and the dorsal rhomboid dark stripe, outlined with red-orange tubercles, are good distinctive characteristics allowing the separation from the above mentioned species, especially from Pachypasa and Phylloidesma species.

Most of the main characteristics of the family Lasiocampidae (Lemaire & Minet 1998; Mosher, 1916) can be found in the S. Panda immature stages. Although, some larval aspects such as the micropylar area, eggs ornamentation, setae distribution, presence of dorsal tubercules as well as urticating organs, number of ocelli and their position, mouth parts; or the of dorsal tubercles as well as urticating organs, number and position, mouth parts; or the of dorsal tubercles as well as urticating organs, number and positions, mouth parts; or the microtubercles containing the dark pigments in charge of cuticle colour (Fitzgerald, 1995). These similarities make us think about the same function, although further research is needed.

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