Bulletin de la Société entomologique de France, **128** (2), 2023 : 173-184. ISSN 0037-928X
https://doi.org/10.32475/bsef_2264 eISSN 2540-2641

Observations on the biology of *Lachnaia cylindrica* (Lacordaire, 1848), with description of the egg and the first instar larva (Coleoptera, Chrysomelidae, Cryptocephalinae)

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(Accepté le 10.V.2023 ; publié en ligne le 19.VI.2023)

Abstract. – During spring 2022, numerous observations of *Lachnaia cylindrica* (Lacordaire, 1848) have been made by the author, providing clarification on the biology of the species. For the first time, adults have been observed breeding on *Pinus halepensis* Mill., 1768. Mating, egg-laying behaviour and first instar larva have been observed and are described. A comparison with data available on other *Lachnaia* species, as well as other species in the tribe Clytrini, is made. The egg of *Lachnaia paradoxa* (Olivier, 1808) is also described for the first time.

Résumé. – **Observations sur la biologie de *Lachnaia cylindrica* (Lacordaire, 1848), avec description de l'œuf et du premier stade larvaire (Coleoptera, Chrysomelidae, Cryptocephalinae)**. Au printemps 2022, de nombreuses observations de *Lachnaia cylindrica* (Lacordaire, 1848) ont été effectuées par l'auteur, permettant d'améliorer les connaissances sur cette espèce. Elle est pour la première fois observée se nourrissant sur *Pinus halepensis* Mill., 1768. L'accouplement, la ponte, ainsi que le premier stade larvaire ont pu être observés et sont décrits ici. Une comparaison avec les données disponibles sur les autres espèces du genre *Lachnaia*, et plus largement de la tribu Clytrini, est faite. L'œuf de *Lachnaia paradoxa* (Olivier, 1808) est ainsi aussi décrit pour la première fois ici.

Keywords. – Clytrini, egg description, behaviour, *Lachnaia paradoxa*, host plant.

Lachnaia cylindrica (Lacordaire, 1848) is a beetle belonging to the Chrysomelidae Latreille, 1802, a diversified family gathering around 40 000 species around the globe (Aberlenc *et al.*, 2020). More precisely, it belongs to the Clytrini Kirby, 1837, now included in the Cryptocephalinae Gyllenhaal, 1813. In metropolitan France, the Clytrini include 38 species in nine genera (Debreuil, 2014), and recent identification keys allow to determine them (for instance, for French species: Alonso, 2007; Debreuil, 2010).

Among *Lachnaia* Chevrolat, 1836, the species *L. cylindrica* (Lacordaire, 1848) is morphologically characterised by the elytral base without margin, the anterior elytral spot placed behind the humeral callus, and the anterior tarsi of the male not particularly elongated and relatively large (Debreuil, 2010). It is also distinguished by the adult activity period, which takes place in early spring, between March and early June (Boyer de Fonscolombe, 1845; Debreuil, 2010; GBIF, 2021; iNaturalist, 2022; OpenObs, 2022) (for internet sources, only data confirmed on picture by the author have been taken into account).

This species has a western Mediterranean distribution, extending from the Iberian Peninsula to Greece including Crete, as well as Algeria, Morocco and Tunisia (Regalin & Medvedev, 2010). In France, it is distributed over the Mediterranean area, but is not known from Corsica (Debreuil, 2014). Towards the North, the distribution limit seems to be the south of the Ardèche department, based on a mention of *L. cylindrica* in Saint-Martin-d'Ardèche, Ardèche, France, on 4.V.1945 (Balazuc, 1984).

The Cryptocephalinae and the Lamprosomatinae Lacordaire, 1848 are together known as the Camptosomata (Chamorro, 2014). This group is distinguished from other Chrysomelidae by a particular larval biology, which has been the subject of many articles (Brown & Funk, 2005; Chaboo *et al.*, 2016). Indeed, Camptosomata larvae develop inside the shelter of a protective shell, formed by plant fragments, faeces or dirt, which they carry with them and from which they leave only after adult emergence. The eggs are already covered by a shell put in place by the female during oviposition. These shells are called egg-cases or larval-cases, and Camptosomata are known as case-bearers (Erber, 1988).

Most Camptosomata larvae live in leaf litter or on various plants, but some genera have a myrmecophilous biology, and feed on plant or animal fragments found in the ant nests. This is particularly the case for *Clytra* Laicharting, 1781, and *Lachnaia*, whose eggs are transported by the ants into the nest. The adults emerge from it after the imaginal moult (Xambeu, 1900; Jolivet, 1952; Agrain *et al.*, 2015). However, for some species belonging to these two genera, obligatory myrmecophily remains a hypothesis, and new observations are needed to better understand their larval biology. This is for instance the case for *Lachnaia paradoxa* (Olivier, 1808) (Petitpierre, 2000).

Concerning *L. cylindrica*, very little information is available on its biology. Petitpierre (2000) wrote that the immature stages are unknown. Despite an extensive literature search, including a study on the immature stages of Cryptocephalinae (Chaboo *et al.*, 2016), no further information was found. The aim of this article is to provide further details on the biology of this species, based on observations made in 2022.

Methods

From 18.III.2022 to 25.III.2022, *L. cylindrica* was encountered repeatedly on "Le domaine de Restinclières", Prades-le-Lez, Hérault, France (*ca* 43°43'06''N 3°51'40''E). Observations were made during sunny days, between midday and late afternoon. They took place on a limestone garrigue, facing south and east, with sparse vegetation mainly composed of bushes

Fig. 1. – Sparsely vegetated scrubland where observations of *Lachnaia cylindrica* took place. Domaine de Restinclières, Prades-le-Lez, France.

of *Rosmarinus officinalis* L., 1753, *Pistachia lentiscus* L., 1753, *Juniperus oxycedrus* L., 1753 and *Juniperus phoenicea* L., 1753, as well as a few *Pinus halepensis* Mill., 1768, of various ages. Figure 1 shows the biotope.

Movements, mating, feeding and egg-laying have been studied in the field. Pictures were taken to illustrate these behaviours (fig. 2-5). A video showing the aspects described in this article is available at the following link: https://youtu.be/zi4evmv3AT4.

Finally, two eggs were collected and reared. The first larval stage was observed. However, the rearing could not be continued because the larvae withered and died. The two first instar larvae were only accurately studied when dead, with the soft parts of the body poorly preserved, especially the abdomen. The description therefore focuses on the head, legs and pronotum, which are also the main elements described in the literature. The morphological terms used in the description are following Reid (1990). The pictures of the egg and larva were taken using focus stacking technology, in the Centre de Biologie pour la Gestion des Populations (CBGP) in Montferrier-sur-Lez, Hérault, France.

During the literature search, a video and several pictures of the oviposition of *Lachnaia paradoxa* (Olivier, 1808), published on the internet, but not reported, were found. The observer was contacted, which allowed access to precise data on the date and place, and confirmation of the insect identification. It was observed in a private garden of Cala Serena, on the island of Mallorca, Spain, between 4.V.2019 and 8.V.2019, and on 26.IV.2020. The egg of *L. paradoxa* is described based on the transmitted pictures.

In a first part, the results of these observations are presented, with several aspects examined in turn. In a second part, they are discussed, based on the consulted literature.

Results

Adult diet. – Adults of *L. cylindrica* were observed on twigs of *Juniperus oxycedrus* (one observation), *J. phoenicea* (four observations), and mainly *Pinus halepensis* (more than 40 observations). Adults were observed feeding only on *P. halepensis*, feeding on young pine needles of small trees. The insect positions itself on the pine-needle, and bites it with its mandibles, collecting pieces of tissue from the needle (fig. 2). It gets closer to the pine-needle base as it continues to feed. The attacked needle either breaks or keeps its initial length, and the remaining part arches and gets brown as it desiccates, leaving a visible trace of the insect feeding damage. Several times, the insect was observed on young buds of *P. halepensis*, but without any evidence of feeding on them (fig. 3).

Mating. – Three matings have been observed on twigs of *P. halepensis*. When a male meets a female, he clings to her elytra (fig. 4). The female does not react and remains motionless, clinging to a twig or a needle. The male then positions himself far back, with his abdomen curved so that its apex is in contact with the female's abdominal apex. The forelegs are positioned towards the middle of the elytra, the middle and hind legs are clasped either to the elytra or on the female's abdomen. In case of disturbance, the male shakes his forelegs, before repositioning them on the female's elytra. The antennae are straight and do not seem to be involved, at least mechanically, in this process. One of the observed matings lasted about 15 minutes, after which female and male parted. As for the remaining two couples, the duration of the mating was not observed, but they lasted at least 10 minutes.

Egg-laying. – This paragraph gives the first description of the oviposition and egg of *L. cylindrica* according to reviewed literature, as well as the first description of the egg of *L. paradoxa*.

Four females were observed on *P. halepensis* twigs, laying eggs. However, the whole process was only observed once.

The female clings to the end of a *P. halepensis* bud with her front and middle legs. An oval, dull yellow egg is laid. It is about 1.3 mm long and 0.6 mm wide. It is held by the hind

Fig. 2-5. – *Lachnaia cylindrica* (Lacordaire). – **2**, Adult feeding on a young needle of *Pinus halepensis*. – **3**, Adult on *P. halepensis* buds; dry needles eaten by the insect are visible. – **4**, Mating on *P. halepensis*. – **5**, Female covering her egg with a protective layer.

legs and moved towards the abdomen at the foveola of the last abdominal sternite, with its length parallel to the body axis. The female then produces a light brown substance at the tip of her abdomen, and adds it to the egg, depositing a succession of 'scales'. These scales are elongated and curved, roughly in the shape of a gutter segment, and are nested around the egg. It is the hind legs that intermittently rotate the egg.

As the scales are placed on the egg, it is increasingly tilted until being held perpendicular to the axis of the body (fig. 5). It is no longer the side of the egg that is inserted into the last sternite's foveola, but the apex of the egg which is still free. The hind legs hold the egg by the scales which cover it more and more, and continue its rotation.

The arrangement of the scales follows a very precise plan: they are applied in a tight spiral and form seven longitudinal ribs. Thus, seen from one of its two poles, the packed egg looks like a seven-pointed star. In profile, it could be compared to a tiny pine cone, with particularly ordered scales (fig. 6, 8a). Each rib consists of about 12 scales, the first ones being smaller than the following.

The female completes the egg covering by placing five small scales on top of it, perpendicular to the others. The protected egg is about 1.8 mm long and 1.3 mm wide. She then drops it to the ground from the branch where she is positioned, 21 minutes after the egg has been laid. The strong wind, which was swaying the branch at the time of observation, does not appear to have disturbed the oviposition, but observation of an oviposition in calm weather would be necessary for comparison. The female then quickly flies away. The area in the immediate vicinity of the oviposition does not seem to show any peculiarity, and in particular no ant nests, although these were carefully looked for.

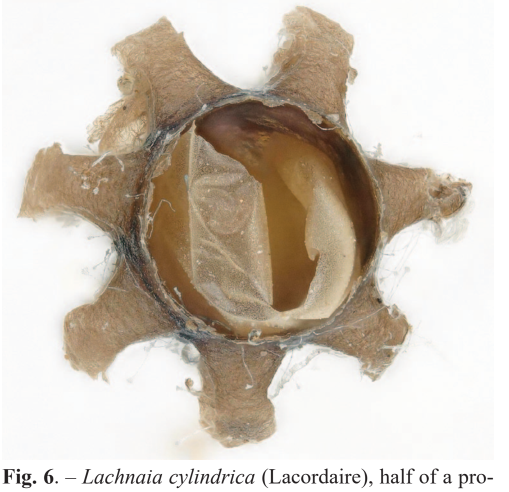

Fig. 6. – *Lachnaia cylindrica* (Lacordaire), half of a protective egg-case, seen from the anterior part, after hatching (this is an egg that has not been completely covered, as the female has been disturbed). The chorion of the egg is visible inside.

Pictures and video of *Lachnaia paradoxa* laying eggs were also studied. These records show that the laid egg is maintained in the same way as in *L. cylindrica*. It is covered with thin scales having widely enlarged edges and prominent beads. The yellow colour of the egg is visible through the centre of the scale. The whole looks like a regular assembly of lozenges. The female finishes by laying a sort of cover of several scales, perpendicular to the others (fig. 7, 8b). Seven to ten minutes elapse between the start of the egg laying and the moment when the egg is released, and at least seven eggs have been laid successively. The final appearance of the case is very different from that surrounding the egg of *L. cylindrica*, confirming the variability of this trait, even within one genus (Erber, 1988; Chaboo *et al.*, 2016).

Fig. 7. – *Lachnaia paradoxa* (Olivier), egg laying. *(Photo by Mirella Zenders)*.

Rearing trial. – An egg of *L. cylindrica* was collected by placing a container under the female when she dropped it on

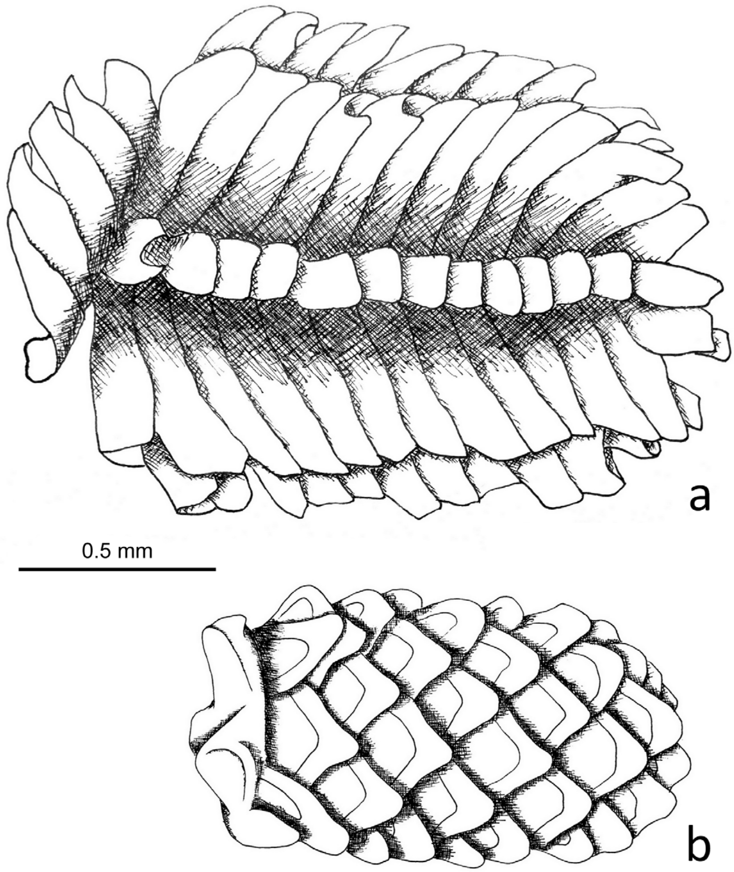

Fig. 8. – *Lachnaia spp.*, eggs in lateral view. – **a**, *L. cylindrica* (Lacordaire). – **b**, *L. paradoxa* (Olivier).

24.III.2022. A second egg was collected during an oviposition, on 25.III.2022, and was therefore not completely covered with scales: a third of the egg protrudes from the protective case (this is the one shown in fig. 6). These two eggs were reared in a tube.

After less than 24 hours, the material covering the egg has changed from light to dark brown.

Unfortunately, continuous monitoring could not be carried out, and the hatching date is not known with certainty: the two eggs hatched between 18.IV.2022 and 1.V.2022. This corresponds to a period of 24 to 35 days between laying and hatching.

The larva from the half-covered egg failed to stay in the protective layer and died soon afterwards, desiccated. The other larva, from a complete oviposition process, survived until 14.V.2022, but did not survive beyond the first larval stage either. There are many possible explanations for the failure of this rearing, including perhaps non-optimal temperature, humidity and feeding conditions.

However, several elements could be observed, and deserve to be described. They relate to the larva resulting from the complete oviposition, *i.e.*, the complete covering of the egg.

The larva has never been observed entirely outside the protective case surrounding the egg (fig. 9). When disturbed, it re-enters and the top of its head, forming a leathery, almost flat disc, obstructs the entrance. When it moves, the case is dragged away, and the body is uncovered up to about the third abdominal segment, leaving the three leg pairs free. The case put in place by the female during oviposition has been slightly enlarged by the larva, which has added some solidified substrate around the open end, thus lengthening the structure.

In the rearing tube, a fine soil substrate was placed. On this substrate, several elements were offered to the neonate larva: larvae, pupae (unidentified Formicidae species) and dead adults of ants (*Messor* Forel, 1890), as well as seeds taken from individuals of *Messor* sp. returning to the nest, on the Restinclières Estate. The larva lost interest in the ants, whatever the stage, and was found the next day in the substrate, gnawing from under a dry seed. In a second test, a wounded ant pupa was presented: the *L. cylindrica* larva apparently took up some oozing liquid for about two seconds before changing direction and was found in the substrate under a seed the next day.

Fig. 9. – *Lachnaia cylindrica* (Lacordaire), first instar larva in its protective case.

Description of the first instar larva. – Neonate larva about 1.39 mm long. Head heavily sclerotized, reddish brown, with dorsal surface, from forehead to clypeus, almost flat and circular. Long legs light brown. Rest of body less sclerotized, pale yellow, except for pronotum, with brown dorsal plate. Abdomen slightly arched ventrally in posterior third.

Head (fig. 10a-b). Anteriorly, forms a disc about 0.51 mm wide, 0.47 mm long. Dorsally, epicranium integument densely punctured, with confluent dots, forming wrinkles behind eyes; ventrally, epicranium integument finely and regularly punctured. Frons, clypeus and labrum fused. Frons microreticulated; clypeus and labrum almost smooth (fig. 11). Epicranial suture (Epcs) clearly visible between frons and epicranium, disappears posteriorly on epicranium; divided into two almost opposite frontal sutures (Frs), which slope and join back of antennal insertions, forming kind of "Y". Six stemmata per side: four placed in a square posterior to antennal insertion, on side of head (St1-4), two positioned under antennal insertion, on ventral side (St5-6). Antennae (Ant) inserted into a groove under frons margin, very short, consisting of two articles; first one slightly longer than wide, second one 1.5 times as wide as long and half as wide as first one. Head capsule with two kinds of setea, simple, pointed setae and broad, papillate setae. Postero-dorsal epicranial setae not visible; five pairs of anterior setae (Aes), Aes1 broad, papillate, next to epicranial suture, Aes2 long simple, pointed, Aes3-5 broad, papillate, above stemmata on epicranium; one pair of solitary setae (Des1), broad, papillate; three pairs of latero-epicranial setae (Les1-3), simple, pointed, in an elongated triangular configuration; three pairs of ventro-epicranial setae (Ves), simple, pointed, Ves1 between St1-4 and St5-6, Ves2 between antennal groove and St5-6, Ves3 under antennal groove, next to base of mandibule; six pairs of frontal setae (Fs) broad, papillate, arranged in three rows: one pair (Fs1) posteriorly, two pairs (Fs2-3) in centre of frons, three pairs (Fs4-6) anteriorly, along the presumed fronto-clypeal junction; one pair of clypeal setae (Cs1), broad, papillate, between Fs3 and Fs4, slightly anteriorly; three pairs of labral external setae (Lbs1-3), simple, pointed; four pairs of epipharyngeal setae (Eps1-4), simple, pointed, small. Mandibles symmetrical, strongly sclerotised, roughly triangular (fig. 10e-f-g). Base of mandible shorter than its length.

Main tooth at apex (Too3), with additional tooth on lower edge. One smaller tooth on upper edge, overlapping internal basal projection (Ibp). Outer margin with two simple setae, distal one (Ms2) longer than proximal one (Ms1).

Thorax. Prothorax with large pronotal sclerite, strongly sclerotised, forming a lateral band wider than head, following curvature of body (fig. 10c); posterior angles broadly truncated, anterior angles rounded; median suture slightly visible, with lighter colouration; 0.18 mm long, 0.54 mm wide. Numerous fine setae present. Legs similar to each other, long and well developed (fig. 10d). Femora about two and a half as long as wide, flattened into the shape of a blade, with several setae, one of them very long. Tibiae long and thin, with many setae. Tarsungulus weekly curved, with one seta at base (Ts).

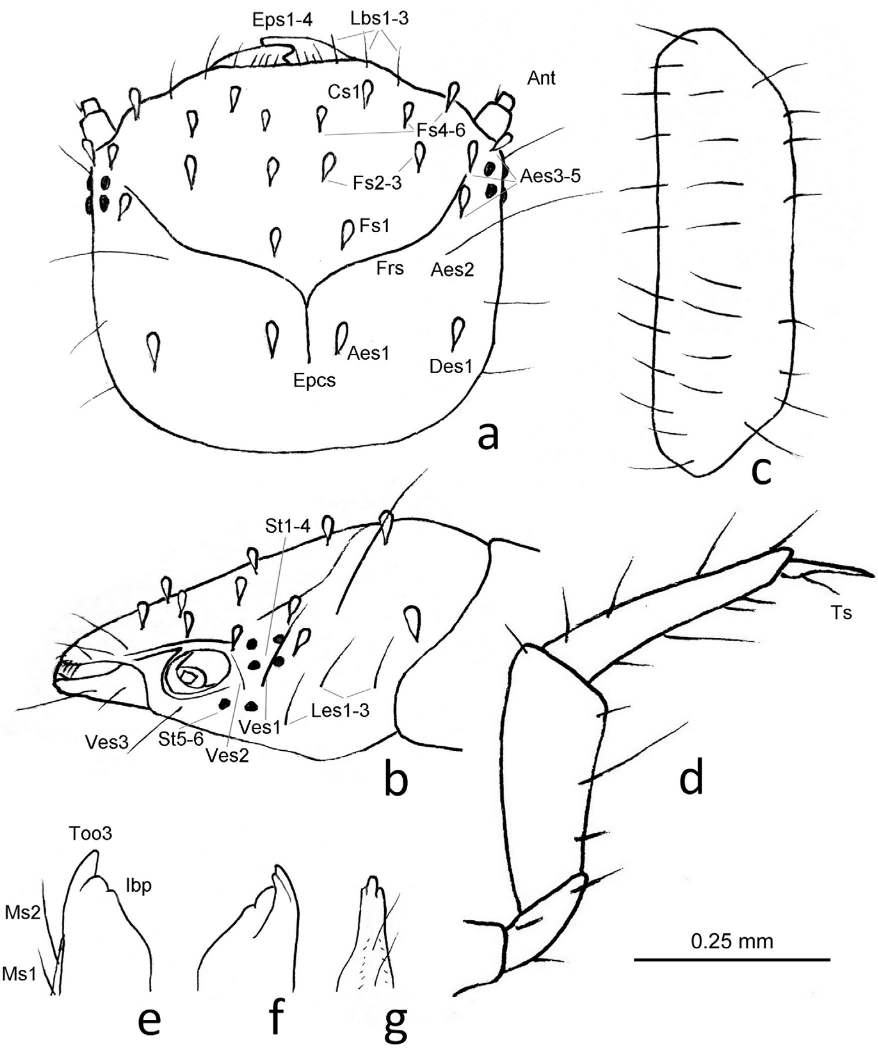

Fig. 10. – *Lachnaia cylindrica* (Lacordaire), first instar larva (same scale for all drawings). – **a**, Head in dorsal view. – **b**, Head in profile view. – **c**, Pronotum in dorsal view. Front is to the left. – **d**, Left median leg. – **e**, Left mandible in dorsal view. – **f**, The same in ventral view. – **g**, The same in side view, from the outside.

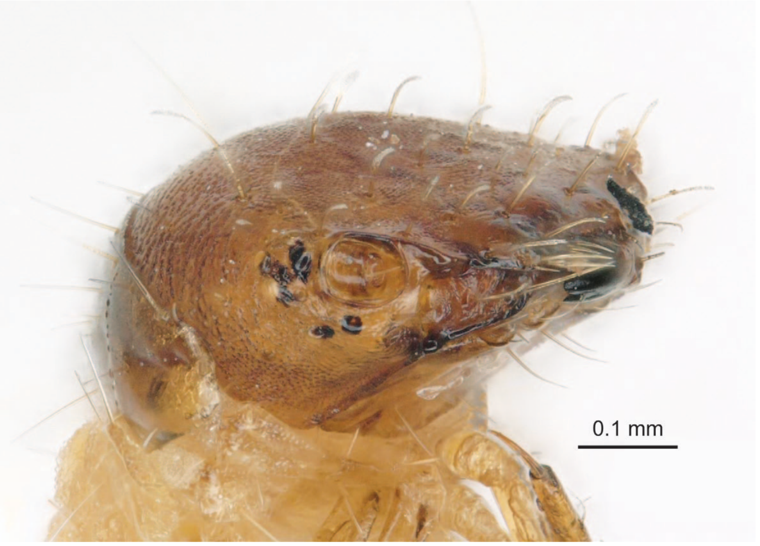

Fig. 11. – *Lachnaia cylindrica* (Lacordaire), first instar larva, detail of head.

Discussion

Adult diet. – Clytrini are considered polyphagous beetles, consuming in Europe mainly broad-leaves species of the Fagaceae and Betulaceae (Jolivet, 1988). Although the adults of *Lachnaia* species found in France often have a notable preference for *Quercus*, they also consume Fabaceae, Rosaceae, Salicaceae, Poaceae, *etc.* (Petitpierre, 2000; Debreuil, 2010). Only the species *L. cylindrica* and *L. tristigma* (Lacordaire, 1848) are cited from *Juniperus sp.* (Cupressaceae), the only gymnosperms mentioned in the consulted literature.

As for *L. cylindrica*, it is described as "Monophagous in France on *Juniperus* and *Cedrus*" (Debreuil, 2014). Jolivet (1967) only mentions it on *Juniperus.* Petitpierre (1983) writes that in Catalonia (Spain), it has only been found on *Quercus sp.*

The observations make it possible to add *P. halepensis* to the list of plants consumed by adults of *L. cylindrica*. *Pinus halepensis* belongs to the same family as the genus *Cedrus*: the Pinaceae. It would be interesting to see if other species of Pinaceae, or more generally other gymnosperms, are consumed by *L. cylindrica*, and if other *Lachnaia* species share this diet.

Mating. – These observations made it possible to specify the mating process in *L. cylindrica*, which has never been observed before, according to the literature studied. Fiori (1948) described mating in *Lachnaia italica* (Weise, 1881), and mentioned repeated movements of the male's antennae, which strike the female's elytra. This behaviour was not noted in the three observed matings. This aside, the elements described here are in agreement with what is known in the literature for Clytrini (Jolivet, 1952; Erber, 1988).

Egg-laying. – In the genus *Lachnaia*, oviposition has been described briefly for *L. italica* by Fiori (1948). The features correspond to those observed for *L. cylindrica* and *L. paradoxa*: laid egg held by the hind legs to put the case into place, egg then released from the female's position. Unfortunately, the egg and its case are neither described nor figured. No other description of the oviposition and egg of *Lachnaia* was found in the literature.

Petitpierre (2000) quotes Steinhausen (1994), explaining that in *Lachnaia*, the eggs bear a filament by which the female attaches them to the substrate. This feature is known and illustrated for *Labidostomis* Chevrolat, 1836 (Jolivet, 1952; Wasowska, 2007), but does not correspond to the observations made for *L. cylindrica* and *L. paradoxa*, nor to what is described in the literature (Fiori, 1948; Erber, 1988). This information must be considered as doubtful, pending the description of oviposition in the other *Lachnaia* species.

Outside the genus *Lachnaia*, several descriptions of Cryptocephalinae eggs show a case structure like that of *L. cylindrica*. These include the eggs of *Clytra quadripunctata* (Linnaeus, 1758) and *Clytra arida* Weise, 1889, species belonging to a genus close to *Lachnaia*, described as being covered with interlocking "tiles" and resembling a small "pine cone" (Erber, 1988; Lee & Morimoto, 1991). The same is true for *Cryptocephalus* Geoffroy, 1762 eggs, illustrated in Erber's work. However, in both cases the arrangement of the scales is not ordered as in *L. cylindrica*.

It would be interesting to study the eggs of other *Lachnaia* species, to know if each species produces a characteristic case shape, and if some of them are similar to those described for *L. cylindrica* and *L. paradoxa*. In addition, it would be useful to repeat the observations, to find out whether oviposition behaviour can be variable, and if so, in what ranges.

Rearing trial. – These observations agree with the descriptions available in the consulted literature. The case, which originates from the egg, serves as protection for the larva, and a larva that lacks this case quickly dies (Jolivet & Petitpierre, 1981; Schöller, 2011). Erber (1988) indicates that myrmecophilous Clytrini larvae are carnivorous, and this evidence is also complemented by the observations of Schöller (2011). However, observations made for the first instar of *L. cylindrica* tend rather to show a preference for phytosaprophagy, which is also a behaviour cited by Schöller (2011) and Agrain *et al.* (2015).

It would be interesting to follow the complete larval development of *L. cylindrica*, to know the diet until the last stage. This would also make it possible to describe the morphology of the aged larva, as well as the larval-case, and to compare them with other species of the genus. Indeed, these elements are known for *L. paradoxa* (Lucas, 1851), *L. italica* (Fiori, 1948), *L. pubescens* (Dufour, 1820) and *L. tristigma* (Lacordaire, 1848) (Xambeu, 1900).

Description of the first instar larva. – Fiori (1948) described for the first time a first instar larva of *Lachnaia*, that of *L. italica*. The detailed description he gives is very comparable to what was observed in *L. cylindrica*. On the head, the same setae were found, sometimes with a slightly different arrangement on the frons and clypeus. In addition, two pairs of fine setae, between Cs1 and Lbs1-3, are mentioned by Fiori (as "*clypeo-frontali*" and "*clypeali interne*") but seems to be absent in *L. cylindrica*. It could correspond to a fourth pair of labral external setae, or an additional epipharyngeal setae. However, it would be interesting to study more abundant material, to better observe the labral setae.

Several identification keys of the known larval stages of Clytrini are available (Medvedev, 1998; Medvedev & Schöller, 2002; Wasowska, 2007).

In the key by Medvedev & Schöller (2002), the following characters are identified: six to ten setae on vertex, one seta near epicranial suture (Aes1), at least three pairs of papillate setae on vertex (Aes1, Aes3-5, Des1) and short epicranial suture (Epcs), leading to the genera *Clytra* and *Lachnaia*. However, the character on the anterior margin of the labrum —bi-emarginate for *Clytra* and *Lachnaia*, feebly arcuate for *Macrolenes* Chevrolat, 1837— is not met here: the anterior margin of the labrum is straight for *L. cylindrica*. Then, the characters discriminating *Lachnaia* and *Clytra* —distinct sclerites on meso- and metathorax, size of setae on the anterior margin of prothorax— cannot be observed here: the meso- and metathorax are not well enough preserved to be studied, and, even if the length of pronotal setae does not seem to be different, some very long setae may have fallen out.

In the key by Wasowska (2007), the following characters are identified: one seta near epicranial suture (Aes1), setae on vertex papillate (Aes1, Aes3-5, Des1) and labral external setae (Lbs2-3) simple, pointed. These characters lead to *Lachnaia*. *Clytra* is distinguished by having Lbs2-3 papillate, as illustrated in Lee & Morimoto (1991).

The key by Medvedev & Schöller (2002) is the most comprehensive one for Palaearctic Clytrini (eight genera) but it is based on last instar larvae. The key by Wasowska (2007) considers fewer genera (only five) but is based on known first instar larvae. The observations made in this article support the discriminating characters identified by Wasowska.

Conclusion

The observations of *Lachnaia cylindrica* carried out in 2022 provide several elements on the biology of this little-known species, notably the diet of the adults, the oviposition behaviour, and the particular sculpture of the protective case of the egg. It also allows to give the first description of its first instar larva.

Literature search has made it possible to find photographic documents and videos that describe the oviposition and egg laying of *Lachnaia paradoxa*.

It would be interesting to continue these observations, not only on these two species, in order to have the description of the complete cycle and in particular to know the host ants, but also on the other *Lachnaia* species, in order to compare the various elements presented here.

Acknowledgments. – First, I would like to thank Mirellas Zeeders, for her permission to use her observation of *Lachnaia paradoxa* oviposition. I would also like to thank Antoine Foucart and Jean-Claude Streito, for their availability and their help in taking photographs, as well as Marc Morvan, from the Muséum national d'Histoire naturelle (Paris), and Jean-Daniel Lheuillier from the media library of Saint-Médard-en-Jalles, for their assistance in bibliographical research. Finally, I would particularly like to thank Rémy Meyer and Lana Coste for their careful proofreading of this work and their precious help with the English translation.

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