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The genus *Lecanopsis* Targioni Tozzetti (Hemiptera, Coccidae): present status and remarks on species identification

Abstract - This paper deals with the results of a revision on the genus *Lecanopsis* Targioni Tozzetti. All the type slides and other specimens from the main European museums and collections have been studied. The revision highlighted synonymies among species and misidentifications of species erroneously placed in this genus. Before the revision the genus included 18 species, but at the end of this study the number of *Lecanopsis* species was reduced to 11, plus 3 unrecognisable species. In addition, 2 new species have been recently collected in Italy. Little is known about the morphology of young instar of several species. In fact, all developmental stages are known for only two species, namely *L. formicarum* Newstead and *L. clodiensis* (Pellizzari). The importance of the 1st-instar nymphs for identifying *Lecanopsis* at the species level is reported.

Key words: Soft scales, systematics.

Some years ago we started a systematic study of all species included in the genus *Lecanopsis* Targioni Tozzetti. The work was stimulated by the discovery of a new species, later described as *L. clodiensis* (Pellizzari). Our study and others (Danzig, 1980; Kosztarab & Kozár, 1988; Hodgson, 1994) drew attention to the fact that *Lecanopsis* was in need of revision, mainly because of poor descriptions of several species. During the revision we studied all of the type material and specimens placed in *Lecanopsis* from all over the world. We also carried out intensive field collecting throughout Italy and added important new knowledge on the morphology, biology and distribution of *Lecanopsis* species.

We have completed the revision of the genus and the results are summarised here.

STATUS OF THE GENUS *LECANOPSIS* BEFORE THIS REVISION

Before our revision the genus included 17 species (Ben-Dov, 1993; Pellizzari, 1995). They were the following:

- 1. *Lecanopsis aphenogastrorum* Gómez-Menor Ortega, 1928
- 2. *Lecanopsis ceylonica* Green, 1922
- 3. *Lecanopsis clodiensis* (Pellizzari, 1995)
- 4. *Lecanopsis fallax* (Giard, 1894)
- 5. *Lecanopsis festucae* Borchsenius, 1952
- 6. *Lecanopsis formicarum* Newstead, 1893
- 7. *Lecanopsis iridis* Borchsenius, 1952
- 8. *Lecanopsis lineolatae* King & Cockerell, 1897
- 9. *Lecanopsis myrmecophila* Leonardi, 1908
- 10. *Lecanopsis nevesi* Gómez-Menor Ortega, 1946
- 11. *Lecanopsis radicumgraminis* (Fonscolombe ,1834)
- 12. *Lecanopsis rhizophila* Targioni Tozzetti, 1868
- 13. *Lecanopsis sacchari* Takahashi, 1928
- 14. *Lecanopsis shutovae* Borchsenius, 1952
- 15. *Lecanopsis taurica* Borchsenius, 1952
- 16. *Lecanopsis terrestris* Borchsenius, 1952
- 17. *Lecanopsis turcica* (Bodenheimer, 1951)

Filippia subterranea Gomez-Menor Ortega was listed as synonym of *L. formicarum*.

PRESENT STATUS

Based on a detailed analysis of the type material of each species placed in the genus, we discovered several misidentifications and improper placements which allowed us to exclude species erroneously placed in *Lecanopsis* (tab. 1). Consequently the number of species included in the genus *Lecanopsis* was reduced from 17 to 12

Table 1 - Genus *Lecanopsis*: present status.

Transferred to other genera	Synonymised with other <i>Lecanopsis</i> species	Recognized <i>Lecanopsis</i> species
<i>Lecanopsis ceylonica</i>	<i>Lecanopsis terrestris</i>	<i>Lecanopsis formicarum</i>
<i>Lecanopsis nevesi</i>	<i>Lecanopsis festucae</i>	<i>Lecanopsis subterranea</i>
<i>Lecanopsis lineolatae</i>		<i>Lecanopsis aphenogastrorum</i>
<i>Lecanopsis sacchari</i>		<i>Lecanopsis taurica</i>
		<i>Lecanopsis iridis</i>
		<i>Lecanopsis shutovae</i>
		<i>Lecanopsis turcica</i>
		<i>Lecanopsis myrmecophila</i>
		<i>Lecanopsis clodiensis</i>
		<i>Lecanopsis</i> n. sp. nr.1
		<i>Lecanopsis</i> n. sp. nr.2

(three of which are unrecognisable species). Two additional new species recently discovered in Italy will be described in the near future.

The following species are unrecognisable:

Lecanopsis rhizophila Targioni Tozzetti, 1868

Lecanopsis radicumgraminis (Fonscolombe, 1834)

Lecanopsis fallax (Giard, 1894)

These were poorly described, never recollected and the types are definitely lost.

IDENTIFICATION OF *LECANOPSIS* INSTARS AND SPECIES

In the genus *Lecanopsis* the female goes through four developmental stages (1st-instar female, 2nd-instar female, 3rd-instar female, adult female), while the male has five (1st-instar male, 2nd-instar male, prepupa, pupa, adult male). The 1st instars (male or female) are clearly identifiable although we are unable to distinguish the gender. Some confusion in identification of the other stages has occurred in the literature. For example, Borchsenius (1957) confused the 2nd-instar male with the 2nd-instar female. Coccidologists not experienced in the group could also confuse 2nd-instar females with 3rd-instar females or vice versa. Boratynski *et al.* (1982) was the first to describe all of the developmental stages of a *Lecanopsis* species correctly. The main morphological characters that aid in separating the different developmental stages are:

- 1st instar (male or female): presence of minaret-like setae.
- 2nd instar male: presence of well-developed antennae and legs. Dorsal tubular ducts forming a single row across IV abdominal segment.
- 2nd instar female: antennae reduced, conical, 5 or 6-segmented; legs reduced, conical, with tibia and tarsus partially fused; peritreme cavity with several spiracular disk-pores (fig. 1,a,b).
- 3rd instar female: antennae reduced, conical, 6 or 7-segmented; legs reduced, with tibia and tarsus not fused together; depending on the species, the legs are more or less developed, subconical or more elongate (fig. 1,c,d,e); peritreme cavity completely covered with spiracular disk-pores so close together that it is hard to count them.
- Adult female: antennae and legs well developed, dorsal longitudinal band of preopercular pores present; ventral genital pores present.

It is well known that the identification of scale insects is mainly based on the morphology of adult females. Nevertheless, in some cases the adult females of different species of a genus may be characterised by a rather uniform interspecific morphology and by high intraspecific variability of numerical morphological characters, widely used in systematics (size, number of pores, number of antennal segments, etc.) making precise identification to species problematic. That is the case with the genus *Lecanopsis*. All the above reported morphological characters, that were previously used to diagnose species, have been shown to be highly variable when long series of

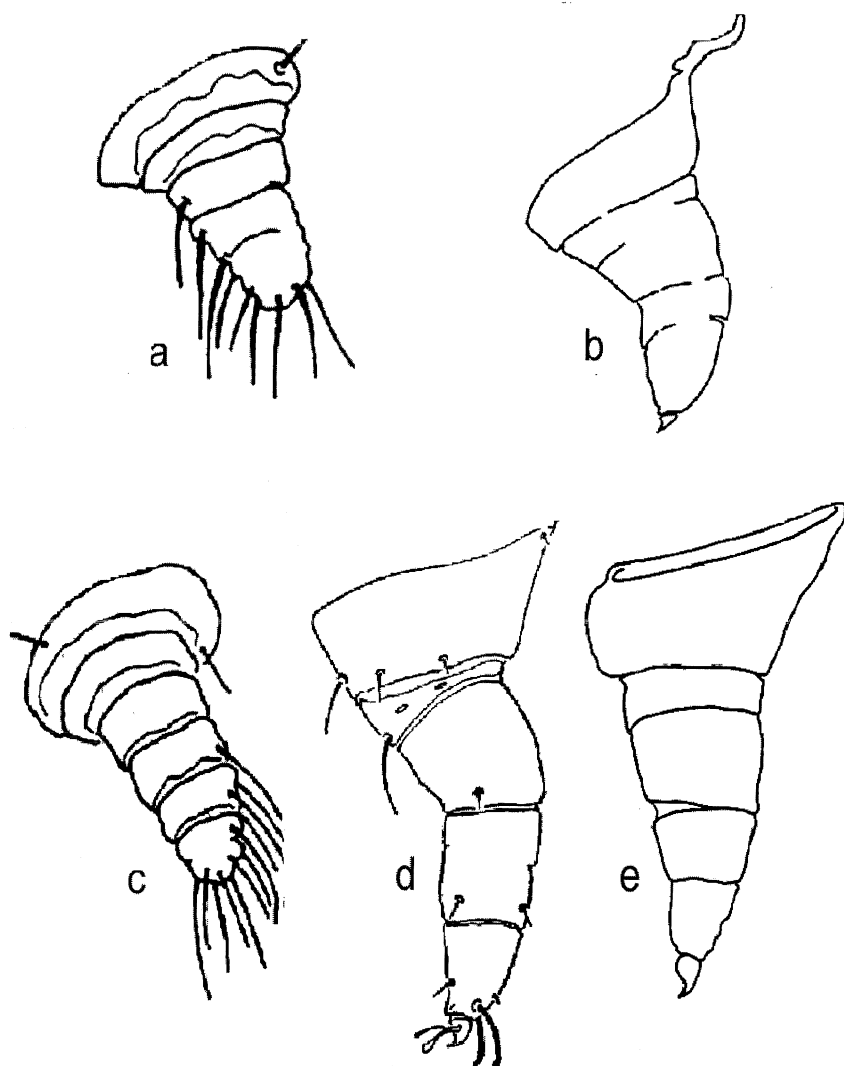


Fig. 1 - a) antenna of 2nd-instar female; b) leg of 2nd-instar female; c) antenna of 3rd-instar female; d) and e) different kinds of leg of 3rd-instar female.

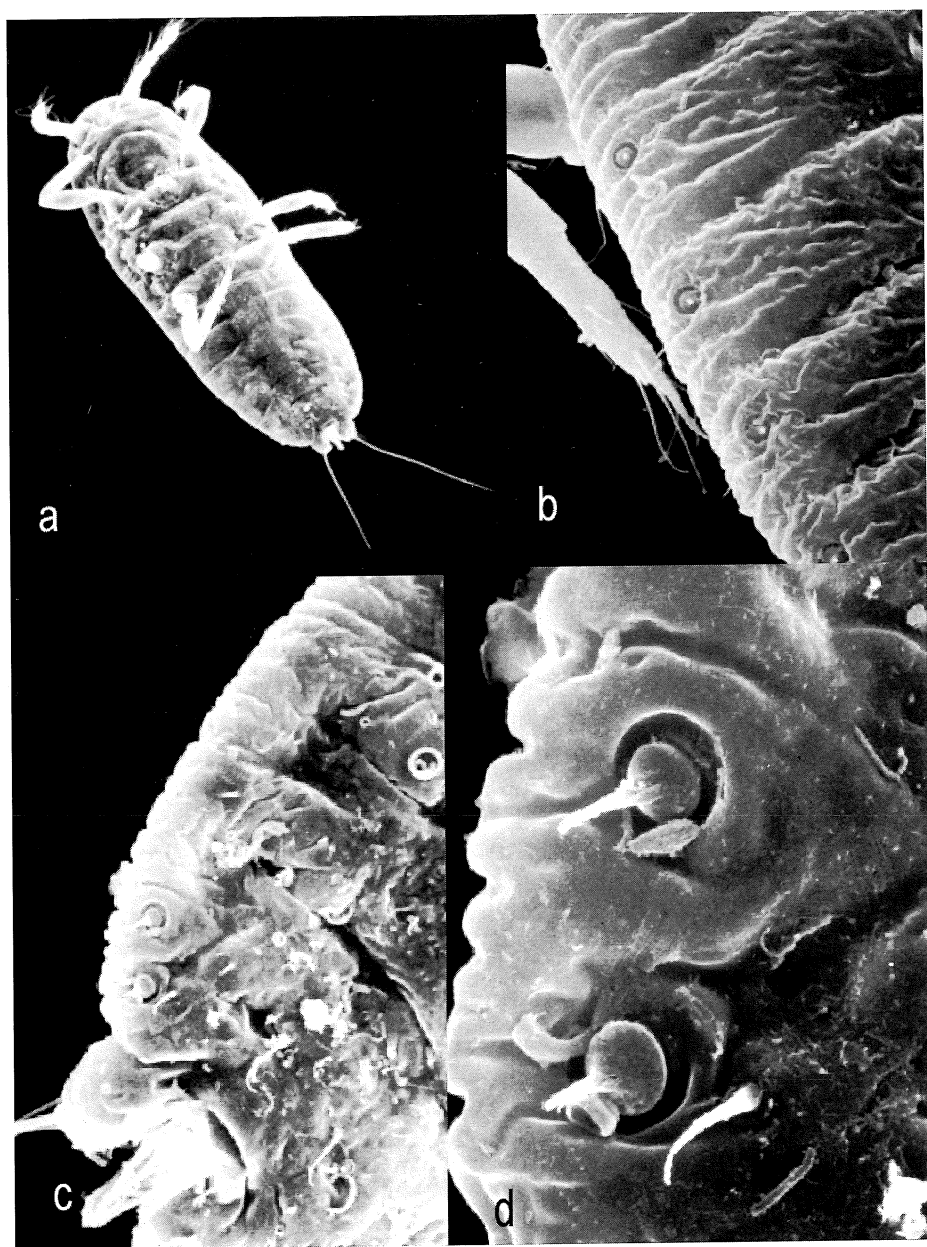


Fig. 2 - a) crawler of *L. clodiensis*. b) marginal minaret-like setae c) ventral position of the last two minaret-like setae d) same as in c, enlarged (SEM microscopy photos).

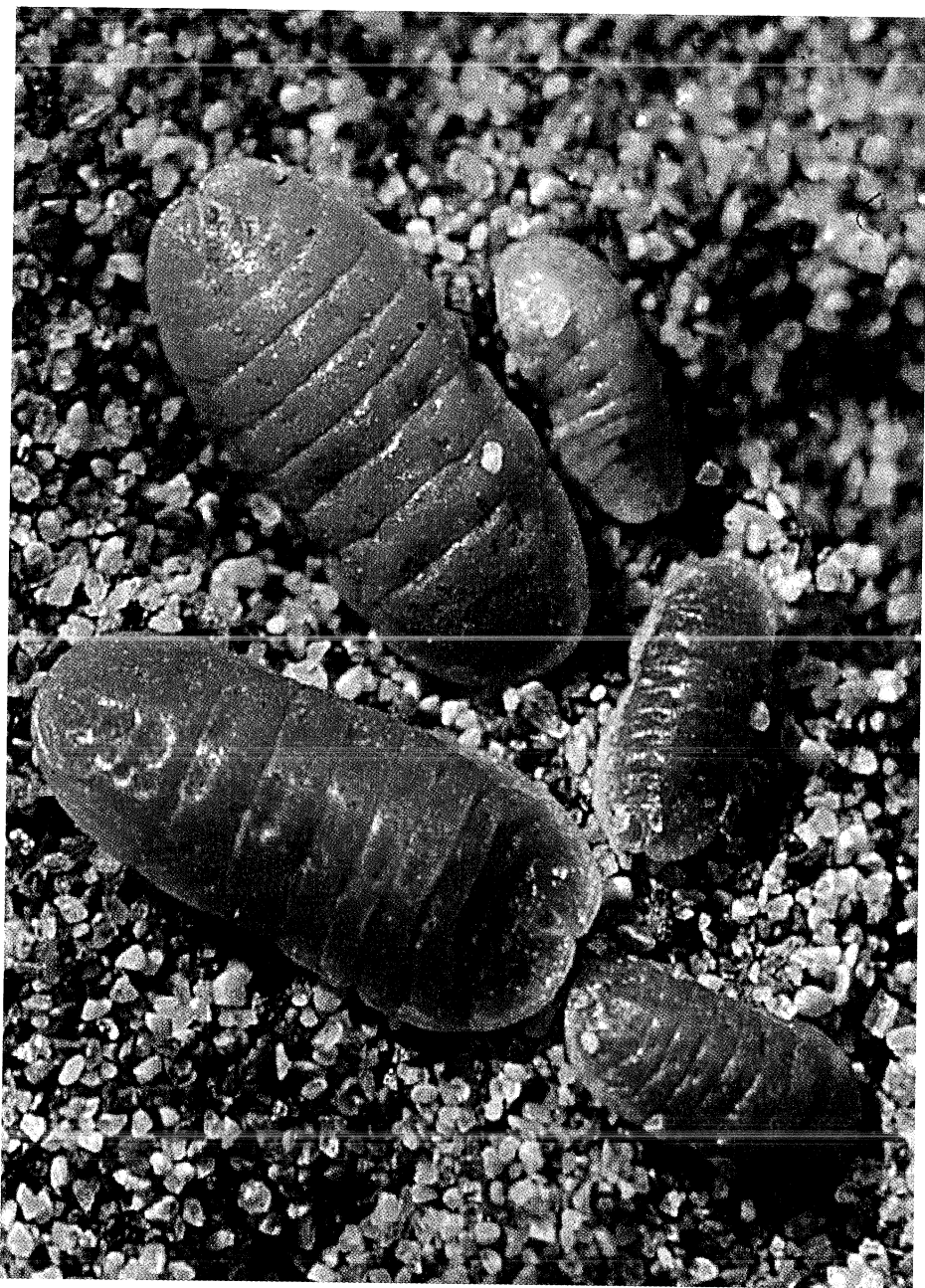


Fig. 3 - Adult females of *L. clodiensis* of different size.

specimens are available for study and comparison (fig.3). The first goal of our work was to discover stable morphological characters that are useful in separating species. Stable characters in the adult females proved to be: the length and width of the dorsal band of preopercular pores, the presence or absence of stigmatic pores near the stigmatic openings, the presence or absence of stigmatic pores near the posterior stigmatic openings and, in some cases, the number of antennal segments. Different arrangements of these characters usually allow identifiers to make accurate identifications at the species level. Nevertheless, in redescribing the species, we occasionally were forced to use words such as "usually" or "often" when referring to characters that are variable within the species. Consequently, mistakes are still possible when using the identification key.

Borchsenius (1957) suggested that young instars of *Lecanopsis* could be used, in the absence of adult females, for tentative identifications. He proposed an identification key based on 3rd-instars females. In our opinion when using 2nd and 3rd-instar females of *Lecanopsis* for identification purposes, it should be taken into account that:

- 1) we have a rather incomplete knowledge of the young instars of the species (tab. 2).
- 2) In fact we know all the developmental stages of only two species: *L. formicarum* and *L. clodiensis*.
- 2) the study of 2nd and 3rd-instar females of a species of the same population and of different populations, demonstrates that these stages also exhibit a high intraspecific variability. Therefore, reliable identifications at the species level can be problematic and should be attempted only for species whose intraspecific variability is known. Presently, this is possible only for *L. clodiensis* and *L. formicarum*, whose intraspecific variability is well known.

The morphology of the 2nd-instar males appears to be rather similar among the species studied so far. Because of this the use of this stage in tentatively identifying species does not appear reliable.

Table 2 - Present knowledge of the developmental stages of *Lecanopsis* species.

Species	Adult female	1 st instar	2 nd instar female	3 rd instar female	2 nd instar male	Adult male
<i>L. formicarum</i>	+	+	+	+	+	+
<i>L. mirmecophila</i>	+	?	?	?	?	?
<i>L. apheogastorum</i>	+	?	?	?	?	?
<i>L. subterranea</i>	+	+	?	+	+	?
<i>L. turcica</i>	+	+	?	+	+	?
<i>L. iridis</i>	?	+	+	+	?	?
<i>L. shutovae</i>	+	?	?	?	?	?
<i>L. taurica</i>	+	?	?	+	+	?
<i>L. clodiensis</i>	+	+	+	+	+	+
<i>Lecanopsis</i> n. sp.n.1	+	+	?	?	?	?
<i>Lecanopsis</i> n. sp.n.2	+	+	?	+	?	?

THE 1st INSTARS OF THE GENUS *LECANOPSIS*:
A RELIABLE STAGE TO IDENTIFY TO THE SPECIES LEVEL.

As reported above, the identification of *Lecanopsis* adult females could be difficult, due to their rather uniform appearance and great amount of intraspecific variability. This difficulty is eliminated when 1st instars are available. Their morphological characters have been demonstrated to be stable even when specimens from different populations are compared. Diagnostic characters of first instars allow for accurate species identifications. The use of 1st instars to determine species of *Lecanopsis* was first suggested by Pellizzari (1995), who presented an identification key based on crawlers of four *Lecanopsis* species, namely *L. formicarum*, *L. turcica*, *L. festucae*, and *L. clo-diensis*. First instar characters were more reliable than those of the adult females.

The most relevant character of the 1st instar is the presence of marginal minaret-like setae (fig. 2, d). The minaret-like setae are present only in the 1st instar. In the 2nd and 3rd instars they are replaced with spine-like setae that may be more or less conical in shape. In the adult female the marginal setae are usually hair-like. The minaret-like setae may be present on margin of the head, thorax and abdomen or only on the head and abdomen. It was previously thought that the minaret-like setae were distributed only on the dorsal margin of the body. The use of SEM microscopy demonstrated that the last two minaret-like setae are in fact on the venter (fig. 2, c, d). Once this position was understood, it was easy to see with a light microscope also by critically focusing on one surface or the other.

Other important morphological characters are the number and distribution of stigmatic pores. The stigmatic pores may form groups between the anterior and posterior spiracles and the body margin or form groups near either spiracle and along the margin of thorax. The different arrangements of minaret-like setae and stigmatic pores allows for accurate identifications at the species level. Number and position of the minaret-like setae and number and distribution of stigmatic pores are stable within the species even when different populations are compared. Unfortunately, the morphology of the 1st instars of three species (*shutovae*, *taurica*, *aphenogastrorum*) is still unknown and it is unlikely that they will be collected since all are known only from the original description.

COMMENTS ON *LECANOPSIS* IDENTIFICATION

Unfortunately several species (*L. mirmecophila*, *L. taurica*, *L. aphenogastrorum*, *L. iridis*, *L. shutovae*) are known only from the type series, which consists of only one or very few specimens. In these cases we do not know their intraspecific variability, if any.

When attempting to make identifications based on 2nd and 3rd-instar females, it should be taken into account, in addition to the possible intraspecific variability, that after moulting they may look different from fully developed individuals. To assure accurate identifications, it is important to obtain as many different instars as possible.

This is possible by rearing specimens in the laboratory or by collecting multiple instars in the field either in one or several visits to the same collecting site.

The availability of 1st instars (crawlers or settled specimens, dead or alive) of a *Lecanopsis* species is very important for making reliable identifications and can solve dubious cases. If adult females with eggsacs are collected, it is convenient to wait for egg hatching, in order to obtain the 1st instars in the laboratory. Even if adult females have yet to produce an eggsac, if they are fertilised they will form an eggsac and lay eggs in the laboratory within a few days. Settled 1st instars may be collected on their host plant starting from May-June till September, depending on climatic conditions. During summer they are mixed with 2nd-instar females, 2nd-instar males and, later, with 3rd-instar females.

Although the identity of a few specimens remains difficult, we believe that the generic revision including redescription and illustrations of all known instars of the species of *Lecanopsis* and the development of an identification key based on stable characters, will assist identifiers in making determination of species in this genus.

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