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Life history and pre-imaginal stages of *Dromius meridionalis* (Coleoptera: Carabidae: Dromiini) in Sardinia

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Abstract. Adults and larvae of *Dromius meridionalis* Dejean, 1825 were collected throughout the year with corrugated cardboard „trapping-bands“ on lime-trees (*Tilia platyphyllos*) at Sassari (Sardinia, Italy). The larval and pupal characters of this trunk-dwelling, undercanopy species are described and discussed. Its life cycle displays a summer breeder element. Its prey is identified as Lepidoptera larvae from the Pyralidae and Occophoridae families.

Pre-imaginal stages, life history, Coleoptera, Carabidae, Dromiini, *Dromius meridionalis*, Palearctic region

INTRODUCTION

Many Carabidae species are currently described as „arboreal“ beetles, often trunk-dwelling, undercanopy or canopy specialists, in tropical forests (Erwin 1979a), whereas in the temperate regions of the Holarctics Carabidae are normally identified as true „ground-beetles“ (Laufkäfer – running beetles – in the German literature) (Thiele 1977), though many species, often water-side generalists or lowland dwellers in unstable environments, have retained a winged or pteripolymorphic condition (Brandmayr 1991, Boer et al. 1980), and a high ability to disperse by flying. There are, however, several winged Carabidae species in these regions that usually complete part or the whole of their life cycle on or under the bark and on the foliage of plants of different species and sizes. In Europe and throughout the Mediterranean area, these are nearly all Lebiinae (sensu latissimo: Casale et al. 1982, Basilewsky 1984) (= Lebiini of other authors). Lebiini and Dromiini (excluding Lionychina), in particular, are often arboreal beetles (see for example Burmeister (1939) and Jeannel (1942)). For this very reason, however, carabidologists are unfamiliar with many of their species, since they are accustomed to collecting insects under stones and dead trees, or in pit-traps. Arboreal species, therefore, are more often collected by those who specialise in phytophagous insects.

The life history and cycle of several Lebiina and Dromiina are unknown. In Europe, Silvestri (1904) was the first to illustrate the hypermetabolic cycle of *Lebia scapularis* (Fourcroy, 1785) and its association with the leaf beetle *Galerucella luteola* (O. F. Müller, 1766). Lindroth (1971) has discussed possible instances of Batesian mimicry of Chrysomelidae by Lebiinae.

In tropical forests, Erwin (1979b) and Erwin & Erwin (1976) have described highly interesting, sometimes parasitoid adaptive specializations in arboreal Carabidae. Much fresh information concerning these climbing and flying insects will undoubtedly be provided by further investigation of their place in canopy environments.

The present paper is a contribution to the knowledge of the immature stages and life cycle of *Dromius meridionalis* Dejean, 1825, a common Euro-Mediterranean, arboreal Dromiina species.

MATERIALS AND METHODS

During a long-term investigation of phytophagous insects in a lime-tree (*Tilia platyphyllos*) avenue in the city of Sassari (Sardinia, Italy), several larvae and adult specimens of Carabidae were collected with corrugated cardboard trap bands fastened round the trunks about 3 m about from the ground. Specimens were found in the spring (April 19, and May 3 and 10, 1995), autumn (November 3, 16 and 29, 1995) and winter (January 9, and March 8, 1996). Only adults were present from May to July.

The adults and some larvae were preserved in 70% ethanol. The remaining larvae were bred in glass capsules at 22 °C. They accepted no food in autumn and spring. Pupae were obtained in April 1995 from hibernating larvae, whereas the larvae collected in autumn did not breed.

Three pupae were preserved in 70% ethanol. Five *Dromius meridionalis* adults were obtained from the others. One pupa (not described) was smaller and displayed highly different chaetotaxic characters. It was probably a *Philorhizus crucifer*, since this species is common on the local *Tilia*.

Drawings were made with a stereomicroscope Wild M5 and microscope Leitz Dialux 20 EB.

RESULTS

Pre-imaginal stages

Egg

No eggs were obtained. Several years ago, however, one of the present authors (A.C.) identified some *D. meridionalis* adults collected by Bin on Monte Peglia (500–600 m, Province of Perugia, central Italy), where two egg-cases attributed to *Dromius* Bonelli, 1810 (*D. meridionalis* or *D. quadrimaculatus* (L., 1758)) were observed in autumn on two Gypsy Moth (*Lymantria dispar* L., 1758) egg-masses on oak trees and described by Bin (1980) as made of „a waxy material completely wrapping the egg, thinner on the ventral than the basal side“, 1 mm long × 0.5 mm wide, with a thin, virtually smooth chorion. From the eggs, Bin obtained adults of *Xenomonus ergenna* Walker (Hymenoptera: Scelionidae, of the Xenomerini tribe, a specialized group of egg parasitoids associated with Carabidae).

3rd-instar larva

The terms used are taken from Böving (1911), Bousquet & Goulet (1984) and Giachino (1989).

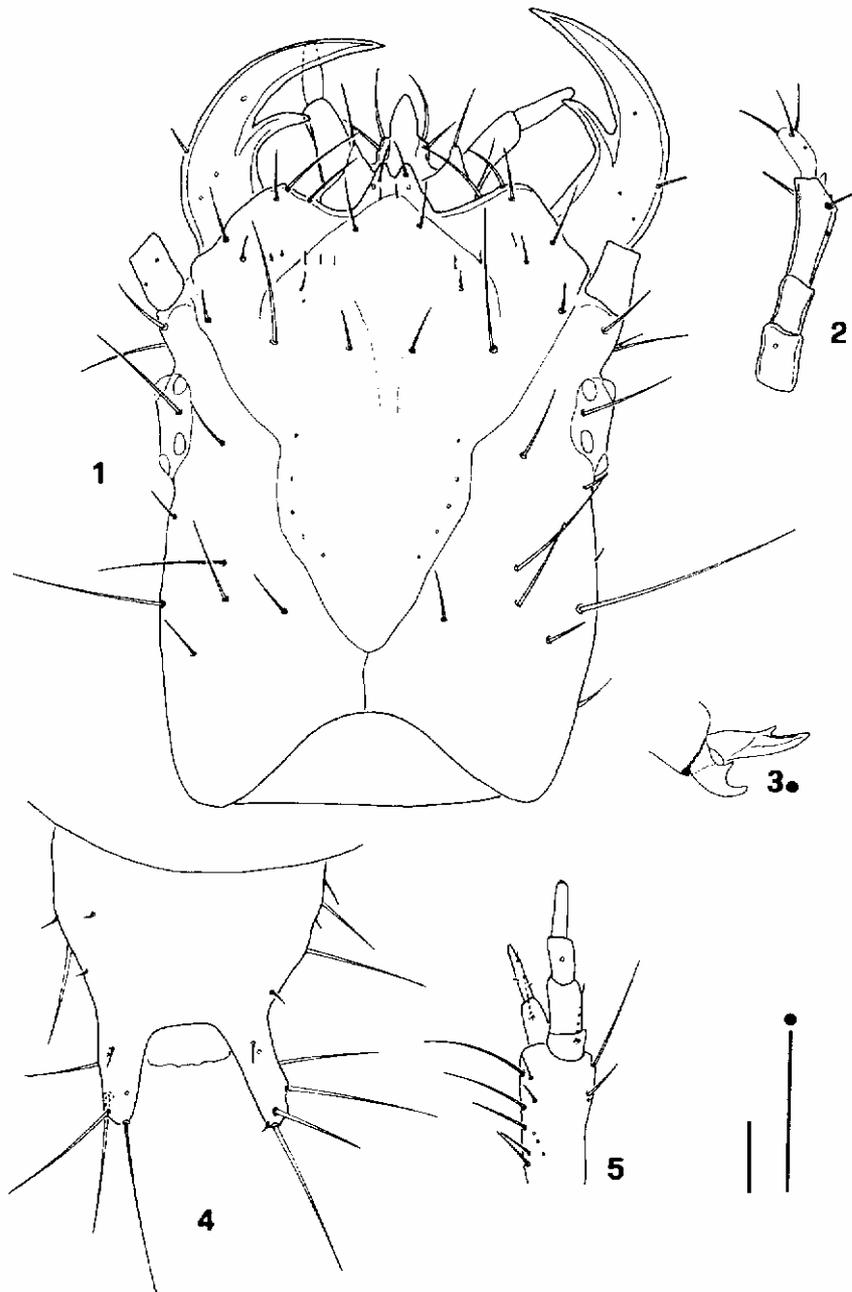
Larva bicuspid, from pale to darker brown, dark red-brown head. Length: 5.9–7.5 mm from apex of mandible to apex of urogomphi, excluding the macrochaetes.

HEAD (Fig. 1). Elongated, L/l ratio 1.48. Frontale sutures clearly visible, bent back, sinuous and almost angular at the centre. Metopic suture perfectly distinguishable along about one-tenth of the clypeus-cervix distance. Chaetotaxy of the cephalic region shown in fig. 1. Setae FR₂ and FR₃ located well forward (almost at the insertion of the antennae). Straight row of 4–6 small setae running from FR₆ to the centre of the frontale.

Anterior edge of the epistoma („nasale“): trilobate. Distinctly protruding side lobes, with subrectilinear, forward-converging side lobes bearing two dorsal setae, one long (FR₇), the other shorter (FR₄), incised, but rounded, at the median lobe, where there is also a seta (FR₅) about as long as FR₆. Central lobe protruding well beyond the side lobes and formed of two subacuminate, symmetric, subtriangular teeth separated by a distinct, deep V-shape groove. FR₁₀ and FR₁₁ set well forward, with FR₁₁ very long.

Eye area, prominent, with six stemmata and two setae. Parietale lacks PA₁, PA₂ and PA₃.

Antennae (Fig. 2): short, about the same length as the mandibles, or a little less (a/M ratio 1.06). First, second, third antennomeres subcylindrical, second and third almost imperceptibly dilated at the apex, fourth cylindrical and subtruncated at the apex. Third antennomere nearly twice as long as the first. Chaetotaxy as proposed by Bousquet & Goulet (1984), except for the absence of AN₁. Distinctly and markedly squamous antennal microsculpture.



Figs 1-5. *Dromius meridionalis* Dejean, mature larva, morphology: head in dorsal view (1), right antenna in dorsal view (2), tarsal claw (3), telson in dorsal view (4), right maxilla in dorsal view (5). Scale: 0.1 mm.

Mandibles: very arcuate, with strong retinaculum and almost smooth inner edge, external marginal seta (MN₁) located before the half-length point.

Maxillae (Fig. 5): distinctly longer than the mandibles (m/M ratio 1.23). Large, stubby stipes, slightly dilated distally; 6–7 masticatory setae (gMX), with well-developed MX₅. Galea with second segment distinctly longer than the first. First segment of the maxillary palpi short and subquadrate, second and third subequal and decidedly longer, fourth about a third longer than the third.

Lower labium: decidedly trilobate, with setae LA₄ at the apex of the side lobes. Central lobe with evident and very prominent membranous lobe, at whose sides setae LA₆ are in an abnormal position and preceded by setae LA₅ in a very advanced position. No setae on the palpi of two segments. First segment distinctly longer than the second.

PRONOTUM. Lateral series of 5–7 setae and pores not directly referable to the pupal setae.

LEGS. Long, relatively robust. Trochanter, femur, tibia and tarsus with lengthwise rows of setae. Chaetotaxy similar to that proposed by Jeannel (1942) and Bousquet & Goulet (1984). Finely denticulate tarsal claws (Fig. 3) different in size, unlike those of *D. agilis* (Fabricius, 1787) as described by Jeannel (1942: fig. 339f).

Telson (Fig. 4) with two strong, short urogomphi, salient and well separated from the base. Chaetotaxy similar to that proposed by Bousquet & Goulet (1984).

Pupa

Whitish, translucent; eyes, pronotum, and apex of mandibles darker, brownish in the more mature specimens. Pupa exarata with free appendages; body elongated and depressed (Figs 6–7). Total length 5.5 mm.

HEAD. Hypognathous (Fig. 6); general characters as in the adult, but with a peculiar chaetotaxy: four long setae on vertex, inserted on conical tubercles, six setae near the anterior margin of frons, one seta (corresponding to the posterior supraorbital seta) on the inner proximal side of each eye, and two setae close to the anterior margin of the clypeus.

PRONOTUM. highly transverse, width/length ratio 1.5. Row of 6 long setae inserted on prominent tubercles on each lateral side of the theca covering the underlying adult pronotum. One anterior and two basal setae on each side, also on tubercles. The entire surface of the disk is densely punctate and finely pubescent; the median groove is wide, whitish and glabrous.

Mesonotum with two lateral (one large, one smaller) and one small posteromedian seta on each side. Two small spots of very short pubescence near the middle. Metanotum: same, but without these spots

Pterothecae short and arcuate. Legs, in the podothecae, with finely denticulate claws, as in the adult.

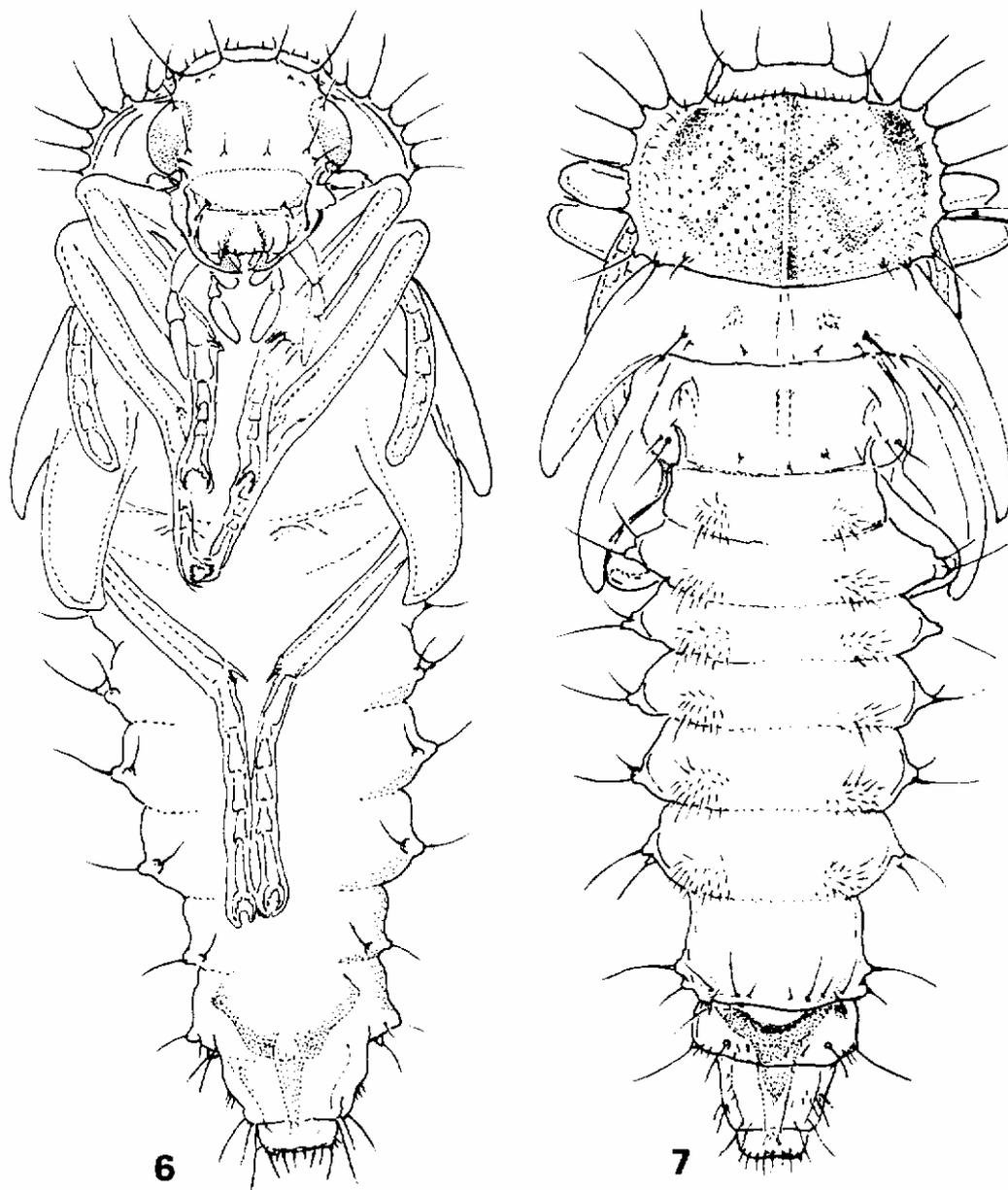
ABDOMEN. Tergites I–VI with posterolateral brush of long, erected hairs on each side. Tergites VII and VIII with row of long setae along the posterior side. Tergites from II to VIII with 2 long lateroventral setae on each side, inserted on large, subconical pleural protuberances. No cerci.

Life cycle (Fig. 8)

Our adult and larva collection times and laboratory breeding data show that in northern Sardinia *D. meridionalis* is a summer breeder with larval (and adult) dormancy (Hürka 1986). This cycle is probably the same as that of other species of arboreal mediterranean Dromiina. Conversely, the larva of North American species *Dromius piceus* Dejean, 1825, living on white and red oaks and jack pine, pupate in August – September (Mahar et al. 1983).

In natural conditions, therefore, they evidently feed and breed under the bark and in canopy of living trees.

Adults emerge at the end of April or beginning of May and disperse by flying and climbing on trees. In June and July, they were collected on the trees where the larvae completed their cycle. In summer and autumn, isolated flying specimens were collected by night at the black light.



Figs 6-7. *Dromius meridionalis* Dejean, pupa, ventral side (6), dorsal side (7). Length 5.5 mm.

Eggs are laid on the bark in summer (sometimes on supports, such as egg-masses of *Lymantria dispar*: see above, and Bin (1980)). Parasitized eggs have been found in late autumn (Bin 1980). *L. dispar*, however, is rare or absent on this *Tilia* avenue and eggs are probably laid in bark fissures or moss on the trunks. No eggs, in fact, were found.

It cannot yet be determined whether adults breed in their first summer or only after the winter dormancy, or both. Larvae evidently complete their entire cycle on the trees, since these flank an avenue with heavy foot and wheeled traffic, and their bases are surrounded by concrete and stones with no room for suitable vegetation.

Absence of the earliest instars in summer and early autumn, is probably due to their preying on Lepidoptera larvae on branches and foliage. In November, mature, 3rd-instar larvae (in Dromiina, the cycle is a normal one composed of three instars) sheltered under the bands with the adults to hibernate. Their diapause, like that of the adults, may be interrupted or irregular. One larva, in fact, and some adults, were collected in January from under bands applied monthly. They had stopped feeding; all larvae taken in autumn and winter died without metamorphosis.

In March – April, larvae and adults begin to be active. The larvae do not eat and metamorphose. In nature, they probably look for a sheltered fissure and scales in the bark or trunk in which to pupate. In the laboratory, adults appeared in 12–14 days: 17–24 April to 3–6 May, and 24–26 April to 6–7 May.

Food

On finding *Dromius* (probably *D. meridionalis*) egg-cases on *Lymantria dispar* egg-masses, Bin (1980) suggested that this oviposition „could be casual, but the formation of an egg-case, regarded as a form of parental care, and possibly also the place chosen for egg laying could be closely related to the diet of larvae. Therefore, larvae of *Dromius* sp. could be predators of the Gypsy Moth eggs, or newly hatched larvae“. As already stated, *L. dispar* is rare on the Sassari lime-trees, whereas adults and larvae of *D. meridionalis* (and other Lebiinae, see section Associated Carabidae) are rather abundant. The only food available is the plentiful larvae of two small moths: *Ephestia elutella pterogrisella* Roesler (Pyalidae, Phicitinae) and *Denisia* sp. (Oecophoridae). Several of their larvae were collected in the company of *Dromius* larvae and adults, and adults were obtained in March and April from hibernating larvae.

It cannot yet be shown whether *D. meridionalis* larvae or adults prey on eggs or newly hatched larvae of a so large moth as *L. dispar*, whose the newly hatched larva is the same size as the mature *Dromius* larva and becomes many times larger in a few days. The observation of *D. meridionalis* egg-cases and oviposition on *L. dispar* egg-masses could thus be a simple, although very interesting, shelter form for the eggs, without any parental care.

Associated Carabidae

We also found the following Lebiinae species: *Philorhizus crucifer crucifer* (Lucas, 1846) (the most common, in all seasons); *Calodromius bifasciatus* (Dejean, 1825) (7 August: 1 specimen; 27 October: 1 specimen), *Paradromius linearis* (Olivier, 1785) (28 July: 1 specimen; 12 October: 1 specimen); and *Lebia scapularis* (Fourcroy, 1785) (2 June: 1 specimen).

There was also a single specimen of *Phyla tethys* (Netolitsky, 1926) (6 October), a winged species of Bembidiini very common in Sardinia, the occurrence of which is certainly casual. Also the presence of *P. linearis*, too, is rather unusual in these „arboreal“ conditions, since it is normally riparian, common on sandy shores along rivers and marshes, often on or near *Carex* spp. and *Phragmites* aquatic plants.

DISCUSSION AND CONCLUDING REMARKS

In Europe and the Mediterranean Region, Dromiina (sensu stricto, excluding Lionychina, which are terrestrial, sandy dwellers both as adults and larvae) are represented by some genera, with several species more or less adapted to live in vegetation.

Four genera in particular are close to each other:

- 1) *Paradromius* Fowler, 1886, with *P. linearis* and *P. longiceps* (Dejean, 1826), both tied to moist environments, along rivers and marshes, sometimes climbing on aquatic plants. Eggs are laid in the soil and larvae are terrestrial (Jeannel 1942).
- 2) *Philorhizus* Hope, 1838 (sensu stricto – Sciaky (1990)), with several „arboreal“, widespread species, together with four (*P. mendizabali* Mateu & Colas, 1954, *P. paulo* Wrase, 1995, *P. liguricus* Sciaky, 1990 and *P. brandmayri* Sciaky, 1990) from Spain and Italy that are brachypterous, terrestrial and all steno-endemic to small mountain areas.
- 3) *Calodromius* Reitter, 1905, with two species in Italy (Vigna Taglianti 1993) both living in vegetation.
- 4) *Dromius* with several species (five in Italy: Vigna Taglianti 1993), all winged and normally associated with arboreal plants, in both lowland and in highland forests.

As mentioned in the Introduction, Dromiini have been observed several times on trunks and foliage. Some species (Habu 1967 ex Hicks, Casale, 1983) have been collected in bird's nests. Jeannel (1942) lists scolytid beetles as possible preys of *D. marginellus* Fabricius, 1794 (= *D. schneideri* Crotch, 1870).

Burmeister (1939) and Jeannel (1942 ex Perris) report larvae and adult specimens of *Calodromius spilotus* (Illiger, 1798) (= *C. quadrinotatus* Panzer, 1801) feeding on young larvae of the weevil *Pissodes notatus* (Fabricius, 1787).

Bisio (1996) has found large numbers of adults of several *Dromius* and *Philorhizus* species hibernating under the bark of living trees at a rather high altitude in the Western Alps.

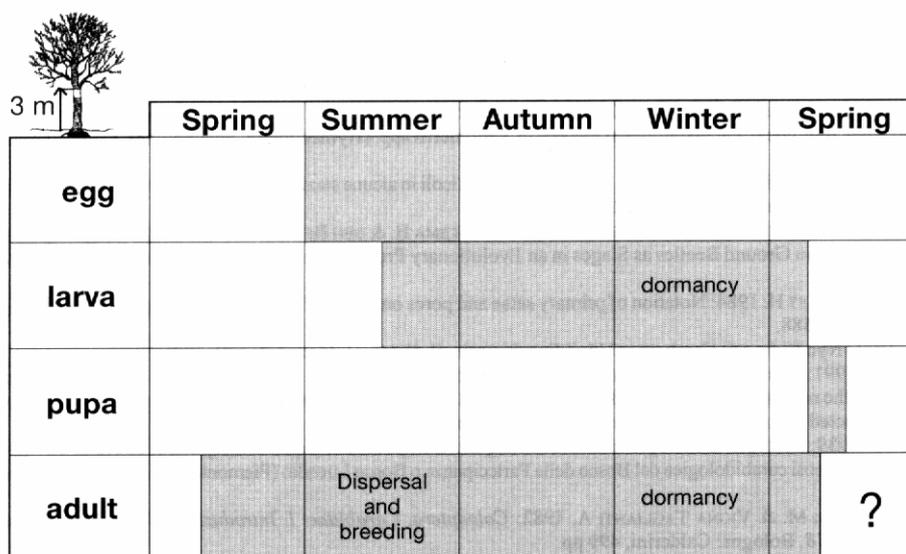


Fig. 8. Reconstructed life cycle in northern Sardinia (Italy) of *Dromius meridionalis* Dejean, an under-canopy, trunk dweller carabid beetle.

This study of *D. meridionalis* has shown that :

- 1) it is a developmental type with larval dormancy;
- 2) it has a poorly specialized way of life, since it can also colonize cultivated trees along avenues in the heart of a city;
- 3) it may prey on Lepidoptera larvae from the Pyralidae (*Ephestia elutella pterogrisella* Roesler) and Oecophoridae (*Denisia* sp.). Predation on moth larvae from various families has been demonstrated several times for the Lebiinae, for example *Calleidina* (Andrewes 1933, Habu 1967, Zhou & Goyer 1993).

A more varied diet (larvae of xylophagous, subcorticolous beetles) seems not impossible, in our opinion, for the more generalist species. The xylophagous Scolytidae or Curculionidae reported as possible preys of other Dromiini, however, were not found on the Sassari lime-trees.

The larval morphological characters were in line with those illustrated for other European *Dromius* species (Jeannel 1942 ex Schiödt, van Emden 1942, Sharova 1958).

The tarsal claws of mature *D. linearis* larvae are toothed and peculiarly asymmetrical. In *D. piceus*, two ventral teeth on each claw are present (Mahar et al. 1983).

The pupa of *D. meridionalis* is described for the first time in this paper. It displays several peculiar features compared with another obtained from another (not bred) larva, which probably belonged to *Philorhizus crucifer*.

As several authors have remarked, the pupal morphology of carabid beetles is so poorly known because the complete development of many species is very difficult to achieve in the laboratory.

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