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# Overwintering stages of *Sisyra iridipennis* A. Costa, 1884 (Neuroptera Sisyridae)

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*Sisyra iridipennis* has a Western Mediterranean distribution throughout the Iberian Peninsula, Maghreb and Sardinia. Little is known about its life history. To determine the overwintering stages of this species, a series of surveys were carried out at Riu Bunnari (Sassari, NW Sardinia). In the period between November and February, *S. iridipennis* was found exclusively as a first instar larva. This spongillafly lives in environments characterized by strong summer dryness, in which the host sponge *Ephydatia fluviatilis* (Linnaeus,1758) (Porifera Spongillidae) exhibits a summer quiescence. It is possible that the life history strategy utilised by *S. iridipennis* has evolved to track this commonly occurring poriferan.

Key words – *Sisyra*, freshwater sponges, life cycle, Mediterranean.

## Introduction

The Sisyridae is a small family of Neuroptera containing about fifty species in four genera among which *Sisyra* is cosmopolitan (Tauber *et al.*, 2003). The larvae are aquatic obligate predators of freshwater sponges (New, 1986).

Despite being one of the few freshwater invertebrate groups uniquely dependent on Porifera as a food source, there has been little research on sisyrid biology. Parfin and Gurney (1956) summarise most early information; Brown (1952) first described the complete sisyrid life cycle. More recent information is supplied by H. Aspöck *et al.* (1980, 2001), Evans & Neunzig (1984), Pupedis (1985), New (1986), Elliott (1996), Meinander (1996), Weißmair (1999), Hölzel & Weißmair (2002).

*Sisyra nigra* (Retzius, 1783) [= *fuscata* (Fabricius, 1793)], *S. vicaria* (Walker, 1853) and *S. terminalis* Curtis, 1854 as well as *Climacia areolaris* (Hagen,1861) are the only species whose life cycles are well known. They all have a “northern” distribution: Holarctic in *S. nigra*, East-Nearctic in *S. vicaria* and *Cl. areolaris*, and European in *S. terminalis*.

*Sisyra iridipennis* A. Costa, 1884 has a Western Mediterranean distribution throughout the Iberian Peninsula (Monserrat, 1986), Maghreb (McLachlan, 1898; Aspöck & Hölzel, 1996; Güsten, 2003) and Sardinia (Costa, 1884a, b; Weißmair, 1999). Little is known about the life history of *S. iridipennis*. The fact that it is found in environments characterized by strong summer dryness, in which the potential host sponge *Ephydatia fluviatilis* (Linnaeus,1758) (Porifera Spongillidae) exhibits a summer quiescence (Pronzato & Manconi, 1994), raises the interesting question of the nature of the life history strategy utilized by the sysirid to track this commonly occurring poriferan. As a start to addressing this question, we first looked at the overwintering strategy of *S. iridipennis*.

During the two winters of 2003 - 2004 and 2004 - 2005, we sampled the host sponge in a short stretch of Riu Bunnari, near Sassari (NW Sardinia), in order to confirm the identity of the overwintering spongillafly and determine the life stage present during the winter months.

## Materials and methods

Sampling was carried out, at more or less monthly intervals, in a short stretch (about 200 m in length) of the Riu Bunnari between November and May in 2003-2004 and 2004-2005 (see Fig. 2).

This river, about 12 km in length, is situated near Sassari (NW Sardinia) (Fig. 1). Its macrozoobenthic communities was studied by Manconi *et al.* (1995). Despite the presence of many signs of human impact, benthic invertebrate populations in the river do not appear to be greatly affected by pollution (Mascolo & Loru, 2000). Water flow is at its highest in winter. In summer a significant portion of the water flow becomes hyporheic but the loss of all surface flowing water is an extremely rare catastrophic event.

During the period of our surveys the sponge was active exhibiting a "fleshy" body. Because the number of sponge colonies was low and the individual colony sizes were small

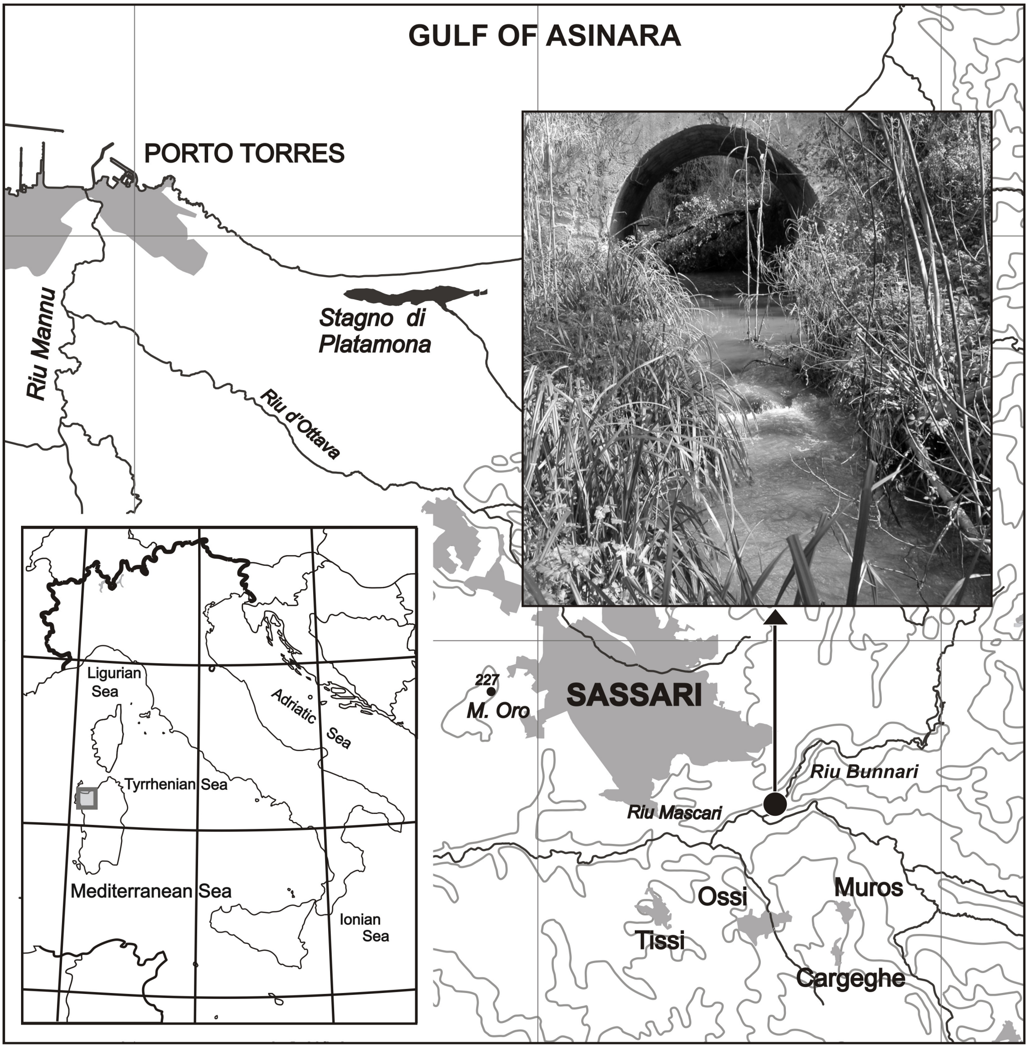


Fig. 1 – Map of the Riu Bunnari region marked with the location and photograph of the sampling site in winter.

(diameter of the largest reached only 5 cm), only a portion (between ¼ to ½ ) of 3 - 5 colonies were taken during each sampling trip. The small amount of samples was assumed not to affect sisyrid and sponge populations and hence future sampling. The fragments of sponge were sampled with a spatula and placed in a container with habitat water.

In the laboratory the habitat water was withdrawn from the sponge colony causing the sisyrid larvae to leave the colony whereupon they were collected and recorded.

As only second and third instar larvae are identifiable to the species level, some first instar larvae were reared to the next stadium, using techniques described in Weißmair (1999). The identification of larval stadia and spongillafly species was made according to Weißmair (1999).

The sponge fragments were prepared for identification as in Pronzato & Manconi (1989) and identified following Pronzato & Manconi (2001).

Voucher specimens of the sisyrid larvae and the identification slides of the sponge colonies have been deposited in the collections of the Civico Museo di Storia Naturale di Ferrara.

## Results

Figure 2 shows the results of the study. The total number of larvae collected was 81, 60 as first instars, 18 as second instars and 3 as third instars. The sponge collected was always *E. fluviatilis*. In the period between November and February, *S. iridipennis* is found exclusively as a first instar larva. From the beginning of March, in addition to first instars, second instar larvae are found. From mid May only third instar larvae are found.

## Discussion

Overwintering stages of only few species of spongillafly are well known: the Holoarctic *S. nigra*, the Palearctic *S. terminalis* and the Nearctic *S. vicaria* and *Cl. areolaris*.

Killington (1936) recorded the first data about the overwintering stage of *S. nigra*, subsequently confirmed by Elliott (1996) and Hölzel & Weißmair (2002). This species spends the winter in the prepupal stage within the cocoon and pupates in the following spring. In England, a small number of individuals may bypass hibernation and continue on to pupate into adults; these adults will produce a second generation that grows rapidly and in turn overwinters in the prepupal stage.

The first data about the overwintering of *S. terminalis* in the larval stage date back to Withycombe (1923) but he makes this observation generically about the genus *Sisyra*, since he did not manage to distinguish between larvae of *S. terminalis* and *S. nigra.* The biology of *S. terminalis*

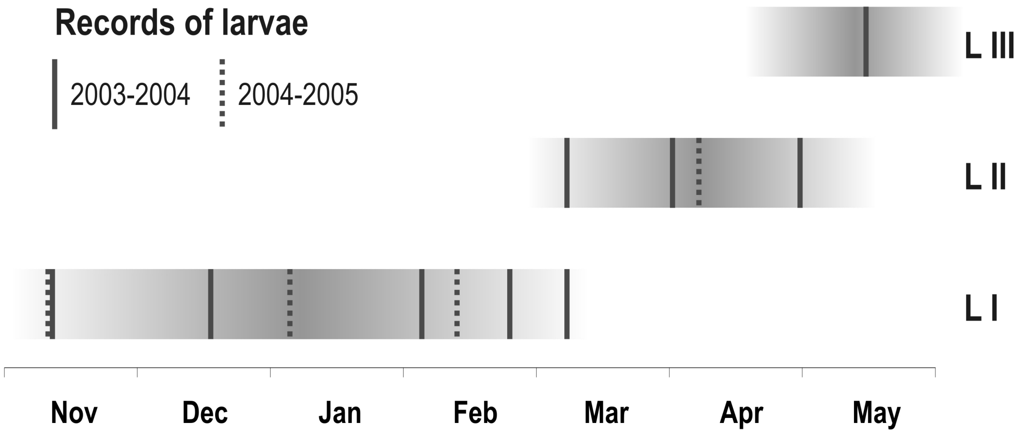


Fig. 2 – Records of spongillafly larvae in Riu Bunnari (NW Sardinia) during the winters of 2003-2004 and 2004-2005.

was clarified later by Weißmair (1994) and Hölzel & Weißmair (2002). Larvae derived from eggs laid early are able to complete their development, overwintering in the prepupal stage whereas larvae derived from eggs laid later (August), overwinter in the I or II larval stadium. In spring the overwintering larvae continue their development and then pupate together with those which overwinter as prepupa. Consequently all adults emerge at the same time.

Prior to Pupedis (1985) the only information about the overwintering stages of *Cl. areolaris* dated back to Roback (1968) and White (1976) who found larvae during the winter. Pupedis (1985) confirmed these observations demonstrating that this species spends the winter as diapausing larvae in the second stadium. A small number of individuals overwinter as first or third instars. In spring, rising water temperature induces growth and moulting; however, migration out onto land for pupation does not occur until the photoperiod lengthens to a certain value. This synchronizes individuals of the spring generation so that they emerge simultaneously. The number of yearly generations varies for *Cl. areolaris* with longitude and depending upon the local environmental conditions.

Pupedis (1985) also determined the overwintering stage of *S. vicaria*. This species spends the winter as a terrestrial, pharate first instar within the eggshell. The eggs are laid on permanent structures overhanging the water. In spring the first instar larvae hatch, fall into the water, and seek out the new sponge colonies. The larvae develop rapidly and adults start to appear in the middle of June. In Connecticut the first generation adults lay diapausing eggs, only a few females may produce non diapausing eggs and consequently a possible second yearly generation. More southerly populations of *S. vicaria* do appear to be multivoltine.

In regards to the life cycles of Tropical sisyrids, the only data available concerns *S. indica* Needham, 1909 and is supplied by Needham (1909) who relayed the following original observations from Dr. Annandale: "this species is common in the canals of *Spongilla carteri* [Carter, 1859], one of our most abundant freshwater sponges in India. I have only found the larvae between August and March, that is to say, in the rains and cold weather, but the sponge as a rule dies in the hot weather".

It is apparent from the results of our survey that most if not all individuals of *S. iridipennis* overwinter in the first larval stadium. The first instars do not exhibit any obvious external development during the five winter months; second instars are found only after March. Even if we cannot completely exclude that a small portion of the population overwinters in other stages, we think this hypothesis is rather improbable on the basis of our knowledge about the environmental conditions and the life cycle of *E. fluviatilis*.

Freshwater sponges are able to get through periods of drought or freezing by producing resistant bodies known as gemmules; the fleshy portion of the colony is lost or greatly reduced during the process of gemmulation. Gemmules represent the quiescent phase of the sponge life cycle. When favorable environmental conditions return, the gemmules, either as a group or individually, give rise to a new sponge colony. Gemmulation is a seasonal process that, in temperate regions, usually occurs in late summer or at the beginning of autumn. Gemmules are consequently present during the winter (hibernation). On the other hand, in dry regions the opposite can happen: gemmulation occurs during the spring so that gemmules are present in summer (aestivation). *E. fluviatilis* populations hibernate in sites north of the 40°N parallel and aestivate south of it. *E. fluviatilis* is the only species known, up until now, to exhibit a life cycle inversion, but it is possible that other cosmopolitan species have the same behaviour (Pronzato & Manconi, 1994). On the basis of morphometrical

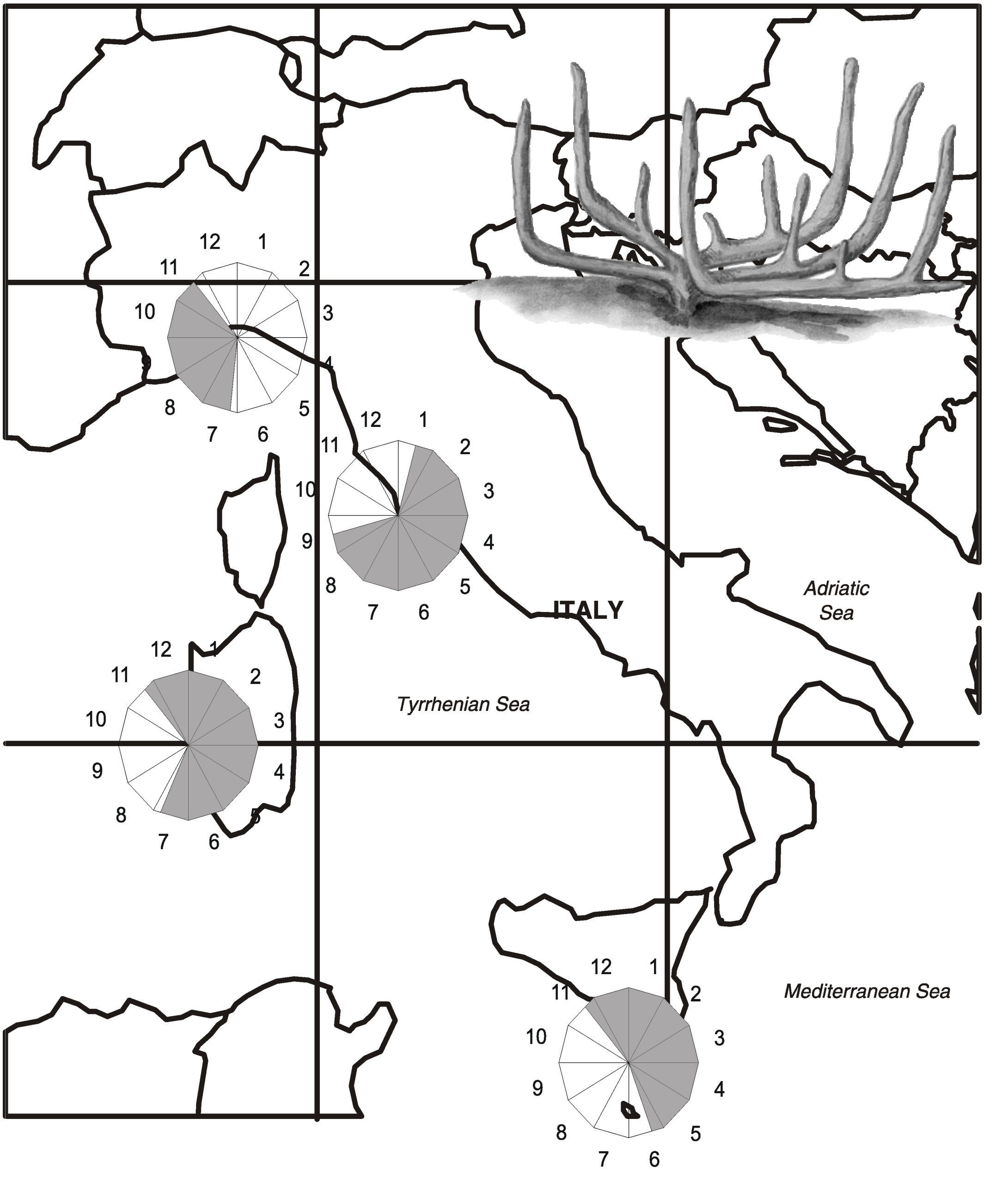


Fig. 3 – Life cycle in different populations of *E. fluviatilis*. Coloured sectors represent the presence of active sponges while numbers represent months. In the period represented by empty sectors the sponge is in quiescence and gemmules are present. The sponge figure is only illustrative and does not represent the aspect of the species in every considered habitat. The active phase of the sponge is preceded by a hatching process and followed by a gemmulation process which both last a few weeks. The border between coloured and empty sectors is therefore approximate (data from Pronzato *et al.*, 1988).

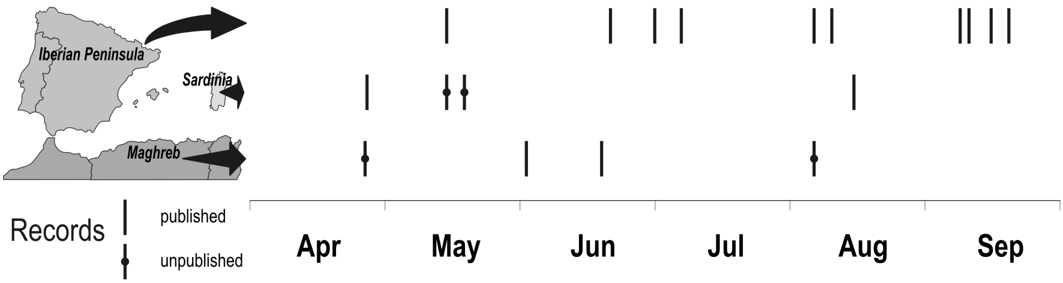


Fig. 4 – Adult records of *S. iridipennis*.

data this species was split, by Ezcurra de Drago (1975), into two subspecies, *E. fluviatilis fluviatilis* (Linnaeus, 1758) living in northern habitats and *E. fluviatilis ramsay* (Haswell, 1882) living in southern ones. The existence of two morphological taxa is consistent with the data on life cycle inversion.

The life cycle of *E. fluviatilis* is well known in Italy (Figure 3). In Sardinia, *E. fluviatilis* starts gemmulation in July; the subsequent aestivation period in the gemmule stage lasts from August to late September. The hatching process begins in October and the active sponge is present from November (Pronzato & Manconi, 1994).

In Sardinia other sponge species with a non-inverted life cycle are also present: *Ephydatia muelleri* (Lieberkühn, 1855) and *Spongilla lacustris* (Linnaeus, 1759) (Pronzato & Manconi, 2001).

From the data in our possession, it is possible to hypothesize the following spongillafly life-cycle. First-instar larvae of *S. iridipennis* establish themselves on *E. fluviatilis* in autumn when the sponges reactivate. They spend the whole winter in quiescence, or possibly diapause, sheltering in the sponges and resuming their development in March. It may be possible that a small portion of the population may overwinter in either the third or second stadium.

In figure 4 the records of adult captures, obtained from published and unpublished data, are plotted. Published records are from Monserrat (1986), Monserrat & Marin (1995) for the Iberian Peninsula, McLachlan (1898) and Güsten (2003) for Maghreb, Costa (1884a, b) for Sardinia. The first adults emerge at the end of April; subsequent adult emergence appears to be concentrated in May, the end of June and the beginning of August.

There is a complete lack of information concerning the fate of *Sisyra* populations in August and in September. In this period *E. fluviatilis* is quiescent and present only as gemmules. Many hypotheses about the life history stages employed by sisyrids during this period are possible: aestivation as eggs, larvae, prepupae or adults or development on other sponge species in permanent rivers.

While we have determined a portion of the life history strategy of *S. iridipennis*, it is still necessary to continue our research with sampling throughout the year to clarify many unknown aspects of the life history of *Sisyra iridipennis*.

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poco più di due volte la loro larghezza massima, molto più brevi della lunghezza del cranio, arcuate in maniera non molto accentuata, sub-

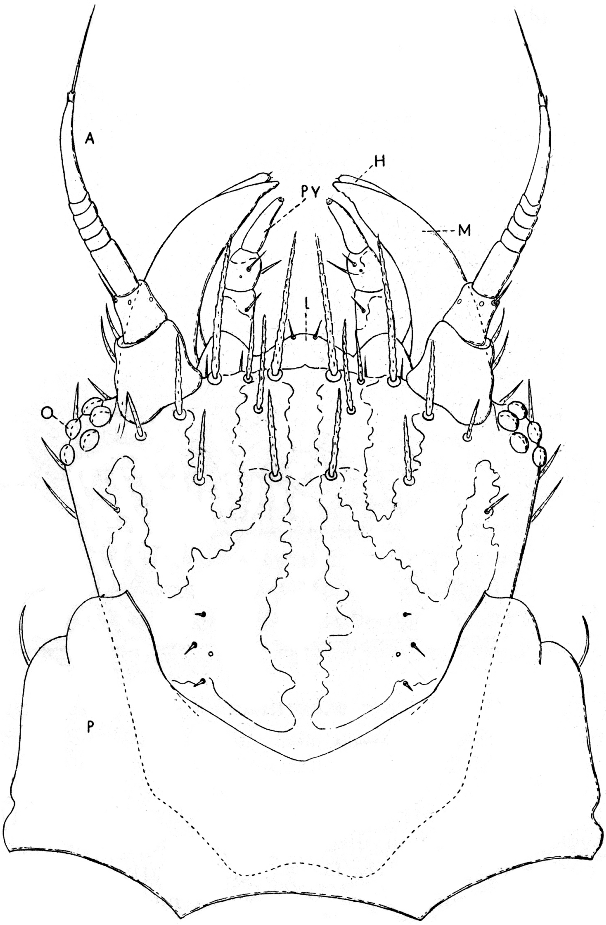


FIG. III.

*Nothochrysa italica* Rossi. - Larva. — Capo visto dal dorso: *A*, antenne; *H*, lobo mascellare; *L*, labbro superiore; *M*, mandibole; *O*, ocelli; *P*, protorace; *PY*, palpi labiali.

distalmente attenuate piuttosto bruscamente. Subprossimalmente ed aboralmente si trovano due setole denticolate. È costante, come nel gen. *Chrysopa*, la presenza della serie lineare dei quattro sensilli dor-

M.M.P., 1946. – Contributi allo studio dei NEUROTTERI Italiani. IV. *Nothochrysa italica* Rossi. *Bollettino dell'Istituto di Entomologia della Università di Bologna*, 15: 85-102.