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REUSE OF OLD NESTS BY THE EUROPEAN PAPER WASP *POLISTES DOMINULA* (HYMENOPTERA VESPIDAE)

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Abu Bakar N.A., Baracchi D., Turillazzi S. – Reuse of old nests by the European paper wasp *Polistes dominula* (Hymenoptera Vespidae).

Similarly to the majority of social insects the nest represents for paper wasps an important component of the colony life and it is intimately linked to its social organization. When, in spring, future foundresses emerge from hibernacula they can choose between building a new nest and reusing an old one. Refurbishing the old nest in order to prepare it for a new breeding season cycle has already been observed in few species of paper wasps. In the present study we found that although the majority of *Polistes dominula* foundresses prefer to start new colonies early in the spring, an eight percent of nests were reused in our population. We speculate that reusing old nests might allow foundresses to save energy and gain time, but in turn it might also impose additional costs such as the risk of incurring in a higher pathogen pressure. Our data shows that the habits of reusing old nest is widespread in *P. dominula* but further experiments are required to test both these hypotheses and to clarify pros and cons of reusing old nests in this *Polistes* paper wasp species.

KEY WORDS: Nesting behaviour; Hymenoptera; Colony cycle; Social insects; Pathogens.

INTRODUCTION

Social wasps of the genus *Polistes* are also commonly known as paper wasps. In *Polistes dominula*, a common species of the Mediterranean regions (AKRE, 1982), the nests are usually started in sheltered locations such as under eaves and shingles of roofs, attics and wall voids and in many other enclosed places (PARDI, 1942). The life cycle of this species can be divided into four phases (REEVE, 1991): foundation stage begins in spring when the overwintered foundresses leave their winter refuges and found a new nest alone or in associative groups (PARDI, 1942; WEST-EBERHARD, 1969). The worker phase starts early in the summer when the first offspring emerges from the nest cells. This first progeny consists typically of sterile females (workers) that perform colony duties such as nest building, foraging, immature brood rearing and colony defence. A *P. dominula* colony can produce on average 100-200 wasps and a combs of 300-400 cells. The colony reproductive phase begins when the first male and female reproductives emerge. When both males and females disperse from the natal nest for mating flights and the old nest is abandoned, the so-called intermediate phase begins (REEVE, 1991). Mated gynes (potentially future foundresses) are the only reproductive individuals that overwinter and start a new colony cycle the next year. All unmated females and all males die before winter. The nest represents the most important element in social insects and in paper wasps the colony social organization is intimately linked to the structure of the nest and the content of the comb (BARACCHI *et al.*, 2007, 2010a). It is thus not surprising that the choice of the nesting site and the substrate where starting the nest is a crucial phase for the future success of the colony. Foundresses prefer building new nests every year rather than reutilizing old nests, although few examples of nest reutilization have been reported in some paper wasp species (*Polistes annularis* (STRASSMANN, 1983), *Polistes humilis* (CUMBER,1951; ITO, 1986), *Polistes fuscatus* (STARR, 1978) and in some European populations of *P. dominula* (GIOVANNETTI *et al.*, 1996)). Reutilization of old nests is obviously restricted to those species that nest in sheltered places and may be facilitated by the fact that gynes, emerged in spring from hibernacula, often return to their natal site (phylopatry) before initiating a new colony (RAU, 1929; WEST-EBERHARD, 1969; STRASSMANN, 1983). This habit also facilitates the encounter of related individuals and associative foundations. Particular local conditions (as for example a strong pressure from social parasites on *P. dominula* colonies in Northern Italy, (GIOVANNETTI *et al.*, 1996) may favour the reutilization of old nests in good status. Nest reuse may represent an energy saving strategy of emerged foundresses since it implies only a partial refurbishment of an already built structure. It has also been proposed that the habit of reusing old nests might permit the foundresses to rear in a shorter time the first batch of workers but evidence for that are still lacking for many species. Despite these advantages, old nests are seldom reused, probably due to the presence of various organisms that colonized them after the end of the colony cycle and that might influence both the stability of the nest structure and the health of future immature brood. In the present work we report new data collected in the spring of 2012 in order to provide additional information about the little studied and known phenomenon of nest reutilization in the paper wasps *P. dominula*.

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MATERIAL AND METHODS

Sampling was carried out in Sant'Albino (43^{O} 04'N, 11^{O} 47' E), a locality at a height of 550 m a.s.l. in the province of Siena, Italy. Collection was done on the 1st of May 2012. All colonies at that time of the season were in an early stage of growth, before the emergence of workers (pre-emergence stage). The colonies were discovered underneath the terracotta tiles of a roof (almost 150 sq meters). Nests occupied by adult wasps (foundresses) were collected without wasps early in the morning and brought to the lab for examination. The types of nest (new – reused) and the number of the cells in each comb were counted and differentiated according to their content. The presence of eggs and larvae in each nest was determined by means of a dissection microscope and recorded. Nests were classified into three groups: empty old nests, reused old nests (old nest with larvae or eggs) and new nests. Old nests were recognized by the presence of meconia (residuals of the faeces of pupating larvae (JEANNE, 1973)). The number of cells and the cell content (immature brood) in the three types of nests were compared using the statistical software SPSS 19.

RESULTS

A total of 211 inhabited nests were collected. Only 16 (8%) of them were reused, 185 (88%) were new nests and 10 (4%) old empty nests.

Nests differed in the number of cells (Kruskal-Wallis test,df = 2, χ^2 = 52.1, p < 0.001). Precisely, old reused nest were bigger than old empty nests (Post Hoc Mann-Whitney U test, n = 10, 16 U = 31.5, p = 0.009) and both were bigger than newly founded nests (Post Hoc Mann-Whitney U test, old empty-new nests: n = 185, 10, U = -0.19, p = 0.001; old reused-new nests: n = 185, 16, Z = -6.1, p = 0.001), (Table 2). In particular the biggest reutilised nest counted 315 cells while the biggest newly founded one counted only 68 cells (for average values see Table 2).

The total number of eggs and larvae found in the collected nests are reported in Table 1.

The average number of eggs and larvae found in the reused nest was (mean ± SD) 19.6 ± 11.3 and 4.3 ± 4.9 respectively while in the new nests was 7.6 ± 5.8 and 0.7 ± 2.4 respectively (Fig. I and Table 2). The three types of nests differed in cells' content (Kruskal-Wallis test, eggs: df = 2, χ^2 = 43.4, p < 0.001; larvae: df = 2; χ^2 = 37.8, p < 0.001). Old reused nests had a statistically higher number of eggs and larvae than new nests (Post Hoc, Mann-Whitney U test, eggs: n = 185, 16, Z = -4.5, p < 0.001; larvae, n = 185, 16, Z = -5.8, p < 0.001).

The size of the comb (i.e. the number of cells) correlated with the number of eggs and larvae in the new colonies (Spearman test, eggs: n = 185, ϱ = 0.3, p = 0.001; larvae: = 0.4, p = 0.001). This correlation was not significant in old reused nests (Spearman test, eggs: n = 16, ϱ = -0.06, p = 0.8; larvae: ϱ = -0.03, p = 0.24) (Fig. II).

DISCUSSION

Our results confirm that the habit of reusing old nests occurs in the European paper wasp *P. dominula* (see also GIOVANNETTI *et al.*, 1996) similarly to what happens in other congeneric species (STRASSMANN, 1983; CUMBER, 1951; ITO, 1986). Although *P. dominula* foundresses clear-

Table 1 – Summarized data from nests inspections.

Type of Nest	Total No. of eggs	Total No. of larvae	Number of Nests
New	1361	135	185 (88%)
Old empty	0	0	10 (4%)
Reused	314	69	16 (8%)

Table 2 – Average number of cells and immature brood in new (n = 185), old empty (n = 10) and reused (n = 16) nests.

Type of nest	Cell/nest	Eggs/nest	Larvae/nest
New	23.1 ± 13.1	7.6 ± 5.8	0.7 ± 2.4
Old empty	103.3 ± 93.1	0	0
Reused	220.2 ± 90.2	19.6 ± 11.3	4.3 ± 4.9

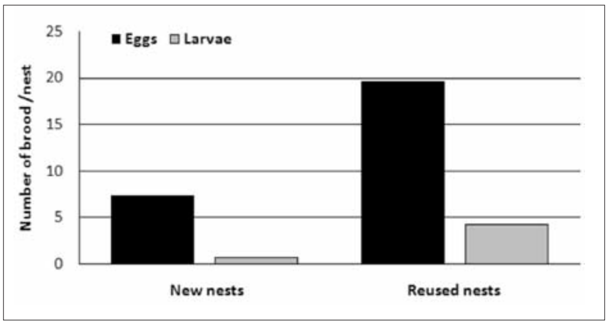

Fig. I – Overall brood content of the new and old reused nest by Polistes dominula.

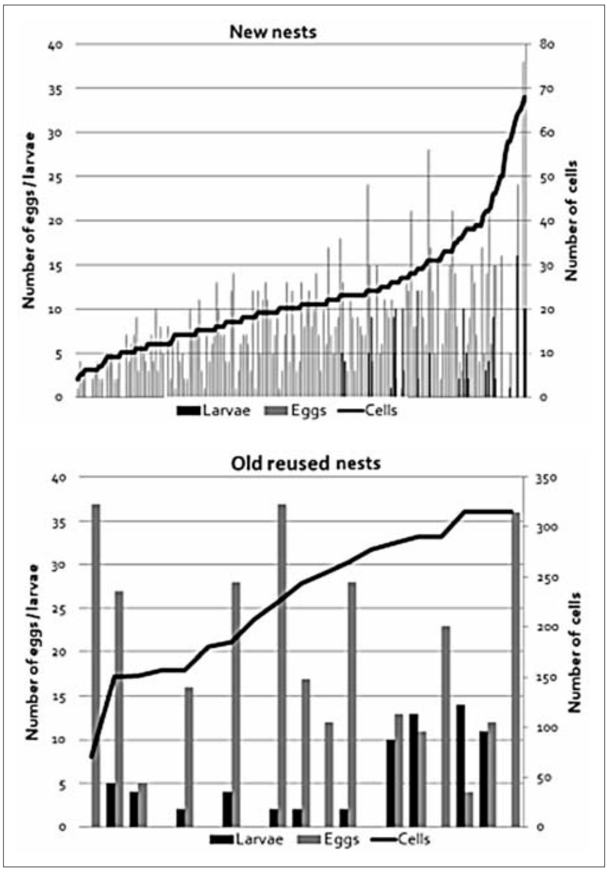

Fig. II – Relation between comb size (number of cells) and brood content in old reused nest and new nests.

ly prefer to start new colonies early in the spring in order to prepare for the new breeding season cycle, our data suggests that reusing old nests represents a more widespread strategy than previously thought. Indeed, at least in our site of study, the eight percent of the total number of active colonies were initiated on reused nests. Not all the old nests present in the site were reused suggesting that their number was not a limiting factor for the reutilization strategy of the foundresses. On average, the reused nests were the biggest among the old ones. This finding might potentially suggest that when foundresses opt for reusing old nests they choose the biggest ones. Yet, this is not the only possible explanation. Indeed, the size of the comb is commonly related to the number of co-foundresses as all of them give a contribution in building the nest. Unfortunately, the lack of information about the number of foundresses present on each colony at the time of collection does not allow us to clarify this point further. Despite that pros and cons of reusing nests are not completely elucidated, it's evident that foundresses who choose to reuse old nests have some advantages but also incur in additional risks. Several local conditions and ecological and contingent factors may influence the choice of the gynes. For example a constant strong pressure from social parasites on *P. dominula* colonies in a particular zone of Northern Italy favours the reuse of old nests in good status (GIOVANNETTI *et al.*, 1996). Our site of study, however, is not characterised by a consistent social parasite pressure.

Nest reuse is clearly an energy saving strategy that might permit foundresses to rear in a shorter time the first batch of workers. Despite we have no information about the time of emergence of imagoes from pupation, our data show that reused nests have a higher number of eggs and, most importantly, a higher number of larvae than new nests collected in the same place and over the same period. Nonetheless, it is important to stress that the number of eggs and larvae found in the nests might depend on the number of eggs-laying females. Liebert and co-workers (2008) showed that in reused nest of *P. dominula* more than one female can lay eggs. Again, the lack of information about foundress reproductive status does not allow us to clarify this important point. Moreover, only the number of reproductives emerged from reused and new nests can give a certain indication about the success of the two strategies. Old nests might also be good indicators that the nesting sites are safe and good places where to start a new colony. Yet, the majority of *P. dominula* foundresses prefer to build a new nest rather than to occupy an old one despite it is costly in term of time and efforts. This suggests that the habit of reusing old nests also imposes additional costs.

For example, old nests of paper wasps often harbour various macro and microorganisms and they often lose their structural strength if infested by moth larvae (YAMANE, 1996). Moreover, the typical presence of larval meconia at the bottom of the cells in old *Polistes* nests (JEANNE, 1973) can expose the brood to pathogens. Social wasps use their antimicrobial venom to disinfect their cuticle and their nests (TURILLAZZI *et al.*, 2006, BARACCHI *et al.*, 2010b, 2012). Those venom antimicrobial peptides delivered on the nest surface confer pathogen resistance at the colony level (TURILLAZZI *et al.*, 2006; LAMBARDI *et al.*, 2007) and old nests might lose their antimicrobial activity over the winter. As a result, foundresses opting for reusing nests might be able to start early the colony cycle but at expenses of brood health and quality. Further experiments are required to test this hypothesis.

To conclude, our data show that the paper wasp *P. dominula* reuses old nests and that this habit is probably more widespread than previously thought. Several ecological factors clearly affect the success of foundresses that decide to found new colonies by reusing old nests. Given that our data are limited and based on a single location of study we have to be very carefully in interpret our results. We can hypothesize that the choice of reusing old nest probably allows foundresses to save energy. Potentially, it might also help foundresses to rear in a shorter time their brood but further experiments are required to test both these hypotheses and to clarify pros and cons of reusing old nests in *Polistes* paper wasps.

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