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Mini Review

Vespiculture of *Polistes Dominula* (*Hymenoptera, Vespidae*): From Laboratory Research to Applicative Uses

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Abstract

Polistes dominula, a model species paper wasps of the family *Vespidae* has been for long reared in captivity for studies on its social biology. Various laboratory breeding systems have allowed many researchers to deepen their knowledge on social behavior, physiology, development, nest construction techniques of this species with results that can also be extended to other social animals. However, like other congeneric species, it also has the potential to be used for useful services to man if bred in the field with vespiculture techniques that will have to be increasingly perfected. Here we briefly trace the story and the perspectives of *Polistes* vespiculture in times of scarcity of these insects.

Keywords: Wasps; *Polistes dominula*; Vespiculture; Rearing techniques

Introduction

Social Wasps represent very important elements of the ecosystems even if they are obnoxious for many persons and can cause serious sanitary and economic problems. They belong to the hymenopteran family *Vespidae*, which comprehends eight subfamilies, including *Polistinae*. This subfamily, together with *Stenogastrinae* and *Vespinae*, is eusocial, with colonies where biological altruism takes place with only some individuals which reproduce themselves helped by, sometimes, completely sterile workers [1]. Social wasps stand at the top of the alimentary chains of insects and have characteristics which make them useful for man, furnishing various kind of ecological services. Their disappearance from some geographic areas may cause evident faults to an ecosystem and problems for venom shortage for people with severe allergies [2,3]. Ecosystem services include ecological, medical, and scientific ones, as reported by a recent paper by Brock RE et al. [4].

Similarly, to Apiculture, Vespiculture consists of all the breeding practices of wasps which can obtain advantages for man and for the environment. Vespiculture has already been known for a long time, especially in Asia; in some countries colonies of wasps are reared for alimentary purposes and larvae, pupae and adults of various species constitute an important apport of proteins for populations [5]. In another way breeding of wasps led to the perform accurate observations and experiments on their social biology and physiology. *Polistes* wasps, form a group of various sub genera which live in the temperate and tropical zones of Northern and Southern hemisphere [6]. *Polistes dominula* is and has been the most studied of all the paper wasps and became a model species for behavioral, evolutionary and ecological research [7]. Moreover, its colonies are common in Southern Europe but have now been introduced in many other countries (USA, Argentina, South Africa, East Australia and New Zealand) and we shall focus on it our attention; last, but not least it was the species on which our group has worked for more than 80 years Pardi L [8]. As their colonies are quite smaller if compared

to those of other social wasps, they are often considered of minor interest by the common people, but they can create some sanitary problems and at the same time, can furnish important services to man.

As other *Polistes* species *Polistes dominula* presents many specific biological characteristics some of which are reported in the following:

a) Their colonies have a medium size with a nest seldom reaching 300 cells and 40-50 adults [9] and as they are preferentially located in closed places, are often out of sight.

b) Nests are at first founded with a single peduncle on flat substrata.

c) New colonies foundation is usually determined by the philopatry tendency of sister foundresses to return to the same natal nest in the following Spring.

d) Colonies can be funded by single or multiple (often related) foundress queens. A linear hierarchy takes form after encounters between associated foundresses [9].

e) Colony mate recognition relies on chemical and visual ques [10,11].

f) Colony aggressivity is usually very scarce before the emergence of workers (S.T. personal observation).

g) Owing to their size, young colonies can be easily manipulated and transplanted to other places.

h) Food for larvae consists mainly of chewed insect larvae and spiders, very seldom of meet.

i) Foraging by adults occurs in a medium range of 200m from the nest [12].

j) Food of adults consists of various sugary sources including the saliva of their larvae [13].

k) Males abandon the colony for performing mating flights and are often chased away from the nests by the workers [14].

l) Colonies can be founded at even in little spaced from one another (S.T. personal observation).

m) Female can sting repeatedly and at the same time, bite an intruder (S.T. personal observation).

n) Adult size does not exceed the size of a honeybee and can easily be marked for individual recognition by the researchers [9,15].

With these characteristics colonies of this species are good candidates to be reared in laboratory cages, at least in the first period of colony development, and to be closely followed when transferred in the field when they become too large.

Laboratory Rearing

Laboratory cages can be of various sizes and materials according to the type of research and depend on the time of the seasonal cycle one wants to study. In his pioneering studies on the social behavior of *P. dominulus* (then still named *Polistes gallicus*), Pardi L [8,9] used to make observations on colonies he had transplanted at the initial stages inside a net cage (4,40x4,35x2m), placed on the terrace of a building of Pisa University, observing the entire cycle of colonies founded in the cage by hibernating females. For convenience the size of the cages in laboratory was progressively reduced (by Pardi himself and then by other researchers) to cubic boxes 60x60x60cm made of wood and glass. A further reduction was made with the use of plastic or glass containers De Souza AR et al. [16] which permitted a more accurate observation of initial foundresses associations and the performance of good quality movies. Several studies were done by various European and American researchers on different aspects of biology of *P. dominula* and other species of *Polistes* (for a partial list see De Souza AR et al. [16]) using slightly different cage models. One of us utilized even smaller cages for a study of the role of body size in determining the reproductive hierarchy between associated females [17].

Caged nests can be tracked easily for nest construction with the supply of material of different color, for observing immatures development, defensive behaviors when the colony is challenged with predators, when the social organization of a colony is upset with the elimination of important individuals etc. In a less cited study [18] we were even able to transplant mature larvae in artificial nests made with groups of single plastic cells. The nests were adopted by the adults and we could measure the weight of single larvae from the egg to the emergence of the pupae and document the fine interactions with the adults.

Field Rearing

Jandt JM et al. [19], on *Polistes fuscatus*, observed that conclusions obtained on social traits from colonies maintained in too small cages could be misleading, with respect to those obtained in field colonies. This can be solved by confining the nest in a protected open box and leaving the wasps to go out freely for foraging. We can induce the foundation of a nest in open boxes previously prepared in an opportune place, and *Polistes* colonies in open boxes can be easily transferred in new locations. Rabb RL et al. [20] did it with colonies of *Polistes fuscatus* and *P. exclamans*, which they posed in tobacco fields to counteract parasite infestations. The same was performed by other researchers: Morimoto R [21] stressed the importance of *Polistes* sp. as natural enemies of insect pests; Giannotti E et al. [22] experimented *P. lanius* in sugarcane plantations; Prezoto F et al. [23] used *P. simillimus*; Butignol CA [24] *P. versicolor* in urban areas; Elisei T et al. [25] *P. versicolor* in *Eucalyptus* forests. Caged *Polistes dominula* colonies can be transferred from one place to another if they are sufficiently active, but acceptance is not always certain.

At present, our group has three different lines of research and application ideas. The first is monitoring of presence of heavy metals or other pollutants in the environment [26]. The second is the study and application of transmission of microorganisms (yeasts) in the vineyards [27]. The third and most important, is the production of venom intended for Immunotherapy for allergic subjects. Vespiculture is the solution to have a good number of

colonies, sometimes difficult to find in nature, so that the increasing demand for venom of this species can be met. Our team uses plastic plant nursery pots with an opening of 16cm and a height of 20cm to organize open air farms in the countryside where there is availability of water and insects. The upside-down pots can be organized in rows or in sectors that still allow easy handling and collection of the pots. The pots we usually use have 7 holes for water outlet of 2cm x 1cm, which are located at the base of the pot. We used both black and brown vases, but the ones used by the wasps are preferentially the black ones [28]. Single foundresses can build the nest directly in the pots. The process cannot be facilitated by bringing hibernating wasps or too young foundations inside, but the acceptance becomes easier if the transplanted nests have various adults and many cells with larvae and pupae. It is certain that the populating of the pots is much easier if the foundresses come from colonies already present in pots utilized the previous year.

To transfer a colony to an operating place, the exit holes are plugged and the whole pot is placed in a bag. The bag will be removed to the new place that must not be too close to the initial position (to avoid wasps returning to the old place). At this point we open the exit holes and wait for the wasps to come out to orient themselves on the new location. In this regard, it is important that the vase is marked as early as a few days before, with flashy signals. The transfer shall be done in the early hours of the day when the wasps are calmer and are mostly on the nest; a rough acceptance of the new location can have a success of 40-50%. The second line of research is the one that refers to the use of *Polistes dominula* as carriers of yeast suitable for winemaking. The discovery that *Saccharomyces cerevisiae* completes the entire biological cycle in wasp colonies, including those of *Polistes dominula* [27], opens interesting perspectives for the natural re-population of yeasts in abandoned vineyards. In a recent paper under revision (Di Paola and coworkers), females and males reared in the laboratory and fed with sugar and marked yeasts have been able, once placed in the vineyard, to convey the yeasts on the grapes. Later we found these in wine. The result also suggests the possibility of intervening naturally on the organoleptic characteristics of a given product.

The third line of applicative research carried out by our group suggests the use of *Polistes dominula* vespiculture for the collection of venom for medical purposes without having to resort to the dissection of large quantities of animals. As described in a recent publication [28], colonies bred in our containers can be regularly subjected to venom sampling induced by light electrical stimulation. The venom collected in this manner maintains the characteristics of the one extracted with the dissection of the sac and the operation can be repeated various times during the season [29].

Conclusion

The Vespiculture of *Polistes* has allowed to reach a very in-depth knowledge of some characteristics of the social biology of these wasps. In the laboratory it has led to the definition of physiological and behavioral aspects and at the same time, has given indications on the procedures to be followed for a breeding carried out in the field, with the prospect of making it easier to use these insects in various contexts (as agents in biological control, as short-range biological indicators, as vectors of hostile or harmful microorganisms, as supplier of compounds useful for medicine, etc.) that will be expanded in the various congeneric species widespread in temperate and tropical environments all over the world. However, much remains to be done to refine the techniques that may be important for the exploitation of these insects. Social wasps, therefore, represent in general a largely unexplored potential for applicative purposes and the reduction of their populations requires their management that can also be obtained through increasingly improved vespiculture practices.

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