CATANIA UNIVERSITY OF STUDY

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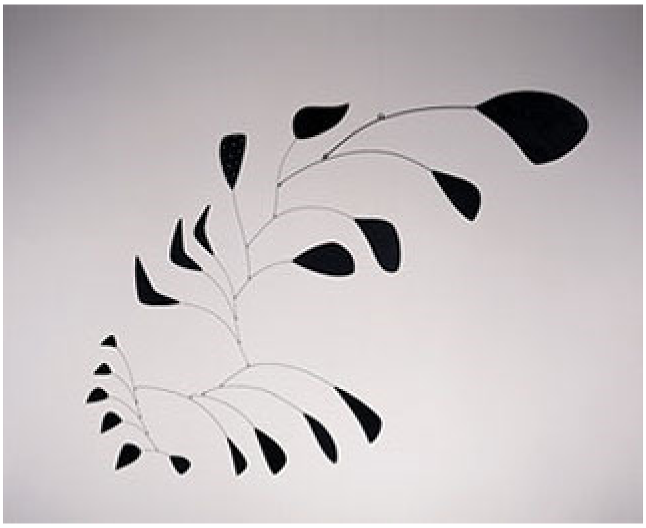
Diversity and flight activity of Staphylinidae in a citrus orchard of the Catania Plain (Sicily)



Alexander Calder. *Vertical Foliage*, 1941

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SUMMARY

ABSTRACT

The present study aims to investigate the diversity and flight activity of Staphylinidae in a citrus orchard of the Catania Plain (Sicily) using different sampling methods (car-net, window traps and pit-fall traps). The study looks at the complex of flying rove beetles with the aim of defining preliminarily the faunistic and zoogeographical structure of this family in the study area. A second aim of the study is to investigate, using window-traps and pit-fall traps, the spatial distribution of flying staphylinids inside the orchard and in adjacent habitats. The use of window traps and car-net allowed to analyse the monthly and daily flight activity of staphylinids and to analyse the flight circadian rhythm and its seasonal variation. Monitoring of wind and temperature also allowed to evaluate the effects these environmental factors on the flight activity.

170 taxa (species, subspecies and 20 morphospecies) of Coleoptera Staphylinidae were collected. Most of the species are eurytopic species or related to substeppic or steppic environments, usually saprophyles with broad ecological valence. 5 species (*Pella leonhardi, Pronomaea sicula, Quedius caelebs, Tasgius globulifer evitendus* and *Tasgius pedator siculus*) are endemics to Sicily, 1 species (*Oxypoda flavissima*) is new for Italian fauna, 11 species (*Acrotona muscorum, Amischa decipiens, Amischa forcipata, Atheta testaceipes, Carpelimus fuliginosus, Dacrila pruinosa, Lithocharis nigriceps, Micropeplus porcatus, Neobisnius lathrobioides, Outachyusa raptoria, Pycnota paradoxa* e *Trichiusa immigrata*) are new for Sicilian fauna. The chorological spectrum is coherent with the environment where the research took place: a large orchard plain characterized by prolonged summer aridity.

The results of the window trap sampling show significant differences in the abundance of the flying species between open areas inside the orchard characterized by herbaceous vegetation (Track) and the inside of the parcels of citrus grove (Citrus). On the other hand the Spearman rank correlation analysis demonstrates that the faunistic structures of this stations are similar.

Comparison between sampling with pit-fall traps and with windows traps one shows that these two sampling methods basically differ by the taxa captures frequencies, in addition to the complete absence of *Ocypus o. olens* in the window traps.

The occurrence of the maximum frequency of catches in the window traps in the spring (often in contrast with car-net data) suggests that in this period blooming and fruits marcescence processes are an attractive stimulus which causes an increase of flight activity.

Hourly sampling with car-net highlighted, in the most abundant species, that flight has a circadian rhythm characterized by morning and afternoon peaks with a break or a decrease at midday.

The beginning of flight activity coincides with dawn in summer period in *Gabronthus maritimus* and in Alaeocharinae and Oxytelinae (not examined at species level). Flight activity's end takes usually place at sunset or twilight. Flight activity after dusk up to an hour after sunset has been detected in the Paederinae *Scopaeus debilis*, *Hypomedon debilicornis*, *Astenus b. bimaculatus* and *Astenus pallidulus*.

There are also seasonal variations of the distance of morning and afternoon peaks from dawn and sunset: in winter they are far away from dawn and from sunset, in spring the afternoon peak gets closer to sunset, in summer morning peak moves closer to dawn and the afternoon one overlaps sunset, in autumn this two peaks move away from dawn and from sunset again.

From autumn to spring the beginning of flight activity is conditioned by temperature. High temperature seems to cause the extension of the midday break which in summer extends until mid-afternoon. Wind is also an environmental factor which influences flight: in several species wind's high speeds reduce flight's activities. However, afternoon peaks also occur in highly windy day.

Key-words: Insect flight, circadian rhythm, car-net, window trap, alien species, Coleoptera.

1 INTRODUCTION

The agricultural production systems that have been imposed in recent years compared with their high productivity have led to a significant reduction of biodiversity, both at species and habitats level (BENTON *et alii* 2003; BUREL *et alii* 2004; TSCHARNTKE *et alii* 2005b).
The functional biodiversity of an agro-ecosystem (fig. 1.1) can be schematically subdivided into Planned Biodiversity, which depends on the agricultural practices used in the management of the agro-ecosystem (plant species used, rotation, tillage, etc.) and Associated Biodiversity, which includes all those components of the fauna and flora that colonize the agro-ecosystem from surrounding environments and become part of the agro-ecosystem in relation to its management and its structure (ALTIERI 1999a).

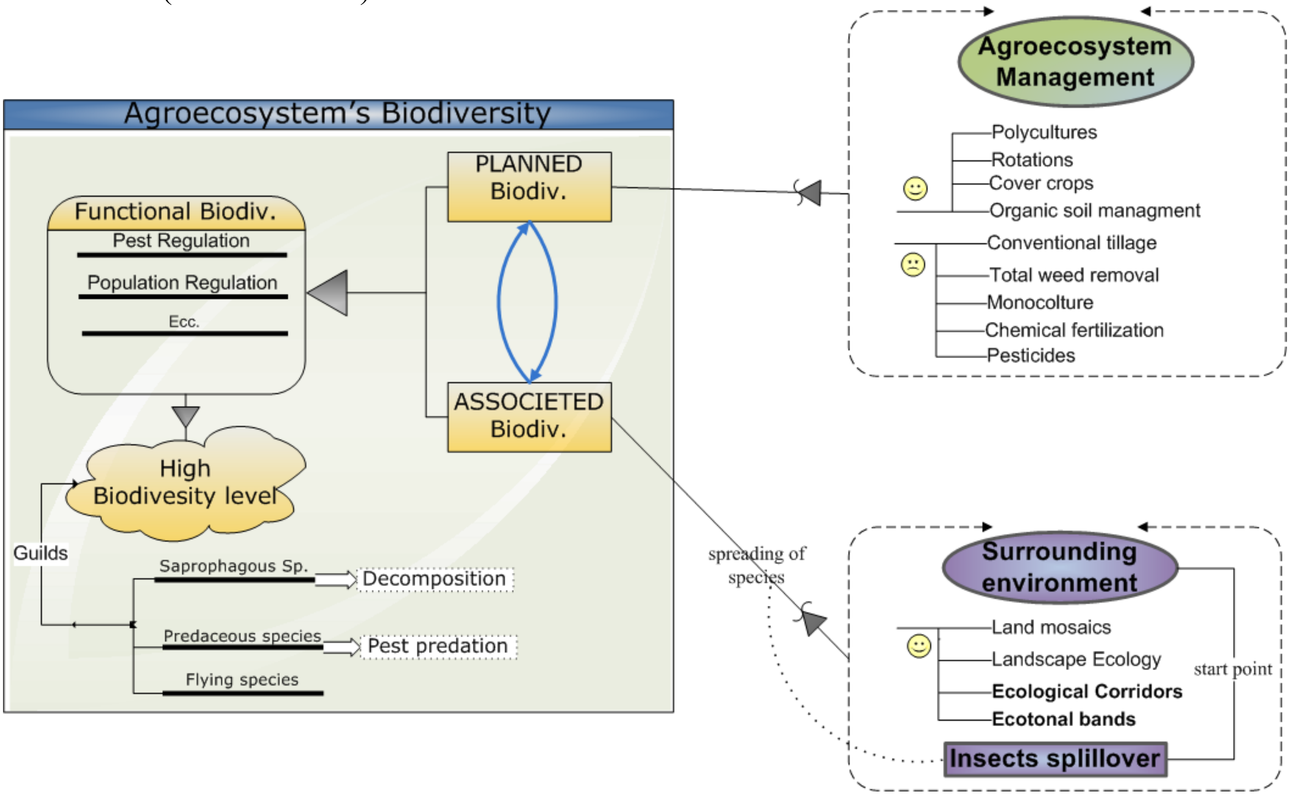


Fig. 1.1 – Diagram of functional biodiversity and relationships of its main components (from ALTIERI 1999a, modified).

Both these components contribute to the functionality of the agro-ecosystem, playing an important role in the regulation of many processes (ALTIERI 1994; ALTIERI 1999a).
At least potentially, some agricultural practices could have a direct influence on functional biodiversity, causing either its increase or its decrease. The use of pesticides, for example, while preserving the crops from harmful species, causes a general decrease in diversity and therefore that of those species which operate as natural predators of dangerous insects, with the consequently increase of these latter (GEIGER *et alii* 2010).
Theoretically, an biodiversity increase should fosters the stability of ecosystems promoting a sustainable production. The use of "agro-ecological practices", such as diversification of crops and presence of marginal areas with natural or semi-natural characteristics, helps to reduce ecological simplification resulting in an increase of functional biodiversity that make agro-ecosystems more stable (ALTIERI 1995; ALTIERI 1999b; THIES & TSCHARNTKE 1999; ALTIERI 2004; WEZEL *et alii* 2009) as an example, to positively react to noxious species attacks, since it's able to support in their internal structure effective helpful insects in the biological control as well as it's able to directly inhibit the external attack of noxious species (ALTIERI *et alii* 2003).

However it was proved that in many cases the increase, or maintain, a high level of biodiversity in agriculture depends not so much on the reduction of conventional farming practices, but rather on other factors, where the mosaic structure of the landscape appears as the most significant one (JONSEN & FAHRIG 1997; HUNTER 2002; HOFFMANN & GREEF 2003; GOODWIN 2003; HENDRICKX *et alii* 2007; DIEKÖTTER *et alii* 2008; GABRIEL *et alii* 2010; WOLTZ *et alii* 2012). The population dynamics of the single cultivated field are directly or indirectly influenced by those established at the wide area level (RAND & LOUDA 2006). The agricultural landscape mosaic (farmlands, tree crops, semi-natural and natural areas, etc.) provides suitable conditions to carry out the biological activities (reproduction, feeding, etc.) of many useful species for agriculture. On the contrary, these conditions do not occur in a landscape characterized by extensive monoculture.

In this context, the Associated Biodiversity represents a significant component of agro-ecosystems not only in terms of biodiversity, but also for the potential regulating capacity that it can play. For example, an increase of generalist predator species is considered useful because, directly or indirectly, they can potentially control the populations of phyto-saprophagous species harmful to agriculture.

A large part of the Associated Biodiversity of agro-ecosystems comes from outside and so it is important to define the modalities through which animals colonize them (NICHOLLS *et alii* 2001; JUEN & TRAUGOTT 2004; ROMERO *et alii* 2008; GRUEBLER *et alii* 2008; BUCHER *et alii* 2010; FOLEY & HOLLAND 2010). Many studies show that the ecological corridors or the ecotonal bands between cultivated areas and natural environments, promote the insects spillover (NICHOLLS *et alii* 2001; TSCHARNTKE *et alii* 2005a).

DUELLI & OBRIST (2003) identify five patterns of distribution of insects between agricultural and non-agricultural areas (especially stenotopic, ecotonal, "disperser" ubiquitous and agricultural species) (fig. 1.2).

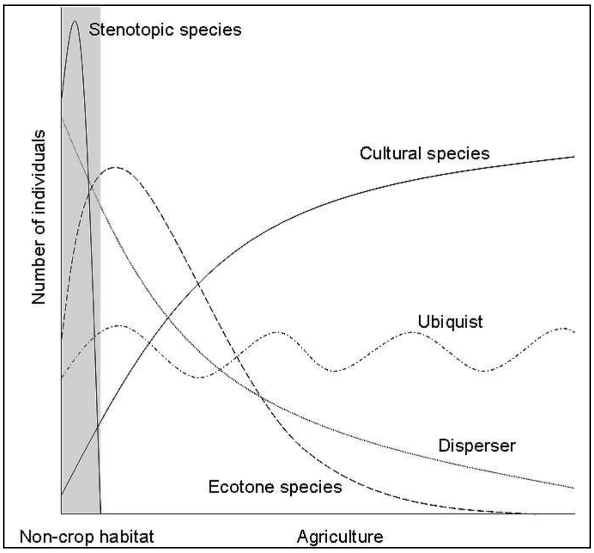


Fig. 1.2 - Distribution patterns of insects among agricultural and non-agricultural environments (from TSCHARNTKE *et alii* 2005a).

The ecotonal species or "disperser" colonize agricultural fields from the natural environments or habitats surrounding, but always maintain their peak abundance in the marginal areas of the field and not in the central areas, as is the case for agricultural species. The ubiquitous species, however, do not show a particular preference between the two types of environments (TSCHARNTKE *et alii* 2005a).

The study of these flows of species among the different components of the landscape mosaic is particularly important to understand the spatio-temporal dynamics which regulate biodiversity and balances in agricultural environments (TSCHARNTKE *et alii* 2005a).

In this context, special attention should be given to flying species representing the contingent of species most involved in these dynamic exchanges between the various components of the environmental mosaic, contributing to determine a considerable part of agro-ecosystems biodiversity (GRUEBLER *et alii* 2008). For example, the value of ground based predators for aphid control has been questioned because selective exclusion studies indicate that the contribution they make is relatively small compared to that of aerial predators and parasitoids (SCHMIDT *et alii* 2003; HOLLAND *et alii* 2006) suggesting that levels of biocontrol may be better improved by encouraging the flying species, such as Syrphidae, Coccinellidae and Parasitica (HOLLAND *et alii* 2008).

Insects flying activity, in natural and agricultural landscape, has been extensively investigated at the level of systematic groups or species (AUKEMA *et alii* 2004; TOEWS *et alii* 2006; GRUEBLER *et alii* 2008; BARSULO & NAKAMURA 2011). Some studies have analysed the flying activities of dispersion, within or among different cultivations, of species of agro-economic interest (SHIMODA & TAKABAYASHI 2001), or between natural or semi-natural environments and cultivated areas (RAND & LOUDA 2006; SZINICZ *et alii* 2005).

In recent years, many studies on airborne insects, carried out with radar observations, showed an enormous aerial "bioflow" (CHAPMAN *et alii* 2003; GEERTS & MIAO 2005; RILEY *et alii* 2007; WOOD & O'CONNOR 2009) which can have important implications for ecological, physiological, and genetic studies of insects, with applications in pest management, conservation, and in environmental change programs (WOIWOD & HARRINGTON 1994; DRAKE & GATEHOUSE 1995).

Flight, as many others biological processes, is characterized by circadian and photoperiodic rhythm (DANKS 2003). Circadian rhythms are endogenous, ~24-h oscillations governing various behavioural and physiological functions. The rhythm synchronizes to and is profoundly affected by light cycles. Light is the most important driver of circadian behaviour. Variations of temperature influences the movement, but entrainment to a temperature cycle does not cause after-effects; light may be unique in its ability to induce after-effects. (TOMIOKA & SAKAMOTO 2006).

The photoperiodic time measurement system (photoperiodic clock) recognizes seasonal change of day-length or night-length (PAVELKA *et alii* 2003), as signals for seasonally cycling deterioration of conditions for life/development, allowing organisms to prepare in advance. Physiological mechanisms of the photoperiodic time measurement system remain obscure. Part of the scientific community accepts that certain elements with circadian oscillatory nature may be functionally involved in photoperiodic clocks. This hypothesis, formulated originally by BŰNNING (1936) for plants, has later received support from other organisms including insects (SAUNDERS 2002).

The flight responds to different ecological requirements leading at different types of movement behaviour.

Migration is a behavioural process which, according to Kennedy's definition (1985), has the following characteristics:

- Migratory movement may be accomplished by the animal's own loco-motory exertions, or it may involve a transporting 'vehicle' such as wind, water, or phoresis on another organism, but in each case the migration is actively initiated and maintained through specialized behaviour patterns.
- Migratory flight is often persistent.
- Responsiveness to stimuli which promote 'station-keeping' flight and settling are inhibited or depressed.
- Migration is usually activated by cues such as photoperiod that act as surrogates for habitat change, rather than directly by a change in the current state of resources.

'*Vegetative'* or *resource-finding movements* are directed towards the exploitation of resources, particularly those required for growth and reproduction (food, shelter, mates, oviposition sites, etc.), and these movements are readily interrupted by an encounter with the resource items (KENNEDY 1985; DINGLE 1996; HARDIE *et alii* 2001).

The term "*dispersal*" is often used if it is not possible to know the behavioural state of an individual insect during a particular movement. The ecological consequences of this movement is a *redistribution* of the populations in their home range.

All these type of movements are relevant in the structuring of the networks of local populations that constitute the metapopulations (HANSKI & GILPIN 1997; HANSKI 1999): each local population may be small, and prone to extinction, but the entire metapopulation survives because re-colonisations of empty habitat patches are sufficient to balance the extinctions that do take place. Without movement, these systems would become extinct, as the local populations die out, one by one. With movement, the metapopulation may survive indefinitely.
All phases in the dispersal process are influenced by ecological and environmental factors; among them predation is perhaps the most relevant (WEISSER 2001). Predation is shown to be an evolutionary force that may: (i) select for dispersal, (ii) select against dispersal and (iii) select for conditional dispersal strategies, i.e. dispersal conditional on predator attack or an increase in the risk of predation. In the predator-prey system, many insect groups are interested on both sides.
Dispersal also strongly influences the areas over which we may need to apply management either to increase (conservation) or decrease (pest control) a species of interest (THOMAS 2001). Movements of individuals link together the various locations where breeding is achieved or attempted. The amount of movement affects how we describe these habitat networks, the dynamics we might expect, and the extent to which local adaptations may evolve. It also affects the scale at which practical management may need to be applied.
Staphylinidae are one of the most important group of epigeic invertebrates in agricultural landscapes in terms of activity and abundance (ORBTEL 1968). They represent about 19% of all beetles in terms of number of individuals. The number of Staphylinidae species is often higher than that of carabids (BOHÁČ & POSPÍŠIL 1984), and in some biotopes staphylinid abundance can be 15 times greater than that of carabid specimens (LUBKE-AL HUSSEIN & WETZEL 1993).
The family Staphylinidae (rove beetles) is one of the largest families of beetles, worldwide distributed, with about 58,240 known species (HERMAN 2001) (including Pselaphinae and Scaphidiinae to which should be added also Scydmaenidae which have recently been included in this family). Staphylinidae show a very high ecological diversification and are practically distributed in all natural, semi-natural and man-made habitats (BOHÁČ 1999).
There are practical difficulties associated with Staphylinidae taxonomy especially in the subfamily of Aleocharinae due to their morphological uniformity (see for example the iconographic catalogue of TRONQUET 2006), to the diagnostic characters difficult to detect (e. g. dichotomic keys of the tribes and genera are based on tarsal formula and on the morphology of the mouth's parts) (BENICK & LOHSE 1974) and especially for the high number of species 16,115 (HERMANN 2001). An organic revision of European species of this subfamily is lacking.
In Italy are present more than 2,200 species (except Pselaphinae, Scaphidiinae and Scydmaenidae), whose more than 650 are present in Sicily (CICERONI *et alii* 1995).
As regards the morphology of adult, staphylinids are a highly diverse group, for size (frequently the body length of adult ranges from 1 to 35 mm), colour pattern (brownish or yellowish to dark, other colour like red or blue are rare) and body shape (elongated and subparallel as in many species of Paederinae, flattened and short as in many Omaliinae, shortened with very long elytra as in Micropeplinae and Proteininae, carrot shaped as in most Tachyporinae, etc.).
The short elytra has allowed abdominal flexibility while maintaining the ability to fly and to protect the delicate wings. In some species wings have been secondarily lost or reduced. Wing reduction and wing dimorphism in both sexes in insect species are common phenomena. Sexual dimorphism in wing development is less common. Both are recorded in the Staphylinidae family (ZANETTI 2006; SOLODOVNIKOV 2012). Wing dimorphism in many species of insects display dispersing and nondispersing strategy. In aphid, for example, the dispersing morphs typically possess a full set of wings as well as a sensory and reproductive physiology that is adapted to flight and reproducing in a new location. In contrast, the nondispersing morphs are wingless and show adaptations to maximize fecundity (BRAENDLE *et alii* 2006).
As regard the trophic habits, the majority of adult staphylinids are known as non-specific predators, feeding on various soil arthropods such as nematodes, mites, Collembola, small insect imagoes and

larvae, etc. (NEWTON 1990; BOHÁČ 1999), but there are many exceptions of mycetophagy e. g. Oxyporinae and the genus *Gyropahena* (Aleocharinae), and saprophagy, e. g. most of Oxytelinae feed on various organic substances. Phytophagy is less common, but for example the species of the Omaliinae genus *Eusphalerum* are pollen feeders (ZANETTI 1987). Some species are omnivorous and combine either mycetophagy or saprophagy with carnivory (GOOD & GILLER 1991) either during the same life stage or in different life stages (THAYER 2005). Relatively poor is the literature on the larval diet, with studies that mainly concern the species of agro-economic interest. Some members of the genus *Aleochara* are known to be parasitoids of fly puparia (MAUS *et alii* 1998). Some authors report high levels of cannibalism in staphylinid larvae but this is not supported by field observations (GOOD & GILLER 1991).

In agricultural management staphylinids are recognized important as predators of some pests e. g. aphids, caterpillars, wire worms and other invertebrates. In Europe are widely identified as important to cereal aphid control. *Tachyporus hypnorum*, in both the larval and adult, *Tachyporus obtusus*, *Tachyporus chrysomelinus* (DENNIS *et alii* 1990), and *Philonthus cognatus* (DENNIS & SOTHERTON 1994). *Atheta coriaria* appears to be an effective biological control agent for certain greenhouse pests such as fungus gnats *Bradysia* spp. (Diptera, Sciaridae) (CARNEY *et alii* 2002). Adults of these species are very mobile and are capable of flying long distances; however, they tend to spend most of their life-span in growing media (HELYER *et alii* 2003). Both the larva and adult may feed on various life-stages of a widerange of arthropod pests, including fungus gnats, shore flies, and thrips (HELYER *et alii* 2003; BIRKEN & CLOYD 2007).

In Staphylinidae, the predominance of trophic habits of generalist predator type should provide biological control services at least equal to those of specialist predators. Generalist predation pressure can be more stable in an agro-ecosystem as generalist predator can subsist on non-target prey even if the target is unavailable (DENNIS & WRATTEN 1991) or may be present before the arrival of pest species or can arrive before that pests attain large population sizes so as, to prevent pest establishment or retard pest population growth (CHANG & KAREIVA 1999). The dynamics of interactions between generalist predators and their many pest and non pest prey is debated by SYMONDSON *et alii* (2002), which also report a review of manipulative field studies that shows, in approximately 75% of cases, that the generalist predators, whether single species or species assemblages, reduced pest numbers significantly.

Agricultural measures (tillage, manure, chemical NPK and pesticides) have a lower and more short-term influence on Staphylinidae communities compared with other factors such as relief of agricultural landscape, surrounding biotopes, soil humidity and crop change (BOHÁČ 1991).

The different responses of Staphylinidae community to the different agricultural practices are to be related both to their particular micro-environmental needs (Staphylinidae are highly dependent from humidity, temperature etc.) and to their high dispersion capability (BOHÁČ 1991).

Staphylinidae are largely used in ecological studies of agro-ecosystems (KROOSS & SCHAEFER 1998; BALOG *et alii* 2003; MONZÓ *et alii* 2005; BALOG & MARKÓ 2006; LUPI *et alii* 2006; CLOUGH *et alii* 2007; BALOG & MARKÓ 2007; BALOG *et alii* 2008a; BALOG *et alii* 2008b; MIÑARRO *et alii* 2009; HONĚK *et alii* 2012).

Many staphylinids possess great dispersal possibilities (CROWSON 1981); this ability differs among various species and groups.

DENNIS & SOTHERTON (1994) have studied the ability of some Staphylinidae to climb cereal plants up to positions where aphid species feed. They observed that *Philontus cognatus* (that is a diurnal hunter on the ground) climb the wheat plants only prior to dispersal flights, while some *Tachyporous* spp., that usually climb lower leaves, climb to higher positions on plants if the purpose is the launch for dispersal flights.

Many species are good flyers (e.g. species of the genera *Oxytelus*, *Philonthus*, *Amischa*, *Atheta* etc.) (BOHÁČ 1999). For example, *Oligota kashmirica benefica* Naomi 1984 (about 1 millimetre long and specialized predator of mites) can cover by a single flight a distance up to 16 meters (SHIMODA *et alii* 1997). Many of the displacements of these specialized predators between the infested plants

occur presumably by flight. These displacements take place both within individual crops and in adjacent areas to search their prey, as in the above mentioned *Oligota kashmirica benefica* (SHIMODA *et alii* 1997).
Many small species are carried by the wind for long distances (e.g. species of the genera *Oxytelus*, *Amischa*, *Atheta*) and some species can be transported by man and have been distributed in this way all over the world (e.g. *Lithocharis nigriceps*). In recent years the expansion of some species has occurred mainly from southeast Asia (e.g., *Oxytelus migrator*, *Philonthus spinipes*) (BOHÁČ 1999).
In agro-ecosystems the activity patterns of staphylinids species are highly variable. As regard the seasonal activity pattern of ground dwelling staphylinids, in Oklahoma winter wheat fields ELLIOT *et alii* (2006) found that most rove beetle species showed no association with a particular season, however some species were dominant in fall or in winter. In citrus groves in Valencia (Spain) MONZÓ *et alii* (2006) report that rove beetles were active throughout the year, fluctuating without a clear pattern. In Sicily in a study carried out in different agricultural environments (PETRALIA 2011) was observed that the 68,18% of catches is concentrated in the months from October to January and the minimum in August, while as regard the number of species, the highest is recorded in April and May. The seasonal flight activity of *Tachyporus hypnorum*, *Oxytelus rugosus* (that show a peak in May/June) and *Oxytelus inustus* (that show peaks in May/June and in autumn), are reported in MARKGRAF & BASEDOW (2002), but there was no correlation in the catches comparison between the flying activity (detected by the windows traps) and the population density (detected with pit-fall traps).
Staphylinid beetles are active mainly during the day (TIKHOMIROVA 1973; SPICAROVA 1982). CHATZIMANOLIS *et alii* (2004) have studied the diurnal/nocturnal activity of rove beetles, sampled with flight intercept traps, in a tropical rainforests. Their results show that the 76.8% were caught during the day. The study of DENNISON & HODKINSON (1983) on the Staphylinidae flying activity patterns in a European forest, shows that most of dominant species were diurnal, but all of them showed some crepuscular activity. TAKAHASHI & MATSUMURA (1993) sampled flying Staphylinidae with a car-net, during one year. The seasonal peaks were in June and in October-November while the daily peak were one hour before sunset (with accounted for the 87.7% of the total sampled specimens).

The present study aims to investigate the diversity and flying activity of Staphylinidae in a citrus orchard of the Catania Plain (Sicily) and in its surroundings, using different sampling methods (car-net, window traps and pit-fall traps). This approach based on the study of whole of Staphilinidae flying species and on different collecting methods permits detailed analysis of the spatio-temporal dynamics of this group of beetles. It provides, in fact, a relatively comprehensive framework of the variations at the level of the single species and especially of the structure of the entire population in response to the variation of different ecological conditions (habitats, seasons, time segment, etc.).
The study looks at the complex of flying species of rove beetles with the aim of defining preliminarily the structure and the faunistic and zoogeographical aspects of the populating of the study area. A second aim of the study is to investigate, using window-traps and pit-fall traps, the spatial distribution of flying Staphylinidae inside the orchard and in adjacent habitats and their characterization by qualitative and quantitative point of view. The use of window traps and monthly car-net allows to analyse the monthly flight activity of staphylinids with particular regards to the most abundant species, while the daily car-net lets to investigate their circadian flight activity with the identification of the different patterns of daily-time flying activity; it is also possible the analysis of the relation of flying activity of staphylinids with some variables like temperature, wind speed and time of the day.
The study purpose is to provide as well some basic indication on Coleoptera Staphylinidae such as the evaluation of the efficiency of trapping methods, and the identification of the most abundant species sampled by each of them, or a description of the population in relation to the different structures of habitat and to seasons variation; moreover was investigated on the identification of

patterns in the daily flying activity, examining their variation based on the interaction between circadian rhythm, temperature, wind speed and seasons.

All this information will be very useful for the study of flight of individual species, and for the setting of further research related to the more general question concerning the way in which fliers species colonize the agro-ecosystem, their contribution to the Associated Biodiversity and their role in biological control of harmful species.

2 STUDY AREA

The research was conducted within the Xirumi citrus company that covers about 200 hectares and is located in contrada Serravalle in the municipality of Lentini (SR) (figs 2.1-2.2).

Fig. 2.1- Location of the study area highlighted by the red dot (from Google Earth mod.).

Fig. 2.2- Detail of the study area included inside the red rectangle (from Google Earth mod.).

In the farm area are planted and cultivated different species and varieties of citrus (orange, clementine, tangerine), but the orange grove takes the greatest extent.
The company is located in an highly citrus-vocation area (fig. 2.3), dotted with numerous water reservoirs and irrigation canals, in which there are a few strips of natural vegetation: shrub and garrigues, ampelodesmos and steppe-like grasslands, mediterranean arid meadows, rupicolous environments.
It is divided into several parcels, with level course of 80 meters on average above sea level.
The native soil tends to be of medium texture, with a good amount of organic matter enriched through regular fertilization with manure and reintegration of organic residues by mechanical processing. Irrigation is performed by sprinkling under foliage and water supply from wells located within the same Farm area.

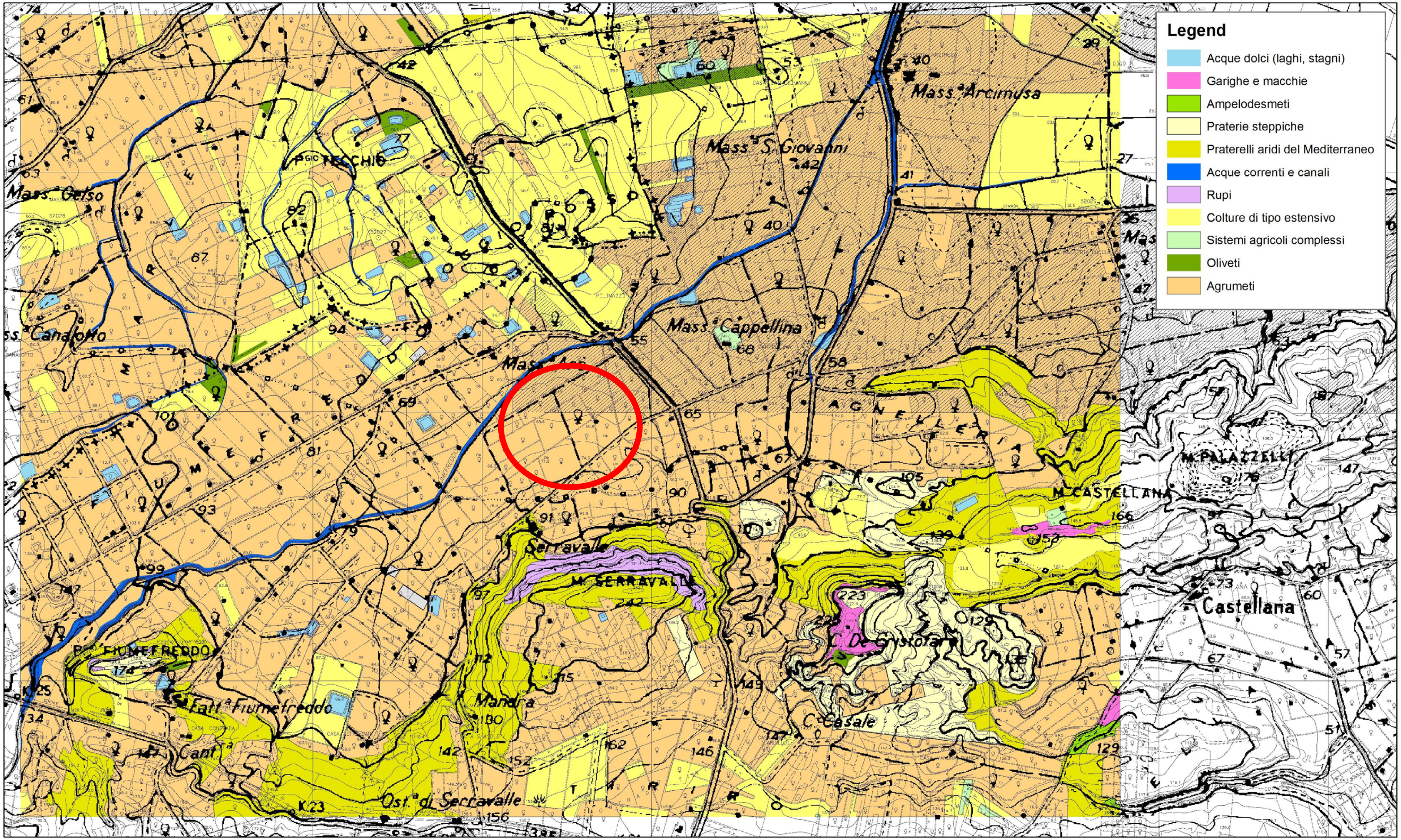


Fig. 2.3 - Land use map in scale 1:20.000 of the wide area where falls the study area (red circle).

Orange cultivars *in situ* are, in order of size: Tarocco, Valencia late, Navelina, Moro e Ovale.The mean age of the plants varies between 10 and 25 years and the spatial area is 6x4 meters. Pruning is done in rotation among the various fields on a regular basis, weeding is done by mechanical crusher and fertilization is performed with organic and minerals compounds according to a specific program based on analytical results (on leaves and ground) which the company periodically submit fields.

2.1 Climate framework

Looking at the thermopluviometric diagram of Lentini (fig. 2.1.1) it shows that the annual mean temperature is approximately 18°C, with a dry period that extends from April to September.

As for precipitation, it shows that they are 600/700 mm with a monthly distribution typically Mediterranean, and a concentration of rainfall in autumn and winter and a drastic reduction of that in the period spring-summer.

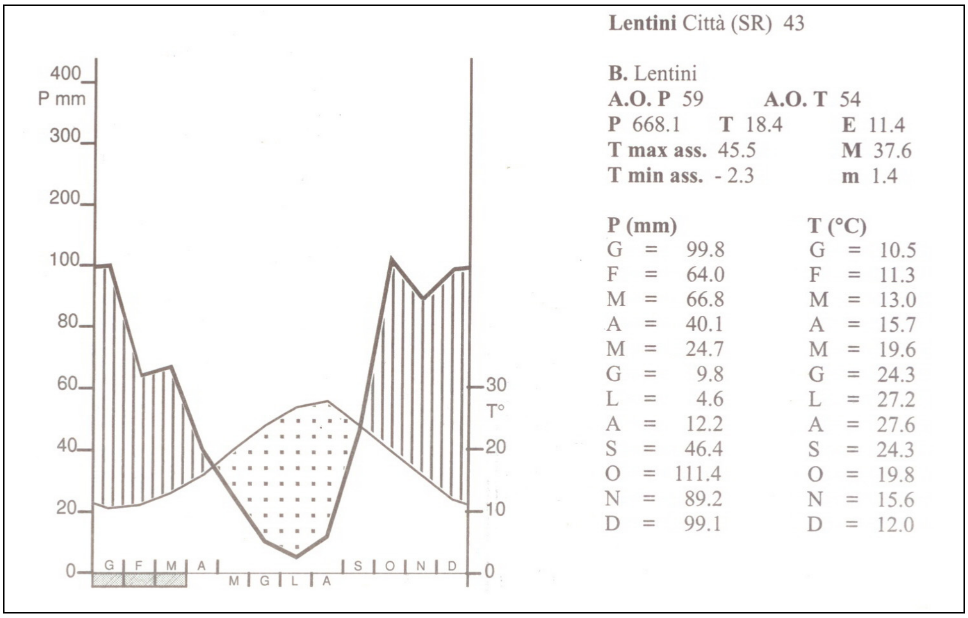


Fig. 2.1.1 – Climate diagram of Lentini thermopluviometric stations (from ZAMPINO *et alii* 1997). To the right are reported elevation characteristics of the station, numbers of years of observation (A.O.), the mean annual and monthly temperature and rainfalls.

Based on available data, the study area falls in the bioclimatic range of superior themo-mediterranean thermotype and sub humid ombrotype (fig. 2.1.2).

For each type or bioclimatic range corresponds to a different kind of natural climaceous vegetation or "climax".

It represents the most advanced natural vegetation for each bioclimatic belt. In the study area, although the deep anthropic changes have resulted in the reduction or disappearance of much of the original natural vegetation, it can be assumed that the original climax vegetation is *Quercus suber* wood, attributable to *Stipo bromoidis-Quercetum suberis*.

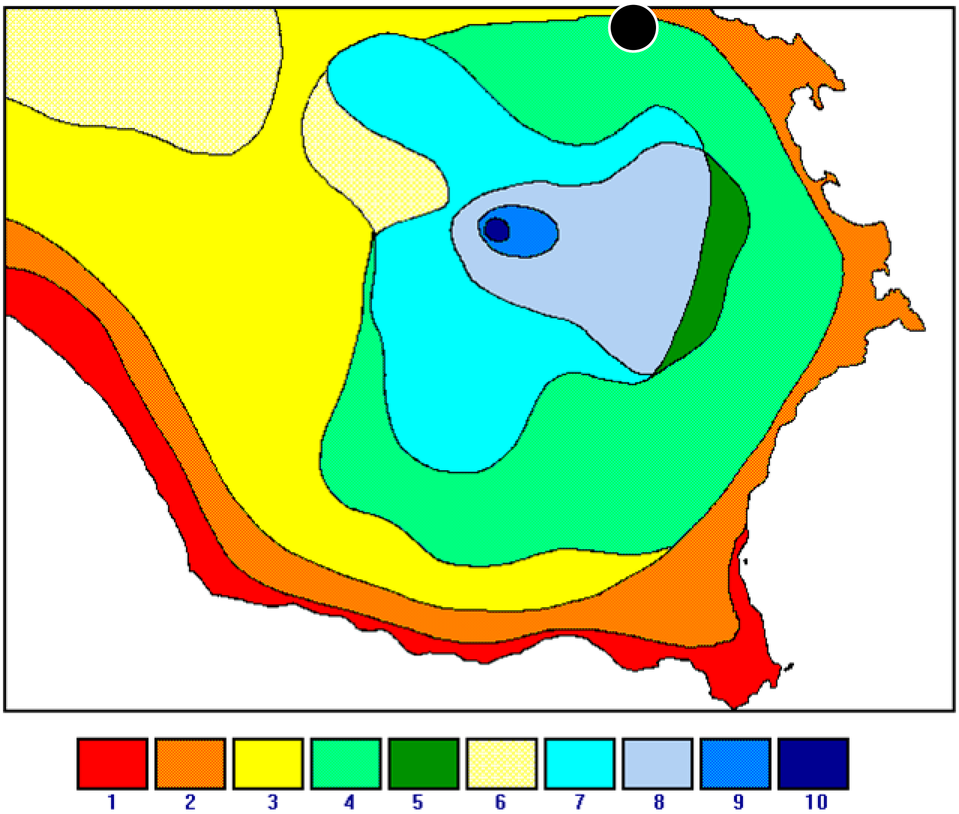


Fig. 3 Carta Bioclimatica della Sicilia sud-orientale
(da Scelsi & Spampinato 1998)

Tipi bioclimatici (termotipi e pluviotipi combinati) presenti nella Sicilia sud-orientale (da Scelsi & Spampinato 1998)

TERMOTIPI→ PLUVIOTIPI↓	Termomediterraneo inf. T = 16-18°C It = 400-449	Termomediterraneo sup. T = 16-18°C It = 399-350	Mesomediterraneo T = 13-16°C It = 349-210	Supra-mediterraneo T = 13-16°C It = 349-210
Semiarido P = 350-450 mm	1) Tmed. i. sar.			
Secco P = 450-600 mm	2) Tmed. i. sec.	3) Tmed. s. sec.	6) Mmed. sec.	
Subumido inf. P = 600-800 mm		4) Tmed. subum. i.	7) Mmed. subum. i.	
Subumido sup. P = 800-1000 mm		5) Tmed. subum. s.	8) Mmed. subum. i.	
Umido inf. P =1000-1350			9) Mmed. umido	10) Supra-med. umido

It = indice di termicità (T + M + m)10; T = temperatura media annuale, M = temperatura media delle massime del mese più freddo, m = temeperatura media delle minime del mese più freddo

Fig. 2.1.2 - Bioclimatic types of South-East Sicily (from Scelsi & Spampinato 1998). With black dot (●) is indicated the location of the study area.

3 Material and methods

In this study we used three different methods of sampling. The windows traps, the pit-fall traps and the car-net.

3.1 Window traps

It is a typical windows aerial traps in panels of Plexiglas (fig. 3.1.1) with size of 33x53. Each trap was hung to a structure in wood laths. The active portion of the trap is about 1.6 meters from the ground. As trap fluid has been used a coolant for car radiator mainly composed of propylene glycol (to prevent complete evaporation), to which were added some water, propylene phenoxytol (an anti-bacterial agent) and liquid dish detergent (to reduce surface tension).

Fig. 3.1.1 – Active window trap in the sampling field (Photo A. Adorno).

The windows traps were used to highlight any differences of Staphylinidae flying activity in different environments inside the research area. (fig. 3.1.2). For this purpose, the traps were placed in four stations.

SCHRUB: two traps (1 and 2) placed in the boundary between the orchard and a shrub area (fig. 3.1.3).

CANE: two traps (3 and 4) placed in the boundary between the orchard and an irrigational canal with a monophytic community of *Phragmites australis* (fig. 3.1.4).

CITRUS: four traps (5, 6, 7 and 11) placed inside an parcel of the citrus grove, between the trees closely to the foliage (fig. 3.1.5).

TRACK: four traps (8, 9, 10 and 12) placed in open areas inside the orchard, at the crossroads of service roads inside the researching area, characterized by herbaceous vegetation (fig. 3.1.6).

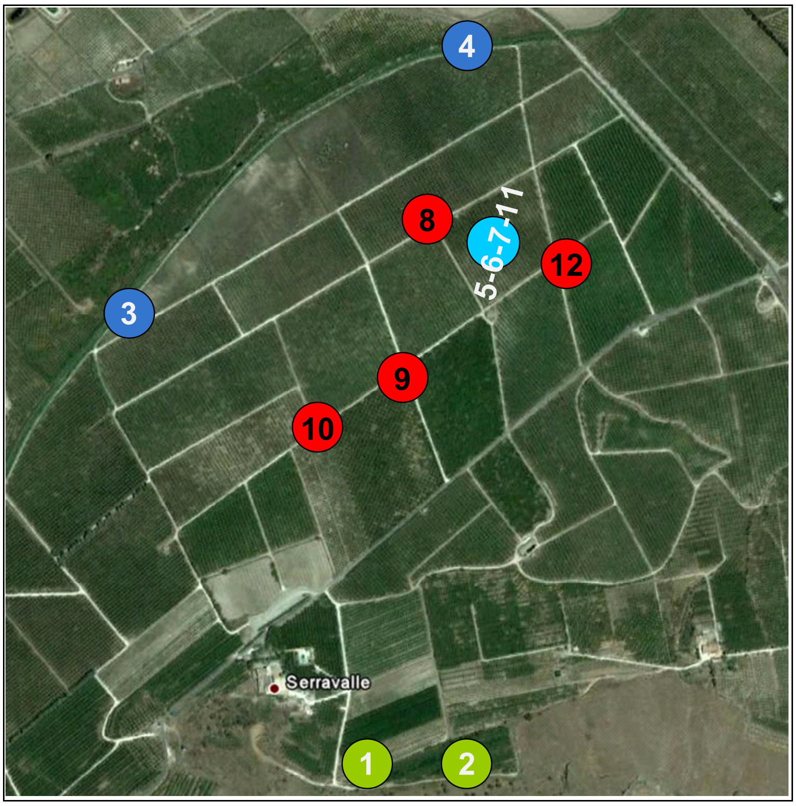


Fig. 3.1.2 – Window traps position within the sampling area, further explanation in the text (form Google Earth, mod.).

Fig. 3.1.3 – **SCHRUB.** Ecotonal strip between the orchard and a shrub area (Photo A. Adorno)

Fig. 3.1.4 – **CANE.** Ecotonal strip between the orchard and irrigational canal with a monophytic community of *Phragmites australis* (Photo A. Adorno).

Fig. 3.1.5 – **CITRUS.** Trap placed inside a parcel of the citrus grove (Photo A. Adorno).

Fig. 3.1.6 – **TRACK.** Trap placed at the crossroads of service roads inside the study area (Photo A. Adorno).

Sampling was carried out over 13 months (from December 2009 to December 2010). During the sampling period, the traps content was collected on average fortnightly, with exception of the month of January.
In February all the traps have not worked properly since on the area occurred violent storms that have broken down several traps and made unusable the material collected from the remaining ones.
During the year of sampling, although sporadically, there has been the loss of some samples probably destroyed by the workers during the picking of oranges and/or maintenance of the orchard.
In the table tab. 3.1.1 are shown dates and active traps for each sampling period.

Monthly	Fortnightly	Date-start	Date-end	Day	working traps
00-December	00-Dec1	05/12/2009	23/12/2009	18	10
	00-Dec2	23/12/2009	07/01/2010	15	10
01-January	01-Jan1	07/01/2010	22/01/2010	15	10
03-March	03-Mar1	27/02/2010	18/03/2010	19	12
	03-Mar2	18/03/2010	02/04/2010	15	12
04-April	04-Apr1	02/04/2010	14/04/2010	12	12
	04-Apr2	14/04/2010	04/05/2010	20	12
05-May	05-May1	04/05/2010	18/05/2010	14	10
	05-May2	18/05/2010	03/06/2010	16	12
06-June	06-Jun1	03/06/2010	16/06/2010	13	12
	06-Jun2	16/06/2010	30/06/2010	14	12
07-July	07-Jul1	30/06/2010	15/07/2010	15	12
	07-Jul2	15/07/2010	31/07/2010	16	12
08-August	08-Aug1	31/07/2010	18/08/2010	18	12
	08-Aug2	18/08/2010	02/09/2010	15	12
09-September	09-Sep1	02/09/2010	17/09/2010	15	6
	09-Sep2	17/09/2010	01/10/2010	14	12
10-October	10-Oct1	01/10/2010	15/10/2010	14	11
	10-Oct2	15/10/2010	29/10/2010	14	11
11-November	11-Nov1	29/10/2010	13/11/2010	15	12
	11-Nov2	13/11/2010	29/11/2010	16	12
12-December	12-Dec1	29/11/2010	17/12/2010	18	10
	12-Dec2	17/12/2010	04/01/2011	18	10

Tab. 3.1.1 - Dates and active traps for each single sampling period.

3.2 Pit-fall traps

In order to investigate whether relationships exist between the biotic communities sampled in aerial ambient and the soil one were placed within the site a certain number of pit-fall traps.

Pit-fall traps, consisting of plastic cups with 8.5 cm superior diameter and 11 cm profundity, filled for two-thirds of a saturated aqueous solution of sodium chloride and vinegar, worked into the ground (fig. 3.2.1); the distance between each other was at least 10 meters.

Fig. 3.2.1 – Active pit-fall trap in the field (Photo E. Allegra).

It was carried out a sampling plan limited to spring and autumn, as both data in the literature both from previous research carried out in eastern Sicily showed that Staphylinidae are most active in these two periods. Concentrating the capture effort during these periods one can get significant results.

The sampling design would have foreseen the use of 18 pit-fall traps placed inside the orchard and in adjacent areas (Scrubs and Cane). Unfortunately the sample has undergone several changes due to the destruction of the traps set within a parcel of the orchard in the month of June, as well within the reeds in the month of November and December because of the soil tillage. For this reason they are considered only 14 traps placed in the habitat Citrus, Track and Shrub (fig. 3.2.2) in the months of May, November and December and totally excluding the sampling of June (tab. 3.2.1).

CITRUS: four traps (9, 10, 11 and 12) have been placed in to the central area of a citrus grove parcel adjacent to that ones were are located the windows traps to avoid interference between the two types of traps.

TRACK1: tree traps (13,14, and 15) have been placed in north-west side of the same parcel where have been placed the citrus one .

TRACK2: tree traps (16, 17, and 18) have been placed in south-east side of the same parcel where have been placed the citrus one.

SHRUB: four traps (1, 2, 3 and 4) have been placed in mediterranean shrub area bordering with the orchard.

Fig. 3.2.2 – Distribution of pit-fall traps within the investigation site. White dots: traps placed in the citrus grove; yellow dots: traps placed in the mediterranean shrub (from Google Earth, mod.).

	Date-start	Date-end	Days	Citrus grove: Track1	Citrus grove: Citrus	Citrus grove: Track2	Shrub	Cane
standard	04/05/2010	03/06/2010	30	3	4	3	4	
standard	15/10/2010	13/11/2010	29	3	4	3	4	
standard	13/11/2010	17/12/2010	34	3	4	3	4	
addictional	04/05/2010	03/06/2010	30					4
addictional	03/06/2010	30/06/2010	27				4	4

Tab. 3.2.1 – Summary table of the entire sampling with pit-fall traps on the number of traps found in each period at each station and the number of days of exposure of the traps. With “standard” are indicated those traps used for the biocenotic analysis; with “addictional” are indicated the other traps used only for faunistic comparisons.

3.3 Car-net

In order to analyze the daily and hourly activities of Staphylinidae flight along the year was used the technique of car-net.
It is a particular technique to collect aerial fauna present in the air layers near the ground. The technique has been used since the fifties for the sampling of Diptera (STAGE *et alii* 1952) adapting a cono of the roary-trap to a car. The widespread use of this collection technique by coleopterologits probably is due to the description of the method of Loshe (FREUDE *et alii* 1965; TÓTHOVÁ *et alii* 2005). Currently, however, there are different versions of this collection device which differ in shape, structure and size (see for example the images reported by TÓTHOVÁ *et alii* 2005) or for positioning the net in other parts of the vehicle such example in the front just above the ground (PECK & COOK 1992).
The interception device used in the present study is based on the model used by Zanetti (MASON *et alii* 2002) (fig. 3.3.1). It is composed of a pyramid-shape net with the base mounted on a rectangular structure (110 cm x 64 cm) of aluminum fixed with clamps on the roof rack bars of a car. The terminal part of the network, where are concentrated the specimens collected, is constituted by a bag easily removable, so as to not having to remove the entire structure to collect the specimens sampled. The net is made tense by a rope that connects the terminal portion of the collector bag with the car. Considering the height of the car, in general the device is placed between 1.5 and 3 meters from the ground: in our case 2 meters

Fig. 3.3.1 – Car-net utilized during the present study (Photo A. Adorno).

The capture technique of the car-net allows to collect in a short time a large quantity of specimens and flying species, some of which are difficult to be sampled with other techniques. Many species considered as rare are, in fact, intercepted preferentially with this technique.
Among Coleoptera, Staphylinidae are one of the families most abundant sampled with this technique (TAKAHASHI & MATSUMURA 1993).
A limitation of this technique is to not be applicable in all meteorological conditions, such as during rain or high-speed wind.
Inside of the citrus grove was individuated a circular path (fig. 3.3.2) of 640 m, to tread in both directions with the car-net at a constant speed of 35 km/h, taking about 5 minutes.

Fig. 3.3.2 – Standard transect effectuated with the car-net (from Google Heart mod. and Photo A. Adorno)

Sampling was carried out in the manner described below.

DAILY SAMPLING

Standard sampling. Were carried out during the daylight hours from sunrise (Sr) to twilight (Tw). The whole day was divided into two groups one antemeridian, from sunrise (Sr) to noon (No) and one postmeridian, from noon (No) to sunset (Ss). From dawn to noon the following hour-segments have been identified: the first at sunrise, the next ½ hour after sunrise, the subsequent ones at intervals of 60 minutes with the last interval that falls at 4h, 5h or at 6h after sunrise, depending on the duration of the day. Using the same criteria, starting from sunset were identified postmeridian segments. Within this time-phase was also conducted a sampling at dusk occurring, depending on the season, approximately 20 minutes after sunset (tab. 3.3.1).

Additional sampling day. On some days were conducted additional sampling at intervals of 30 minutes (tab. 3.3.1).

Additional sampling evening. During the summer were also made samples from ½ hour to 2 hours after sunset (tab. 3.3.1).

	Day	02.15	03.17	03.24	04.14	04.20	07.13	07.27	08.04	09.23	10.01	10.02	10.28	10.29	11.11	11.18	12.02	12.03
standard sampling (274)		Sr	Sr	Sr	Sr	Sr	Sr	Sr	Sr	Sr	Sr	Sr	Sr	Sr	Sr	Sr	Sr	Sr
		Sr+½h	Sr+½h	Sr+½h	Sr+½h	Sr+½h	Sr+½h	Sr+½h	Sr+½h	Sr+½h	Sr+½h	Sr+½h	Sr+½h	Sr+½h	Sr+½h	Sr+½h	Sr+½h	Sr+½h
		Sr+1h	Sr+1h	Sr+1h	Sr+1h	Sr+1h	Sr+1h	Sr+1h	Sr+1h	Sr+1h	Sr+1h	Sr+1h	Sr+1h	Sr+1h	Sr+1h	Sr+1h	Sr+1h	Sr+1h
		Sr+2h	Sr+2h	Sr+2h	Sr+2h	Sr+2h	Sr+2h	Sr+2h	Sr+2h	Sr+2h	Sr+2h	Sr+2h	Sr+2h	Sr+2h	Sr+2h	Sr+2h	Sr+2h	Sr+2h
		Sr+3h	Sr+3h	Sr+3h	Sr+3h	Sr+3h	Sr+3h	Sr+3h	Sr+3h	Sr+3h	Sr+3h	Sr+3h	Sr+3h	Sr+3h	Sr+3h	Sr+3h	Sr+3h	Sr+3h
		Sr+4h	Sr+4h	Sr+4h	Sr+4h	Sr+4h	Sr+4h	Sr+4h	Sr+4h	Sr+4h	Sr+4h	Sr+4h	Sr+4h	Sr+4h	Sr+4h	Sr+4h	Sr+4h	Sr+4h
		Sr+5h	Sr+5h	Sr+5h	Sr+5h	Sr+5h	Sr+5h	Sr+5h	Sr+5h	Sr+5h	Sr+5h	Sr+5h	Sr+5h	Sr+5h				
					Sr+6h	Sr+6h	Sr+6h	Sr+6h	Sr+6h									
		No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
					Ss-6h	Ss-6h	Ss-6h	Ss-6h	Ss-6h									
		Ss-5h	Ss-5h	Ss-5h	Ss-5h	Ss-5h	Ss-5h	Ss-5h	Ss-5h	Ss-5h	Ss-5h	Ss-5h	Ss-5h	Ss-5h				
		Ss-4h	Ss-4h	Ss-4h	Ss-4h	Ss-4h	Ss-4h	Ss-4h	Ss-4h	Ss-4h	Ss-4h	Ss-4h	Ss-4h	Ss-4h	Ss-4h	Ss-4h	Ss-4h	Ss-4h
		Ss-3h	Ss-3h	Ss-3h	Ss-3h	Ss-3h	Ss-3h	Ss-3h	Ss-3h	Ss-3h	Ss-3h	Ss-3h	Ss-3h	Ss-3h	Ss-3h	Ss-3h	Ss-3h	Ss-3h
		Ss-2h	Ss-2h	Ss-2h	Ss-2h	Ss-2h	Ss-2h	Ss-2h	Ss-2h	Ss-2h	Ss-2h	Ss-2h	Ss-2h	Ss-2h	Ss-2h	Ss-2h	Ss-2h	Ss-2h
		Ss-1h	Ss-1h	Ss-1h	Ss-1h	Ss-1h	Ss-1h	Ss-1h	Ss-1h	Ss-1h	Ss-1h	Ss-1h	Ss-1h	Ss-1h	Ss-1h	Ss-1h	Ss-1h	Ss-1h
		Ss-½h	Ss-½h	Ss-½h	Ss-½h	Ss-½h	Ss-½h	Ss-½h	Ss-½h	Ss-½h	Ss-½h	Ss-½h	Ss-½h	Ss-½h	Ss-½h	Ss-½h	Ss-½h	Ss-½h
		Ss	Ss	Ss	Ss	Ss	Ss	Ss	Ss	Ss	Ss	Ss	Ss	Ss	Ss	Ss	Ss	Ss
		Tw	Tw	Tw	Tw	Tw	Tw	Tw	Tw	Tw	Tw	Tw	Tw	Tw	Tw	Tw	Tw	Tw
		16	16	16	18	18	18	18	18	16	16	16	16	16	14	14	14	14
additional sampling (37)	day (27)	Sr+2h½	Sr+2h½					Sr+2h½										
		Sr+3h½	Sr+3h½												Sr+3h½		Sr+3h½	Sr+3h½
		Sr+4h½	Sr+4h½															
															No-½h	No-½h		
															No+½h	No+½h		
		Ss-4h½															Ss-4h½	
		Ss-3h½											Ss-3h½				Ss-3h½	
		Ss-2h½											Ss-2h½				Ss-2h½	Ss-2h½
		Ss-1h½	Ss-1h½										Ss-1h½					Ss-1h½
		7	4					1					3		3	2	4	3
	eavening (10)						Ss+½h	Ss+½h	Ss+½h									
							Ss+1h	Ss+1h	Ss+1h	Ss+1h	Ss+1h							
							Ss+1h½											
							Ss+2h											
							4	2	2	1	1							

Tab. 3.3.1 – Summary table of the daily sampling protocol effectuated with the car-net.

Days of sampling. During the years 2010 and 2011 were carried out 23 sampling days. Six of these were excluded from the analysis as performed in extremely windy days with negligible number of catches, or for problems of malfunctioning of the control unit for the detection of meteorological parameters, or for the inability to carry out the entire set of daily hour-sampling. Also in the month of January, due to the adverse weather conditions, have not been made samples. In the present study were taken, therefore, in consideration only 17 sampling days falling in 9 months, between the years 2010 and 2011 (tab. 3.3.2).

(mm.gg)	(yy)	Sunrise	Noon	Sunset	Daylight
09.23	2010	5.49.05	11.52.48	17.56.32	12.07.27
10.01	2010	5.55.52	11.50.06	17.44.21	11.48.29
10.02	2010	5.56.44	11.49.48	17.42.51	11.46.07
10.28	2010	6.21.00	11.44.15	17.07.31	10.46.31
10.29	2010	6.22.01	11.44.11	17.06.22	10.44.21
11.11	2010	6.35.29	11.44.30	16.53.32	10.18.03
11.18	2010	6.42.51	11.45.40	16.48.30	10.05.39
12.02	2010	6.56.51	11.49.57	16.43.03	9.46.12
12.03	2010	6.57.46	11.50.20	16.42.55	9.45.09
02.15	2011	6.50.22	12.15.05	17.39.48	10.49.26
03.17	2011	6.09.33	12.09.27	18.09.21	11.59.48
03.24	2011	5.59.04	12.07.24	18.15.44	12.16.40
04.14	2011	5.28.13	12.01.23	18.34.33	13.06.20
04.20	2011	5.20.02	12.00.00	18.39.57	13.19.55
07.13	2011	4.50.13	12.06.15	19.22.17	14.32.04
07.27	2011	5.00.36	12.06.59	19.13.22	14.12.46
08.04	2011	5.07.23	12.06.32	19.05.42	13.58.19

Tab. 3.3.2 - Days of daily sampling carried out with the car-net. There are indicated sunrise, noon and sunset time.

Environmental parameters measured. During the day of sampling have been detected, by means of a thermo-pluviometric (Watch Dog 700, Spectrum Thecnologies inc.) control unit placed inside the sampling site, with an interval of 60 seconds, the following parameters: air temperature, relative humidity, speed, draft and wind direction. For analysis and statistical processing (unless otherwise stated) were used the mean values corresponding to the five-minute sampling of standard segments and additional daytime and evening.

MONTHLY SAMPLING

The same car-net technique was used, using the same path as described above, to make a single monthly sampling over the period in which the window traps were active. A total of 11 samples were collected from December 2009 to November 2010 (tab. 3.3.3). Of these, three (highlighted in yellow in the table) correspond to the standard hour-sampling. Sampling were carried out in the late afternoon hours (sunset or near sunset) in spring and summer, and in the early afternoon hours in autumn and winter. All sampling were carried out under conditions of no wind.

Date	Solar time	Segment
23/12/2009	13.06.00	Ss-3h½
05/01/2010	14.42.00	Ss-2h
27/02/2010	16.17.00	Ss-1h½
14/04/2010	16.10.00	Ss-2h½
18/05/2010	17.18.00	Ss-1h½
30/06/2010	18.48.00	Ss-½h
31/07/2010	18.31.00	Ss-½h
02/09/2010	17.36.00	Ss-1h
23/09/2010	16.58.00	Ss-1h
29/10/2010	13.06.00	Ss-4h
18/11/2010	13.48.00	Ss-3h

Tab. 3.3.3 - Days of monthly sampling carried out with the car-net.

OTHER SAMPLES

To test if the cenosis of Staphylinidae of the citrus is linked to this habitat samples were taken in a arable land bordering the citrus orchard (fig. 3.3.3). The pairs of samples were carried out between December and January in the same day and a few minutes away from each other (tab. 3.3.4).

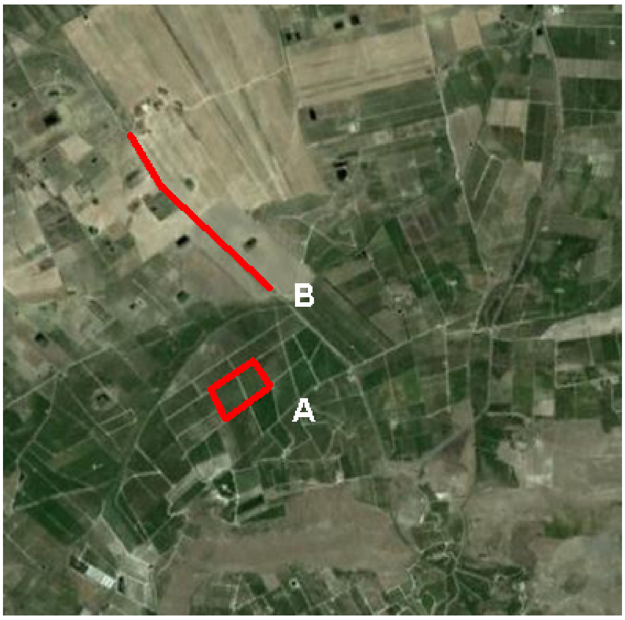


Fig. 3.3.3 – Standard transect effectuated with the car-net, A: orchard citrus, B: arable land (from Google Heart, mod.).

Date	Orchard citrus	Arable land
23/12/2009	15.54	16.18
05/01/2010	14.42	15.17
	15.55	16.14

Tab. 3.3.4 - Days and time of sampling carried out with the car-net in orchard citrus and arable land.

3.4 Species identification

Staphylinidae collected with window traps, pit-fall traps and car-net were sorted previously by subfamilies and then, excluding Pselaphinae, at species level and sometimes at morphospecies level, with the exception of those collected with the daily car-net for which were excluded from the determination at the specific level Oxytelinae in relation to the large number of specimens sampled (13.461) and Aleocharinae both for the high number of counted specimens (7.809) and especially for the considerable uncertainties taxonomic and systematic that this subfamily presents in Mediterranean area.

3.5 Data standardization

It appeared appropriate and necessary to standardize the results for a uniform comparison between the stations, eliminating the factors of variability represented by the efficiency of traps (number of "active" traps for sampling) and the number of effective days for each sample: is then proceeded to calculate the Density of Activity (DA) (BRANDMAYR *et alii* 2005) for each Taxon, as the ratio between the total number of individuals captured during each sampling session and the number of traps found still working, multiplied for the session's days; this result has applied an additional correction factor (CF) consisting of the ratio between the total of individuals and the DA, thus obtaining the Standard Capture Density (CSD) (ADORNO 1995)

$$DA = [nb.ind. / (nb.trap * dd)]$$

$$FC = nb.TOT.ind. / DA$$

$$CSD = [nb.ind. / (nb.trap * dd)] * FC$$

3.6 Data analysis

Margalef's index (d)

This index measures the richness of taxa (in this case families or species) of the stations, calculated as follows:

$$d = (S-1)/\ln N$$

where:

S = number of taxa

N = total amount of specimens collected in the station

The reference interval for this index, which considers a medium to good level in terms of richness, is between 2 and 5, where for values below 2 is considered a low diversity.

Shannon's index (H')

In order to assess the level of biodiversity of the stations, we used the Shannon index calculated as follows:

$$H' = -\sum_{j=1}^{s} p_j \log p_j$$

where:

s = number of taxa;

pj = Nj / N (relative abundance);

Nj = number of specimens belonging to a certain taxon in the station;

N = total amount of specimens in the station.

This is an index that is determined by the number of species and the distribution of their relative abundances in the station. It is strongly influenced by the mean abundances (CHEMINI 1991).
The Shannon's index assumes the interval between 1 and 3.5 as medium values of biodiversity.

Bray-Curtis index

The Bray-Curtis index or coefficient of similarity (a semi-quantitative index) estimates the similarity between pairs of samples taking into account not only the presence / absence, but also the abundances of individual taxa. This was calculated using the formula:

$$BC = 100 \frac{\sum_{i=1}^{p} 2\min(y_{ij}, y_{ik})}{\sum_{i=1}^{p} (y_{ij} + y_{ik})}$$

where:

p = total number of taxa
i = taxon
y_{ij} = abundance of the taxon (i) in the first sample (j)
y_{ik} = abundance of the taxon (i) in the second sample (k).

This index takes the value 0 if the two samples have no taxa in common, and is equal to 100 if the two samples are identical.

Non metric multidimensional scaling (n-MDS).

In order to highlight similarities and differences between the traps and the stations have been used also the multivariate analysis of communities using the methodology of Non-Metric Multidimensional Scaling (NMDS).
This technique is considered by CLARKE & WARWICK (2001), at least from the conceptual point of view, the easier to apply; it keeps a clear and direct link with the original data. It is also very flexible as it requires no assumptions about the form of the data distribution.
This methodology has been applied both after a square-root transformation of abundance data of each taxon. The data thus treated were then used to obtain a Bray-Curtis similarity matrix. Referring to that it was possible to construct a series of plots that allow to show the similarities between the various units of sampling (traps and stations). Each point on the graphs represents a single sampling unit, whose position is determined by all the taxa and the number of specimens collected for each of them.
In this way, homogeneous groups can be observed between the sampling units. Since the graphs projected a multidimensional space in two-dimensions or three-dimensions, the technique provides a measure of "stress" or the "forcing" of the plot. CLARKE & WARWICK (2001) suggest not to consider plots with stress values higher than 0,18 as being unrepresentative.

Analysis of similarity (ANOSIM)

This technique provides a measure of the significance of differences between the groups identified a priori (CLARKE & WARWICK 2001) The test results is a value, called R, which reflects the difference observed between the distances of the points belonging to each of the groups compared, with respect to the distance of the points belonging to other groups:

$$R = r_b - r_w / 1/4\ [n\ (n-1)]$$

where:

r_b = mean diversity within the group;
r_w = mean diversity with the other groups;
n= total number of sample units.

The value of R (R observed) can vary between -1 and 1 and assumes the value 0 when the null hypothesis (H_0: no difference between the sampling units) is true, and takes the value 1 when all replies of a certain sampling unit are more similar together than to all other replicas of the sampling

units. Values less than zero, represent the opposite case.
The ANOSIM test, using a predetermined number of times, recalculates the value of R randomly permuting membership group of each replication. In this way it is obtained a distribution of R simulated with which to compare the value of R observed.
The null hypothesis is rejected when R observed falls outside the distribution of the R simulated: the higher the R observed value is away from that of R simulated values, the more likely that the clusters on the plot of the representations are not random.
Together with the calculation of R is produced an estimation of the significance that allows to evaluate the possibility of making a mistake in interpreting R.
It was also estimated the statistical significance of differences between stations using the Parwise tests, based on the value of R observed between pairs of stations.

Permutional ANOVA (PERMANOVA)

Permanova is a routine for testing the simultaneous response of one or more variables to one or more factors in an analysis of variance experimental design on the basis of any resemblance measure, using permutation methods. The main differences between ANOSIM and PERMANOVA is that, the first one, before to proceed with the analysis, rank the value of the resemblance matrix, so the derived information regard the relationship among the dissimilarities, instead of the differences on the *value* of dissimilarities witch is returned from the permanova methods. If this method is used with only one variable in conjunction with the Euclidean distance, the results of permanova test are the same as those of the traditional ANOVA.

Hierarchical clustering

The aims of this classification method is to find "natural groupings" of samples such that samples within a group are more similar to each other, generally, than samples in different groups. For the similarity between cluster the complete linkage algorithm was used.

Similarity profile (SIMPROF)

This routine is a tests for evidence of structure in an a priori unstructured set of samples. First a resemblance profile is determined by ranking the resemblance matrix for the data. A mean profile is then calculated by randomising the order of each variables values and re-calculating the profile. The pi statistic is calculated as the deviation of the actual data profile with the mean one. This is compared with the deviations of further randomly generated profiles to test for significance. The null hypothesis is no structure so randomisation allowed

Contribution of variables to similarity (SIMPER)

This routine identify variables (species) that most contribute to the difference between two groups (stations). It decomposes the average Bray-Curtis similarities or Euclidean distances between all pairs of site groups into percentage contributions from each species, listing the species in decreasing order of such contributions.

Statistical analyzes were performed with the software "R v2.15.2 statistical programming language" and "Primer 6 v 6.1.13 & Permanova + v 1.0.3".

RESULTS

4 FAUNISTIC ANALYSIS

4.1 General analysis of sampling for species of Staphylinidae (excluding Pselaphinae)

Staphylinidae collected with window traps, pit-fall traps and car-net were sorted previously by subfamilies and then, excluding Pselaphinae, at species level and sometimes at morphospecies level, with the exception of those collected with the daily car-net; so we excluded from the determination at the specific level Oxytelinae in relation to the large number of specimens sampled (13.461) and Aleocharinae both for the high number of counted specimens (7.809) and especially for the considerable uncertainties taxonomic and systematic that this subfamily presents in Mediterranean area.

For the nomenclature, reference is made to the checklist of the Italian fauna (CICERONI *et alii* 1995) updated to LÖBL & SMETANA (2004) and others more recent reviews (ASSING 2005, ASSING 2007, ASSING 2008a, ASSING 2008b, ASSING 2010, BORDONI 2008, FELDMANN 2007, MARUYAMA 2006, TRONQUET 2004, TRONQUET 2006, SCHÜLKE 2011). The subgenus are not considered.

Regarding *Geostiba plicatella* (Fauvel, 1878), *Stenus brunnipes* Stephens, 1833, *Ocypus ophthalmicus* (Scopoli 1763) and *Xantholinus graecus* Kraatz, 1858, because of the complex taxonomic problems still unsolved, the specimens sampled were not allocated to any of the subspecies currently recognized as valid.

Chorological categories were referred at the species level and based on classification proposed by VIGNA TAGLIANTI *et alii* 1992. The distribution are deduced from PILON (2004), ZANETTI (2004) LÖBL & SMETANA (2004) and the others more recent reviews above mentioned. The eventual presence of the species in the extrapalaearctic regions is given by the following acronyms: **COS**: Cosmopolitan; **NAR**: Nearctic Region; **AFR**: Afrotropical Region; **ORR**: Oriental Region; **NTR**: Neotropical Region; **AUR**: Australian Region. Also, the alien species (**ias**) and the introduced species (**i**) are indicated.

The distribution in Italy is taken from the checklist of the Italian fauna (CICERONI *et alii* 1995) updated according to the project CKmap (PILON 2004, ZANETTI 2004). Regarding *Heterothops minutus* Wollaston 1860 it was referred to ZANETTI (2011) that records it for the whole mainland Italy, Sardinia and Sicily.

In total were surveyed 170 taxa (species, subspecies and 20 morphospecies) of Coleoptera Staphylinidae that are reported in table 4.1.1.

Subfamily	Taxa	Chorological category	ITA dist.	CN	PT	WT
	Acrotona muscorum (Brisout, 1860)	ASE	N S Si –	54		5
	Acrotona parvula (Mannerheim, 1830)	PAL	N S Si Sa	2		1
	Alaobia scapularis (Sahlberg, 1831)	EUR	N – Si Sa			1
	Aleochara bipustulata (Linné, 1760)	PAL	N S Si Sa	10	8	12
	Aleochara clavicornis Redtenbacher, 1849	AIM	N S Si Sa			1
	Alianta bipartita Fauvel, 1900	Tirrenic	N S Si –	2		1
	Aloconota gregaria (Erichson, 1839)	TEM	N S Si Sa	65	3	65
	Aloconota sulcifrons (Stephens, 1832)	COS	N S Si Sa	6		1
	Amarochara forticornis (Lacordaire, 1835)	EUR	N S Si Sa		8	1
	Amarochara umbrosa (Erichson, 1837)	ASE	N S Si –	278	3	14
	Amischa decipiens (Sharp, 1869)	EUR	N – Si –	22	2	30
	Amischa forcipata Mulsant & Rey, 1873	WEU	N S Si –	18		
	Amischa nigrofusca (Stephens, 1832)	TEM	N S Si Sa	8		
	Amischa sp.	-	-	9		
	Atheta (*Microdota*) sp.	-	-	9		13
	Atheta aeneicollis (Sharp, 1869)	EUM	N S Si Sa	35	23	27
	Atheta amicula (Stephens, 1832)	CEM+NTRi	N S Si Sa	17	7	
	Atheta atramentaria (Gyllenhal, 1810)	PAL+AFR+ORR	N S Si Sa	22		1
	Atheta cauta (Erichson, 1837)	SIE	N S? Si Sa?	2		
	Atheta coriaria (Kraatz, 1856)	COS	N S Si Sa	10	9	
	Atheta gr. *fungi*	-	-	426	29	144
	Atheta inquinula (Gravenhorst, 1802)	TEM	N S Si Sa	110	3	22
	Atheta laticollis (Stephens, 1832)	ASE	N S Si Sa	1	1	
	Atheta longicornis (Gravenhorst, 1802)	PAL+ORR	N S Si Sa	1		
	Atheta mucronata (Kraatz, 1859)	ias	– S Si –	32	58	7
ALEOCHARINAE	*Atheta nigra* (Kraatz, 1856)	ASE	N S Si Sa	3		
	Atheta oblita (Erichson, 1839)	EUM	N S Si Sa		2	
	Atheta occulta (Erichson, 1837)	PAL	N S Si –	3		
	Atheta orbata (Erichson, 1837)	EUM	N S Si –		2	
	Atheta palustris (Kiesenwetter, 1844)	PAL	N S Si Sa	103		2
	Atheta sp.	-	-	1		
	Atheta sp. 1	-	-	1		
	Atheta sp. 2	-	-	1		
	Atheta sp. 3	-	-	1		
	Atheta sp. 4	-	-	1		
	Atheta testaceipes (Heer, 1839)	EUR	N S Si –	2	3	
	Atheta triangulum (Kraatz, 1856)	PAL	N S Si Sa	1		
	Atheta xanthopus (Thomson, 1856)	EUR	N S Si –	3		1
	Borboropora sp. 1	-	-	1		
	Callicerus atricollis (Aubé, 1850)	Alpine-Appeninic	N S Si –		5	
	Caloderina hierosolymitana (Saulcy, 1865)	EME	– S Si –	1		
	Cordalia obscura (Gravenhorst, 1802)	TEM+NARi	N S Si Sa	329	42	23
	Dacrila pruinosa (Kraatz, 1856)	MED	N S Si –	9	2	5
	Diestota guadalupensis Pace, 1987	ias	N S Si Sa	3		
	Falagrioma thoracica (Stephens, 1832)	TEM	N S Si –		3	
	Geostiba plicatella (Fauvel, 1878)	WME	– – Si –		11	
	Gnypeta rubrior Tottenham, 1939	CEU	N S Si –	1		
	Liogluta longiuscula (Gravenhorst, 1802)	PAL	N S Si Sa	23		6
	Myrmecopora fugax (Erichson, 1839)	MED	N S Si Sa	3		
	Myrmoecia sp. 1	-	-		5	4
	Nehemitropia lividipennis (Mannerheim, 1830)	COS	N S Si Sa	34		3

Subfamily	Taxa	Chorological category	ITA dist.	CN	PT	WT
ALEOCHARINAE	*Neohilara subterranea* (Mulsant & Rey, 1853)	EUR	N S Si –	2		1
	Notothecta inflata Fauvel, 1869	NAF	– S Si –		1	
	Oligota muensteri Bernhauer, 1923	EUR	– – Si –	9	3	12
	Oligota parva Kraatz, 1862	EUM+AFR+NAR+NTR	N S Si Sa	5	1	
	Oligota punctulata Heer, 1839	EUM	N S Si –	15	2	2
	Oligota sp.	-	-	10		5
	Outachyusa raptoria (Wollaston, 1854)	AFM	– S Si –	17		1
	Oxypoda brevicornis (Stephens, 1832)	SIE	N S Si Sa	30	4	3
	Oxypoda carbonaria (Heer, 1841)	EUM	N S Si Sa	6		1
	***Oxypoda flavissima* Assing, 2008**	WME	– – Si –		1	6
	Oxypoda haemorrhoa (Mannerheim, 1830)	PAL	N S Si Sa	12		3
	Oxypoda lurida Wollaston, 1857	EUM	N S Si Sa		2	
	Oxypoda sp. 1	-	-	3		2
	Oxypoda sp. 2	-	-	2		1
	Oxypoda subnitida Mulsant & Rey, 1875	WME	– – Si –	11		6
	E *Pella leonhardi* Bernhauer, 1912	SIC	– – Si –		2	
	E *Pronomaea sicula* Assing, 2007	SIC	– – Si –	21	1	16
	Pycnota paradoxa (Mulsant & Rey, 1861)	EUR	N – Si –			1
	Tetralaucopora longitarsis (Erichson, 1839)	PAL	N S Si Sa	1		
	Thecturota marchii (Dodero, 1922)	ias	N S Si Sa	48		1
	Tinotus morion (Gravenhorst, 1802)	OLA	N S Si –			1
	Trichiusa immigrata Lohse, 1984	ias	N S Si –	31		2
HABROCERINAE	*Habrocerus capillaricornis* (Gravenhorst, 1806)	OLA+AUR+NTR	N S Si Sa	93	2	
MICROPEPLINAE	*Micropeplus fulvus fulvus* Erichson, 1840	PAL+ORR	N S Si Sa	1		
	Micropeplus porcatus (Paykull, 1789)	PAL	N S Si –	1		
	Micropeplus staphylinoides (Marsham, 1802)	EUM	N S Si Sa	1	2	
OMALIINAE	*Eusphalerum luteicorne luteicorne* (Erichson, 1840)	NAF	– – Si Sa?	3		4
	Lesteva sicula sicula Erichson, 1840	EUR	– S Si –	1		
	Omalium allardi Fairmaire & Brisout de Barneville, 1859	EUM+AURi	N S Si Sa	1		
	Omalium excavatum Stephens, 1834	EUM+NAR	N S Si Sa	1		
	Paraphloeostiba gayndahensis (MacLeay, 1871)	ias	N S Si Sa	504	135	44
OXYTELINAE	*Anotylus complanatus* (Erichson, 1839)	PAL+AUR+NTR	N S Si Sa	31		6
	Anotylus intricatus (Erichson, 1840)	PAL	N S Si –			2
	Anotylus inustus (Gravenhorst, 1806)	PAL	N S Si Sa	3	3	42
	Anotylus nitidulus (Gravenhorst, 1802)	OLA+NTR+ORR	N S Si Sa	2779	18	247
	Anotylus sculpturatus (Gravenhorst, 1806)	CEM	N S Si Sa	24	6	55
	Anotylus speculifrons (Kraatz, 1857)	TEM	N S Si Sa	457	3	111
	Anotylus tetracarinatus (Block, 1799)	OLA	N S Si Sa	25		5
	Carpelimus corticinus (Gravenhorst, 1806)	OLA+AUR+NTR	N S Si Sa	161	19	80
	Carpelimus exiguus (Erichson, 1839)	PAL+AFR+ORR+AUR	N S Si Sa	3		
	Carpelimus fuliginosus (Gravenhorst, 1802)	AFM	N S Si –	1		
	Carpelimus nigrita (Wollaston, 1857)	PAL+AFR+ORR	N S Si –	2		2
	Carpelimus pusillus (Gravenhorst, 1802)	OLA+AUR	N S Si Sa			2
	Carpelimus siculus (Mulsant & Rey, 1878)	SICAppeninic+Greece	– S Si –	2		1
	Carpelimus vitalei (Bernhauer, 1935)	SICAppeninic	– S Si Sa	1		
	Ochthephilus sp. 1	-	-	2		
	Planeustomus sp. 1	-	-	3		6
	Platystethus degener Mulsant & Rey, 1878	OLA	N S Si –			5
	Platystethus nitens (Sahlberg, 1832)	PAL	N S Si Sa	26	1	70

Subfamily	Taxa	Chorological category	ITA dist.	CN	PT	WT
	Achenium striatum striatum (Latreille, 1804)	WME	N S Si Sa	1		1
	Achenium tenellum Erichson, 1840	NAF	– S Si Sa			1
	Astenus bimaculatus bimaculatus (Erichson, 1840)	PAL	N S Si Sa	3		
	Astenus lyonessius (Joy, 1908)	EUM	N S Si Sa	7	31	2
	Astenus pallidulus (Wollaston, 1864)	WME	– S Si –	2		
	Astenus sp.	-	-		1	
	Astenus thoracicus thoracicus (Baudi di Selve, 1857)	MED	N S Si –	1		
	Domene stilicina (Erichson, 1840)	MED	– S Si Sa	2	21	
Paederinae	*Hypomedon debilicornis* (Wollaston, 1857)	ias	N S Si –	46		2
	Lithocharis nigriceps (Kraatz,1859)	COS	N S Si –	5		
	Luzea nigritula (Erichson, 1840)	EUM	N S Si Sa	26		1
	Medon perniger Coiffait, 1978	Alpine-Appeninic	N S Si Sa	4		
	Rugilus orbiculatus (Paykull, 1789)	OLA+AUR	N S Si –	34	3	2
	Scopaeus debilis Hochhuth, 1851	TEM	N S Si Sa	398		6
	Scopaeus mitratus Binaghi, 1935	SICAppeninic+Greece	N S Si –	135		9
	Scopaeus sp.	-	-	2		1
	Sunius algiricus (Coiffait, 1970)	NAF	– S Si –	21	2	
	Megarthrus bellevoyei Saulcy, 1862	PAL	N S Si Sa	5999	19	24
Proteininae	*Proteinus atomarius* Erichson, 1840	OLA	N S Si Sa	294		4
	Proteinus ovalis Stephens, 1834	EUR	N S Si Sa	1		
	Bisnius sordidus (Gravenhorst, 1802)	COS	N S Si –	1		
	Euryporus aeneiventris P. Lucas, 1846	WME	– S Si Sa		1	
	Gabrius nigritulus (Gravenhorst, 1802)	COS	N S Si Sa	30		4
	Gabronthus maritimus (Motschulsky, 1858)	ASE+AFR+ORR	N S Si Sa	1663	7	61
	Gauropterus fulgidus fulgidus (Fabricius, 1787)	OLA+ORR	N S Si Sa		1	
	Gyrohypnus angustatus Stephens, 1833	CEM+NARi	N S Si Sa	19	1	
	Gyrohypnus fracticornis (O. Müller, 1776)	CAE+Ni+AURi+NARi+NTRi	N S Si Sa	4		1
	Heterothops minutus Wollaston, 1860	EUM	N S Si Sa	139	1	12
	Lepidophallus pseudohesperius (Reitter, 1908)	WME	– – Si Sa	7	6	12
	Leptacinus intermedius Donisthorpe, 1936	OLA	N S Si Sa	76		8
	Megalinus glabratus (Gravenhorst, 1802)	TEM	N S Si Sa	11	85	25
	Neobisnius lathrobioides (Baudi di Selve, 1848)	TEM+NARi	N S Si Sa	17		
	Neobisnius procerulus procerulus (Gravenhorst, 1806)	PAL+AFR+AUR+NTR	N S Si Sa?	6		
	Ocypus olens olens (O. Müller, 1764)	EUM+NARi	N S Si Sa		96	
	Ocypus ophthalmicus (Scopoli, 1763)	PAL	N S Si Sa		51	2
Staphylininae	*Othius laeviusculus* Stephens, 1833	EUM	N S Si Sa	2		
	Philonthus concinnus (Gravenhorst, 1802)	PAL+NARi	N S Si Sa	36	17	166
	Philonthus debilis (Gravenhorst, 1802)	PAL+NARi	N S Si Sa	10		
	Philonthus intermedius (Lacordaire, 1835)	TEM	N S Si Sa			2
	Philonthus jurgans Tottenham, 1937	EUR+NAR	N S Si –	7		2
	E *Quedius caelebs* Rottenberg, 1870	SIC	– – Si –		1	3
	Quedius humeralis Stephens, 1832	TUE	N S Si Sa	2		
	Quedius levicollis (Brullé, 1832)	EUM	N S Si Sa	1	1	3
	Quedius pallipes P. Lucas, 1846	WME	N S Si Sa		23	2
	Quedius praecox (Gravenhorst, 1802)	WME	– – Si Sa			1
	Quedius scintillans (Gravenhorst, 1806)	TEM	N S Si Sa	1		
	Quedius semiobscurus (Marsham, 1802)	EUM	N S Si Sa		1	2
	E *Tasgius globulifer evidentus* (Tottenham, 1945)	EUR	– S? Si –			2
	E *Tasgius pedator siculus* (Aubé, 1842)	EUM	– – Si –		5	
	Xantholinus graecus Kraatz, 1858	MED	– S Si –	9	37	7
	Xantholinus rufipes Lucas, 1846	NAF	– – Si –	1		

Subfamily	Taxa	Chorological category	ITA dist.	CN	PT	WT
STENINAE	*Stenus brunnipes* Stephens, 1833	PAL	N S Si –			6
	Stenus mendicus mendicus Erichson, 1840	MED	– S Si Sa			1
	Stenus similis (Herbst, 1784)	CEM	N S Si Sa			2
	Stenus sp. 1	-	-	4		
	Stenus sp. 2	-	-	2		2
	Stenus sp. 3	-	-	2		
TACHYPORINAE	*Bolitobius castaneus* (Stephens, 1832)	TUE	N S Si Sa			1
	Cilea silphoides (Linné, 1767)	COS	N S Si Sa	1		
	Mycetoporus glaber glaber (Sperk, 1835)	EUM	N S Si Sa	2		
	Mycetoporus nigricollis Stephens, 1835	EUM	N S Si –			1
	Mycetoporus reichei (Pandellé, 1869)	EME	N S Si Sa	4		1
	Sepedophilus aestivus (Rey, 1882)	WME	N S Si Sa	14		
	Sepedophilus marshami (Stephens, 1832)	ASE+NARi	N S Si –	5	5	
	Sepedophilus nigripennis (Stephens, 1832)	EUM	N S Si Sa	5	6	5
	Tachinus flavolimbatus Pandellé, 1869	WME	– S Si –	65	6	5
	Tachyporus abner Saulcy, 1865	MED	N S Si Sa	2		
	Tachyporus caucasicus Kolenati, 1846	EUM	– S Si Sa	6		
	Tachyporus hypnorum (Fabricius, 1775)	PAL	N S Si Sa	18	2	14
	Tachyporus nitidulus (Fabricius, 1781)	COS	N S Si Sa	95	8	57

Tab 4.1.1 – Taxa of Staphylinidae surveyed. With letter **E** are indicated the endemic Sicilian taxa. For each taxon is also reported the chorological category and the distribution in Italy following the symbology used in the checklist of the Italian fauna (CICERONI *et alii* 1995). In **bold** are marked the species new for Italian fauna, in red (**Si**) the species new for Sicilian fauna, in green (**Si**) the species confirmed for Sicilian fauna. There is also indicated the number of specimens collected by the different techniques utilized: Car net (**CN**); Pit-fall traps (**PT**) and Windows traps (**WT**). Further explanations and clarifications in the text.

4.2 Commentary on the most interesting species

SPECIES AND SUBSPECIES ENDEMIC TO SICILY

Five taxa are Sicilian endemism.

***Pella leonhardi* (Bernhauer, 1912)**
Habitat: The genus *Pella* Stephens, 1835 includes species that are myrmecophiles. Ant species with which *P. leonhardi* enfeoffed are not known.
Geographical distribution: The species was previously known only for the holotype (Monte Cola, Sicily) (MARUYAMA 2006) and for another specimens of Nebrodi Mounts (Messina, Santo Saba, pit-fall traps) (in coll. Zanetti).
Sampling methods: Pit-fall traps.

***Pronomaea sicula* Assing, 2007**
Habitat: The habitat of the species of the genus *Pronomaea* Erichson, 1837 is poorly known. They normally inhabit the open spaces and sometimes are associated with ants, but nothing is known about their biological cycle and feeding habits. ASSING (2007) reports for *P. sicula* catches in a valley of the watercourse at 800 m a.s.l. and on the banks of a river.
Geographical distribution: *P. sicula* has recently been described as endemic of Sicily, where is vicarious for the similar *P. rostrata* Erichson, 1837. This second according to ASSING (l. c.) has atlanto-mediterranean distribution, being present in most of Europe except for the northern most regions, Balkans, and Maghreb (fig. 4.1).
Sampling methods: Car-net, window traps, pit-fall traps.

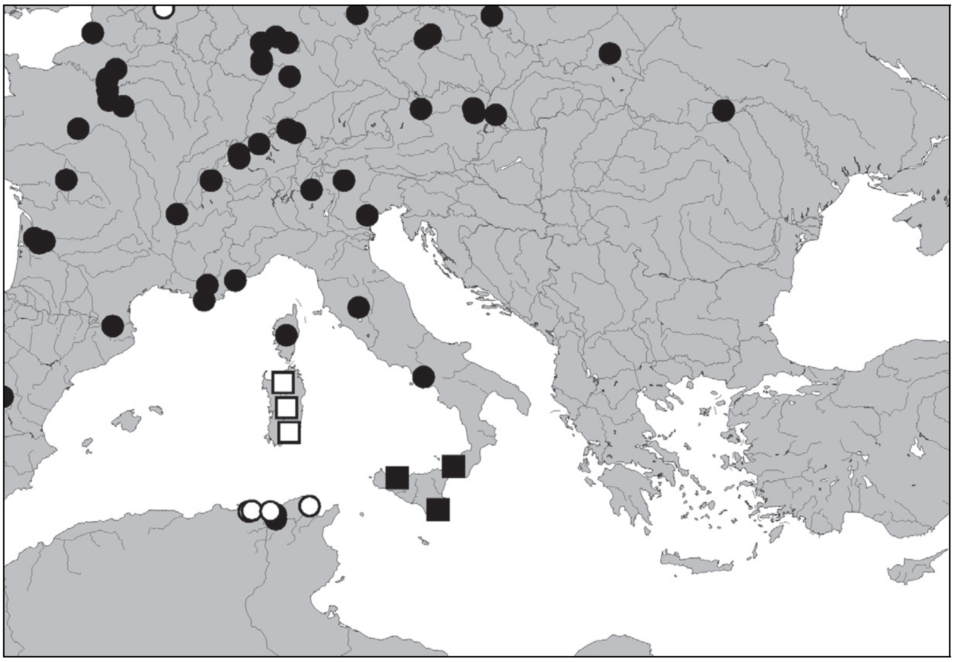


Fig. 4.1 - Distribution of *Pronomaea rostrata* (partial) (circles), *P. sardoa* Assing, 2007 (open squares) and *P. sicula* (filled squares) (from ASSING 2007).

***Quedius caelebs* Rottenberg, 1870**
Habitat: There are no data in the literature about the ecology of the species. Considering its affinity with *Q. picipes* (Mannhereim, 1830) it can be hypothesized that it is mainly related to open environments. It was not found in forest environments of Nebrodi Mounts (SABELLA & ZANETTI 1991).
Geographical distribution: It is a sicilian endemic species (LÖBL & SMETANA 2004).
Sampling methods: Window traps, pit-fall traps.

***Tasgius globulifer evitendus* (Tottenham, 1945)**
Habitat: In Sicily it is relatively common in open areas (meadows, pastures) from sea level to mountain.
Geographical distribution: The subspecies is endemic of Sicily, while the nominal subspecies is reported for most of Europe territories, Turkey and Syria.
Sampling methods: Window traps.

***Tasgius* (*Tasgius*) *pedator siculus* (Aubé 1842)**
Habitat: In Sicily it is common in open xeric and sub-xeric environments and also in anthropized environments.
Geographical distribution: The subspecies is endemic of Sicily, while the nominal subspecies is reported for most of central and southern Europe, for Algeria, Turkey and Iran.
Sampling methods: Pit-fall traps.

SPECIES NEW FOR ITALIAN FAUNA

***Oxypoda flavissima* Assing, 2008**
Habitat: The species has been discovered in recent years in Madeira in the month of April sifting the litter at the base of *Erica arborea*, at an altitude of 1.350 m and after the washing of wet grass and moss in a dark valley of a stream at an altitude of 700 m (ASSING 2008a).
Geographical distribution: So far known with a few specimens from Spain, Morocco and Madeira (fig. 4.2). The catches with car net in Sicily give the hypothesis that it is a species expanding its range area.

Sampling methods: Window traps, pit-fall traps.

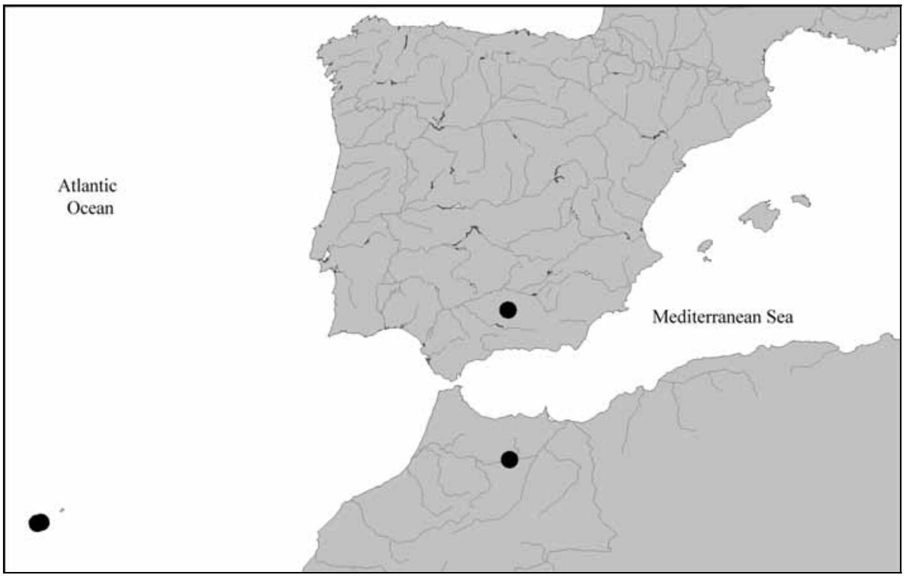


Fig. 4.2 - Distribuzione finora nota di *Oxypoda flavissima* (from ASSING 2008a).

SPECIES NEW FOR SICILIAN FAUNA

***Acrotona muscorum* (Brisout, 1860)**
Habitat: Eurytopic and saprophytic species slightly thermophilic.
Geographical distribution: Widely distributed in Europe, also reported for India and Nepal. It was previously known just for the mainland Italy.
Sampling methods: Car-net, window traps.

***Amischa decipiens* (Sharp, 1869)**
Habitat: Phytodetriticolous species associated to open environments.
Geographical distribution: Widely distributed throughout Europe, it's present also in the Canary Islands and Tunisia. In Italy it was previously known only for the northern regions.
Sampling methods: Car-net, window traps, pit-fall traps.

***Amischa forcipata* Mulsant & Rey, 1873**
Habitat: Phytodetriticolous species associated to open environments.
Geographical distribution: Known for the majority of western European regions with the exception of Spain and Portugal, was previously reported to mainland Italy.
Sampling methods: Car-net.

***Atheta testaceipes* (Heer, 1839)**
Habitat: Species probably eurytopic with not well known ecology.
Geographical distribution: Reported for much of central and northern Europe and for the island of Cyprus; known so far for the mainland Italy.
Sampling methods: Car-net, pit-fall traps.

***Carpelimus fuliginosus* (Gravenhorst, 1802)**
Habitat: Eurytopic and saprophytic species.
Geographical distribution: Species widely distributed throughout Europe, Asiatic Turkey, North Africa (Algeria and Libya) and it is also present in the Afrotropical region. Was previously known for the mainland Italy.
Sampling methods: Car-net.

***Dacrila pruinosa* (Kraatz, 1856)**
Habitat: Species with not well-known ecology.
Geographical distribution: Species mentioned for Great Britain, France, Italy (where it was known so far only for the continental regions), Czech Republic, Albania, Greece, Egypt, Tunisia, Algeria and the Canary Islands and generically reported for Syria.
Sampling methods: Car-net, window traps, pit-fall traps.

***Lithocharis nigriceps* (Kraatz,1859)**
Habitat: Species probably eurytopic with not well-known ecology.
Geographical distribution: Cosmopolitan species reported for most of the Italian mainland.
Sampling methods: Car-net.

***Micropeplus porcatus* (Paykull, 1789)**
Habitat: Eurytopic and phytodetriticolous species.
Geographical distribution: Species widely distributed in Europe (Austria, Belgium, Bosnia-Herzegovina, Czech Republic, Denmark, Estonia, Finland, France, Great Britain, Germany, Greece, Hungary, Ireland, Italy, Latvia, Norway, Russia, Poland, Slovakia, Sweden and Switzerland) and North Africa (Algeria, Morocco and Tunisia) and reported also for Asiatic Turkey and Far East Russia. Reported throughout mainland Italy and Sardinia. PETRALIA (2011) has recently cited it for the Pineta di Vittoria collected by pit-fall traps, and catches in the Plain of Catania confirm the presence of this species in Sicily.
Sampling methods: Car-net.

***Neobisnius lathrobioides* (Baudi di Selve, 1848)**
Habitat: Ripicolous and limicolous species.
Geographical distribution: Widely distributed in Europe, North Africa (Canary Islands, Madeira, Morocco, Algeria, Tunisia, Egypt), Asiatic Turkey, Iran and introduced in the Nearctic region. It was previously known for most of the Italian mainland and Sardinia.
Sampling methods: Car-net.

***Outachyusa raptoria* (Wollaston, 1854)**
Habitat: Ripicolous, psammophylous and thermophilic species.
Geographical distribution: Reported for Spain, Italy, France, North Africa (Canary Islands, Madeira, Morocco, Algeria, Tunisia, Egypt), Afrotropical region, Yemen and HongKong. It was so far reported only for the central and southern regions of the Italian peninsula.
Sampling methods: Car-net, window traps.

***Pycnota paradoxa* (Mulsant & Rey, 1861)**
Habitat: It is found normally in the nests of small mammals and sometimes in that of birds (KOCH 1989). In northern Italy regularly inhabits nests of *Talpa europaea* (OSELLA & ZANETTI 1974).
Geographical distribution: Widely distributed throughout Europe, in Italy was reported so far only for the northern regions.
Sampling methods: Window traps.

***Trichiusa immigrata* Lohse, 1984**
Habitat: It is found in decomposing material in plane areas in agro-ecosystems, rarely in altitude. Often caught with car-net.
Geographical distribution: Described in Germany (first capture in 1975) (LOHSE 1984), but undoubtedly of American origin, is diffused throughout Europe and is known also for Island of Réunion (Pace, pers. com.).
Sampling methods: Car-net, window traps.

SPECIES CONFIRMED FOR SICILIAN FAUNA

Is here confirmed the presence in Sicily of 7 species uncertainly reported in the checklist of the Italian fauna (CICERONI *et alii* 1995).

***Astenus thoracicus thoracicus* (Baudi di Selve, 1857)**
Habitat: Species probably associated to open environments, with not well-known ecology.
Geographical distribution: The nominal subspecies is known for Uzbekistan, Asiatic Turkey, Syria, Cyprus, Azerbaijan, Georgia, Greece, Italy and Canary Islands and is generically mentioned for North Africa. Was previously known only for mainland Italy. In Morocco is present *A. t. villiersi* Koch, 1941.
Sampling methods: Car-net.

***Atheta cauta* (Erichson, 1837)**
Habitat: Saprophyte species of open environments.
Geographical distribution: Widely distributed in central and northern Europe and in the Far East of Russia and Siberia. In Italy it was previously reported with certainty only for the northern regions.
Sampling methods: Car-net.

***Hypomedon debilicornis* (Wollaston, 1857)**
Habitat: In the decomposing material at low altitudes, anthropophilic (KOCH 1989). The males of this species are very rare, it is probably mostly parthenogenetic (COIFFAIT 1984).
Geographical distribution: It is a cosmopolitan species. In Italy, where it was previously reported with certainty only for peninsular regions, it is surely alien species, but is not identified the date of the introduction being known since 1800.
Sampling methods: Car-net, window traps.

***Neobisnius procerulus* (Gravenhorst, 1806)**
Habitat: Ripicolous and limicolous species.
Geographical distribution: Cosmopolitan species, reported with certainty for the mainland Italy and with uncertainty for Sardinia.
Sampling methods: Car-net.

***Oligota muensteri* Bernhauer, 1923**
Habitat: Species with unknown ecology.
Geographical distribution: Species distributed in Europe (Finland, Norway, Sweden, southern Russia, France, Italy and Malta), Canary Islands and Madeira. In Italy it was so far reported with uncertainty only for Sicily.
Sampling methods: Car-net, window traps, pit-fall traps.

***Oligota punctulata* Heer, 1839**
Habitat: Species with unknown ecology.
Geographical distribution: Species distributed in Europe (Spain, Italy, Croatia, Albania, France, Belgium, Austria, Czech Republic, Germany, Ireland, Great Britain, Denmark, the Netherlands) and North Africa (Tunisia, Algeria, Morocco, Madeira). In Italy it was so far known with certainty only for peninsular regions.
Sampling methods: Car-net, window traps, pit-fall traps.

***Sepedophilus marshami* (Stephens, 1832)**
Habitat: Eurytopic and saproxylic species.
Geographical distribution: Widely distributed in Europe, also reported for Asiatic Turkey, Eastern Siberia, North Korea and Tunisia, introduced in the Nearctic region. In Italy it was so far known with certainty for peninsular regions.
Sampling methods: Car-net, pit-fall traps.

ALIEN SPECIES

***Atheta mucronata* (Kraatz, 1859)**
Habitat: *A. mucronata* seems to be an r-selected inhabitant of unstable habitats like excrements, compost, carrion, etc. (see material section). The specimens from Israel were collected with pit-fall traps filled with a mix of glycerine, ethanol, acetic acid, and water while one specimen from Sicily was caught with a car-net (FELDMAN 2007).
Geographical distribution: Described from Ceylon, the species is known for the Afrotropical region and Eastern Europe (FELDMANN 2007). It has been already known for Sicilia (with the synonym of *Atheta vitalei* Bernhauer, 1932, described on specimens collected in 1929). It is present, although localized, around the Mediterranean basin (fig. 4.3). It is unclear whether the species is expanding its range area, although this is probable in relation to climate changes.
Sampling methods: Car-net, window traps, pit-fall traps.

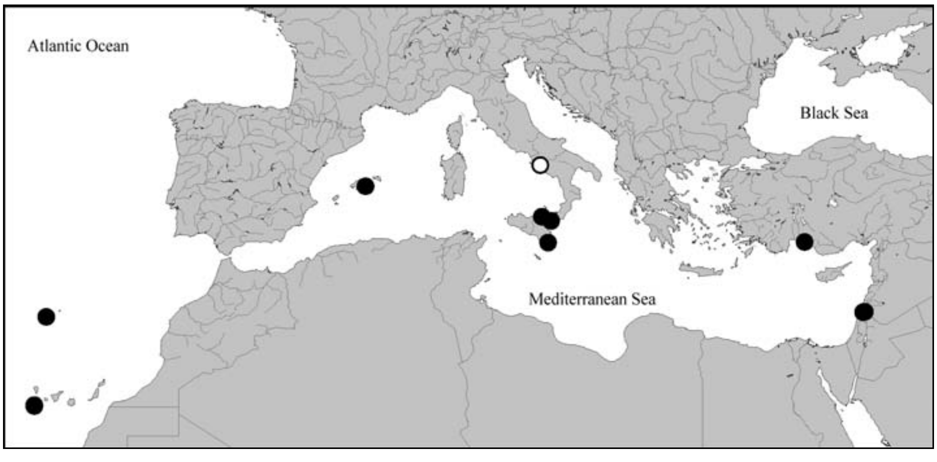


Fig. 4.3 - Distribution of *Atheta mucronata* within the mediterranrean region (from FELDMANN 2007).

***Diestota guadalupensis* Pace, 1987**
Habitat: It is found in decomposing material, often in the hollows of trees. Often sampled also by car net (DE MARZO & ZANETTI 2007).
Geographical distribution: Alien species, native to the island of Guadalupe, is probably present in Italian peninsula and its major islands. It is also been reported in France and Great Britain (LÖBL & SMETANA 2004). The first capture in Italy dates back to 1982.
Sampling methods: Car-net.

***Hypomedon debilicornis* (Wollaston, 1857)**
Discussed among species whose presence has been confirmed in Sicily.

***Paraphloeostiba gayndahensis* (MacLeay, 1871)**
Habitat: In decomposing material of vegetal origin, anthropophilic also in cultivated environments to plain from low altitude. His diet is mixed (it feeds on decomposing material, nematodes, etc.). It is currently one of the most abundant Staphylinidae beetles in Italy. In North America is considered an assist in agriculture as a pollinator of Araceae and Annonaceae (see http://eol.org/data_objects/17719792).
Geographical distribution: Cosmopolitan species native to Australia, which has appeared in Italy around 1988.
Sampling methods: Car-net, window traps, pit-fall traps.

***Thecturota marchii* (Dodero, 1922)**
Habitat: In the decomposing material, anthropophilic also in agroecosystems. Findable with difficulty by direct searches, it is often abundant in catches with car net (Zanetti, com. pers.).
Geographical distribution: Widespread throughout Europe and the Canary Islands, it is considered alien species of unknown origin, present in Europe with certainty since 1920 (HORION 1967).
Sampling methods: Car-net, window traps.

***Trichiusa immigrata* Lohse, 1984**
Already discussed among the new species for the fauna of Sicily.

OTHER TAXA OF PARTICULAR FAUNISTIC, BIOGEOGRAPHICAL AND ECOLOGICAL INTEREST

***Achenium striatum* (Latreille, 1804)**
Habitat: The species of the genus *Achenium* Leach, 1819 are characterized by the body strongly flattened, which is an adaptation to life in the fissures of the soil, especially in clay. Besides, they are thermophilic and prefer the Mediterranean open environments. *A. striatum* was found mainly under stones in various types of herbaceous environments (humid or ruderal grasslands, meadows) and in uncultivated areas, from sea level to 900 m a.s.l. (ASSING 2010).
Geographical distribution: Algeria, Tunisia, Malta, Sicily and Calabria (ASSING l. c.).
Sampling methods: Car-net, window traps.

***Achenium tenellum* Erichson, 1840**
Habitat: The habitat of *A. tenellum* is substantially the same as *A. striatum* (ASSING 2010).
Geographical distribution: Algeria, Tunisia, Sardinia, Sicily, Calabria (ASSING l. c.).
Sampling methods: Window traps.

***Alianta bipartita* Fauvel, 1900**
Habitat: *A. bipartita* is very rare species, whose ecology precise information is not available. As well as in Sicily, was captured with car net in Corsica (Aleria, leg. Zanetti) and in the Pyrenees (TRONQUET 2006). The available data are referred to open mediterranean plain environments but also to mountainous areas (Corsica: Corte; Southern France: Frejus and Mosset).
Geographical distribution: Known for the South of France (Frejus and Mosset in the Pyrenees) and Corsica, Liguria (Genoa), Tuscany (Grosseto) and Sicily.
Sampling methods: Car-net, window traps.

***Borboropora* sp.**
Note. The genus *Borboropora* Kraatz, 1862 includes two species, *B. kraatzi* Fuss, 1862 and *B. reitteri* (Weise, 1877) of southern Europe. The specimen collected does not seem to correspond to any of the two, and may be a taxon new to science.
Sampling methods: Car-net, window traps.

***Caloderina hierosolymitana* (Saulcy, 1865)**
Habitat: The species is found in open areas, in particular in agroecosystems, at low altitude in the mediterranean area, in decomposing material (Zanetti, unpublished data).
Geographical distribution: It's a typical mediterranean element with eastern gravitation, known for central and southern Italy (from Tuscany to Calabria), Sicily, Croatia, Greece, Cyprus, Turkey, Syria (LÖBL & SMETANA 2004).
Sampling methods: Car-net.

***Carpelimus siculus* (Mulsant & Rey, 1878)**
Habitat: According BINAGHI (1974) the species is linked to hygropetricous environment (Tolfa Mounts). In Sicily the species was sampled on Peloritans in riparian habitat with the washing of mosses (Adorno, unpublished data).
Geographical distribution: Known for Sicily, central Italy and Greece (LÖBL & SMETANA 2004).
Sampling methods: Car-net, window traps.

***Carpelimus vitalei* (Bernhauer, 1935)**
Habitat: The species is found on the banks of streams and often with car net (Zanetti, pers. com.).
Geographical distribution: Note so far only from Sicily, is also present in central Italy (Sinello 5 km from the mouth, car net leg. Zanetti) and in Sardinia (between Orosei and Galtelli and San Teodoro loc. Coda Cavallo, car-net leg. Zanetti).
Sampling methods: Car-net.

***Eusphalerum luteicorne luteicorne* (Erichson, 1840)**
Habitat: The adults of all species of the genus *Eusphalerum* Kraatz, 1857 are floricolous, while the diet of the larvae, probably edaphic, is unknown. *E. luteicorne* is a mediterranean species linked to scrub environments where it is found often on *Euphorbia* (ZANETTI 1987).
Geographical distribution: *E. luteicorne* is a polytypic W-mediterranean species. The ssp. *luteicorne* is found in Sicily and Tunisia, the ssp. *cincticolle* (Chevrolat, 1860) in Algeria. Are known populations intermediate between the two subspecies (ZANETTI 1991).
Sampling methods: Car-net, window traps.

***Geostiba plicatella* (Fauvel, 1878)**
Habitat: Like the congeners, *G. plicatella* is species of litter and soil environments for which shows adaptive features (microphthalmia, apterism). Differently form most other *Geostiba*, has a rather wide geographical distribution. Generally this phenomenon is explained by the presence of pteridimorphism with rare individuals winged (documented for example in *G. circellaris* (Gravenhorst, 1806) that allow the dispersion of the species. This would explain the presence of *G. plicatella* in agroecosystems (Zanetti, pers. com.).
Geographical distribution: The species is widespread in Sicily, Lampedusa, Morocco, Algeria and the Iberian Peninsula, with 11 subspecies whose value should be confirmed (LÖBL & SMETANA 2004).
Sampling methods: Pit-fall traps.

***Lepidophallus pseudohesperius* (Reitter, 1908)**
Habitat: It's species of mediterranean open environments.
Geographical distribution: It's W-Mediterranean species reported for Sardinia, Sicily, Tunisia, Algeria, Morocco, Spain and Portugal (LÖBL & SMETANA 2004). For Sardinia has been described *L. melonii* Bordoni, 2004, which is probably a synonym of *L. pseudohesperius* (Ciceroni, pers. com.). The genus *Lepidophallus* Coiffait, 1956 has recently been placed in synonymy with *Megalinus* Mulsant & Rey, 1877 (BORDONI 2008), but the argumentations presented require further confirmation.
Sampling methods: Car-net, window traps, pit-fall traps.

***Neohilara subterranea* (Mulsant & Rey, 1853)**
Habitat: The habitat of this species is unknown with certainty. It was found in tunnels of small mammals, in plant debris and in mosses (KOCH 1989), but most of the catch was made with car net in different environments, from alpine forests to mediterranean cultivated field.
Geographical distribution: It's known for most of Europe (LÖBL & SMETANA 2004).
Sampling methods: Car-net, window traps.

***Notothecta inflata* Fauvel, 1869**
Habitat: Myrmecophilous species, which has been reported by SILVESTRI (1912) for the nests of *Messor barbarus* (L.) var. *niger* Andrè of Catania and Strongoli (Calabria). It seems feeding the seeds present in the nests.
Geographical distribution: It is known for southern Italy, Sicily, Tunisia and Algeria (LÖBL & SMETANA 2004).
Sampling methods: Pit-fall traps.

***Oxypoda subnitida* Mulsant & Rey, 1875**
Habitat: The species seems to be linked to open mediterranean lowlands.
Geographical distribution: Basin of the western Mediterranean: Spain, southern France, Corfu Island, Italy, including Sicily, Island of Malta, Morocco (TRONQUET 2004).
Sampling methods: Car-net, window traps.

***Planeustomus* sp.**
Nota. The genus *Planeustomus* Jacquelin du Val, 1857 includes 16 palaearctic species, related to the silty banks, especially common in the warmer regions of the Western Palearctic region. In the absence of a modern revision, identification of specimens is almost impossible.
Sampling methods: Car-net, window traps.

***Quedius praecox* (Gravenhorst, 1802)**
Habitat: It is linked to open spaces, also salty, in plains (Zanetti, pers. com.).
Geographical distribution: Atlanto-Mediterranean species widespread in Sicily, Sardinia, Tunisia, Algeria, Morocco, Spain, Portugal, France and Great Britain (LÖBL & SMETANA 2004).
Sampling methods: Window traps.

***Sepedophilus aestivus* (Rey, 1882)**
Habitat: Eurytopic species, which live in plant debris.
Geographical distribution: SCHUELKE (2011) has recently approved that under the name of *S. immaculatus* (Stephens, 1832) have been confused two species, *S. immaculatus* with ponto-mediterranean gravitation, present in much of mainland Italy, and *S. aestivus*, considered so far wrong its synonyms, described from Provence. The latter, with atlanto-mediterranean gravitation, is known for France, Switzerland (Ticino), Spain, Portugal, Gibraltar, Morocco and Italy (Piedmont, Sicily and Sardinia).
Sampling methods: Car-net.

***Sunius algiricus* (Coiffait, 1970)**
Habitat: On the basis of data collection, is linked to open plane environments, also brackish (ADORNO & ZANETTI 2003).
Geographical distribution: Is known for southern Italy (Aspromonte), Sicily and Algeria (ADORNO & ZANETTI l. c.; LÖBL & SMETANA 2004).
Sampling methods: Car-net, pit-fall traps.

***Xantholinus graecus* Kraatz, 1858**
Habitat: It is found both in open environments and in in thermophilous woods (ZANETTI & TAGLIAPIETRA 2005) in mediterranean environment.
Geographical distribution: Species with E-mediterranean gravitation known for di Croazia, southern Italy, Sicily and circumsicilan islands, Greece, Turkey, Cyprus and southern Russia (ASSING 2008a) (fig. 4.4).
Sampling methods: Car-net, window traps, pit-fall traps.

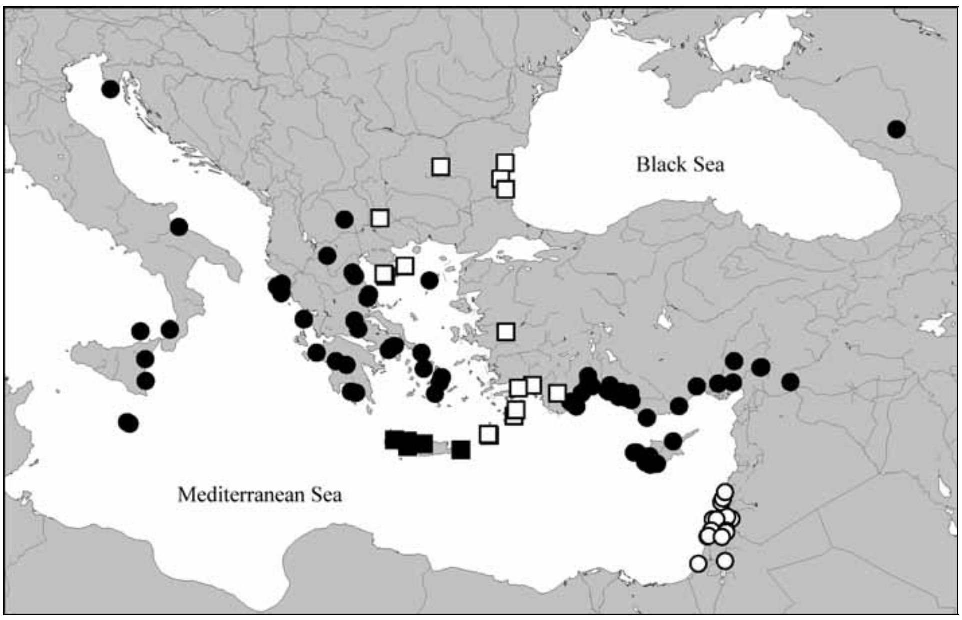


Fig. 4.4. – Distribution of *Xantholinus graecus* (filled circles) and of simil species *X. gridellii* Coiffait, 1956 (open circles), *X. varnensis* Coiffait, 1972 (open squares) and *X. minos* Assing 2008 (filled squares) (from ASSING 2008a).

TAXA MOST ABUNDANT SAMPLED

***Aloconota gregaria* (Erichson, 1839)**
Habitat: In plant debris in open moist lowland (Zanetti, pers. com.).
Geographical distribution: Europe, North Africa, Asia east to Central Asia (LÖBL & SMETANA 2004).
Sampling methods: Car-net, window traps, pit-fall traps.

***Amarochara umbrosa* (Erichson, 1837)**
Habitat: It lives in a wide range of open environments and forest in all types of material in decomposition, between the roots of old trees and in nests of small mammals and fox. It is an active flier that is often collected with car net and other interception techniques.
Geographical distribution: *A. umbrosa* is widespread in central and southern parts of the Palearctic region, from Spain to China (ASSING 2002).
Sampling methods: Car-net, window traps, pit-fall traps.

***Anotylus complanatus* (Erichson, 1839)**
Habitat: In decaying material, often in dung, from the plains to the mountains (Zanetti, pers. com.).
Geographical distribution: Palaearctic Region, Australian and Neotropical Region (LÖBL & SMETANA 2004).
Sampling methods: Car-net, window traps.

***Anotylus nitidulus* (Gravenhorst, 1802)**
Habitat: In decomposing material, from the plains to the mountains, often anthropophilic.
Geographical distribution: Palaearctic, Nearctic, Neotropical and Eastern Region (LÖBL & SMETANA 2004).
Sampling methods: Car-net, window traps, pit-fall traps.

***Anotylus speculifrons* (Kraatz, 1857)**
Habitat: In decomposing material at low altitudes, both anthropised and natural environments.
Geographical distribution: Reported for Europe, North Africa and several regions of Palearctic; data that should be further reviewed through a review of materials (Schuelke, *in litteris*).
Sampling methods: Car-net, window traps, pit-fall traps.

Atheta* gr. *fungi
Note. The subgenre *Mocyta* Mulsant & Rey 1874 of *Atheta* Thomson, 1858 includes several taxa that are extremely critical. Very abundant in nature in vegetable detritus, include both populations parthenogenetic or with biparental sexual reproduction, characterized by great genetic variability, in which a morphological approach is totally inadequate for the identification of the species.
Sampling methods: Car-net, window traps, pit-fall traps.

***Atheta inquinala* (Gravenhorst, 1802)**
Habitat: In decomposing material of various kind, in different environments (Zanetti, pers. com.).
Geographical distribution: Europe, North Africa, Central Asia (LÖBL & SMETANA 2004).
Sampling methods: Car-net, window traps, pit-fall traps.

***Atheta mucronata* (Kraatz, 1859)**
Already discussed between alien species.

***Atheta palustris* (Kiesenwetter, 1844)**
Habitat: In plant debris in damp open environments (Zanetti, pers. com.).
Geographical distribution: Palearctic Region (LÖBL & SMETANA 2004).
Sampling methods: Car-net, window traps.

***Carpelimus corticinus* (Gravenhorst, 1806)**
Habitat: In silt banks and plant debris in wet environments, even in agroecosystems (Zanetti, pers. com.).
Geographical distribution: Subcosmopolitan (LÖBL & SMETANA 2004).
Sampling methods: Car-net, window traps, pit-fall traps.

***Cordalia oscura* (Gravenhorst, 1802)**
Habitat: In decomposing material, often anthropophilic, in the plains and lowlands (Zanetti, pers. com.).
Geographical distribution: Europe, North Africa, Asia Palearctic east to central Asia. Imported in North America (LÖBL & SMETANA 2004).
Sampling methods: Car-net, window traps, pit-fall traps.

***Gabronthus maritimus* (Motschulsky, 1858)**
Habitat: In decomposing material, often anthropophilic, in the plains and lowlands (Zanetti, pers. com.).
Geographical distribution: Southern Europe, North Africa, Middle East, Taiwan, Japan, and eastern Ethiopian region (LÖBL & SMETANA 2004). It's possibly an alien species.
Sampling methods: Car-net, window traps, pit-fall traps.

***Habrocerus capillaricornis* (Gravenhorst, 1806)**
Habitat: In plant debris, both in forest and open environments, at low altitudes (Zanetti, pers. com.).
Geographical distribution: Palaearctic, Nearctic, Neotropical and Australian Region.
Sampling methods: Car-net, pit-fall traps.

***Heterothops minutus* Wollaston, 1860**
Habitat: It is species of ecotones and open environments, where it is found in plant debris. It is often sampled by car net.
Geographical distribution: Reported only recently for Italy, this species is often confused with *H. dissimilis* (Gravenhorst, 1802), has a distribution still not perfectly known. It was reported for the Azores, Canary Islands, Madeira, Spain, Great Britain, Ireland, France, Germany, Austria, Czech Republic, Sweden and Morocco. The examination of italian material showed that both species are present in Italy. *H. minutus* has southern Italy gravitation because it is present from the Po valley to the south mainland and is particularly abundant in Sardinia and Sicily, while *H. dissimilis* is found in alpine valley (ZANETTI 2011).
Sampling methods: Car-net, window traps, pit-fall traps.

***Leptacinus intermedius* Donisthorpe, 1936**
Habitat: In plant debris in plains and lowlands, often anthropophilic.
Geographical distribution: Europe, North Africa, Cyprus, Turkey, North America (LÖBL & SMETANA 2004).
Sampling methods: Car-net, window traps.

***Megalinus glabratus* (Gravenhorst, 1802)**
Habitat: In decomposing material, often in the dung, in open thermophilic environments (Zanetti, pers. com.).
Geographical distribution: Europe, North Africa, the Near East (LÖBL & SMETANA 2004).
Sampling methods: Car-net, window traps, pit-fall traps.

***Megarthrus bellevoyei* Saulcy, 1862**
Habitat: In decomposing material, in open low-altitude environments (Zanetti, pers. com.).
Geographical distribution: Palearctic Region, with large gaps in Central Asia (LÖBL & SMETANA 2004).
Sampling methods: Car-net, window traps, pit-fall traps.

***Ocypus olens olens* (O. Müller, 1764)**
Habitat: Usually in open plain environments, often anthropophilic. In Sicily and Sardinia, where there are no congeneric competitors in forest environments, even in the woods (ZANETTI 2011).
Geographical distribution: Europe and North Africa, in the Azores is present the ssp. *azoricus* (Méquignon, 1942) (LÖBL & SMETANA 2004).
Sampling methods: Pit-fall traps.

***Paraphloeostiba gayndahensis* (MacLeay, 1871)**
Already discussed between alien species.

***Philonthus concinnus* (Gravenhorst, 1802)**
Habitat: In decomposing material, often coprophilous, at low altitudes (Zanetti, pers. com.).
Geographical distribution: Palaearctic Region, imported into the Nearctic region.
Sampling methods: Car-net, window traps, pit-fall traps.

***Platystethus nitens* (Sahlberg, 1832)**
Habitat: On mud and in wet plant debris, especially at low altitudes (Zanetti, pers. com.).
Geographical distribution: Palearctic Region.
Sampling methods: Car-net, window traps, pit-fall traps.

***Proteinus atomarius* Erichson, 1840**
Habitat: Usually in rotting fungi, from plain to mountain level (Zanetti, pers. com.).
Geographical distribution: Europe, North Africa, Turkey, Mongolia, North America (LÖBL & SMETANA 2004).
Sampling methods: Car-net, window traps.

***Scopaeus debilis* Hochhuth, 1851**
Habitat: Eurytopic in moist plant debris, often collected with car net (Zanetti, pers. com.).
Geographical distribution: Europe, North Africa, the Near East, Central Asia (LÖBL & SMETANA 2004).
Sampling methods: Car-net, window traps.

***Scopaeus mitratus* Binaghi, 1935**
Habitat: In moist environments of low altitude (Zanetti, pers. com.).
Geographical distribution: Continental Italy south of the Po, Sicily, Greece.
Sampling methods: Car-net, window traps.

***Tachyporus nitidulus* (Fabricius, 1781)**
Habitat: Eurytopic in plant debris (Zanetti, pers. com.).
Geographical distribution: Cosmopolitan (LÖBL & SMETANA 2004).
Sampling methods: Car-net, window traps, pit-fall traps.

4.3 Biogeographic considerations

Current knowledge on the geographical distribution of Italian Staphylinidae can be considered satisfactory and the data lend themselves to some simple biogeographic considerations, excluding from the latter the 20 morphospecies.

Overall Staphylinidae of the area under study are characterized from the point of view biogeographic as shown in fig. 4.3.1.

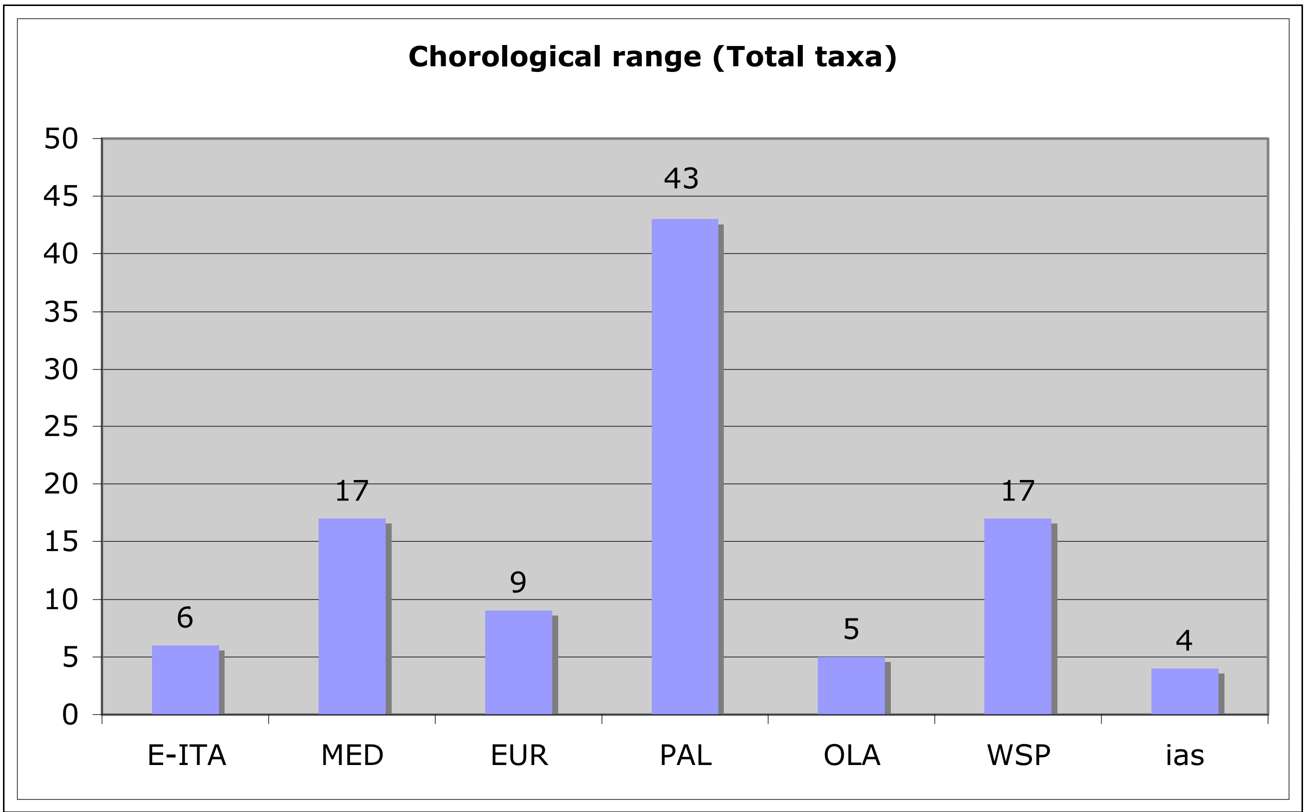


Fig. 4.3.1 – Percentage of chorological range of total of taxa (excluding morphospecies). **E-ITA**: Italian endemic; **MED**: Mediterranean; **EUR**: European; **PAL**: Palaearctic; **OLA**: Holarctic; **WSP**: Widespread; **ias**: alien species.

More than 69% of the taxa shows a wide distribution; the most abundant ones are that with more or less broad distribution in the Palaearctic region (43% of the total), followed by that at wider distribution (Holarctic and extra-Holarctic) equal to 22% of total number of taxa considered to which must be added the 4% of alien species.

The Italian endemic taxa are only 8 (6% of total), among them five are endemics to Sicily, *Pella leonhardi* and *Pronomaea sicula*, are species presumably myrmecophyles, while *Quedius caelebs Tasgius pedator siculus* and *Tasgius globulifer evidentus* are generally related to open environments.

1 species, *Carpelimus vitalei*, has Siculo-Apennine geonemy and is ripicolous, and 2 species, *Callicerus atricollis*, with unknown ecology, and *Medon perniger*, linked to open spaces, shows a Alpine-Apennine distribution.

Scarce is the European component s. l. (9%), which includes, however, one species, *Oligota muensteri*, known in Italy only for Sicily, while more significant is the Mediterranean component s. l. (17%). In conclusion it is a chorological spectrum coherent with the environment where the research took place: a large orchard plain characterized by prolonged period of aridity.

Considering the taxa with Palaearctic distribution *sensu latu* (fig. 4.3.2) can be observed as those with Euromediterranean geonemy amount to 31% of the total of this component, followed by Holopalearctic ones (30%); a substantial number of taxa has Turanian-European Mediterranean distribution (17%), and a significant number of taxa has Asian-European geonemy (8%) and Central-Asian-European Mediterranean distribution (6%). These data are consistent with the ecological context where the research took place with many taxa eurytopics or related to sub-steppe or steppe open spaces, usually with broad ecological valence and saprophyles.

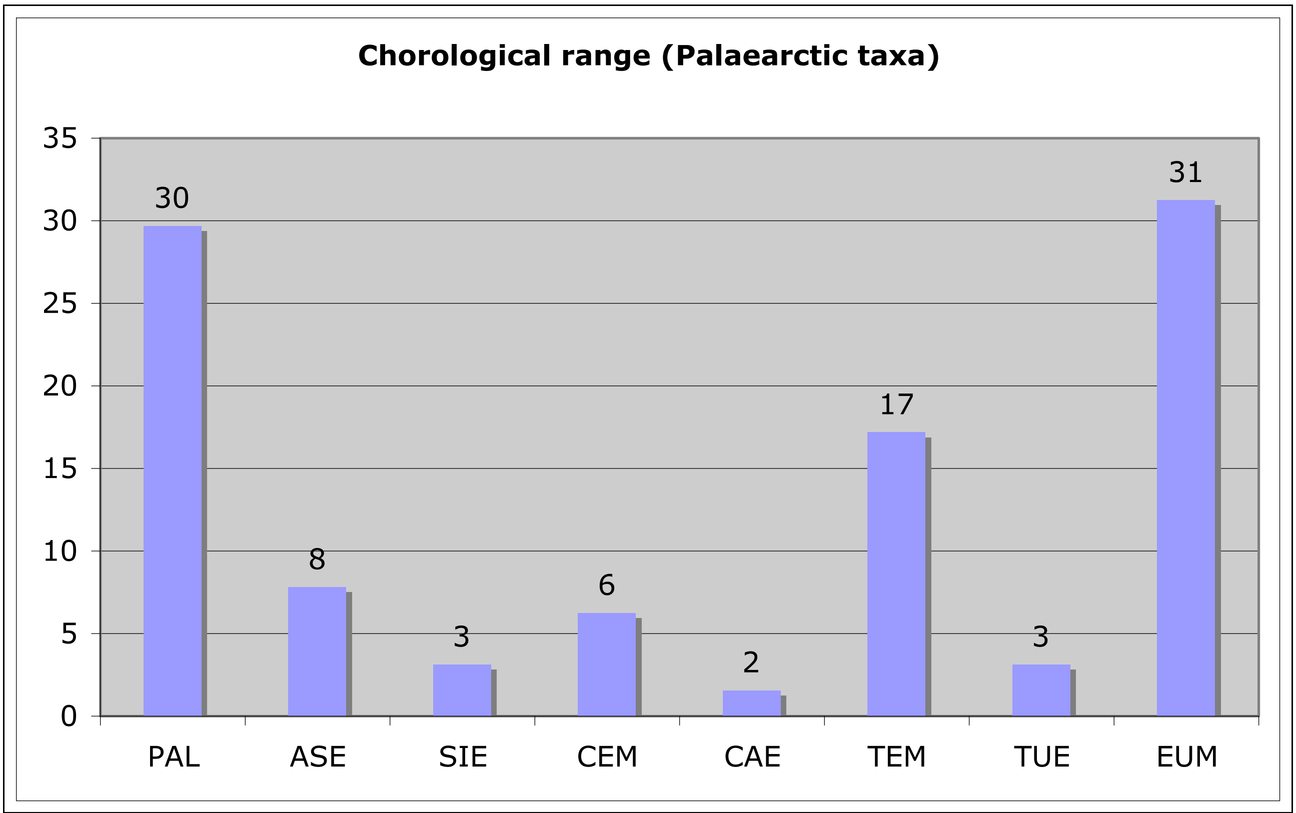


Fig. 4.3.2 – Percentage of chorological range of Palaearctic taxa. **PAL**: Palaearctic; **ASE**: Asian-European; **SIE**: Siberian-european; **CEM**: Central European-Mediterranean; **CAE**: Central Asian-European; **TEM**: Turanian European-Mediterranean; **TUE**: Turanian European; **EUM**: European-Mediterranean.

Considering the species with mediterranean distribution (fig. 4.3.3) can be seen as the 44% is represented by the Western-Mediterranean, between which is to be mentioned *Alianta bipartita*, thermophilic and hygrophilous species presumably linked to open environments, showing Tirrenian distribution *sensu* La Greca. *Geostiba plicatella*, species living in soil and litter, *Oxypoda flavissima*, linked to soil and litter, and *Oxypoda subnitida*, phytodetriticolous and thermophilic species linked to open environments, are known in Italy only for Sicily.

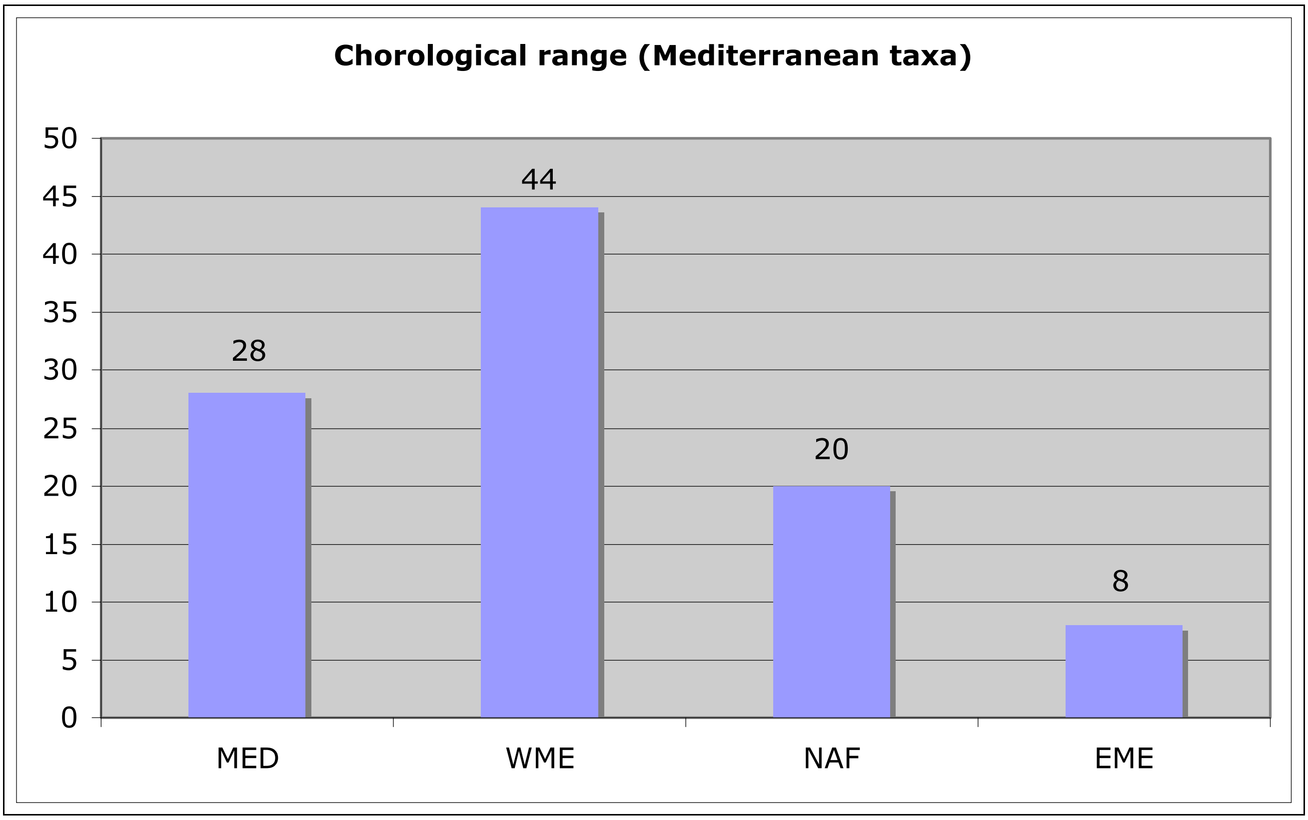


Fig. 4.3.3 – Percentage of chorological range of Mediterranean taxa. **MED**: Holomediterranean; **WME**: West Mediterranean; **NAF**: North African; **EME**: East Mediterranean.

Very significant (20%) is the North African component, which includes three species, *Xantholinus rufipes*, species with unknown ecology, *Eusphalerum luteicorne luteicorne*, floricolous related to mediterranean maquis, and *Sunius algiricus*, thermophilic and subalophile species linked to open enviroments, which shows a clear Sicilian-Maghrebian geonemy, being known in Europe only for Sicily, while other two species, *Notothecta inflata*, myrmecophilous and thermophilic, and *Achenium tenellum*, thermophilic species with adaptation to life in the fissures of the soil and linked to open environments, are also reported for the Italian peninsula. Although poorly represented, the taxa with East-European geonemy (8%), include species of great biogeographical interest that show a typical trans-jonian distribution *sensu* La Greca such *Carpelimus siculus*, ripicolous, and *Scopaeus mitratus*, linked to humid environments of low altitude.

4.4 Comparison of sampling with the different capture techniques

Among the various collection techniques used (pit-fall traps, window traps, monthly car-net and daily car-net) are possible comparison mainly qualitative because they differ significantly in the sampling modality. The pit-fall traps and the window traps are, in fact, intercepting traps more or less passive which, in a relatively long period of time, collect respectively the fauna moving on the ground or the flying insects, while the car-net intercepts actively flying insects, recording, in a short periods of time, frequencies of capture significantly higher than those of the other two methods of sampling.
In any case, we must consider that the data of the pit-fall traps refer to only three sampling periods (May and from mid-October to mid-December), while those of the window traps and car-net refer to 12 months.
The qualitative comparisons between different types of sampling were performed for all subfamilies of Staphylinidae, even for Aleocharinae and Oxytelinae are missing data related to species surveyed with the daily car-net (see par. 4. 1).

ALEOCHARINAE AND OXYTELINAE

In total by means of the three collection techniques (monthly car net, window traps and pit-fall traps) were sampled 92 taxa of Aleocharinae and Oxytelinae.
In the table below (tab. 4.4.1) are listed the 20 taxa releved with all three different collection techniques. The first 8 species are the first eight most abundantly sampled relative to the total sample (see tab. 4.1.1). Interesting are the data relating to *Cordalia oscura* and *Atheta mucronata* that, despite the small size of the sampling, are more abundantly surveyed by pit-fall traps; in proportion to the effort of capture, also *Atheta aeneicollis* can be considered similar of the previous two taxa. For these three species can assume a closer link with the habitat of the soil than the other.

Taxa	CN	WT	PT	Total
Anotylus nitidulus	2779	247	18	3044
Atheta gr. *fungi*	426	144	29	599
Anotylus speculifrons	457	111	3	571
Cordalia obscura	329	23	42	394
Amarochara umbrosa	278	14	3	295
Carpelimus corticinus	161	80	19	260
Atheta inquinula	110	22	3	135
Aloconota gregaria	65	65	3	133
Atheta mucronata	32	7	58	97
Platystethus nitens	26	70	1	97
Atheta aeneicollis	35	27	23	85
Anotylus sculpturatus	24	55	6	85
Amischa decipiens	22	30	2	54
Anotylus inustus	3	42	3	48
Pronomaea sicula	21	16	1	38
Oxypoda brevicornis	30	3	4	37
Aleochara bipustulata	10	12	8	30
Oligota muensteri	9	12	3	24
Oligota punctulata	15	2	2	19
Dacrila pruinosa	9	5	2	16

Tab. 4.4.1 – Taxa of Aleocharinae and Oxytelinae sampled with all the three collecting techniques used.

Anotylus nitidulus, *Atheta* gr. *fungi* and *Carpelimus corticinus* show capture frequencies significant with all the three sampling methods, while *Anotylus speculifrons*, *Amarochara umbrosa, Atheta inquinula, Aloconota gregaria, Platystethus nitens, Anotylus sculpturatus* have been recorded at

low frequencies by the pit-fall traps. This may be due either to their lower connection with the habitat of the soil, or by a substantial flying activity in the period in which pit-fall traps were used.
As regards the taxa recorded with two of the three techniques of collection (tab. 4.4.2) they are 33, 25 of which (75.7%) were collected with car-net and window traps; all, with the exception of *Atheta* (*Microdota*) sp. were more abundantly sampled with the monthly car-net.
At least for the first 10 species in order of abundance, in relation to the frequency of captures recorded, it can be assumed that the data indicate a significant flying activity at least in the periods considered.
5 taxa were sampled with car-net and pit-fall traps and only 3 with window traps and pit-fall traps, but all with an amount of samples too small to make assumptions.

Taxa	CN	WT	PT	Total
Atheta palustris	103	2		105
Acrotona muscorum	54	5		59
Thecturota marchii	48	1		49
Anotylus complanatus	31	6		37
Nehemitropia lividipennis	34	3		37
Trichiusa immigrata	31	2		33
Anotylus tetracarinatus	25	5		30
Liogluta longiuscula	23	6		29
Atheta atramentaria	22	1		23
Atheta (*Microdota*) sp.	9	13		22
Outachyusa raptoria	17	1		18
Oxypoda subnitida	11	6		17
Oligota sp.	10	5		15
Oxypoda haemorrhoa	12	3		15
Planeustomus sp. 1	3	6		9
Aloconota sulcifrons	6	1		7
Oxypoda carbonaria	6	1		7
Oxypoda sp. 1	3	2		5
Carpelimus nigrita	2	2		4
Atheta xanthopus	3	1		4
Acrotona parvula	2	1		3
Alianta bipartita	2	1		3
Carpelimus siculus	2	1		3
Neohilara subterranea	2	1		3
Oxypoda sp. 2	2	1		3
Atheta amicula	17		7	24
Atheta coriaria	10		9	19
Oligota parva	5		1	6
Atheta testaceipes	2		3	5
Atheta laticollis	1		1	2
Myrmoecia sp. 1		4	5	9
Amarochara forticornis		1	8	9
Oxypoda flavissima		6	1	7

Tab. 4.4.2 – Taxa of Aleocharinae and Oxytelinae sampled with two of the three collecting techniques used.

The taxa collected with only one of the techniques used (tab. 4.4.3) are 38, of which 23 (60.5%) collected with car-net, 7 with window traps and 8 with pit-fall traps; they always show capture frequencies very low except for *Geostiba plicatella*, sampled at significant frequencies by pit-fall traps, since it confirms the close relationship of this species with the soil and litter.

Taxa	CN	WT	PT	Total
Amischa forcipata	18			18
Amischa sp.	9			9
Amischa nigrofusca	8			8
Atheta nigra	3			3
Atheta occulta	3			3
Carpelimus exiguus	3			3
Diestota guadalupensis	3			3
Myrmecopora fugax	3			3
Atheta cauta	2			2
Ochthephilus sp. 1	2			2
Atheta longicornis	1			1
Atheta sp.	1			1
Atheta sp. 1	1			1
Atheta sp. 2	1			1
Atheta sp. 3	1			1
Atheta sp. 4	1			1
Atheta triangulum	1			1
Borboropora sp. 1	1			1
Caloderina hierosolymitana	1			1
Carpelimus fuliginosus	1			1
Carpelimus vitalei	1			1
Gnypeta rubrior	1			1
Tetralaucopora longitarsis	1			1
Platystethus degener		5		5
Anotylus intricatus		2		2
Carpelimus pusillus		2		2
Alaobia scapularis		1		1
Aleochara clavicornis		1		1
Pycnota paradoxa		1		1
Tinotus morion		1		1
Geostiba plicatella			11	11
Callicerus atricollis			5	5
Falagrioma thoracica			3	3
Atheta oblita			2	2
Atheta orbata			2	2
Oxypoda lurida			2	2
Pella leonhardi			2	2
Notothecta inflata			1	1

Tab. 4.4.3 – Taxa of Aleocharinae and Oxytelinae sampled with one of the three collecting techniques used.

OTHER SUBFAMILIES

In total the four collection techniques (monthly car-net, daily car-net, window traps and pit-fall traps) counted 79 taxa of other subfamilies of Staphylinidae.

12 taxa were collected with all the four techniques used (tab. 4.4.4), with the first three species which are also the most abundantly sampled relative to the total sample (see tab. 4.1.1). *Xantholinus graecus* and, in proportion to the effort to capture, even *Paraphloeostiba gayndahensis* resulted more abundantly sampled by pit-fall traps, which could indicate a closer relationship of these two species than the other with the environment of the soil. Besides these two taxa, as expected, the daily car-net has sampled others species with higher frequencies of capture except for *Philonthus concinnus*, for which the most effective sampling method resulted in the window traps.

Taxa	CN-h	CN	WT	PT	Total
Megarthrus bellevoyei	5488	361	24	19	5892
Gabronthus maritimus	1314	307	61	7	1689
Paraphloeostiba gayndahensis	286	215	44	135	680
Philonthus concinnus	30	4	166	17	217
Tachyporus nitidulus	65	29	57	8	159
Heterothops minutus	112	17	12	1	142
Tachinus flavolimbatus	51	12	5	6	74
Xantholinus graecus	8	1	7	37	53
Rugilus orbiculatus	25	7	2	3	37
Tachyporus hypnorum	10	7	14	2	33
Lepidophallus pseudohesperius	6	1	12	6	25
Sepedophilus nigripennis	4	1	5	6	16

Tab. 4.4.4 – Taxa of Staphylinidae (excluding Aleocharinae and Oxytelinae) sampled with all of the four collecting techniques used.

The taxa sampled with three of the four techniques (tab. 4.4.5) are 15. Among them, more than half (8) were collected with daily and monthly car-net and with window traps, 4 with daily and monthly car-net and with pit-fall traps and 3 with daily car-net, window traps and pit-fall traps, among them *Megalinus glabratus* and *Astenus lyonessius* are more thoroughly surveyed by pit-fall traps, suggesting that are the species most closely related to the ground.

Taxa	CN-h	CN	WT	PT	Total
Scopaeus debilis	340	56	6		402
Proteinus atomarius	262	27	4		293
Scopaeus mitratus	130	5	9		144
Leptacinus intermedius	66	8	8		82
Hypomedon debilicornis	42	4	2		48
Gabrius nigritulus	20	10	4		34
Luzea nigritula	25	1	1		27
Gyrohypnus fracticornis	2	2	1		4
Habrocerus capillaricornis	75	16		2	93
Sunius algiricus	19	2		2	23
Gyrohypnus angustatus	18	1		1	20
Sepedophilus marshami	1	2		5	8
Megalinus glabratus	11		25	85	121
Astenus lyonessius	7		2	31	40
Quedius levicollis	1		3	1	5

Tab. 4.4.5 – Taxa of Staphylinidae (excluding Aleocharinae and Oxytelinae) sampled with three of the four collecting techniques used.

The taxa sampled with two of the four techniques (tab. 4.4.6) are 19, almost all surveyed at low frequencies of capture. Among them, 8 taxa were collected only with monthly and daily car-net and 4 with daily car-net and window traps. One of only 2 species that have been recorded with daily car-net and pit-fall traps, it is interesting *Domene stilicina*, which registers the most of the catches with pit-fall traps. Only 2 taxa were sampled with monthly car-net and window traps, but with very low frequencies. Finally, 4 species have been recorded with window traps and pit-fall traps with *Ocypus ophthalmicus* and *Quedius pallipes*, which recorded the majority of the catch with pit-fall traps, with significative frequency.

Taxa	CN-h	CN	WT	PT	Total
Neobisnius lathrobioides	10	7			17
Sepedophilus aestivus	12	2			14
Neobisnius p. procerulus	5	1			6
Tachyporus caucasicus	3	3			6
Medon perniger	3	1			4
Quedius humeralis	1	1			2
Tachyporus abner	1	1			2
Philonthus jurgans	7		2		9
Eusphalerum l. luteicorne	3		4		7
Mycetoporus reichei	4		1		5
Achenium s. striatum	1		1		2
Domene stilicina	2			21	23
Micropeplus staphylinoides	1			2	3
Scopaeus sp.		2	1		3
Stenus sp. 2		1	2		3
Ocypus ophthalmicus			2	51	53
Quedius pallipes			2	23	25
Quedius caelebs			3	1	4
Quedius semiobscurus			2	1	3

Tab. 4.4.6 – Taxa of Staphylinidae (excluding Aleocharinae and Oxytelinae) sampled with two of the four collecting techniques used.

The taxa collected with only one of the techniques used (tab. 4.4.7) are 33, 17 of them with daily car-net, 2 with monthly car-net, 9 with window traps and 5 with pit-fall traps. These taxa were recorded with frequencies capture generally very low on which it is not possible to advance hypotheses except for *Ocypus o. olens* sampled with high frequencies only by the pit-fall traps.

Taxa	CN-h	CN	WT	PT	Total
Philonthus debilis	10				10
Lithocharis nigriceps	5				5
Astenus b. bimaculatus	3				3
Mycetoporus g. glaber	2				2
Othius laeviusculus	2				2
Stenus sp. 3	2				2
Astenus pallidulus	2				2
Astenus t. thoracicus	1				1
Cilea silphoides	1				1
Lesteva s. sicula	1				1
Micropeplus f. fulvus	1				1
Micropeplus porcatus	1				1
Omalium allardi	1				1
Omalium excavatum	1				1
Proteinus ovalis	1				1
Quedius scintillans	1				1
Xantholinus rufipes	1				1
Stenus sp. 1		2			2
Bisnius sordidus		1			1
Stenus brunnipes			6		6
Philonthus intermedius			2		2
Stenus similis			2		2
Tasgius globulifer evidentus			2		2
Achenium tenellum			1		1
Bolitobius castaneus			1		1
Mycetoporus nigricollis			1		1
Quedius praecox			1		1
Stenus m. mendicus			1		1
Ocypus o. olens				96	96
Tasgius pedator siculus				5	5
Astenus sp.				1	1
Euryporus aeneiventris				1	1
Gauropterus f. fulgidus				1	1

Tab. 4.4.7 – Taxa Staphylinidae (excluding Aleocharinae and Oxytelinae) sampled with one of the four collecting techniques used.

4.5 Comparison of sampling with the car-net in Citrus Orchard and Arable Land

The comparison between these data, although based on only three pairs of samples (see materials and methods section. 3.3), allows to highlight a substantial similarity of the faunistic composition in the two investigated environments. All the most abundant species, found with at least ten specimens during this sampling (tab. 4.5.1), are present in both stations. Furthermore, with the exception of *Atheta triangulum* and *Tetralaucopora longitarsis* (both sampled with a single specimen), all species sampled in Arable Land were surveyed also in Citrus Orchard during the subsequent samplings.

Taxa	Orchad	Arable	Total
Anotylus speculifrons	121	80	201
Atheta gr. *fungi*	14	39	53
Gabronthus maritimus	39	5	44
Megarthrus bellevoyei	31	2	33
Aloconota gregaria	13	16	29
Acrotona muscorum	7	22	29
Tachyporus nitidulus	2	25	27
Liogluta longiuscula	2	16	18
Atheta palustris	12	2	14
Nehemitropia lividipennis	4	8	12
Oxypoda brevicornis	6	5	11
Atheta amicula	7	3	10
Total specimend	334	272	606
Total species	43	35	54

Tab. 4.5.1 – Species sampled with car-net with 10 or more specimens in Orchad Citrus and Arable Land.

RESULTS

5 WINDOW TRAPS

With this technique were sampled 1.599 specimens belonging to 97 species (tab. 5.1).

	Shrub		Cane		Citrus				Track								
Taxa	01	02	03	04	05	06	07	11	08	09	10	12	Shrub	Cane	Citrus	Track	Total
Anotylus nitidulus	5	2	28	11	6	7	5	3	90	27	31	32	7	39	21	180	247
Philonthus concinnus	-	-	16	4	10	11	5	4	44	9	23	40	-	20	30	116	166
Atheta gr. *fungi*	2	3	14	11	11	10	6	3	30	16	27	11	5	25	30	84	144
Anotylus speculifrons	7	5	18	17	-	1	2	2	33	2	15	9	12	35	5	59	111
Carpelimus corticinus	3	1	5	9	2	3	2	1	25	11	10	8	4	14	8	54	80
Platystethus nitens	1	-	6	14	3	2	1	-	20	3	6	14	1	20	6	43	70
Aloconota gregaria	1	-	8	9	1	2	1	-	21	3	6	13	1	17	4	43	65
Gabronthus maritimus	-	-	12	5	2	1	-	2	18	8	6	7	-	17	5	39	61
Tachyporus nitidulus	2	1	8	6	3	3	3	-	6	3	7	15	3	14	9	31	57
Anotylus sculpturatus	1	1	4	4	-	1	-	-	5	4	1	34	2	8	1	44	55
Paraphloeostiba gayndahensis	1	-	2	-	12	9	3	-	3	6	6	2	1	2	24	17	44
Anotylus inustus	-	3	7	5	3	1	1	1	9	3	4	5	3	12	6	21	42
Amischa decipiens	1	3	2	3	1	1	1	1	7	3	1	6	4	5	4	17	30
Atheta aeneicollis	1	1	1	4	-	2	-	1	8	3	3	3	2	5	3	17	27
Megalinus glabratus	-	-	4	2	-	-	2	1	7	1	6	2	-	6	3	16	25
Megarthrus bellevoyei	-	-	4	4	2	2	-	-	7	3	1	1	-	8	4	12	24
Cordalia obscura	-	1	1	3	-	-	-	-	10	1	5	2	1	4	-	18	23
Atheta inquinula	-	-	-	-	1	-	1	-	13	1	2	4	-	-	2	20	22
Pronomaea sicula	1	1	3	-	1	-	-	-	2	2	3	3	2	3	1	10	16
Tachyporus hypnorum	-	-	-	2	1	-	-	1	2	4	3	1	-	2	2	10	14
Amarochara umbrosa	-	-	1	1	-	-	-	-	8	2	1	1	-	2	-	12	14
Atheta (Microdota) sp.	3	-	-	5	-	1	-	-	3	1	-	-	3	5	1	4	13
Heterothops minutus	-	-	3	2	1	-	-	-	2	1	1	2	-	5	1	6	12
Lepidophallus pseudohesperius	-	-	1	-	-	2	3	-	1	1	2	2	-	1	5	6	12
Oligota muensteri	1	-	-	1	-	1	1	-	3	3	-	2	1	1	2	8	12
Aleochara bipustulata	-	-	-	-	-	1	1	-	6	-	2	2	-	-	2	10	12
Scopaeus mitratus	-	-	-	4	-	1	-	-	2	1	-	1	-	4	1	4	9
Leptacinus intermedius	-	-	2	2	-	-	-	-	2	1	-	1	-	4	-	4	8
Atheta mucronata	-	1	-	1	4	-	-	-	1	-	-	-	1	1	4	1	7
Xantholinus graecus	-	1	-	1	-	-	1	-	-	-	2	2	1	1	1	4	7
Oxypoda flavissima	-	-	6	-	-	-	-	-	-	-	-	-	-	6	-	-	6
Anotylus complanatus	1	1	-	1	-	-	1	-	1	-	1	-	2	1	1	2	6
Planeustomus sp. 1	1	-	1	-	-	1	-	-	2	-	-	1	1	1	1	3	6
Liogluta longiuscula	-	-	-	1	1	-	-	-	1	-	3	-	-	1	1	4	6
Stenus brunnipes	-	-	1	-	-	-	-	-	1	-	1	3	-	1	-	5	6
Scopaeus debilis	-	-	-	1	-	-	-	-	2	-	3	-	-	1	-	5	6
Oxypoda subnitida	2	-	-	-	-	-	-	-	1	-	3	-	2	-	-	4	6
Sepedophilus nigripennis	-	1	1	1	-	1	-	-	1	-	-	-	1	2	1	1	5
Dacrila pruinosa	-	-	-	2	-	-	-	-	3	-	-	-	-	2	-	3	5
Oligota sp.	-	-	1	-	-	-	2	-	-	1	-	1	-	1	2	2	5
Platystethus degener	-	-	-	1	-	-	1	-	2	1	-	-	-	1	1	3	5
Anotylus tetracarinatus	-	-	1	-	-	-	-	-	1	1	2	-	-	1	-	4	5
Tachinus flavolimbatus	-	-	-	-	1	-	-	1	1	-	1	1	-	-	2	3	5
Acrotona muscorum	-	-	-	-	-	-	-	-	3	1	-	1	-	-	-	5	5
Proteinus atomarius	-	-	2	1	-	-	-	-	1	-	-	-	-	3	-	1	4
Eusphalerum l. luteicorne	-	-	-	1	1	1	1	-	-	-	-	-	-	1	3	-	4
Myrmoecia sp. 1	1	-	1	-	-	-	1	-	-	1	-	-	1	1	1	1	4

Gabrius nigritulus	-	-	-	-	-	-	-	1	2	1	-	-	-	-	1	3	4
Nehemitropia lividipennis	-	-	1	-	-	-	-	-	-	-	-	2	-	1	-	2	3
Quedius caelebs	-	-	1	-	-	-	-	-	2	-	-	-	-	1	-	2	3
Oxypoda brevicornis	-	-	-	-	-	-	1	-	-	1	1	-	-	-	1	2	3
Quedius levicollis	-	-	-	-	-	-	-	-	-	-	1	2	-	-	-	3	3
Oxypoda haemorrhoa	-	-	-	-	-	-	-	-	1	-	-	2	-	-	-	3	3
Philonthus jurgans	-	-	2	-	-	-	-	-	-	-	-	-	-	2	-	-	2
Quedius pallipes	-	-	1	1	-	-	-	-	-	-	-	-	-	2	-	-	2
Quedius semiobscurus	1	-	1	-	-	-	-	-	-	-	-	-	1	1	-	-	2
Anotylus intricatus	-	-	1	-	-	-	-	-	-	-	1	-	-	1	-	1	2
Atheta palustris	-	-	1	-	-	-	-	-	-	1	-	-	-	1	-	1	2
Carpelimus nigrita	-	-	1	-	-	-	-	-	1	-	-	-	-	1	-	1	2
Hypomedon debilicornis	-	-	-	1	-	-	-	-	1	-	-	-	-	1	-	1	2
Trichiusa immigrata	-	-	-	1	-	-	-	-	-	1	-	-	-	1	-	1	2
Oligota punctulata	-	-	-	-	1	-	-	1	-	-	-	-	-	-	2	-	2
Tasgius globulifer evidentus	-	-	-	-	-	1	-	-	-	-	1	-	-	-	1	1	2
Astenus lyonessius	-	-	-	-	-	-	-	1	-	-	-	1	-	-	1	1	2
Oxypoda sp. 1	-	-	-	-	-	-	-	1	1	-	-	-	-	-	1	1	2
Stenus sp. 2	-	-	-	-	-	-	-	-	1	-	1	-	-	-	-	2	2
Carpelimus pusillus	-	-	-	-	-	-	-	-	1	-	-	1	-	-	-	2	2
Ocypus ophthalmicus	-	-	-	-	-	-	-	-	-	1	-	1	-	-	-	2	2
Rugilus orbiculatus	-	-	-	-	-	-	-	-	1	-	-	1	-	-	-	2	2
Stenus similis	-	-	-	-	-	-	-	-	1	-	-	1	-	-	-	2	2
Philonthus intermedius	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	2	2
Alianta bipartita	-	-	1	-	-	-	-	-	-	-	-	-	-	1	-	-	1
Mycetoporus nigricollis	-	-	1	-	-	-	-	-	-	-	-	-	-	1	-	-	1
Scopaeus sp.	-	-	1	-	-	-	-	-	-	-	-	-	-	1	-	-	1
Thecturota marchii	-	-	1	-	-	-	-	-	-	-	-	-	-	1	-	-	1
Oxypoda sp. 2	-	-	-	1	-	-	-	-	-	-	-	-	-	1	-	-	1
Quedius praecox	-	-	-	1	-	-	-	-	-	-	-	-	-	1	-	-	1
Stenus m. mendicus	-	-	-	1	-	-	-	-	-	-	-	-	-	1	-	-	1
Tinotus morion	1	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	1
Carpelimus siculus	-	1	-	-	-	-	-	-	-	-	-	-	1	-	-	-	1
Neohilara subterranea	-	1	-	-	-	-	-	-	-	-	-	-	1	-	-	-	1
Acrotona parvula	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	1	1
Atheta atramentaria	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	1	1
Mycetoporus reichei	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	1	1
Aleochara clavicornis	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	1	1
Amarochara forticornis	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	1	1
Atheta xanthopus	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	1	1
Bolitobius castaneus	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	1	1
Pycnota paradoxa	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	1	1
Achenium s. striatum	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	1	1
Achenium tenellum	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	1	1
Alaobia scapularis	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	1	1
Aloconota sulcifrons	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	1	1
Gyrohypnus fracticornis	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	1	1
Luzea nigritula	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	1	1
Outachyusa raptoria	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	1	1
Oxypoda carbonaria	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	1	1
Total specimens	37	28	177	145	68	66	46	25	426	137	196	248	65	322	205	1007	1599
Total species	20	17	42	39	21	24	23	16	57	41	40	46	27	59	42	81	97

Tab. 5.1 – Results of sampling with window traps. Number of specimens sampled per trap and per station.

5.1 Sampling analysis

As can be seen from table 5.1.1, more than 73% of the taxa (71 of 97) were sampled with a number of specimens lower than or equal to 9 and about 50% (49 of 97) with a number of specimens lower or equal to 3. The top 10 taxa in order of abundance (which include 66% of all specimens sampled) are shown in fig 5.1.1.

Num. of specimens	Num. of taxa	Cum. frequency
1	26	26,8
2	18	45,4
3	5	50,5
4	4	54,6
5	7	61,9
6	7	69,1
7	2	71,1
8	1	72,2
9	1	73,2
12	4	77,3
13	1	78,4
14	2	80,4
16	1	81,4
22	1	82,5
23	1	83,5
24	1	84,5
25	1	85,6
27	1	86,6
30	1	87,6
42	1	88,7
44	1	89,7
55	1	90,7
57	1	91,8
61	1	92,8
65	1	93,8
70	1	94,8
80	1	95,9
111	1	96,9
144	1	97,9
166	1	99
247	1	100

Tab. 5.1.1 – N. taxa relative to number of sampled specimens

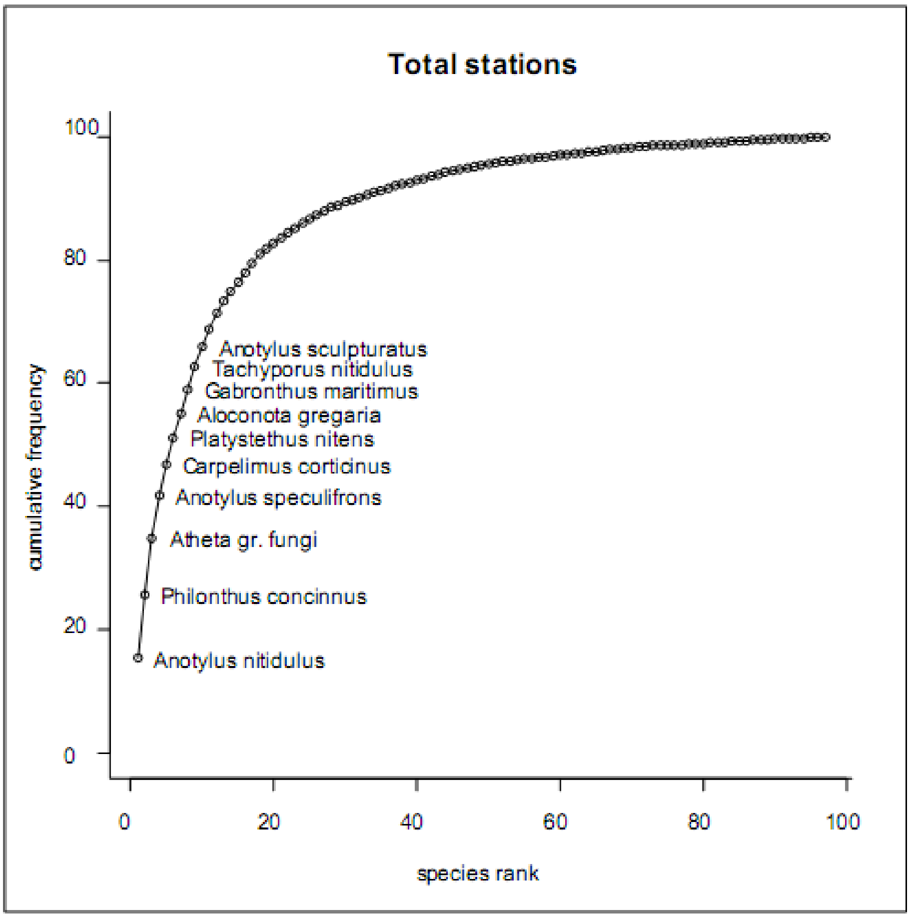


Fig. 5.1.1 – Species rankorder of total window traps sampling.

The values of the standard Skewnes (16.28) and Kurtosis (38.47) indicate that the data diverge from a normal distribution, as is outside the range of ± 2. This situation is also reflected in the individual stations.

Furthermore, the assumption of homoskedasticity is violated, as evidenced by the significant value of the index of Levene's (3.336 with $p = 0.0204$) relative to the whole sample.

These data, in violation of two of the main assumptions of the analysis of variance (homoskedasticity and data normal distribution) suggest to analyze them with non-parametric methods.

Table 5.1.2 shows the number of taxa sampled in each station, and the number of taxa exclusive of one, two or three stations, and those present in all stations.

			Shrub	Cane	Citrus	Track
Total			27	59	42	81
Exclusive			3	10	1	25
in common with	two stations	Shrub	-	1	0	1
		Cane	1	-	1	14
		Citrus	0	1	-	8
		Track	1	14	8	-
	tree stations	Shrub+Cane	-	-	0	1
		Shrub+Citrus	-	0	-	0
		Shrub+Track	-	1	0	-
		Cane+Citrus	0	-	-	11
		Cane+Track	1	-	11	-
		Citrus+Track	0	11	-	-
	All station		21	21	21	21

Tab. 5.1.2 – Number of taxa sampled in each station, and number of taxa exclusive of one, two or three stations, and number of taxa present in all stations.

The station that has sampled the largest number of taxa (83.5% of total) and exclusive taxa (25) is **Track**, while **Shrub** with just 27 taxa (27.8% of the total) is the one that has sampled the least number of taxa and **Citrus** that with the lowest number of exclusive taxa (1).

The taxa exclusive of a single station (tab. 5.1.3) are 39 (equal to 40% of the total of those sampled). They were collected more or less sporadically, 26 (more than 66% of the total) with only one specimen, 9 (23%) with two specimens, 2 with three specimens, 1 with five and 1 with six specimens.

Among these taxa 12 were sampled only with window traps and in particular in **Track**: *Achenium tenellum*, *Alaobia scapularis*, *Aleochara clavicornis*, *Bolitobius castaneus*, *Carpelimus pusillus*, *Philonthus intermedius*, *Pycnota paradoxa* and *Stenus similis*, in **Cane**: *Mycetoporus nigricollis*, *Quedius praecox* and *Stenus m. mendicus*, in **Shrub**: *Tinotus morion*.

20 taxa were sampled with the car-net, 4 also with the pit-fall traps and 3 both with car-net and pit-fall traps.

Taxa	Shrub	Cane	Citrus	Track	Total
Carpelimus siculus	1	-	-	-	1
Neohilara subterranea	1	-	-	-	1
Tinotus morion	1	-	-	-	1
Oligota punctulata	-	-	2	-	2
Oxypoda flavissima	-	6	-	-	6
Philonthus jurgans	-	2	-	-	2
Quedius pallipes	-	2	-	-	2
Alianta bipartita	-	1	-	-	1
Mycetoporus nigricollis	-	1	-	-	1
Oxypoda sp. 2	-	1	-	-	1
Quedius praecox	-	1	-	-	1
Scopaeus sp.	-	1	-	-	1
Stenus m. mendicus	-	1	-	-	1
Thecturota marchii	-	1	-	-	1
Achenium s. striatum	-	-	-	1	1
Achenium tenellum	-	-	-	1	1
Acrotona muscorum	-	-	-	5	5
Acrotona parvula	-	-	-	1	1
Alaobia scapularis	-	-	-	1	1
Aleochara clavicornis	-	-	-	1	1
Aloconota sulcifrons	-	-	-	1	1
Amarochara forticornis	-	-	-	1	1
Atheta atramentaria	-	-	-	1	1
Atheta xanthopus	-	-	-	1	1
Bolitobius castaneus	-	-	-	1	1
Gyrohypnus fracticornis	-	-	-	1	1
Luzea nigritula	-	-	-	1	1
Mycetoporus reichei	-	-	-	1	1
Ocypus ophthalmicus	-	-	-	2	2
Outachyusa raptoria	-	-	-	1	1
Oxypoda carbonaria	-	-	-	1	1
Oxypoda haemorrhoa	-	-	-	3	3
Philonthus intermedius	-	-	-	2	2
Pycnota paradoxa	-	-	-	1	1
Quedius levicollis	-	-	-	3	3
Rugilus orbiculatus	-	-	-	2	2
Stenus similis	-	-	-	2	2
Stenus sp. 2	-	-	-	2	2
Total species	3	10	1	25	39
Total specimens	3	17	2	39	61

Tab. 5.1.3 – Taxa exclusive to one station and number of specimens sampled.

The taxa sampled in all stations (tab. 5.1.4) are 21 (21.6% of total) with 1.048 specimens. Among them 17 were collected with car-net and pit-fall traps, 3 (*Anotylus complanatus*, *Atheta* (*Microdota*) sp. and *Planeustomus* sp. 1) also with car-net, 1 (*Myrmoecia* sp. 1) also with pit-fall traps and none only with window traps.

Other taxa to be mentioned as only collected with window traps are *Anotylus intricatus* and *Stenus brunnipes* sampled in **Track** and **Cane**, *Tasgius globulifer evidentus* sampled in **Track** and **Citrus** and *Platystethus degener* sampled in **Track**, **Citrus** and **Cane.**

Taxa	Shrub	Cane	Citrus	Track	Total
Anotylus nitidulus	7	39	21	180	247
Atheta gr. *fungi*	5	25	30	84	144
Anotylus speculifrons	12	35	5	59	111
Carpelimus corticinus	4	14	8	54	80
Platystethus nitens	1	20	6	43	70
Aloconota gregaria	1	17	4	43	65
Tachyporus nitidulus	3	14	9	31	57
Anotylus sculpturatus	2	8	1	44	55
Paraphloeostiba gayndahensis	1	2	24	17	44
Anotylus inustus	3	12	6	21	42
Amischa decipiens	4	5	4	17	30
Atheta aeneicollis	2	5	3	17	27
Pronomaea sicula	2	3	1	10	16
Atheta (*Microdota*) sp.	3	5	1	4	13
Oligota muensteri	1	1	2	8	12
Atheta mucronata	1	1	4	1	7
Xantholinus graecus	1	1	1	4	7
Anotylus complanatus	2	1	1	2	6
Planeustomus sp. 1	1	1	1	3	6
Sepedophilus nigripennis	1	2	1	1	5
Myrmoecia sp. 1	1	1	1	1	4
Total specimens	58	212	134	644	1048

Tab. 5.1.4 – Taxa and number of specimens sampled in all stations.

The table 5.1.5 shows the top 5 taxa in order of rank in each station.

Shrub	Cane	Track	Citrus
Anotylus speculifrons	*Anotylus nitidulus*	*Anotylus nitidulus*	*Atheta* gr. *fungi*
Anotylus nitidulus	*Anotylus speculifrons*	*Philonthus concinnus*	*Philonthus concinnus*
Atheta gr. *fungi*	*Atheta* gr. *fungi*	*Atheta* gr. *fungi*	*Paraphloeostiba gayndahensis*
Carpelimus corticinus	*Platystethus nitens*	*Anotylus speculifrons*	*Anotylus nitidulus*
Amischa decipiens	*Philonthus concinnus*	*Carpelimus corticinus*	*Tachyporus nitidulus*

Tab. 5.1.5 – Top 5 taxa in rank / order in the 4 stations investigated.

The most abundant species sampled, with the exception of *Philonthus concinnus,* are present in all stations where they occupy the first places in rank/order. In particular:

Anotylus nitidulus is the most abundant species sampled and is common to all the stations where it occupies the 1st place in rank /order in **Cane** and **Track**, the 2nd in **Shrub** and the 4th in **Citrus**.

Anotylus speculifrons is the fourth most abundant species sampled and is common to all the stations where he detains the 1st place in rank/order in **Shrub**, the 2nd in **Cane** and the 4th in **Track**, while in **Citrus** does not occupy any of the first five places in rank/order.

Atheta gr. *fungi* is the third most abundant taxon sampled and is common to all the stations where he occupies the 1st place in rank/order in **Citrus** and the 3rd in **Shrub**, **Cane** and **Track.**

Carpelimus corticinus is the fifth most abundant species sampled and is common to all stations where it occupies the 4th place in rank/order in **Shrub**, the 5th in **Track**, while in **Citrus** and **Cane** does not occupy any of the first five places in rank/order.

Philonthus concinnus is the second most abundant species sampled; was not sampled in **Shrub**, while in the other stations it occupies the 2nd place in rank/order in **Citrus** and **Track** and the 5th in **Cane**.

Amischa decipiens is the thirteenth most abundant species sampled and is common to all stations where it occupies the 5th place in rank/order in **Shrub**, while in the other does not occupy none of the first five places in rank/order.

Platystethus nitens is the sixth most abundant species sampled and is common to all stations where it occupies the 4th place in rank/order in **Cane**, while in the other does not occupy any of the first five places in rank/order.

Paraphloeostiba gayndahensis and *Tachyporus nitidulus* are respectively the eleventh and ninth most abundant species sampled and are common to all stations where they occupy respectively the 3rd and 5th place in rank/order in **Citrus**, while in the others do not take any of the first 5 places in rank/order.

The stations show a remarkable similarity with regard to the first five taxa in rank/order.

The Spearman rank correlation shows significant association between all the results of the pairwise referees except for **Shrub**/**Citrus** (fig. 5.1.5). The highest values of the Spearman index are found between **Citrus** and **Track** (0.6) and between **Cane** and **Track** (0.5) with high significance.

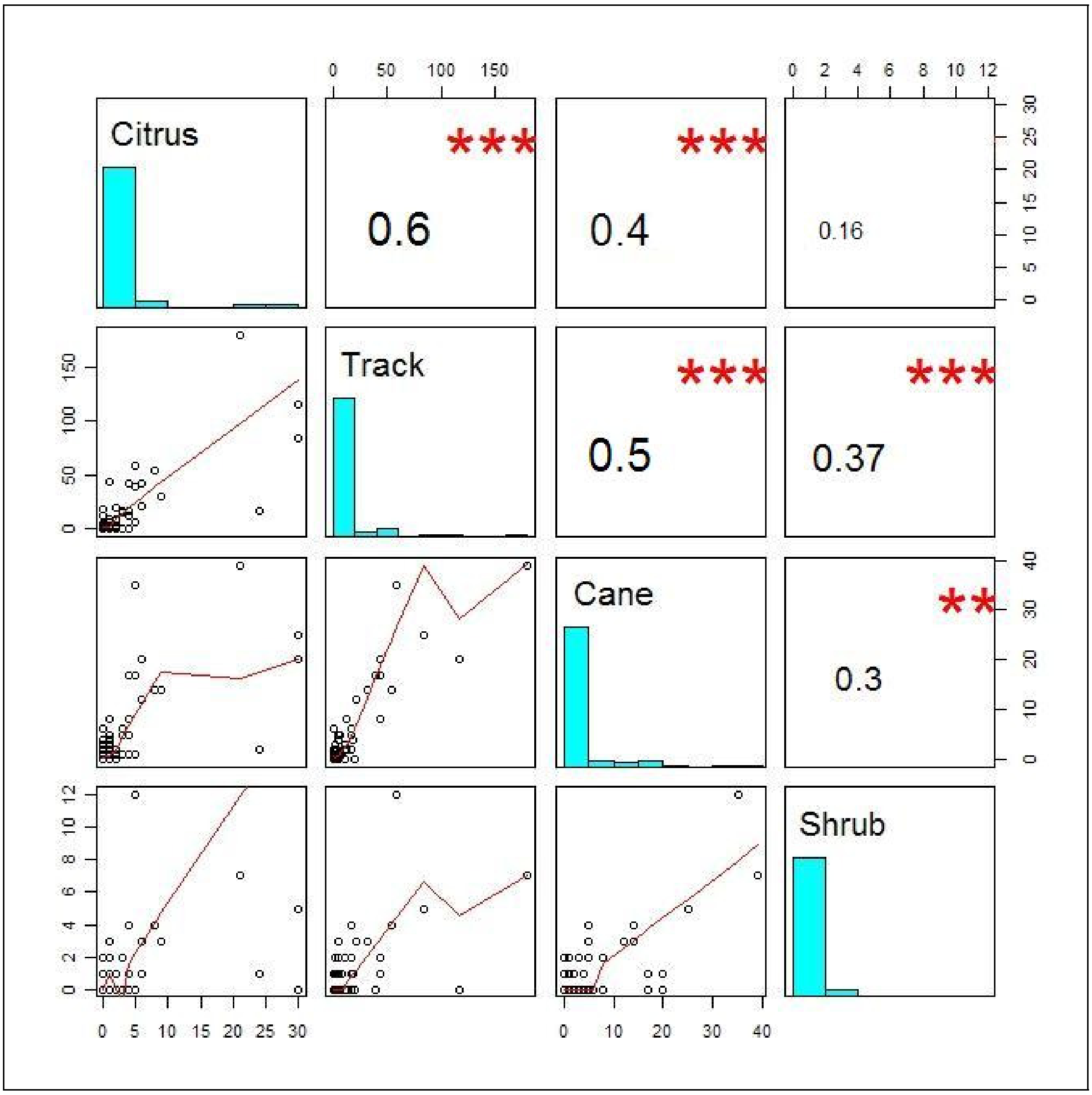


Fig. 5.1.5 - Spearman rank correlation between stations.

5.2 Staphylinidae flying activity in different environments

The windows traps were used to highlight any differences of Staphylinidae flying activity in different environments inside the research area.

It was tested the null hypotheses of absence of *a priori* structure within the full set of samples (here represented by the traps). For this purpose it was used the similarity profile test (SIMPROF) (fig. 5.2.1) The test was highly significant (sample statistic: Pi = 6,009; significance level = 0,01%; simulation permutations: 9999; number of permuted statistics greater than or equal to Pi: 0) so the null hypotheses is rejected.

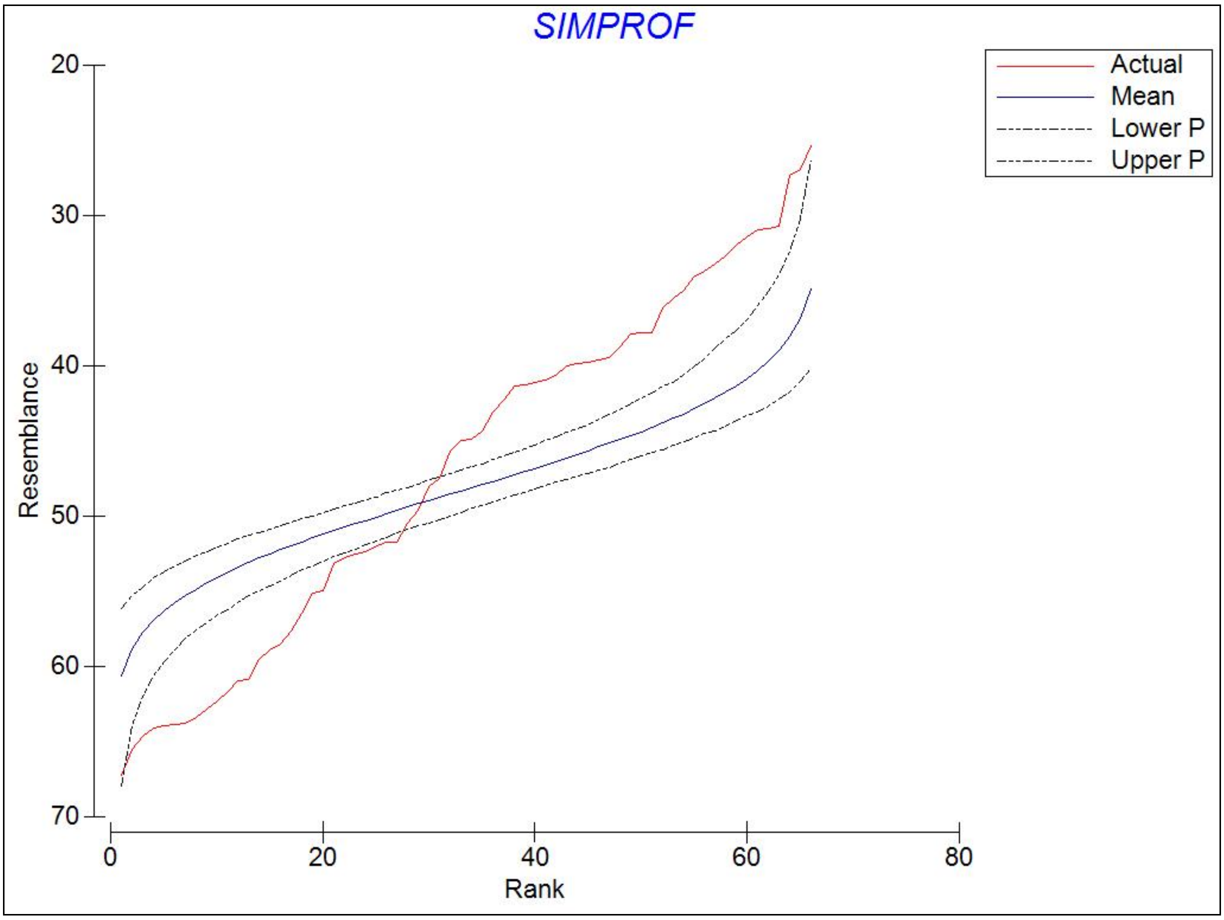


Fig. 5.2.1 - Similarity profile test: simulation permutations between the traps of different stations.

Test results can be easily interpreted by analyzing the dendrogram based on the Bray-Curtis similarity matrix. The dendrogram (fig. 5.2.2) shows three clusters significantly different (highlighted by blacklines). The first one groups **Track** and **Cane** traps, the second one **Shrub** traps and the third one **Citrus** traps.

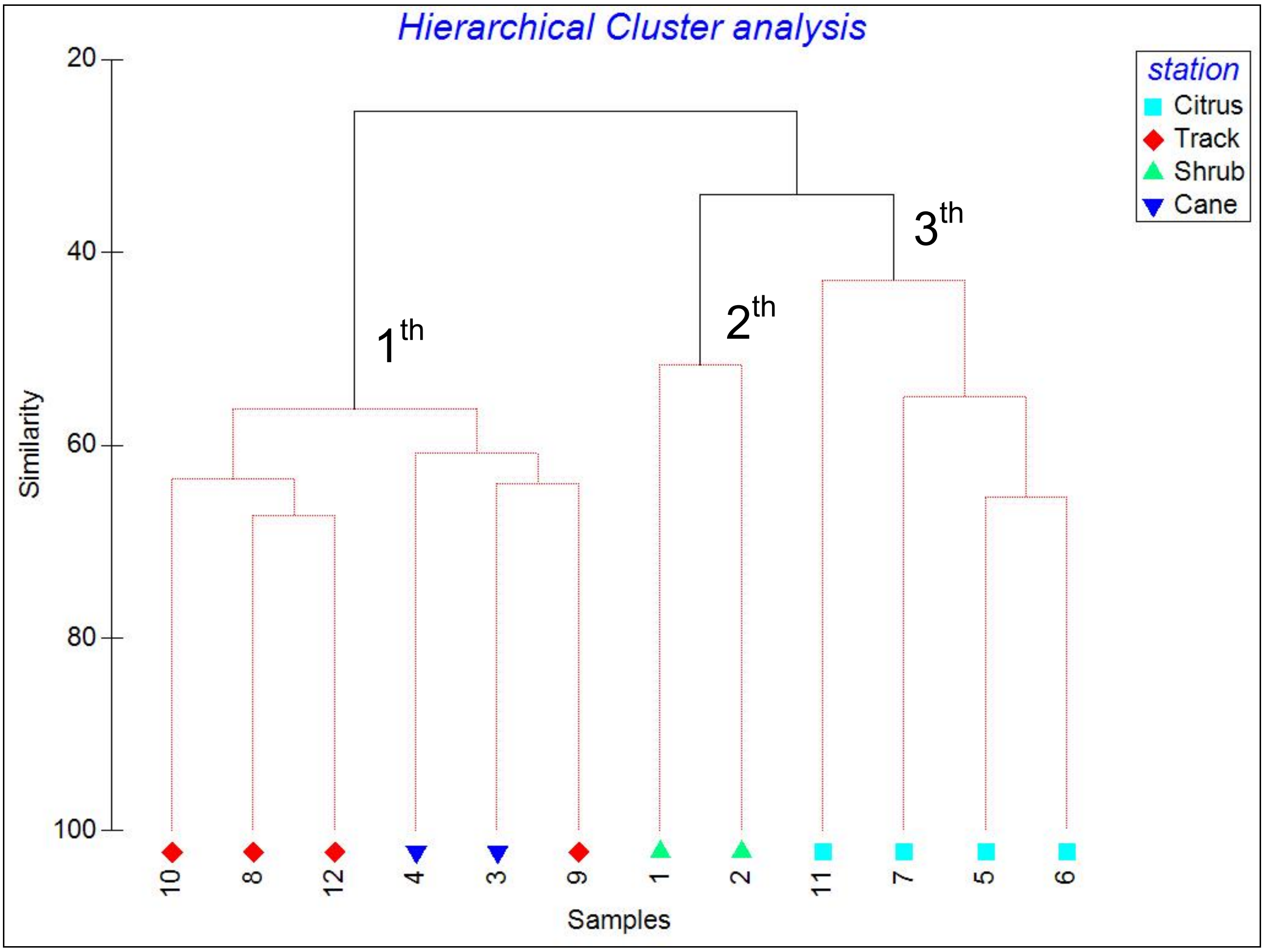


Fig. 5.2.2 – Dendrogram based on similarity index of Bray Curtis between the traps of stations investigated in relation to Staphylinidae taxa. The black lines show the clusters that are statistically significantly different (at least $p < 0,5\%$) according to the SIMPROF test.

The n-MDS (fig. 5.2.3) shows, in 2D, the same trap groups defined by the dendrogram, distinguished by figures with similarity always exceeding 40%.

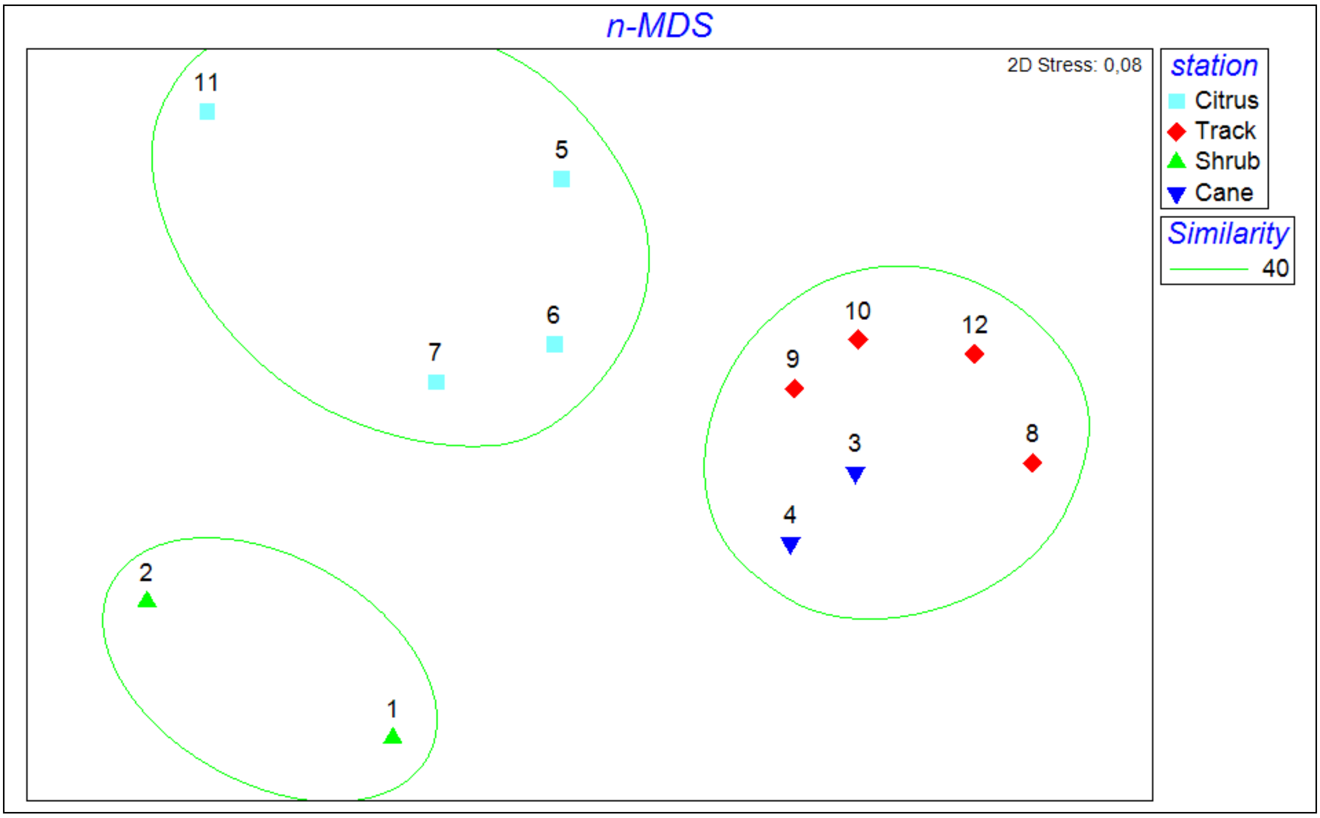
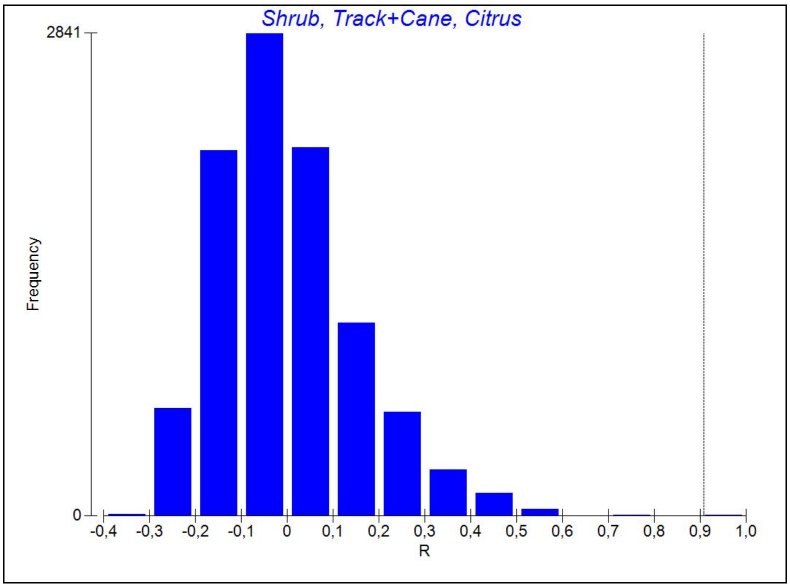


Fig. 5.2.3 – Nonmetric Multi Dimensional Scaling (NMDS) elaborated on the Bray Curtis similarity matrix between the traps of investigated stations, in relation to taxa of Staphylinidae (2 D vision).

Since it agreed that groups between traps are not random we used the ANOSIM test (always based on the matrix of Bray Curtis similarity index) to verify the hypothesis H_0 of no difference among groups of traps grouped by the cluster analysis (**Track+Cane**, **Shrub** and **Citrus**). The global test rejects the null hypothesis with high level of significance (fig. 5.2.4).



		Permutations	
R	Sign. Level %	N	N ≥ Observed
0.907	**0.02**	999	1

Fig. 5.2.4 - ANOSIM test: distribution of expected frequencies of R (histogram) compared with the observed value of R (**0,907**) (continuous line) between the traps of the stations investigated in relation to taxa of Staphylinidae. The traps of **Track** and **Cane** are considered together.

In the comparisons between pairs of traps (tab. 5.2.1) based on Pairwise tests are found high values of R among all groups of traps analyzed, but only in those comparisons **Track+Cane** versus **Citrus** and **Track+Cane** versus **Shrub** are significant. The not significant value of the comparison **Shrub** versus **Citrus** can not be considered as based on a too small number of permutations.

			Permutations	
Stations	R	Sign. Level %	N	N ≥ Observed
Shrub, Track+Cane	1	**3.6**	28	1
Shrub, Citrus	0,714	6.7	15	1
Track+Cane, Citrus	0,873	**0.5**	210	1

Tab. 5.2.1 – Results of ANOSIM Pairwise tests. The significance % refers to the number of values of R that fall within the range of expected frequencies compared to the total number of possible permutations. In **bold** the significative value.

As mentioned in materials and methods, the rational behind the ranking procedure in ANOSIM is that the information of interest is the relationship among the dissimilarities and not the value of dissimilarities themselves. To analyze these latter, we performed a PERMANOVA test both on the value of Bray-Curtis resemblance matrix and on the value of Euclidean resemblance matrix obtained from the standardized sampled value (tab. 5.2.2). These results are coincident with each other and with those of ANOSIM test and confirmed the difference between **Track+Cane** and **Citrus** and **Track+Cane** and **Shrub**.

	Bray-Curtis resemblance matrix				Euclidean resemblance matrix			
Global test	pseudo-F = 4.56 P (perm) = 0.0002				pseudo-F = 4.0834 P (perm) = 0.003			
Pairwise test:	t	P (perm)	Perm.	P (MC)	t	P (perm)	Perm.	P (MC)
Shrub, Track+Cane	2.4336	0.0348	28	**0.0057**	1.9732	0.036	28	**0.029**
Shrub, Citrus	1.5187	0.0701	15	0.1102	1.4078	0.133	15	0.137
Track+Cane, Citrus	2.2836	0.0047	210	**0.0028**	2.2282	0.006	207	**0.004**

Tab. 5.2.2 – Permanova test based on value of Bray-Curtis resemblance matrix and of Euclidean resemblance matrix obtained from the standardized sampled value. In bold the significative value of $p \leq 0.05$.

The difference between trap groups comes from quantitative differences, as we can infer from Shannon's index which are higher in **Track** and **Cane** than in **Citrus** and **Shrub** traps. Such differences, analyzed with ANOVA test, are significant at $p \leq 0.05$ (fig. 5.2.5).

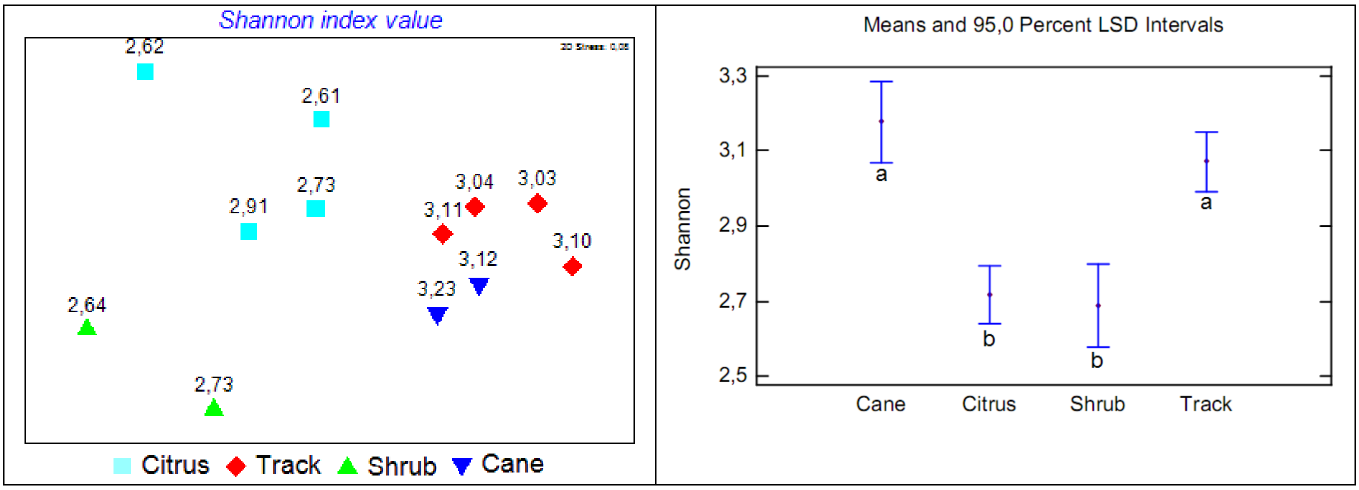


Fig. 5.2.5 – Shannon index value overlapped at n-MDS (right) and plot of means and 95% of LSD interval of Shannon's index of the four stations (left). The mean values indicated with different letters differ significantly at $p \leq 0.05$.

The difference between trap groups also comes from qualitative differences, as it is revealed by Margaleff's index (fig. 5.2.6) which shows similar relationship of the values respect to those reported by Shannon's index. Both indexes show results which are consistent with ANOSIM test.

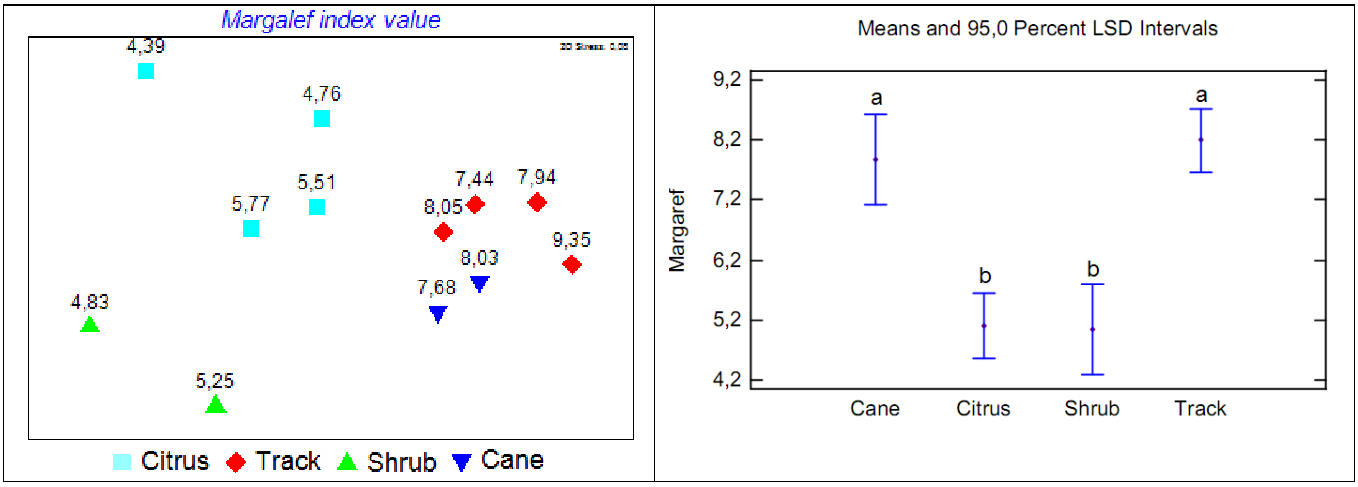


Fig. 5.2.6 – Margalef index value overlapped at n-MDS (right) and plot of means and 95% of LSD interval of Margalef's index of the four stations (left). The mean values indicated with different letters differ significantly at $p \leq 0.05$.

The average dissimilarity from **Tracks+Cane** to **Citrus** computed with SIMPER method is 57.20. In table 5.2.2 and fig. 5.2.7 are shown the thirteen taxa which most contribute (with percentage ≥ 2%) to determine about 40% of the dissimilarity between the stations. Of these only *Cordalia obscura* and *Amarochara ombrosa* turn out exclusives of **Track+Cane** and only *Paraphloestiba gayndahensis* is most abundant in **Citrus** than in **Track+Cane**.

		Average abundance					
	Species	Track+Cane	Citrus	Av Diss.	Diss/SD	Contrib%	Cum.%
1	*Anotylus nitidulus*	5,75	2,28	2,99	2,59	5,23	5,23
2	*Anotylus speculifrons*	3,7	0,98	2,4	2,19	4,19	9,42
3	*Anotylus sculpturatus*	2,57	0,25	2,05	1,43	3,59	13,01
4	*Aloconota gregaria*	3,04	0,84	1,93	2,38	3,38	16,39
5	*Platystethus nitens*	3,1	1,02	1,85	1,8	3,23	19,62
6	*Gabronthus maritimus*	2,97	0,98	1,76	2,56	3,08	22,7
7	*Philonthus concinnus*	4,48	2,69	1,72	1,49	3	25,7
8	*Carpelimus corticinus*	3,26	1,4	1,64	2,76	2,87	28,57
9	*Cordalia obscura*	1,75	0	1,54	3,16	2,69	31,26
10	*Atheta* gr. *fungi*	4,16	2,67	1,34	1,55	2,35	33,61
11	*Tachyporus nitidulus*	2,68	1,28	1,28	1,28	2,24	35,85
12	*Paraphloeostiba gayndahensis*	1,58	2,02	1,26	1,35	2,21	38,06
13	*Amarochara umbrosa*	1,37	0	1,19	3,21	2,09	40,15

Tab. 5.2.2 - Species which most contribute to average dissimilarity, based on Bray Curtis values, between **Citrus** and **Track+Cane** stations.

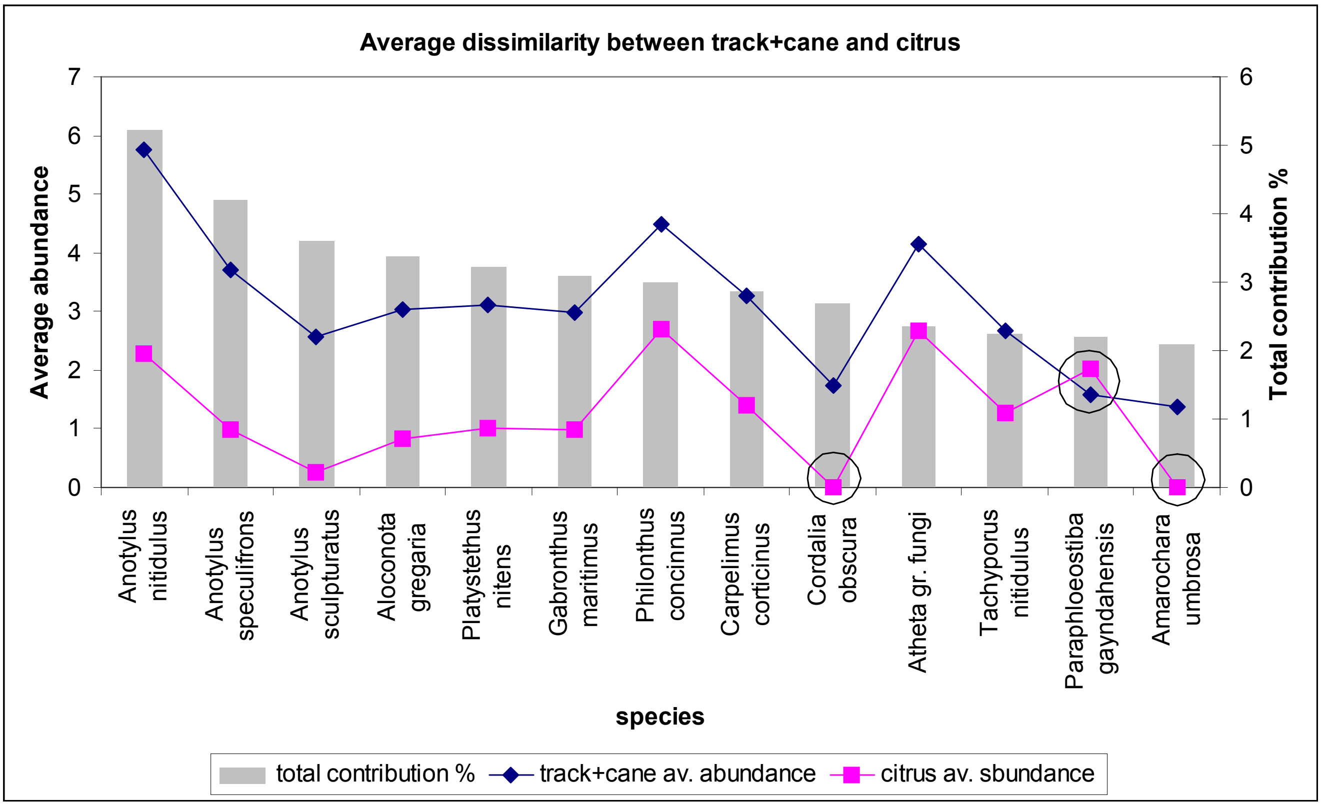


Fig. 5.2.7 – Most important species that contribute to average dissimilarity, based on Bray Curtis values, between **Citrus** and **Track+Cane** stations.

The results of Spearman rank correlation, that show a high similarity between the stations investigated, with the exception of the pair **Shrub/Citrus**, are only apparently incoherent with those shown by tests ANOSIM, Parwaise and PERMANOVA, which show significant differences between the stations investigated. The fig. 5.2.7 shows, in fact, how such differences depend mainly from the different capture frequencies of taxa more abundantly sampled in the two stations and not

from differences in quality of the two samples, although the number of taxa sampled sporadically (with 1-3 specimens) in one of the two stations contribute to emphasize these differences.
It can therefore formulate the hypothesis that the species of Staphylinidae flying inside and outside the citrus grove, at least as regards those most abundantly sampled, do not differ substantially. For these species outside the citrus grove it has been detected a higher number of catches, with the exception of *Paraphloestiba gayndahensis*. This may be explained by assuming that in open environments Staphylinidae have a more intense flying activity for the dynamic search of suitable sites for breeding, feeding, and resting. A second hypothesis may instead be linked to an higher visibility and attraction of the windows traps placed in open environments for flying insects than those located in densely wooded areas.

5.3 Flight monthly activity of Staphylinidae

The monthly distribution's analysis of capture's abundances and the species amount fig. 5.3.1 shows that the highest capture's frequencies and the largest species amount are recorded in the period between march and may, with a significant decrease in the period between June and Decembre, while in January we record the lowest capture's amount of species as well as of specimens. This month and February's one, when traps didn't be active (see materials and methods) haven't been used in the following analyses.

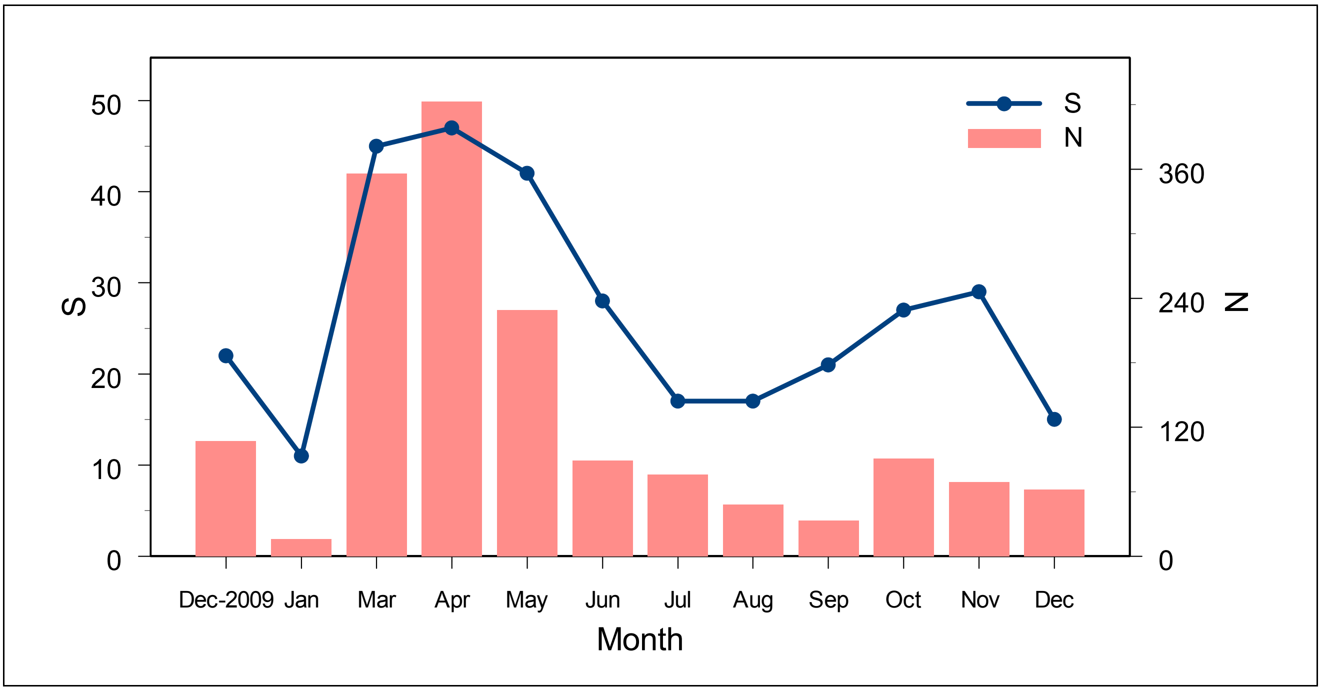


Fig. 5.3.1 – Number of species (S) and specimens (N) of Staphylinidae sampled with windows traps per month from January to December 2010.

Permanova test based on value of Euclidean resemblance matrix obtained from the montly number of specimens (N) and species (S) shows that the period March-May differs significatively from period of June-Septembre as well as from period Octobre-Decembre as concern the two analysed variables, while the two periods June-Septembre and Octobre-Decembre don't show significative differences.

	N Euclidean distance				S Euclidean distance			
Global test	pseudo-F = 24.39 P (perm) = **0.005**				pseudo-F = 4.0834 P (perm) **= 0.003**			
Pairwise test:	t	P (perm)	Perm.	P (MC)	t	P (perm)	Perm.	P (MC)
Mar-May, Jun-Sept	5,4964	0,032	35	**0,006**	7,2446	0,033	20	**0,002**
Mar-May, Oct-Dec	4,5139	0,091	10	**0,012**	4,8121	0,088	9	**0,007**
Jun-Sept, Oct-Dec	0,9782	0,408	32	0,357	0,71168	0,489	19	0,501

Tab. 5.3.1 – Permanova test based on value of Euclidean resemblance matrix obtained from the montly number of specimens (N) and species (S). In bold the significative value of p≤ 0.05.

Similarities between stations traps have been valuated by Bray-Curtis index and tested with ANOSIM in each period (tab. 5.3.2). The period March-May shows a high and significative R value, with stations clearly determined mainly for the comparison of Citrus and Track for which parwise test is significative. The period June-Septembre shows a significative R value, but strictly lower, with stations less clearly determined, with the comparison Citrus/Track carried out with parwise test which is still significative. The period Octobre-Decembre shows a low R value and not significative without a stations differenziation.

Sperman's rank correlation index between Citrus and Track's stations is highly significative for all the pairwise compared periods with the exception of June-Septembre.

	Anosim		
Groups	Global Test	Pairwise Tests	Sperman rank correlarion
Total	R: 0.701; P (perm) **0.1%**	Citrus, Track, R:0.77 P (perm) **2.9%**	Citrus, Track; **0.61** ***
Mar-May	R: 0.692; P (perm) **0.1%**	Citrus, Track, R:0.77 P (perm) **2.9%**	Citrus, Track; **0.56** ***
Jun-Sept	R: 0.467; P (perm) **0.9%**	Citrus, Track, R:0.59 P (perm) **2.9%**	Citrus, Track; 0.17 ns
Oct-Dec	R: 0.173; P (perm) 11..9%		Citrus, Track; **0.57** ***

Tab. 5.3.2 – Result of Anosim global and pairwise test performed on Bray-Curtis similarity matrix between the traps of investigated stations, and Sperman rank correlarion between Citrus and Track station. In bold the significative value at p≤ 0.05.

RESULTS

6 PIT-FALL TRAPS

For this analysis were used traps placed inside a plot of the citrus orchard (Citrus) and its margins (Citrus-Track-1 and Citrus-Track-2) and in an area of maquis (Shrub) contiguous to the orchard, in the months of May, and from mid-October to mid-December 2010.
Were sampled 745 specimens belonging to 60 taxa, 13 of which were collected only with this technique (tab. 6.1).

	Shrub				Citrus-Track2			Citrus				Citrus-Track1							
Taxa	01	02	03	04	16	17	18	09	10	11	12	13	14	15	S	CT2	C	CT1	Tot.
Ocypus o. olens	17	9	5	5	14	11	9	3	1	6	9	5	1	1	36	34	19	7	96
Megalinus glabratus	-	-	-	-	2	8	10	6	-	7	11	12	18	11	-	20	24	41	85
Paraphloeostiba gayndahensis	-	1	-	-	8	5	4	34	4	2	6	3	7	3	1	17	46	13	77
Atheta mucronata	8	3	2	1	2	1	-	5	4	5	6	8	3	3	14	3	20	14	51
Ocypus ophthalmicus	-	-	1	4	-	21	6	1	-	2	7	2	5	2	5	27	10	9	51
Cordalia obscura	-	-	-	-	6	2	4	1	-	2	2	11	8	2	-	12	5	21	38
Xantholinus graecus	2	1	-	1	-	6	-	1	1	-	7	6	8	4	4	6	9	18	37
Astenus lyonessius	-	-	-	-	3	2	2	1	-	2	1	12	3	5	-	7	4	20	31
Atheta gr. *fungi*	1	2	-	3	5	1	3	2	1	1	3	5	1	1	6	9	7	7	29
Quedius pallipes	-	-	-	-	1	2	2	1	-	1	1	4	1	10	-	5	3	15	23
Domene stilicina	-	-	-	-	2	1	1	1	2	1	2	4	3	4	-	4	6	11	21
Megarthrus bellevoyei	-	-	-	-	5	-	10	-	-	1	1	2	-	-	-	15	2	2	19
Atheta aeneicollis	-	-	-	-	2	2	2	2	1	2	3	1	1	2	-	6	8	4	18
Philonthus concinnus	-	-	-	-	4	1	-	2	-	1	4	2	1	2	-	5	7	5	17
Anotylus nitidulus	-	-	-	-	3	-	1	1	-	-	1	3	2	2	-	4	2	7	13
Geostiba plicatella	-	-	-	-	-	-	-	-	-	2	1	4	3	1	-	-	3	8	11
Aleochara bipustulata	-	-	-	-	1	-	-	4	-	1	-	1	-	1	-	1	5	2	8
Amarochara forticornis	-	-	-	-	-	1	1	1	-	1	2	2	-	-	-	2	4	2	8
Atheta coriaria	-	-	-	1	-	-	-	-	2	2	-	2	1	-	1	-	4	3	8
Gabronthus maritimus	-	-	-	-	1	-	-	1	-	-	1	3	1	-	-	1	2	4	7
Lepidophallus pseudohesperius	-	-	-	-	-	2	-	-	-	2	2	-	-	-	-	2	4	-	6
Tachinus flavolimbatus	-	1	-	-	3	-	-	-	-	-	-	-	2	-	1	3	-	2	6
Callicerus atricollis	-	-	-	-	1	-	-	1	-	1	1	1	-	-	-	1	3	1	5
Carpelimus corticinus	-	1	-	-	-	-	1	-	-	-	-	-	-	3	1	1	-	3	5
Sepedophilus marshami	1	1	1	1	-	-	-	-	-	-	-	-	1	-	4	-	-	1	5
Sepedophilus nigripennis	2	1	-	-	-	-	-	-	1	-	1	-	-	-	3	-	2	-	5
Anotylus sculpturatus	-	-	-	-	1	-	-	-	1	-	-	1	1	-	-	1	1	2	4
Atheta amicula	-	2	-	1	1	-	-	-	-	-	-	-	-	-	3	1	-	-	4
Oxypoda brevicornis	-	-	-	-	-	-	-	1	-	-	-	3	-	-	-	-	1	3	4
Aloconota gregaria	-	-	-	-	-	-	-	-	-	-	-	2	-	1	-	-	-	3	3
Amarochara umbrosa	-	-	-	-	1	-	-	-	-	1	-	1	-	-	-	1	1	1	3
Anotylus inustus	-	-	-	-	-	1	-	-	-	-	-	1	-	1	-	1	-	2	3
Atheta inquinula	-	-	-	-	1	-	-	-	-	2	-	-	-	-	-	1	2	-	3
Rugilus orbiculatus	-	-	-	-	-	-	1	-	-	-	-	-	2	-	-	1	-	2	3
Tachyporus nitidulus	-	-	-	-	-	-	-	1	-	-	-	1	1	-	-	-	1	2	3
Atheta oblita	-	1	-	-	-	-	-	-	-	-	-	1	-	-	1	-	-	1	2
Atheta orbata	-	-	-	-	-	-	-	-	-	-	-	1	1	-	-	-	-	2	2
Atheta testaceipes	-	-	-	-	1	-	-	-	-	-	-	-	-	1	-	1	-	1	2
Micropeplus staphylinoides	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-	2	-	2
Oligota muensteri	-	-	-	-	-	-	-	-	-	1	-	1	-	-	-	-	1	1	2
Oligota punctulata	-	-	-	-	-	-	-	-	1	-	-	1	-	-	-	-	1	1	2
Oxypoda lurida	-	-	-	-	-	-	-	-	-	1	1	-	-	-	-	-	2	-	2

Sunius algiricus	-	-	-	-	1	-	-	-	-	1	-	-	-	-	-	1	1	-	2
Tachyporus hypnorum	-	-	-	-	-	-	1	-	-	-	1	-	-	-	-	1	1	-	2
Tasgius pedator siculus	-	-	-	-	-	-	-	-	-	-	-	1	-	1	-	-	-	2	2
Anotylus speculifrons	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	1	-	-	1
***Astenus* sp.**	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	1	1
Atheta laticollis	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	1	-	-	1
Falagrioma thoracica	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	1	-	-	1
Gauropterus f. fulgidus	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	1	1
Notothecta inflata	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	1	1
Oligota parva	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	1	-	-	1
Oxypoda flavissima	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	1	1
Pella leonhardi	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	1	1
Platystethus nitens	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	1	-	-	1
Pronomaea sicula	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	1	1
Quedius caelebs	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	1	-	-	1
Quedius levicollis	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	1	-	1
Euryporus aeneiventris	-	1	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	1
Quedius semiobscurus	-	-	-	1	-	-	-	-	-	-	-	-	-	-	1	-	-	-	1

Total specimens	31	24	9	18	71	68	61	70	19	48	77	110	76	63	82	200	214	249	745
Total species	6	12	4	9	25	17	19	20	11	24	25	35	24	23	15	37	35	43	60

Tab. 6.1 - Results of sampling with pit-fall traps. Number of specimens sampled per trap and per station. The taxa sampled exclusively with this technique are highlighted in **red**.

6.1 Community analysis

In the analysis we excluded the trap PT-10 because it found partially damaged in two of three samples.

It was tested the null hypotheses of absence of *a priori* structure within the full set of samples (here represented by the traps). For this purpose the similarity profile test (SIMPROF) was used (fig. 6.1.1). The test was highly significant (sample statistic: Pi = 9.252; significance level = 0,01%; simulation permutations: 9999; number of permuted statistics greater than or equal to Pi: 0) so the null hypotheses is rejected.

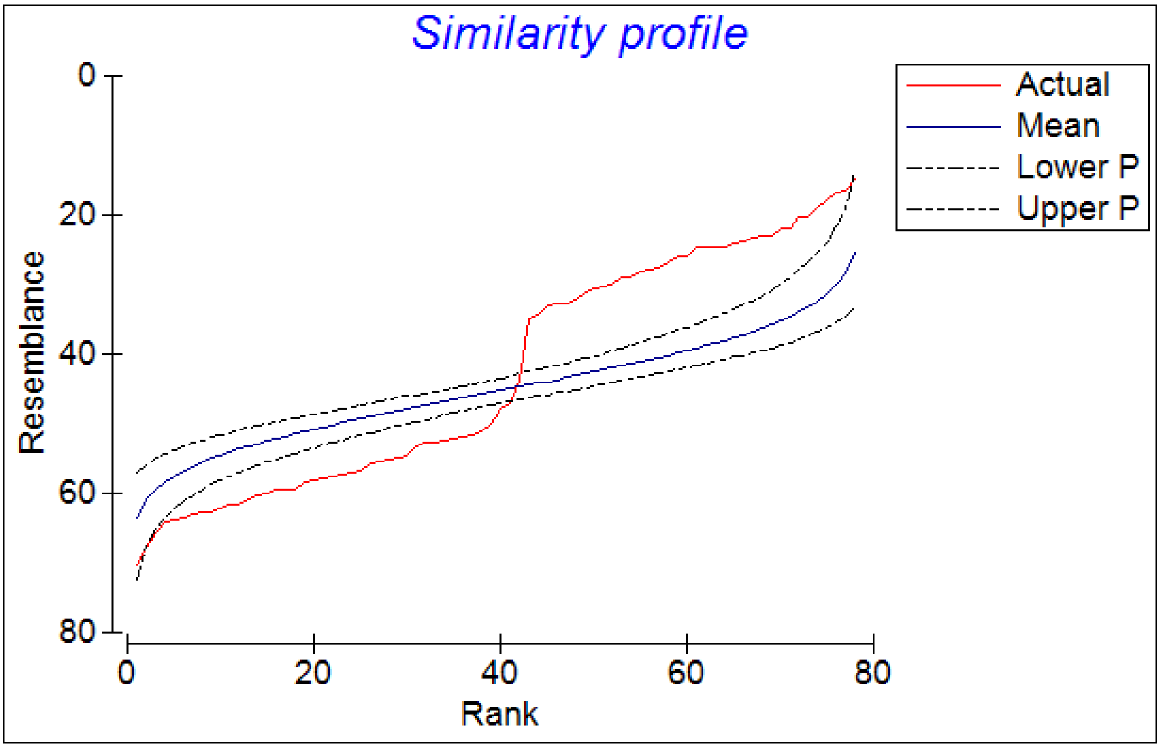


Fig. 6.1.1 - Similarity profile test: simulation permutations between the pit-fall traps of different stations.

Test results can be interpreted by analyzing the dendrogram based on the Bray-Curtis similarity matrix (fig. 6.1.2), that shows two clusters significantly different (highlighted by blacklines). The first one groups all **Shrub** traps, while the second one groups all **Citrus** traps.

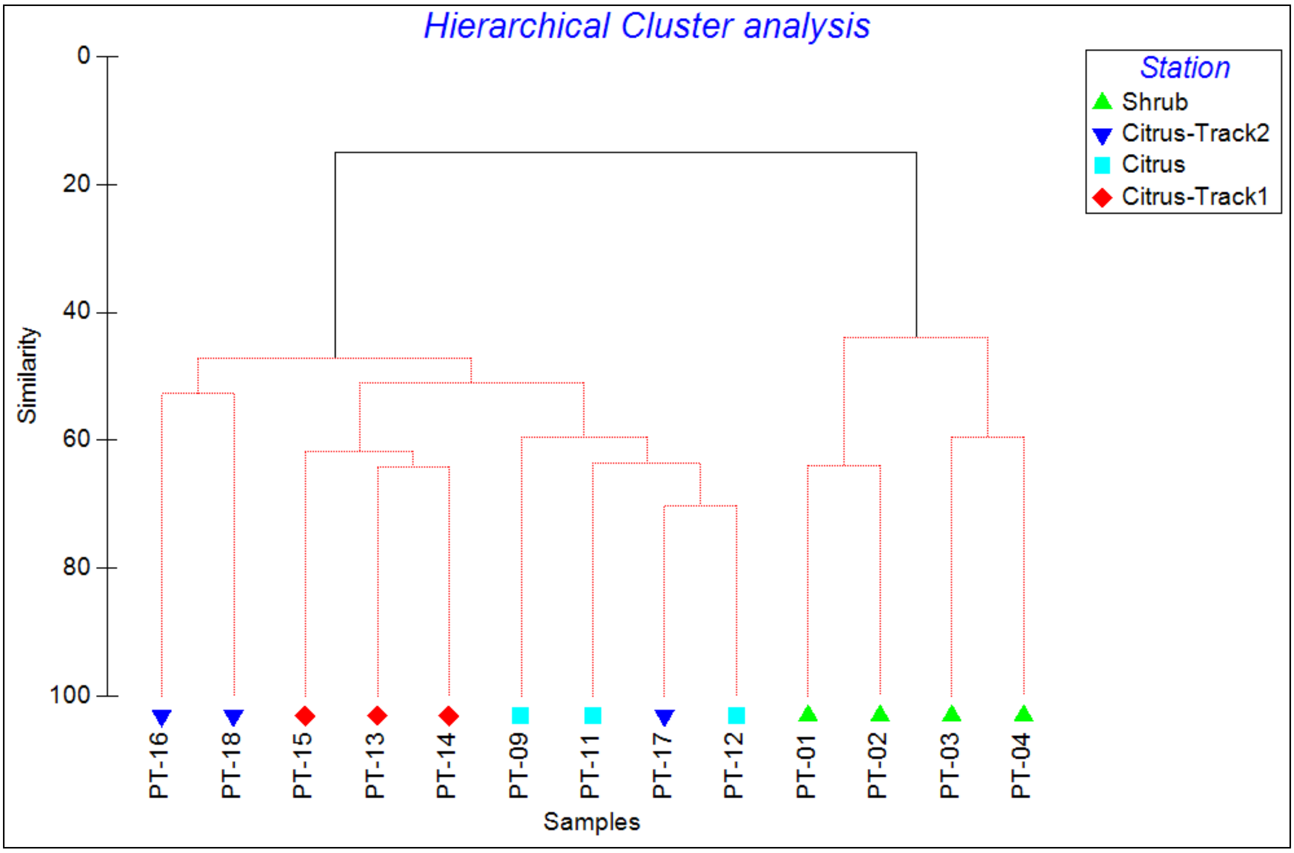


Fig. 6.1.2 – Dendrogram based on similarity index of Bray Curtis between the traps of stations investigated in relation to Staphylinidae taxa. The black lines show the clusters that are statistically significantly different (at least p <0,5%) according to the SIMPROF test.

The n-MDS (fig. 6.1.3) shows, in 2D, the same trap groups defined by the dendrogram and a clear separation of traps Shrub compared to others. The grouping of traps placed in the parcel of the citrus orchard and its margins, shows a separation of the traps placed in Citrus-Track 1 compared to the other.

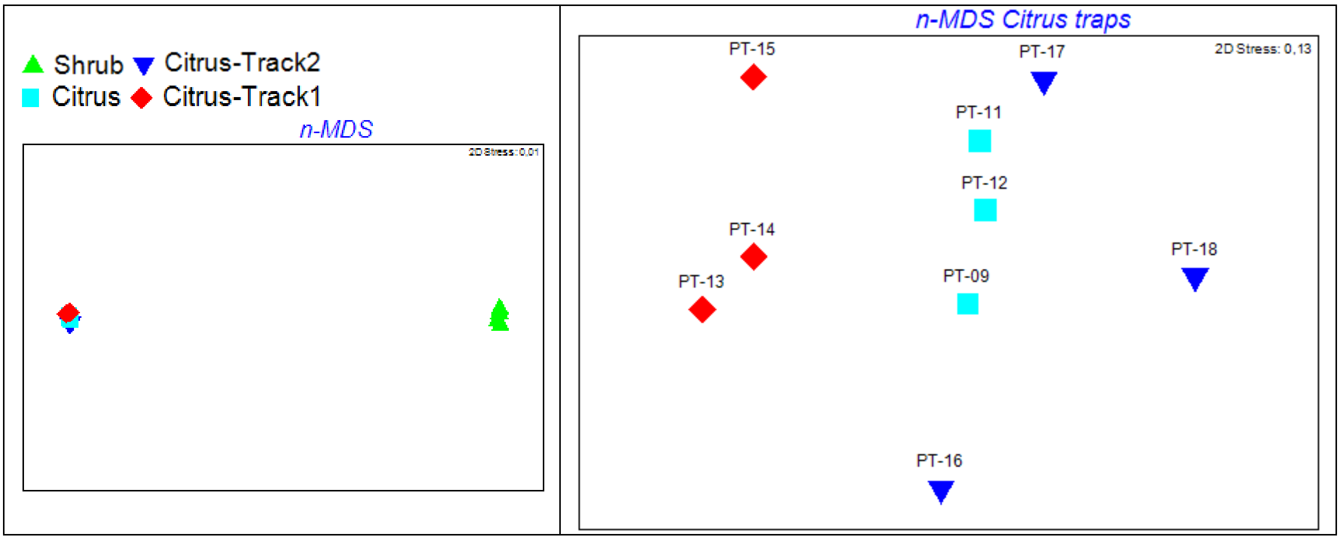
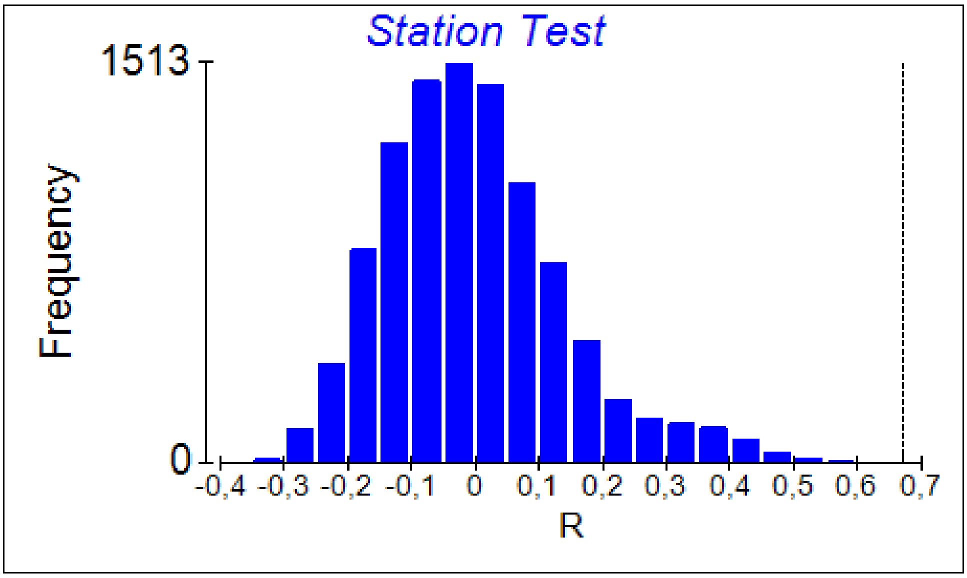


Fig. 6.1.3 – Nonmetric Multi Dimensional Scaling (NMDS) elaborated on the Bray Curtis similarity matrix between the traps of investigated stations, in relation to taxa of Staphylinidae (**left**). Subset of n-MDS between the Citrus traps (**right**).

We used the ANOSIM test (always based on the matrix of Bray Curtis similarity index) to verify the hypothesis H_0 of no difference among groups of traps of the four stations. The global test rejects the null hypothesis with high level of significance (fig. 6.1.4).



		Permutations	
R	Sign. Level %	N	N ≥ Observed
0.672	**0.01**	9999	0

Fig. 6.1.4 - ANOSIM global test: distribution of expected frequencies of R (histogram) compared with the observed value of R (**0,672**) (continuous line) between the traps of the stations investigated.

Considering the relation between pairs of traps (tab. 6.1.1) based on Pairwise tests, it is observed that all those of the **Shrub** and **Citrus** stations show values of R equal to 1 and are significant. As regards the comparisons between the stations of **Citrus**, **Citrus** versus **Citrus-Track2** shows a value of R very low (0.1); the other comparisons show a value of R greater than 0.5. However the significance values of R of all these comparisons cannot be taken into consideration because they are based on a too small number of permutations.

			Permutations	
Stations	R	Sign. Level %	N	N ≥ Observed
Shrub, Citrus-Track2	1	**2,9**	35	1
Shrub, Citrus	1	**2,9**	35	1
Shrub, Citrus-Track1	1	**2,9**	35	1
Citrus-Track2, Citrus	0,111	40	10	4
Citrus-Track2, Citrus-Track1	0,556	10	10	1
Citrus, Citrus-Track1	0,926	10	10	1

Tab. 6.1.1 – Results of ANOSIM pairwise tests. The significance % refers to the number of values of R that fall within the range of expected frequencies compared to the total number of possible permutations. In **bold** the significative value.

The analyzes show that there are no substantial differences between the taxa of Staphylinidae sampled in **Citrus**, **Citrus-Track1** and **Citrus-Track2**, while **Shrub** differs significantly from the first three. The latter station is characterized by the presence exclusive, although sporadic, of *Euryporus aeneiventris* and *Quedius semiobscurus* and by the absence of species frequently sampled in the other three stations: *Megalinus glabratus*, second species for frequencies capture, *Cordalia oscura, Astenus lyonessius, Quedius pallipes, Domene stilicina, Megarthrus bellevoyei, Atheta aeneicollis, Philonthus concinnus, Anotylus nitidulus* and *Geostiba plicatella.*

6.2 Comparison between window traps and pit-fall traps

The comparison between sampling with pit-fall traps and with windows traps is limited to the period in which both techniques were used at the same time (May, from mid-October to mid-December 2010).

The dendrogram of the similarity based on the matrix of Bray-Curtis (fig. 6.2.1) shows four clusters significantly different (highlighted by black lines). The first one groups all **Shrub** pit-fall traps, the second one groups all **Citrus, Citrus-Track1** and **Citrus-Track2** pit-fall traps, the third one groups two **Citrus** and one **Shrub** window traps, the last one groups all **Track+Cane** windows traps with one **Shrubs** and two **Citrus** window traps.

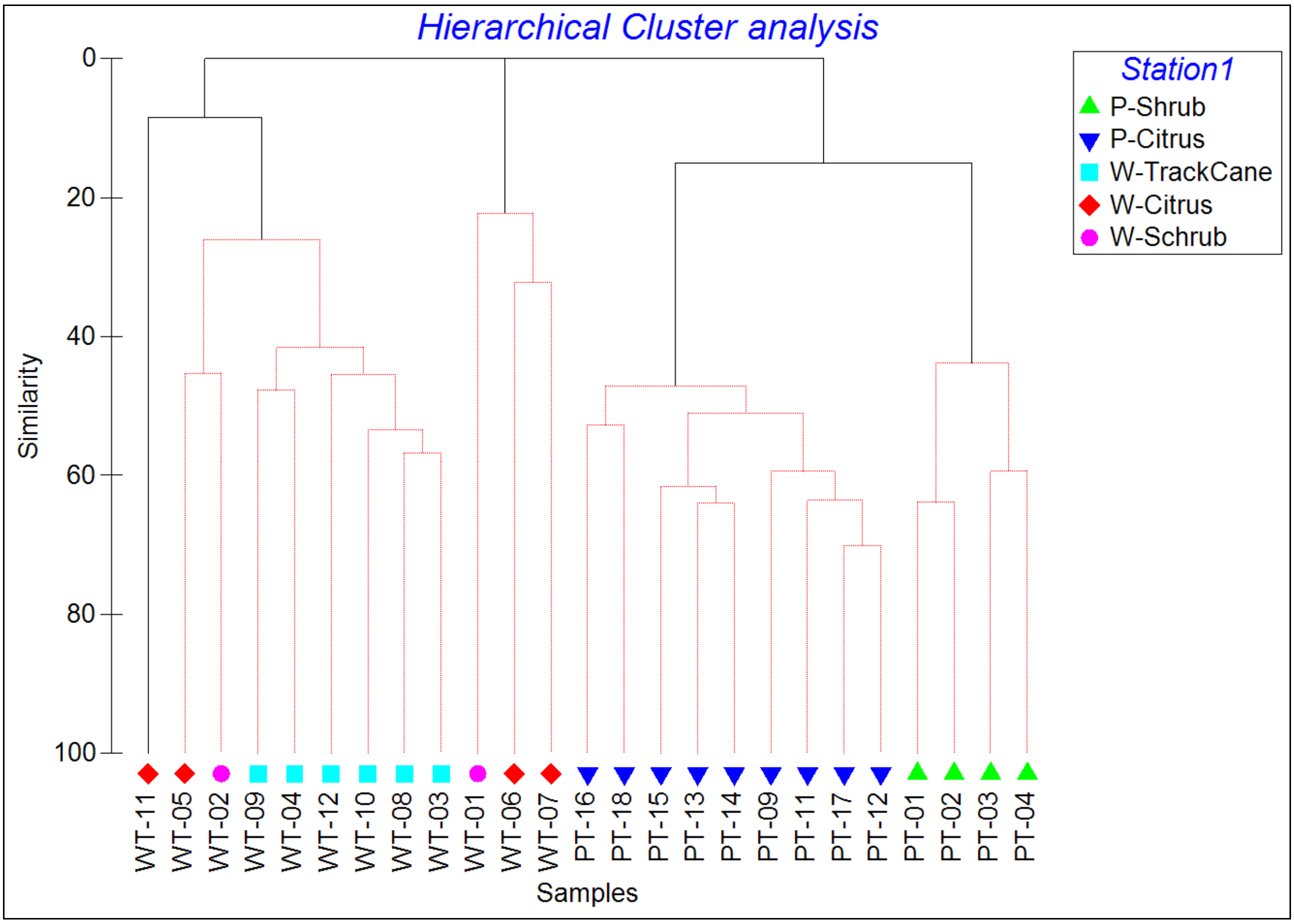


Fig. 6.2.1 – Dendrogram of values based on similarity index of Bray Curtis between pit-fall traps and window traps of stations investigated in relation to Staphylinidae taxa. The black lines show the clusters that are statistically significantly different (at least p <0,5%) according to the SIMPROF test.

The n-MDS (fig. 6.2.2) shows, in 2D, the same trap groups defined by the dendrogram and underlines the isolated position of WT11, that among all the traps window is the one that has sampled the least number of specimens (4) and of species.

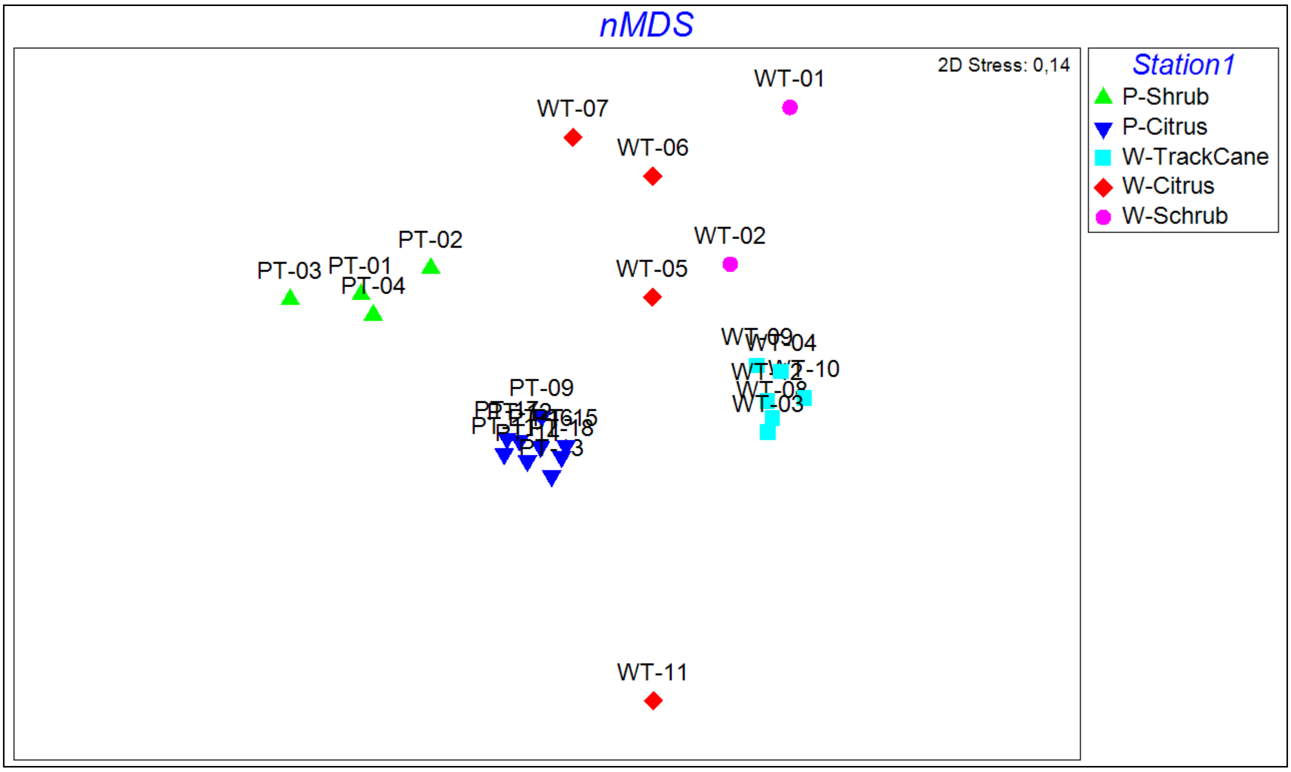
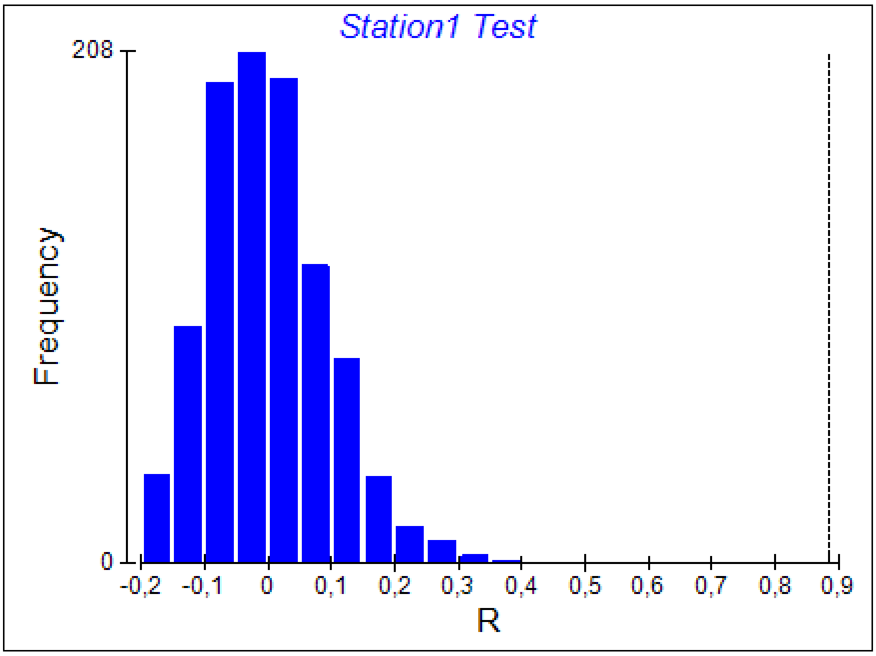


Fig. 6.2.2 – Nonmetric Multi Dimensional Scaling (NMDS) elaborated on the Bray Curtis similarity matrix between pitfall traps and window traps of investigated stations, in relation to taxa of Staphylinidae (2 D vision).

We used the ANOSIM test (always based on the matrix of Bray Curtis similarity index) to verify the hypothesis H_0 of no difference among groups of traps grouped by the cluster analysis. The global test rejects the null hypothesis with high level of significance (fig. 6.2.3).



		Permutations	
R	Sign. Level %	N	N ≥ Observed
0.885	**0.1**	999	0

Fig. 6.2.3 – ANOSIM global test: distribution of expected frequencies of R (histogram) compared with the observed value of R (**0,885**) (continuous line) between traps of the stations investigated with pit-fall traps and window traps in relation to taxa of Staphylinidae.

In comparisons between pairs of traps (tab. 6.2.1) based on Pairwise test occur high values of R (≥ 0.7) among all groups of traps analyzed, with the exception of the comparison **Window-Citrus** versus **Window-Schrub,** that however can not be considered because based on a too small number of permutations. All other comparisons are significant with the exception of the value R of the comparison **Pit-fall-Shrub** versus **Window-Schrub**, that also in this case cannot be considered as based on a too small number of permutations.

			Permutations	
Stations	R	Sign. Level %	N	N ≥ Observed
P-Shrub, P-Citrus	1	**0,1**	715	1
P-Shrub, W-TrackCane	1	**0,5**	210	1
P-Shrub, W-Citrus	0,74	**2,9**	35	1
P-Shrub, W-Schrub	0,821	6,7	15	1
P-Citrus, W-TrackCane	1	**0,1**	999	0
P-Citrus, W-Citrus	0,848	**0,1**	715	1
P-Citrus, W-Schrub	0,967	**1,8**	55	1
W-TrackCane, W-Citrus	0,706	**0,5**	210	1
W-TrackCane, W-Schrub	0,875	**3,6**	28	1
W-Citrus, W-Schrub	-0,161	60	15	9

Tab. 6.2.1 – Results of ANOSIM pairwise tests. The significance % refers to the number of values of R that fall within the range of expected frequencies compared to the total number of possible permutations. In **bold** the significative value.

The differences among the catches made by the two different sampling techniques analyzed with PERMANOVA (based on the Euclidean resemblance matrix obtained from the standardized sampled value) result statistically significant (Pseudo-F = 6,66; P-perm = 0,001).
The average squared distance from the groups of pit-fall traps and windows traps computed with SIMPER method is 515,18. In tab. 6.2.2 and in fig. 6.2.4 are shown the fifteen taxa which

contribute to determine more than 90% of the average squared distance between the two different sampling techniques. Among these only *Ocypus o. olens* results exclusive of pit-fall traps, and none of these species has been collected exclusively with window traps.

		Sampling techniques					
	Species	Pit-fall-tr	Window-tr	Av.Sq.Dist	Sq.Dist/SD	Contrib%	Cum.%
1	*Anotylus nitidulus*	0,929	7,25	91,4	0,73	17,73	17,73
2	*Paraphloeostiba gayndahensis*	5,5	1,83	90,6	0,34	17,59	35,32
3	*Ocypus o. olens*	6,86	0	69,4	0,85	13,48	48,79
4	*Megalinus glabratus*	6,07	1,17	58,1	0,75	11,28	60,08
5	*Ocypus ophthalmicus*	3,64	8,33E-02	41	0,37	7,95	68,03
6	*Atheta mucronata*	3,64	0,417	17,5	0,86	3,39	71,42
7	*Cordalia obscura*	2,71	0,25	17,2	0,53	3,34	74,76
8	*Xantholinus graecus*	2,64	8,33E-02	14,6	0,7	2,83	77,59
9	*Astenus lyonessius*	2,21	0,167	13,8	0,39	2,68	80,26
10	*Carpelimus corticinus*	0,357	2,17	10,9	0,42	2,12	82,38
11	*Megarthrus bellevoyei*	1,36	0,167	9,07	0,36	1,76	84,14
12	*Quedius pallipes*	1,64	0,167	8,83	0,36	1,71	85,85
13	*Platystethus nitens*	7,14E-02	1,83	8,81	0,5	1,71	87,56
14	*Atheta* gr. *fungi*	2,07	2,67	8,79	0,57	1,71	89,27
15	*Tachyporus nitidulus*	0,214	1,75	7,88	0,46	1,53	90,8

Tab. 6.2.2 - Species which most contribute to average squared distance based on the Euclidean resemblance matrix between pit-fall traps and windows traps groups.

Figure 6.2.4 shows how the two sampling techniques differ substantially for the different frequencies of taxa captures, with the exception of the already mentioned *Ocypus o. olens*, sampled only with pit-fall traps and with relatively high frequencies of capture.

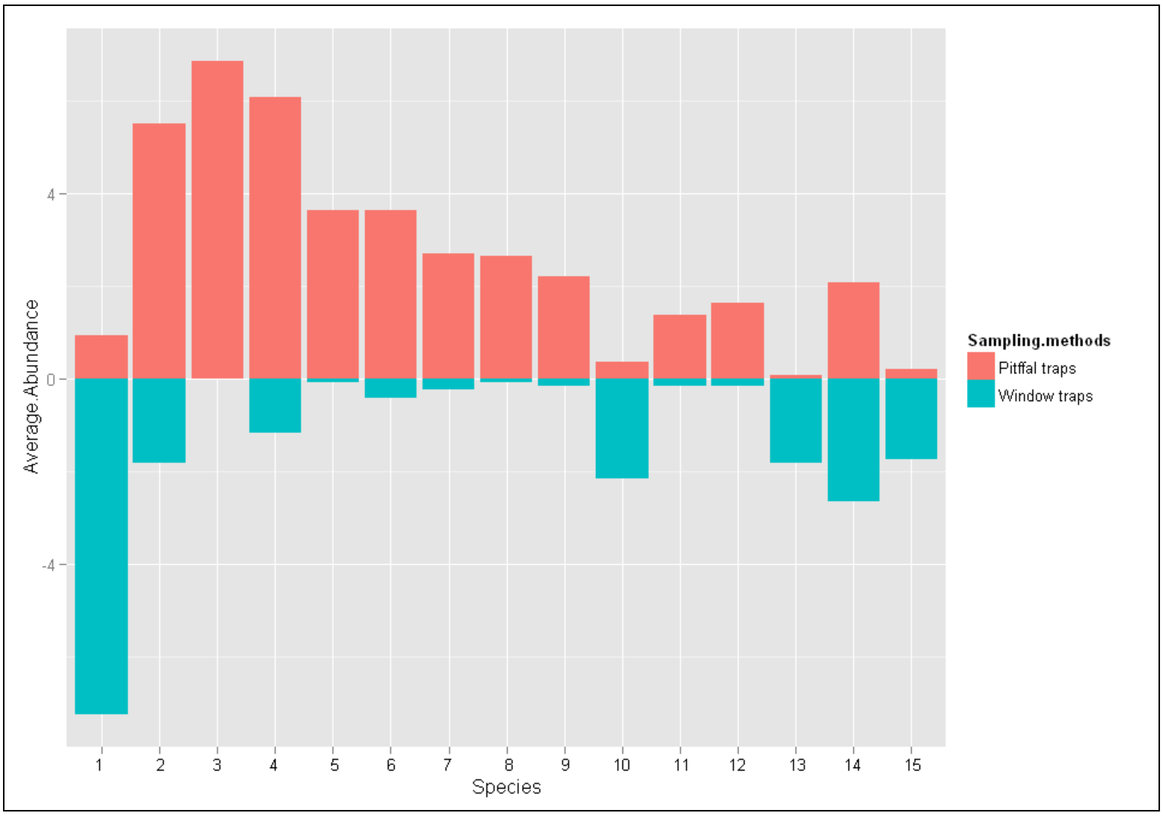


Fig. 6.2.4 - Species which most contribute to average squared distance based on the Euclidean resemblance matrix between pit-fall traps and windows traps groups. Numbers refer to the species in tab 6.2.2

Regarding the species of Staphylinidae more abundantly sampled, it can be assumed that, at least during the periods of the year taken into consideration, they live on the ground and apply the flying to perform displacements related to the search of suitable sites for feeding and reproduction. Among these, some species such as *Anotylus nitidulus, Carpelimus corticinus* and *Atheta* gr. *fungi*, show a flying activity more conspicuous, which is confirmed by the data of monthly car-net (see par. 4.4).

Results

7 Hourly car-net

7.1 Preliminary analysis of temperature and wind speed

Temperature

As regard the diurnal temperatures, the range of variation during the sampling days with hourly car-net was 36.12 °C with a minimum value of 1.18 °C and a maximum of 37.3 °C. The average daily temperature was of 20.7 °C with a median of 20.9 °C, and 50% of the values of the temperature fall between 15.9 °C and 25.2 °C (fig. 7.1.1).

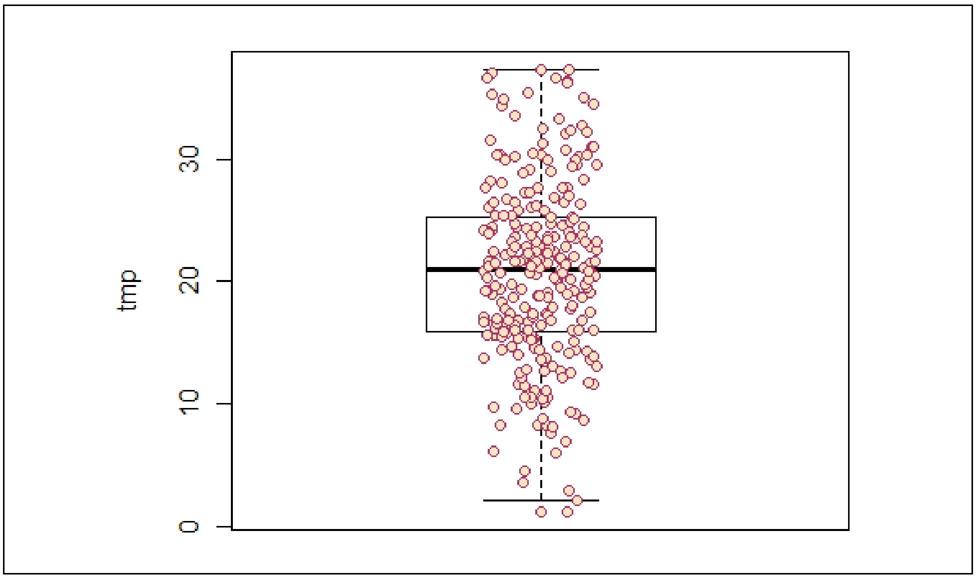


Fig. 7.1.1 - Box and whisker plot of the values of the diurnal temperature recorded during the sampling with hourly car-net.

The general trend of the catches with the hourly car-net in relation to the values of the diurnal temperature is represented in fig. 7.1.2. The temperature range in which catches are recorded is between 8.2°C and 37.3°C, with a concentration between 18°C and 25°C.

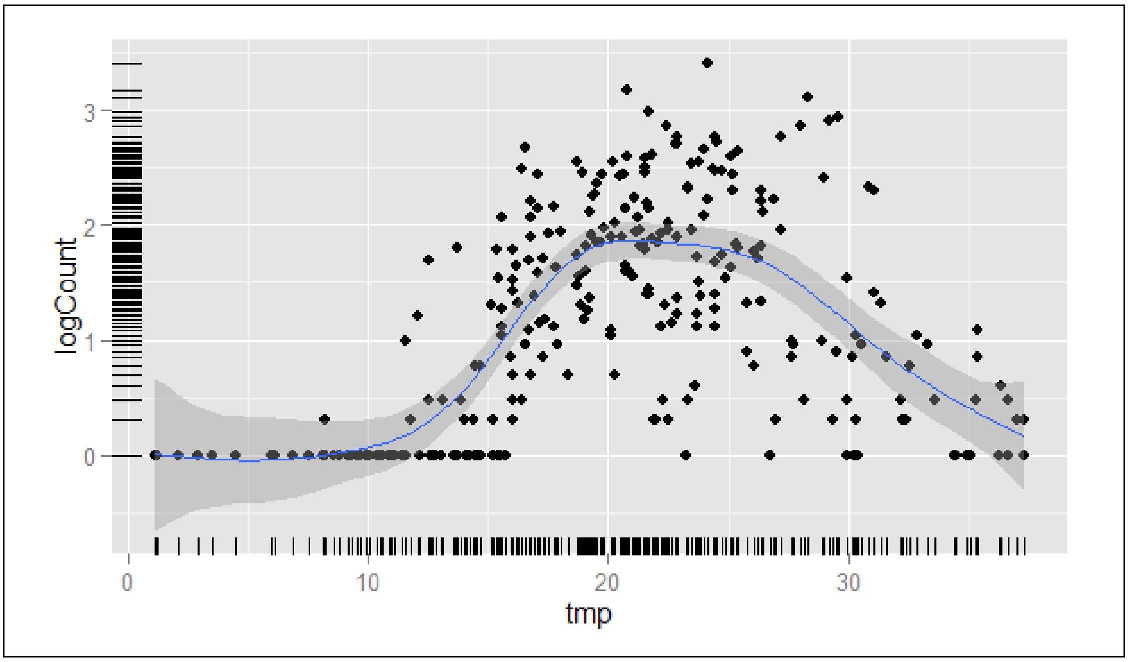
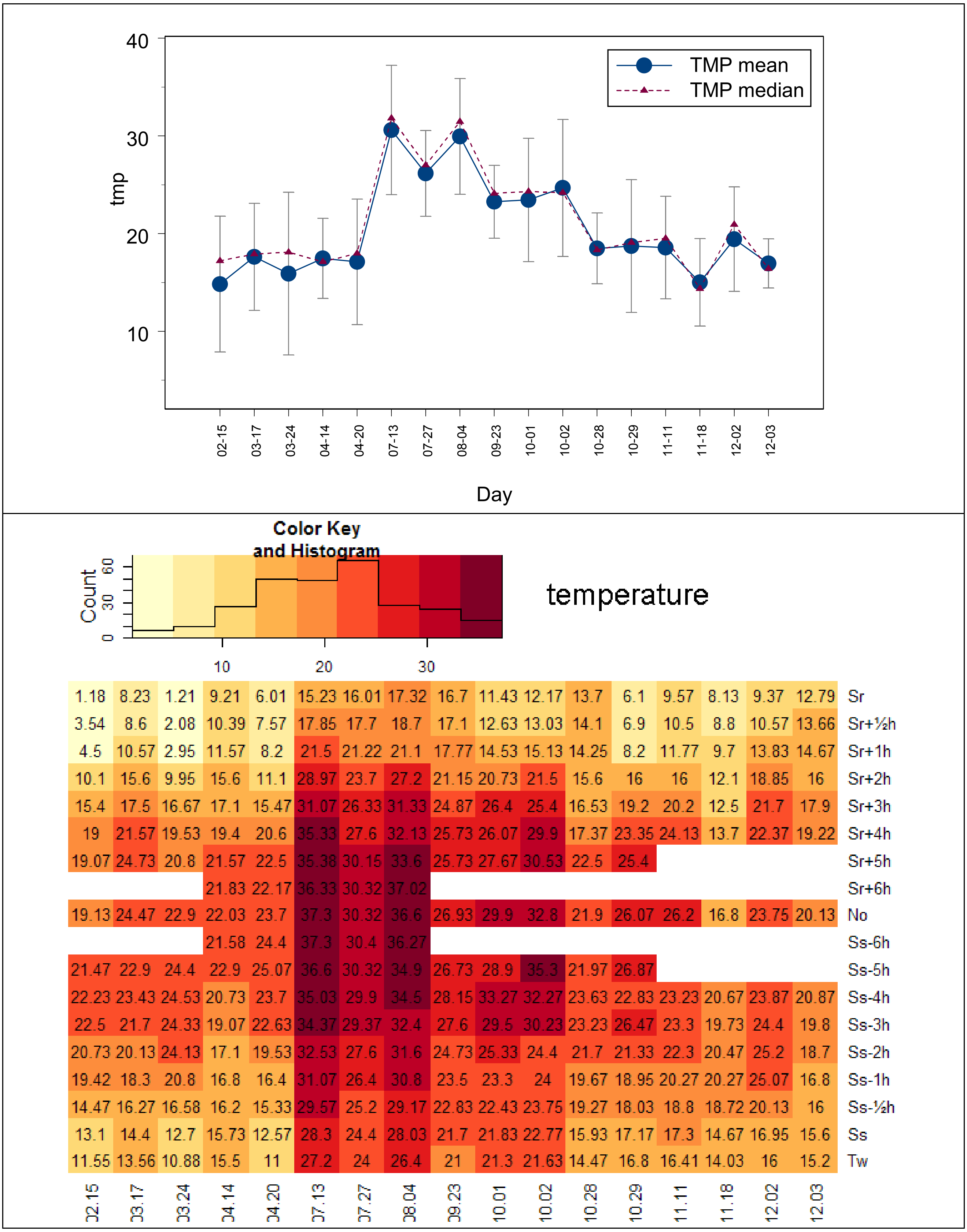


Fig. 7.1.2 - Scatter plot of diurnal temperature value versus log transformed catch values. The solid line is the smoother and light gray band is the 95% confidence interval. Smoothing df = 6.696; F = 36.18; p-value = <2e-16 ***

The figure below (fig. 7.1.3) shows the trend of the mean values and medians of diurnal temperature for sampling dates and the heat map with the values of the diurnal temperature.



7.1.3 - Trend of mean values and medians for sampling dates with hourly car-net and heat map with the values of the diurnal temperature.

The classification tree was used to identify in sampling with hourly car-net any homogeneous groups of dates based on the values of the diurnal temperature and significantly different between them. The regression tree has identified three terminal nodes significantly different (p <0.01) (fig. 7.1.4).
The first cluster includes the days of summer and early-autumn (from day 07-13 to day 10-02), within this grouping is possible to identify two terminal nodes separating (node3) hottest days (07-13; 08-04) than (node 4) with lower temperatures (07-27, 09-23, 10-01, 10-02); the second cluster with a single terminal node (node5) groups the days of late-autumn, winter and early-spring (from day 10-28 to day 04-20).

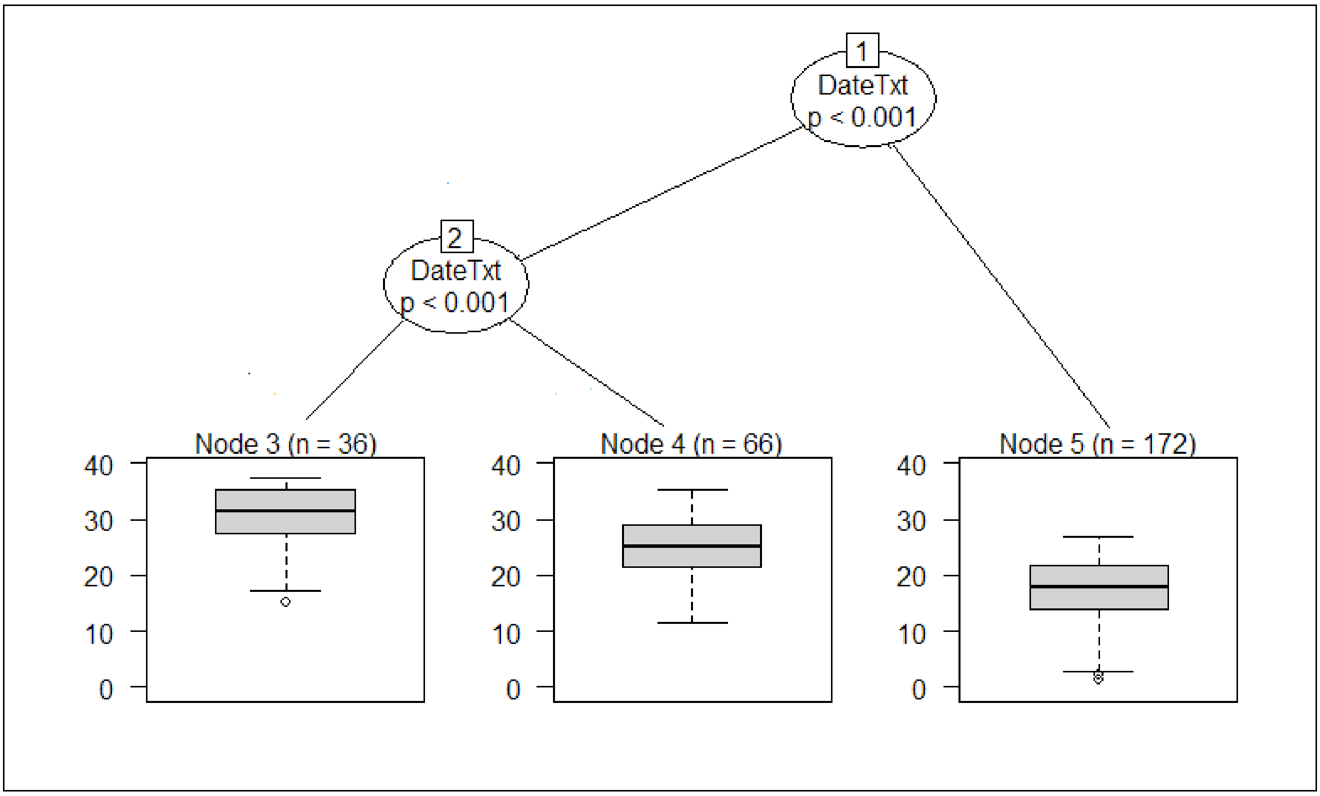


Fig. 7.1.4 – Classification tree of sampling dates in relation to diurnal temperatures recorded during the sampling with hourly car-net.

The box plots in fig. 7.1.5 shows the relationships between the values of the temperature and the frequencies of capture recorded in each sampling period.

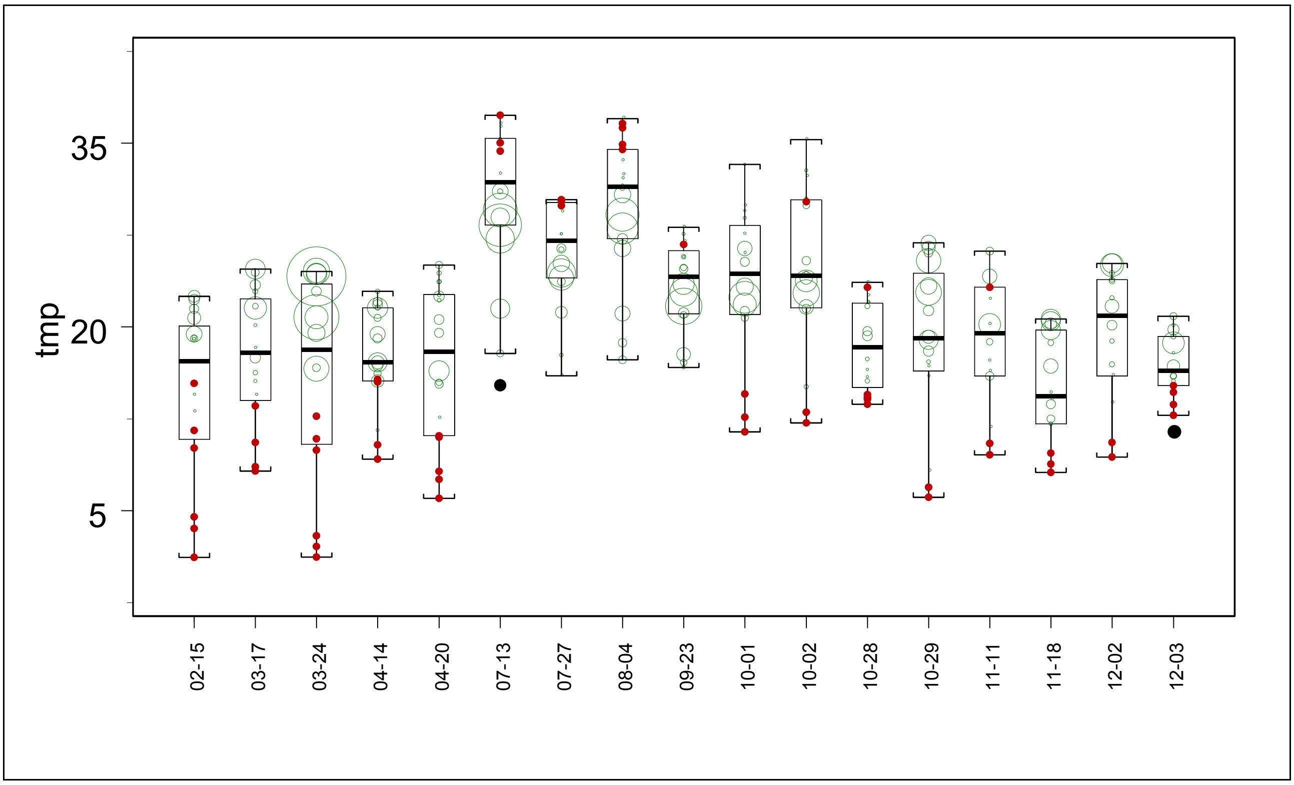


Fig. 7.1.5 –Box plot of the values of the diurnal temperature for sampling dates. The bubble plot of the frequency of capture (green circles) were overlaid to temperature values. The red dots (●) indicate the temperature values for which no catches were registered, the black points (●) the outlier values of temperature.

On summer days, the most abundant amount of catches are observed at temperatures below or close to the median, and generally in those falling in the bottom tails as well, while for many higher temperatures falling in the up tails, there are no catches registered. In the remaining days, the most abundant amount of catches are recorded at temperatures greater than or close to the median, while at lower temperatures, especially those falling in the bottom tails, catches are generally absent (see red dots in the graph).

Taking into consideration the values of the temperature in relation to the hourly segments (fig. 7.1.6), as expected, the highest ones are observed in the central hours of the day. At sunrise and at one hour after sunrise, in general, there are catches registered only when the temperature shows values above the median and falling in the up tail. Tendency the abundance of the catches is closer to the median in the central hours of the morning and then concentrate in the first quartile and the bottom tail in the middle of the day. In the late afternoon catches are distributed throughout the temperature range, while at the sunset and dusk they concentrate on higher values of temperature, which fall into the up tail.

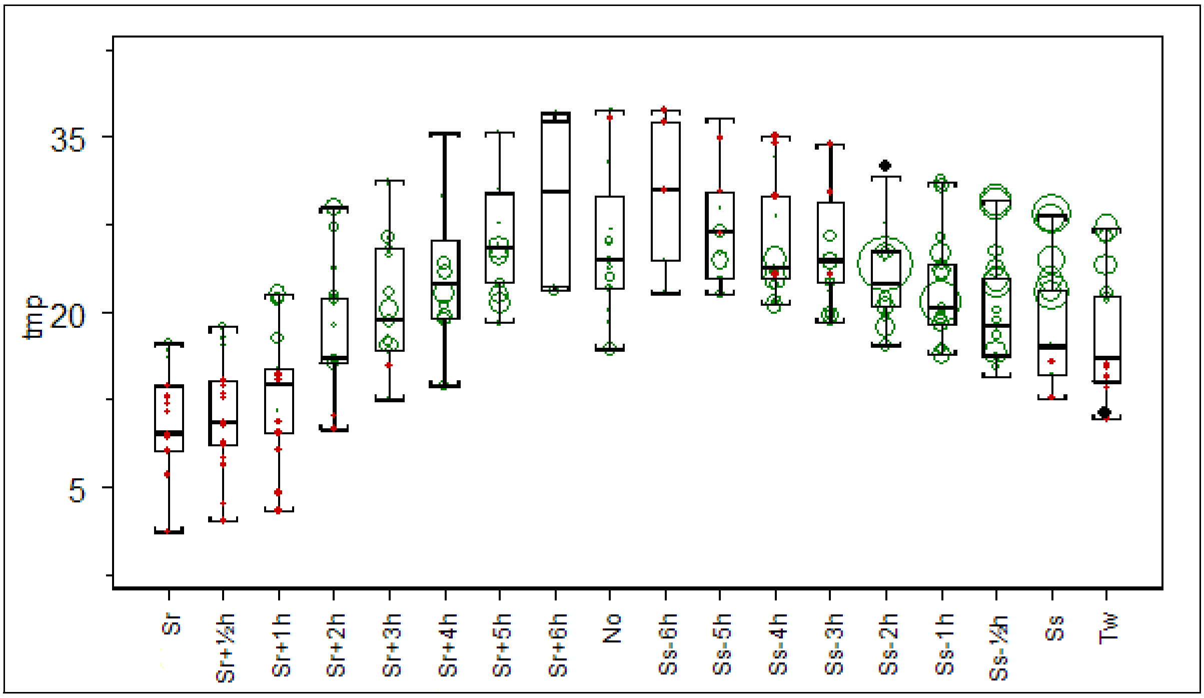


Fig. 7.1.6 –Box plot of the values of the diurnal temperature for hourly segments. The bubble plot of the frequency of capture (green circles) were overlaid to temperature values. The red dots (●) indicate the temperature values for which no catches were registered, the points (●) the outlier values of temperature. The hours segments Sr+6h and Ss-6h contains only 5 observations therefore they can not be evaluated

Fig. 7.1.7 shows the hourly temperature trends associated with the frequency of capture represented in bubble plot for each sampling day.

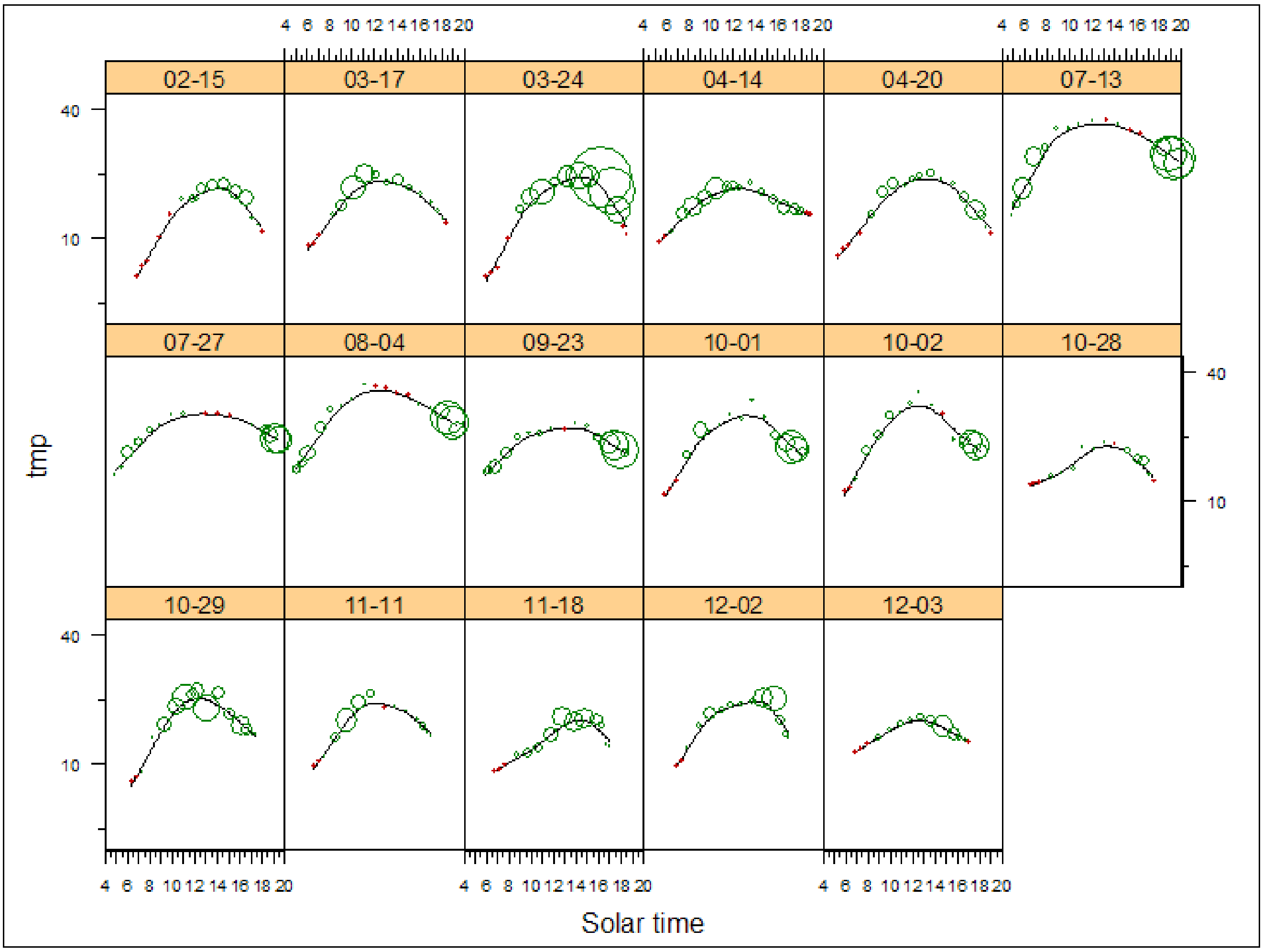


Fig. 7.1.7 – Hourly temperature trends associated with the frequency of capture represented in bubble plot (green circles) for each sampling day. The red dots (●) indicate the wind speed values for which no catches were registered. Solid line is a smoothing loess (span 0.5, degree one, family Gaussian).

Wind speed

As regard the wind speed, the maximum speed recorded during the days of sampling with hourly car-net is 6.1 m/s. The observed mean is 0.98 m/s, while the median is 0.52 m/s (see fig. 7.1 .8). There are 8 data considered outliers with values of wind speed ranging from 4.1 to 6.1 m/s. Of these: one was recorded on the day of 3-17, in the hour segment Ss-2h, four on the day 7-13 and five on the days n 7-27, in both cases in afternoon segments.

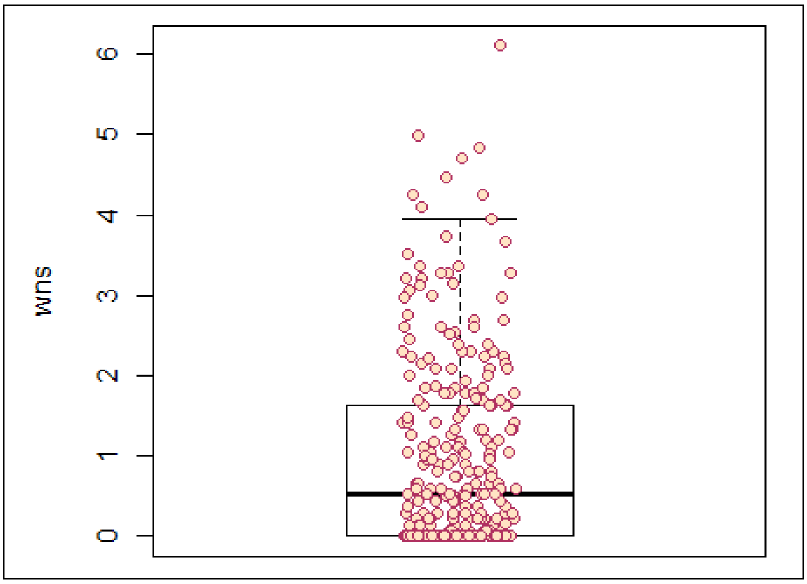


Fig. 7.1.8 - Box and whisker plot of the values of wind speed recorded during the sampling with hourly car-net.

The general trend of the catches with the hourly car-net in relation to values of wind speed is shown in fig. 7.1.9. The low wind speeds, below about 1 m/s do not affect the catches (smoothing curve in this portion of the data indicates an increase in catches with increasing wind speed). At higher speeds, in general, a negative correlation is observed.

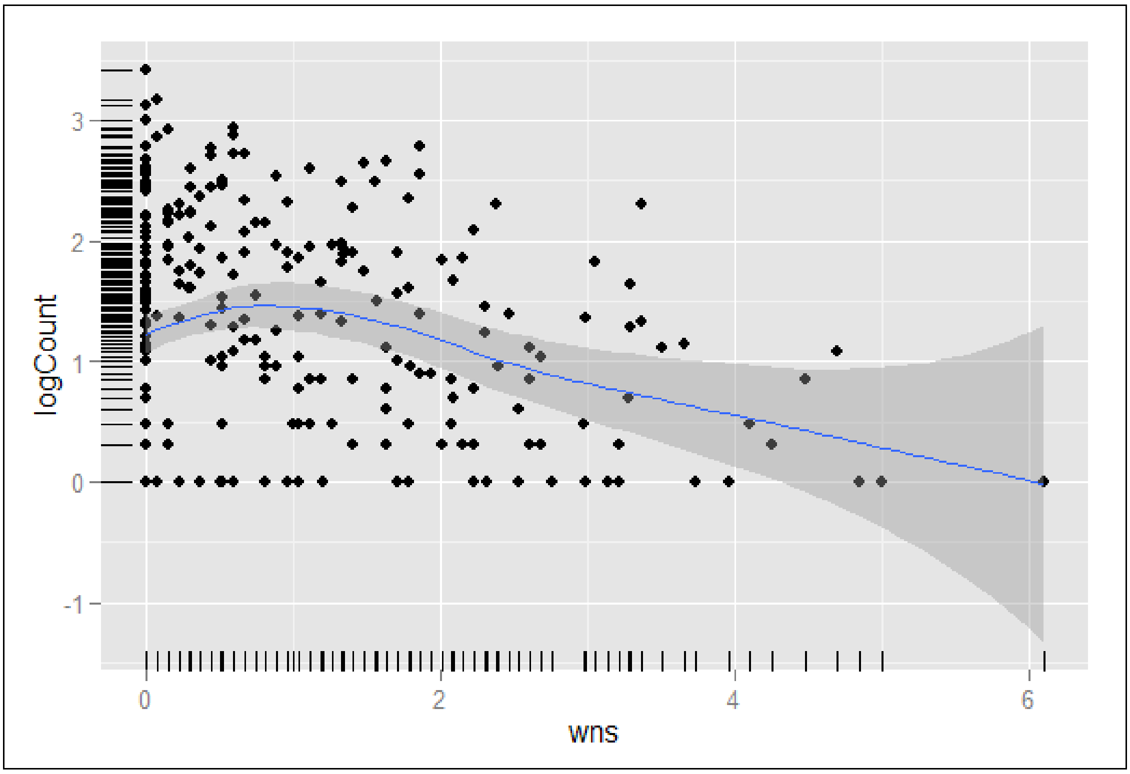
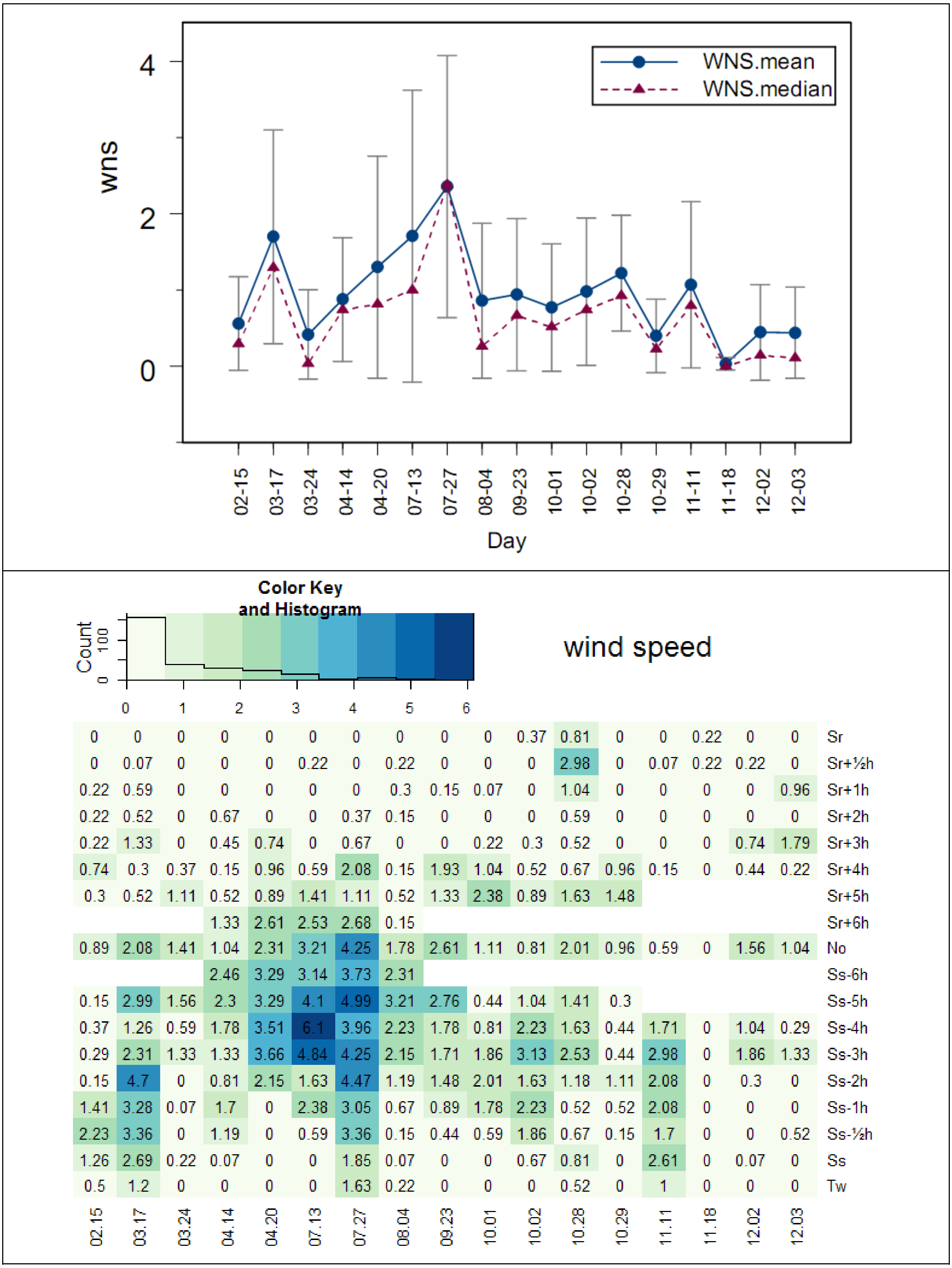


Fig. 7.1.9 - Scatter plot of speed wind value versus log transformed catch values. The solid line is the smoother and the light gray band is the 95% confidence interval. Smoothing df = 3.626 ; F = 4.748; p-value = 0.000722 ***

Fig. 7.1.10 shows the trend of the mean values and medians of the wind speed for sampling dates and the heat map of the wind speed values.



7.1.10 - Trend of mean values and medians for sampling dates with hourly car-net and heat map with the values of the wind speed.

The box plots in fig. 7.1.11 shows the relationship between the values of wind speed and the frequency of captures recorded in each sampling period.

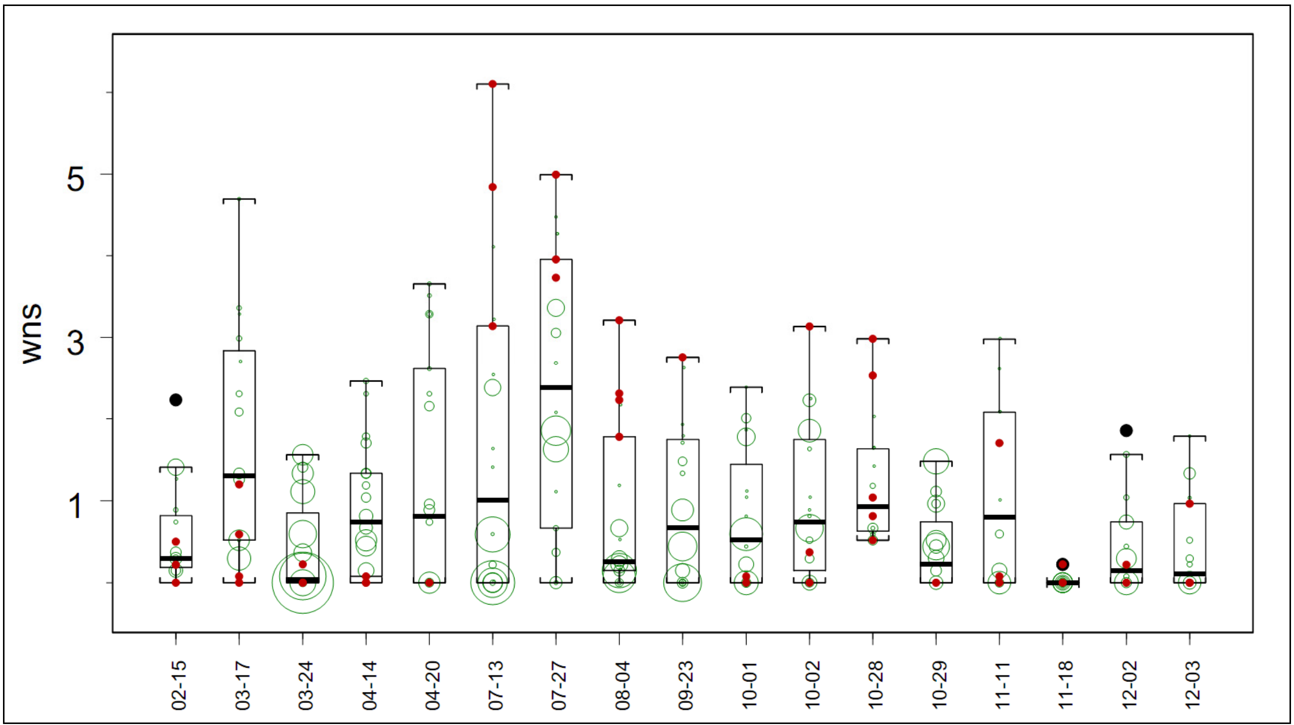


Fig. 7.1.11 –Box plot of the values of the wind speed for sampling dates. The bubble plot of the frequency of capture (green circles) were overlaid to wind speed values. The red dots (●) indicate the wind speed values for which no catches were registered, the points (●) the outlier values of wind speed.

The less windy days, identifiable by the low amplitudes of the box and whisker plot and the very low values of the medians close to zero, are the 02-15, 03-24, 10-29, 11-18, 12-02 and 12-03. On average, in these days, the 75% of values of the wind speed is between 0 and 1 m/s, while the remaining 25%, which includes the up tails (excluding outliers), does not exceed the values of 1.4-1.6 m/s. The most windy days are the 03-17, 04-20, 07-13 and 07-27, in the latter the median value is the highest of all the examined series.

The majority of the most abundant catches occurs at low wind speeds, however, in some cases, at high values of wind speed are associated abundant catches. This is make to assume that the effect of the wind on catches acts in conjunction with other variables and/or factors. Within the same day, the windy phenomenon can occur in different ways, such as isolated random events, or in continuous form, or may be concentrated in a few hours of the day as systemic event as it happens especially in the summer.

Looking at the values of the wind speed in relation to the hourly segments (fig. 7.1.12), it is generally observed that the wind speed is low in the early hours of the morning and reaches the highest values in the first hours of the afternoon then decreases until sunset. The catches in the first segment times, despite the lack of wind, are almost null, indicating in this case an effect of temperature on the flying activity. For the next hourly segments before noon, with wind values not exceeding 1.5 m/s, catches mainly concentrate around the median, at noon and up to 3 hours before sunset, catches show the highest frequencies below the median and in the bottom tail. In the late afternoon and dusk, catches are distributed more widely, although sometimes are recorded high values of wind speed. This may also depend on the circadian rhythm.

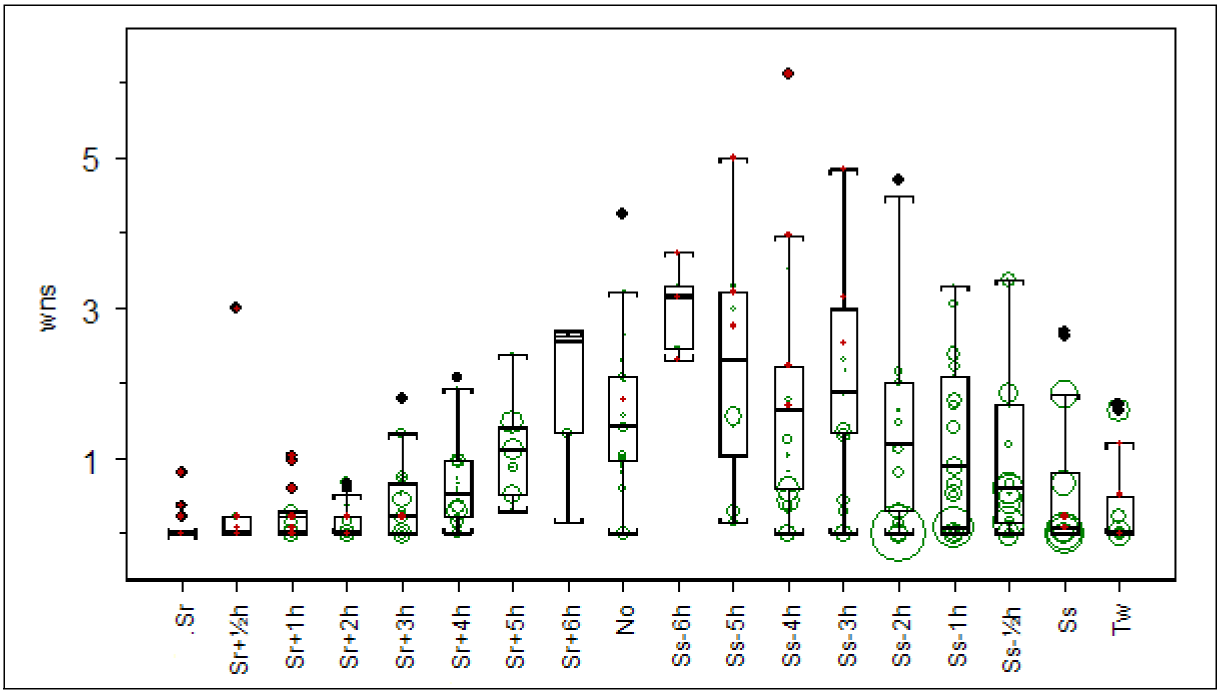


Fig. 7.1.12 – Box plot of the values of the wind speed for hourly segments. The bubble plot of the frequency of capture (green circles) were overlaid to wind speed values. The red dots (●) indicate the wind speed values for which no catches were registered, the points (●) the outlier values of wind speed. Hours segments Sr+6h and Ss-6h contains only 5 observations therefore they can not be evaluated

Fig. 7.1.13 reports hourly trends of the wind speed associated with the frequencies of capture represented in bubble plot for each sampling day.

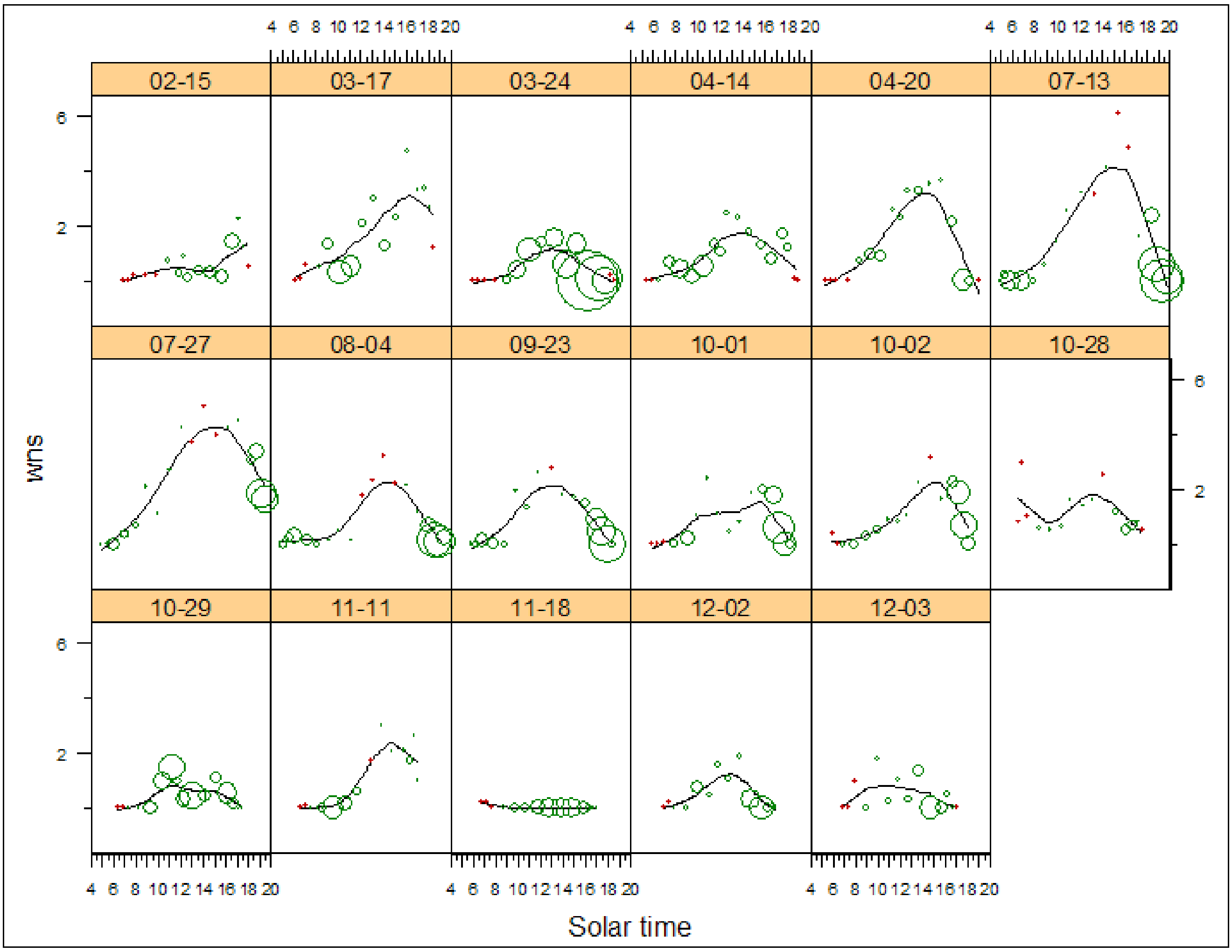


Fig. 7.1.13– Hourly trends of wind speed associated with the frequencies of capture represented in bubble plot (green circles) for each sampling day The red dots (●) indicate the wind speed values for which no catches were registered. Solid line is a smoothing loess (span 0.5, degree one, family Gaussian).

7.2 Analysis of flying activity

In that paragraph are presented the results of sampling made with the hourly car-net. For each of the species most abundantly sampled, and for subfamilies where determinations are not available, have been elaborated and commented:

- Tables of the monthly presence/absence. Each table has been designed to have an annual framework of the presence/absence of species per month, regardless of the technique or the sampling protocol. Its monthly presence has been reported with a filled sphere; if the species was sampled also with the pit-fall traps is indicated with a empty sphere; if it was sampled by pit-fall traps only the data is shown with an asterisk.

- Contingency tables between dates and hourly segments of catches and heat map graphics with values of temperature and wind, expressed in colorimetric scale overlaid on the latter. The data are set according to the succession of months in the year, considering that the sampling started on 09-23-2010 and ended on 08-04-2011. The hourly segments vary as a result of varying the number of daylight hours in the seasons and then some of them are absent in some periods and have been highlighted in gray in the contingency table and in white in heat map graphics.

- Graphs of smoothing regressions between the logarithms of the catches and temperature values and graphs of linear regressions between the logarithms of the catches and the values of wind speed. In each plot, the solid line is the smoother and light gray band is the 95% confidence interval, the rugs at the bottom of the plot show the locations of the data points along the x axis.

- Graphs of seasonal variations of flying activity cadence. In order to represent in scatter plot the relationship between the logarithm of the catch and the hourly segment, that was transformed into a numerical value (tab. 7.2.1). The days of sampling falling in each season are shown in tab. 7.2.1. To interpret the trend has been inserted a smoothing curve (solid line); the light gray band is the 95% confidence interval.

A detailed analysis has been performed for *Megarthrus bellevoyei*, the most abundant species, to illustrate the methodology of analysis and use it as a reference point. The results are presented giving an overview of the subfamilies.

Segment	Value
Sr	-7
Sr+½h	-6.5
Sr+1h	-6
Sr+2h	-5
Sr+3h	-4
Sr+4h	-3
Sr+5h	-2
Sr+6h	-1
No	0
Ss-6h	1
Ss-5h	2
Ss-4h	3
Ss-3h	4
Ss-2h	5
Ss-1h	6
Ss-½h	6.5
Ss	7
Tw	7.2

Season	Date	label	light hours
01-winter	02/15/2011	02-15	10.49.26
	03/17/2011	03-17	11.59.48
02-spring	03/24/2011	03-24	12.16.40
	04/14/2011	04-14	13.06.20
	04/20/2011	04-20	13.19.55
03-summer	07/13/2011	07-13	14.32.04
	07/27/2011	07-27	14.12.46
	08/04/2011	08-04	13.58.19
	09/23/2010	09-23	12.09.50
	10/01/2010	10-01	11.48.29
	10/02/2010	10-02	11.46.07
04-autumn	10/28/2010	10-28	10.46.31
	10/29/2010	10-29	10.44.21
	11/11/2010	11-11	10.18.03
	11/18/2010	11-18	10.05.39
	12/02/2010	12-02	9.46.12
	12/03/2010	12-03	9.45.09

Tab. 7.2.1 – Left: hourly segments and corresponding numerical values used for graphics elaboration on the seasonal catches trend. Right: sampling days that fall in each season.

Micropeplinae

With the hourly car-net were sampled three species belonging to this subfamily. None of them was sampled with frequencies that allow analysis of flying activity. The tab. 7.2.2 shows, for each species, the sampling data (date, time, hour segment), the values of temperature (in degrees Celsius) and wind speed (in meters per second).

Species	Date	Segment	SolarTime	tmp	wns	count
Micropeplus f. fulvus	10-29-2010	Ss-½h	16.36	18.0	0.15	1
Micropeplus porcatus	03-24-2011	Ss-4h	14.20	24.5	0.59	1
Micropeplus staphylinoides	04-14-2011	Sr+4h	9.28	19.4	0.15	1

Tab. 7.2.2 – Captures data of Micropeplinae with hourly car-net.

Proteininae

With the hourly car net were sampled three species belonging to this subfamily. The abundances of capture allow a significant analysis of flying activity for *Megarthrus bellevoyei* and *Proteinus atomarius*. The data for *P. ovalis* sampling (date, time, hour segment), the values of temperature (in degrees Celsius) and wind speed (in meters per second) are shown in tab. 7.2.3.

Species	Date	Segment	SolarTime	tmp	wns	count
Proteinus ovalis	10-01-2010	Ss	17.44	21.8	0	1

Tab. 7.2.3 – Captures data of *Proteinus ovalis* with hourly car-net.

Megarthrus bellevoyei

It is a species with adults flying from October to April (tab. 7.2.4).

Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep	Oct	Nov	Dec
●	●	●	●						o	o	o

Tab. 7.2.4 - Presence data of *Megarthrus bellevoyei* in the months of the year, explanations in the text.

The preliminary observation of the catches trend with the hourly car net (tab. 7.2.5) shows a peculiar concentration in the detection of March 24, which can not be correlated with specific environmental factors. It can be assumed that the detection coincides with a specific phase of the biological cycle of this species, for example with the swarm of adults, with a consequent peak of their dispersion. These coincidences can not be easily identified, but they may be considered as an hidden factor behind the significant changes of flying activity.

	Feb	Mar		Apr		Jul		Aug	Sep	Oct				Nov		Dec		
Seg	02.15	03.17	03.24	04.14	04.20	07.13	07.27	08.04	09.23	10.01	10.02	10.28	10.29	11.11	11.18	12.02	12.03	tot
Sr	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sr+½h	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sr+1h	-	-	-	6	-	-	-	-	-	-	-	-	-	1	-	2	-	9
Sr+2h	-	4	-	58	-	-	-	-	-	-	-	1	-	32	15	11	3	124
Sr+3h	-	6	39	58	11	-	-	-	-	-	-	-	3	11	38	26	-	192
Sr+4h	1	24	97	5	1	-	-	-	-	-	-	-	-	7	43	-	-	178
Sr+5h	-	5	28	1	2	-	-	-	-	-	-	-	-					36
Sr+6h				-	-	-	-	-										-
No	-	-	-	-	-	-	-	-	-	-	-	-	-	-	64	-	-	64
Ss-6h				-	-	-	-	-										-
Ss-5h	1	-	1	-	-	-	-	-	-	-	-	-	-					2
Ss-4h	14	-	27	-	-	-	-	-	-	-	-	-	10	-	81	-	1	133
Ss-3h	35	-	45	-	-	-	-	-	-	-	-	-	1	-	140	2	13	236
Ss-2h	64	-	1595	12	1	-	-	-	-	-	-	-	-	-	130	195	148	2145
Ss-1h	127	1	732	33	257	-	-	-	-	-	-	3	21	-	47	185	74	1480
Ss-½h	3	15	431	20	44	-	-	-	-	-	-	6	12	3	15	19	5	573
Ss	1	1	-	-	-	-	-	-	-	-	-	-	-	-	2	2	1	7
Tw	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
tot	246	56	2995	193	316	-	-	-	-	-	-	10	47	54	575	442	245	5179

Tab. 7.2.5 - Contingency table between dates and hourly segments for catches of *Megarthrus bellevoyei.*

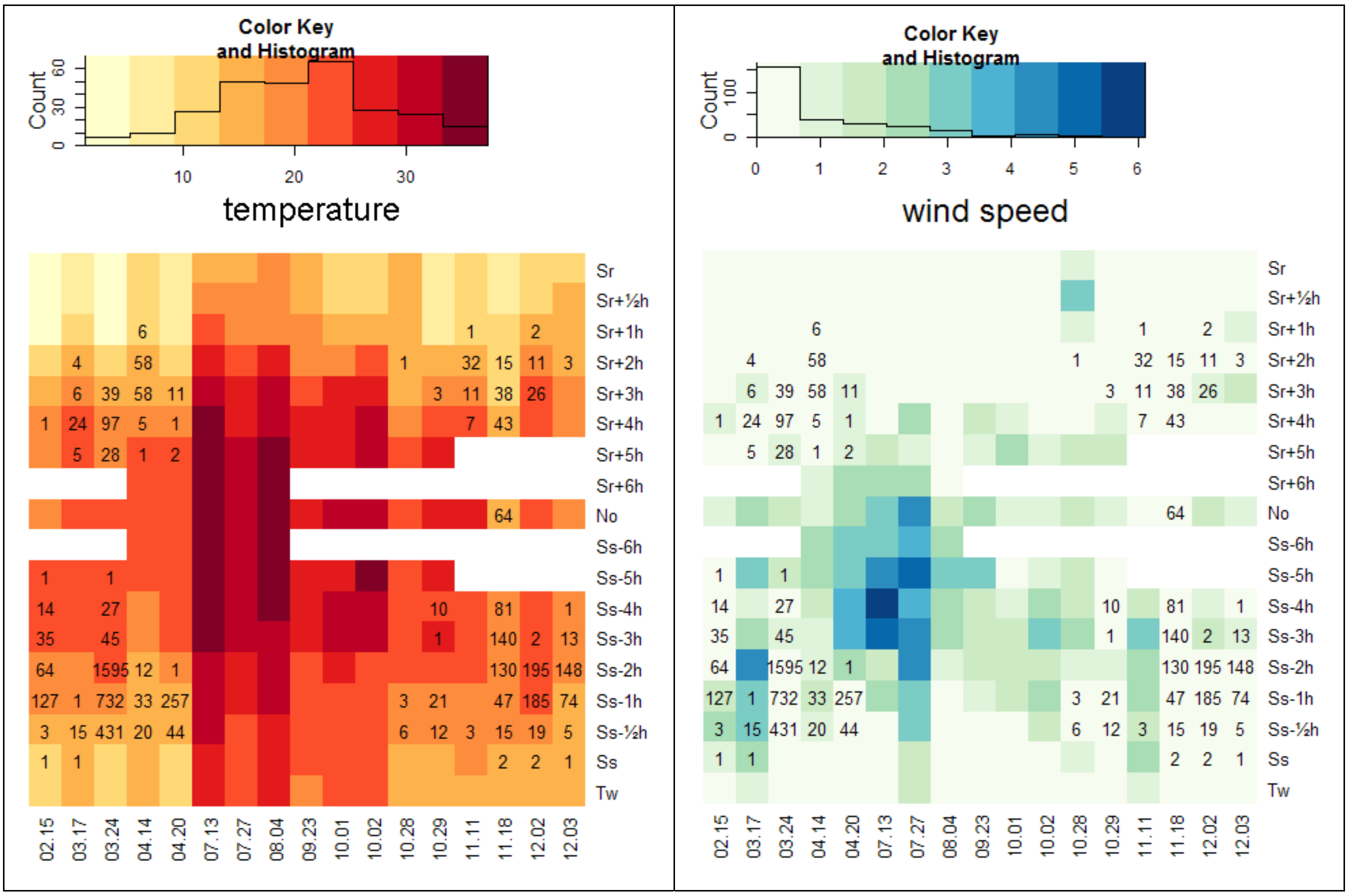


Fig. 7.2.1 - Heat map with the values of temperature (left) and wind (right) overlaid on those of the contingency table of *Megarthrus bellevoyei.*

The examination of the heat map with the values of temperature (Fig. 7.2.1) shows how the start of the flying activity is presumably influenced by temperature: no flying activity was detected below 11.57 °C . However, it seems also important the temperature value in the morning in the period preceding the beginning of the flying activity. The detection of 02-15 provides a significant example: the extremely cold temperature in the morning seem to determine the absence of flying activity until the early afternoon. Even the comparisons between samples of close dates indicate (with the exception of two samples of December) a delay in the flying activity in the days with colder morning. The flying activity does not begin until one hour after sunrise and ends at sunset, or just before. An interruption of the flying activity is observed, with one exception, around noon. The maximum values are generally observed in the afternoon, one hour or two before sunset.

In detail there are significant differences in the pattern of flying activity between the days of sampling even when they are contiguous. The comparison between them by considering the environmental factors that have been found permits to evaluate the possible effects of these on the flying activity trend.

The first data with number of catches that allow the analysis are those of 10-29, when the flying activity is concentrated in the afternoon. However, comparison with the data of temperature in November and December samplings shows that the latter was particularly cold in the morning of 10-29. Is not to exclude, therefore, that in October days with higher morning temperatures animals could show trends in morning flying activity more similar to those observed in November and December. In this respect it can be observed that the temperatures measured in the morning 10-28 are greater than or similar to those of the months of November and December, but without register a significant morning flying activity presumably in relation to the wind speed greater than or equal to 1 m/sec (fig. 7.2.1).

On November 11, it does not appear significant flying activity in the afternoon. The same situation occurs on March 17. In both cases are detected strong wind conditions, around 2 m/s.

The 18 November is the only day in which it was detected a significant flying activity at noon: the catches at this time are higher than those in the morning, resulting in an increasing flying activity until 3 hours before sunset. The comparison with the contiguous measurements points out that on this day the temperature in the morning and in the middle of the day was significantly lower. This is the central hours temperature the lowest of the entire series of samples. It can be assumed that the low temperature has led to a delay of flying activity with the disappearance of its interruption during the central hours of the day.
It is also noted how the interactions wind/temperature may be relevant even with not excessive values of the wind. In particular, the almost absence of flying activity in the morning of 3 December can be explained by the higher wind speed associated with lower temperatures; such association could have prevented the realization of the optimum temperature for the flight.
The temperature range in which the flying activity were observed is 11.6 - 26.5 °C (fig. 7.2.2). The effect of wind on the catches, recorded in the afternoon, tested with regression analysis is highly significant (fig. 7.2.3). Above a wind speed of 3.4 m/s, there were no catches.

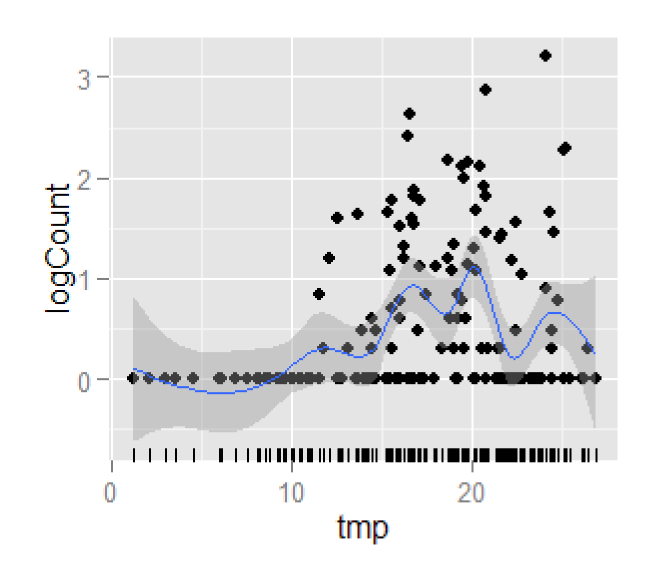


Fig. 7.2.2 - Scatter plot of temperature value versus log transformed catch values. The solid line is the smoother and light gray band is the 95% confidence interval.
Smoothing df = 8.747; F = 4.775; p-value = 1.11e-05 ***

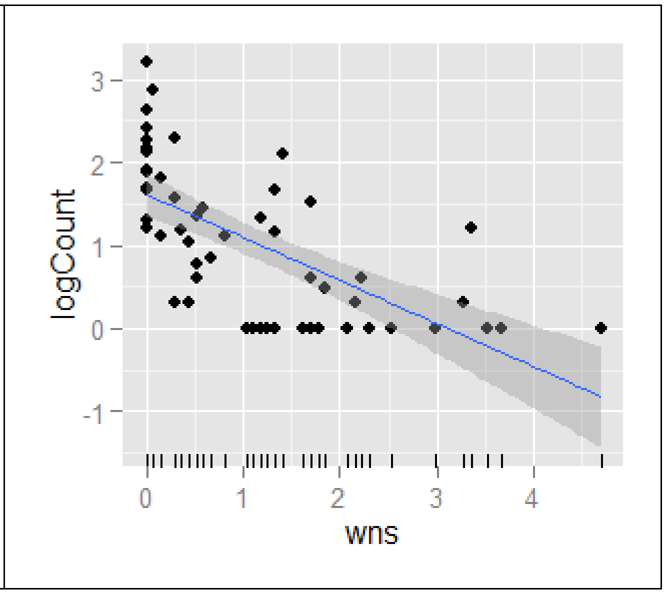


Fig. 7.2.3 - Scatter plot of wind speed value versus log transformed catch values. The solid line is the linear regression and light gray band is the 95% confidence interval.
R^2 = 0.4353; F-statistic: 40.85; p-value: 4.293e-08***

Overall, the daily flying activity of this species shows the following general scheme: flying activity in the morning and in the afternoon, where we observe the highest peak; interruption of the flying activity at noon, with one exception. The starting of the flying activity appears to depend on reaching of a proper body temperature; the end of the flying activity is determined by the attenuation of brightness. The increase of the wind speed negatively influences the flying activity, inducing a significant reduction or blocking it.
Taking into consideration the seasonal variations in the rhythm of the flight (fig. 7.2.4) there is a bimodal activity with one peak in the morning and one sharper in the afternoon, separated by a break. In the summer adults are not present. The differences between the other seasons are not very relevant: the afternoon peak is closer to sunset in spring and autumn, and the break is wider in spring.

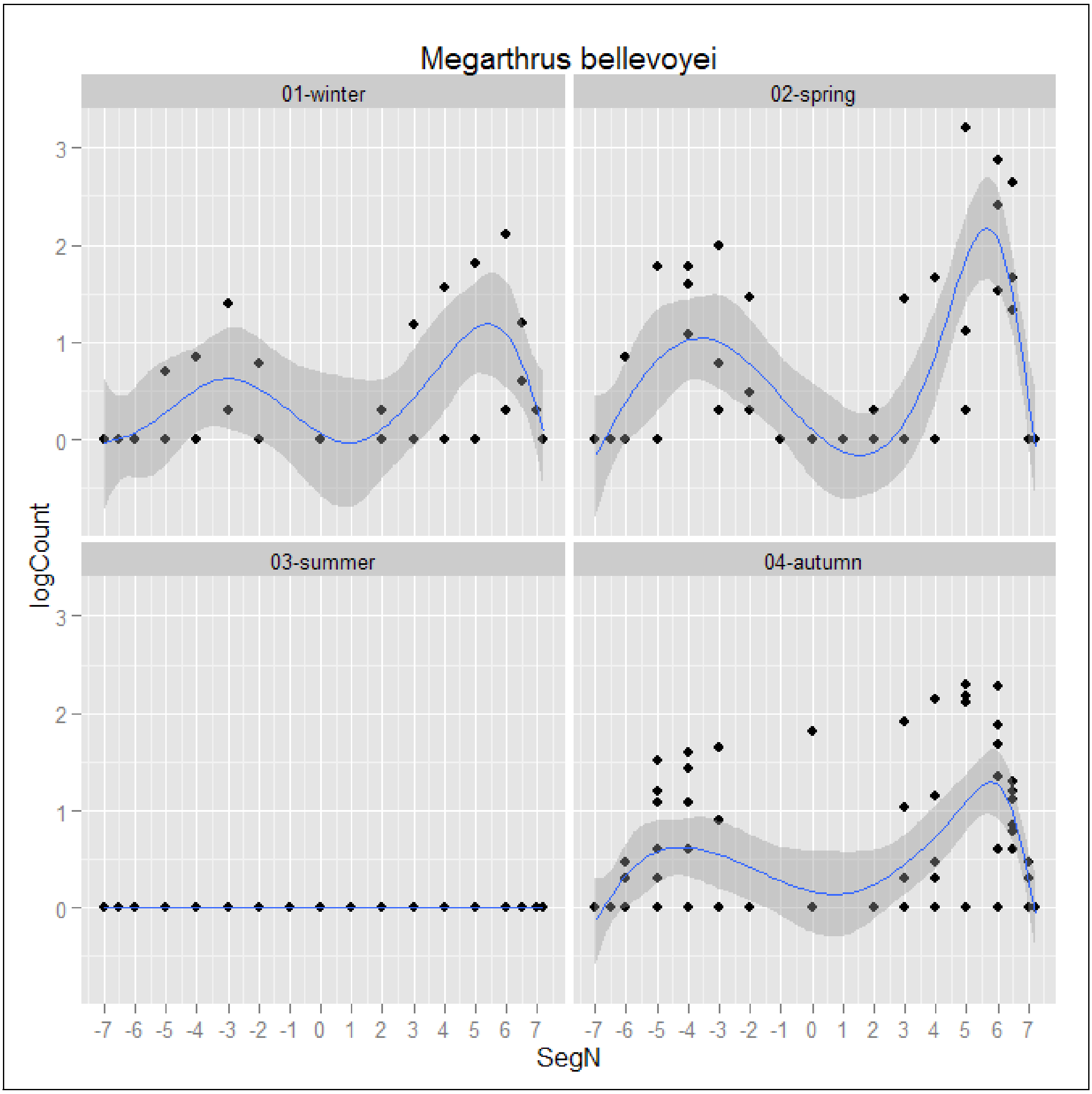


Fig. 7.2.4 – Seasonal variation in flying activity of *Megarthrus bellevoyei.*

Proteinus atomarius

It has a phenology more ample than *Megarthrus bellevoyei* with the presence of flying adults between August and April, although the catches for the months of August and September are referred to one or two specimens.

Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep	Oct	Nov	Dec
●	●	●	●				●	●	●	●	●

Tab. 7.2.6 – Presence data of *Proteinus atomarius* during the months of the year, explanations in the text.

The trend of catches the with the hourly car-net (tab. 7.2.7) shows the maximum frequencies in spring. This species was sampled with frequencies of capture much lower than *M. bellevoyei*.

	Feb	Mar		Apr		Jul		Aug	Sep	Oct				Nov		Dec		
Seg	02.15	03.17	03.24	04.14	04.20	07.13	07.27	08.04	09.23	10.01	10.02	10.28	10.29	11.11	11.18	12.02	12.03	tot
Sr	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sr+½h	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sr+1h	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sr+2h	-	-	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-	3
Sr+3h	-	-	-	9	2	-	-	-	-	-	-	-	-	-	2	-	-	13
Sr+4h	1	-	1	1	1	-	-	-	-	-	-	-	-	-	-	-	-	4
Sr+5h	-	-	-	5	-	-	-	-	-	-	-	-	-					5
Sr+6h				-	-	-	-	-										-
No	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	2
Ss-6h				-	-	-	-	-										-
Ss-5h	-	-	1	-	-	-	-	-	-	-	-	-	-					1
Ss-4h	2	-	5	-	-	-	-	-	-	-	-	-	1	-	1	-	-	9
Ss-3h	4	1	6	3	-	-	-	-	-	-	-	-	-	-	4	-	1	19
Ss-2h	5	-	24	34	13	-	-	-	-	-	-	-	-	-	5	-	5	86
Ss-1h	9	-	20	17	19	-	-	-	-	-	1	1	-	-	3	3	2	75
Ss-½h	1	2	1	6	10	-	-	1	-	3	-	-	-	-	-	-	-	24
Ss	1	-	-	-	1	-	-	-	-	1	1	1	-	-	-	-	1	6
Tw	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	1
tot	24	3	58	78	46	-	-	1	1	4	2	2	1	-	15	3	10	248

Tab. 7.2.7 - Contingency table between dates and hourly segments for catches of *Proteinus atomarius*.

Examination of the heat map with the values of temperature and wind speed (fig. 7.2.5) shows correlations with capture frequencies similar to those observed for *Megarthrus bellevoyei*.

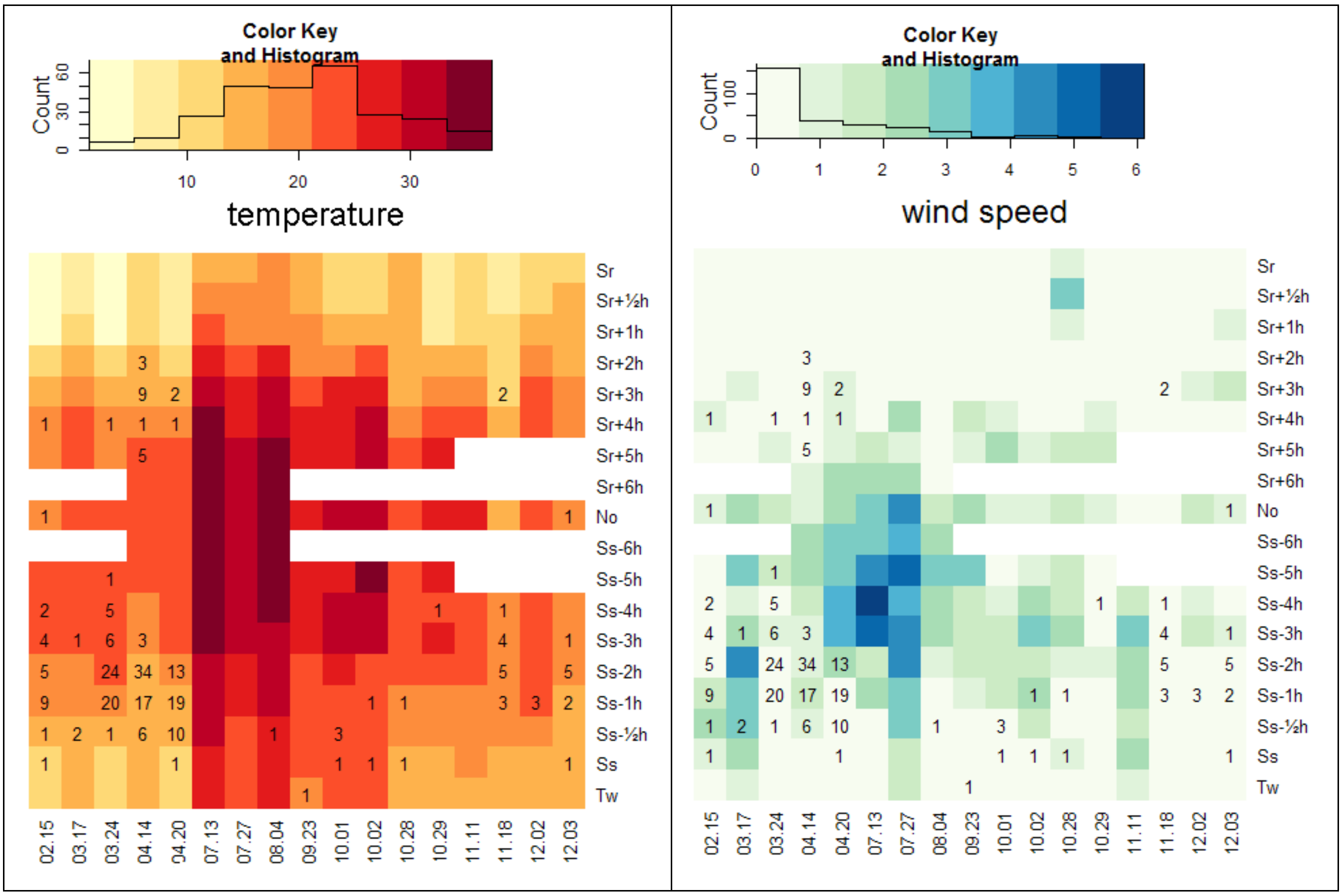


Fig. 7.2.5 - Heat map with the values of temperature (left) and wind (right) overlaid on those of the contingency table of *Proteinus atomarius.*

The temperature range in which the flying activity were observed is 12.5 - 29.2 °C (fig. 7.2.6). The effect of wind on the catches, recorded in the afternoon period, tested with regression analysis is highly significant (fig. 7.2.7). Above a wind speed of 3.4 m/s, there were no catches.

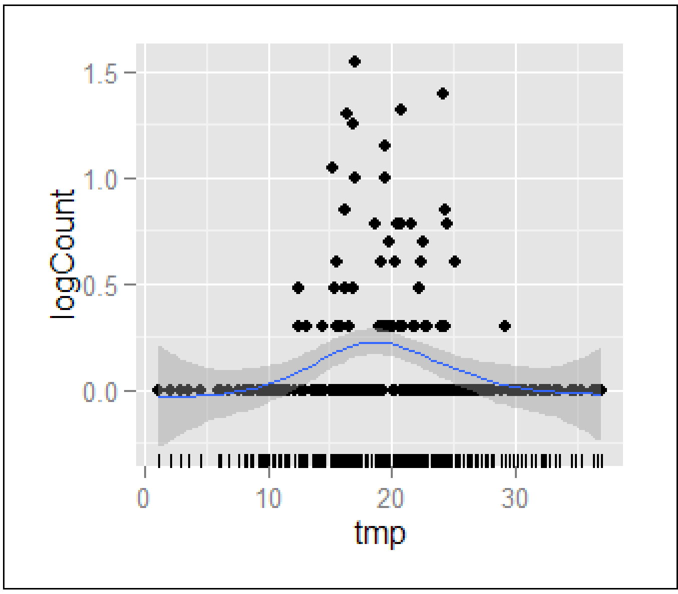


Fig. 7.2.6 - Scatter plot of temperature value versus log transformed catch values. The solid line is the smoother and light gray band is the 95% confidence interval.
Smoothing df = 4.316; F = 4.129 p-value = 0.00106 **

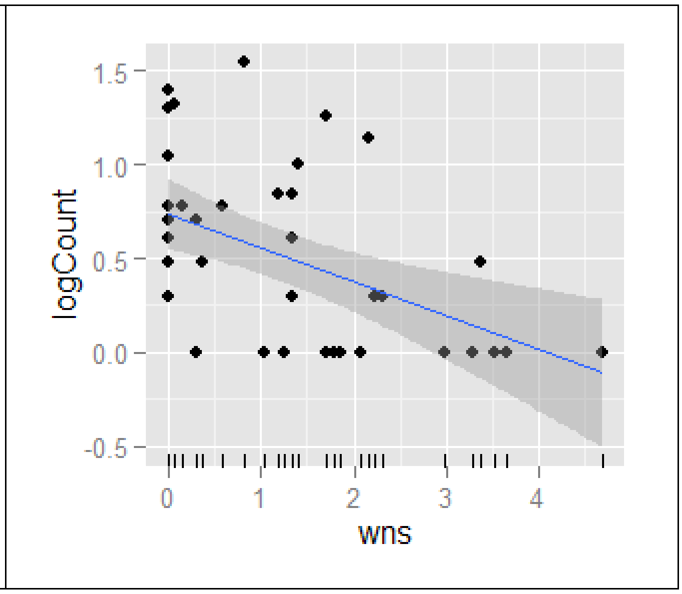


Fig. 7.2.7 - Scatter plot of wind speed value versus log transformed catch values. The solid line is the linear regression and light gray band is the 95% confidence interval.
R^2: 0.2286; F-statistic: 11.56; p-value: 0.001569**

The daily flying activity is main in the afternoon and the maximum values are observed one or two hours before sunset. In the morning, a fair amount of activity was detected only once in the spring survey. The flying activity does not start until two hours after sunrise and ends at sunset, or just before.

Taking into consideration the seasonal variations in the rhythm of the flying activity (fig. 7.2.8) is observed that it is clearly perceptible in spring where the activity is more consistent; it is bimodal with a morning peak and one more pronounced in the afternoon, separated by an interruption. In winter and autumn the little amount of data show flying activity in the morning and at noon, while is evident a peak in the afternoon. In summer the limited data indicate a flying activity exclusively in the afternoon close to sunset.

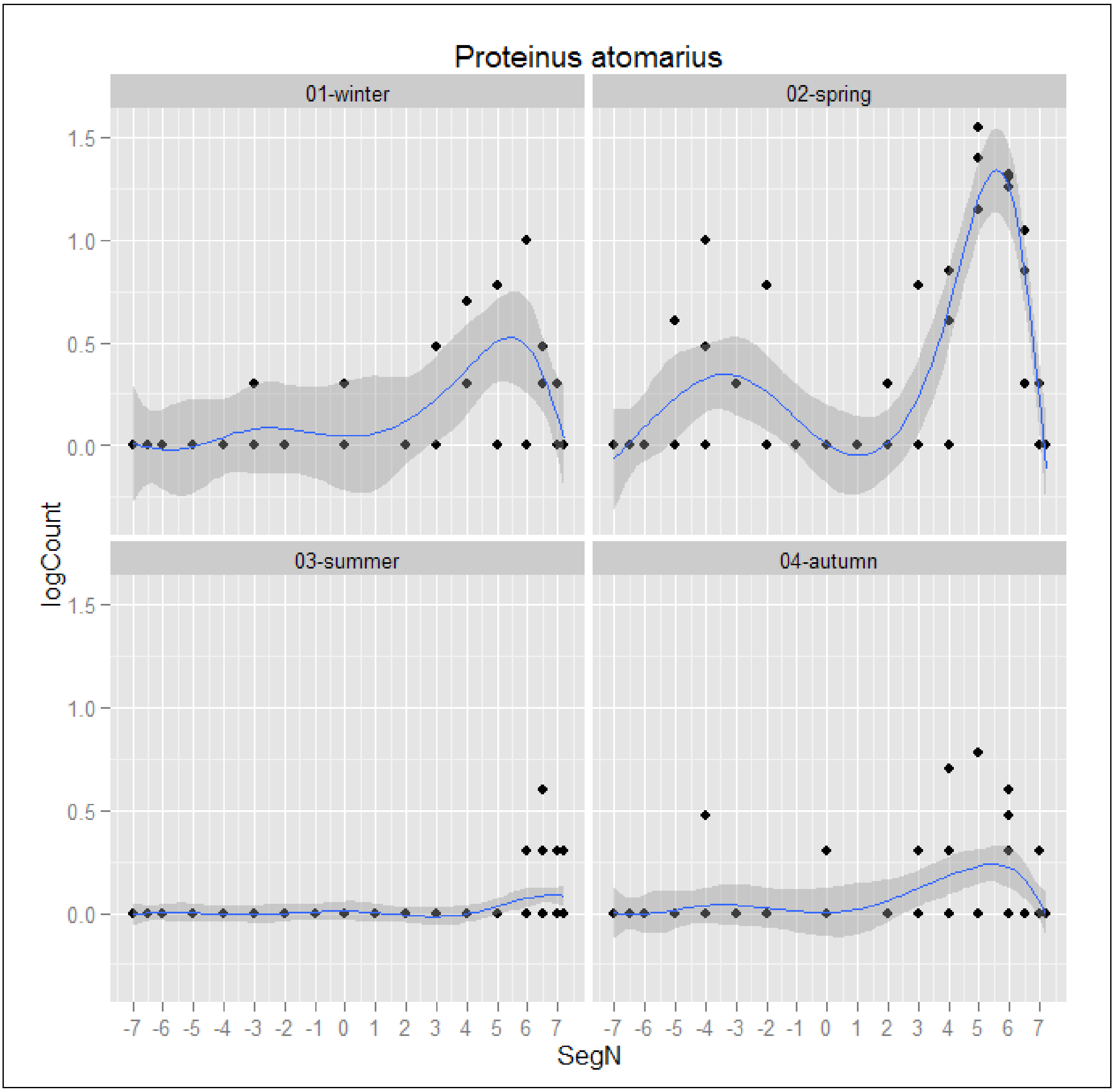


Fig. 7.2.8 – Seasonal variation in flying activity of *Proteinus atomarius.*

Omaliinae

With the car-net (hourly protocol) were sampled five species belonging to this subfamily. The species, for which it was not possible to comment on the flying activity because of low abundances, are shown in tab. 7.2.8. For each of them are shown the sampling data (date, time, hour segment), the values of temperature (expressed in degrees centigrade) and the wind speed (expressed in meters per second).

Species	Date	Segment	SolarTime	tmp	wns	count
Eusphalerum l. luteicorne	03-17-2011	Ss-3h	15.09	21.7	2.31	1
	03-24-2011	Sr+5h	10.59	20.8	1.11	1
	04-20-2011	Sr+5h	10.20	22.5	0.89	1
Lesteva s. sicula	10-28-2010	Ss-½h	16.37	19.3	0.67	1
Omalium allardi	04-14-2011	Ss-1h	17.34	16.8	1.70	1
Omalium excavatum	02-15-2011	Ss-2h	15.39	20.7	0.15	1

Tab. 7.2.8 – Captures data of Omaliinae with hourly car-net.

Paraphloeostiba gayndahensis

Adults flying presumably throughout the year, although in January and September, there were no catches (tab. 7.2.9); abundances significant only in summer.

Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep	Oct	Nov	Dec
	●	●	●	○	○	●	●		●	●	●

Tab. 7.2.9 – Presence data of *Paraphloeostiba gayndahensis* in the months of the year, explanations in the text.

The trend of catches with the hourly car-net (tab. 7.2.10) shows that most of them are concentrated in the afternoon of July 13. It is probable that this abundance is the result of a swarming.

	Feb	Mar		Apr		Jul		Aug	Sep	Oct				Nov		Dec		
Seg	02.15	03.17	03.24	04.14	04.20	07.13	07.27	08.04	09.23	10.01	10.02	10.28	10.29	11.11	11.18	12.02	12.03	tot
Sr	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sr+½h	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sr+1h	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sr+2h	-	-	-	-	-	2	1	-	-	-	-	-	-	-	-	-	-	3
Sr+3h	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sr+4h	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	1
Sr+5h	-	-	-	-	-	-	-	-	-	-	-	-	-					-
Sr+6h				-	-	-	-	-										-
No	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ss-6h				-	-	-	-	-										-
Ss-5h	-	-	1	-	1	-	-	-	-	-	-	-	-					2
Ss-4h	1	-	-	-	-	-	-	-	-	-	-	-	3	-	-	1	-	5
Ss-3h	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	2
Ss-2h	-	-	-	-	1	-	-	1	-	1	-	2	1	1	-	-	-	7
Ss-1h	-	-	-	-	-	13	2	8	-	3	4	-	-	-	-	1	-	31
Ss-½h	-	-	-	-	-	61	5	14	-	1	1	-	-	-	-	-	-	82
Ss	-	-	-	-	-	115	4	9	-	-	-	-	-	-	-	-	-	128
Tw	-	-	-	-	-	22	1	1	-	-	-	-	-	-	-	-	-	24
tot	2	-	1	-	3	213	13	33	-	5	5	2	4	1	-	2	1	285

Tab. 7.2.10 - Contingency table between dates and hourly segments for catches of *Paraphloeostiba gayndahensis.*

The temperature range in which the flying activity were observed is 19.5 - 31.6 °C (fig. 7.2.10), coherently with the flying activity of this species predominantly in summer.
The afternoon catches in summer are much lower than in the more windy day (fig. 7.2.9), but the regression is not statistically significant (fig. 7.2.11). However above a wind speed of 3.4 m/s, there were no catches.

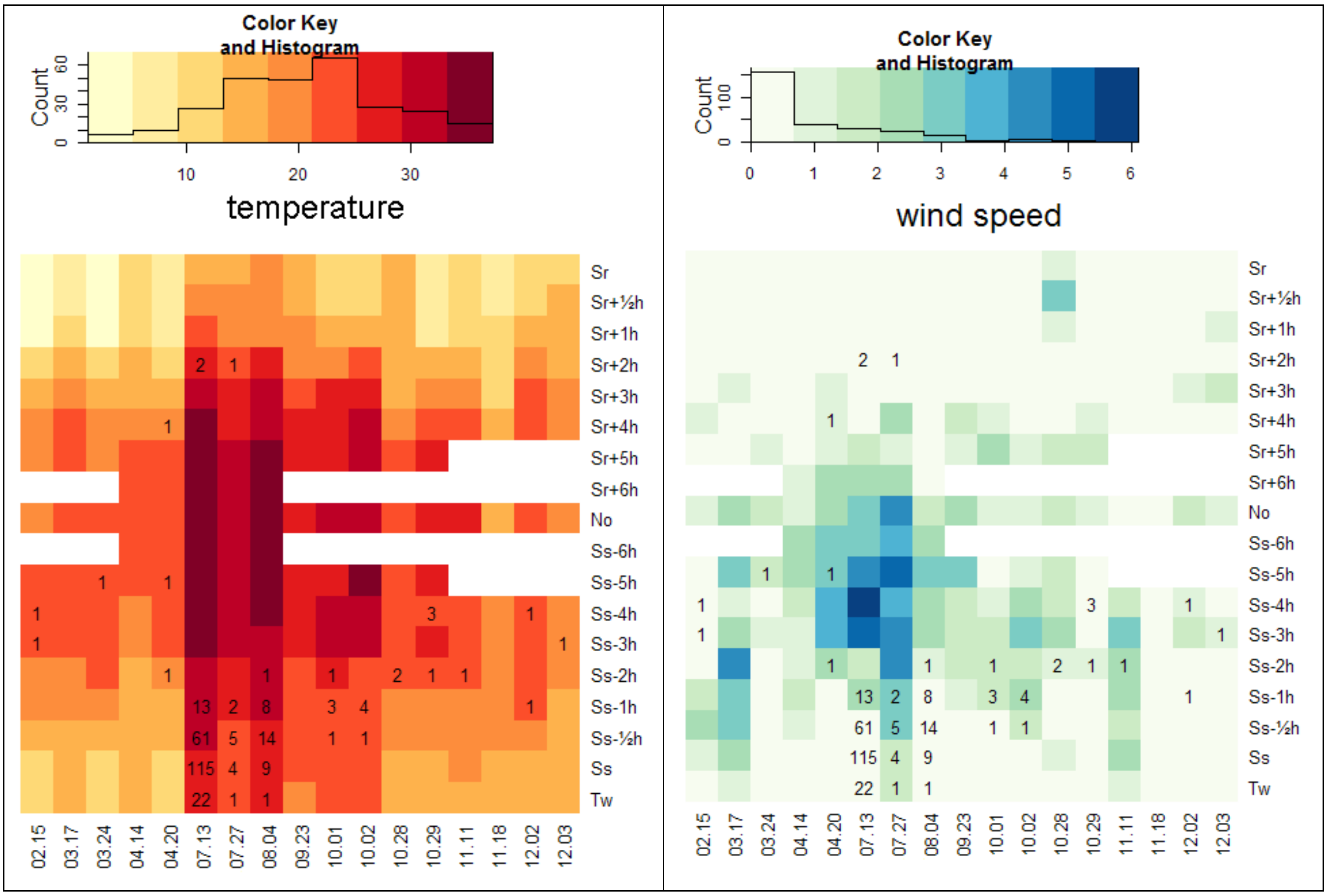


Fig. 7.2.9 - Heat map with the values of temperature (left) and wind (right) overlaid on those of the contingency table of *Paraphloeostiba gayndahensis.*

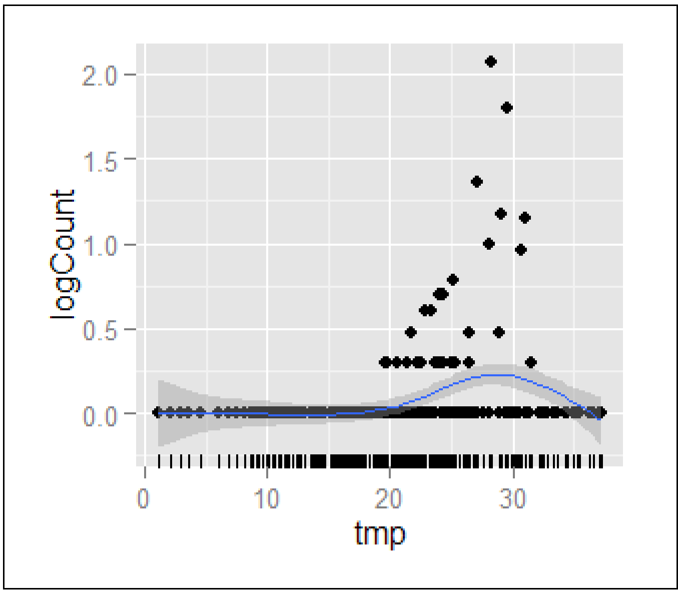


Fig. 7.2.10 - Scatter plot of temperature value versus log transformed catch values. The solid line is the smoother and light gray band is the 95% confidence interval.
Smoothing df = 4.62; F = 5.601; p-value = 3.87e-06 ***

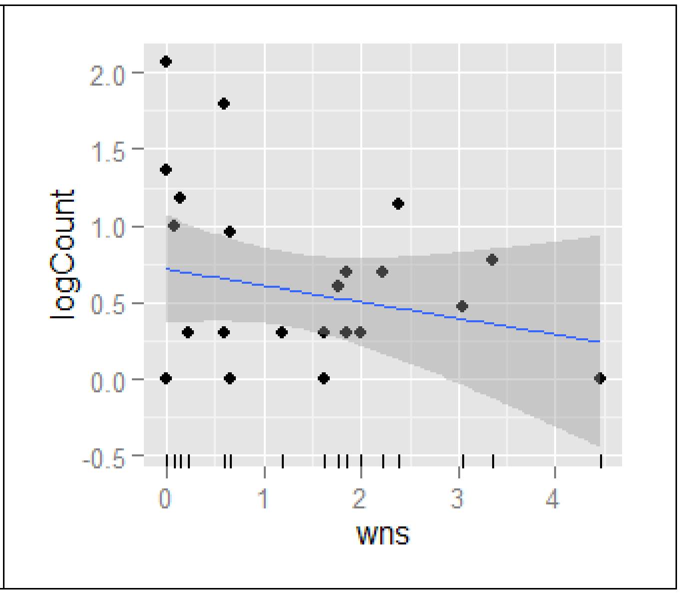


Fig. 7.2.11 - Scatter plot of wind speed value versus log transformed catch values. The solid line is the linear regression and light gray band is the 95% confidence interval.
R^2: 0.04817; F-statistic: 1.164; p-value: 0.2918

The daily flying activity is concentrated in the late afternoon between one hour before sunset and the dusk, and the flying activity in the morning is sporadic and no activity have been observed before two hours from dawn.

Considering the seasonal variations in the rhythm of the flight (fig. 7.2.12), in winter the limited data indicate flying activity only in the afternoon. Even in the spring data are scarce and show activity in the morning and in the afternoon. In summer, the rhythm is bimodal: low flying activity in the morning and a strongly accentuated peak at sunset. In autumn data are not many, but they indicate an unimodal rhythm with flying activity concentrated in the afternoon.

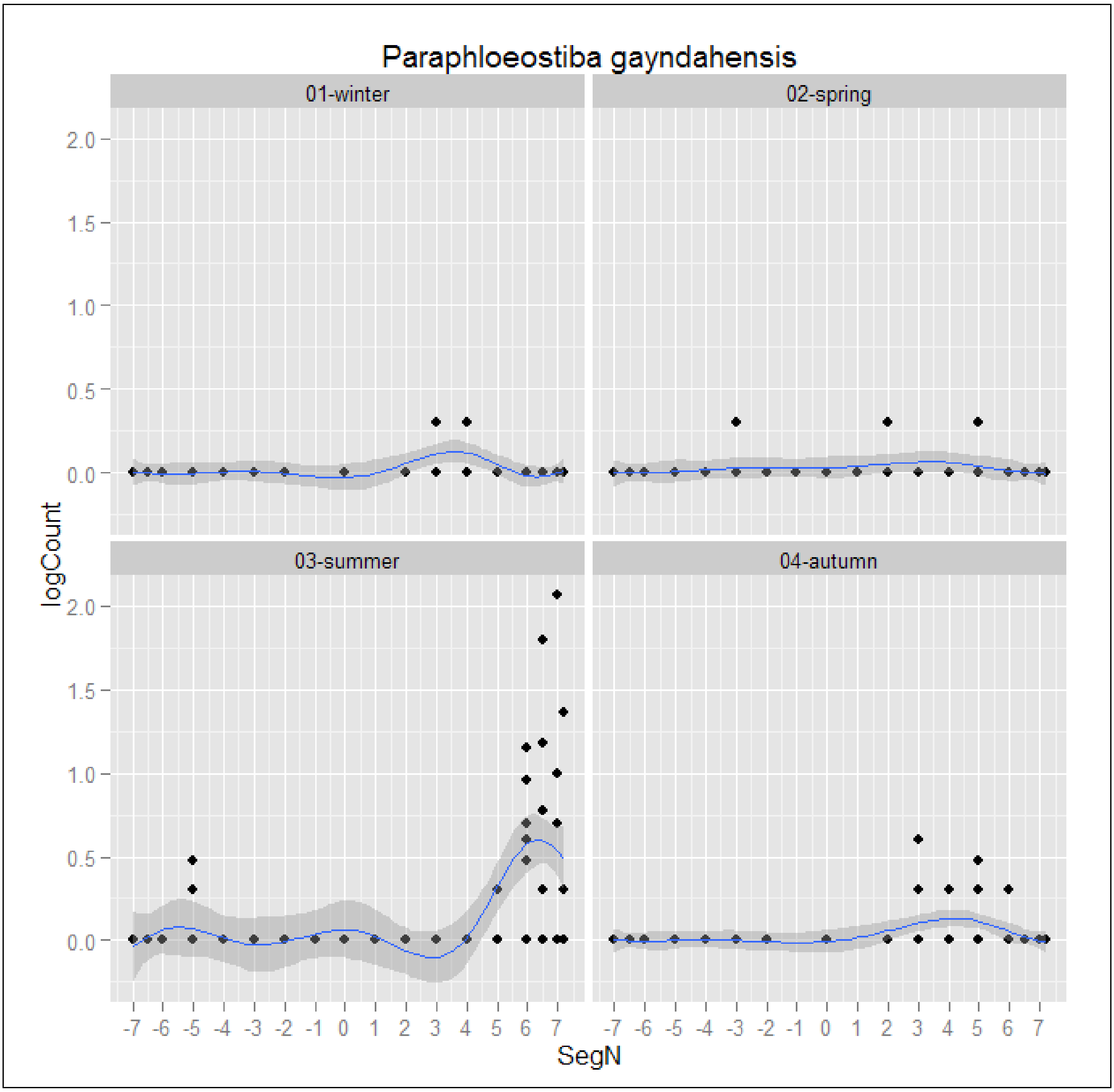


Fig. 7.2.12 – Seasonal variation in flying activity of *Paraphloeostiba gayndahensis.*

Steninae

With the hourly car-net were sampled three species belonging to this subfamily. None of them was sampled with frequencies that allow analysis of flying activity. The sampling data (date, time, time segment), the values of temperature (expressed in degrees centigrade) and the wind speed (expressed in meters per second), are shown in tab. 7.2.11.

Species	Date	Segment	SolarTime	tmp	wns	count
Stenus sp. 1	10-29-2010	Ss-4h	13.06	22.8	0.44	1
	11-18-2010	Ss-3h	13.48	19.7	0	1
Stenus sp. 2	10-29-2010	Ss-4h	13.06	22.8	0.44	1
Stenus sp. 3	10-29-2010	Ss-3h	14.06	26.5	0.44	1
	03-24-2011	Ss-4h	14.20	24.5	0.59	1

Tab. 7.2.11 – Captures data of Steninae with hourly car-net.

Staphylininae

With the hourly car-net were sampled 19 species belonging to this subfamily. The species for which it was not possible to comment on the flight activity because of low abundances, are shown in tab. 7.2.12. For each of them are shown the sampling data (date, time, time segment), the values of temperature (expressed in degrees centigrade) and the wind speed (expressed in meters per second).

Species	Date	Segment	SolarTime	tmp	wns	count
Gyrohypnus fracticornis	10-29-2010	Ss-4h	13.06	22.8	0.44	2
Lepidophallus pseudohesperius	11-11-2010	Sr+3h½	10.05	24.0	0	2
Lepidophallus pseudohesperius	12-02-2010	Sr+3h	9.56	21.7	0.74	1
Lepidophallus pseudohesperius	12-02-2010	No	11.45	23.8	1.56	2
Lepidophallus pseudohesperius	12-03-2010	Ss-4h	12.42	20.9	0.29	1
Neobisnius lathrobioides	03-24-2011	Ss-4h	14.20	24.5	0.59	1
Neobisnius lathrobioides	07-13-2011	Sr+2h½	7.20	28.2	1.04	1
Neobisnius lathrobioides	07-13-2011	Tw	19.45	27.2	0	6
Neobisnius lathrobioides	07-13-2011	Ss+½h	20.02	26.6	0	1
Neobisnius lathrobioides	07-27-2011	Ss-½h	18.44	25.2	3.36	1
Neobisnius p. procerulus	07-13-2011	Sr+1h	5.50	21.5	0	1
Neobisnius p. procerulus	07-13-2011	Ss	19.22	28.3	0	1
Neobisnius p. procerulus	07-13-2011	Tw	19.45	27.2	0	1
Neobisnius p. procerulus	07-13-2011	Ss+½h	20.02	26.6	0	2
Othius laeviusculus	10-29-2010	No	11.44	26.1	0.96	1
Othius laeviusculus	04-14-2011	Sr+5h	10.28	21.6	0.52	1
Philonthus debilis	03-17-2011	Sr+5h	11.09	24.7	0.52	5
Philonthus debilis	03-17-2011	Ss-4h	14.09	23.4	1.26	1
Philonthus debilis	07-27-2011	Sr+2h½	7.30	25.4	0.15	1
Philonthus debilis	08-04-2011	Ss-½h	18.35	29.2	0.15	1
Philonthus debilis	08-04-2011	Ss	19.05	28.0	0.07	2
Philonthus jurgans	11-11-2010	No-½h	11.05	24.1	1.48	2
Philonthus jurgans	03-17-2011	Sr+5h	11.09	24.7	0.52	2
Philonthus jurgans	03-24-2011	Ss-4h	14.20	24.5	0.59	1
Philonthus jurgans	08-04-2011	Sr+3h	8.07	31.3	0	1
Philonthus jurgans	08-04-2011	Ss-1h	18.05	30.8	0.67	1
Quedius humeralis	11-11-2010	Sr+3h½	10.05	24.0	0	1
Quedius levicollis	10-02-2010	Sr+5h	10.56	30.5	0.89	1
Quedius scintillans	12-02-2010	Ss-2h½	14.13	24.8	0.30	1
Xantholinus graecus	10-01-2010	Sr+3h	9.05	26.4	0.22	1
Xantholinus graecus	10-01-2010	Ss-2h	15.44	25.3	2.01	1
Xantholinus graecus	10-02-2010	Sr+3h	8.56	25.4	0.30	2
Xantholinus graecus	10-02-2010	Sr+4h	9.56	29.9	0.52	2
Xantholinus graecus	10-02-2010	Ss-1h	16.42	24.0	2.23	1
Xantholinus graecus	11-18-2010	Ss-4h	12.48	20.7	0	1
Xantholinus rufipes	11-18-2010	Sr+3h	9.42	12.5	0	1

Tab. 7.2.12 – Captures data of Staphylininae with hourly car-net.

Gabronthus maritimus

It is a species with adults flying throughout the year (tab. 7.2.13). The higher frequencies of capture with window traps are recorded in April, with the monthly car net in May, while the trend of the catch with the hourly car-net (tab. 7.2.14) shows the most abundant catches during July-August, in March and October

Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep	Oct	Nov	Dec
●	●	●	●	○	●	●	●	●	●	●	●

Tab. 7.2.13 – Presence data of *Gabronthus maritimus* in the months of the year, explanations in the text.

	Feb	Mar		Apr		Jul		Aug	Sep	Oct				Nov		Dec		
Seg	02.15	03.17	03.24	04.14	04.20	07.13	07.27	08.04	09.23	10.01	10.02	10.28	10.29	11.11	11.18	12.02	12.03	tot
Sr	-	-	-	-	-	-	-	3	-	-	-	-	-	-	-	-	-	3
Sr+½h	-	-	-	-	-	1	1	5	-	-	-	-	-	-	-	-	-	7
Sr+1h	-	-	-	-	-	3	5	36	1	-	-	-	-	-	-	-	-	45
Sr+2h	-	-	-	1	-	10	2	17	-	1	1	-	-	-	-	-	-	32
Sr+3h	-	2	-	-	-	-	3	2	-	1	-	-	5	2	-	3	-	18
Sr+4h	-	1	-	5	3	-	-	-	-	-	-	-	6	1	-	-	-	16
Sr+5h	-	2	3	3	-	-	-	-	-	-	-	-	-					8
Sr+6h				-	-	-	-	-										-
No	1	-	1	1	-	-	-	-	-	-	-	-	1	-	1	-	-	5
Ss-6h				-	-	-	-	-										-
Ss-5h	1	-	2	-	-	-	-	-	-	-	-	-	-					3
Ss-4h	3	-	12	-	-	-	-	-	-	-	-	-	29	-	11	-	4	59
Ss-3h	1	-	18	3	-	-	-	-	-	-	-	-	8	-	7	1	4	42
Ss-2h	-	-	125	-	-	-	-	-	-	-	-	-	4	-	14	17	10	170
Ss-1h	-	-	71	-	-	6	2	10	6	7	3	-	54	-	2	46	-	207
Ss-½h	-	-	-	-	-	59	33	35	20	35	12	2	14	-	-	5	-	215
Ss	-	-	-	-	-	49	169	66	19	8	31	-	-	-	-	-	-	342
Tw	-	-	-	-	-	37	64	26	5	6	10	-	-	-	-	-	-	148
tot	6	5	232	13	3	165	279	200	51	58	57	2	121	3	35	72	18	1320

Tab. 7.2.14 - Contingency table between dates and hourly segments for catches of *Gabronthus maritimus.*

The temperature data relative to summer (fig. 7.2.13) point to an interruption of flying activity during a wide time interval of central hours as a possible effect of high temperatures. At this time was often also found a strong wind. The temperature range in cui the flying activity were observed is 15.6 - 31.3 °C (fig. 7.2.14). In summer the winds of moderate strength do not stop the flight during late afternoon hours and sunset (fig. 7.2.13), but the scarce flying activity recorded in some days of winter (03-17), spring (04-20) and autumn (11-11) seems to be related with the presence of wind. In fact the regression analysis, for afternoon period, demonstrates a significant negative effect of the wind on the flying activity (fig. 7.2.15). Above a wind speed of 3.4 m/s, no catches were registered.

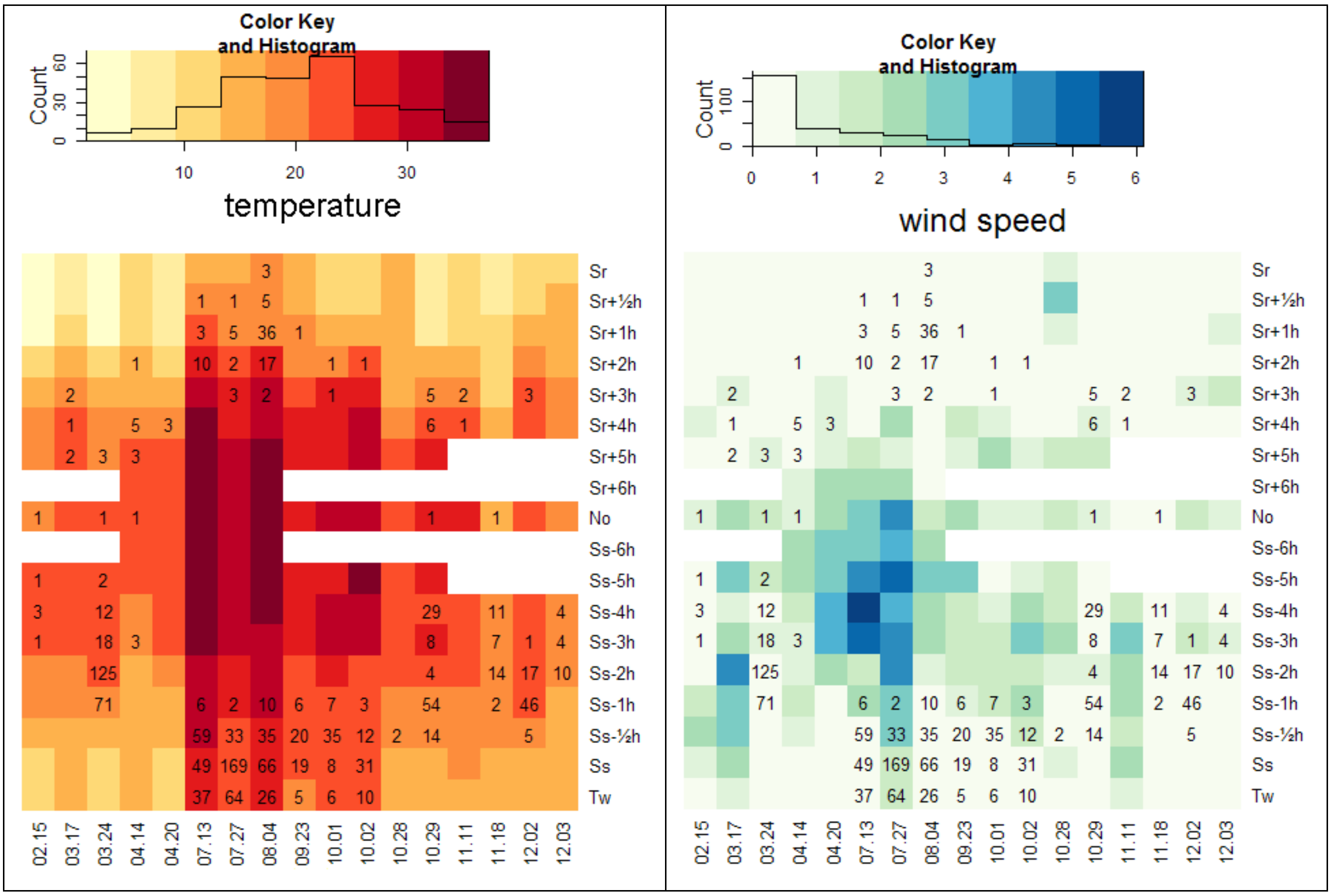


Fig. 7.2.13 - Heat map with the values of temperature (left) and wind (right) overlaid on those of the contingency table of *Gabronthus maritimus.*

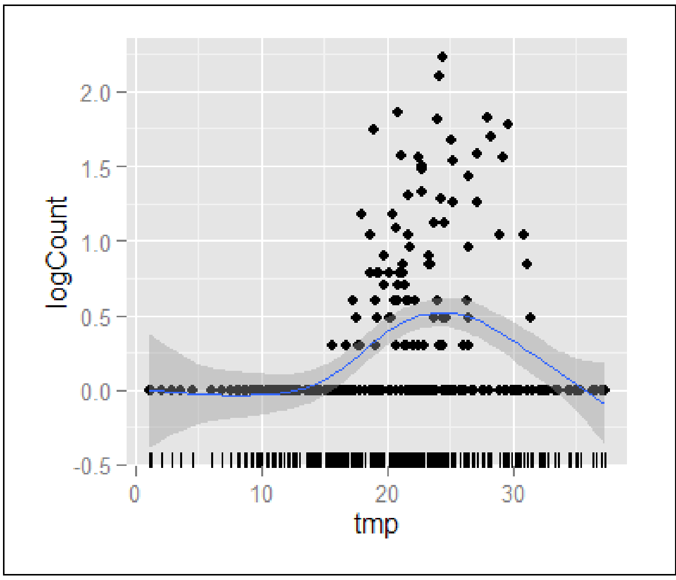


Fig. 7.2.14 - Scatter plot of temperature value versus log transformed catch values. The solid line is the smoother and light gray band is the 95% confidence interval.
Smoothing: 4.437; F: 5.402; p-value: 1.4e-10 ***

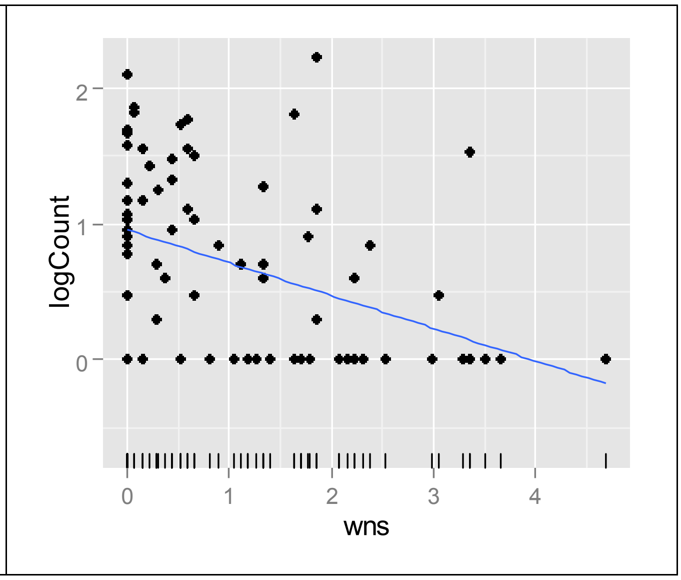


Fig. 7.2.15 - Scatter plot of wind speed value versus log transformed catch values. The solid line is the linear regression and light gray band is the 95% confidence interval.
R^2: 0.1614, F-statistic: 14.82; p-value: 0.0002423***

In summer and until the beginning of October, the flying activity is concentrated in the first part of the morning and especially in the late afternoon until dusk, and is distributed in the late morning and afternoon in the rest of the year.

Considering the seasonal variations in the rhythm of the flight (fig. 7.2.16), it is bimodal with marked differences between the seasons. In winter data are too little to show a rhythm of activity. In spring are showed two peaks of activity with the afternoon more remarkable and a reduction in the central hours. In summer the flying activity has two evident peaks: one in the early hours of the morning, the other, much more important, at sunset - dusk. In autumn, the morning peak is far from dawn, that afternoon, much more pronounced, is close to sunset and during the central hours activity is just detectable.

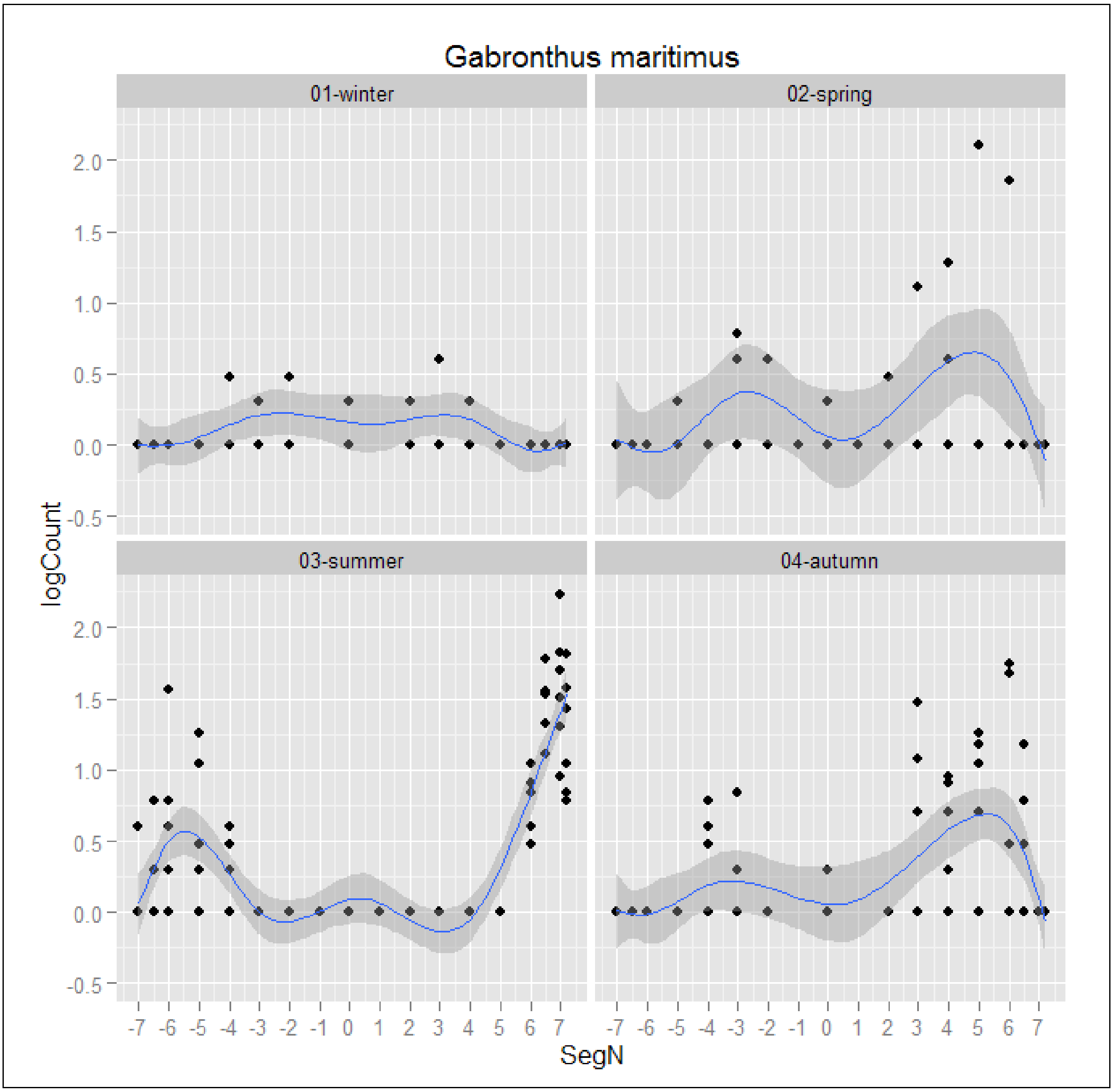


Fig. 7.2.16 – Seasonal variation in flying activity of *Gabronthus maritimus.*

Heterothops minutus

The adults flying are probably present during the whole year, although they are not sampled in January and April (tab. 7.2.15).

Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep	Oct	Nov	Dec
	●	●		●	○	●	●	●	●	●	●

Tab. 7.2.15 – Presence data of *Heterothops minutus* in the months of the year, explanations in the text.

The trend of captures with hourly car net (tab. 7.2.16) shows consistent data just for the summer period, indicating a flying activity concentrated in late afternoon. The little data available for the rest of year suggest a prevalence of flying activity in the afternoon.

	Feb	Mar		Apr		Jul		Aug	Sep	Oct				Nov		Dec		
Seg	02.15	03.17	03.24	04.14	04.20	07.13	07.27	08.04	09.23	10.01	10.02	10.28	10.29	11.11	11.18	12.02	12.03	tot
Sr	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sr+½h	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sr+1h	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sr+2h	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sr+3h	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	2
Sr+4h	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	2
Sr+5h	-	1	-	-	-	-	-	-	-	-	-	-	-					1
Sr+6h				-	-	-	-	-										-
No	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	2
Ss-6h				-	-	-	-	-										-
Ss-5h	-	-	-	-	-	-	-	-	-	-	-	-	-					-
Ss-4h	-	1	-	-	-	-	-	-	-	-	-	-	7	-	1	-	-	9
Ss-3h	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	1
Ss-2h	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	1
Ss-1h	-	-	-	-	-	-	-	-	2	4	1	-	-	-	-	1	-	8
Ss-½h	-	-	-	-	-	12	-	13	7	-	1	-	-	-	-	-	-	33
Ss	-	-	-	-	-	13	-	18	7	-	-	-	-	-	-	-	-	38
Tw	-	-	-	-	-	14	-	2	-	-	-	-	-	-	-	-	-	16
tot	1	2	-	-	-	39	-	33	18	4	2	-	7	2	2	3	-	113

Tab. 7.2.16 - Contingency table between dates and hourly segments for catches of *Heterothops minutus.*

The temperature range in which the flight activity were observed is 19.1 – 29.2 °C (fig. 7.2.18). The regression analysis for summer afternoon period shows a significant negative effect of the wind on the flying activity (fig. 7.2.19). Above a wind speed of 2.2 m/s, no catches were registered.

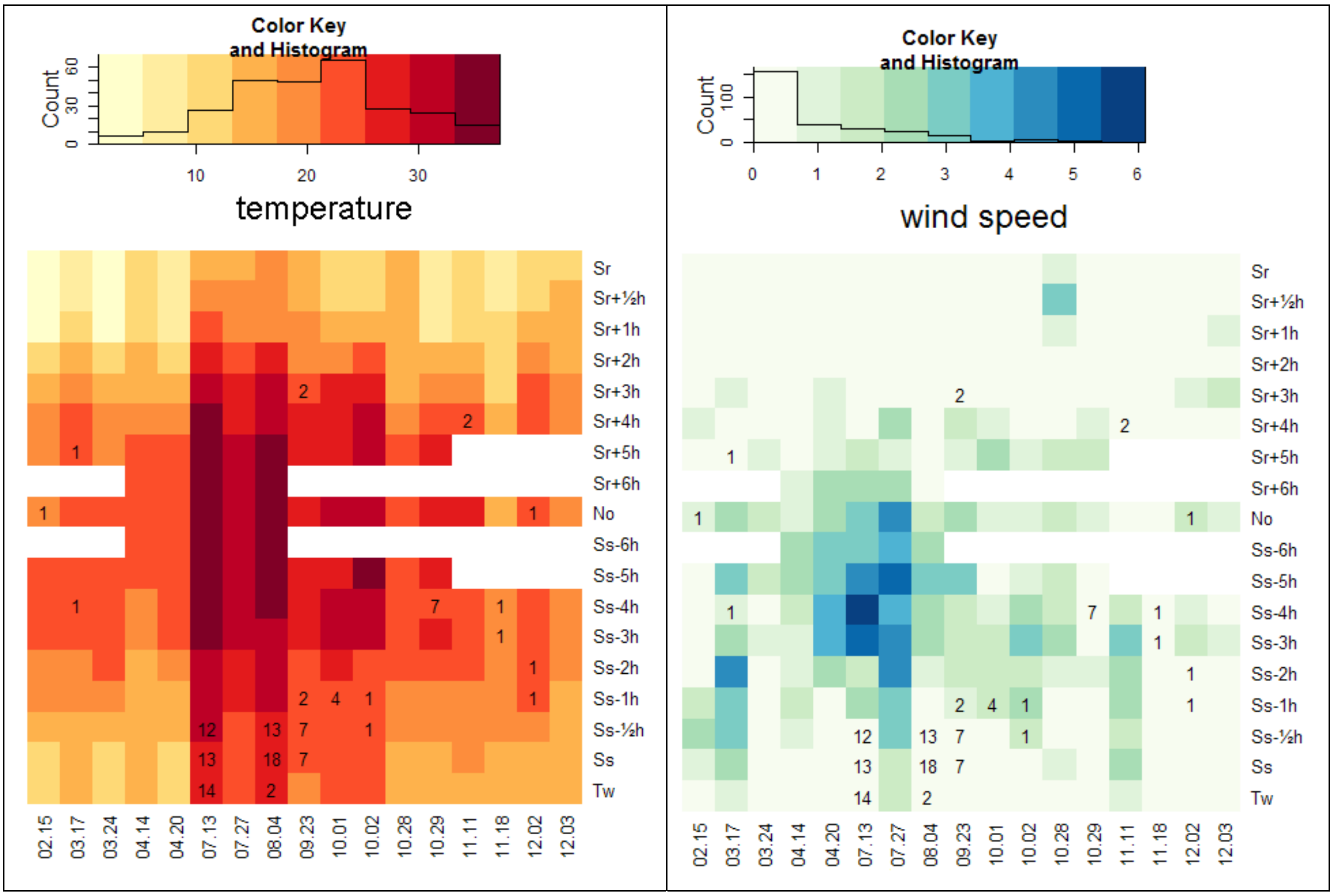


Fig. 7.2.17 - Heat map with the values of temperature (left) and wind (right) overlaid on those of the contingency table of *Heterothops minutus*.

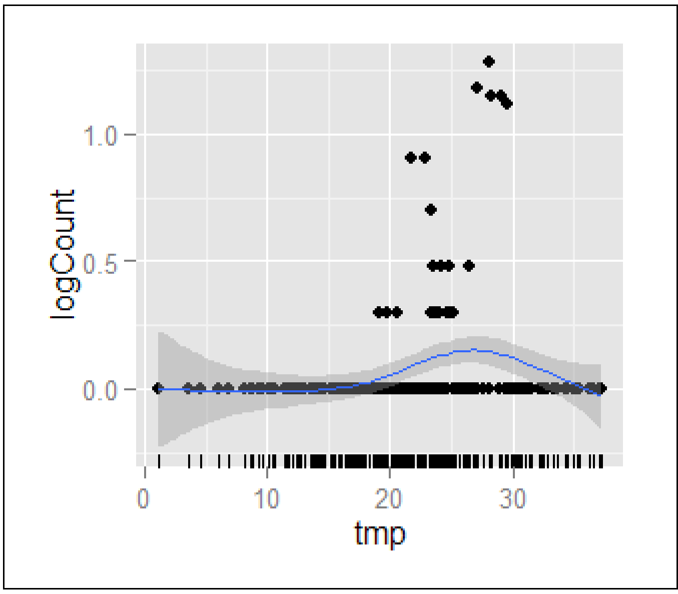


Fig. 7.2.18 - Scatter plot of temperature value versus log transformed catch values. The solid line is the smoother and light gray band is the 95% confidence interval.
Smoothing: 3.824; F: 4.717; p-value: 0.00148 **

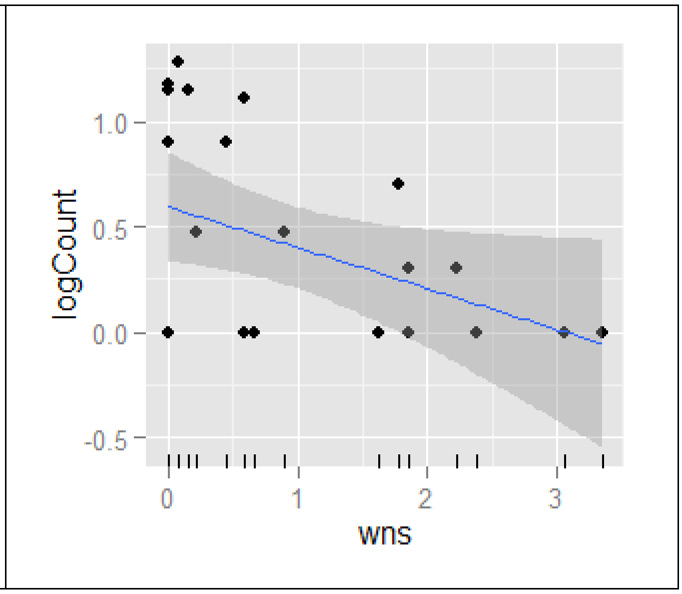


Fig. 7.2.19 - Scatter plot of wind speed value versus log transformed catch values. The solid line is the linear regression and light gray band is the 95% confidence interval.
R^2: 0.1726; F-statistic: 4.589; p-value: 0.04349*

Considering the seasonal variations in the rhythm of flight (fig. 7.2.20), the data for the winter period are too small to suggest a mode of rhythm, if we look at sporadic flying activity only during central hours and early afternoon. For spring there are no data. In the summer appears an evident peak at sunset and dusk, but there is also a data recorded for the morning. In the autumn, the limited data show a unimodal rhythm with a slight increase on the flight in the afternoon.

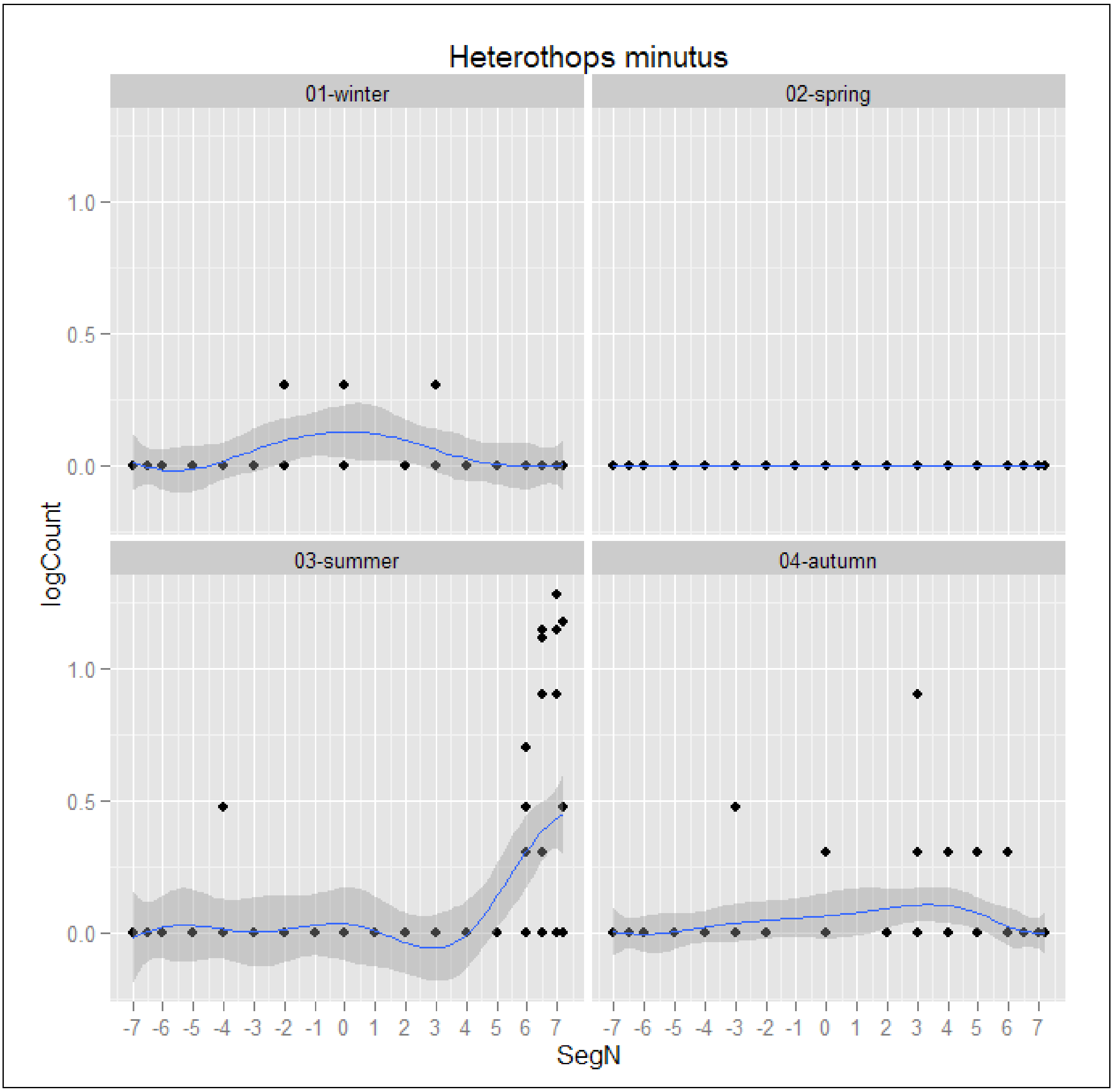


Fig. 7.2.20 – Seasonal variation in flying activity of *Heterothops minutus.*

Leptacinus intermedius

Flying adults probably during the whole year, although no captures occurred in January and November (tab. 7.2.17).

Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep	Oct	Nov	Dec
	●	●	●	●	●	●	●	●	●		●

Tab. 7.2.17 – Presence data of *Leptacinus intermedius* in the months of the year, explanations in the text.

The trend of catches with the hourly car net (tab. 7.2.18) shows consistent data only for summer, with flying activity concentrated, as in the preceding species, in the late afternoon, and there were no catches in autumn. The few data available for the rest of the year indicate a prevalence of flying activity in the afternoon.

	Feb	Mar		Apr		Jul		Aug	Sep	Oct				Nov		Dec		
Seg	02.15	03.17	03.24	04.14	04.20	07.13	07.27	08.04	09.23	10.01	10.02	10.28	10.29	11.11	11.18	12.02	12.03	tot
Sr	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sr+½h	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sr+1h	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	1
Sr+2h	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	2
Sr+3h	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	1
Sr+4h	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sr+5h	-	-	-	-	-	-	-	-	-	-	-	-	-					-
Sr+6h				1	-	-	-	-										1
No	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ss-6h				-	-	-	-	-										-
Ss-5h	1	1	1	-	-	-	-	-	-	-	-	-	-					3
Ss-4h	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2
Ss-3h	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ss-2h	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
Ss-1h	-	-	-	-	-	-	-	1	2	-	-	-	-	-	-	-	-	3
Ss-½h	-	-	-	-	-	3	1	4	-	-	-	-	-	-	-	-	-	8
Ss	-	-	-	-	-	4	2	19	2	-	-	-	-	-	-	-	-	27
Tw	-	-	-	-	-	6	1	6	-	-	-	-	-	-	-	-	-	13
tot	1	1	4	1	-	15	5	31	4	-	-	-	-	-	-	-	-	62

Tab. 7.2.18 - Contingency table between dates and hourly segments for catches of *Leptacinus intermedius.*

The temperature range in which the flight activity were observed is 21.1 – 30.8 °C (fig. 7.2.22). For summer afternoon period the regression analysis shoes a negative effect of wind on the flying activity (fig. 7.2.23). Above a wind speed of 3.4 m/s, no catches were registered.

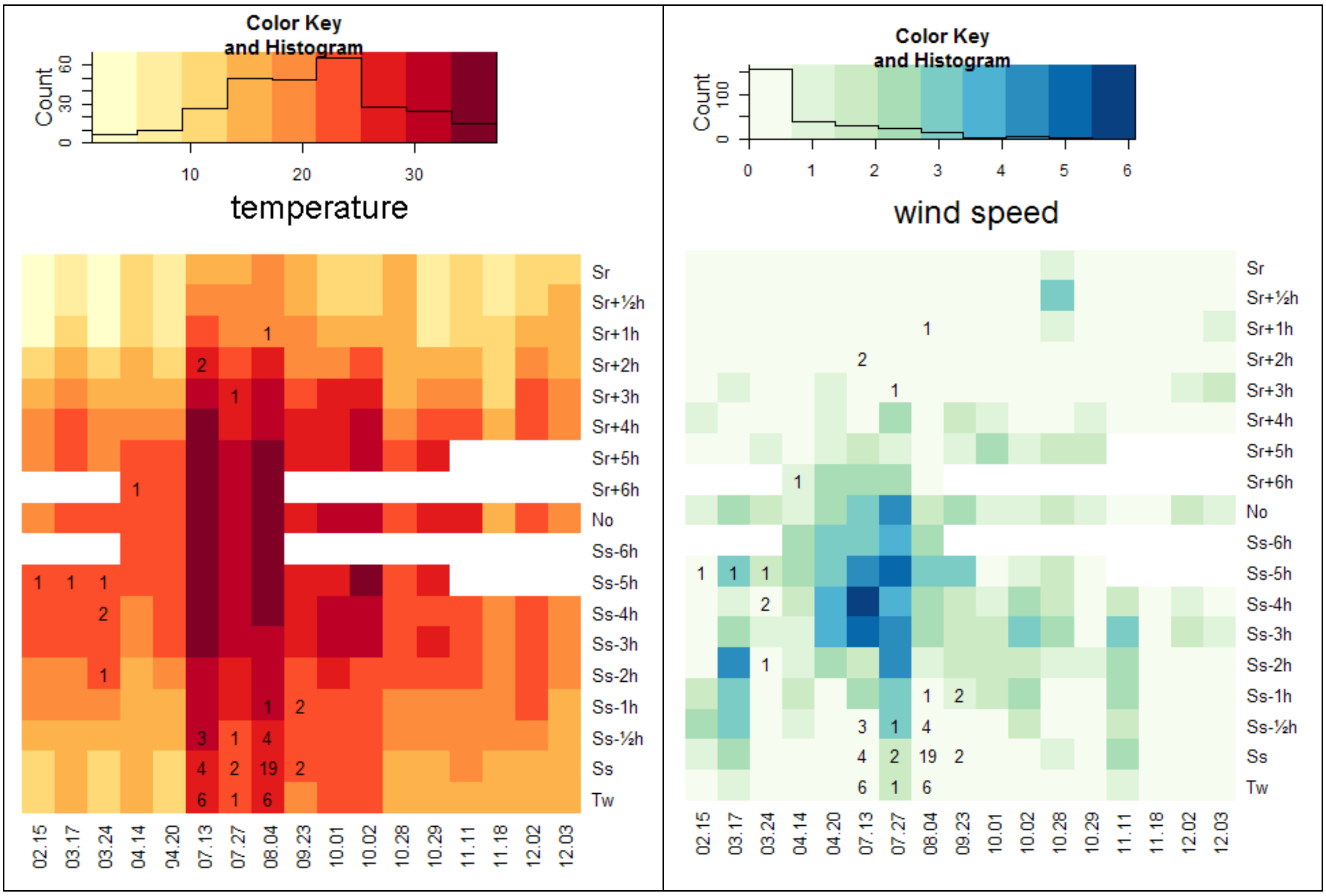


Fig. 7.2.21 - Heat map with the values of temperature (left) and wind (right) overlaid on those of the contingency table of *Leptacinus intermedius.*

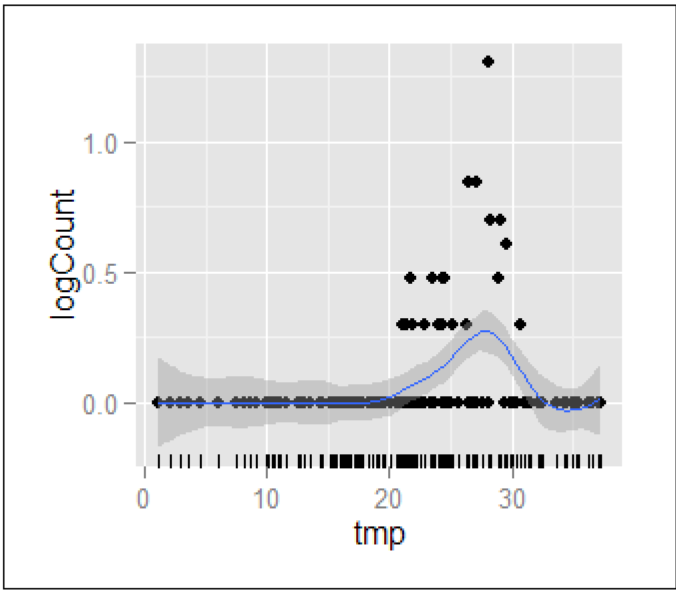


Fig. 7.2.22 - Scatter plot of temperature value versus log transformed catch values. The solid line is the smoother and light gray band is the 95% confidence interval.
Smoothing: 7.211; F: 8.093; p-value: 1.35e-05 ***

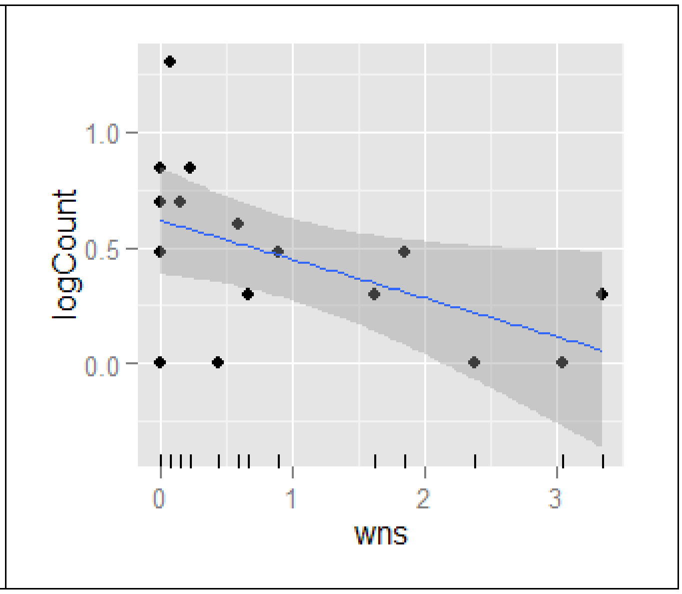


Fig. 7.2.23 - Scatter plot of wind speed value versus log transformed catch values. The solid line is the linear regression and light gray band is the 95% confidence interval.
R^2: 0.2626; F-statistic: 4.986; p-value: 0.04239*

Philonthus concinnus

Adults flying presumably during the whole year, even if no capture occurred in January (tab. 7.2.19). The frequencies of capture with the car net are small, while the species was abundantly sampled with windows traps, where it is the second in order of rank with more than 10% of the total catches. With both the car net and window traps the most abundant catches are recorded between March and April.

Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep	Oct	Nov	Dec
	●	●	●	○	●	●	●	●	●	●	●

Tab. 7.2.19 – Presence data of *Philonthus concinnus* in the months of the year, explanations in the text.

While the catches with the hourly car net were little (tab. 7.2.20), a flying activity emerges in the central hours. In summer prevail catches near sunset.

	Feb	Mar		Apr		Jul		Aug	Sep	Oct				Nov		Dec		
Seg	02.15	03.17	03.24	04.14	04.20	07.13	07.27	08.04	09.23	10.01	10.02	10.28	10.29	11.11	11.18	12.02	12.03	tot
Sr	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sr+½h	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sr+1h	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sr+2h	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sr+3h	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sr+4h	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	1
Sr+5h	1	-	2	-	2	-	-	-	-	-	-	-	-					5
Sr+6h				-	-	-	-	-										-
No	-	-	5	-	2	-	-	-	-	-	-	-	2	-	-	-	-	9
Ss-6h				-	-	-	-	-										-
Ss-5h	-	-	7	-	-	-	-	-	-	-	-	-	-					7
Ss-4h	1	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-	3
Ss-3h	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
Ss-2h	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ss-1h	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ss-½h	-	-	-	-	-	2	1	-	-	-	-	-	-	-	-	-	-	3
Ss	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	1
Tw	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	1
tot	3	-	14	-	4	4	1	1	-	-	-	-	4	-	-	-	-	31

Tab. 7.2.20 - Contingency table between dates and hourly segments for catches of *Philonthus concinnus.*

Megalinus glabratus

Adults flying in autumn period (tab. 7.2.21). Both with car net and window traps the most abundant catches are recorded between September and November.

Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep	Oct	Nov	Dec
				*				●	○	○	○

Tab. 7.2.21 – Presence data of *Megalinus glabratus* in the months of the year, explanations in the text.

The exiguous catches with hourly car net (tab. 7.2.22) show a flying activity during the central hours of the day.

	Feb	Mar		Apr		Jul		Aug	Sep	Oct				Nov		Dec		
Seg	02.15	03.17	03.24	04.14	04.20	07.13	07.27	08.04	09.23	10.01	10.02	10.28	10.29	11.11	11.18	12.02	12.03	tot
Sr	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sr+½h	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sr+1h	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sr+2h	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sr+3h	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sr+4h	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	1
Sr+5h	-	-	-	-	-	-	-	-	1	3	1	-	-					5
Sr+6h				-	-	-	-	-										-
No	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	1
Ss-6h				-	-	-	-	-										-
Ss-5h	-	-	-	-	-	-	-	-	-	-	1	-	-					1
Ss-4h	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	1
Ss-3h	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	1
Ss-2h	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ss-1h	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ss-½h	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ss	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Tw	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
tot	-	-	-	-	-	-	-	-	1	4	2	1	-	2	-	-	-	10

Tab. 7.2.22 - Contingency table between dates and hourly segments for catches of *Megalinus glabratus*.

Gyrohypnus angustatus

Adults flying in July, August, December, February, March (tab. 7.2.23) with captures always little abundant with a maximum of 6 specimens with hourly car-net.

Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep	Oct	Nov	Dec
	●	●		*		●	●				●

Tab. 7.2.23 – Presence data of *Gyrohypnus angustatus* in the months of the year, explanations in the text.

Sporadic catches with the hourly car-net highlight flying activity in the late afternoon hours in summer and during the central hours in spring.

Gabrius nigritulus

Adults flying presumably during the whole year, even if no capture occurred in November (tab. 7.2.24). Sporadic captures with a maximum of 5 specimens with hourly car-net.

Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep	Oct	Nov	Dec
●	●	●	●	●	●	●	●	●	●		●

Tab. 7.2.24 – Presence data of *Gabrius nigritulus* in the months of the year, explanations in the text.

The occasional catches with the hourly car-net highlight flying activity in the late afternoon hours in summer and autumn and during the central hours in spring.

Overall, the species belonging to the subfamily Staphylininae show flying activity that extends throughout the day with bimodal patterns as *G. maritimus* (with antemeridian activity and postmeridian peak) or with predominant postmeridian activity, as for *H. minutus* and *L. intermedius*, or in the central hours of the day as *P. concinnus* and *M. glabratus*. For other species, all sampled sporadically, 6 have been recorded throughout the day, 3 in the morning only and 2 in the afternoon only. The species listed in tab. 7.2.25 continue their flying activity even after the sunset.

Species	Segment	Date	
		07/13/11	08/04/11
Heterothops minutus	Ss+½h	1	
Leptacinus intermedius	Ss+½h	1	1
Neobisnius lathrobioides	Ss+½h	1	
Neobisnius p. procerulus	Ss+½h	2	

Tab. 7.2.25 - Staphylininae species with flying activity that extends after the sunset.

Paederinae

With the hourly car-net were sampled 14 species belonging to this subfamily; those for which it was not possible to comment the flying activity, because of the scarcity of catches, are shown in tab. 7.2.26. For each of them are shown the sampling data (date, time, time segment), the values of temperature (expressed in degrees centigrade) and the wind speed (expressed in meters per second).

Species	Date	Segment	SolarTime	tmp	wns	count
Achenium s. striatum	10-29-2010	No	11.44	26.1	0.96	1
	10-01-2010	Ss	17.44	21.8	0	1
Astenus b. bimaculatus	07-13-2011	Tw	19.45	27.2	0	1
Astenus pallidulus	08-04-2011	Tw	19.25	26.4	0.22	1
Astenus t. thoracicus	07-13-2011	Ss	19.22	28.3	0	1
Domene stilicina	12-03-2010	Ss-1h½	15.12	17.5	0.67	1
	03-24-2011	Sr+4h	9.59	19.5	0.37	1
Lithocharis nigriceps	11-18-2010	Ss-2h	14.48	20.5	0	1
	07-13-2011	Tw	19.45	27.2	0	3
	07-27-2011	Tw	19.33	24.0	1.63	1
Medon perniger	10-01-2010	Ss-½h	17.14	22.4	0.59	1
	03-24-2011	Ss-2h	16.15	24.1	0	1
	07-13-2011	Ss	19.22	28.3	0	1

Tab. 7.2.26 – Capture data of Paederinae with hourly car-net.

Scopaeus debilis

It is the most abundant species among Paederinae with adults flying from March to October (tab. 7.2.27) with a prevalence of catches with hourly car-net in summer and with monthly car-net in spring.

Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep	Oct	Nov	Dec
		●	●	●	●	●	●	●	●		

Tab. 7.2.27 – Presence data of *Scopaeus debilis* in the months of the year, explanations in the text.

The catches with the hourly car-net (tab. 7.2.28) are particularly abundant in the late afternoon of July 13 and may point to a swarming. The flying activity is concentrated in summer in the late afternoon and at sunset with limited activity in the early hours of the morning.

	Feb	Mar		Apr		Jul		Aug	Sep	Oct				Nov		Dec		
Seg	02.15	03.17	03.24	04.14	04.20	07.13	07.27	08.04	09.23	10.01	10.02	10.28	10.29	11.11	11.18	12.02	12.03	tot
Sr	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sr+½h	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sr+1h	-	-	-	-	-	3	1	3	-	-	-	-	-	-	-	-	-	7
Sr+2h	-	-	-	-	-	6	3	-	-	-	-	-	-	-	-	-	-	9
Sr+3h	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sr+4h	-	1	-	1	1	-	-	-	-	-	-	-	-	-	-	-	-	3
Sr+5h	-	-	2	2	-	-	-	-	1	-	-	-	-					5
Sr+6h				1	-	-	-	-										1
No	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ss-6h				-	-	-	-	-										-
Ss-5h	-	-	-	-	-	-	-	-	-	-	-	-	-					-
Ss-4h	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	1
Ss-3h	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ss-2h	-	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3
Ss-1h	-	-	-	-	-	3	-	13	1	1	-	-	1	-	-	-	-	19
Ss-½h	-	-	-	-	-	23	-	29	4	4	-	-	-	-	-	-	-	60
Ss	-	-	-	-	-	40	6	21	1	2	-	-	-	-	-	-	-	70
Tw	-	-	-	-	-	81	12	13	1	2	-	-	-	-	-	-	-	109
tot	-	1	5	4	1	156	22	79	8	9	-	-	2	-	-	-	-	287

Tab. 7.2.28 - Contingency table between dates and hourly segments for catches of *Scopaeus debilis.*

The temperature range in which the flight activity were observed is 19 – 31.1 °C (fig. 7.2.25). For summer afternoon period the regression analysis shoes a negative effect of wind on the flying activity (fig. 7.2.26). Above a wind speed of 2.4 m/s, no catches were registered.

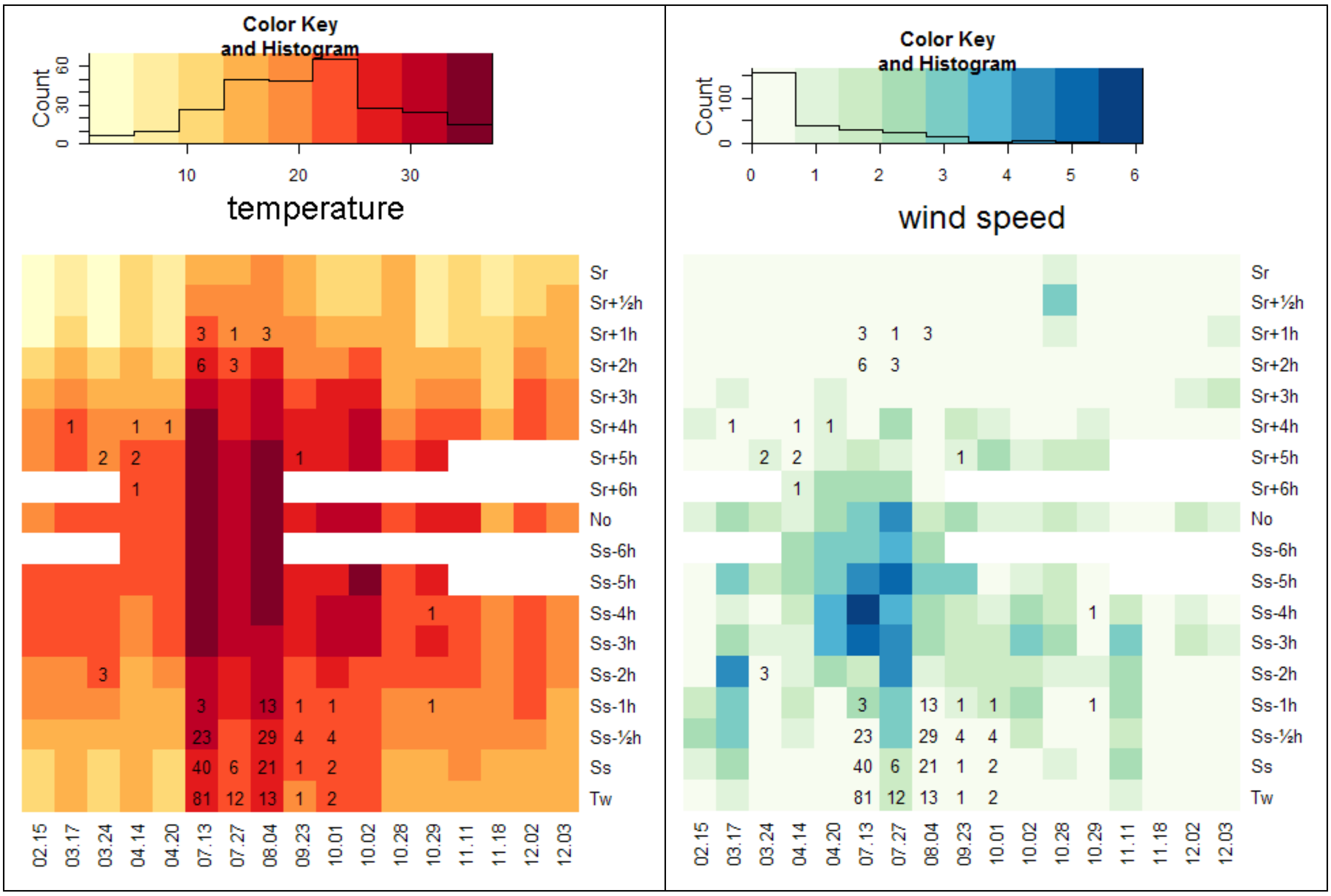


Fig. 7.2.24 - Heat map with the values of temperature (left) and wind (right) overlaid on those of the contingency table of *Scopaeus debilis.*

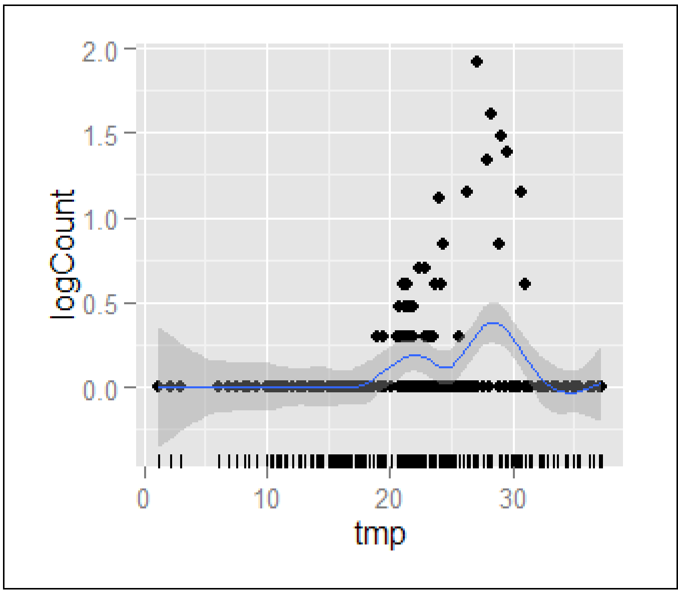


Fig. 7.2.25 - Scatter plot of temperature value versus log transformed catch values. The solid line is the smoother and light gray band is the 95% confidence interval.
Smoothing: 7.9; F: 8.596; p-value: 0.000147 ***

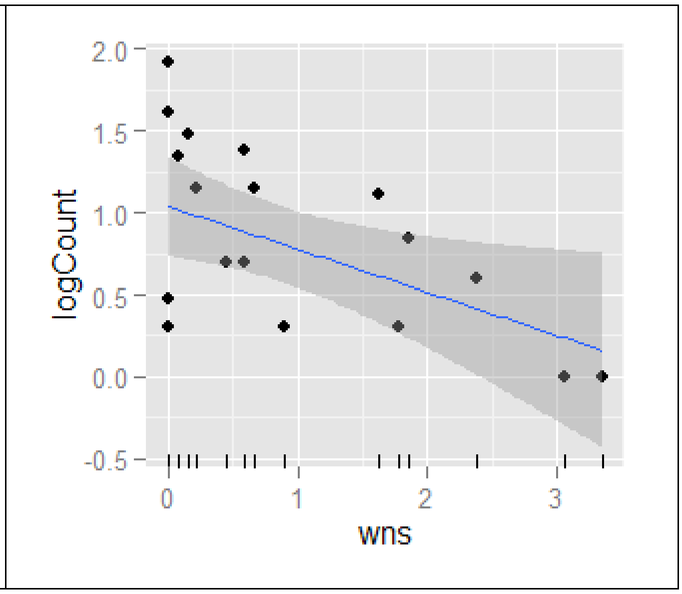


Fig. 7.2.26 - Scatter plot of wind speed value versus log transformed catch values. The solid line is the linear regression and light gray band is the 95% confidence interval.
R^2: 0.2568; F-statistic: 6.218; p-value: 0.02261**

Considering the seasonal variations in the rhythm of flight (fig. 7.2.27), in winter the unique data indicates flying activity only in the late morning. In spring the flying activity is detected in the late morning and in the afternoon. In summer, the rhythm is bimodal: a lower peak in the morning and a strongly accentuated one at sunset. The additional evening samples reveal that the flying activity in July and August is extended until one hour after sunset. In the autumn, the limited data indicate a flying activity only in the afternoon.

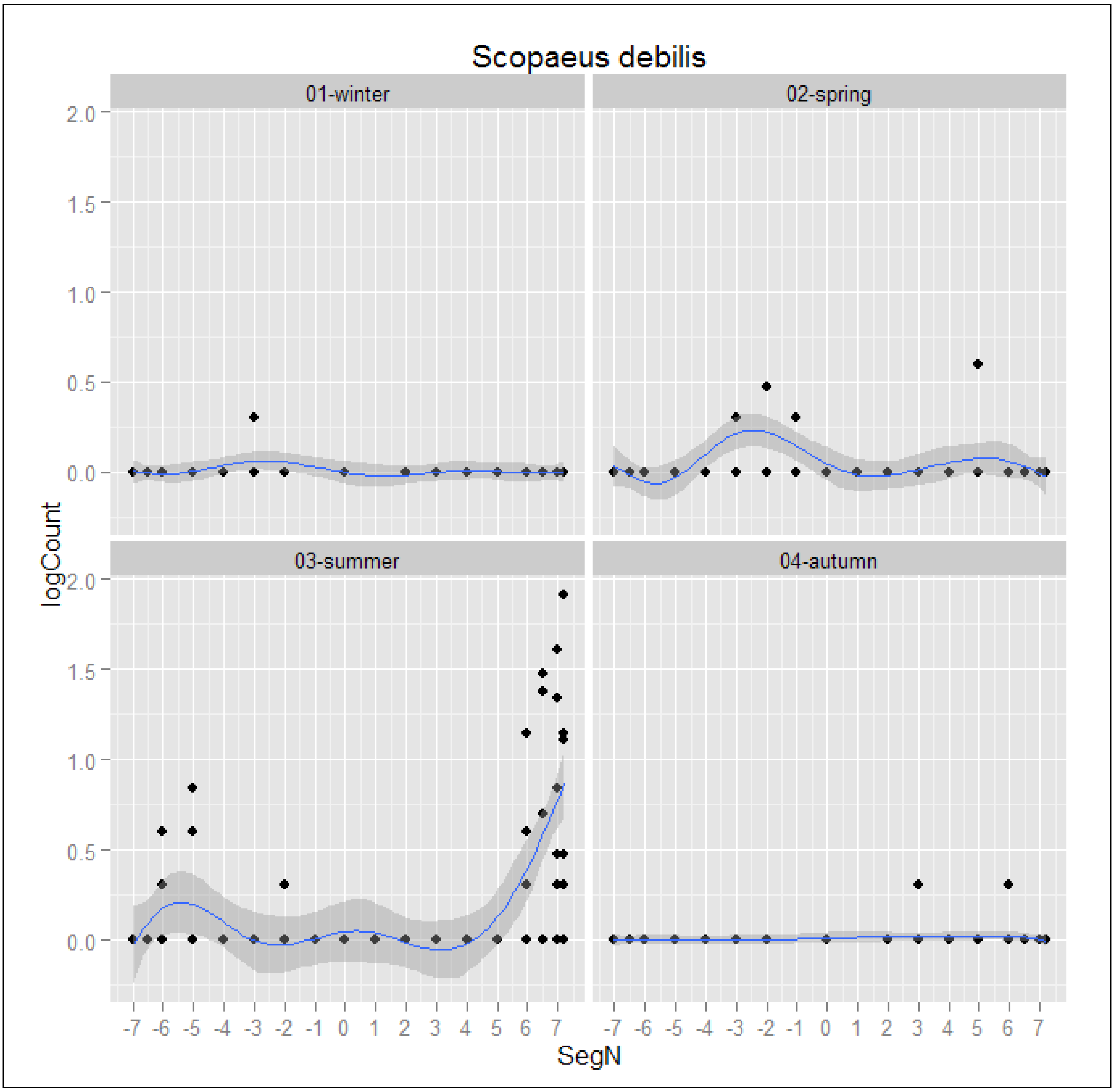


Fig. 7.2.27 – Seasonal variations in flying activity of *Scopaeus debilis.*

Scopaeus mitratus

Species less abundant than the previous one, but with adults flying presumably throughout the year (although it has not been sampled in January and September) (tab. 7.2.29), with a prevalence of catches from summer until early autumn.

Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep	Oct	Nov	Dec
	●	●	●	●	●	●	●		●	●	●

Tab. 7.2.29 – Presence data of *Scopaeus mitratus* in the months of the year, explanations in the text.

The data of the hourly car net (tab. 7.2.30) indicate the prevalence of flying activity in the afternoon. A single case of flying activity detected at noon.

	Feb	Mar		Apr		Jul		Aug	Sep	Oct				Nov		Dec		
Seg	02.15	03.17	03.24	04.14	04.20	07.13	07.27	08.04	09.23	10.01	10.02	10.28	10.29	11.11	11.18	12.02	12.03	tot
Sr	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sr+½h	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sr+1h	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	1
Sr+2h	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sr+3h	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sr+4h	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
Sr+5h	-	-	-	1	-	-	-	-	-	-	-	-	-					1
Sr+6h				-	-	-	-	-										-
No	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	1
Ss-6h				-	-	-	-	-										-
Ss-5h	-	-	1	-	-	-	-	-	-	-	-	-	-					1
Ss-4h	-	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	1	3
Ss-3h	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ss-2h	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	1
Ss-1h	-	-	-	-	-	-	3	1	-	1	2	-	-	-	-	1	-	8
Ss-½h	-	-	-	-	-	9	1	14	-	-	2	-	-	-	-	-	-	26
Ss	-	-	-	-	-	37	1	15	-	-	10	-	-	-	-	-	-	63
Tw	-	-	-	-	-	15	1	-	-	-	4	-	-	-	-	-	-	20
tot	-	2	2	1	-	61	6	32	-	1	18	-	-	1	-	1	1	126

Tab. 7.2.30 - Contingency table between dates and hourly segments for catches of *Scopaeus mitratus*.

The temperature range in which the flight activity were observed is 20.9 – 31.6 °C (fig. 7.2.29). The afternoon catches in July-August are significantly lower in the most windy day, but the regression for the summer afternoon period is not statistically significant (fig. 7.2.30). However, above a wind speed of 3.4 m/s, there were no catches.

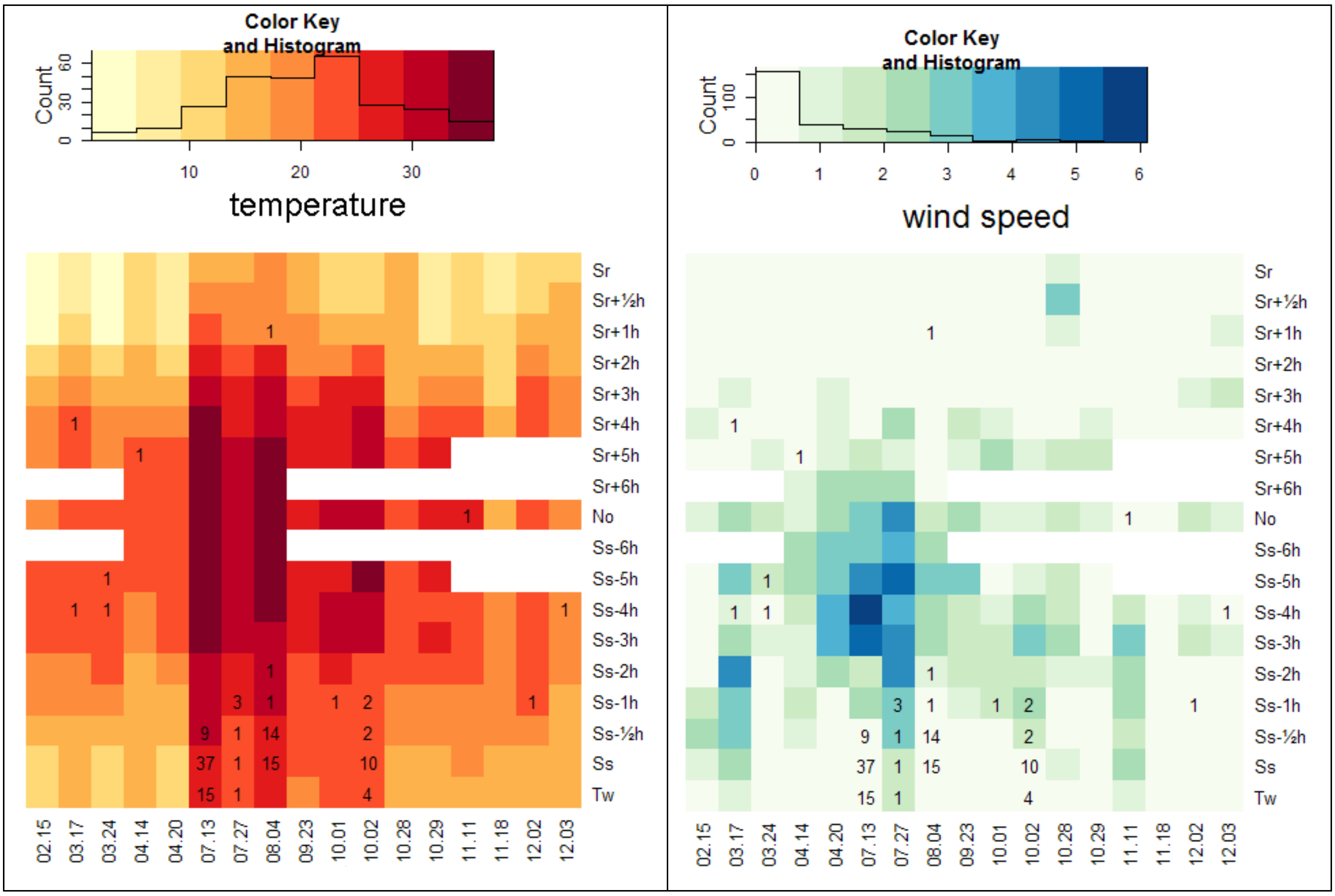


Fig. 7.2.28 - Heat map with the values of temperature (left) and wind (right) overlaid on those of the contingency table of *Scopaeus mitratus*.

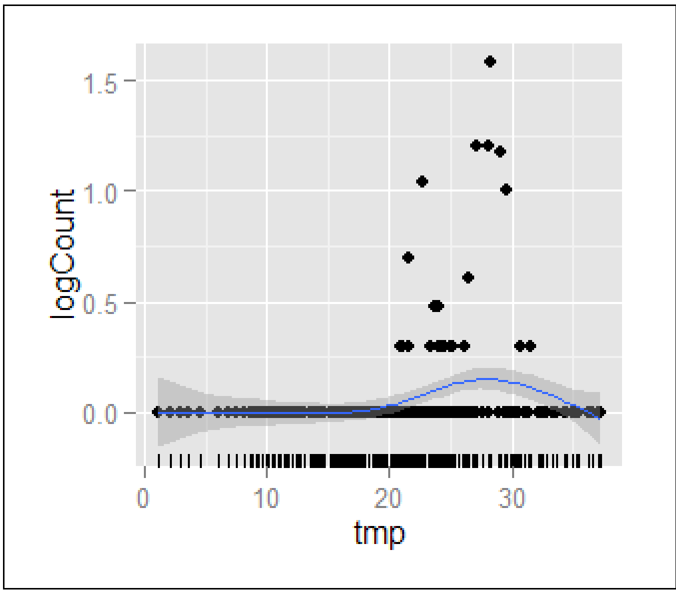


Fig. 7.2.29 Scatter plot of temperature value versus log transformed catch values. The solid line is the smoother and light gray band is the 95% confidence interval.
Smoothing: 4.331; F: 5.286; p-value: 0.000187 ***

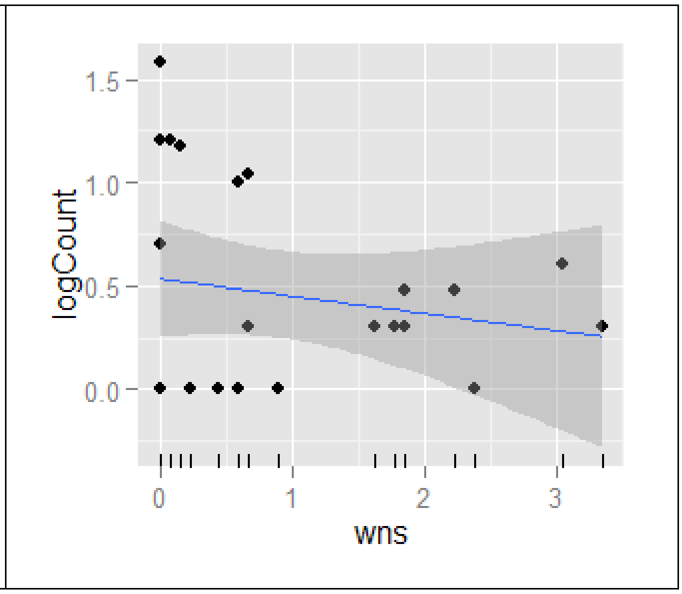


Fig. 7.2.30 - Scatter plot of wind speed value versus log transformed catch values. The solid line is the linear regression and light gray band is the 95% confidence interval.
R^2: 0.03124; F-statistic: 0.7094; p-value: 0.4087

Considering the seasonal variations in the rhythm of flight (fig. 7.2.31), in winter and spring, the limited data indicate a flying activity in the morning and in the afternoon. In summer there has been a sharp afternoon peak at sunset and dusk; a single data indicates flying activities just after sunrise.

Also for this species the additional evening samples reveal that flying activity in July and August is extended until one hour after sunset. In the autumn, the little data indicate a flying activity at noon and in the afternoon.

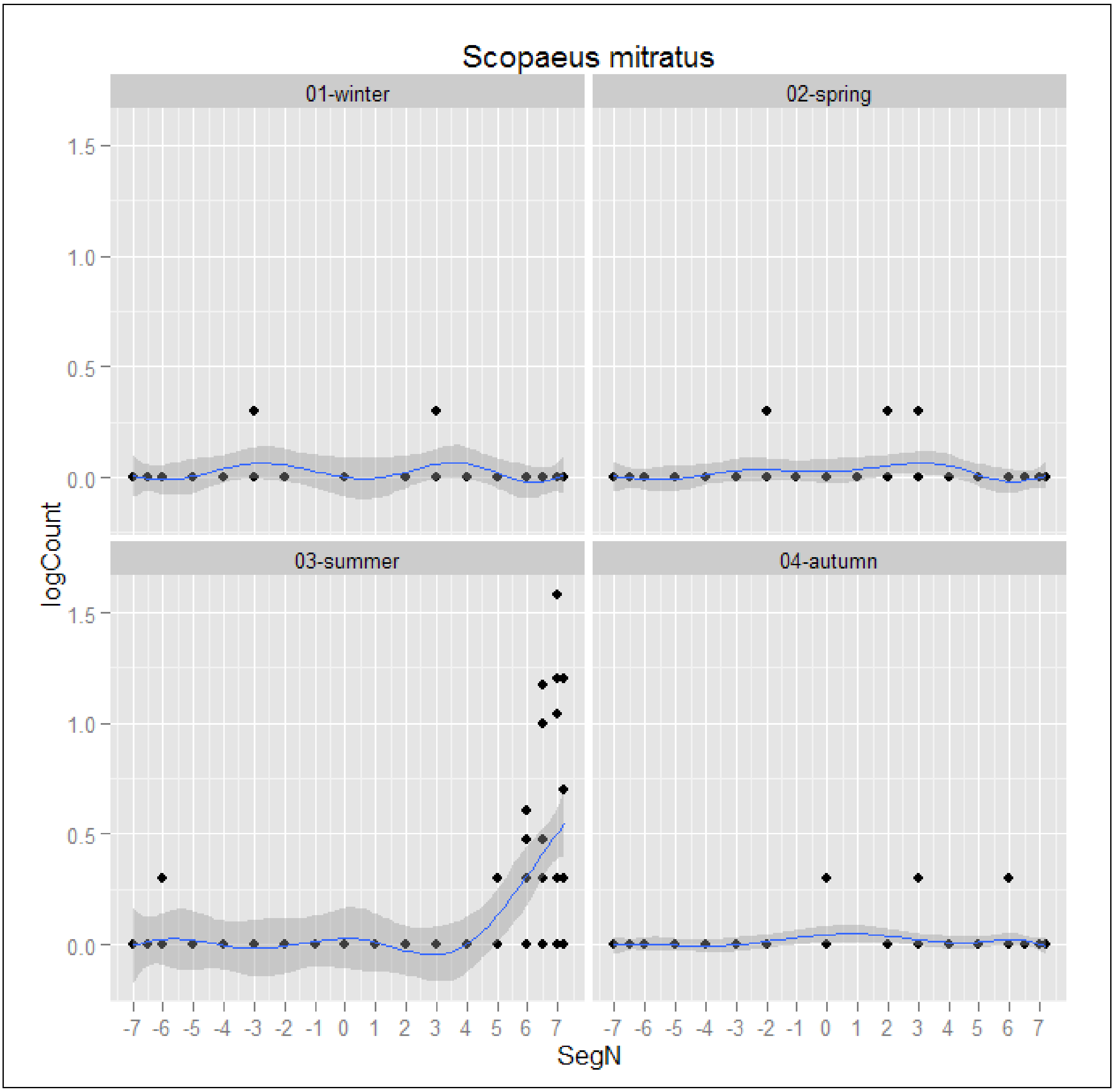


Fig. 7.2.31 – Seasonal variation in flying activity of *Scopaeus mitratus.*

Hypomedon debilicornis

Relatively abundant species, with adults flying from April to early autumn, with no catches in May and June (tab. 7.2.31). Catches of April report only one sample surveyed with window traps. The data of the hourly car-net show flying activity only in the late afternoon.

Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep	Oct	Nov	Dec
			●			●	●	●	●		

Tab. 7.2.31 – Presence data of *Hypomedon debilicornis* in the months of the year, explanations in the text.

Rugilus orbiculatus

Little abundant species, with adults flying presumably throughout the year (tab. 7.2.32), although there are no catches in January and November and in May it was sampled only with pit-fall traps.

Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep	Oct	Nov	Dec
	●	●	●	*	●	●	●	●	●		●

Tab. 7.2.32 – Presence data of *Rugilus orbiculatus* in the months of the year, explanations in the text.

The data of the hourly car-net show flying activity almost exclusively in the afternoon (only one specimen caught in antemeridian period, four hours after sunrise), especially at sunset and dusk. Also found in the additional samples post-dusk until half an hour after sunset.

Sunius algiricus

Little abundant species, with adults flying from June to August (tab. 7.2.33).

Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep	Oct	Nov	Dec
				*	●	●	●		*	*	

Tab. 7.2.33 – Presence data of *Sunius algiricus* in the months of the year, explanations in the text.

The data of the hourly car-net, however little, show flying activity almost exclusively at sunset and dusk with a single capture antemeridian at one hour after sunrise. The species was also found in the additional samples post-dusk until half an hour after sunset.

Luzea nigritula

Little abundant species with adults flying from April to October, although not sampled in May and September (tab. 7.2.34). Catches of April are only with one specimen captured with window traps.

Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep	Oct	Nov	Dec
			●		●	●	●		●		

Tab. 7.2.34 – Presence data of *Luzea nigritula* in the months of the year, explanations in the text.

The data of the hourly car-net, however little, show flying activity almost exclusively at sunset and dusk, but with a single specimen captured at one hour after sunset. The species was also found in the additional samples post-dusk until half an hour after sunset.

Astenus lyonessius

Little abundant species, with adults flying in February, March, May and October (tab. 7.2.35).

Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep	Oct	Nov	Dec
	●	●		○					●		

Tab. 7.2.35 – Presence data of *Astenus lyonessius* in the months of the year, explanations in the text.

The data of the hourly car net, however little, show flying activity almost in spring with flight in the late morning and early afternoon. A single specimen was caught in late October an hour before sunset.

Overall, species of Paederinae show flying activity principally in summer concentrated in the afternoon with a peak at sunset, or at dusk. In the days of 07-13 and 08-04 were collected 409 specimens belonging to 11 species representing respectively 76.9% and 78.6% of the total number of specimens and species surveyed for the subfamily.
An exception is for *A. lyonessius, D. stilicina* and *A. striatum* which have never been sampled in summer months and at sunset.
The species listed in tab. 7.2.36 are those who continue flying activity even after the sunset.

Species	Segment	Date 07/13/11	07/27/11	08/04/11
Astenus b. bimaculatus	Ss+1h	1		
Astenus pallidulus	Ss+1h	1		
Hypomedon debilicornis	Ss+½h	2		
	Ss+1h	1		
Luzea nigritula	Ss+½h	5		1
Rugilus orbiculatus	Ss+½h	1		
Scopaeus debilis	Ss+½h	39	4	1
	Ss+1h	3	4	2
Scopaeus mitratus	Ss+½h	2		
Sunius algiricus	Ss+½h	3		

Tab. 7.2.36 - Paederinae species with flying activity that extends after the sunset.

Tachyporinae

With the hourly car-net were sampled 11 species belonging to this subfamily. Those for which it was not possible to give comments on the flight activity because of low abundances, are shown in tab. 7.2.37 (species are indicated in bold with summer presences). For each of them are shown the sampling data (date, time, time segment), the values of temperature (expressed in degrees centigrade) and the wind speed (expressed in meters per second).

Species	Date	Segment	SolarTime	tmp	wns	count
Cilea silphoides	10-02-2010	Tw	18.08	21.6	0	1
Mycetoporus g. glaber	03-24-2011	No	12.07	22.9	1.41	1
	04-14-2011	Sr+6h	11.28	21.8	1.33	1
Mycetoporus reichei	12-02-2010	Ss-3h	13.43	24.4	1.86	1
		Ss-2h½	14.13	24.8	0.30	1
	04-20-2011	Sr+5h	10.20	22.5	0.89	2
Sepedophilus marshami	09-23-2010	Ss-1h	16.58	23.5	0.89	1
	10-29-2010	Ss-4h	13.06	22.8	0.44	1
	07-13-2011	Ss	19.22	28.3	0	1
Sepedophilus nigripennis	09-23-2010	Ss	17.58	21.7	0	1
	10-01-2010	Ss-2h	15.44	25.3	2.01	1
	10-02-2010	Ss-½h	17.12	23.8	1.86	1
		Ss	17.42	22.8	0.67	1
Tachyporus abner	10-02-2010	Ss-½h	17.12	23.8	1.86	1
Tachyporus caucasicus	12-03-2010	Ss-2h½	14.12	19.0	0.45	1
	02-15-2011	Ss-1h	16.39	19.4	1.41	1
	03-24-2011	Sr+5h	10.59	20.8	1.11	1

Tab. 7.2.37 – Capture data of Tachyporinae with hourly car-net.

Tachyporus nitidulus

Adults flying from autumn to spring (tab. 7.2.38) with a prevalence of catches with hourly car-net in the late autumn and with window traps in spring.

Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep	Oct	Nov	Dec
●	●	●	●	o	o				●	●	●

Tab. 7.2.38 – Presence data of *Tachyporus nitidulus* in the months of the year, explanations in the text.

The data of the hourly car-net (tab. 7.2.39), although in relatively low abundance, indicate that in autumn the flying activity is mainly in the afternoon, with a few appearances in the morning and noon. In February there were only a few catches in the afternoon, while in spring data show flying activity in the late morning, during the central hours and in early afternoon.

	Feb	Mar		Apr		Jul		Aug	Sep	Oct				Nov		Dec		
Seg	02.15	03.17	03.24	04.14	04.20	07.13	07.27	08.04	09.23	10.01	10.02	10.28	10.29	11.11	11.18	12.02	12.03	tot
Sr	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sr+½h	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sr+1h	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	1
Sr+2h	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sr+3h	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1
Sr+4h	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	1	3
Sr+5h	-	-	1	-	-	-	-	-	-	-	-	-	-					1
Sr+6h				-	-	-	-	-										-
No	-	-	1	1	-	-	-	-	-	-	-	-	-	-	2	-	-	4
Ss-6h				1	-	-	-	-										1
Ss-5h	-	1	1	-	-	-	-	-	-	-	-	-	-					2
Ss-4h	2	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5
Ss-3h	2	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	4	7
Ss-2h	1	1	-	-	-	-	-	-	-	-	-	-	1	-	1	1	6	11
Ss-1h	-	-	-	-	-	-	-	-	-	1	1	-	-	1	-	3	1	7
Ss-½h	-	-	-	-	-	-	-	-	-	-	-	1	-	1	1	2	1	6
Ss	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	1	2
Tw	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
tot	5	2	6	4	-	-	-	-	-	1	1	1	1	3	5	7	15	51

Tab. 7.2.39 - Contingency table between dates and hourly segments for catches of *Tachyporus nitidulus*.

The temperature range in which the flight activity were observed is 13.8 – 25.2 °C. Above a wind speed of 4.7 m/s, there were no catches registered.

Tachinus flavolimbatus

Species with adults flying from October to May (tab. 7.2.40), although in January there are no catches and the data of May refers to a single individual sampled with monthly car-net. There is a clear prevalence of catches during spring.

Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep	Oct	Nov	Dec
	●	●	●	●					●	○	○

Tab. 7.2.40 – Presence data of *Tachynus flavolimbatus* in the months of the year, explanations in the text.

The data of the hourly car-net (tab. 7.2.41), although in relatively low abundance, show in spring a flying activity mainly in the central hours, while in autumn the activity is dispersed from late morning to afternoon.

	Feb	Mar		Apr		Jul		Aug	Sep	Oct				Nov		Dec		
Seg	02.15	03.17	03.24	04.14	04.20	07.13	07.27	08.04	09.23	10.01	10.02	10.28	10.29	11.11	11.18	12.02	12.03	tot
Sr	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sr+½h	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sr+1h	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sr+2h	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sr+3h	-	-	-	-	-	-	-	-	-	-	-	-	-	3	-	-	-	3
Sr+4h	-	1	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-	4
Sr+5h	-	-	2	9	-	-	-	-	-	-	-	-	-					11
Sr+6h				5	-	-	-	-										5
No	-	-	1	5	2	-	-	-	-	-	-	-	-	-	2	-	-	10
Ss-6h				1	-	-	-	-										1
Ss-5h	-	-	1	1	2	-	-	-	-	-	-	-	-					4
Ss-4h	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
Ss-3h	1	-	-	1	-	-	-	-	-	-	-	-	-	-	2	-	-	4
Ss-2h	-	-	-	3	2	-	-	-	-	-	-	-	-	-	1	-	-	6
Ss-1h	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	1
Ss-½h	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	1
Ss	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Tw	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
tot	1	1	5	28	6	-	-	-	-	-	-	1	1	3	5	-	-	51

Tab. 7.2.41 - Contingency table between dates and hourly segments for catches of *Tachynus flavolimbatus.*

The temperature range in which the flight activity were observed is 16.8 – 21.1 °C. Above a wind speed of 3.3 m/s, there were no catches registered.

Tachyporus hypnorum

Little abundant species with adults flying from October to May (tab. 7.2.42). With the hourly car-net the species was sampled in spring and autumn between noon and late afternoon.

Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep	Oct	Nov	Dec
●	●	●	●	○					●	●	●

Tab. 7.2.42 – Presence data of *Tachyporus hypnorum* in the months of the year, explanations in the text.

Sepedophilus aestivus

Species low abundant with adult flying in March, July, September, October and December (tab. 7.2.43) With the hourly car-net it was sampled in spring, summer and early autumn always in the afternoon or at dusk.

Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep	Oct	Nov	Dec
		●				●		●	●		●

Tab. 7.2.43 – Presence data of *Sepedophilus aestivus* in the months of the year, explanations in the text.

Considering that all the species of this subfamily were sampled at low seasonal capture frequencies, variations in the rhythm of flight were investigated only at the level of subfamily (fig. 7.2.32). In winter, the limited data indicate a rhythm unimodal with flying activity continue from late morning to late afternoon. In the spring, the rhythm is similar, but with a strong increase of activity in the central hours. In summer, the limited data determined just from the 3 species of *Sepedophilus* indicate flying activity only in the late afternoon with a peak at sunset. In autumn there was a hint of bimodality: activity in the morning, reduction at noon, afternoon peak.

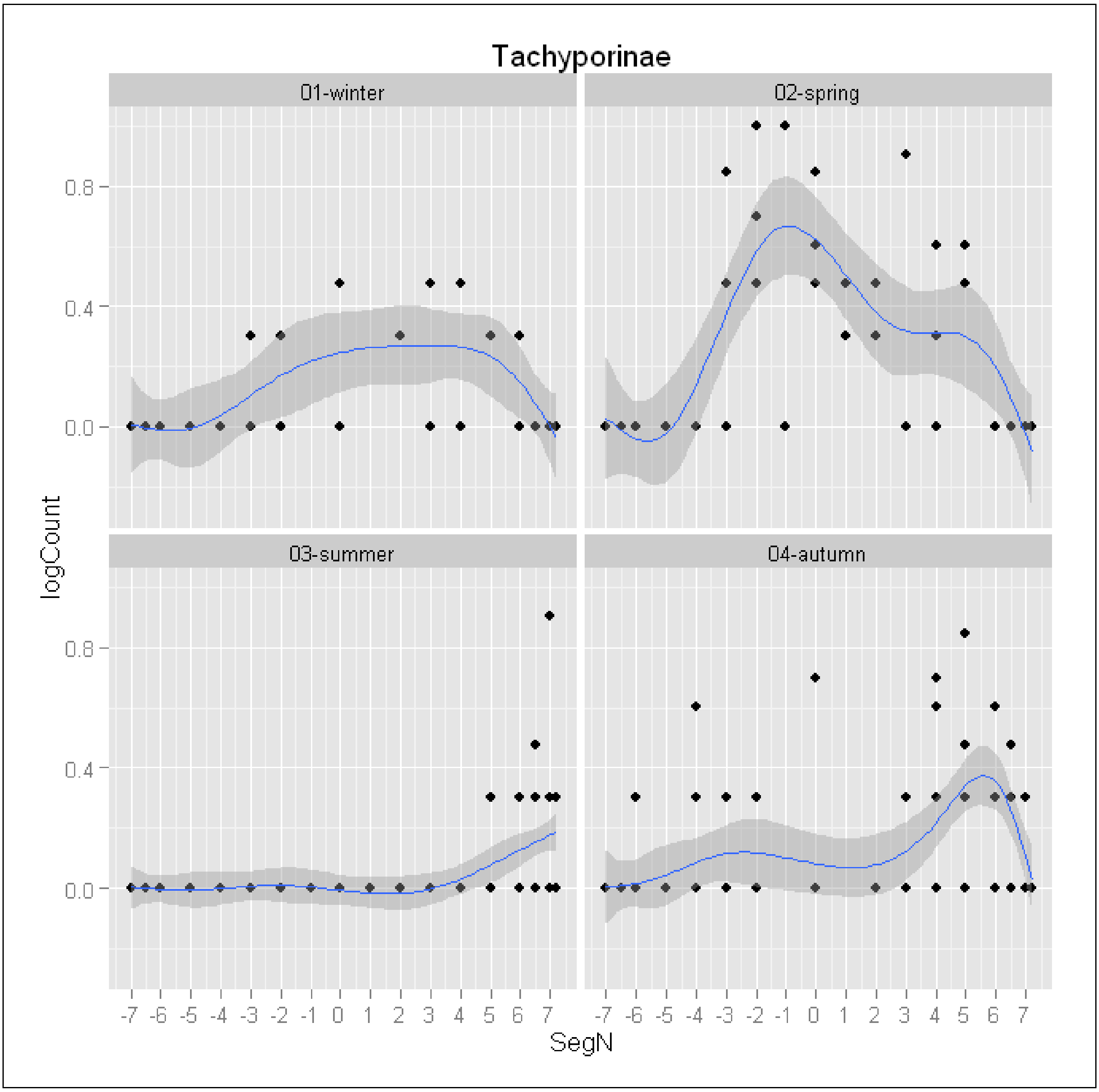


Fig. 7.2.32 – Seasonal variation in flying activity of Tachyporinae.

Habrocerinae

This family is present with only one species.

Habrocerus capillaricornis

Species detected with sensible abundance; adult flying presumably throughout the year, although there were no catches in January and February (fig. 7.2.44), with the majority of catches in summer.

Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep	Oct	Nov	Dec
	●	●	●	○	●	●	●	●	●		●

Tab. 7.2.44 – Presence data of *Habrocerus capillaricornis* in the months of the year, explanations in the text.

Analyzing the data of hourly car-net (tab. 7.2.45), the concentration on the afternoon of July 13 of most of the catches suggests an episode of swarming. In summer and in early October, the flying activity was detected only in the late afternoon, sunset and dusk; for the remaining period, in which the data relate however sporadic catches, in the afternoon.

	Feb	Mar		Apr		Jul		Aug	Sep	Oct				Nov		Dec		
Seg	02.15	03.17	03.24	04.14	04.20	07.13	07.27	08.04	09.23	10.01	10.02	10.28	10.29	11.11	11.18	12.02	12.03	tot
Sr	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sr+½h	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sr+1h	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sr+2h	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sr+3h	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sr+4h	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sr+5h	-	-	-	-	-	-	-	-	-	-	-	-	-					-
Sr+6h				-	-	-	-	-										-
No	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ss-6h				-	-	-	-	-										-
Ss-5h	-	-	-	-	-	-	-	-	-	-	-	-	-					-
Ss-4h	1	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	2
Ss-3h	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ss-2h	-	-	5	-	-	-	-	-	-	-	-	-	-	-	-	-	3	8
Ss-1h	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	1
Ss-½h	-	-	-	-	-	14	1	7	-	-	-	2	-	-	-	-	-	24
Ss	-	-	-	-	-	33	-	3	-	-	1	-	-	-	-	-	-	37
Tw	-	-	-	-	-	5	-	-	-	-	-	-	-	-	-	-	-	5
tot	1	-	5	-	-	52	1	10	1	-	1	2	1	-	-	-	3	77

Tab. 7.2.45 - Contingency table between dates and hourly segments for catches of *Habrocerus capillaricornis.*

The temperature range in which the flight activity were observed is 18.7 - 29.6 °C (fig. 7.2.33). The afternoon catches in summer are much lower during the most windy day, but the regression is not statistically significant (fig. 7.2.35). However, above a wind speed of 3.4 m/s, there were no catches.

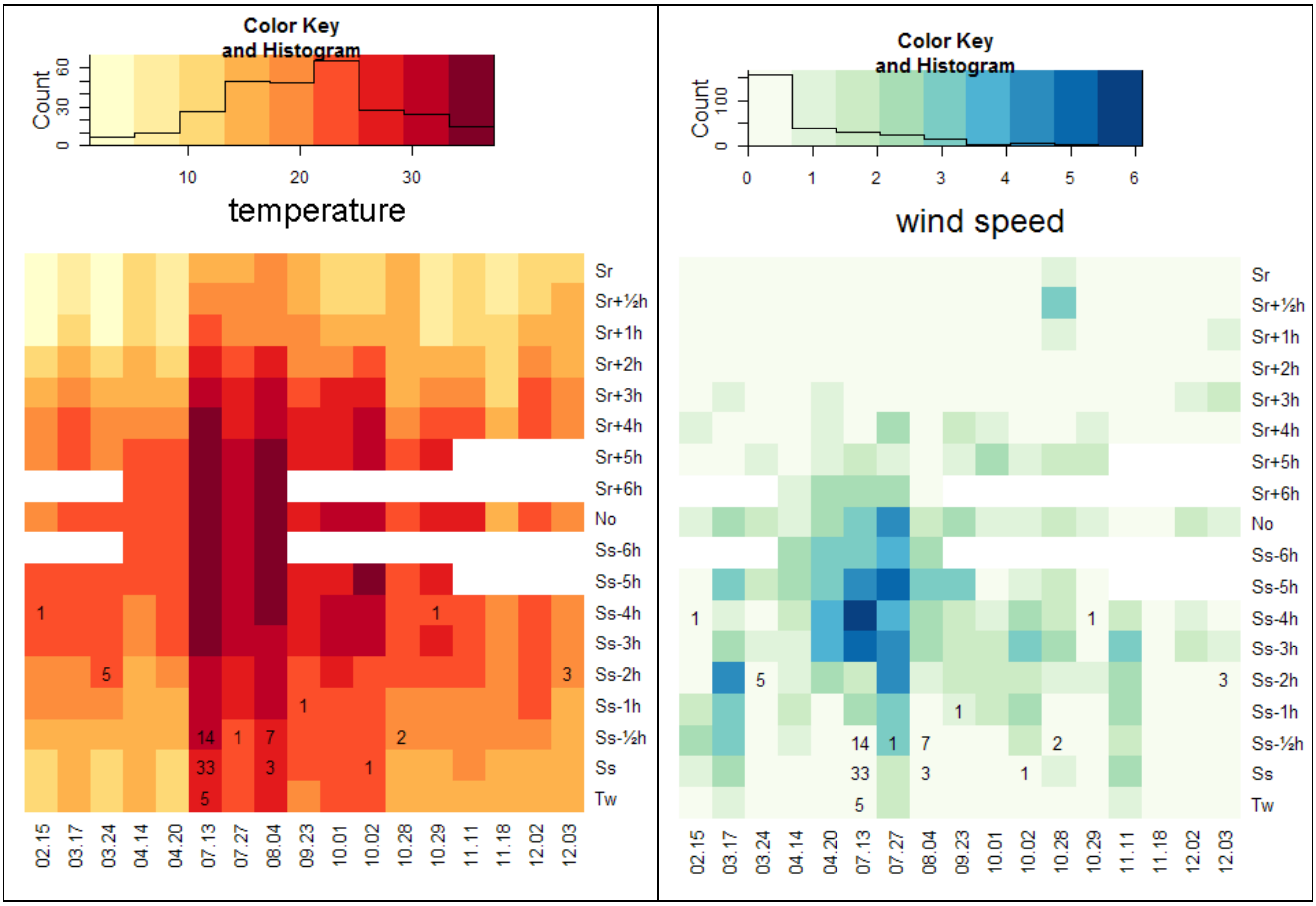


Fig. 7.2.33 - Heat map with the values of temperature (left) and wind (right) overlaid on those of the contingency table of *Habrocerus capillaricornis.*

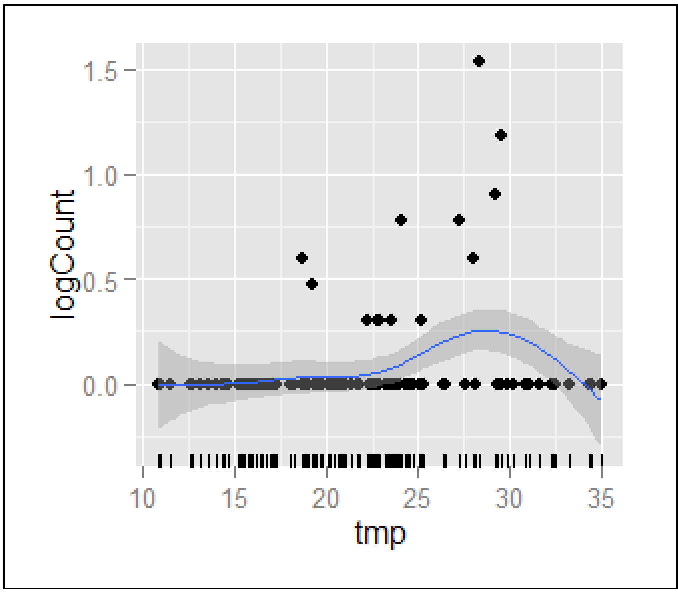


Fig. 7.2.34 - Scatter plot of temperature value versus log transformed catch values. The solid line is the smoother and light gray band is the 95% confidence interval.
Smoothing: 4.515; F: 5.489; p-value: 0.00664 **

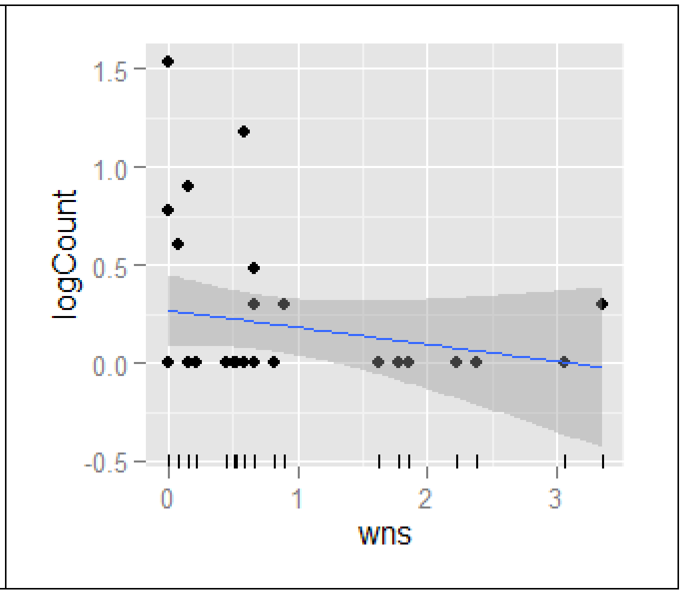


Fig. 7.2.35 - Scatter plot of wind speed value versus log transformed catch values. The solid line is the linear regression and light gray band is the 95% confidence interval.
R^2: 0.3887; F-statistic: 1.396 ;p-value: 0.2467

Considering the seasonal variations in the rhythm of flight (fig. 7.2.36), the limited data indicate a trend of flying activity similar for all seasons. The activity is in the afternoon, with concentration at sunset in summer.

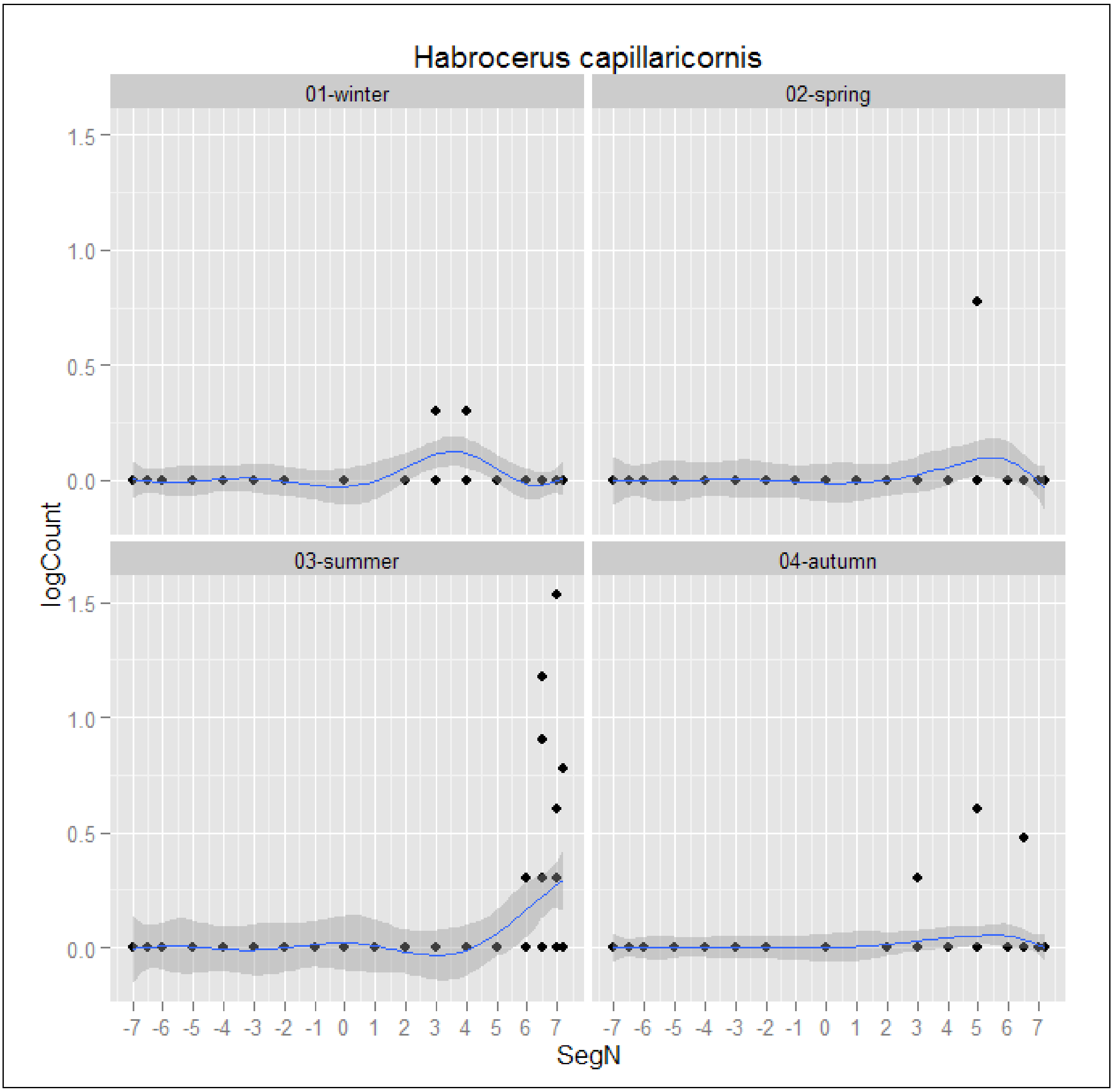


Fig. 7.2.36 – Seasonal variation in flying activity of *Habrocerus capillaricornis.*

Aleocharinae

Have not been determined those species of sampling with hourly car-net; the analysis refers, therefore, to the whole subfamily.
From the samplings made with the monthly car-net and window traps, for which the species have been determined, it is noted that adults of the 5 most abundant species (more than 50 catches) are presumably flying throughout the year, although are absent in the samples of a few months.
Among these species, *Cordalia obscura*, shows the frequencies of capture the most significant and high with the monthly car-net in summer; *Atheta* gr. *fungi* recorded the most abundant catches, both with the monthly car-net and with window traps in spring and autumn; *Amarochara umbrosa* and *Atheta palustris*, sampled mainly with the monthly car-net, have a peak in spring; *Atheta inquinula* has presences distributed from spring to autumn.
The differences in the frequency of capture of these taxa in the different periods of the year strongly influence the pattern of flying for the subfamily.

	Feb	Mar		Apr		Jul		Aug	Sep	Oct				Nov		Dec		
Seg	02.15	03.17	03.24	04.14	04.20	07.13	07.27	08.04	09.23	10.01	10.02	10.28	10.29	11.11	11.18	12.02	12.03	tot
Sr	-	-	-	-	-	-	-	11	4	-	-	-	-	-	-	-	-	15
Sr+½h	-	-	-	-	-	1	1	13	2	-	-	-	-	-	-	-	-	17
Sr+1h	-	-	-	-	-	32	11	23	7	-	2	-	-	-	-	-	-	75
Sr+2h	-	2	-	15	-	150	23	25	23	10	19	6	2	11	-	6	15	307
Sr+3h	-	10	2	81	16	8	8	4	13	46	28	5	44	82	7	67	3	424
Sr+4h	11	111	27	98	38	-	2	-	2	-	22	8	100	46	8	3	17	493
Sr+5h	24	139	125	175	62	-	-	-	15	1	1	1	169					712
Sr+6h				45	10	-	-	-										55
No	7	19	34	44	9	-	-	-	-	1	5	1	32	16	36	18	7	229
Ss-6h				18	13	-	-	-										31
Ss-5h	41	11	138	10	34	-	-	-	-	4	-	1	78					317
Ss-4h	32	33	168	29	10	-	-	-	2	5	1	2	300	-	94	11	18	705
Ss-3h	33	16	69	34	12	-	-	-	9	7	-	-	88	1	74	9	25	377
Ss-2h	32	7	106	30	33	4	-	2	45	40	8	6	39	1	55	41	73	522
Ss-1h	14	2	46	10	18	58	25	70	129	69	60	18	75	-	25	57	14	690
Ss-½h	-	-	4	3	6	243	61	463	124	168	55	18	18	27	8	14	6	1218
Ss	-	-	-	-	-	676	140	336	94	66	62	1	7	-	1	13	3	1399
Tw	-	-	-	-	-	100	38	70	1	5	8	-	-	-	-	1	-	223
tot	194	350	719	592	261	1272	309	1017	470	422	271	67	952	184	308	240	181	7809

Tab. 7.2.46 - Contingency table between dates and hourly segments for catches of Aleocharinae.

Analyzing the data of the hourly car-net for the whole Aleocharinae (tab. 7.2.46), flying activity in summer is concentrated in the first part of the morning and in late afternoon until dusk. One observes au interruption of the flight over a wide interval in central hours correlated with the high temperatures (fig. 7.2.37). In early autumn (early October) the activity is concentrated at the end of the afternoon. In the remaining part of the year flight has its highest values in the late morning and the first half of the afternoon, without any interruption during the central hours. In April, the flying activity is much higher in the morning. The low temperatures in the morning result in a delay of the flight (fig. 7.2.37). The strong wind attenuates flying activity more or less strongly, but not cancelling it (fig. 7.2.37).
The temperatures range in which the flying activity were observed is 12.5 - 33.3 °C (fig. 7.2.38). In the complex of catches regression analysis with the wind speed results significantly negative (fig. 7.2.39). Above values of 4.7 m/s catches are not registered.

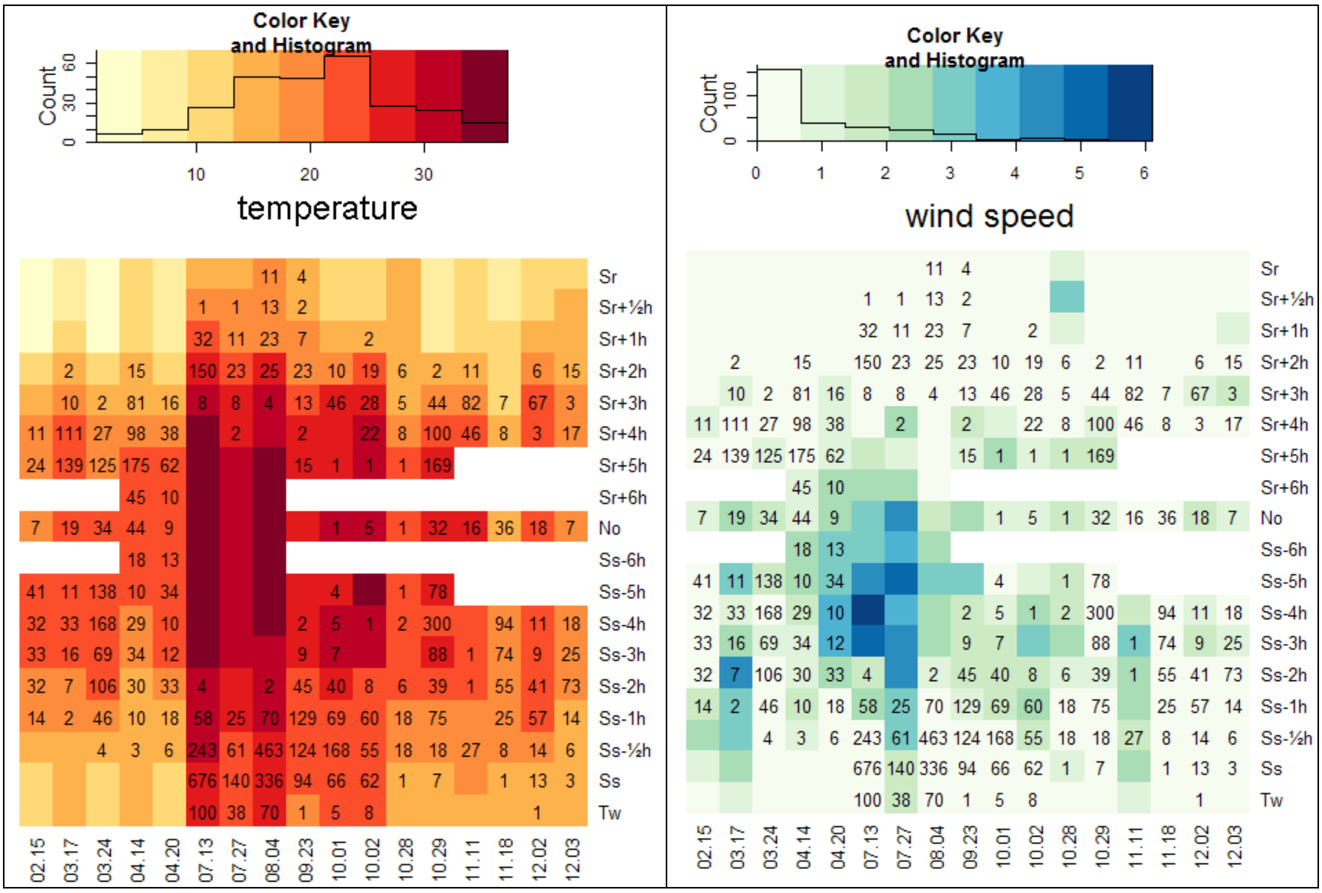


Fig. 7.2.37 - Heat map with the values of temperature (left) and wind (right) overlaid on those of the contingency table of Aleocharinae.

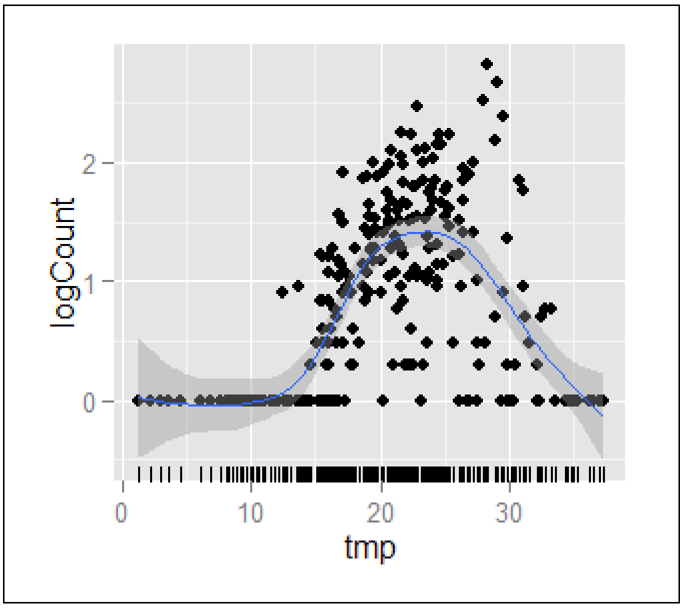


Fig. 7.2.38 - Scatter plot of temperature value versus log transformed catch values. The solid line is the smoother and light gray band is the 95% confidence interval.
Smoothing: 6.27; F: 7.274; p-value: <2e-16 ***

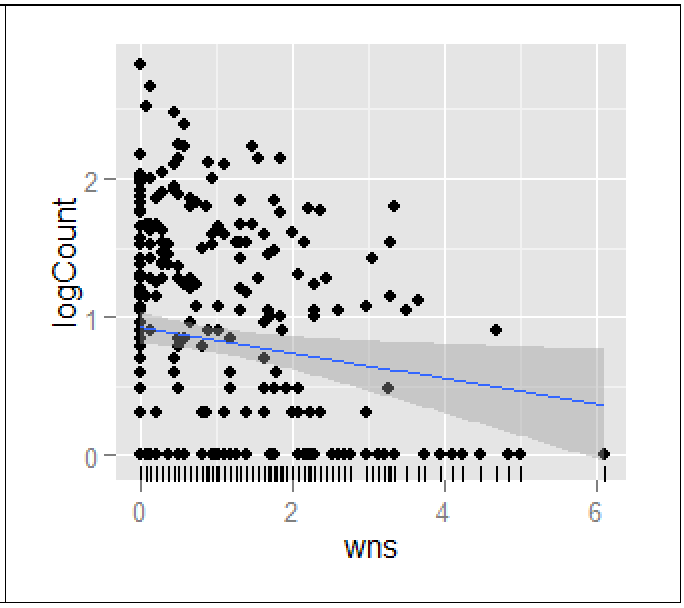


Fig. 7.2.39 - Scatter plot of wind speed value versus log transformed catch values. The solid line is the linear regression and light gray band is the 95% confidence interval.
R^2: 0.02012; F-statistic: 5.585; p-value: 0.01882*

In fig. 7.2.40 can see changes in the rhythm of flight during the day in the four seasons. The rhythm is bimodal with one morning peak and one afternoon peak. The differences between seasons mainly concerned with the amplitude and intensity of the two peaks' interval: the narrow and not pronounced interval in winter, expands slightly in spring, reaches its maximum in summer, where is characterized by the almost total absence of flying activity, and fades again in autumn. This variation is associated with that of the location of peaks relative to dawn and sunset: in winter are distant from dawn and sunset, in spring the afternoon peak is close to sunset, in summer the morning peak is close to dawn and the afternoon one coincides with sunset, in autumn the two peaks become again far from dawn and sunset.

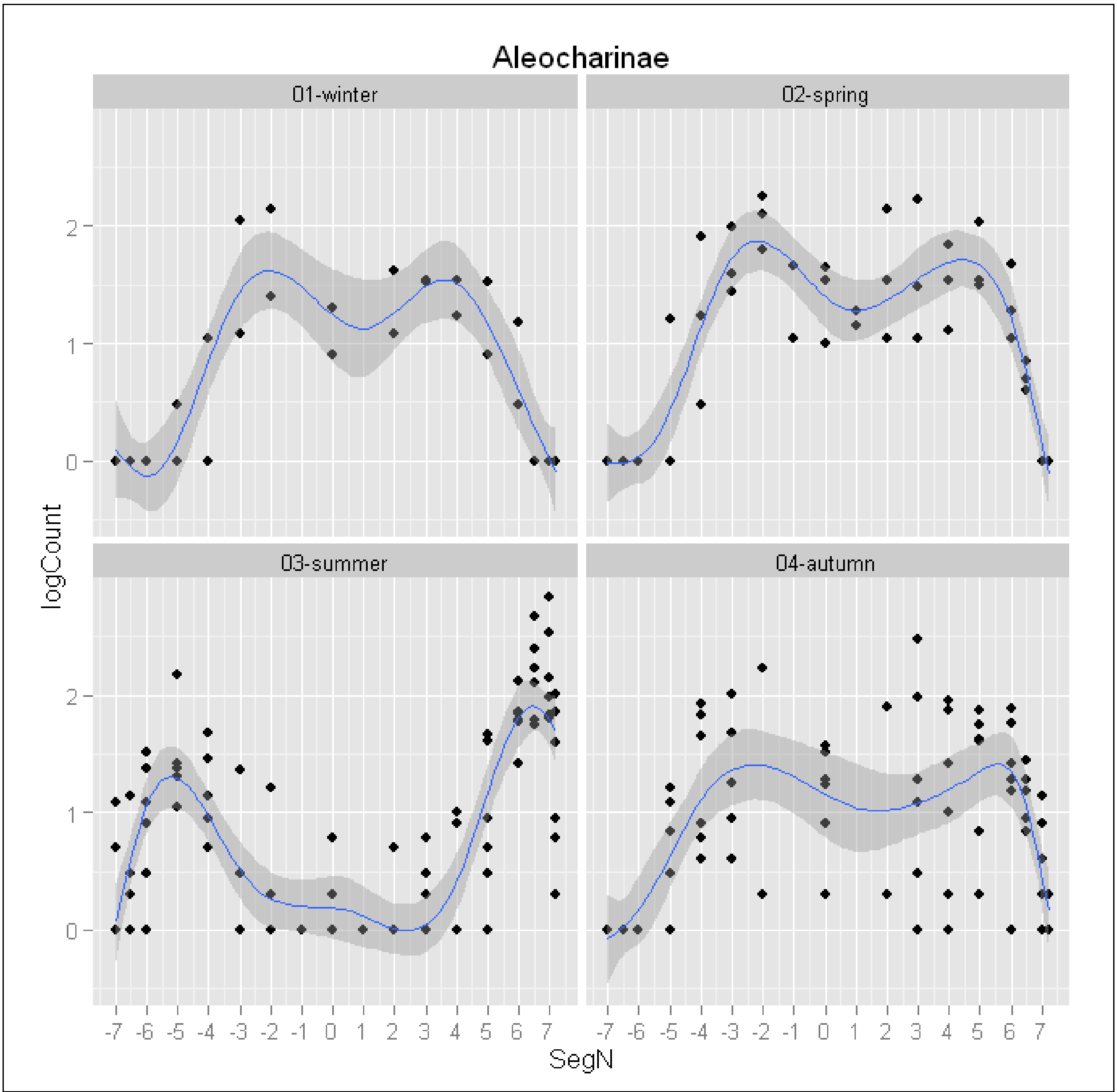


Fig. 7.2.40 – Seasonal variation in flying activity of Aleocharinae.

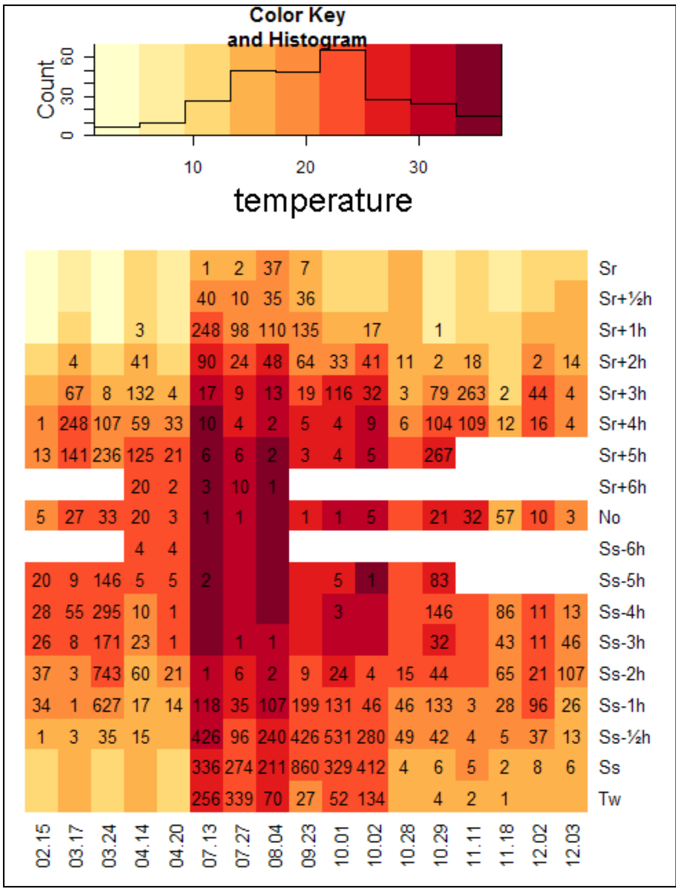
Oxytelinae

Have not been determined those species in the samples with hourly car-net; the analysis refers, therefore, to the whole subfamily. By sampling with monthly car-net and window traps is showed that 75% of the specimens of Oxytelinae belongs to a single species, *Anotylus nitidulus* with adults flying throughout the year, with a peak of abundance in late winter-spring. Two other species are relatively abundant: *Anotylus speculifrons*, absent in summer, and *Carpelimus corticinus*, present during all the year round with summer peak detected with monthly car-net and spring peak detected with window traps.

	Feb	Mar		Apr		Jul		Aug	Sep	Oct				Nov		Dec		
Seg	02.15	03.17	03.24	04.14	04.20	07.13	07.27	08.04	09.23	10.01	10.02	10.28	10.29	11.11	11.18	12.02	12.03	tot
Sr	-	-	-	-	-	1	2	37	7	-	-	-	-	-	-	-	-	47
Sr+½h	-	-	-	-	-	40	10	35	36	-	-	-	-	-	-	-	-	121
Sr+1h	-	-	-	3	-	248	98	110	135	-	17	-	1	-	-	-	-	612
Sr+2h	-	4	-	41	-	90	24	48	64	33	41	11	2	18	-	2	14	392
Sr+3h	-	67	8	132	4	17	9	13	19	116	32	3	79	263	2	44	4	812
Sr+4h	1	248	107	59	33	10	4	2	5	4	9	6	104	109	12	16	4	733
Sr+5h	13	141	236	125	21	6	6	2	3	4	5	-	267					829
Sr+6h				20	2	3	10	1										36
No	5	27	33	20	3	1	1	-	1	1	5	-	21	32	57	10	3	220
Ss-6h				4	4	-	-	-										8
Ss-5h	20	9	146	5	5	2	-	-	-	5	1	-	83					276
Ss-4h	28	55	295	10	1	-	-	-	-	3	-	-	146	-	86	11	13	648
Ss-3h	26	8	171	23	1	-	1	1	-	-	-	-	32	-	43	11	46	363
Ss-2h	37	3	743	60	21	1	6	2	9	24	4	15	44	-	65	21	107	1162
Ss-1h	34	1	627	17	14	118	35	107	199	131	46	46	133	3	28	96	26	1661
Ss-½h	1	3	35	15	-	426	96	240	426	531	280	49	42	4	5	37	13	2203
Ss	-	-	-	-	-	336	274	211	860	329	412	4	6	5	2	8	6	2453
Tw	-	-	-	-	-	256	339	70	27	52	134	-	4	2	1	-	-	885
tot	165	566	2401	534	109	1555	915	879	1791	1233	986	134	964	436	301	256	236	13461

Tab. 7.2.47 - Contingency table between dates and hourly segments for catches of Oxytelinae.

Analyzing the data of the hourly car net for the whole Oxytelinae (tab. 7.2.47), flying activity is comparable to that of Aleocharinae with a more anticipated and extended activity in the morning in summer. In summer, in fact, the interruption of the flight during central hours, correlated with the high temperatures (fig. 7.2.41) is less pronounced than that of Aleocharinae, while the low temperatures in the morning determine a minor delay in the start of the flight (fig. 7.2.41). The strong wind attenuates flying activity more or less stoutly, but not stopping it (fig. 7.2.41).
The temperatures range in which the flight activity were observed is 8.2 - 37.3 °C (fig. 7.2.42). In the complex of catches the regression analysis with the wind speed results significantly negative (fig. 7.2.43). Above values of 4.7 m/s are not recorded catches.



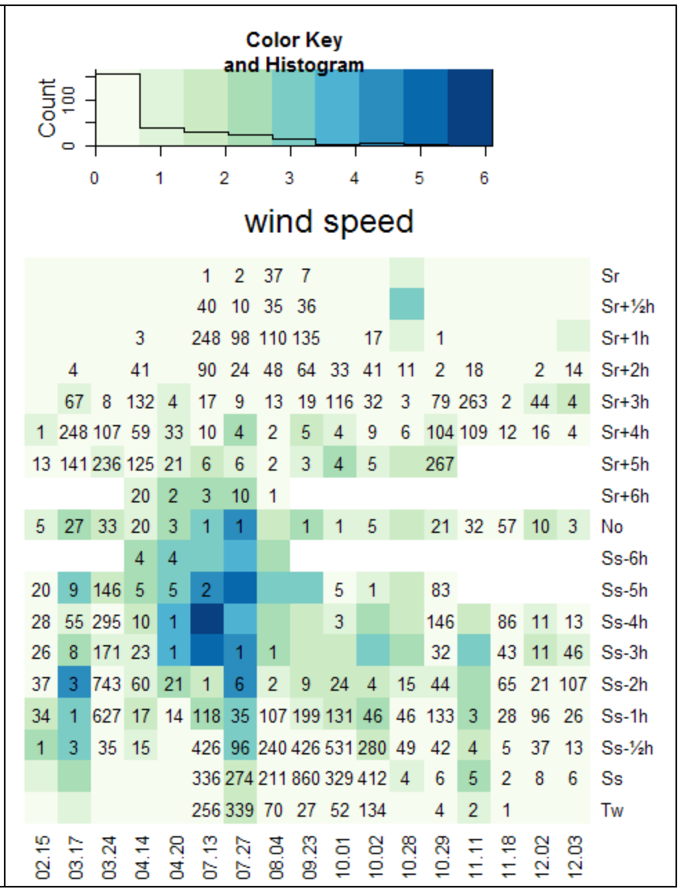


Fig. 7.2.41 - Heat map with the values of temperature (left) and wind (right) overlaid on those of the contingency table of Oxytelinae.

The flying activity is similar to that of Aleocarinae.

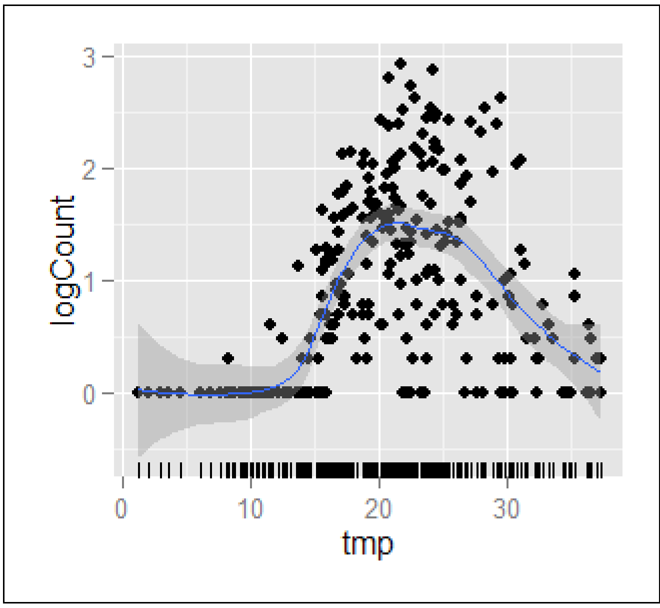


Fig. 7.2.42 - Scatter plot of temperature value versus log transformed catch values. The solid line is the smoother and light gray band is the 95% confidence interval.
Smoothing: 6.718; F: 7.685 ; p-value: <2e-16 ***

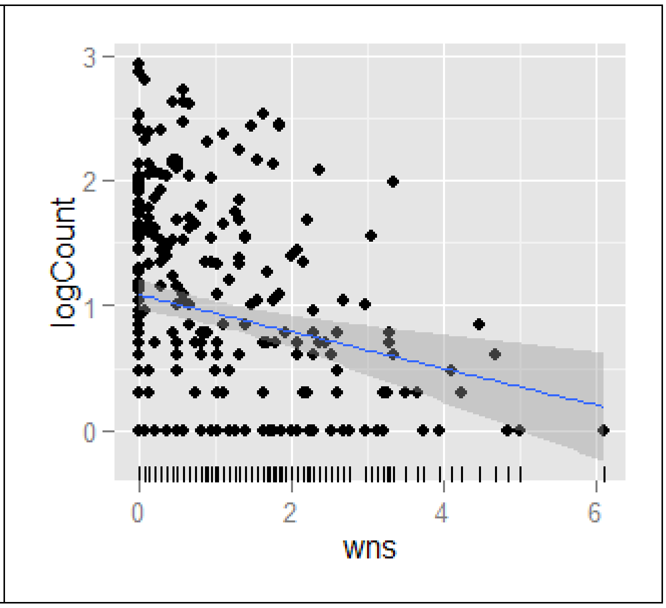


Fig. 7.2.43 - Scatter plot of wind speed value versus log transformed catch values. The solid line is the linear regression and light gray band is the 95% confidence interval.
R^2: 0.04348; F-statistic: 12.36; p-value: 0.0005127***

In fig. 7.2.44 can be seen changes in the rhythm of flight during the day in the four seasons. The rhythm is bimodal with one peak in the morning and one in the afternoon. In winter, the two peaks are not very accentuated and close to central hours; in spring they are accentuated and the afternoon one is close to sunset; in summer we have the maximum enhancement with the morning peak close to dawn and the afternoon peak close to dusk, separated by a strong reduction in activity during central hours; in autumn increases again the distance from dawn and sunset and decreases sharply their accentuation.

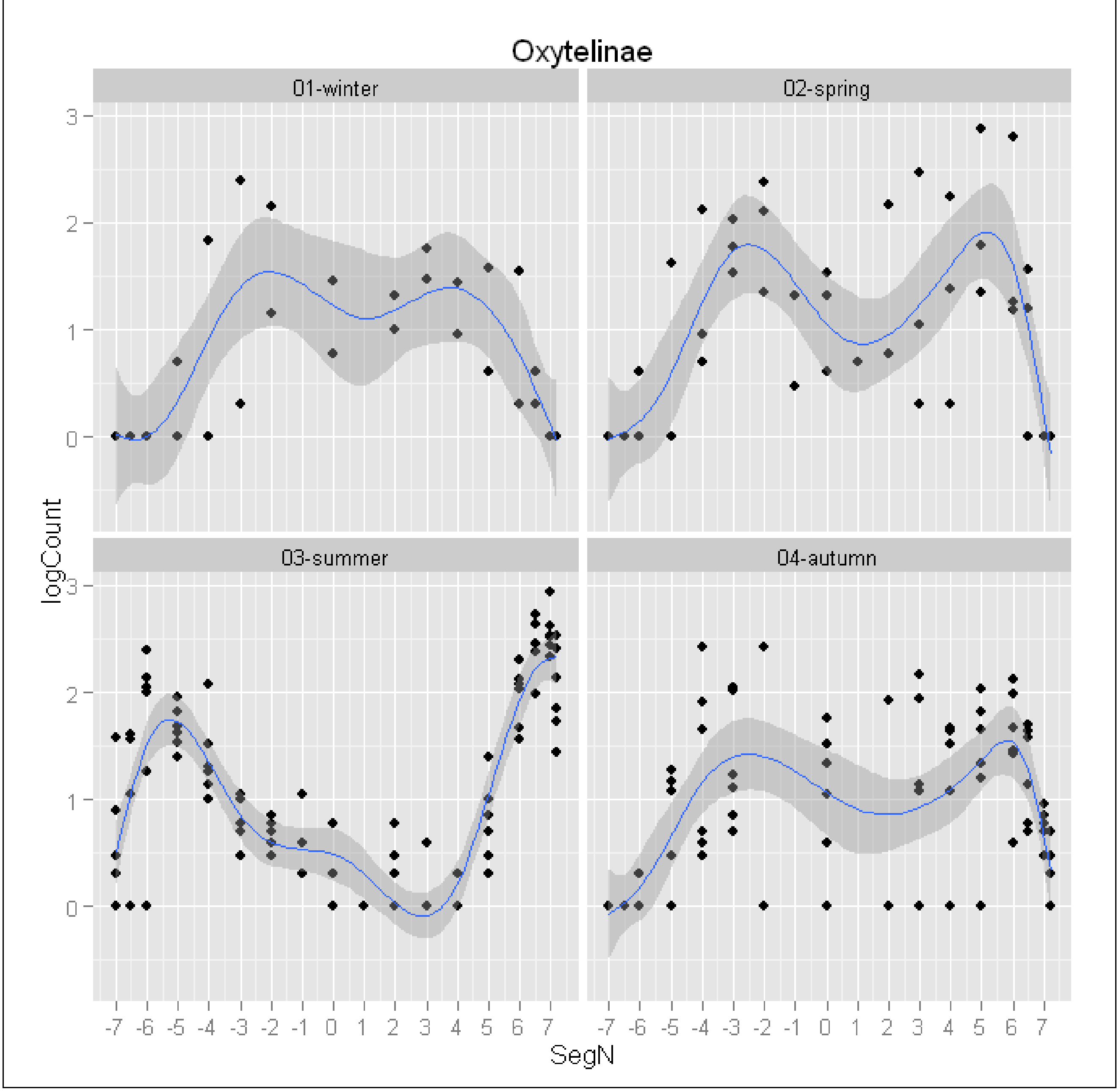


Fig. 7.2.44 – Seasonal variation in flying activity of Oxytelinae.

8 CONCLUSIONS

170 taxa (species, subspecies and 20 morphospecies) of Coleoptera Staphylinidae were collected. 5 species (*Pella leonhardi, Pronomaea sicula, Quedius caelebs, Tasgius globulifer evitendus* and *Tasgius pedator siculus*) are endemics to Sicily, 1 species (*Oxypoda flavissima*) is new for Italian fauna, 11 species (*Acrotona muscorum, Amischa decipiens, Amischa forcipata, Atheta testaceipes, Carpelimus fuliginosus, Dacrila pruinosa, Lithocharis nigriceps, Micropeplus porcatus, Neobisnius lathrobioides, Outachyusa raptoria, Pycnota paradoxa* e *Trichiusa immigrata*) are new for Sicilian fauna. The presence in Sicily of 7 species has been confirmed (*Astenus thoracicus thoracicus*, *Atheta cauta*, *Hypomedon debilicornis, Neobisnius procerulus*, *Oligota muensteri*, *Oligota punctulata* e *Sepedophilus marshami*) and 6 alien species have been reported (*Atheta mucronata, Diestota guadalupensis, Paraphloeostiba gayndahensis, Thecturota marchii* besides *Hypomedon debilicornis* e *Trichiusa immigrata* previously mentioned among the species new for sicilian fauna).
More than 69% of the taxa has a wide distribution (Palearctic, Holarctic and extraholarctic), scarce is the European component s. l. (9%) and the Italian endemic (6%), while more significant is the Mediterranean component s. l. (17%). It is a chorological spectrum coherent with the environment where the research took place: a large orchard plain characterized by prolonged summer aridity. Such coherence is confirmed by a more detailed analysis of the chorological categories.
Considering the taxa with Palaearctic distribution we can observe that those with Euromediterranean geonemy amount to 31% of the total of this component, followed by Holopalearctic ones (30%); a substantial number of taxa has Turanian-European Mediterranean distribution (17%), and a significant number of taxa has Asian-European geonemy (8%) and Central-Asian-European Mediterranean distribution (6%). Most of these are eurytopic species or related to substeppic or steppic environments, usually saprophyles with broad ecological valence.
64% of the species with Mediterranean distribution, is Western-Mediterranean s. l.; these species they are generally thermophilic, among them few are related to the environment of the litter, while most are typical of open spaces or of Mediterranean maquis.
Several predatory staphylinid species do fly actively within the citrus orchard, but only some of the sampled species (*Anotilus inustus*, *Atheta mucronata*) are potential biocontrol agents of citrus pests, notably *Ceratitis capitata* (URBANEJA *et alii* 2006; ADORNO *et alii* 2012). Further investigation is needed to assess the ecological services that they can provide in an integrated framework.

1.599 specimens belonging to 97 species were sampled with window traps, 71 (73% of total species) with a number of specimens lower than or equal to 9, while 49 taxa (about the 50%) with an amount of specimens less or equl to 3. First 10 taxa in order of abundance include the 66% of whole sampled specimens.
The results of Spearman rank correlation, that show a high and significant similarity among analysed stations, **Shrub**/**Citrus** pairwise apart, are only apparently incoherent with those shown by tests ANOSIM, Parwaise and PERMANOVA, which show significant differences between the stations investigated. Such differences depend mainly from the different capture frequencies of taxa more abundantly sampled in the two stations and not from differences in quality of the two samples, although the number of taxa sampled sporadically (with 1-3 specimens) contribute to emphasize these differences.
It can therefore formulate the hypothesis that the species of Staphylinidae flying between trees (**Citrus**) and in orchard open environments (**Track**), at least as regards those most abundantly sampled, do not differ substantially. For these species in the border area of the parcels (**Track**), a larger amount of captures has been detected, with the exception of *Paraphloestiba gayndahensis*. This fact could be explained by assuming that in open environments Staphylinidae have a more intense flying activity for the dynamic search of suitable sites for breeding, feeding, and resting. Otherwise we can suppose that open air windows traps are more attractive with flying insects than the ones placed in densely wooded areas.

745 specimens belonging to 60 taxa were sampled with pit-fall traps, placed only in May and from second half of October to the second half of December 2010; 13 of them were collected exclusively with this method, but only *Ocypus olens olens*, which is the most sampled species with pit-fall traps, and *Geostiba plicatella,* show considerable captures frequencies. We can assume that these two species are dispersed by walking or flying at lower altitudes than those that allow capture by the car-net or the window traps.
The analyses of the pit-fall sampling shows that there are no substantial differences between **Citrus** and **Citrus-Track1**/**Citrus-Track2**, while **Shrub** differs significantly from the other stations. The latter station is characterized by the exclusive presence, although sporadic, of *Euryporus aeneiventris* and *Quedius semiobscurus* and by the absence of species frequently sampled in the other three stations as *Megalinus glabratus*, *Cordalia oscura* and *Astenus lyonessius.*
Comparison between sampling with pit-fall traps and with windows traps one, limited to the period in which both techniques were used at the same time, shows that these two sampling methods basicly differ by the taxa captures frequencies, in addition to the complete absence of *Ocypus olens olens* in the windows traps. Regarding the species of Staphylinidae more abundantly sampled, it can be assumed that they live on the ground and use flying to perform displacements related to the search of suitable sites for feeding and reproduction. Among these, some species such as *Anotylus nitidulus*, *Carpelimus corticinus* and *Atheta* gr. *fungi*, show a flying activity more conspicuous, which is confirmed by the data of monthly car-net.

Car-net captures concern an air layer between 0.5-3 metres from the ground above citrus orchard tracks. What has been inquired is, therefore, the sum of flying activities which take place out of the narrow foliage extent and the space between adjoining trees foliages. Most of the movements as expected, are included in the vegetative movements, but, surely, migratory movements, are also intercepted as well as dispersal subsequent to eclosions. Dispersal can be intercepted, to a short extent, also by window traps placed on tracks sides (**Track**), while **Citrus** ones especially intercept flights between foliages, or between foliages and ground.
Usually, captures frequencies by window traps are lower than those acquired by car-net: only a Staphylininae species, *Philonthus concinnus*, is characterized by a flying activity mainly detected by window traps.
Regarding the comparison between the different stations, with a few exceptions, species are considerably more frequent in **Track** window traps; while several species are absent or rare in **Citrus**. Such condition could be a result of dispersion flights which, easily intercepted by car-net, could be detected by **Track** window traps too, while foliages could obstruct the entry to **Citrus** window traps. Some species are not captured by the window traps or are rare in all stations, while they are abundantly sampled by car-net. This seems to indicate that there are flight modes which are hardly intercepted by the window traps.
Window traps have mainly sampled in spring time (whether the specimens amount or species one), while in summer – autumn captures are scanty, sometimes in complete contrast to car-net's data. This may be due to seasonal variations of the characteristics of the flight: flight between foliages and/or toward them would occur mainly in spring time. We can suppose that in this period blooming and fruits marcescence processes effect an attractive stimulus which causes an increase of flight activity. This fact could be the origin of variations in *Paraphloeostiba gayndahensis* captures: the large amount in window traps of **Citrus** in spring time could be the result of flights located between foliages, or between foliages and the ground, such flights are not intercepted by car-net that would instead intercept, to a large extent, summer dispersion flights.
The diversity of capture frequencies, between the stations of the window traps and between the two flight detection methods, can also be influenced by events of population redistribution in the environmental mosaic inside and outside the citrus orchard. In fact, the car-net sampling carried out in the surrounding arable land shows that the distribution area of the faunal ensemble which

carachterize the orchard also includes surrounding habitats; so that the inside-outside ensemble would represent a habitats mosaic with metapopulations. We can suppose that the orchard in spring time could represent an attractive habitat for Staphylinidae causing also migratory fluxes from outside to inside that would be intercepted by window traps. Such discontinuous fluxes could be not intercepted by car-net since surveys involve only single days. This hypothesis would be in accord with the fact that generalistic predators, like Staphylinidae, often colonize crops just next to the beginning of reproductive cycles of their potential preys. (SETTLE *et alii* 1996, PETERSEN 1999). On the other hand the non-stop dispersal flights could guarantee during the year a rebalancing of population distribution in the environmental mosaic.
Captures of *Philonthus concinnus* represent a possible example of these processes. In this species captures are scanty in car-net while they are abundant in spring time in window traps of **Citrus** and mostly of **Track** ones. It could be a matter of a species preferring open air and heterogeneous habitat which carachterize **Track** and carrying out moving flights in the same habitat. Alternatively captures in **Track** window traps could be the result of occasional flights from the outside or from orchard border toward the inside. The rarity in car-net may be due to the discontinuity of these flights.

The flights of the inquired species clearly show a circadian rhythm often characterized by morning and afternoon peaks divided by a break or a decrease at midday. The most significant data of the flights activities are reported in tab. 8.1.

	Temperature range		Total seasonal abundance				Maximum daily flight peak				Total abundance in the morning				Flight		
Species	min	max	Wi	Sp	Su	Au	Wi	Sp	Su	Au	Wi	Sp	Su	Au	Start	Noon break	End
Megarthrus bellevoyei	11,6	26,5	302	**3504**		**1373**		PM		PM	40	306		193	Sr+1h	evident	Ss
Proteinus atomarius	12,5	29,2	27	**182**	8	31		PM			1	22		2	Sr+2h	evident	Tw
Paraphloeostiba gayndahensis	19,5	31,6	2	4	**269**	10			PM			1	3		Sr+2h	evident	Tw
Gabronthus maritimus	15,6	31,3	11	248	**810**	251			PM		5	15	92	17	Sr	evident	Tw
Heterothops minutus	19,1	29,2	3	+	**96**	14			PM		1		2	2	Sr+3h	Not evidente	Tw
Leptacinus intermedius	21,1	30,8	2	5	**55**	+			PM			1	4		Sr+2h	present	Tw
Scopaeus debilis	19	31,1	1	10	**274**	2			PM		1	7	17		Sr+1h	present	Tw
Scopaeus mitratus	20,9	31,6	2	3	**118**	3			PM		1	1	1		Sr+1h	Not evidente	Tw
Tachyporus nitidulus	13,8	25,2	7	10	2	**32**				PM		3		3	Sr+1h	Not evidente	Ss
Tachinus flavolimbatus	16,8	21,1	2	**39**		10		AM			1	19		3	Sr+3h	absent	Ss-½h
Habrocerus capillaricornis	18,7	29,6	1	5	**65**	6			PM						Ss-4h	*	Tw

Tab. 8.1. Significant data of flight activities of the most abundant species sampled with hourly car-net. Most relevant abundances in boldface. +: flight detected only with other sampling methods. ▒ absence in the season. PM: peak in the afternoon. AM: peak in the morning. *: Flight only in the afternoon.

Most of the flight activity in summer season usually is detected in the afternoon; *Proteinus atomarius* e *Tachinus flavolimbatus* are exceptions since they shows flights activity peaks only in springtime, *Tachyporus nitidulus*, as well, with a peak only in autumn and *Megarthrus bellevoyei* with peaks in spring and autumn. Only one species, *Habrocerus capillaricornis*, has no morning flight activity and another one, *Tachinus flavolimbatus,* has a flight activities peak in the morning. About morning flight activities species, midday break is not verified in three species (*Heterothops minutus*, *Scopaeus mitratus* and *Tachyporus nitidulus*) and is absent in one only (*Tachinus flavolimbatus*).
The beginning of flight activity coincides with dawn only in *Gabronthus maritimus*, in summer period. Flight activity's end takes usually place at sunset or twilight. Twilight flight species, with the only exception of *Proteinus atomarius*, have an activity peak in summer. Flight activity after dusk up to an hour after sunset has been detected in the Paederinae *Scopaeus debilis*, *Hypomedon debilicornis*, *Astenus b. bimaculatus* and *Astenus pallidulus*.
From autumn to spring the beginning of flight activity is conditioned by temperature since flight activity requires that the body temperature reaches a threshold that varies according to the species. The lowest threshold, 11.6 °C has been detected for *Megarthrus bellevoyei,* the highest one, 21.1

°C, for *Leptacinus intermedius* (tab. 8.1). High temperature seems to cause the extension of the midday break which in summer extends until mid-afternoon; this fact prevents the high values of temperature lead to an excessive loss of water during the flight, especially in windy days.
In the coldest seasons the interruption or reduction of flight in the central hour and at the beginning of afternoon checked for several species, however, cannot be related to temperature. It clearly seems caused by the circadian rhythm configuration.
Wind is also an environmental factor which influences flight: in several species wind's high speeds reduce flight's activities. However, afternoon peaks also occur in highly windy day.
Comparison between sampling carried out with hourly car-net in very near dates allows sometimes to detect very considerable differences in captures. Such variations can be the evidence of dispersion episodes following eclosions. This is the case of *Megarthrus bellevoyei*: in march 24th more than the half of captures obtained in the space of a year were observed. Other species where we can suppose a similar event are *Paraphloeostiba gayndahensis*, *Scopaeus debilis* and *Habrocerus capillaricornis*.
Aleocharinae and Oxytelinae were not studied at species level, however it is possible to give information about flight activity of each subfamily.
In both subfamilies flight rhythm is bimodal with a morning and an afternoon peak and the beginning of flight activity coincides with dawn in summer period. Differences between seasons essentially refer to extent and depth of the interval between the two peaks: the interval between the peaks is narrow and little deep in winter, slightly widen in spring, reaches its top in summer, when it's characterized by almost an absence of flight, and reduces again in autumn.
There are also seasonal variations of the distance of morning and afternoon peaks from dawn and sunset: in winter they are far away from dawn and from sunset, in spring the afternoon peak gets closer to sunset, in summer morning peak moves closer to dawn and the afternoon one overlaps sunset, in autumn this two peaks move away from dawn and from sunset again. In Oxytelinae we observe an earlier and more prolonged morning flight activity in summer, while flight interruption in central hours is less marked. In both subfamilies morning low temperatures cause a delay in flight beginning and strong wind reduce flight's activity more or less considerably.

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