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Session 1. Integrated Pest Management: Biological – biotechnological control methods – Models – Vectors of disease

Lutte biologique contre la Pseudococcidae *Heliococcus bohemicus* Sulc
au moyen d'une stratégie mettant en œuvre deux prédateurs, *Chrysoperla* sp.
et *Exochomus quadripustulatus* (Linné)

G. Sentenac et P. Kuntzmann 3-12

Résumé: L'objectif de cette étude est de mettre au point et d'évaluer une combinaison des méthodes de lutte biologique contre la cochenille *Heliococcus bohemicus*. Les moyens biologiques mis en œuvre sont d'ores et déjà commercialisés, notamment par la société Koppert, il s'agit de *Chrysoperla* sp. et d'*Exochomus quadripustulatus*. En présence de fourmis on ne peut pas faire l'économie de la mise en place au printemps d'un dispositif dont la vocation est de limiter en partie la fréquentation des ceps par ces dernières. Au cours de la première année d'étude, l'emploi des deux agents de lutte biologique a permis de réguler de manière satisfaisante les populations d'*Heliococcus bohemicus*. L'efficacité obtenue en automne 2010, à l'optimum des effectifs de Pseudococcidae, est de 64%, sans que nous soyons en mesure de préciser l'activité respective de *Chrysoperla* sp et d'*E. quadripustulatus*. Au cours de la deuxième année d'étude, avec seulement trois lâchers de chrysopes réalisés, les efficacités sont d'un niveau bon à moyen excepté en fin de saison.

Influence of the hosts *Planococcus citri* and *Planococcus ficus* on oviposition,
development, sex ratio and survival of *Leptomastix dactylopii*

P. M. Marras, A. Cocco, A. Lentini 13-18

Abstract: *Leptomastix dactylopii* Howard (Hymenoptera: Encyrtidae) is a koinobiont endoparasitoid of several mealybug species and is often effectively used as a biological control agent of the citrus mealybug, *Planococcus citri* (Risso) (Hemiptera: Pseudococcidae), in citrus orchards and ornamental greenhouses. *Leptomastix dactylopii* has also been used in vineyards to control the vine mealybug, *Planococcus ficus* (Signoret) (Hemiptera: Pseudococcidae), with unsatisfactory results, probably due to the low host suitability or vineyard microclimatic conditions.

In order to investigate the *P. ficus* suitability as host for the parasitoid, no-choice experiments were carried out by exposing *L. dactylopii* females, obtained from two separate rearing lines on *P. ficus* or *P. citri*, to third-instar nymphs and young adult females of either *P. ficus* or *P. citri*. The number of parasitized mealybugs as well as developmental time, number of male and female offspring, sex ratio, offspring longevity, body size of maternal line females and body size of female offspring were recorded.

The host species did not affect the developmental time, adult longevity and sex ratio of the parasitoid offspring. However, *L. dactylopii* females reared on *P. ficus* produced significantly less offspring, which were also smaller in size than those reared on *P. citri*.

The results of this study suggest that both *P. ficus* and *P. citri* are suitable hosts for the development of *L. dactylopii*.

Preliminary results on the influence of nitrogen fertilization on the development

of *Planococcus citri* and *Planococcus ficus* on grapevine

A. Cocco, P. M. Marras, T. Nuvoli, M. G. Mameli, A. Lentini 19-24

Abstract: The effects of different nitrogen fertilization regimes on female development of the vine mealybug, *Planococcus ficus* (Signoret), and the citrus mealybug, *Planococcus citri* (Risso) (Hemiptera: Pseudococcidae), were investigated on *Vitis vinifera* L., cv Vermentino. The experiment was carried out under indoor conditions using 50 potted plants, separated in 5 groups and supplied weekly with 1.5l of water with different rates of ammonium nitrate fertilizer: 0, 0.25, 0.5, 1 and 2g/l of nitrogen (N). Five grapevines of each treatment were infested with approx. 200 first-instar mealybugs (24 hours old) of either *P. ficus* or *P. citri*. The female life history parameters recorded included survival, development time from first instar to ovipositing female, body length of ovipositing females and number of eggs produced. The concentration of nitrogen on leaves, indirectly measured throughout the experiment by determining the chlorophyll content by a Spad meter, was significantly lower in unfertilized plants than in those supplied with 0.5, 1 and 2g/l of nitrogen. No difference was found between grapevines fertilized with 0.25g/l of N and the remaining treatments. The survival of *P. ficus* in unfertilized plants was lower than in those supplied with nitrogen. The survival of the citrus mealybug did not show differences among treatments, but it was by far lower than that of the vine mealybug. The development time of *P. ficus* on unfertilized grapevines was significantly longer than in all other treatments, while no differences were found on plants infested with *P. citri*. The development time of the citrus mealybug was significantly longer than that of *P. ficus* in all treatments. Vine mealybug females reared on vines supplied with 1 g/l of nitrogen were significantly larger in size than those of other treatments, while the body size of *P. citri* females did not differ significantly among groups. However, citrus mealybugs were always significantly smaller than *P. ficus* females. The fecundity of the two mealybug species was not significantly affected by increasing nitrogen rates, although *P. ficus* females produced more eggs than *P. citri*. The nitrogen fertilization significantly affected development time, size and fecundity of *P. ficus*, while no differences were found on the survival and sex ratio. In contrast, biological parameters of *P. citri* did not seem to be influenced by different nitrogen regimes, although results might have been affected by the high mortality of immatures. *V. vinifera* showed to be a more suitable host for the development and reproduction of *P. ficus* than of *P. citri*.

25 years of mating disruption in Switzerland

P. Kehrli, D. Pasquier, P.-J. Charmillot 25-28

Abstract: The European vine moth (*Lobesia botrana*) and the grape berry moth (*Eupoecilia ambiguella*), are the two major lepidopteran pest insects in European vineyards. In the past these two moth species were controlled by the application of insecticides, but over the last three decades mating disruption has established itself as a popular alternative to insecticides in Switzerland. Today this integrated pest management measure is implemented in more than 60% of Swiss vineyards. Moreover, our long lasting monitoring program shows that mating disruption protects vineyards better against grape moths than classical chemical control. Thus, it can be concluded that the introduction of mating disruption was (and still is) a success story and that Swiss winegrowers would not like to miss this sustainable and environmentally friendly pest control strategy.

Research and management oriented sampling plans for vine inhabiting

Scaphoideus titanus grape leafhopper nymphs

I. Rigamonti, V. Trivellone, C. Brambilla, M. Jermini, J. Baumgärtner 29-35

Abstract: This paper summarizes the methodology used for describing the spatial distribution of the grape leafhopper *Scaphoideus titanus* in a vineyard located in Southern Switzerland and presents sampling plans for research and management purposes. The sampling technique consisted of repeated visual counts of *S. titanus* nymphs. In general, a vineyard is a highly structured environment whose influence on spatial distributions is studied by analyses of variance and quantified by regression models developed in a stratified and multi-stage sampling universe.

First, a regression model was applied to the relationship between the proportion of infested trunk shoot leaves and the mean density of trunk shoot leaves. This allowed the translation of a critical density for entering the vineyard in an adaptive management (AM) program into a critical proportion. A sequential binomial sampling plan was developed to efficiently decide whether a vineyard should be included into the AM program or not. Second, the spatial distribution in the entire vine plant canopy was analysed. Since there were significant differences between densities on trunk shoots and productive shoots, two different sampling plans were designed. However, there were no significant differences between other strata (parts of the vineyard, leaf position within shoots), so that they were disregarded in sampling plan design. The mean crowding – mean regression model, with the intercept set to 0, indicated aggregated distributions at the vineyard, shoot type and shoot levels. On the basis of this statistics, enumerative and sequential sampling plans are proposed and implemented in the AM framework. The here presented sampling techniques are advantageous over the previously used beating tray method and the sampling plans are useful for research and management purposes.

Scaphoideus titanus and *Metcalfa pruinosa* egg distribution on different woody parts of Kober 5BB grapevine

E. Gargani, G. Torrini, S. Caradonna, B. Bagnoli 37-42

Abstract: Egg distribution of *Scaphoideus titanus* Ball, the vector of the grapevine disease Flavescence dorée, and of *Metcalfa pruinosa* (Say), one of the most common planthopper in the Italian vineyards, was investigated on Kober 5BB grapevines to verify the oviposition preferential sites in terms of the age and the anatomic part of the cane.

Wood samples of one, two-three and more than three year old vines from an abandoned field in Veneto (Northern Italy) were analysed. The vine samples were collected during winter, stocked at 4°C till the beginning of June, cut in pieces of different length and then put in rearing boxes, maintained at 24°C, 75% RH and 16:8 photoperiod, to obtain the first instar larvae of *S. titanus* and *M. pruinosa*. At the end of egg hatching, some pieces of one and two-three year old canes were analysed under a dissecting to evaluate the different susceptibility of buds, nodes and internodes to host the eggs of the two Auchenorrhyncha. The same observations were conducted on portions of elder wood (*Sambucus nigra* L.) to verify the presence of eggs of the two insects.

Both species, in particular *S. titanus*, showed a strong preference to lay eggs in the bark of two or older canes, even if the one year old wood was confirmed to be susceptible to egg laying. In both species the node area, in particular the zone close to the bud was preferred to the internodes' area, mainly with regard to the one year old wood. Our results confirm the hypothesis that the different parts of the branch of the vine show differences in terms of susceptibility to oviposition by the two species.

Multiannual infestation patterns of grapevine canopy inhabiting

Scaphoideus titanus Ball leafhoppers

I. Rigamonti, V. Trivellone, M. Jermini, J. Baumgärtner 43-48

Abstract: This paper summarizes the procedures for designing, parametrizing and validating a model representing five years infestation patterns of *Scaphoideus titanus* populations in grapevine plant canopies, on the basis of temperature influences. The development of *S. titanus* comprises nymphs, adults, diapausing eggs and post diapausing eggs. The basic elements of the model are temperature-dependent i) stochastic development of the four “life stages”, ii) developmental and senescence rates, and stage-specific survivorships, and iii) reproduction. The phenology model is based on a time-varying delay with attrition and operates on a time step length of 1 hour. It is initialized by proportional entries of hatching eggs resulting from a Weibull frequency distribution. Temperature effects on the survivorship of non-diapausing life stages are modelled via attrition and on fecundity rates via input into the diapausing egg stage. Diapausing eggs, however, do not suffer from adverse temperature conditions. If the temperature is between 0°C and the lower developmental threshold all life stages except the diapausing eggs suffer from an additional temperature dependent mortality. The model is validated with observations made during five years in a Southern Switzerland (located at Contone) vineyard. The model predictions

are in agreement with the observations. The successfully validated model will be inserted into an Adaptive Management system aiming at rationalizing pest management and learning how the pest population system works.

Marrying research and management activities: adaptive management of Grape leafhopper *Scaphoideus titanus*

M. Jermini, V. Trivellone, C. Cara, I. Rigamonti, J. Baumgärtner 49-56

Abstract: This paper deals with the study and management of the Grape leafhopper *Scaphoideus titanus* Ball, vector of the *Candidatus Phytoplasma vitis* pathogen, in vineyards located in Southern Switzerland. *S. titanus* is an invasive species of North American origin that became a component of a complex population system and an object of a complex population management set-up. Uncertainties have been recorded in three areas: uncertainty about the observations and measurements, uncertainty about the underlying behavior of the system and uncertainty about the environment. For dealing with complex problems high in uncertainty, an adaptive management (AM) strategy is developed and implemented. Progress is reported in the area of technology selection for measuring infestation levels and temperature profiles (*i*), the quantitative analytical tools have been advanced as to obtain a better insight into the dynamics of the population system (*ii*) and the timing of insecticide applications and monitoring operations (*iii*), the ground has been solidified for the design and implementation of an integrated population and disease transmission system (*iv*). The detailed presentation of the methodologies and the results of different component studies by Rigamonti *et al.* (2011a; 2011b; 2013), Prevostini *et al.* (2013) and Trivellone *et al.* (2011) allows focusing on AM design, implementation and preliminary achievements. The AM framework was concluded to be adequate for dealing with high uncertainties associated with the complexities of the *S. titanus* population system and the design and implementation of an IPM program.

WAMS - an adaptive system for knowledge acquisition and decision support: the case of *Scaphoideus titanus*

M. Prevostini, A. V. Taddeo, K. Balac, I. Rigamonti, J. Baumgärtner, M. Jermini 57-64

Abstract: WAMS (Wireless-sensor-network-based Adaptive Management System) is a pest control tool that makes continuous use of weather and pest monitoring information for the dual purpose of improving the knowledge on pest systems and ameliorating pest management decisions. It operates at the interface between research and pest management, establishes a close-loop between monitoring, management and analysis of systems, and automatically improves the reliability of pest control relevant predictions as soon as additional information becomes available. Population models, based on time-varying distributed delays, are at the core of WAMS. The paper identifies some important WAMS features, evaluates the predictive capabilities and its alert mechanisms as satisfactory, and reports some preliminary experiences that reveal advantages and benefits in the areas of (*i*) knowledge improvement and (*ii*) control rationalization. The preliminary experiences also point to some drawbacks and shortcomings related mainly to (*i*) the need of a continuous engagement of actors (growers, extensionists, applied entomologists) and (*ii*) the importance given to the vector in the case of the case of an economically relevant pathogen-vector-host plant system.

Winter temperature and Flavescence dorée vector ecology

J. Chuche, D. Thiéry 65-70

Abstract: The invasive leafhopper *Scaphoideus titanus* is spreading in Europe from ca. 35 to 50°N. According to the origin area of this insect, we hypothesized that its Southern limit of distribution could partly be the consequence of the lack of cold temperatures that are essential to break egg diapause. We investigated the effects of winter incubation temperature on hatching and post hatching development. Here, we conclude that winter temperatures could be one from other key factors explaining the weak colonization of Southern vineyards in Europe by *S. titanus*.

Genomic analysis of multitrophic interactions between grapevine

– the vine mealybug *Planococcus ficus* and GLRaV-3 virus

A. Reineke, A. Timm 71-75

Abstract: Little is known about the genetic effects involved in interactions between grapevine plants, their insect herbivores and pathogens transmitted by insect vectors despite the importance of such information for understanding how defence mechanisms operate at each trophic level. The current study used genomic methods to investigate interactions among grapevine *Vitis vinifera*, grapevine leafroll associated virus 3 (GLRaV-3) and the GLRaV-3 vector vine mealybug *Planococcus ficus*. These three species have been intensely researched due to the serious economic injury caused to grapevine by GLRaV-3 and *P. ficus*. Here we investigated which genes were implicit in the response of grapevine to attack by *P. ficus* (either vectoring GLRaV-3 or not) as well as which genes were involved in *P. ficus* attack on grapevine in the presence of GLRaV-3. Microarrays, cDNA-AFLP analysis and qPCR were used to identify candidate genes putatively involved in these interactions. Only a small number of genes were differentially regulated in each species, although a temporal pattern in the expression behaviour of these genes was evident. These results provide baseline information about the effect of a plant virus on its insect vector and the response of a plant to simultaneous insect and virus damage. They might also pave the way for a potential manipulation of the grapevine - mealybug - system to achieve sustainable and ecologically efficient control of *P. ficus* damage and prevent spread of GLRaV-3.

EcoViti: a systemic approach to design low pesticide vineyards

D. Lafond, T. Coulon, R. Métral, A. Mérot, J. Wéry 77-86

Abstract: With the emergence of a social pressure for an “environmentally friendly” agriculture, the reduction of pesticide use is a key component of sustainable agriculture. Despite the efforts made toward a lower use of pesticides, some limits have been reached. To go further, a more integrated modification of the crop management system becomes necessary. The EcoViti project proposes a method for prototyping new vineyard cropping systems at field scale. The method is based on expert knowledge, conceptual modelling and field experiments in a coordinated network of experimental platforms. This systemic approach has several differences with the classical experimental approach, either in the design of the experiments or in the project management, which are discussed here.

Prediction of population dynamics of the grape berry moth *Eupoecilia ambiguella* and the European grapevine moth *Lobesia botrana* using the simulation model “Twickler”

A. Baumann, P. Schwappach, K. Schmidt 87-93

Abstract: The grape berry moth and European grapevine moth are the key pests of viticulture in Europe. The control commonly relies on insecticide treatments, at least outside of areas, where mating disruption is applied. Using the simulation model “Twickler” the effectiveness of insecticide treatments should be enhanced by combining data from weather stations with data from population dynamics of earlier years that end up in forecasts concerning important biological stages of the grape moths. The “Twickler” model was tested using datasets of population dynamics from several Franconian vineyards (Germany). The model simulates the population development of *E. ambiguella* and *L. botrana* and predicts the start of flight occurrence, beginning of oviposition and first larvae-hatching. These modelled information coincided well with corresponding data monitored in the vineyards. Twickler predicts the beginning of egg deposition and larvae hatching earlier than found in reality, indicating some deviance with respect to the underlying biology of the moths. Nevertheless it is seen as an advantage especially for extension services, since there would be enough time to release warnings to vine-farmers. This enables the farmer to apply insecticides at the right time and achieve a maximum efficacy and thus protect natural resources. Yet there are some technical problems that need to be solved, hence further investigations are suggested to confirm these results.

Can European grapevine moth, *Lobesia botrana* (Lepidoptera: Tortricidae) be eradicated from California?

L. G. Varela, M. L. Cooper, R. J. Smith 95-102

Abstract: *Lobesia botrana* (Denis & Schiffermüller), European grapevine moth, was reported for the first time in North America in mid-September 2009 in vineyards in Napa County, California. Moths have since been detected in eleven California counties, as determined by a program deploying pheromone-baited traps at densities of 6 to 10 traps per square kilometer in all grape-growing regions of California. State and federal agencies mounted a rapid response to the detections, and implemented aggressive quarantine and treatment programs. Quarantined areas have been established in an 8-kilometer radius from detection after 2 or more moths within 4.8km or any other life stage are detected in a generation. As of August 2011, an area of approximately 6000 square kilometers in 10 California counties is under quarantine for European grapevine moth. A single moth was found in an 11th county that is not in quarantine. In 2010, the treatment programs targeted all vineyard acreage within 200m (Napa) or 1000m (all other counties) of a detection. Insecticide applications were recommended for all three generations, and mating disruption dispensers were recommended in Napa County only. In 2011, recommendations were to treat the first two of the three generations on all vineyard acreage within 500m of a life stage detection and to apply mating disruption, except in areas of the state that are attempting to be released from quarantine regulations. The aggressive treatment programs reduced Napa County populations from 99,266 moths trapped during the first flight of 2010, to 1,329 and 281 in the second and third flights, respectively. As of August 2011, traps in Napa County have caught 96 and 16 moths during the first and second flights, respectively. Detected infestations in the other 10 counties are very low, with a total of 128 males caught in 2010 and 33 males in the 1st and 2nd generations of 2011. In field trials, we demonstrated the efficacy of various insecticide products used in the treatment programs. Ongoing surveys of host plants cited in the literature have not identified any alternate hosts of consequence in Napa County. Although we detected eggs and larvae in olive flowers during the first generation of 2010 only, the populations were three-fold lower than in adjacent vineyards, and subsequently we have not detected any life stages in olive. We collected and analyzed data on the treatment programs in Napa and Sonoma counties, where populations are the largest or most persistent. Given the aggressive treatment programs, the availability of very effective tools such as insecticides and mating disruption, the lack of alternate hosts of consequence, and the apparently high level of compliance with treatment and quarantine programs, the question remains: Have we temporarily lowered populations to undetectable levels or is eradication of *L. botrana* from California feasible?

Management of bitter rot and ripe rot of grapes in sub-tropical vineyards in Australia

C. C. Steel, L. A. Greer, S. Savocchia 103-110

Abstract: Two bunch rot diseases associated with viticulture in warm and wet conditions are bitter rot, (*Greeneria uvicola*) and ripe rot (*Colletotrichum acutatum*). Surveys of vineyards in the Hunter Valley region of New South Wales revealed that in some seasons these are the predominant fungi associated with bunch rots. Our observations also demonstrate that bitter rot is associated with growing seasons that are warmer and drier than normal while *B. cinerea* predominates in cooler and wetter years. Mature berries from seven *Vitis vinifera* cultivars (Cabernet Sauvignon, Chardonnay, Sauvignon Blanc, Semillon, Shiraz, Traminer and Riesling) were evaluated for susceptibility to *C. acutatum* and *G. uvicola* infection and all were found to be equally susceptible. Susceptibility in field grown vines is linked to date of maturity and regional climatic events (rainfall and temperature). In a series of *in vitro* screening trials, fungicides belonging to the strobilurin group were found to be the most effective at inhibiting mycelia growth of *C. acutatum* and *G. uvicola*. Fungicides registered in Australia and commonly used for *B. cinerea* management (e.g. chlorothalonil, iprodione and pyrimethanil) were not as effective. As strobilurin fungicides cannot be applied to wine grapes grown in Australia after bunch closure we examined their efficacy at preventing *C. acutatum* and *G. uvicola* flower infections. In experiments using potted and field-grown grapevines an application of Cabrio (a.i.

pyraclostrobin) at flowering was found to limit *C. acutatum* and *G. uvicola* infection. A combination of canopy management that avoids over exposing fruit to heat stress and strategically applied strobilurin sprays, coupled with growing varieties that can be harvested prior to the onset of summer rainfall in sub-tropical areas appears to be the best management option for bitter rot and ripe rot of grapes in Australia.

Effects of cover crops and vineyard management strategies on arthropod biodiversity

A. Freund, J. Harnecker, R. Kauer, A. Reineke 111-116

Abstract: Increased biodiversity is promoted as an important aim for sustainable viticulture and can have direct and indirect consequences in terms of biological control of grapevine pests. An important aspect for enhancing functional biodiversity within vineyards is the species composition and management of cover crops and ecological infrastructures such as hedges surrounding vineyards. In addition, vineyard management practices can have an impact on the level of biodiversity. We assessed arthropod species richness and number of individuals per species in vineyard plots managed either according to integrated, bioorganic or biodynamic standards. Besides the application of different plant protection strategies, vineyards were differing in particular regarding the composition of cover crops, as integrated vineyards were covered by a grassy cover, while in organically managed vineyards a highly diverse mixture of herbaceous plants was planted. Arthropods were trapped on the vineyard floor by pitfall traps, in the canopy via beating trays and in the cover crops using a sweep net. Overall, a higher number of arthropod species and individuals were found in the bioorganic and biodynamic vineyards, which was in particular evident for arthropods trapped in the different cover crops. In addition, selected plants often found at vineyard edges or as part of cover crop mixtures were assessed for their attractiveness for arthropods via vacuum sampling. A number of plants like wild carrots (*Daucus carota*), winter vetches (*Vicia villosa*) or white mustard (*Sinapis alba*) proved to particularly favour the occurrence of certain arthropods within vineyards, among them a number of parasitic Hymenoptera and Diptera. Results of these studies prove the importance of type and structure of cover crops for enhancing arthropod biodiversity within vineyards.

Influence of regulated deficit irrigation and partial rootzone drying on leafhoppers infestations on grapevine

G. Serra, A. Cocco, M. G. Mameli, G. Delrio, A. Lentini 117-120

Abstract: A field trial was carried out from 2009 to 2011 to investigate the influence of two irrigation methods on the productivity of *Vitis vinifera* (cv Vermentino) and population density of the leafhoppers *Jacobiasca lybica* and *Zygina rhamni*. The trial was set up in a commercial vineyard in Southern Sardinia to compare two irrigation strategies: regulated deficit irrigation (RDI) and partial rootzone drying (PRD) with two restoration volumes: 80% and 40% of the crop evapotranspiration (ETc). The irrigation strategy and the restoration volume significantly affected xylematic potential trends, but treatments did not show values over a moderate stress level. Water use efficiency was influenced by the irrigation strategy only in 2009, whereas it was affected by the restoration volume and was higher in 40% ETc treatment in all three years. PRD-80% ETc showed the highest *J. lybica* density, whereas the RDI-40% ETc was the least infested. *Z. rhamni* was very abundant only in 2009, but showed no differences among treatments. The 3-years trial demonstrates that the lower restoration volume (40% ETc) allow a better water use efficiency and lower *J. lybica* infestations.

Session 2. Biology and epidemiology of pathogens, fungal, bacterial and physiological diseases

Molecular, proteomic and morphological characterization of the ascomycete

Guignardia bidwellii, agent of grape black rot and genotype diversity between populations from selected sites in Europe

B. Wicht, M. Jermini, C. Gessler, G. Antonio, L. Broggini 123-125

Abstract: The causal agent of grape black rot, *Guignardia bidwellii*, is not a subject of much interest in Europe and little scientific literature on it is available. Identification was and still is based on symptoms, more seldom also on the fungus morphology by microscopic observation. We present here a preliminary report on its characterisation by molecular and proteomic methods, which indicates the existence of two distinct taxa, isolated from *Vitis* resp. *Parthenocissus* host plants. Furthermore, a microsatellite analysis of *G. bidwellii* on DNA extracted from grape berries and leaves showing symptoms of black rot, collected from several European populations, showed that berry and leave symptoms derive from the same basic inoculum. However, the 12 collections made at different sites and years could be separated into 4 four populations.

Climate change and mycotoxins in wine

M. Storari, G. Al Broggini, I. Pertot, C. Gessler 127-128

Abstract: Mycotoxin contamination of food presents a high health risk. Climate change may lead to conditions favorable to fungi producing mycotoxins not present currently. We present here a project and preliminary results oriented toward defining and dealing with the future risk of ochratoxin A contamination of wine in the Alpin region of Northern Italy.

Levels of *trans*-resveratrol in leaves of vines affected with “esca”

F. Calzarano, V. D’Agostino, F. Osti, S. Di Marco 129-136

Abstract: A survey was carried out on esca symptomatic vines, diseased asymptomatic vines and healthy vines in vineyards previously inspected for more than 15 years. The levels of *trans*-resveratrol were determined on leaves with different symptoms severity and on leaves of asymptomatic vines, and compared with what assessed on leaves from healthy plants, at three different phenological growth stages. Moreover, in the laboratory, leaves collected from healthy vines were immersed in cultural filtrates of *Phaeomoniella chlamydospora* (Pch) or in sterile liquid growth medium and then in a suspension of *trans*-resveratrol or distilled water to assess the possible effects. The levels of *trans*-resveratrol in symptomatic leaves were particularly high at pre-bunch closure but also at harvest, increasing with the severity of foliar symptoms. At veraison, a dramatic decrease in *trans*-resveratrol content was observed and no differences were noticed among the different leaf groups or subgroups. In the laboratory test *trans*-resveratrol did not show any kind of effect on cut leaves previously immersed in Pch filtrates compared to what was observed for distilled water. The response of the plant to foliar symptoms as *trans*-resveratrol production varied in different phenological stages probably in relation to specific physiological conditions occurring at these stages. The correlation between *trans*-resveratrol levels and severity of symptoms on the leaf surface noticed at pre-bunch closure and at harvest but not at veraison as well as the lack of effects on cut leaves allowed us to hypothesize that *trans*-resveratrol is not involved in the control of foliar symptoms. However, taking into account the current hypothesis on the origin of foliar symptoms, *trans*-resveratrol may be considered as an important factor to better understand the plant response to symptoms expression.

Impact of transposons and mycoviruses on the phenotype of *Botrytis cinerea* isolates

E. Kecskeméti, A. Brathuhn, B. Berkelmann-Löhnertz, A. Reineke 137-141

Abstract: The presence of genetic elements such as transposons as well as the infection of fungal strains with fungal viruses (mycoviruses) can have significant effects on distinctive phenotypic traits of phytopathogenic fungi. The ubiquitous fungus *Botrytis cinerea* is known to be associated with two types of dsRNA viruses (BVX and BVF) as well as with two transposons, Boty and

Flipper. Here, we assessed the distribution of these elements in *B. cinerea* strains in a German grapevine growing region and investigated whether their presence had any effects on *B. cinerea* phenotypic characteristics. Results of the study indicate that *B. cinerea* strains without a transposable element showed a significantly reduced growth at lower temperatures and a lower laccase activity. Such knowledge may contribute to a better understanding of evolutionary processes and genetic structure of *B. cinerea* populations associated with grapevine plants in the field and might thus have implications on future control programmes.

Session 3. Biology and population dynamics of insects and moths

Performance of a wine trap device to monitor *Lobesia botrana* adult populations in Murcia vineyards

B. Bagnoli, A. Lucas Espadas, J. Serrano Palao, B. M. Garcia Perez, M. Pastor Juan, A. Puche Cascales, M. Ortega, P. Sambado, A. Lucchi 145-150

Abstract: The food traps have had a considerable importance in the monitoring of *Lobesia botrana* (Denis & Schiffermüller) since the early decades of the last Century. The bait for these traps consisted of juices of various kinds such as vinegar, sugar, molasses, fruit juices, cider, and beer. Trapping females with these devices is considered a valuable tool to predict the onset of oviposition, essential to properly time pesticide treatments. With the identification of the sex pheromone and its use in monitoring traps, the studies aimed at the development of food traps were significantly reduced. However, in the wine-growing areas in which *L. botrana* is managed by using the mating disruption technique, the need for food traps and/or other valid tools to monitor adult population has become more and more urgent. In the district of Murcia (Spain), some investigations have been conducted in the last three years (2008-2011) to assess the validity of a wine trap device to capture *L. botrana* males and females. This device consists of a conical terra-cotta flower pot (upper diameter 15cm; height 20cm) surmounted by a circular disc positioned 10cm over the rim. The trap is filled to the brim with a water-alcoholic solution consisting of 50% red wine (variety “Monastrell”), fixed to a pole just above the level of the clusters and checked every 3-4 days for adults counting and pot refilling. In the three years the monitoring activity has been carried out in vineyards of the red variety “Monastrell” in Yecla (Murcia) from April to October. In such context the captures obtained in wine traps have been compared with the captures obtained in pheromone traps, both in mating disrupted and in not-mating disrupted vineyards. In 2010, adults caught in wine traps have been properly sexed and the females dissected to check the mating status. Very intriguing outcomes have emerged from the survey both in terms of number and timing of catches and in terms of the mating status of the females collected in the wine traps.

Intensity of vibrational signals determines mating behaviour in *Scaphoideus titanus* Ball (Hemiptera: Cicadellidae)

A. Eriksson, A. Lucchi, G. Anfora, M. Virant-Doberlet, V. Mazzoni 151-155

Abstract: Insects use different signal modalities to communicate with their conspecifics. Substrate-borne vibrations are widely used among those communicating with mechanical signals. We studied the role of signal intensity for the mating behaviour in *Scaphoideus titanus*, a vibrational communicating leafhopper that is a vector of the lethal phytoplasma grapevine disease Flavescence dorée. As males called for the females and the substrate velocity (intensity) measured at the dominant frequency of the female replies was in the range 0.0005-0.001mm/s, males either walked around randomly and emitted long, irregular identification signals, or performed call-fly behaviour, by jumping off the plant after a female reply. When males perceived female signals over 0.001mm/s they started searching while performing a location duet. Only when male and female were on the same leaf, courtship duets were recorded with intensities over 0.01mm/s. These results show that *S. titanus* males may adjust their behavioural strategies to localize conspecific partners according to signal intensity.

Should grape moth larval immunity help explaining resistance against natural enemies?

F. Vogelweith, D. Thiéry, Y. Moret, J. Moreau 157-164

Abstract: In tritrophic systems (plants, phytophagous insects and natural enemies), host plant variation often keys the relative performance of both the herbivore and its associated natural enemies. In bottom-up effects, host plants could affect the fitness of phytophagous insects including growth rate and adult fertility. These effects are indirectly reflected in parasitoids whose success depends on their host quality. For instance, nutrient deficiency or/and toxic defensive compounds of the plants could slow-down the development of herbivorous insects, thus extending the window of vulnerability of attacks by natural enemies.

The immune system is arguably the most common resistance mechanisms used by phytophagous insects against natural enemies such as parasites and parasitoids. However, only a limited number of studies have really linked tritrophic interactions and immune defenses of phytophagous insects. Our work considers two grape moths, the European grapevine moth, *Lobesia botrana*, and the European grapeberry moth *Eupoecilia ambiguella*.

In this study, we have tested the influence of different grapevine varieties on the baseline level of three immune parameters (concentration of haemocytes, activity of the prophenoloxidase system and antimicrobial activity) of larvae of the European grapevine moth. In this presentation we discuss the results obtained in this experiment and their effects and importance in tritrophic.

Occurrence of earwigs in vineyards and their impact on aroma and flavour of 'Chasselas' and 'Pinot Noir' wines

J.-P. Burdet, J. Karp, P. Deneulin, C. Linder, P. Kehrli 165-171

Abstract: The European earwig *Forficula auricularia* L. (Dermaptera, Forficulidae) is an omnivorous predator that is considered a beneficial insect. In vineyards it preys on pests such as grape berry moth and other tortricids. Over the last few years earwig abundance increased occasionally to levels that were no longer tolerated by European winegrowers since they may erode berries, transfer fungi spores and contaminate grape clusters with their faeces. Moreover, they are suspected of affecting aroma and flavour of wines. In this study we surveyed the population dynamics of *F. auricularia* in four commercial vineyards, and we artificially contaminated grapes with adults and their faeces.

In May, earwig nymphs started to colonise grapevines and the first adults were observed at the beginning of June. The abundance of earwigs on grapevines and within grape clusters reached their peak in the middle of summer. Although the population density was comparable among vineyards, more individuals were observed in the tighter 'Pinot noir' clusters than in the looser 'Chasselas' clusters. The local environment seemed to have only a minor influence on the abundance of earwigs.

The sensory evaluation revealed that 0.6g of earwig faeces per kilogram of 'Chasselas' grapes had a negative impact on the quality of the corresponding wines. Contaminated wines were less fruity and less floral, and their aroma was described as faecal. Generally, the wines were judged to be of lower quality. However, the addition of four living adults per kilogram of grapes affected the sensory characteristics of 'Chasselas' wines only marginally. The contamination of 'Pinot noir' grapes with four different levels of living earwig adults showed that the corresponding wines smelled and tasted significantly different than the uncontaminated control wines when ten or more earwigs per kilogram of grapes were used. Contaminated 'Pinot noir' wines were described as "animal", "reductive", "vegetal", "acidic", "bitter" and "tannic" and were of lower quality.

In conclusion, our results show that earwig faeces and adult levels of ten or more individuals per kilogram of grapes negatively influence aroma and flavour of 'Chasselas' and 'Pinot noir' wines. Winegrowers should therefore monitor the development of *F. auricularia* populations in their vineyards in order to avoid the production of poor wines.

Notes on the biology and the pest status of *Antispila* sp. (Lepidoptera: Heliozelidae)
in North-eastern Italy

C. Duso, M. Baldessari, A. Pozzebon, E. Ferrari, G. Angeli, L. Mazzon,
L. Tonina, E. J. van Nieukerken 173-176

Abstract: Recently, the Nearctic leafminer *Antispila* sp. (Lepidoptera: Heliozelidae) has been reported as a new invasive pest in North-Italian vineyards. It has been widely detected in the Trentino and Veneto Regions, both in unsprayed and commercial vineyards. Morphological and molecular studies strongly suggest an American origin of this species. The life cycle of *Antispila* sp. has been investigated in two vineyards located in Trentino and Veneto Regions in 2010. Two to three generations can be completed annually depending on environmental conditions. The impact of natural antagonists in controlling *Antispila* sp. populations appeared to be low to moderate. The incidence of infestation can reach significant levels with possible implications for yields.

Monitoring and control of European grapevine moth, *Lobesia botrana*
(Lepidoptera: Tortricidae) in California vineyards

R. A. van Steenwyk, L. G. Varela, M. L. Cooper 177-186

Abstract: Commercially available and USDA APHIS *L. botrana* pheromone monitoring lures as well as wine, vinegar and brown sugar bait were compared during the spring of 2010. Alpha Scents™ EGVM and Pherocon® EGVM (rubber septa lures) captured significantly more moths in early spring, while the EGVM biolure® (membrane lure) caught significantly more moths during late spring. The USDA APHIS lures were no better than the commercial lures and all pheromone lures captured significantly more moths compared to the bait pan traps. Also in 2010, small plot insecticide efficacy trials were conducted against first generation larvae. All materials evaluated provided good to excellent control of young larvae with abamectin and spinetoram providing excellent control of mature larvae. In a large plot insecticide efficacy trial, one application of methoxyfenozide gave significantly better control compared to three applications of *Bacillus thuringiensis*, one application of chlorantraniliprole or two applications of spinosad.

Herbicides against stinging nettle to control grapevine bois noir disease:
does the timing of application affect the emergence
of its vector *Hyalesthes obsoletus*?

P. Kehrli, N. Delabays 187-190

Abstract: The planthopper *Hyalesthes obsoletus* is the principal vector of the grapevine yellows disease 'bois noir' in Swiss vineyards and stinging nettle (*Urtica dioica*) is its favourite host plant. Viticultural control practices therefore target stinging nettle, the actual reservoir and source of both the disease and the vector. In order to kill developing nymphs of *H. obsoletus*, it is currently recommended to apply herbicides against stinging nettle in the end of the season. To test if this late period of herbicide application is justified, stinging nettles were treated with glyphosate in the fall, in the spring or not at all and emergence traps were placed in the centre of treated and untreated patches for studying herbicide's direct impact on the vector. Although the autumnal treatment was slightly more efficient, herbicide applications at both dates controlled the growth of stinging nettle in the subsequent summer very well. However, emerging *H. obsoletus* adults were captured in all three treatments and there was no significant difference among them. The aerial application of glyphosate did therefore not restrain nymphs' development in the soil. Government agencies should consequently reconsider if the authorisation of herbicide applications against potential host plants in autumn is justified since our results suggest that stinging nettle could also be controlled in spring, alike other viticultural weeds.

Grape rust mite: a reoccurring viticultural pest

C. Linder, M. Bouchaib, S. Emery 191-195

Abstract: The grape rust mite (GRM) *Calepitrimerus vitis* (Nalepa) is a well known eriophyoid in European vineyards. High densities of hibernating GRMs can significantly retard the growth of

shoots in early spring and they can also cause leaf and shoot distortions. Retarded shoot growth is an increasing problem in the Valais, the hottest and driest viticultural region of Switzerland. To avoid damages, winegrowers rely on pre-bud burst treatments mostly based on the basis of the damage in the previous season. Occasionally, an empirical threshold level of 20 GRMs/bud is applied. For a better estimation of this threshold, the dynamics of early spring GRM populations were studied in five vineyards of the cultivar “Amigne” over the last three years. With one exception, GRM densities below the current threshold had no effect on shoot growth and cluster number. However, values near or above this level, necessitated chemical interventions. The trapping of GRMs at the basis of shoots with double-faced adhesive tape helped to identify the start of GRM activity in the spring and highlighted a massive migration of individuals from the old wood towards developing shoots. Although the number of overwintering GRMs captured at the basis of shoots was highly correlated with populations found in the buds, it explained some shortcomings of the latter. The use of double-faced adhesive tape may therefore provide a reliable method to estimate pest pressure and to monitor the period of bud colonisation.

These two information may be very helpful to winegrowers in order to assess the necessity of a chemical intervention against GRM and to determine its timing in early spring.

Observations on population dynamics of leafhoppers in Western Sicily vineyards

H. Tsolakis 197-202

Abstract: From 2007 to 2009 field observations were carried out in two vineyards (organically and conventionally managed) in Menfi (Agrigento province, Sicily). Population dynamics of two leafhoppers, *Jacobiasca lybica* (cotton leafhopper) and *Zygina rhamni* were followed by chromotropic traps and leaf observation in field. Both species were constantly present in vineyards. *Z. rhamni* did not register statistical differences between the two fields, while *J. lybica* was mostly present in the conventionally managed field. In this last vineyard for two consecutive years (2007 and 2008) *J. lybica* population exceeded the intervention threshold of 0.5 leafhopper/leaf. On the other hand, in the organically managed vineyard the cotton leafhopper population remained below the intervention threshold for all the observation period.

Evaluation of infestation by *Lobesia botrana* (Dennis et Schiffermüller) (Lepidoptera, Tortricidae) and its relation to territorial differences and cultivar susceptibility

E. Gennuso, E. Ragusa, H. Tsolakis 203-210

Abstract: A three year study (2008-2010) was carried out in two organically managed vineyards in western Sicily to verify both the influence of different cultivars and microclimatic conditions on grape moth infestation and on mould infections of grapes. Observations were done on two autochthonous cultivars (Inzolia and Catarratto) and four international ones (Chardonnay, Cabernet Sauvignon, Syrah and Merlot). Results showed a different degree of infested grapes among the different cultivars in both farms but also a different level of infestation between the two farms for the same cultivar. Chardonnay was the most infested cultivar by the grape moth larvae, while Merlot was the less infested one. *Botrytis cinerea* was almost absent on the majority of the cultivars, while the sour bunch rot was always present. This disease was sometimes present on all infested grapes. On the other hand, *Aspergillus* was present at very low levels on the majority of the cultivars.

Pyralidae Phycitinae in Italian vineyards:

behavioural and molecular genetic investigations

I. Martinez-Sañudo, L. Mazzon, P. Dalla Vecchia, B. Bagnoli, A. Lucchi,

E. Marchesini, N. Mori 211-215

Abstract: In the last four years, during several surveys carried out in different wine growing areas of Veneto and Tuscany regions (Northern and Central Italy) for the monitoring and control of the tortricid moths *Lobesia botrana* (Denis & Schiffermüller), *Eupoecilia ambiguella* (Hübner) and *Argyrotaenia ljugiana* (Thunberg), larvae of Pyralidae Phycitinae have been

frequently found within the clusters, mainly after veraison. Samples of these larvae were used for laboratory observations and reared to obtain the moths. Moreover, in order to collect field adults, pheromone sticky traps were installed in some vineyards. A randomized amount of the samples was then utilized for molecular analysis. A fragment of the cytochrome oxidase I (Barcode) was chosen for the sequencing. The identity of the species was verified using the on-line databases BOLDSYSTEM and GenBank (NCBI). A total of 32 larvae and 28 adults (obtained from both reared larvae and sticky traps) were processed, and sequences of approximately 610bp were obtained. The phylogenetic analysis of the collected phycitins revealed the existence of 5 groups. The members of the first group present a homology of 99-100% with *Ephestia unicolorella woodiella* Richard & Thomson. In both regions this species resulted the predominant phycitin collected in the clusters. A similarity of 100% with *Ephestia elutella* (Hübner) was found for the members of the second group, all collected in Veneto vineyards with pheromone sticky traps, with the exception of one larva. The third group coincides with *Cryptoblabes gnidiella* (Millière). This species was only found in Tuscany, where it is the most frequent phycitin observed in the coastal vineyards. The fourth group, including the 24% of the phycitin larvae collected in Veneto, shows a similarity of 99-100% with *Ectomyelois* (= *Apomyelois*) *ceratoniae* (Zeller). For the members of the last group, collected in the pheromone sticky traps exposed in Veneto, no correspondence was found in the GenBank and the morphological identification is still in progress. Results of this research, still ongoing, constitute a significant contribution to the characterisation of the phycitin population inhabiting the grape clusters during ripening in several important areas of our Country.

Development of larval instars of *Empoasca vitis* and *Edwardsiana rosae* (Homoptera: Cicadellidae) on grapevine leaves at different temperature regimes

A. Reineke, M. Hauck 217-221

Abstract: The polyphagous grape leafhopper *Empoasca vitis* (Homoptera: Cicadellidae) is regarded as a major insect pest in many European grapevine growing areas. Both larvae as well as adults feed on the phloem vessels of the leaves, causing characteristic symptoms also referred to as hopperburn. While *E. vitis* is long known as a widespread insect in Southern European vineyards, it has only just recently been recognized as an important pest in cooler climates such as Middle European winegrowing regions. This increase in grape leafhopper population sizes might be due to an increase in more favourable weather conditions maybe as a result of climatic change. In addition, a couple of monitoring studies have shown that there are a numerous other leafhopper species occurring in vineyards besides *E. vitis* as well. The rose leafhopper *Edwardsiana rosae* (Homoptera: Cicadellidae) is one of the leafhopper species occasionally found on grape vine leaves, with no data presently available on its putative potential to cause economic damage on grapevine. Here, we report on a first data set obtained in a laboratory study on the development of larvae of two leafhopper species, *E. vitis* and *E. rosae* under five different temperature regimes on grapevine leaves. Single leaves of *Vitis vinifera* were collected in the field between the beginning of May and mid August 2009, 2010 and 2011, respectively, and were screened for the presence of leafhopper eggs in the veins of the respective leaves. Freshly emerged larvae were transferred to new grapevine leaves and were kept solitary throughout the experiment at the following night:day (N:D) temperature regimes: 10°C (N) - 20°C (D), 13°C (N) - 23°C (D), 15°C (N) - 25°C (D), 18°C (N) - 28°C (D), 20°C (N) - 30°C (D). These set-ups were selected as typical night-day temperatures and putative climate change scenarios in middle European viticulture. At least 30 larvae per species and temperature range were screened. Developmental time from first instar larvae to adult was shortest at the 15°C (N) - 25°C (D) temperature range. None of the individuals of both species completed development from the egg stage to first instar at the temperature regime of 20°C night and 30°C day temperature. At this temperature range, either no egg hatch was observed or hatch of first instar larvae was not successful. These results suggest that warm (18°C) nights and moderately warm (28°C) days are representing the upper thermal threshold for development of both *E. vitis* and *E. rosae* embryonic stages on grapevine leaves, contradicting current assumptions of an increasing importance of *E. vitis* as a grapevine pest under future climate change.

Surveying the leaf arthropod community in Médoc vineyards
under mating disruption against the European grapevine moth

L. Delbac, M. Dupont, P. Moreau, D. Thiéry 223-229

Abstract: Mating disruption (MD) is a well known efficient technical crop protection against grape berry moths used all over European vineyards. The method is specific and requires observations of non target pests like microscopic arthropods under the foliage. In 2010, a skill transfer between INRA and an agricultural supplier started in Medoc AOC region near Bordeaux. Three fauna monitoring occurred during the growing season: flowering, bunch closure and maturity. Biodiversity was always important in the monitored vineyards, and this concerned both beneficials and pests. Typhlodroms were the most represented in the leaf communities. The history of MD did not seem to influence the biodiversity observed, and we found no clear effect of weed cover occurrence. We report the others species which were counted by our methodology.