Short Paper

Investigations on the flight behaviour of *Anisandrus dispar* (Fabricius, 1792) (Coleoptera: Scolytidae) in trap catches in the apple orchards of the Lower Adige Valley in South Tyrol

Untersuchungen zum Flugverhalten von *Anisandrus dispar* (Fabricius, 1792) (Coleoptera: Scolytidae) laut Fallenfängen aus vier Apfelanbaulagen des Südtiroler Unterlandes in den Jahren 2018 bis 2024

Studi sulla dinamica di volo dell'*Anisandrus dispar* (Fabricius, 1792) (Coleoptera: Scolytidae) sulla base delle catture effettuate con trappole in quattro zone di coltivazione di mele della Bassa Atesina negli anni dal 2018 al 2024

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ABSTRACT

Anisandrus dispar (Fabricius, 1792), known as "ambrosia beetle" is a pest of economic concern. To characterize its seasonal flight activity, we monitored populations from 2018 to 2024 by using ethanol-baited traps in two distinct phenological areas within the apple growing region of lower Adige Valley, Italy. Two independent trapping sites were positioned in each area. During all years and in all locations, we observed a main period from February to the end of May, where the *A. dispar* female flight occurred. However, the initiation of flight activity differed significantly between "early" and "late" phenological areas. The analysis of the six years of flight dynamics period provides some new insights. These findings improve our current understanding of its flight activity and provide a hypothesis related to more accurate prediction of the start of the female flight in spring.

KEYWORDS

Monitoring, apple, invasive alien pests, phenology, *Anisandrus dispar* (Fabricius, 1792) (Coleoptera: Scolytidae)

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INTRODUCTION

This short article refers to annual flight dynamics of *Anisandrus dispar* during the continuous monitoring at four trap sites; we have already presented summary data on this species for 5 years of catches from 2018 to 2022. A description of the agricultural impact is also included [1].

In this short communication we discuss the raw data of the *A. dispar* "flight dynamics" investigated from 2018 to 2022, previously summarized in [1] and we have added the 2023 and 2024 data recordings, completing the data set for four trap locations.

The so-called "Ambrosia Beetle" species: *A. dispar* (Fabricius, 1792) (Coleoptera: Scolytidae) and, to a much lesser extent, the "small wood borer" *Xyleborinus saxesenii* (Ratzeburg, 1837) (Coleoptera: Scolytidae) are regularly found in South Tyrolean apple orchards in the trunks of apple trees. Accordingly, both species are also monitored in ethanol traps that are operated on site [2].

Based on our surveys using ethanol traps since 2017, the females of both species occur regularly and in considerable numbers in the vicinity of apple orchards [3]. *X. saxesenii* results as a species frequently caught in ethanol traps but is not of primary importance for Malus plants [3].

Anisandrus (Xylosandrus) *dispar* was first mentioned in South Tyrol in 1954 [4]. In 1966, the species was named as a "dangerous bark beetle in fruit growing", in the specialist journal for fruit growing and viticulture [5].

The third occurring species, *Xylosandrus germanus* (Blandford, 1894), was first detected in South Tyrol in a diseased apple plant in 2018. This was part of routine analyses conducted by the Virology and Diagnostics unit at the Laimburg Research Centre, using the barcoding method [1]. *X. germanus* was also regularly detected in trap catches at our trap sites between 2018 and 2022 [1].

Compared to the absolute numbers of *A. dispar* and *X. saxesenii* trapped per year, *X. germanus* can be considered a sporadically detected species.

The spread of invasive, "Ambrosia Beetle" species of the genus *Xylosandrus* also harmful for apples, cannot be ruled out for South Tyrol either. According to [6], *Xylosandrus crassiusculus* (Motschulsky) and *Xylosandrus compactus* (Eichhoff), which have been detected in central Italy since 2017, occur on oak trees in association with *X. germanus*. According to [7], *X. crassiusculus* can be detected using ethanol funnel traps.

As a rule, only the females of the Ambrosia beetle species fly out and can be caught using traps [8]. The ethanol produced by the damaged plant is one of the attractants used to lure female beetles [2].

In this project, we were interested in recording the annual flight dynamic, particularly the onset of flight of *A. dispar* in spring and in creating an overview of the most important "Ambrosia beetle" species detectable with the aid of ethanol baited funnel traps (see below).

BIOLOGY AND BEHAVIOR OF *A. DISPAR*

Anisandrus dispar is a univoltine species [9]. In spring, the first females hatch from the host plants in search for new suitable host plants into which they drill tunnels and lay eggs. This behavior can cause severe injuries to the host plant, which, in the case of this work are the cultivated apple trees. For detailed *A. dispar* biology and behavior, we refer to [1]. Often, one *A. dispar* female can bore several tunnels, either in the original host plant or in a "new" one [10]. As a rule, *A. dispar* favors stressed, injured, dying or dead trees as hosts, which frequently emit ethanol [11].

Studies have shown that the "ambrosia" fungi transferred by the female beetle to the host plant [8] after the borehole is made stimulates the latter to produce ethanol, so that the ethanol-insensitive "Ambrosia funghi" species has an advantage over wood-borne fungi. Kühnholz et al. [12] postulated, that "vulnerability to attack is heightened by altered winter and spring temperatures", without further indications to the host plant, to which they refer. It can be assumed that the conditions for ethanol formation and ethanol emission in the apple trees are already in place at the time of the female beetle's departure.

According to Mani [2] and Egger [13], the onset of flight and the flight behavior of *A. dispar* females, as observed from trap catches, indicate that females begin flying at daily maximum temperatures of 18.0 and 20.5 ℃. Egger [13] quotes Schvester [14] and gives daily maxima of 20-22℃ for the months of March and April for more southerly areas.

MATERIAL AND METHODS

The four trap locations were distributed in two different areas and equipped with modified funnel traps. The traps used in the study were Rebell Rosso (Biogard, Nova Milanese, Italy) traps, as a modified "funnel" version of the same.

The GPS coordinates of the trap locations are:

- Laimburg (LB) Depot: N 46.3798216, E 11.2870815,
- Laimburg (LB) 103: N 46.3801534, E 11.2886131,
- Happacherhof: N 46.3560495, E 11.3023662,
- Binnenland: N 46.3417697, E 11.2791317.

The first two mentioned trap sites are located in a phenologically "late" northern region, while the other two trap sites were chosen for comparison in areas characterized by "earlier" phenological development.

The trap sites "Laimburg (LB) Depot", "Laimburg (LB) 103", "Happacherhof", and "Binnenland" continued to be operated until 2023 or 2024, i.e. after the completion of the "European shot-hole borer" (*A.*

dispar) projects in 2020 on apples launched in 2016. At the end of the 2023, the two trap sites (LB Depot and LB 103) at Laimburg Research Centre had to be closed. For further description of the trap locations, see [1] and [15]. LB Depot and LB 103 trapping sites were 4.0 and 4.5 km away from the two other sites, "Happacherhof" and "Binnenland". The latter two sites were 1.7 km apart from each other and located south of the Laimburg Research Centre. We considered both trap sites set in a phenological "early" area.

The meteorological station located in the "late" northern area Laimburg (N 11.288711, E 46.382457) is situated within a 300 m radius of both trap sites, LB Depot and LB 103. For the southern area, two meteorological stations are used: one positioned near the "Happacherhof" site (N 11.300994, E 46.360723), and another near the "Binnenland" site at Roten Tor (N 11.263282, E 46.334810).

Funnel traps were used for monitoring. These were modified based on the design of the standard adhesive trap "Rebell Rosso™", so that the captured individuals were preserved in a bottle filled with 70% ethanol. This bottle also served as an attractant dispenser [1]. Part of the data has been displayed in summarized format for the period from 2018-2022 [1]. In this short communication we discuss the *A. dispar* flight dynamic for the entire survey period. The funnel traps were operated for seven years (2018-2024) from the second half of February to the end of September and were emptied weekly. All the data are accessible in the repository [15]. In 2025, four new trap locations were established outside the area that had been surveyed between 2018 and 2024. This data will be shown and discussed in a dedicated article currently in preparation for publication.

For comparison purposes, the flight start for each trap site, year and location was considered counting the days from 1st January of the respective year to the date of the flight start. Meteorological data for all the trap locations were provided by the advisory board (Südtiroler Beratungsring für Obstbau; Lana; Italy).

Monitoring of two potentially harmful species with quarantine status of the genus *Xylosandrus* [6], which have not yet been detected in South Tyrol, is carried out automatically including *Anisandrus maiche* (Kurentzov), a recently "new" discovered Ambrosia beetle species, found in Ticino in Switzerland [16]. It is considered as a possible species of future quarantine interest.

We classified the main target species *A. dispar* after preserving the catches in ethanol [17] [18]. Regarding the minor species *X. saxesenii* and *X. germanus*, all female individuals were identified at species level, and these data were also recorded [15].

To facilitate a comparison of the influence of trap location and year on the onset of *A. dispar* flight, the start date of flight was identified for each trap location and year between 2018 and 2022. This date was defined as the last day of the period during which the first catch was made, based on continuous monitoring in two areas of the Lower Adige Valley. Data from 2018 to 2022, along with data from 2023 and 2024, were also used to describe the shape of the annual flight curve and to identify key population parameters.

RESULTS

The modified funnel traps were operated on average between 203 and 253 days per year. In the years from 2018 to 2024, mainly the two "Ambrosia beetles" *A. dispar* (Tab. 1, Tab. 2) and *X. saxesenii* were detected at the four trap sites (two sites at the Laimburg location were abandoned in 2024).

None of the two *Xyleborinus* species of quarantine importance (*X. crassiusculus* and *X. compactus*) were recorded during the monitoring period.

The *Xyleborinus saxesenii* and *Xylosandrus germanus* data for the years 2023 and 2024 are expressed as individuals caught per day referred to the end-date of the catch period, mostly one week, and are not discussed here but reported in the repository attachment [15].

Anisandrus maiche (Kurentzov) a recently "new" Ambrosia beetle species discovered in the Ticino region (CH) [16] was not found during the monitoring period 2024.

FLIGHT START OF *A. DISPAR* IN SPRING

For the "raw" trapping site data related to the period from 2018 to 2024 in the two areas, see the repository part [15]; the meteorological data are available on request from the author. The observed flight starts of *A. dispar* are reported in Table 1 and Table 2 for every single year, considering the period from 2018 to 2023 and 2018 to 2024, respectively.

We measured the onset of flight for A. dispar from 2018 to 2023 for each trap location by calculating the number of days from January 1st of the respective year. A Two-Way ANOVA revealed that the flight onset differed significantly among years ($F=6.79$; $p=0.002$). The trap sites showed a variable flight start for *A. dispar* females between 63.05 and 74.5 days from the 1st of January on; expressed in "real" day-data, the flight during the 6 years observation started between the 7th and the 19th of March. The mean value across all four locations corresponds to day 70.75 of the year, indicating an average flight onset on March 11th.

Considering the four locations together comparing the 6 years of observation, we noticed a different flight start depending on the year (Two Way ANOVA; $F=5.133$ $p \leq 0.012$), particularly for the two years, 2019 ($d=61.00 \pm 2.923$; $t=5.2$ $p=0.002$) and 2023 ($d=62.75 \pm 2.923$ $t=5.2$ $p=0.002$) with an early start vs. the 2018 year with a very late start ($d=82.5 \pm 2.923$). At the two Laimburg trap sites over the 6-years period, the flight started on nearly the same day (74.5 and

Tab. 1: *A. dispar* first observed flight period: start, end, mean value of the first flight (in catches per day) at the Laimburg locations.

Trap site	Start	End	*A. dispar* /d
LB Depot	26.03.2018	31.03.2018	0,40
LB Depot	28.02.2019	01.03.2019	3,00
LB Depot	10.03.2020	17.03.2020	2,43
LB Depot	04.03.2021	11.03.2021	0,29
LB Depot	17.03.2022	24.03.2022	1,43
LB Depot	02.03.2023	09.03.2023	0,29
LB103	26.03.2018	31.03.2018	0,40
LB103	28.02.2019	04.03.2019	1,00
LB103	10.03.2020	17.03.2020	5,86
LB103	11.03.2021	18.03.2021	0,14
LB103	10.03.2022	17.03.2022	0,71
LB103	23.02.2023	02.03.2023	1,00

Tab. 2: *A. dispar* first observed flight period: start, end, mean value of the first flight (in catches per day) at the "Binnenland" and "Happacherhof" locations.

Trap site	Start	End	*A. dispar* /d
Binnenland	12.03.2018	16.03.2018	1,75
Binnenland	28.02.2019	04.03.2019	0,75
Binnenland	10.03.2020	17.03.2020	7,71
Binnenland	25.02.2021	04.03.2021	0,29
Binnenland	23.02.2022	03.03.2022	0,13
Binnenland	23.02.2023	02.03.2023	0,29
Happacherhof	12.03.2018	16.03.2018	11,00
Happacherhof	25.02.2019	28.02.2019	3,00
Happacherhof	18.02.2020	25.02.2020	0,29
Happacherhof	04.03.2021	11.03.2021	0,14
Happacherhof	23.02.2022	03.03.2022	0,13
Happacherhof	23.02.2023	02.03.2023	1,43

73.83 for "LB Depot" and "LB 103"); this also accounts for both locations outside the Laimburg area (66.67 and 63.5 for "Binnenland" and "Happacherhof").

The differences expressed in days were statistically significant comparing the "early" "Happacherhof" location vs. both the "late" Laimburg locations (LB Depot and LB 103) ($t=3.925$ $p\leq0.05$; $t=3.61$ $p\leq0.05$, respectively) with an earlier flight start of 11.3 and 10.33 days. The difference between the phenological "early" "Binnenland" trap location and both the Laimburg trap locations was marked (data not shown) but not statistically significant ($p>0.05$).

ANNUAL FLIGHT DYNAMICS OF *A. DISPAR* WITH MORE THAN ONE MAXIMUM

For this analysis we considered a 6- and 7-year period respectively for the four trapping sites in the two areas.

Regarding *A. dispar*, the visualization of the accumulated flights for six years (2018-2023) and for the four trap sites shows a second peak in all the locations after the maxima and the flight decrease in May (Fig 1, Fig. 2, Fig.3, Fig. 4).

A third peak was observed in all the trap sites mentioned from July onwards until the end of the monitoring period (Fig 1, Fig. 2, Fig.3, Fig. 4).

DISCUSSION

Part of the data (2018-2022) has already been presented and discussed [1]. We saved these datasets (*Anisandrus dispar* and *Xyleborinus saxesenii*) together with the 2023 and 2024 data in the repository part [15]. This also includes the presence data for *Xylosandrus germanus*.

Regarding *X. germanus*, the 2023 and 2024 surveys revealed a similarly sporadic presence as observed since its initial detection during the trap monitoring program in 2018 in apple plantations [1].

The strategic positioning of the four trap locations across the two areas situated in close proximity to both, the railway and the main motorway makes them particularly suitable for monitoring invasive species (Fig. 5). *A. maiche* (Kurentzov), recently found in the Ticino region (CH), is seen as a "new" "Ambrosia beetle" [16] and as a possible future quarantine species of interest. It is not yet included in official lists [19] [20] [21] and is not currently classified as particularly harmful. From a phytosanitary perspective, every newly discovered and described "Ambrosia beetle" species must be regarded as a potentially invasive species comparable to the *Xylosandrus* species (*X. crassiusculus* and *X. compactus*), which were not detected at our trapping sites in 2024 and 2025. However, both species are already present in Central Italy and are considered harmful to the local ecosystem [6].

FLIGHT START OF *A. DISPAR* REFERRING TO KNOWN TEMPERATURE THRESHOLD VALUES AND OBSERVED PHENOLOGY

Due to the evident climate change-effects, also recognized in our re-

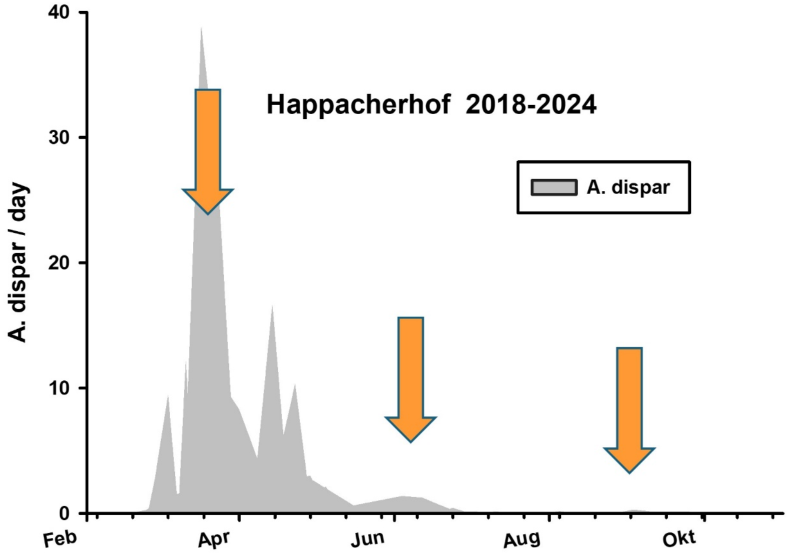

Fig. 1: *A. dispar* cumulated trap catches for the 7-year period from 2018 to 2024.

gion and reported for apple phenology [22], we should only consider measured temperatures or observed phenological stages; when we attempt, to predict or describe the spring flight start of *Anisandrus dispar*.

Beck [23] proposed the idea that the exceeding of a daily temperature maxima for a certain number of days triggers insect behavior, such as the flight start of overwintering female adults in spring [23]. Similar experiences are known for the flight start of the "European Cockchafer" (*Melolontha melolontha* L.) [24].

From this perspective, the onset of *A. dispar* flight must be discussed in relation to the currently proposed daily temperature thresholds for female emergence and the initiation of flight activity, as well as the locally measured temperatures [2] [13] [14]. Although we have extensive catch data spanning six years of annual flight observations, a comparison between the published temperature thresholds for flight initiation (daily temperatures of 18-22 ℃) and the temperatures we measured prior to flight onset at the different trap sites was still insufficient to draw reliable conclusions (data not shown). The limited number of trap locations in only two areas further restricts the statistical power of our analysis.

We exclude a possible influence of day length on the flight start from this discussion because the two areas we investigated are on a similar latitude. As explained before, the two areas are not distinctive enough regarding the local daily temperature maxima and the exceeding of a known critical threshold experienced by the female.

We noticed a difference in days regarding first trap catches (considered flight start) between the two phenological "earlier" trap locations ("Happacherhof" and "Binnenland"; "early" southern area) vs. the phenological "later" trap locations LB Depot and LB 103 (northern area). The attributes "early" and "late" refer to the start of the growing process of the apple cultivar and the event of the phenological stage B53, which defines the start of the apple plant bud break in spring [22], personal communication (M.Wolf). According to this, based on the differences observed in the flight start and the classification of the two areas as "early" and "late" sites, we must assume that temperatures may play a decisive role in inducing *A. dispar* females to leave the nests for reproduction at a specific moment, when conditions are optimal.

There is a remarkable effect of the apple variety on the beginning of the vegetative activity in spring. In parts, the rootstock can have also an influence on the "earliness" of the plant. Despite these two biotic factors, the local temperatures measured during the period prior to the growing season must be the main factor that influences the vegetation start in the defined areas.

In 2025, we began investigating the onset of the *A. dispar* female flight during early spring at four new trap locations situated outside the two areas surveyed over the past six to seven years. These investigations aimed to explore the potential for predicting the start of flight based on daily temperatures recorded from January 1st onward,

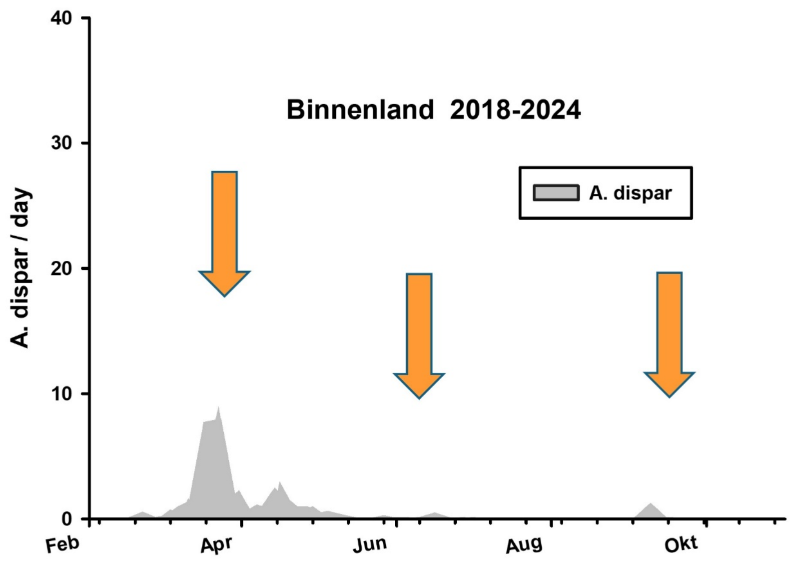

Fig. 2: *A. dispar* cumulated trap catches for the 7-year period from 2018 to 2024.

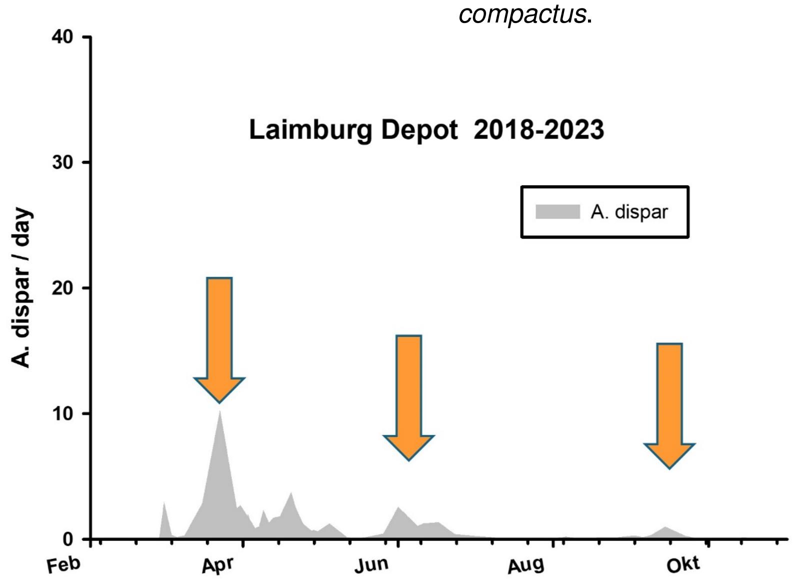

Fig. 3: *A. dispar* cumulated trap catches for the 6-year period from 2018 to 2023.

particularly in 4 areas with distinct phenological characteristics, with one trapping site inside each different area. The new trap locations were selected to cover a wide range of spring temperature conditions, focusing on areas with notable differences in plant and insect phenologies from "early" to "late" seasonal development. This work is part of a new project originally planned for 2024 but initiated in February 2025. The results will be presented and discussed in a dedicated article, as the data are still being processed and some meteorological records remained incomplete.

Despite attempts to validate the former results in four areas outside those for which we presented actual data, investigations will continue over the next years. They will focus on the two remaining trap locations within the "early" area covered by the "Happacherhof" and "Binnenland" trap sites, in order to monitor the flight dynamics of *A. dispar*. In addition, samples will be taken of species with a faunistic value, including "Ambrosiabeetle"-species, which may have economic (*Xyleborinus germanus*) importance and possible species of quarantine relevance: e.g. *X. crassiusculus* and *X. compactus*.

FLIGHT DYNAMIC OF *A. DISPAR* APPEARED POLIVOLTINIC

In most years, *A. dispar* exhibited a bimodal (or sometimes trimodal) flight pattern, indicating that female attacks can also occur in late summer (Fig 1, Fig. 2, Fig.3, Fig. 4).

The second small peak of *A. dispar* female flight was observed starting in June, followed by an even smaller, third peak in the fall. Since *A. dispar* is described as a strictly univoltine species [9] [13], this recurrent phenomenon requires further explanation. Our unpublished data on the breeding behavior of *A. dispar* from the years 2017-2020 showed the opposite. During these years we investigated annual field attacks by *A. dispar* on cleared apple trees, finding females already drilling and nesting from March to the first decade of May, but not later [3].

Considering investigations in an area with prevalent chestnut cultivations (Washington; Onalaska county; U.S.A) Bhagwandin stated, that *A. dispar* is capable of a second generation. According to Bhagwandin [25], part of the re-increased flight activity of *A. dispar* after the decline at the end of May should be considered as a distinct female flight peak. Similar observations result from the work of Roediger [9], whose studies on the biology have been done on caged wooden logs with *A. dispar* brood inside. His conclusion on the origin of this phenomena, was, that the a part of the F1 progeny of the maternal female leaves the nest after they have completed the development (e.g. in July) without overwintering.

We observed similar phenomena in all the trap locations, but, as stated before [3], it appears to lack any epidemiological importance. We argue, that females caught in the traps during this late period are probably "old" overwintering females who finished the nest-attending activity of

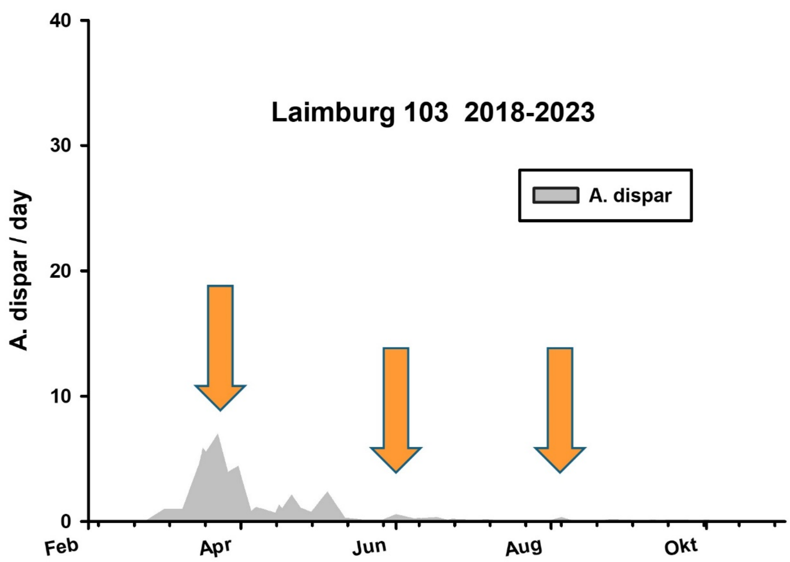

Fig. 4: *A. dispar* cumulated trap catches for the 6-year period from 2018 to 2023.

Fig. 5: The modified funnel trap (based on the Rebell Rosso trap) at the “Binnenland” trap site; near to apple cultivation and the A22 motorway (in the back of the picture).

the new generation set up in the same year. This could, contrarily to the findings of Roediger [9] explain this “late” flight activity with a distinctive peak during June in all the years. In support of this hypothesis, we refer to [8]. In this work the “maternal” *A. dispar* female survived until the full development of their F1 progeny.

At the trap locations we observed a third series of isolated peak maxima of *A. dispar* females, caught starting from July until September, especially at the Laimburg trap locations. In the other two locations, “Binnenland” and “Happacherhof”, we observed this phenomenon to a lesser extent. As stated traps placed between the orchard area and an area containing “wild hosts” e.g. forests (see [4]) show a delayed flight activity, following the author [2] when flight in the orchard had already finished. “Binnenland” and “Happacherhof” are trap locations more distant from putative “wild hosts”.

We argue that the causes for the third peak may be linked in part to the same causa hypotized for the second peak. Specifically, the *A. dispar* females involved in this late summer flight may have originated from nests in a specific group of wild hosts with a particular “late” phenology. Starting from this findings we had to investigate the phenomena properly with a specific methodology. Due to the limited epidemiological importance of this “late peaks”, the affords to identify the plant species from which *A. dispar* females have their origin are considered to high.

ZUSAMMENFASSUNG

Anisandrus dispar (Fabricius, 1792), aus der Gruppe der „Ambrosiakäfer”, ist ein Schädling mit wirtschaftlicher Bedeutung. Um seine saisonale Aktivität zu charakterisieren, haben wir den Flug von 2018 bis 2024 mit Hilfe von Ethanol-Köderfallen in zwei unterschiedlichen phänologischen Gebieten innerhalb der Apfelanbauregion des Südtiroler Unterlandes, Italien überwacht. In jedem Gebiet wurden zwei unabhängige Fallenstandorte eingerichtet. In den Jahren und an allen Standorten beobachteten wir eine Hauptflugperiode von Februar bis Ende Mai, in der die Weibchen von *A. dispar* flogen. Der Beginn der Flugaktivität unterschied sich jedoch erheblich zwischen dem phänologisch „frühen” und „späten” Gebiet. Die Analyse der Flugdynamik über einen Zeitraum von sechs Jahren liefert einige neue Erkenntnisse. Diese Ergebnisse verbessern unser derzeitiges Verständnis der Flugaktivität und liefern eine Hypothese für eine genauere Vorhersage des Flugbeginns der Weibchen im Frühjahr.

RIASSUNTO

Anisandrus dispar (Fabricius, 1792) è un fitofago di importanza economica. Per caratterizzare la sua attività stagionale di volo, abbiamo monitorato le popolazioni dal 2018 al 2024 utilizzando trappole a base di etanolo in due aree fenologiche distinte all’interno della regione di coltivazione delle mele della Bassa Atesina, in Italia. In ciascuna delle aree sono state posizionate due siti di cattura indipendenti tra di loro. Durante tutti gli anni e in tutti i siti, abbiamo osservato un periodo, da febbraio alla fine di maggio, in cui si è verificato la maggior parte del volo annuale delle femmine di *A. dispar*. Tuttavia, l’inizio dell’attività di volo differiva in modo significativo tra le due aree fenologiche “precoci” e “tardive”. L’analisi dei sei anni di dinamiche di volo ha fornito alcune informazioni interessanti. Questi risultati migliorano la nostra attuale comprensione della sua attività di volo e forniscono un’ipotesi relativa a una previsione più accurata del volo primaverile delle popolazioni di *A. dispar*.

REFERENCES

[1] Wolf M., Gruber A. (2023). Untersuchungen zum Auftreten von Xylosandrus germanus (Blandford, 1894) (Coleoptera: Scolytidae) in Fallenfängen im Apfelanbau des Südtiroler Unterlandes. Gredleriana 23 (23), DOI:10.5281/zenodo.8370577.

[2] Mani E., Remund U., Schwaller F. (1990). The disparate bostrichid, Xyleborus dispar F. (Coleoptera: Scolytidae) in fruit arboriculture and in viticulture. Revue Suisse de Viticulture, d'Arboriculture et d'Horticulture, 22 (2), 109-116.

[3] Wolf M., Gruber A. (2023). Erhebungen und Untersuchungen zum Befall durch heimische Borkenkäferarten im Südtiroler Apfelanbau. Entomologentagung 2023. Deutsche Gesellschaft für allgemeine und angewandte Entomologie (DGaaE). Freie Universität Bozen-Bolzano, Bozen (BZ), Italien.

[4] Kahlen M. (2018). Die Käfer von Südtirol. Ein Kompendium. Veröffentlichungen des Naturmuseums Südtirol 13.

[5] Innerhofer L. (1966). Ein gefährlicher Borkenkäfer im Obstbau. Obstbau Weinbau 3 (5), 112.

[6] Contarini M., Vannini A., Giarruzzo F. et al. (2020). First record of Xylosandrus germanus (Blandford)(Coleoptera: Curculionidae, Scolytinae) in the Mediterranean scrubland in Southern Italy, and its co-presence with the co-generic species Xylosandrus compactus (Eichhoff) and Xylosandrus crassiusculus (Motschulsky). EPPO Bulletin, 50 (2), 311-315, DOI:10.1111/epp.12660.

[7] Kovach J., Gorsuch C.S. (1985). Survey of ambrosia beetle species infesting South Carolina peach orchards and a taxonomic key for the most common species. Journal of Agricultural Entomology 2 (3), 238-247.

[8] Biedermann P. (2014). Käfer als Pilzzüchter. Die Biologie der Ambrosiakäfer und wie man sie beobachtet. Artenschutzreport 33, 43-45.

[9] Roediger H. (1956). Zur Biologie und Bekämpfung des Ungleichen Holzbohrers (Xyleborus dispar f.) Nachrichtenblatt des deutschen Pflanzenschutzdienstes 8, 36-40.

[10] Kushiyev R., Tuncer C., Erper I. et al. (2018). Efficacy of native entomopathogenic fungus, Isaria fumosorosea, against bark and ambrosia beetles, Anisandrus dispar Fabricius and Xylosandrus germanus Blandford (Coleoptera: Curculionidae: Scolytinae). Egyptian Journal of Biological Pest Control, 28 (1), 1-6, DOI:10.1186/s41938-018-0062-z.

[11] Wood D.L. (1982). The role of pheromones, kairomones, and allomones in the host selection and colonization behavior of bark beetles. Annual Review of Entomology 27, 411-446, DOI:10.1146/annurev.en.27.010182.002211.

[12] Kühnholz S., Borden J.H., Uzunovic A. (2001). Secondary ambrosia beetles in apparently healthy trees: adaptations, potential causes and suggested research. Integrated Pest Management Reviews 6, 209-219, DOI:10.1023/A:1025702930580.

[13] Egger A. (1973). Beiträge zur Biologie und Bekämpfung von Xyleborus (Anisandrus) dispar F. und Xyleborinus saxeseni Ratz. (Col., Scolytidae). Anzeiger für Schädlingskunde, Pflanzen- und Umweltschutz 46, 183-186, DOI:10.1007/BF01991812.

[14] Schvester D. (1955). Le xylébore disparate, Anisandrus dispar F.(coléoptèra scolytide) en France. Annales des Epiphyties 3 (3), 225-257.

[15] Wolf M. (2025). Repository A. dispar Laimburg Journal 18 19 20 21 22 23 24 25 [Data set]. Zenodo, DOI:10.5281/zenodo.16683130.

[16] Ribeiro-Correia J.P., Prospero S., Beenken L. et al. (2023). Distribution of the invasive Anisandrus maiche (Coleoptera: Scolytinae) in Switzerland, first record in Europe of its ambrosia fungus Ambrosiella cleistominuta, and its new association with Xylosandrus crassiusculus. bioRxiv, DOI:10.1101/2023.03.30.534995.

[17] Grüne S. (1979). Handbuch zur Bestimmung der europäischen Borkenkäfer = Brief illustraed Key to European Bark Beetles. M. & H. Schaper, Hannover, Germany.

[18] Freude H., Harde K.W., Lohse G.A. (eds.) (1981). Bruchidae-Curculionidae. (Die Käfer Mitteleuropas : 10). Spektrum Akademischer Verlag, Heidelberg, Germany.

[19] European and Mediterranean Plant Protection Organization (EPPO) (ed.) (2024). EPPO A1 List of pests recommended for regulation as quarantine pests. Retrieved June 08, 2025, from https://www.eppo.int/ACTIVITIES/plant_quarantine/A1_list.

[20] European and Mediterranean Plant Protection Organization (EPPO) (ed.) (2024). EPPO A2 List of pests recommended for regulation as quarantine pests. Retrieved June 08, 2025, from https://www.eppo.int/ACTIVITIES/plant_quarantine/A2_list.

[21] European and Mediterranean Plant Protection Organization (EPPO) (ed.) (2024). EPPO Alert List. Retrieved June 08, 2025, from https://www.eppo.int/ACTIVITIES/plant_quarantine/alert_list.

[22] Wesche J., Ebner E., Frank G. (2021). Blühtermine alter und neuer Apfelsorten in Südtirol. Laimburg Journal 3, DOI:10.23796/LJ/2021.010.

[23] Beck S.D. (1983). Insect Thermoperiodism. Annual Review of Entomology 28, 91-108, DOI:10.1146/annurev.en.28.010183.000515.

[24] Reichholf J. (1979). Zur Populationsdynamik des Feldmaikäfers (Melolontha melolontha L.) im niederbayerischen Inntal. Spixiana 2 (2), 153-166.

[25] Bhagwandin H.O. (1992). The shothole borer: an ambrosia beetle of concern for chestnut orcharding in the Pacific Northwest. Annual Report of the Northern Nut Grower's Association 93, 168-177.