

# Sinus management, grassland mowing in an agricultural environment: how to improve and adapt the management in favour of butterflies and insects?

Jurgen Couckuyt

**Abstract.** The term sinus management was used when the author saw a Google Earth photograph (Fig.1) of a nature reserve De Venne (S1) that he was managing as a hay meadow. This new way of mowing was photographed in July 2013 for an update of Google Earth's website during that year. The mowing track looked like the sinusoid line of the mathematical profile of alternative current. The author coined the term sinus path to describe it and sinus management for the mowing system and these two terms will be used throughout this article. When managing grasslands for butterflies, it is important to maintain all conditions that butterflies need at different stages of their development. When mowing a grassland with sinus management, a lot of nectar sources are still available for adult butterflies, as well as food plants for larvae and shelter zones for eggs and pupae. All requirements for each stage are present throughout the whole year. A range of microclimates is formed, creating optimal conditions for warming up zones and conditions for female butterflies to lay eggs on the present host plants. The interaction between an area administered with sinus management and the surrounding landscape is essential. Within huge areas of natural landscape, this way of management is not really necessary. However, it becomes of importance in small, isolated places and if corridors are not present in that surrounding landscape. Sinus management can provide all conditions needed for the invertebrate fauna as well as for the botanical development. There is no strict time schedule with sinus management, allowing a nature manager to reach as well his goal of a nutrient poor, as a rich flowering grassland. Today, sinus management has been introduced in several grasslands in Flanders and the Netherlands. A detailed step by step brochure (S2) of this sinus management is available as supplementary material. All photographs are taken by the author unless otherwise mentioned.

**Samenvatting.** Het begrip sinusbeheer werd gebruikt toen de auteur een luchtfoto zag op Google-Earth van een natuurnatuurreservaat dat hij beheerde als een nat hooiland. Deze nieuwe vorm van maaien werd gefotografeerd tijdens een update van Google-Earth luchtfoto's in 2013. Het gemaaid pad had de vorm van een sinuslijn die vergelijkbaar is met de alternerende sinusoïde van elektrische wisselstroom. De auteur noemde het gemaaid pad logischerwijze een sinuspad en het beheer sinusbeheer. Deze twee termen zullen doorheen het artikel worden gebruikt. Wanneer men graslanden beheert voor dagvlinders, is het belangrijk dat alle voorwaarden aanwezig zijn voor hun ontwikkeling. Wanneer men het grasland maait met sinusbeheer, zijn er nog steeds nectarbronnen aanwezig voor de volwassen dagvlinders. Zowel waardplanten voor de rupsen als overwinteringszones voor eitjes en poppen worden overal gespaard tijdens de maaisessies. Alle vereisten voor ieder stadium zijn aanwezig doorheen het ganse jaar. Overal wordt een microklimaat gecreëerd dat optimale condities biedt als opwarmingszones en voorwaarden voor de wijfjes bij het afleggen van de eitjes op de aanwezige waardplanten. De interactie tussen een gebied dat beheerd wordt met sinusbeheer en het omgevende landschap is essentieel. In zeer grote natuurlijke omgevingen is dit soort beheer niet echt nodig. Maar het wordt wel heel belangrijk in kleine geïsoleerde gebieden waar weinig tot geen corridors aanwezig zijn in het landschap. Met sinusbeheer kan je aan alle voorwaarden voldoen die nodig zijn voor het beheer van insecten maar tevens ook de botanische doelstellingen behalen. Er moet geen strikt tijdsschema gevuld worden met sinusbeheer en toch kan de beheerder het natuurstreefdoel, een schraal bloemrijk grasland, beogen. Actueel wordt sinusbeheer reeds toegepast op meerdere plaatsen in Vlaanderen en Nederland. Een gedetailleerde stap voor stap brochure (S2) van het sinusbeheer is beschikbaar als supplementair materiaal. Alle foto's in dit artikel zijn genomen door de auteur tenzij anders vermeld.

**Résumé.** La notion de gestion sinusoïdale a été utilisée lorsque l'auteur a vu sur Google-Earth une photo aérienne d'une réserve naturelle qu'il gérait comme prairie de fauche humide. Cette nouvelle forme de tonte fut photographiée lors d'une mise à jour des photos aériennes de Google-Earth en 2013. Le chemin tondu avait la forme d'une ligne sinusoïdale qui est comparable à la sinusoïde alternante du courant électrique alternatif. Il est logique que l'auteur nomme le chemin tondu un chemin sinusoïdal et la gestion, gestion sinusoïdale. Ces deux termes seront utilisés tout au long de l'article. Lorsque vous gérez des prairies pour des papillons, il est important que toutes les conditions soient réunies pour leur développement. Lorsque vous tondez la prairie de façon sinusoïdale, il y a encore des sources de nectar pour les papillons adultes. Aussi bien les plantes hôtes pour les chenilles que les zones d'hivernage pour les œufs et les chrysalides sont épargnés partout lors des moments de tonte. Toutes les exigences pour chaque stade sont réunies tout au long de l'année. Un microclimat est créé partout, offrant des conditions optimales telles que des zones de réchauffement et conditions pour les femelles lors de la ponte des œufs sur les plantes hôtes présentes. L'interaction entre une zone gérée de façon sinusoïdale et le paysage environnant est essentielle. Dans de très grands environnements naturels, cette façon de gérer n'est pas vraiment nécessaire. Mais cela devient très important dans des petites zones isolées où peu ou pas de couloirs sont présents dans le paysage. Avec la gestion sinusoïdale, vous pouvez remplir toutes les conditions nécessaires à la gestion des insectes mais aussi atteindre les objectifs botaniques. Il n'y a pas de calendrier strict à suivre pour la gestion sinusoïdale et pourtant le gestionnaire peut viser l'objectif de la nature, une prairie maigre et fleurie. Actuellement, la gestion sinusoïdale est déjà appliquée en plusieurs endroits en Flandre et aux Pays-Bas. Une brochure détaillée étape par étape (S2) sur la gestion sinusoïdale est disponible en tant que matériel complémentaire. Toutes les photos de cet article sont prises par l'auteur, sauf indication contraire.

**Key-words:** Sinus management – sinus path – mowing grassland management – faunistic and botanical management – butterflies and insects – hay fields – meadows – grasslands.

Couckuyt J.: Singeldreef 42, B-9160 Lokeren. couckuyt.jurgen@telenet.be

## Historical perspective of De Venne

All this started with a small parcel of land called De Venne what is a historical name for a local wet place, because of its lower profile in the environment. This parcel measuring about 88 m by 70 m (0.6061 ha), owned by the local non-profit nature association vzw Durme (S1), is a remnant of the period when the North Sea was retreated. This depression was filled with seawater and kept everything land-locked until all living creatures like mollusks died and their shells sank to the bottom forming a small calcareous layer (Slabbaert *et al.* 2008)

Centuries passed and the depression became a fen with a characteristic vegetation. In Flanders we call this a 'gaver'. The typical vegetation unit under these conditions and management, results in a marsh-marigold grassland or *Caltha palustris* meadow. Such grasslands are groundwater dependent.

In the early 2000's, the author was a volunteer of vzw Durme and became the nature manager of this nature reserve in his neighbourhood.

De Venne as we see it today, is a remnant of former times when the landscape was surrounded by meadows and hayfields. There were many hedges, little pools and small bushes scattered all over the area. With the small scaled farming activity in those times, there was always plenty of nectar, food plants and shelter available for a wide range of local insects.

It must have been a paradise for the butterflies. The hayfield management had a positive influence on the grassland butterflies providing all conditions during the whole year. Today, this extensive agriculture landscape with its typical fauna and flora has disappeared.

Modern agriculture and urbanisation have changed the environment drastically, with a huge and largely adverse effect on several butterfly species.

Many species became extinct because the necessary conditions were no longer present.

Today, not only the human impact on this environment, but also climate change has an influence on the landscape and the species that are still present.

## From no management to sinus management

When in early 2000, the author began his first mowing session, De Venne had been unmanaged for a decade after it was acquired by vzw Durme in the early 90's. Ultimately, the lack of management transformed a historical wet hayland into a young willow forest covered with wild undergrowth. Intensive management was required (fig. 2) to get the former meadow in its original state and bring more sunlight in this nature reserve.

Willow (*Salix* sp.) and black alder (*Alnus glutinosa*) were scattered around, nettle (*Urtica dioica*), cleavers (*Galium aparine*) and hedge bindweed (*Convolvulus arvensis*) dominated the ground layer. Even a lot of poplars (*Populus* sp.) grew in this parcel from the time when locals tried to use this unsuitable agricultural land, but it didn't work out well.

However, one could still find a few signs of the time when de Venne was a wet meadow that had been mown

in summertime. In a few open spots, you could find ragged-robin (*Lychnis flos-cuculi*), brown sedge (*Carex disticha*), cuckooflower (*Cardamine pratensis*) and St. Peter's wort (*Hypericum tetrapterum*).

In spring and winter it was probably too wet to be managed by local farmers. As the richness of the soil must have been lower at that time, there were probably a lot of typical flowers and animals living in it. Today's influence of the surrounding intensive agriculture is unfavourable for its fauna and flora.

Management is necessary to prevent a meadow from becoming a forest. The author's starting point was that if a parcel had been a meadow in the past, it should be managed as a meadow, so, regular mowing is essential!

During the following years, all central trees were removed, the mowing management was initiated and De Venne changed into a rough flowering grassland called a *Convolvulo-Filipenduletea* association (fig.3). A lot of the typical species like meadowsweet (*Filipendula ulmaria*), purple loosestrife (*Lythrum salicaria*) and valerian (*Valeriana officinalis*), were scattered all over the grassland. Also the grass species changed to more specific



Fig. 1. The first sinus path ever photographed in De Venne, Lokeren, Belgium. © Google Earth, 7.vii.2013.

Fig. 1. Het eerste sinuspad ooit gefotografeerd in De Venne, Lokeren, België. © Google Earth, 7.vii.2013.



Fig. 2. It took several years to transform a downgraded wet hayland into a restored historical grassland. De Venne, 03.vii.2007.

Fig. 2. Het duurde een aantal jaren om een gedegradeerd nat hooiland om te vormen tot een gerestaureerd historisch grasland. De Venne, 03.vii.2007.



Fig. 3. De Venne is changing in a flowering grassland dominated by Meadowweet and Purple loosestrife. 10.vii.2008.

Fig. 3. De Venne is aan het veranderen in een bloeiend grasland dat wordt gedomineerd door moerasspirea en grote kattenstaart. 10.vii.2008.



Fig. 4. De Venne become a flowering grassland dominated by Ragged Robin. 22.v.2010.

Fig. 4. De Venne wordt een bloeiend grasland gedomineerd door echte koekoeksbloem. 22.v.2010.

ones for this type of grassland. Instead of the dominating reed canary grass (*Phalaris arundinacea*), species like marsh foxtail (*Alopecurus geniculatus*), False oat-grass (*Arrhenatherum elatius*) and Rough meadow grass (*Poa trivialis*) made their appearance. Even different species of typical *Carex* were taking over.

In the beginning, the objective of the management was to go back to the original state of the grassland: a nutrient poor, flowery meadow with lots of butterflies and insects. This was like what every normal manager would do, to get the meadow back in its original state. A classical intensive hay management was the obvious instrument. Some years later, one could already see the evolution in the desired grass type as it became a *Calthion palustris* grassland, dominated by Ragged Robin and Brown sedge (fig. 4).

### Phased mowing for butterfly management

Since the '70s, the author has been interested in butterflies but at that time he was not aware of the negative spiral which nature was in. In those days more

species were present than nowadays. For example, the wall butterfly, *Lasiommata megera* (Linnaeus, 1767), was common in the author's playground. Even the small heath, *Coenonympha pamphilus* (Linnaeus, 1758), the Essex skipper, *Thymelicus lineola* (Ochsenheimer, 1808) and the small tortoiseshell, *Aglais urticae* (Linnaeus, 1758) were well represented in the environment.

Today the wall butterfly has disappeared, and species like the small heath, Essex skipper and small tortoiseshell are very rare. Even the numbers of common butterflies are much lower now. This had to be taken in consideration when managing a grassland like De Venne. Even none of these species occurred in this nature reserve and still are not present. It was important to know that the author wanted to manage this grassland in benefit of species actually present and not with a nature target that perhaps could never be achieved.

As years passed by, a phased mowing system took over the classical hay management. So when mowing this meadow, a part of it was always left unmowed (fig. 5) where adult butterflies and their early stages could survive. However, after mowing, it was often noticed that there hardly remained nectar sources in the unmowed parts and butterflies were rarely seen after a mowing session. Because of this alternating mowing system, one was forced to mow the nectar parts. This situation was very dissatisfying. Even though different parts were left uncut during subsequent mowing sessions, the meadow remained too monotonous.

A more diversified system of managing de Venne was needed. When looking at the intensively cultivated surroundings, the question rose how to provide opportunities to the butterflies for their survival in such a small and isolated locality.



Fig. 5. Phased mowing in De Venne in the year 2009. In the background an unmowed part. 10.viii.2009.

Fig. 5. Gefaseerd maaien in De Venne in het jaar 2009. Op de achtergrond een ongemaaid stuk 10.viii.2009.

If all the nectar sources were removed, where would the insects go? Such a situation is now found in many parts of Flanders, no matter the size of the nature parcels.

Furthermore, the question is how many suitable hayfields, meadows or other grasslands still exist in our agricultural and urban environment and are there connections between these remaining grasslands?

Around De Venne, there are not many corridors linking them. Every square meter is exploited for maximal agricultural production. Trees or verges between the fields are regarded as a loss of profitability. Being a consequence of political measures, this has drastic effects on the remaining nature in all agricultural environments. Even today, this negative effect is still ongoing.

Nowadays, it is out of the question to manage hay fields like during passed centuries when the grasslands were part of a favourable landscape for many butterflies. This means no tabula rasa (S1) management of the whole grassland!

If you do so, it's not unthinkable that species are lost because there's no alternative habitat in the neighbourhood. Even with a phased grassland management there is a lack of favourable conditions for butterflies in isolated nature reserves in the middle of cornfields, flowerless grasslands and over-fertilised environments.

## 2013, from phased mowing management to the first sinus path

If the objective is to create a nutrient deficient meadow with typical plants, it is necessary to mow regularly and intensively. When it is also managing for the benefit of insects, less mowing is needed, otherwise nectar sources and shelter are removed at the time they are essential. Less mowing regularly results in less flowers because soil nutrients are not reduced. If a nature manager notices that the soil remains enriched, his automatic reaction is to mow intensively but with a lot of remaining question marks: to mow or not to mow, when to mow and how often to do so?

After the last phased mowing session at the end of the summer 2012, the author overlooked the mowed meadow and questioned himself how to make a better system for the benefit of butterflies and for the botanical management of the meadow. How to make the habitat optimal for butterflies and at the same time achieve a nutrient deficient meadow with its typical vegetation? After thinking for a long time, he imagined the idea of mowing, but not in straight lines or in blocks across the meadow, but to follow a winging pattern across the grassland. The next mowing session could then follow a different winging pattern adjacent to previous sinuous pattern. The result of this regime would be to get a more variated management instead of the monotonous blocks of vegetation and to create a larger margin effect across the whole habitat.

In spring 2013, a hand driven cutter bar was ordered from vzw Durme and on a sunny morning in early May, two employees arrived at De Venne with the cutter bar and were told by the author that he would do the cutting himself. They watched with amazement when he started the cutter bar and drove a winding path (fig. 6) through the meadow like a drunkard. As experienced field workers, they had never seen this before and were unable to understand the purpose behind this apparently crazy procedure. Walking through the fresh mowed sinus path (fig. 7) was interesting because it gave a good impression

of how many different kinds of vegetation would be mown and how many would not be mown. Immediately the contrast with traditional hay management was noticed. With this new method, others would clearly see which part had to be mowed and which part had to be left unmowed. No more flags or sticks in the ground that tell which parts had to be spared.



**Fig. 6. A sinus path determines which part will be mown (left) and which part will not be mown (right), De Venne. 26.v.2014.**

Fig. 6. Een sinuspas bepaalt welk stuk gemaaid wordt (links) en welk stuk niet gemaaid wordt (rechts). De Venne, 26.v.2014.



**Fig. 7. All types of vegetation are mowed as unmowed depending on the inner- or outer side of the sinus path. De Venne. 12.v.2015.**

Fig. 7. Alle vegetatietypen worden gemaaid als niet-gemaaid, afhankelijk van de binnen- of buitenkant van het sinustraject. De Venne. 12.v.2015.

In the following days, several visits to De Venne were made. On the sinus path, it was possible to walk through the heart of the flowering meadow and watch butterflies visiting the flowers. This mowing regime allowed observers to get close to them without destroying the vegetation. Another feature that took the attention was the fact that many butterflies were taking advantage of the short vegetation in the sinus path. A microclimate had been created, it was much warmer there and there was shelter from the wind depending of the orientation of the curves in the sinus path. The curves exposed to the sun and out of the wind were most advantageous. With the shifting of the sun during the day, other curves took over (fig. 8a, b, c). This was a clear advantage for many species



**Fig. 8. Maximum microclimate in several curves in the morning-(a), noon-(b) and evening sun(c), regardless of the combination of wind, during the whole season.**

Fig. 8. Maximaal microklimaat in verschillende bochten in de ochtend- (a), middag- (b) en avondzon (c), ongeacht de combinatie van wind, gedurende het hele seizoen.

which depend on these sheltered, sunlit places. Especially in spring, when the temperature above the hay field is often too low for butterflies, the small open places along the sinus path, protected by higher surrounding vegetation, can be beneficial for butterflies to bask and shelter. Later, when the large skipper, *Ochlodes sylvanus* (Esper, 1777) hatched, it was noticed how the males adopted a curve along the sinus path as a territory that they defended, patrolling from one curve to another scaring off rival males and other species and waiting for a female to appear (fig. 9a). It quickly became clear that a sinus path in the management of grasslands had added value for butterflies. The author reasoned that it would also be advantageous to other grassland butterflies. It is known that several butterfly species like to stay in the transition zone from shorter to longer vegetation. With this sinus pattern, there is a much longer margin created than if you manage in straight and monotonous lines (fig. 9b). This is also one of the big advantages of sinus management. Nature management is based on straight lines and square blocks so sinus management looks unnatural.

The presence of short vegetation throughout the season is probably advantageous for butterflies. It can also be expected that females will oviposit on host plants in this sinus path. For every species suitable conditions, humidity, temperature and microclimate are present along the many curves. Thus, the author is convinced of the benefit of this new management, but quickly felt the need to gather data to have an objective evaluation if it is really beneficial to butterflies and other insects.

### Mowing the hayland by following the sinus pattern

When the spring flowers are producing seeds, it is time to mow the meadow. But instead of mowing the whole grassland, a sinus path pattern is followed (fig. 10a, b, c). The external side of the sinus path, the meadow is left unmowed leaving plenty of nectar sources and shelter.

The sinus path can be mown in a variety of ways, to different depth and width of the sinus pattern. Vegetation is left uncut both towards the outer edge and also to the center of the meadow. Vice versa, it is also cut both towards the outer edge as to the center of the meadow. A varied random pattern is adopted, which includes all kinds of vegetation types that are present in the meadow. A consequence of this procedure is that parts of the

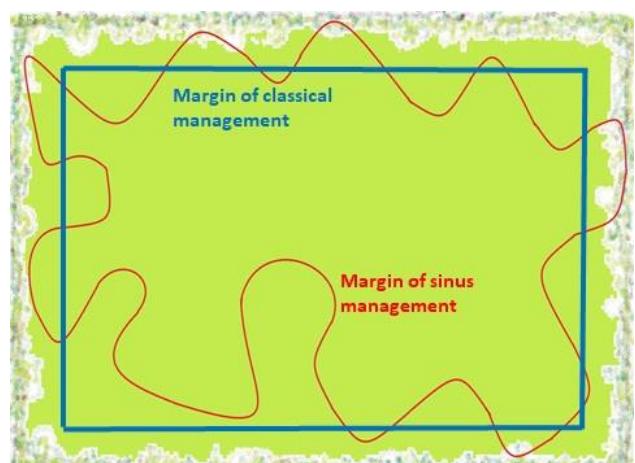
vegetation around the outer edge will become rougher in time, with young trees starting to appear. At long last, as the sinus management proceeds in time, it will be cut too. Generally, when managing for butterflies, all kinds of other insects will also find their way into the hayland.

Mowing the inner side of the sinus path, means also achieving the botanical goal: a nutrient deficient, flower rich grassland. Species like the meadow brown, *Maniola*



**Fig. 9a. A male large skipper defends his territory in one of the curves in the sinus path. The margin of the sinus path provides also a good microclimate. 30.v.2017.**

Fig. 9a. Een mannetje groot dikkopje verdedigt zijn territorium in een van de bochten in het sinustraject. De marge van het sinustraject zorgt ook voor een goed microklimaat. 30.v.2017.



**Fig. 9b. A sinus pattern creates more and longer margin conditions than in a classical hay management with straight lines.**

Fig. 9b. Een sinuspatroon creëert meer en langere randvoorwaarden dan in een klassiek hooibeleid met rechte lijnen.



**Fig. 10.** Even in other grasslands, sinus management has been introduced. The inside of the sinus pattern will always be mowed, the outside is left unmowed. Notice that the sinus path is also unmowed! a. De Moortels (S1) in Doorslaar near Lokeren in 2015. © Google Earth. b. Meadow in Daknam near Lokeren. 26.viii.2016. c. De Moortels in Doorslaar near Lokeren in 2015. 14.vi.2015.

Fig. 10. Ook in andere graslanden is sinusbeheer geïntroduceerd. De binnenkant van het sinuspatroon wordt steeds gemaaid, de buitenzijde wordt niet gemaaid. Merk op dat het sinustraject ook ongemaaid is. A. De Moortels (S1) in Doorslaar bij Lokeren in 2015. © Google Earth. B. Weide in Daknam bij Lokeren. 26.viii.2016. C. De Moortels in Doorslaar bij Lokeren in 2015. 14.vi.2015.

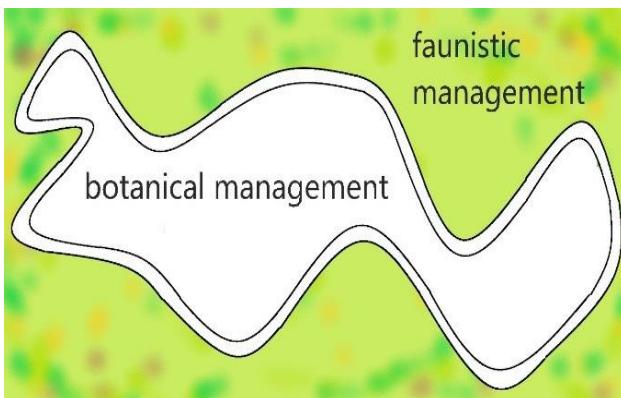
*jurtina* (Linnaeus, 1758) and the clouded yellow, *Colias croceus* (Geoffroy, 1785) were also seen laying eggs in this short, cut vegetation. The original sinus path is left unmowed because chances are high that females of several species have laid their eggs on host plants there.

conditions for female grassland butterflies. This short vegetation is also ideal for the red admiral, *Vanessa atalanta* (Linnaeus, 1758) laying the eggs individually amongst short cut and fresh nettles in the sinus path.

Along the outer side of the sinus path, larvae of the large skipper and pupae of the orange tip, *Anthocharis cardamines* (Linnaeus, 1758) will be spared in summer because the meadow is not mown in a tabula rasa way. Both species prefer longer vegetation where they overwinter in that stage and sinus management offers a better chance of survival than a classical hay management. The larvae of many other species which depend on nettles or long uncut grass in the random vegetation will also be spared during the mowing season. Nests of larvae of the peacock, *Aglais io* (Linnaeus 1758), the small tortoiseshell, and the map butterfly, *Araschnia levana* (Linnaeus, 1758), are also found here. Even the caterpillars of the comma, *Polyommatus icarus* (Rottemburg, 1775), the brown argus, *Aricia agestis* ([Denis & Schiffermüller], 1775) and the small copper, *Lycaena phlaeas* (Linnaeus, [1760]) are species which prefer host plants in a short open vegetation structure. In different areas where sinus management is employed, eggs and caterpillars have been found in the sinus path. It is there where the exposition of the present host plants provides ideal

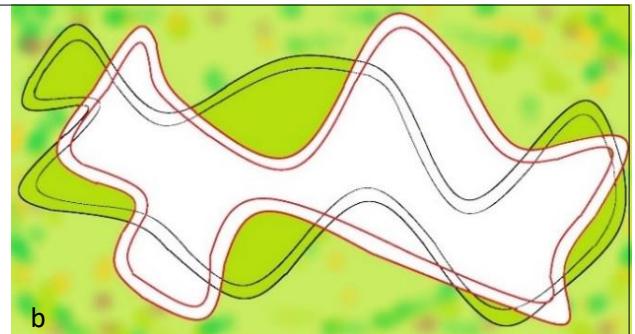
Another feature is that in the unmowed part, the summer flowers succeed the spring vegetation in a natural way, with the result that nectar sources are continuously available. In the sinus path there is a second blooming of spring flowers, which means a better and more varied offer over time of nectar sources in the grassland. In a classically managed hayland, butterflies have to search for nectar elsewhere when the meadow has been mown completely.

Later in the season, the vegetation in the sinus managed area will have grown and it will be time for a



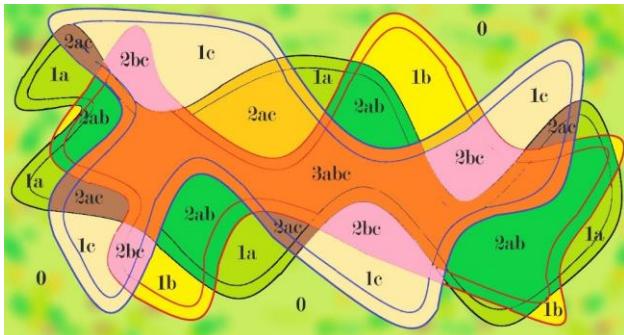
**Fig. 11.** Integrated botanical and faunistic management.  
Fig. 11. Geïntegreerd botanisch en faunistisch beheer.

For example, the first generations of the common blue, *Polyommatus icarus* (Rottemburg, 1775), the brown argus, *Aricia agestis* ([Denis & Schiffermüller], 1775) and the small copper, *Lycaena phlaeas* (Linnaeus, [1760]) are species which prefer host plants in a short open vegetation structure. In different areas where sinus management is employed, eggs and caterpillars have been found in the sinus path. It is there where the exposition of the present host plants provides ideal



**Fig. 12.** a. The second sinus mowing session with a sinus path cutting in the previous one. b. Followed in time by the second mowing session (white zone) following the second sinus path pattern.

Fig. 12. a. De tweede sinusoidale maissessie waarbij het sinustraject de vorige snijdt. B. gevolgd door de tweede maaisessie (witte zone) dat het patroon van het tweede sinuspad volgt.



**Fig. 13. After 3 sinus mowing sessions you will have already a huge diversity in vegetation in a random way. The more to the center, the more it is mown intensively, the more nutrient deficient.**

Fig. 13. Na 3 sinus maaisessies heb je al een grote diversiteit in vegetatie op een willekeurige manier. Hoe dichter bij het centrum, hoe intensiever gemaaid en nutriëntarmer.

second sinus mowing session, covering different parts of the meadow, again in a random pattern. Cutting a sinus path different from the previous one (fig. 12a) is the important measure in sinus management! This second sinus mowing session means mowing the sinus path and later mowing the grassland (fig. 12b) is done during the summer, when the vegetation has regrown after the previous mowing session, and there is no more short vegetation. This means that after two sinus sessions, there will be parts that were mown only in the first session, parts only in the second session and the centre twice. In this way, favourable conditions for the next generation butterflies are produced together with a new visual border between the new mowed and unmowed parts of the meadow.

In a rich nutrient grassland, the manager can have a third sinus mowing session or even a fourth one, in shifted patterns different from previous ones and often cut to a different height and width. It all depends on local situations. Whatever the detail, there will always be 40 to 50 % left unmowed and scattered over the whole area. This management results in the presence of all kinds of plants in this parcel, meaning that the requirements of a wide range of animals will also be achieved.

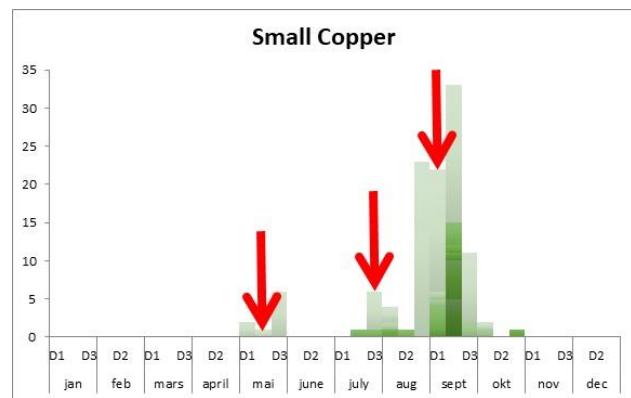
In fig. 13, the sinus mowing sessions are represented by a, b and c. The numbers represent the total numbers this zone has been cut over the 3 sessions. 2bc means that this zone has been cut twice, the first time in the second sinus mowing session b and the second time in the last sinus mowing session c. In the first session this zone has been spared. 1b means that the zone has been cut only once during the second sinus mowing session b. This zone was spared in the first and the third sinus mowing session.

### Timing of classical hay periods are not crucial

In classical hayland management, two mowings a year has been the standard procedure, scheduled on two dates that are similar to those when farmers in previous centuries cut their grasslands. The goal is to produce a nutrient deficient grassland with a lot of flowers.

With sinus management, the dates selected for mowing are not the main focus. The manager simply starts cutting a sinus path when he considers the time is right. There are several alternatives open to him: his decision

depends on the environmental conditions, the weather, soil conditions, requirements of the local plants and flight time of target species. The most important parameters are the phenology graphs (fig. 14) of the local species.



**Fig. 14. Phenology of the Small copper from 2010 until 2017 in De Moortels. The red arrows indicate the potential times of mowing a sinus path for the Small copper.**

Fig. 14. Fenologie van de kleine vuurvlinder van 2010 tot 2017 in De Moortels. De rode pijlen duiden de mogelijke periodes aan om een sinuspad te maaien voor de kleine vuurvlinder.



**Fig. 15. Egg of the small copper found in the sinus path on sorrel, 24.v.2017.**

Fig. 15. Eitje van een kleine vuurvlinder op veldzuring gevonden op het sinuspad, 24.v.2017.



**Fig. 16. Egg of the common blue found in De Moortels in the sinus path on white clover. 17.ix.2017.**

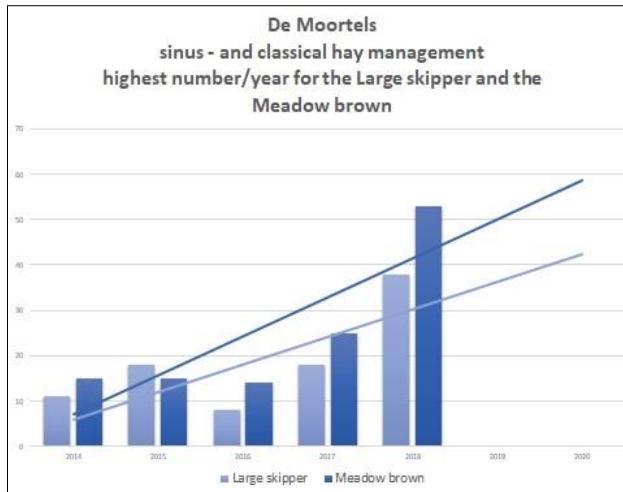
Fig. 15. Eitje van een icarusblauwtje op witte klaver gevonden op het sinuspad te Moortels, 17.ix.2017.



**Fig. 17.** the green lines represent parcels with sinus management, the red lines are parcels with classical hay management in De Moortels. © Google Earth.

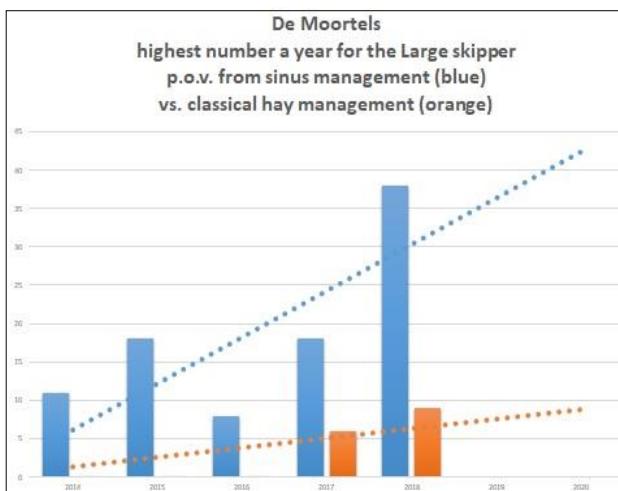
Fig. 17. De groene lijnen geven de percelen met sinusbeheer weer, de rode lijnen stellen de percelen met klassiek hooiland beheer voor. © Google Earth.

Combined with the present host plants, a sinus path is mown when those species start to fly. That way, males can take up territories in the curves of the sinus path and females can use the microclimate in the curves for laying their eggs on the short vegetation on the present host-



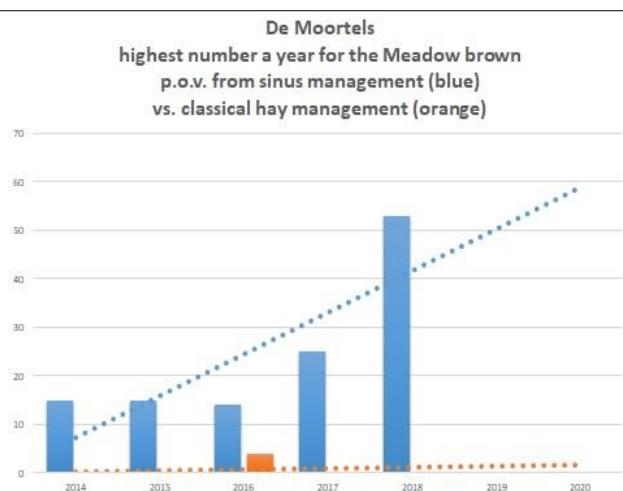
**Fig. 18.** Indicative graph of the highest yearly number of typical grassland species like large skipper and meadow brown in De Moortels.

Fig. 18. Indicatieve grafiek van het hoogste jaarlijkse aantal typische graslandssoorten zoals groot dikkopje en bruin zandoogje in De Moortels.



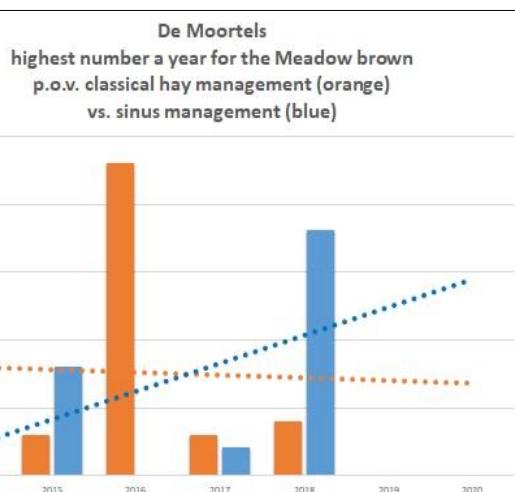
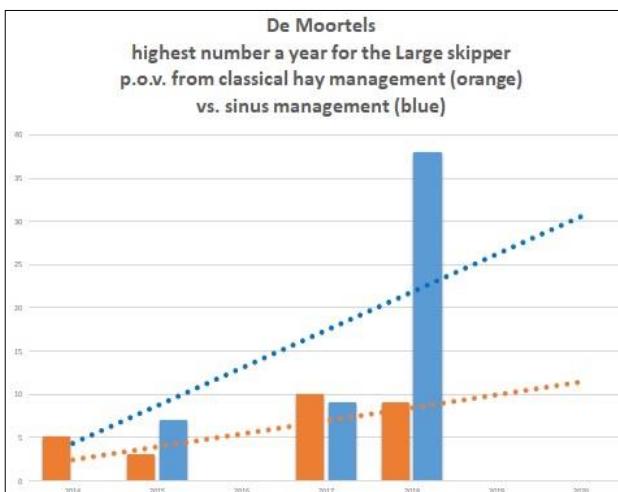
**Fig. 19a.** Indicative graph of the highest yearly number but for the same date, between both managements seen from the point of view of the parcels with sinus management, for the large skipper and the meadow brown.

Fig 19a. Indicatieve grafiek van het hoogste jaarlijkse aantal, maar voor dezelfde datum, tussen beide beheerswijzen gezien vanuit het gezichtspunt van de percelen met sinusbeheer, voor het groot dikkopje en het bruin zandoogje.



**Fig. 19a.** Indicative graph of the highest yearly number but for the same date, between both managements seen from the point of view of the parcels with sinus management, for the large skipper and the meadow brown.

Fig 19a. Indicatieve grafiek van het hoogste jaarlijkse aantal maar voor dezelfde datum, tussen beide beheerswijzen gezien vanuit het oogpunt (p.o.v.) van de percelen met sinusbeheer, voor het groot dikkopje en het bruin zandoogje.



**Fig. 19b.** Indicative graph of the highest yearly number but for the same date, between both managements seen from the point of view (p.o.v.) of the parcels with classical hay management, for the large skipper and the meadow brown.

Fig. 19b. Indicatieve grafiek van het hoogste jaarlijkse aantal maar voor dezelfde datum, tussen beide beheerswijzen gezien vanuit het oogpunt (p.o.v.) van de percelen met klassiek hooibleid, voor groot dikkopje en de bruin zandoogje.



Fig. 20. Sinus management in De Moortels. 24.v.2016.

Fig. 20. Sinusbeheer in De Moortels. 24.v.2016.



Fig. 21. Classical hay management in De Zure gavers. 20.vi.2018.

Fig. 21. Klassiek hooiland beheer in De Zure gavers. 20.vi.2018.

plants. This has been documented by regular observations: several eggs of Small copper and Common blue, *Polyommatus icarus* (Rottemburg, 1775) have been found on their host plants sorrel (*Rumex acetosa*) (fig. 15) and white clover (*Trifolium repens*) (fig. 16) in the sinus path.

### Sinus management and monitoring in De Moortels

De Moortels (2,53 Ha) is also a Gaver or a marsh-marigold grassland, and have many parcels of haylands. This meadow has been monitored for butterflies since 2014 and has more opportunities for research than De Venne. Previously, nature management in De Moortels consisted simply of extensive grazing by horses. However, this parcel has always been a meadow. Because of the wet situation however, typical vegetation was disappearing and in 2010 the local nature association decided to start a classical hay management. Every year since then, this area was monitored a few times for butterflies during every season. In 2014 the author became also the manager of this nature reserve and immediately combined the classic hay management with sinus management (Fig. 17). The following years sinus mowing was introduced in more parcels and the reserve was ideal to investigate the effects

of sinus management versus classical hay management on the same location.

Since 2010, this area has been closely monitored for butterflies and has given indicative results. Fig. 18 shows the evolution of several species (highest number a year) from 2014 until 2018. Since the introduction of hay management, numbers are increasing but the biggest effect occurred in 2014 when sinus management has been integrated. Especially species like large skipper and meadow brown, both depending on grass in their development have a huge benefit of the sinus management. In fig. 19a, 19b the difference is even more visible between both kinds of management. In these graphics, the 2 grassland managements are measured separately and compared with each other with the highest numbers a year at the same date. It is remarkable that more numbers are found in the sinus managed parcels.

## Research

In 2019, research will start to investigate the impact of sinus management on local insects and plants. It will be concentrated on two groups of insects: butterflies and bees. Temperature and humidity will be monitored with a set of data loggers. The author has selected two parcels in his neighbourhood for this research, both of which are imbedded in the agricultural environment and are isolated meadows with absence of connecting corridors. These meadows have the same abiotic conditions and the only difference is in their management. De Moortels is managed with sinus management (fig. 20) and the other locality, de Zure Gavers (S1), is managed in the classical way, with two yearly cuttings of the entire meadow (fig. 21). The two localities are separated by 7 km and the external influences are comparable, both in biotic and abiotic ways. The only difference is in the management. Results of this research will be provided in a future article.

## Summary

Sinus management is based on several features that distinguishes it from a classical hayland management.

1. Continuous nectar sources during the whole season.
2. 40 to 50% is left unmowed during every mowing session, generating random conditions for the development and hibernation of other stages.
3. All-round microclimates during the whole year.
4. The effect of the margin is 2 to 3 times longer because of the sinuous pattern.
5. The precise mowing period is not essential.
6. The variation in vegetation leads to variation in fauna.

## Supplementary materials

The supplementary materials for this article can be found online at:

[http://www.phegea.org/Phegea/Appendices/Phegea47-3\\_page\\_111.pdf](http://www.phegea.org/Phegea/Appendices/Phegea47-3_page_111.pdf)

- S1. nature reserves from vzw Durme.
- S2. consecutive sequences of sinus management.

## Acknowledgements

I wish to thank Barry Goater for checking the language and also a special thanks to Nathalie Coulon for the translation of the French part of the abstract.

Throughout the years, I had much help with the management in De Venne from local friends. Thank you

Thomas Van Lancker, Kurt and Wout Jonckheere, Kristof Alexander and Eric Carlier.

I also appreciate the support of the field team of vzw Durme: Kristof Scheldeman, Eric Van Lemberghen, Kris Leunis and the other temporary employees.

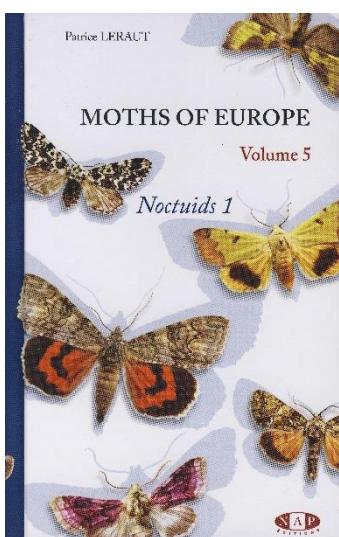
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## Boekbespreking

Leraut P.: *Moths of Europe. Volume 5 Noctuids 1, Volume 6 Noctuids 2.*

13 × 20 cm, 621 en 575 pagina's, ca. 1500 foto's van adulthen, foto's van genitalia, verspreidingskaartjes voor bijna elke soort, N.A.P. Editions, [www.napeditions.com](http://www.napeditions.com), contact@napeditions.com, gebonden, 80,00 € (ISBN 978-2-913688-30-8 en 978-2-913688-32-2).



In deze beide delen van de reeks *Moths of Europe* behandelt P. Leraut de vroegere, grote familie Noctuidae. In feite kan met beter spreken van de superfamilie Noctuoidea waarin ook de familie Notodontidae hoort. DNA-onderzoek en nauwkeuriger morfologische studies hebben aangetoond dat de vroegere familie Noctuidae een amalgaam is van verschillende taxonomische groepen en de familie is daardoor opgesplitst in vier families: Erebidae, Eutelidae, Nolidae en Noctuidae. In deel 5 worden de Erebidae, Eutelidae en een deel van de Noctuidae behandeld, in deel 6 volgen de rest van de Noctuidae en de Nolidae.

De inleiding tot volume 5 geeft, na enkele algemeenheden over deze families, een duidelijk overzicht van de moderne systematiek van de Noctuoidea met in het totaal 5 families: Notodontidae, Erebidae (Lymantriinae, Arctiinae, Erebinae, Pangraptinae, Boletobiinae, Hypenodinae, Rivulinae, Hypeninae, Scoliopteryginae, Herminiinae en Calpinae), Euteliidae, Noctuidae (Diopsinae, Plusiinae, Cuculliinae, Dilobinae, Pantheinae, Eustrotiinae, Acontiinae, Bagisarinae, Amphipyrinae, Metoponiinae, Acronictinae, Oncocnemidinae, Aediinae, Heliothisinae, Condicinae, Bryophilinae, Eriopinae en Noctuinae) en Nolidae (Nolinae en Chloephorinae). De subfamilie Noctuinae bevat ongeveer evenveel soorten als alle andere groepen samen.

In het systematische deel van beide boeken worden de soorten alle op dezelfde wijze behandeld. De juiste wetenschappelijke naam, met auteur en jaar van beschrijving wordt in sommige gevallen gevolgd door een lijstje van synoniemen en een Engelse naam (in de Franse edities is dit een Franstalige naam). Verder wordt de type-localiteit vermeld en wordt het uiterlijk van de soort in het kort beschreven: grootte, kenmerken (soms voor mannetje en vrouwtje apart) en variabiliteit. Tevens wordt verwezen naar nauw verwante soorten of naar soorten met dewelke verwisseling mogelijk is. In het stukje "Biology" worden de voedselplanten van de rups aangegeven voor zover die bekend zijn en het biotootype. Het aantal generaties en de vliegtijd worden aangegeven en in het stukje "Distribution" wordt tamelijk gedetailleerd aangegeven waar de soort voorkomt. Ook wordt aangegeven of de soort lokaal voorkomt of wijd verspreid is, of het een migrant is en dergelijke meer.

De verspreiding van de meeste soorten wordt trouwens grafisch op een kaartje voorgesteld door zwarte vlekken. Enkele erg lokale soorten, zoals b.v. *Heteropalpia vetusta* (Walker, 1865) die in Europa enkel op Cyprus voorkomt, zijn niet voorzien van een verspreidingskaartje.

Bijna alle soorten worden in natuurlijke grootte en in kleur afgebeeld op 123 (deel 5) en 127 (deel 6) kleurenplaten. Van sommige soorten worden zowel mannetje als vrouwtje afgebeeld en soms worden foto's van enkele veel voorkomende variaties toegevoegd. Bij elk exemplaar wordt aangegeven waar het verzameld werd, soms ook wanneer en telkens staat er een verwijzing naar de tekstpagina. De foto's zijn van goede kwaliteit. Van enkele groepen zeer nauw verwante soorten worden ook de mannelijke en vrouwelijke genitalia afgebeeld door foto's.

In deze boeken wordt één nieuwe soort (*Mniotype adjaciensis*) en vijf nieuwe ondersoorten beschreven. Andere taxonomische ingrepen zijn vier nieuwe synoniemen, enkele soorten worden nu als ondersoort ondergebracht bij een andere soort en enkele vroegere ondersoorten worden nu als aparte soort beschouwd. De enige wijziging die een Belgische soort aanbelangt, is het overplaatsen van *Herminia tarsipennalis* Treitschke, 1835 naar het in 1988 door Berio beschreven genus *Treitschkendia* op basis van een klein verschil in de 7<sup>de</sup> mannelijke sterniet.

Beide boeken zijn keurig uitgegeven en de hele reeks van 6 delen vormt, samen met een gelijkaardig deel over de dagvlinders, een mooi synoptisch overzicht over de Europese Lepidoptera.

Willy De Prins