Original article KOREAN JOURNAL OF APPLIED ENTOMOLOGY

한국응용곤충학회지
Korean J. Appl. Entomol. 60(4): 479-487 (2021)
DOI: https://doi.org/10.5656/KSAE.2021.11.0.038

ⓒ The Korean Society of Applied Entomology
pISSN 1225-0171, eISSN 2287-545X

Some Biological Characteristics of Plum Sawfly *Monocellicampa pruni* (Hymenoptera: Tenthredinidae)

Nam Hai Nguyen[1,2], Woong Ki[1], Min-Hyeok Im[3] and Ki-Jeong Hong[1]*

[1]Department of Plant Medicine, Sunchon National University, Suncheon 57922, Korea
[2]Plant Protection Research Institute, Ha Noi 11910, Viet Nam
[3]Bio-Plant Environment Research Center (BPERC), Gwangju 62364, Korea

자두수염잎벌(*Monocellicampa pruni*)의 생물학적 특성

능엔남하이[1,2] · 기웅[1] · 임민혁[3] · 홍기정[1]*

[1]식물의학과 순천대학교, [2]베트남식물보호연구소, [3](주)바이오식물환경연구소

ABSTRACT: This study investigated the life history of the plum sawfly *Monocellicampa pruni* Wei, 1998 through field observations and laboratory experiments. *M. pruni* is a univoltine, complete metamorphosis species with five instars at the larval stage. Adults emerge from the soil around mid-March when Japanese plum trees are in their flowering period. The adults deposit one (rarely two) egg(s) under the epidermis layer of the calyx. After hatching, the larva soon burrows into the fruitlet, consumes the endocarp and remains inside the fruit within its four-time moulting transitions before reaching full growth. At maturity (in May), the larva leaves the infested fruitlet through an exit hole and burrows into the soil at a depth of 2 - 11 cm for spinning its cocoon and hibernates until the next spring as the larval form. Under laboratory conditions (T = 20°C; RH = 40 - 60%), the male lived for a slightly shorter period than the female, 6.03 ± 0.40 and 7.55 ± 0.45 days, respectively. A female could produce 30.29 ± 4.50 eggs in her lifespan. In the field, the duration of the egg was approximately 10 - 11 days and that of the larva was approximately 31 - 34 days.

Key words: Plum sawfly, life history, developmental duration, longevity, fecundity

초 록: 본 연구는 포장 및 실험실 조사를 통해 자두수염잎벌(*Monocellicampa pruni* Wei, 1998)의 생활사를 확인하였다. 자두수염잎벌은 5령의 유충 단계를 가지는 일화성 곤충이다. 성충은 자두가 만개하는 3월 중순경에 흙에서 나와 꽃받침의 표피층 밑에 1개(드물게 2개)의 알을 낳는다. 부화 후, 유충은 곧 어린 과실 속으로 파고들어 성충이 되기 전 4번의 탈피 과정 동안 과실 안에서 과육을 섭식한다. 유충이 성숙하면(5월) 과실에서 나와 2 - 11 cm깊이의 땅속으로 파고 들어가 번데기방을 만들고 이듬해 봄까지 전용 형태로 월동한다. 실험실 조건(T = 20°C, RH = 40 - 60%)에서 수컷 성충의 생존기간은 암컷성충보다 약간 짧았고(수컷 6.03 ± 0.40일 및 암컷 7.55 ± 0.45일), 암컷은 평생 30.29 ± 4.50개의 알았다. 포장에서 알기간은 약 10 - 11일이었고, 유충기간은 약 31 - 34일이었다.

검색어: 자두수염잎벌, 생활사, 발육기간, 수명, 생산력

Sawflies are amongst the most devastating pest of plum. Within 40 described species of genus *Hoplocampa,* Hartig 1837 (Liston et al., 2019; Taeger et al., 2010), the black plum sawflies *H. minuta* Christ, 1791 and yellow *H. flava* Linnaeus, 1761 have been the primary, host-specific pests of European plum (*Prunus domestica* L.) since the early XIX century (Almaši, 2010; Petherbridge et al., 1933; Tamosiunas et al., 2014). Those species can cause 36 - 96% loss of production and often have more severe effects in organic or non-treated orchards (Andreev and Kutinkova, 2010; Arnaoudov and Andreev, 2002; Caruso and Cera, 2004; Jaastad et al., 2007; Molinari et al., 1996; Oroian et al., 2009).

***Corresponding author:** curcul@scnu.ac.kr
Received September 8 2021; **Revised** November 8 2021
Accepted November 29 2021

This is an Open-Access article distributed under the terms of the Creative Commons Attribution Non-Commercial License (http://creativecommons.org/licenses/by-nc/3.0) which permits unrestricted non-commercial use, distribution, and reproduction in any medium, provided the original work is properly cited.

The genus *Monocellicampa*, a small group of subfamily Nematinae, contains only two species of *M. pruni* Wei, 1998 and *M. yangae* Liu et al. (2017) that both damage Japanese plum (*Prunus salicina* Lindl.) in China (Liu et al., 2017; Wei, 1998). Their morphology is allied to the genus *Hoplocampa*. Characterisations, including the absence of the m-cu vein in the hind wing and epicnemial surface weakly outlined by a furrow, are the keys to distinguish the genus (Liu et al., 2017; Prous et al., 2014). When hosting in plum, larvae of *M. pruni* possess only six pairs of prolegs on abdominal segments II-VII after the first instar (Nguyen et al., 2020), which is a distinctive feature typical of Nematinea larvae species that have seven prolegs pairs (Stehr, 1987). *M. pruni* was discovered more than two decades ago. Somehow, this species has been ignored in many recent reports of the plum sawflies pest in the country of origin (Liu et al., 2017). There has been a lack of information about the infestation status until a report of *M. pruni* in South Korea. The damage resulted in slow development and early drop-down of the fruits and it was so severe that there was no harvest in the reported orchard (Park et al., 2019). *M. pruni* is rapidly spreading throughout the country, especially in organic-based farming orchards (Park et al., 2019), thereby raising urgent requirements for management and prevention of the pest. However, until now, knowledge about *M. pruni* has only been reported for its morphology.

In order to gain more insight about the pest, our present study aims to determine the main biological characteristics of *M. pruni* in discussion with some *Hoplocampa* species. These results will form the basis for management of this devastating species.

Materials and Methods

Insect source

M. pruni at all developmental stages were collected in a 7 - 8 years old organic Japanese plum orchard in Okgok-myeon, Gwangyang-si, Jeollanam-do, South Korea at an altitude of 160 m above sea level.

Determining the biology of *Monocellicampa pruni*

We conducted a series of investigations both in the field and laboratory conditions to determine the biology of *M. pruni*. From early April 2019, and from end of February 2020 and 2021, two insect tent traps (l = 2 m; w = 1 m; h = 1 m) were placed under the plum canopy covering 2 m^2 of soil to observe the adult's emergence from the ground. The traps were checked every two days until the first emergence of sawfly was found inside. Subsequently, the daily checking frequency was adjusted until no adults appeared for five days. Sawflies collected from the trap were counted, sexed and brought back to the laboratory in Sunchon National University for the pair-mating experiment.

Adults of the opposite sex on the same emergence day were coupled in a 450-ml rectangular transparent plastic container with a total of 29 pairs being crossed. Four plum flowers with water-soaked cotton covering the stem were placed in the container for oviposition. Pollens (Cheonji Herbs, Seoul, Korea) were supplied as food and a water-soaked cotton pad was placed on the container's bottom to retain moisture. Flowers were changed every day and the number of oviposited eggs was counted under a Leica EZ4HD microscope (Leica Microsystems, Wetzlar, Germany). The insects were reared until death in an incubator (Sanyo Incubator - MIR253, Sanyo Electric Co. Ltd, Osaka, Japan) set at T = 20°C ± 2°C, RH = 40 - 60% to determine longevity and fecundity.

As it was difficult to rear the insect under cultured conditions, the immature stages of the plum sawfly *M. pruni* were investigated in the orchard. Five plum branches were selected and covered by net bags (l = 150 cm; d = 50 cm) before the flowering period. From 23 - 24 May 2020 when plum trees were in full blossom, forty to fifty adult pairs of *M. pruni* were released within 24 h into each net bag for oviposition. Twenty flowers (at the earlier stage) or fruits (later stage) were collected every day from each net bag until the first appearance of the exit hole on the fruitlet was confirmed. Eggs and larvae were observed by dissecting the fruits (or flowers) under the Leica EZ4HD microscope (Leica Microsystems, Wetzlar, Germany). Larval instar was determined by counting the number of head capsules inside the fruit. The first appearance date of each developmental stage in net bags was recorded. Time between each stage-first-appearance was considered the developmental duration. In addition, a data logger Hobo Pro v2 (Onset, Bourne, MA, USA) was placed at a height of 1.5 m above the ground in the orchard to gather data on temperature and

humidity with the measurements being set at hour intervals.

The site where *M. pruni* sawflies pupate in the soil was investigated by a field experiment. Fifteen water draining PVC pipes (l = 40; d = 10 cm) were vertically inserted into the soil to a depth of at least 30 cm. In early May 2019, thirty infested fruits with no identified exit holes were picked by hand and placed inside each pipe to allow the larva to escape and burrow into the soil for hibernation. All pipes were kept under field conditions until the spring of the following year 2020. From end February to early March 2020, the pipes were removed and taken back to the laboratory for further investigation. The pipes were opened using a cutting machine (Falcon - FD5016D, Hyunsung tools, Seoul, Korea) to access the soil column inside. Each soil column was then horizontally cut into slices of 1 cm. The soil slices of different depths were transferred to different zipper bags (20 × 30 cm) and labelled. The zipper bags were kept under room conditions (T = 22°C ± 2°C). The number of adults that emerged from each zipper bag was counted to obtain data on the depth that sawfly pupated in the soil.

Data analysis

Daily temperature and humidity were calculated, based on the average hourly data gained from the logger equipment. The difference in longevity between male and female adults was determined by two samples t-test after checking the homogeneity of variances. Hypothesis tests were performed using Minitab software v.18.1 (Minitab LLC, State College, PA, USA). Charts were drawn using Microsoft Excel 2016 (Microsoft Corp., Redmond, DC, USA).

Results

The adults

The sawfly adults start emerging in spring around mid- or end-March after a long hibernation period underground. Their emergence usually coincides with the flowering stage of plum in which they deposit eggs and occurs within about two weeks until the flower petals fall off (Fig. 1). Male and female longevity was 6.03 and 7.55 days, respectively, under laboratory rearing conditions. The longest lifespan was recorded at 12 days for females and 11 days for males. Females lived slightly longer than males (df = 56; t-statistic = 2.55; p-value = 0.014, Table 1).

Oviposition and the eggs

M. pruni started laying eggs about 1.5 days after emergence with an average of 30.29 eggs per female (Table 1). Notably,

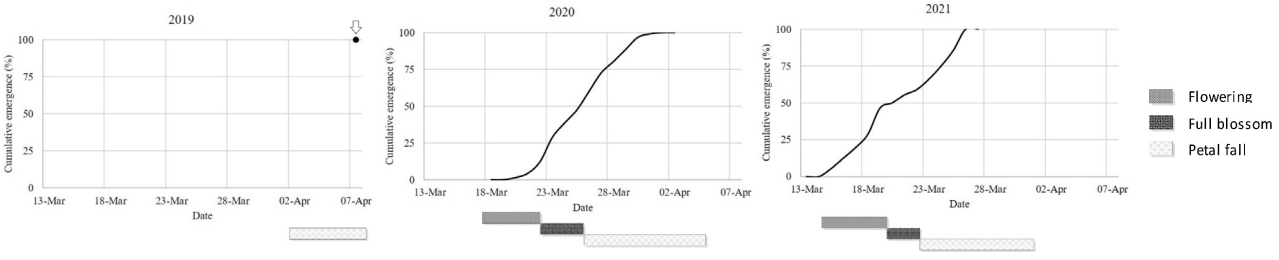

Fig. 1. Cumulative spring emergence of *Monocellicampa pruni* in relationship with vegetation development of Japanese plum (Gwangyang-si, Korea, 2019 – 2021).

Table 1. Longevity and fecundity of adult plum sawfly *Monocellicampa pruni* reared in laboratory conditions (T = 20°C , RH: 40 - 60%)

Parameters	n	Mean (± SE)	Max	Min
Male longevity (days)	29	6.03 ± 0.40	11	1
Female longevity (days)	29	7.55 ± 0.45*	12	2
Pre-oviposition (days)	28	1.54 ± 0.16	5	1
Fecundity (eggs/female)	28	30.29 ± 4.50	86	2

(*) indicates mean longevity between male and female are significantly different (*df* = 56, T-stat = 2.55, *p*-value = 0.014).

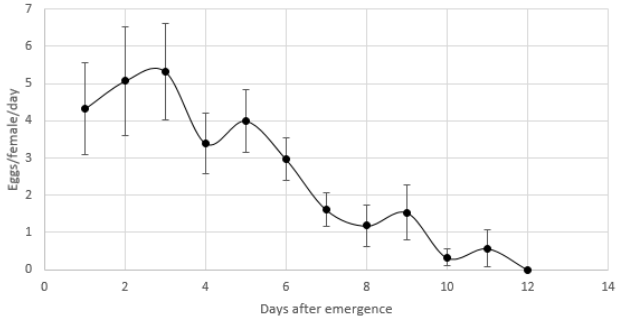

Fig. 2. Mean (± SE) number of eggs laid per day by a female and oviposition duration of plum sawfly *Monocellicampa pruni*.

Table 2. Appearance of immature stages of *Monocellicampa pruni* after oviposition in field conditions (Gwangyang-si, Korea, 2020)

Stage	First appearance in net bag no.					Duration to next first moulting	Weather condition	
	1	2	3	4	5			
Egg (*)	23-Mar	23-Mar	23-Mar	24-Mar	24-Mar	10 - 11		
1st instar	02-Apr	02-Apr	02-Apr	03-Apr	04-Apr	8 - 9		
2nd instar	10-Apr	11-Apr	11-Apr	11-Apr	13-Apr	5 - 6	T (°C)	RH (%)
3rd instar	15-Apr	16-Apr	17-Apr	17-Apr	18-Apr	8 - 10	Mean: 11.89	Mean: 60.08
4th instar	23-Apr	24-Apr	25-Apr	27-Apr	27-Apr	6 - 7	Max: 19.72	Max: 97.90
5th instar	30-Apr	01-May	02-May	04-May	03-May	3 - 4	Min: 7.74	Min: 32.07
Exit hole	03-May	05-May	06-May	07-May	06-May	-		
Days from 1st instar to exit hole						31 - 34		
Days from oviposition to exit hole						41 - 44		

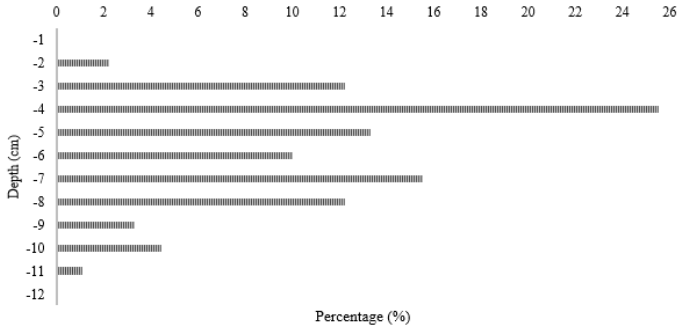

Fig. 3. Percentage of plum sawfly *Monocellicampa pruni* pupated at different depths under the soil surface.

the highest number of eggs laid by a female reached 86 eggs. The oviposition duration of the female was over a period of up to 11 days. Eggs were mostly laid on the first five days after the emergence of adults with an average of 3.4 - 5.3 eggs/female/day (Fig. 2).

The developmental duration of eggs was about 10-11 days in the field (Table 2).

The larvae

In the field condition, the first instar was recorded 10 - 11 days after oviposition. The second, third, fourth and fifth instars appear 8 - 9, 5 - 6, 8 - 10 and 6 - 7 days, respectively, after its relative previous stages. The larvae spend about 31 - 34 days developing mostly inside the fruitlet before escaping to spin their cocoons in the soil (Table 2).

Pupation site

The experiment involving the investigation of the pupation's depth indicated that the cocoons could be found at depths from 2 to 11 cm under the soil surface, with 89% of them pupated at 3 - 8 cm (Fig. 3).

Discussion

The life history of *M. pruni* here is similar to its relative *Hoplocampa* species. As a univoltine species, they also appear in a short period, damaging plum at the flowering and fruit-setting stages, then spend almost of their time hibernating under the ground. Due to the late installation of traps, the adult's first appearance was not known until the year 2019, but the last emergence of adults was still recorded at the petal-fall stage (Fig. 1, arrow). Additional observations in 2020 and 2021, comprising the whole emergence process of *M. pruni,* also revealed that adults waking in the spring coincided with the opening of blossoms, which occurred within a short period of 12 - 13 days (Fig. 1). Soon after crawling up from the soil, adults begin their flight activities and seeking mates. They are black, 4.5 - 6.5 mm in length. Females are usually larger than males and easy to distinguish by their roundish abdomen and an exposed saw-like ovipositor (Fig. 4). They are quite active on clear and sunny days, making it possible to observe their flight movement between flowers by shaking or tapping on the canopy. Adults were observed consuming flower stamens and pollens both in the field and laboratory.

Biological characteristics of adults *M. pruni* observed in the laboratory also reflected their features in the field. The relatively-short lifespan observed under cultured rearing conditions supports the adult's brief introduction in the orchard. Our investigation indicated that *M. pruni* adults appeared for about 24 days in the field. This is quite similar to some species of the genus *Hoplocampa,* such as the apple sawfly *H. testudinea* presented within 2 - 3 weeks (Graf et al., 1996) or plum sawfly species *H. minuta* and *H. flava* needed 6 - 17 days to reach 75% cumulative flight (Tamosiunas et al., 2014) in the field. More works still need to be done to gain more insight into this species. The 20°C condition applied in our study here was significantly higher than the field conditions, which probably led to the adults' short lifespan. In addition, the limitation of flowers supplied for oviposition might also affect the egg-laying activities of *M. pruni.* Further studies on temperature-dependent development or different host plants should be undertaken to address these issues.

While laying eggs, the female faces down to the stem of the flower, uses her hind legs to grasp the calyx and deposit into the cuticle layer (Fig. 5A). One (rarely two) egg(s) was found on each flower in field conditions (Fig. 5B). However, there were 13 eggs recorded in a single flower in the cultured rearing condition (Fig. 5C). Eggs are elongated (at oviposition), about 0.5 mm in length and transparent white (Fig. 5D). They shrink to an oval shape with evidence of two red spots of ocelli and a head capsule in preparation for hatching. It is possible to

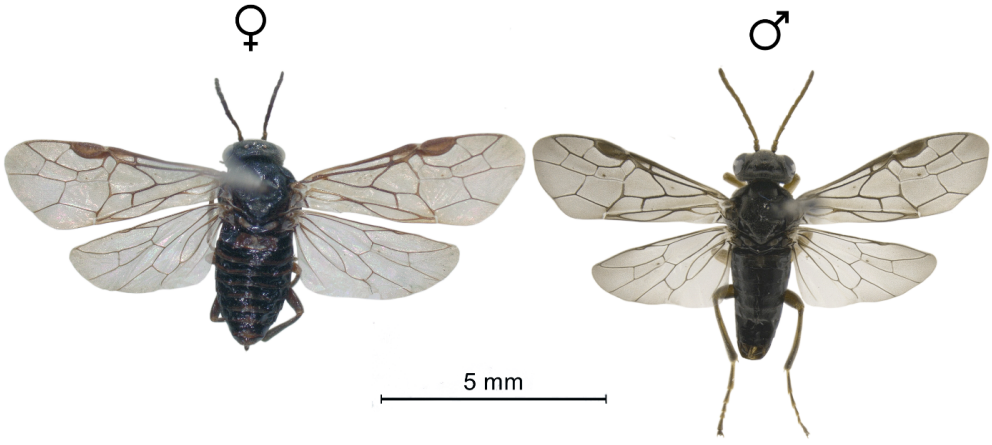

Fig. 4. Adults of plum sawfly *Monocellicampa pruni.* A- female (left). B- male (right).

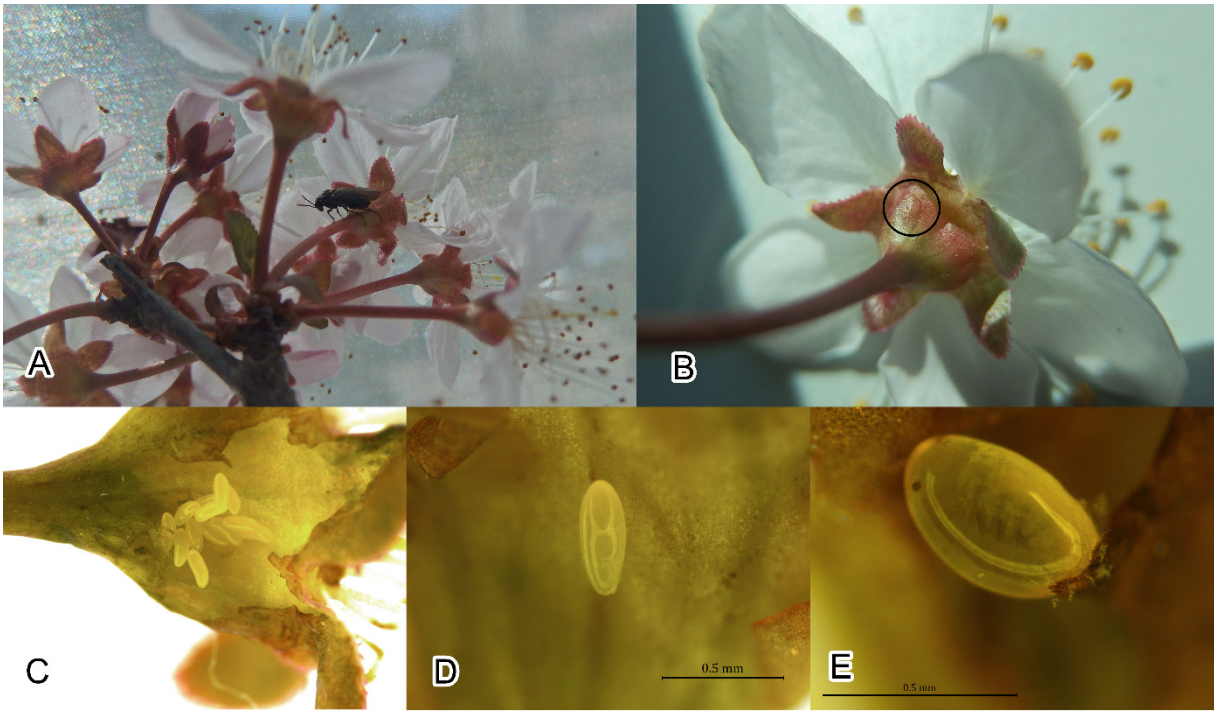

Fig. 5. Oviposition and eggs of plum sawfly *Monocellicampa pruni*. A - female depositing egg on calyx of the flower. B - egg laid under the cuticle layer (circle). C - a cluster of eggs laid under laboratory conditions. D - egg elongated at oviposition. E - egg shrinks to an oval shape in preparation for hatching with visible red ocelli.

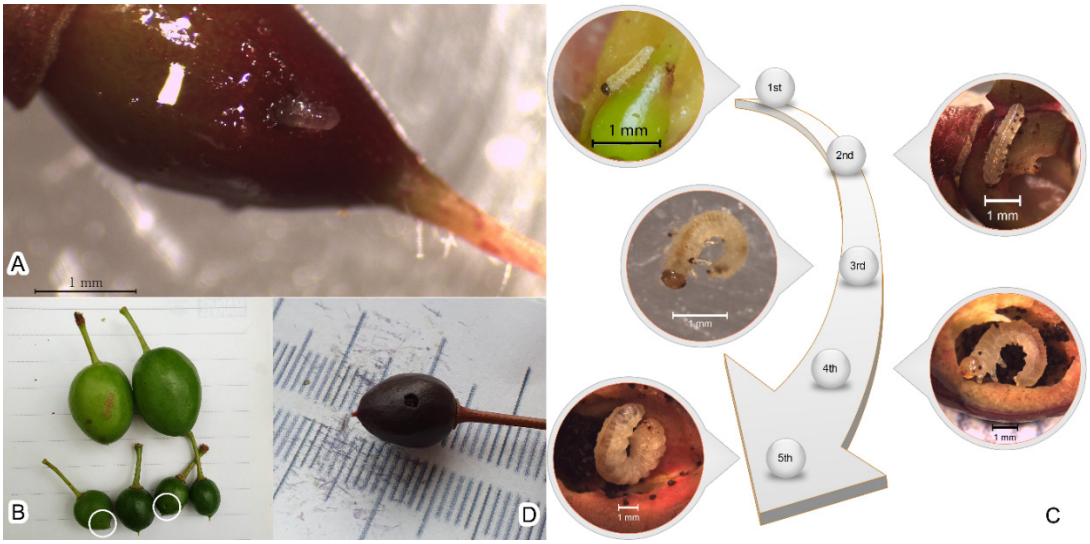

Fig. 6. Larva of *Monocellicampa pruni*. A - First instar burrowing into the fruitlet; B - damaged (with entrance hole in circle, lower) and undamaged fruit (upper); C - five larval instars of *Monocellicampa pruni*; D - larva leave a hole on fruitlet after escape.

observe the movement of the larva inside the egg under a microscope (Fig. 5E);

On hatching, larvae are about 1 mm in length and soon start entering the developing fruitlet, which was still covered by the withering calyx at this time (Fig. 6A). After that, the entrance hole is filled up due to the fruit's growth and remains only as a small sting. The infestation leads to slow fruit development and subsequent early drop-down of fruit (Fig. 6B). There are five larval instars of *M. pruni*, which can be determined by counting the number of head capsules inside the fruit (Fig. 6C).

The larva consumes the endocarp part of the fruitlet and remains inside the invaded fruitlet until reaching mature. The condition of one exit hole indicates that one larva of *M. pruni* causes damage to one fruitlet only. At full growth, the last instar larva (which measures about 11 mm at this time), creates a hole (Fig. 6D) to escape from the fruit and enter the soil for hibernation, where they remain inside until the following spring as the larva form; The developmental duration of *M. pruni* larvae here was quite similar to *H. flava* which was about 33 days (Petherbridge et al., 1933). However, its biology associated with plum noticeably differs from other species of *Hoplocampa*. The larva of *M. pruni* infests only one plum fruitlet. In contrast, plum sawfly *H. flava* (Petherbridge et al., 1933), *H. minuta* (AgroAtlas, 2009) or apple sawfly *H. testudinea* (Miles, 1932) usually need several (3 - 6) fruits for their development. This might be the reason why the reduction of prolegs occurs in *M. pruni* since the insect does not migrate to other fruits.

Like other plum sawflies, *M. pruni* overwinter in a cocoon under the soil. Cocoons are oval, made of smooth brown solid filaments, about 6 - 6.2 mm in length and 3 - 3.2 mm in width. Due to the secretion from the spinning process, the cocoon's outer surface is formed by the particle texture of the soil, giving it a similar appearance to soil colour and making it extremely difficult to detect (Fig. 7). However, there are usually sparkling sand particles adhering to the outer surface, thereby making it like a small rough-coated stone. It is unclear whether different soil types or soil cover materials have any impact on migration of *M. pruni* into the ground or not. However, these findings still contribute significant academic information for further study management and control of *M. pruni*. Some sawfly species emergence in the spring is driven by soil temperature

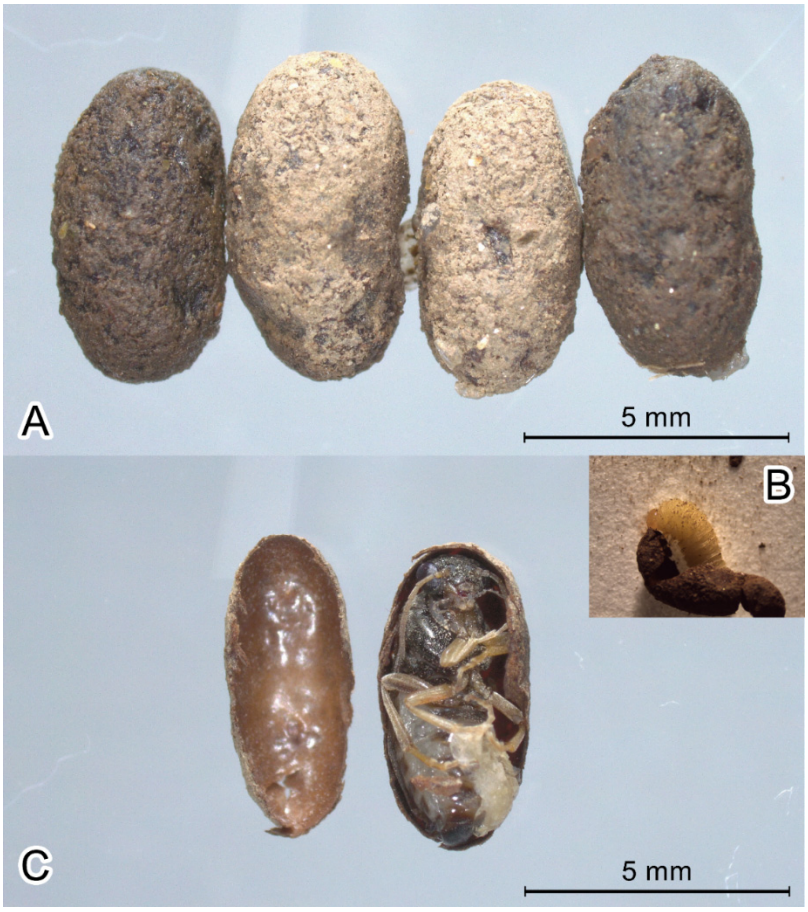

Fig. 7. Cocoon of *Monocellicampa pruni*. A - cocoons appear like rough-coated stones; B - fifth instar larva living inside the cocoon (photo taken in October); C - a moulting pupa preparing for emergence (photo taken in March).

(Graf et al., 1996; Tamosiunas et al., 2014). Thus, the results here suggest the location of the site where we should place thermal measurement equipment to gain more reliable data or the application of bio-products and chemicals. Besides, concerns regarding the overwintering behaviour of *M. pruni* are still needed to be clarified, as some sawflies species can remain in the soil for several years (Hadzistevic, 1959). This information is not yet known for *M. pruni*.

Previous studies proved that environmentally-friendly approaches could be applied to control the plum sawflies species of *H. minuta* and *H. flava*. The timing of the control application is always the key factor for success. Until now, no programme has been proposed for control of *M. pruni*. However, according to observations in the field, control measures for the pest should be implemented prior to the larva's entrance into fruitlets. The duration from egg to larva hatch is probably the ideal time for action. Treatment, at around the time of petal falling, appears suitable in case of *M. pruni* here and this appears to have no negative impact on pollination. Applications of the entomopathogenic nematode are recommended for soil treatment, but it should be done before the sawfly settle inside their cocoons (Nježić and Ehlers, 2020). The developmental duration of larva, indicated in this study, could help optimising the effectiveness of this application.

Acknowledgement

We would like to thank farmer J.S. Kim of Hanultari Farm, who kindly donated his orchard for this study's experiment. This research was supported by a Research promotion program of Sunchon National University.

Statements for Authorship position & contribution

Nguyen, N.H.: Sunchon National University, researcher; carried out the survey, analysed data, and wrote the manuscript.

Ki, W.: Sunchon National University, researcher; field survey, data collecting.

Im, M.-H.: Bio-Plant Environment Research Center, researcher; field survey, data collecting.

Hong, K.J.: Sunchon National University, professor; designed the research and revised the manuscript.

All authors have read and approved the manuscript.

Literature Cited

AgroAtlas. 2020. *Hoplocampa minuta* Christ. - Black Plum Sawfly. http://www.agroatlas.ru/en/content/pests/Hoplocampa_minuta/index.html (accessed 19 April, 2020).

Almaši, R. 2010. Major insect pests on stone fruits. Biljni Lekar (Plant Doctor) 38, 362-374.

Andreev, R., Kutinkova, H. 2010. Possibility of reducing chemical treatments aimed at control of plum insect pests. ISHS Acta Horticulturae 874: IX International Symposium on Plum and Prune Genetics, Breeding and Pomology. Acta Horticulturae, Leuven, Belgium, 16-19 March 2008, Palermo, Italy, pp. 215-220.

Arnaoudov, V., Andreev, R. 2002. A study on carpophagus Hymenoptera and Lepidoptera of plums in the Plovdiv fruit growing region. ISHS Acta Horticulturae 577: VII International Symposium on Plum and Prune Genetics, Breeding and Pomology. Acta Horticulturae, Leuven, Belgium, 20 August 2001, Plovdiv, Bulgaria, pp. 247-253.

Caruso, S., Cera, M.C. 2004. Control strategies for plum sawflies (*Hoplocampa flava, Hoplocampa minuta*) in organic farming. IOBC/WPRS Bulletin 27, 107-111.

Graf, B., Höhn, H., Höpli, H.U. 1996. The apple sawfly, *Hoplocampa testudinea*: A temperature driven model for spring emergence of adults. Entomol. Exp. Appl. 78, 301-307. doi:10.1111/j.1570-7458.1996.tb00794.x

Hadzistevic, D. 1959. The existence of several years' diapause in the plum sawflies (*H. minuta* and *H. flava*) in the Sarajevo region. Proceedings of the 1st World Congress of Agricultural Research. Rome, Italia, pp. 1371-1376.

Jaastad, G., Røen, D., Bjotveit, E., Mogan, S. 2007. Pest management in organic plum production in Norway. ISHS Acta Horticulturae 734: VIII International Symposium on Plum and Prune Genetics, Breeding and Pomology. Acta Horticulturae, Leuven, Belgium, 05 September 2004, Lofthus, Norway, pp. 193-199.

Liston, A., Prous, M., Vardal, H. 2019. A review of West Palaearctic *Hoplocampa* species, focussing on Sweden (Hymenoptera, Tenthredinidae). Zootaxa 4615, 1-45. doi:10.11646/zootaxa.4615.1.1

Liu, T., Liu, L., Wei, M. 2017. Review of *Monocellicampa* Wei (Hymenoptera: Tenthredinidae), with description of a new species from China. Proc. Entomol. Soc. Wash. 119, 70-77. doi:10.4289/0013-8797.119.1.70

Miles, H.W. 1932. On the biology of the apple sawfly, *Hoplocampa testudinea* Klug. Ann. Appl. Biol. 19, 420-431. doi:10.1111/

j.1744-7348.1932.tb04332.x

Molinari, F., Carli, G., Pari, P. 1996. First note on plum sawflies in Emilia Romagna (Nothern Italy). ISHS Acta Horticulturae 422: International Conference on Integrated Fruit Production. Acta Horticulturae, Leuven, Belgium, 28 August 1995, Cedzyna, Poland, pp. 370-371.

Nguyen, N.H., Im, M.-H., Hong, K.-J. 2020. Description of the Japanese plum sawfly larva *Monocellicampa pruni* (Hymenoptera: Tenthredinidae) in South Korea. Korean J. Appl. Entomol. 59, 443-449. doi:10.5656/KSAE.2020.10.0.059

Nježić, B., Ehlers, R.-U. 2020. Entomopathogenic nematodes control plum sawflies (*Hoplocampa minuta* and *H. flava*). J. Appl. Entomol. 144, 491-499. doi:10.1111/jen.12755

Oroian, I., Oltean, I., Odagiu, A., Paulette, L., Iederan, C., Brașovean, I. 2009. The control and monitoring of the orchard pests in Transylvania. Res. J. Agric. Sci. 41, 277-283.

Park, B., Nguyen, N.H., Lee, J.-W., Hong, K.-J. 2019. A new sawfly pest, *Monocellicampa pruni* Wei (Hymenoptera, Tenthredinidae) attacking fruitlets of Japanese plum in South Korea. Korean J. Appl. Entomol. 58, 329-333. doi:10.5656/KSAE.2019.11.0.038

Petherbridge, F.R., Thomas, I., Hey, G.L. 1933. On the biology of the plum sawfly, *Hoplocampa flava* L., with notes on control experiments. Ann. Appl. Biol. 20, 429-438. doi:10.1111/j.1744-7348.1933.tb07440.x

Prous, M., Blank, S.M., Goulet, H., Heibo, E., Liston, A.D., Malm, T., Nyman, T., Schmidt, S,, Smith, D.R., Vårdal, H., Viitasaari, M., Vikberg, V., Taeger, A. 2014. The genera of Nematinae (Hymenoptera, Tenthredinidae). J. Hymenopt. Res. 40, 1-69. doi:10.3897/JHR.40.7442

Stehr, F.W. 1987. Immature insects, volume 1. Kendall/Hunt Pub. Co., Dubuque, IA, USA, p. 754

Taeger, A., Blank, S.M., Liston, A.D. 2010. World catalog of Symphyta (Hymenoptera). Zootaxa 2580, 1-1064. doi:10.11646/zootaxa.2580.1.1

Tamosiunas, R., Valiuskaite, A., Surviliene, E., Rasiukeviciute, N. 2014. Species ratio, spring emergence, population dynamics and damage of plum sawflies *Hoplocampa minuta* and *H. flava* in plum orchard. Zemdirbyste 101, 91-100. doi:10.13080/z-a.2014.101.013

Wei, M. 1998. Two new genera of Hoplocampinae from China with a key to known genera of the subfamily in the world (Hymenoptera: Nematidae). J. Cent. South Univ. 18, 12-18.