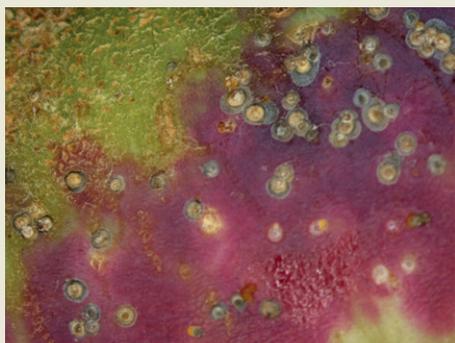


MONITORING AND MANAGEMENT OF SAN JOSÉ SCALE

(*Quadraspidiotus perniciosus*)

in V4 region countries

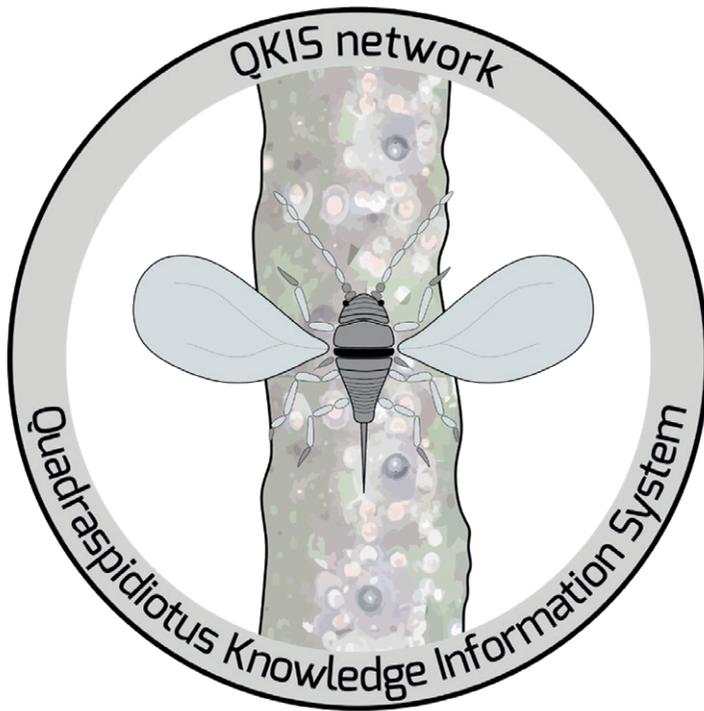


• supported by

• Visegrad Fund



Monitoring and management
of San José Scale
(*Quadraspidiotus perniciosus*)
in V4 region countries
PRACTICAL GUIDE



2025

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• •

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Introduction

Comstockaspis perniciosus (Comstock, 1881) previously known as *Quadraspidiotus perniciosus*, (Comstock, 1881), common name San José scale (SJS) is one of the dynamically spreading alien invasive armored scale insect species. It is a cosmopolitan and a polyphagous species and is one of the most important pests of fruit crops and ornamental plants worldwide. It prefers tropical climate but has the status of the pest in the countries of temperate climate in almost all European countries.

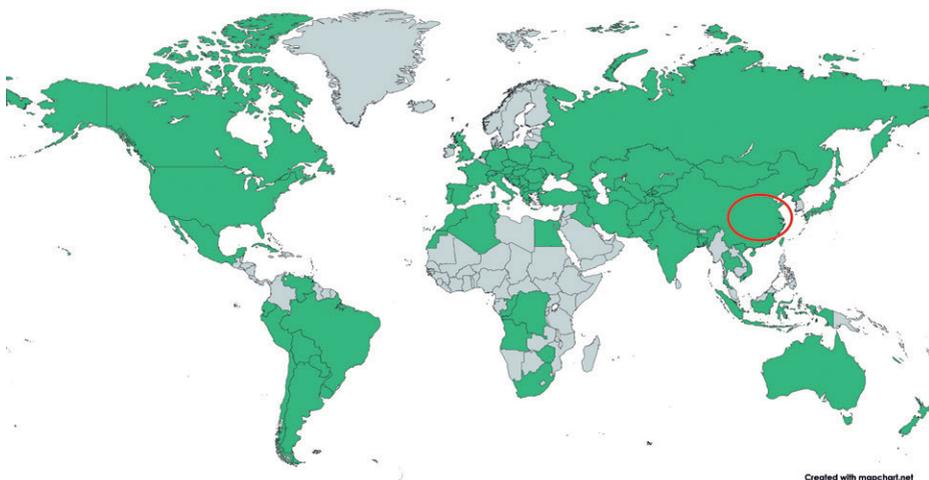
The example of the San José scale is the first historically documented instance of invasion and/or gradation caused by the introduction of cultivated monocultures. Moreover, the first documented case of insecticide resistance to an was reported in 1914, involving populations of San José scale in Washington (USA).

Distribution

C. perniciosus is a polyphagous invasive species that originated in Eastern Asia, most likely in Northern China and the Russian Far East. It was introduced with plant material subsequently to the Mediterranean region and North America. It was first discovered and described in 1873 in San Jose, California. These two geographical names are the source of the common name for this species in most languages. Since then it has been introduced to most parts of the world, and has been reported from more than 60 countries on all permanently inhabited continents.

Occurrence of SJS in Visegrad countries

The SJS was first documented in Hungary in 1928, though its introduction likely predated this record. By the early 1930s, it had caused significant damage nationwide, but chemical treatments successfully mitigated its impact by the end of the decade. However, plant protection treatments were largely neglected during World War II, leading to a rapid increase in SJS populations. After the war, chemical treatments were subsequently employed to control the pest, followed by the adoption of integrated pest management (IPM) methods from the late



Distribution area of SJS. Occurrence of SJS was confirmed from countries in green.
Area of probable origin is signed by a red circle

1980s onwards. In Poland, the initial outbreak of the SJS was documented in 1948 and 1949 in the southern region of the country. This infestation was effectively managed through the use of non-selective pesticides. However, in 2015, a second outbreak of the SJS was observed, primarily affecting fruits, with a particular prevalence on *Malus* species. The SJS was documented from the 1930s onwards in the southern and eastern regions of the Slovak part of Czechoslovakia. Additionally, the first record in the Czech part of the country was in Uherské Hradiště, and subsequently the pest spread to southern Moravia.

Common host plants

Overall, this scale insect utilizes over 40 plant families, encompassing more than 70 genera and nearly 190 plant species.

Preferred host plants include members of the family *Rosaceae*, such as the genera *Malus*, *Pyrus*, *Prunus*, *Rubus* as well as nut trees, other fruit trees and fruiting shrubs.

Morphology and identification

C. perniciososa (Comstock), as all armored scales, is morphologically distinct with extreme sexual dimorphism. Adult females develop after three stages of growth which includes two moulting (first- and second-instar nymph). However, males develop after five stages of growth including four moulting (first- and second-instar nymph, the prepupa, and pupa).

ADULT FEMALE

- **Mobility:** NO
- **Feeding:** YES
- **Body:** soft, flattened; head, thorax and abdomen are fused together, yellow in colour, without wings and legs, antennae reduced; 0.8–1.5 mm long
- **Scale cover:** light to dark grey, circular, slightly convex, larval exuviae central or subcentral; diameter 1.5–2.2 mm



Female with scale cover



Females without scale cover

ADULT MALE

- **Mobility:** YES
- **Feeding:** NO
- **Body:** distinct head, thorax, and abdomen; one pair of wings; 3 pairs of legs; plumose antennae; lacks functional mouthparts, yellowish-tan in colour, ca. 1 mm long



The characteristic dark band across the back of thorax (dorsum).

Male of SJS

FIRST-INSTAR (L1) NYMPHS

Crawler:

- **Mobility:** YES
- **Feeding:** YES
- **Body:** elongate oval, yellow, with legs and antennae; ca. 0.24 mm long, 0.18 mm wide
- **Scale cover:** NO

White cap nymph

- **Mobility:** NO
- **Feeding:** YES
- **Body:** legs and antennae undergo atrophy; ca. 0.24 mm long, 0.18 mm wide
- **Scale cover:** white, circular; diameter ca. 0.25 mm

Black cap nymph

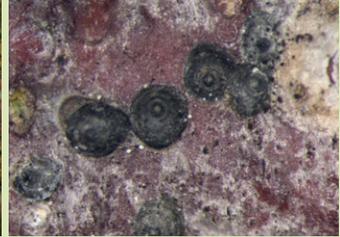
- **Mobility:** NO
- **Feeding:** YES
- **Body:** similar to adult female but smaller; ca. 0.24 mm long, 0.18 mm wide
- **Scale cover:** black, dark grey, similar to adult female, but smaller; diameter ca. 0.27 mm



Crawler



White cap nymphs



Black cap nymph

SECOND-INSTAR (L2) FEMALE NYMPH

- **Mobility:** NO
- **Feeding:** YES
- **Body:** similar to adult female but smaller
- **Scale cover:** similar to adult female but smaller; ca. from 0.35 mm long, 0.25 mm wide

SECOND-INSTAR (L2) MALE NYMPH

- **Mobility:** NO
- **Feeding:** YES
- **Body:** elongate, light yellow; from 0.38 mm long, 0.25 mm wide
- **Scale cover:** elongate, oval, light brown, ca. 1.4 mm long



Second instar female nymphs



Second instar male nymph

PREPUPA – THIRD-INSTAR (L3) MALE NYMPH

- **Mobility:** NO
- **Feeding:** NO
- **Body:** elongate; wings start to develop; 0.60 mm long, 0.35 mm wide
- **Scale cover:** elongate, oval, light brown; 0.75 mm long, 0.40 mm wide



Prepupa

PUPA – FOURTH-INSTAR (L4) MALE NYMPH

- **Mobility:** NO
- **Feeding:** NO
- **Body:** elongate; wings developed, mouthparts reduced; 0.70 mm long, 0.35 mm wide
- **Scale cover:** elongate, oval, grey, with yellow subterminal exuviae; 0.85 mm long, 0.45 mm wide



Pupa

LIFE CYCLE

The overwintering stage is immature first-instar nymphs under black scale cover (so-called black cap nymph). They can be found on branches and trunks of host plants. In the beginning of April, nymphs start to moult, and then grow. At this time differences in morphological features between male and female become visible. Second instar nymphs are usually observed in the second half of April. Adult females appear after the next moult, and adult males after the prepupa and pupa stages. Usually males are observed a few days later than females. Adult female and mass male flight is observed from the end of May. SJS females are immobile throughout life, without legs or wings, and covered with a scale. Males are winged, with reduced mouthparts. They live only a few days and die after mating. The first-instar nymphs pass through three stages: crawler, white cap, and black cap. Crawlers emerge from the female scale cover and actively move on the shoots to select a favorable location to feed. They are observed on trees from the mid-June till the turn of June and July. During this time they can be dispersed by wind, other insects, birds or infested seedlings in nurseries. This instar is also the most susceptible to agrochemicals because it lacks a scale cover. However, crawlers are difficult to detect due to their small size and mobility unless they occur in large numbers. They are active for less than 24 hours after hatching and within this time they settle on the trunks, shoots, leaves and fruits. Then they hind legs under their body, become flattened and insert their mouthparts into the tissues and start feeding. They start to produce a cottony wax until their body is completely covered. The scale cover is white at first (white cap scale) and then turns black (black cap scale). Adults of the second generation appear in mid-July, while the first crawlers of this generation are observed in the beginning of August. They overwinter on the trunks and twigs of the trees as a black cap scale. In Poland there are two generations of this pest, however according to the literature data, two or three generations occur per year in the northern hemisphere and three or four in the southern hemisphere. Sometimes, generations overlap due to the prolonged time of laying eggs by females and large numbers of specimens in each generation.

Life cycle and life stages of San Jose scale

Adult male

Mobility: YES

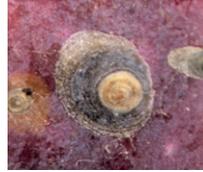
Feeding: NO

Body: distinct head, thorax, and abdomen; one pair of wings; 3 pairs of legs; plumose antennae; lacks functional mouthparts, yellowish-tan in colour, ca. 1 mm long

The characteristic dark band across the back of thorax (dorsum) makes them different from other species of Diaspididae.



male



female

Adult female

Mobility: NO

Feeding: YES

Body: soft, flattened; head, thorax and abdomen are fused together, yellow in colour, without wings and legs, antennae reduced; 0.8–1.5 mm.

Scale cover: light to dark grey, circular, slightly convex, larval exuviae central or subcentral; diameter 1.5–2 mm.

Pupa – fourth-instar (L4) male nymph

Mobility: NO

Feeding: NO

Body: elongate; wings develop, mouthparts reduce.

Scale cover: elongate, oval, grey, with yellow subterminal exuviae.



pupa

Prepupa – third-instar (L3) male nymph

Mobility: NO

Feeding: NO

Body: elongate; wings start to develop.

Scale cover: elongate, oval, light brown.



prepupa

Second-instar (L2) male nymph

Mobility: NO

Feeding: YES

Body: elongate, light yellow.

Scale cover: elongate, oval, light brown.



L2 male nymph

Ovovivipary:

Form of reproduction between egg-laying (ovipary) and live-bearing (vivipary) reproduction.

Ovoviviparous animals possess embryos that develop inside eggs that remain in the mother's body until they are ready to hatch.

Black cap nymph

Mobility: NO

Feeding: YES

Body: similar to adult female but smaller.

Scale cover: black, dark grey, similar to adult female, but smaller.



L1 (black cap nymph)



L1 (white cap nymph)

First-instar (L1) nymphs

with 3 developmental phases
no sexual dimorphism

Crawler:

Mobility: YES

Feeding: YES

Body: elongate oval, yellow, with legs and antennae, 0.3 mm in length.

Scale cover: NO

White cap nymph

Mobility: NO

Feeding: YES

Body: legs and antennae undergo atrophy.

Scale cover: white, circular.

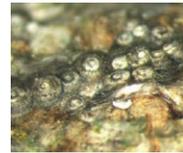
Second-instar (L2) female nymph

Mobility: NO

Feeding: YES

Body: similar to adult female but smaller.

Scale cover: similar to adult female but smaller.



L2 female nymph

ovovivipary

mating



Phenology

What is phenology?

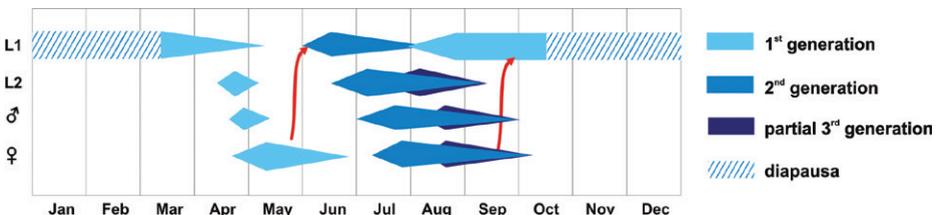
Phenology is the study of plant and animal life cycles, especially their timing as driven by changes in weather and climate, including events, such as flowering of plants, arrival of migratory birds, and of course, hatching of larvae of SJS as well. Knowledge of the timing of these events in the case of a pest species, such as SJS, plays a very important role in agriculture. Correct information on the phenology of a pest species can help to decide proper timing in using pesticides against the given pest.

Phenology of SJS

SJS is an alien invasive pest in Europe, the number of its generations per year varies between 1 (e.g., higher altitudes in Switzerland) and 4 (e.g., in Portugal). In the Visegrad countries the number of its generations per year is generally two, but microclimatic conditions highly affect the development of SJS, thus partial third generation is often reported in Hungary and also from Poland. Sometimes, generations overlap due to the prolonged egg-laying period of female and the large numbers of specimens in each generation, mainly in the case of 2nd and partial 3rd generation.

Phenology patterns of SJS in Visegrad countries

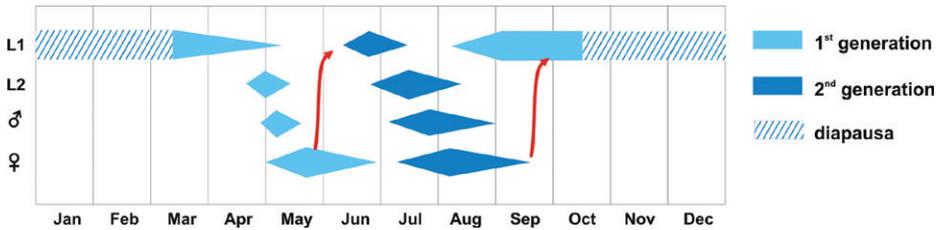
Colors represent a given generation, the widest part of a rhombus means the mass peak of a given lifestage.



SJS phenology in Hungary (after Kozár 1989)

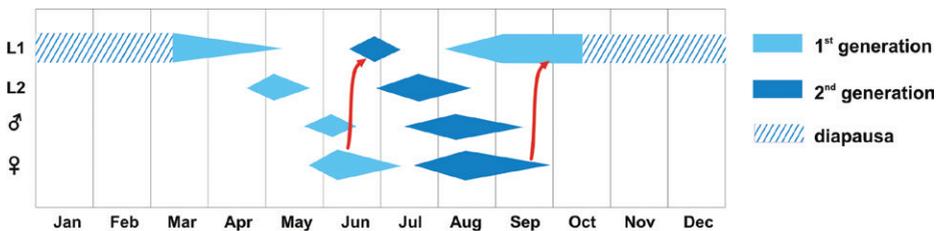
In Hungary the overwintering first-instar nymphs may start growing as early as mid-March, depending on the weather. Second-instar nymphs are usually observed from the beginning of April. After the next molt, adult females appear from the second half of April. Males generally emerge a few days later than females, so their mass flight can be expected by the end of April. Adults of the

second generation appear in early July, and the first mobile larvae (crawler) are observed from the end of July. A partial third generation is also possible, with adult females expected from the end of August and the crawler larvae from mid-September. These larvae overwinter on the trunks and branches of trees in the so-called „black-cap” form.



SJS phenology in Czechia (after Rychla 2015)

In Chechia the overwintering first-instar nymphs continue their development from early April. Second-instar nymphs are usually observed from mid-April. After the next molt, adult females appear from early May. Males generally emerge a few days later than females, and their mass flight can be expected from mid-May. Adults of the second generation appear in early July, and the crawler larvae are observed from the end of July. These larvae overwinter on the trunks and branches of trees in the so-called „black-cap” form.



SJS phenology in Poland (after Golan, 2015)

In Poland the overwintering first-instar nymphs generally continue their development from early April. Second-instar nymphs are usually observed from the second half of April. After the next molt, adult females appear at the end of May. Males generally emerge a few days later than females, so their mass flight can be expected at the end of May or the beginning of June. Adults of the second generation appear in mid-July, and the crawler larvae are observed from early August. These larvae overwinter on the trunks and branches of trees in the so-called „black-capped” form.

Monitoring

Where to look:

- all year-round on the bark of branches of all sizes
- on the skin of fruits and occasionally on foliage

Monitoring during winter

Counting of nymphs in the black cap stage during winter inspection. Localized (focal) infestation is common. Under the microscope, the number of scales in the black cap stage and the percentage of living nymphs are determined.

Monitoring during summer

In summer, the number of adult scales, the percentage of living individuals, and the number of first-instar nymphs in all three developmental stages (crawlers, white cap, black cap) are assessed.

The level of fruit infestation

The level of fruit infestation by SJS is assessed before harvest on a sample of 500 fruits – based on the presence of characteristic red spots with central scales or fruits bearing visible scales.

Monitoring of SJS males

SJS males are monitored using different types of pheromone traps. Traps are hung at the end of April or beginning of May, three per site, with a minimum distance of 50 meters between them. Ideally, it is advisable to check the catches in the traps at least twice a week and record them in a table (e.g. Excel) for the later creation of a flight curve chart. A magnifying glass or binocular microscope is needed to count captured males due to their very small size. Based on the catches, flight activity of SJS males can be easily determined.



Pheromone trap - Delta type



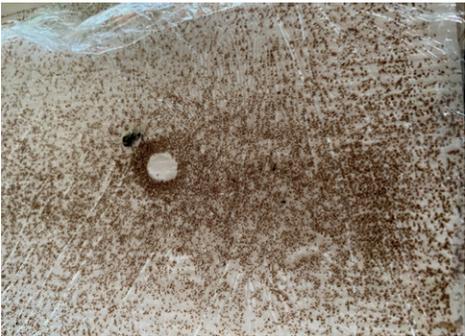
Other type of pheromone trap with a captured male marked by a red circle



Tent trap - simplified variation of Delta trap - used in Hungary for experimental purposes (left); captured males in the trap (right)

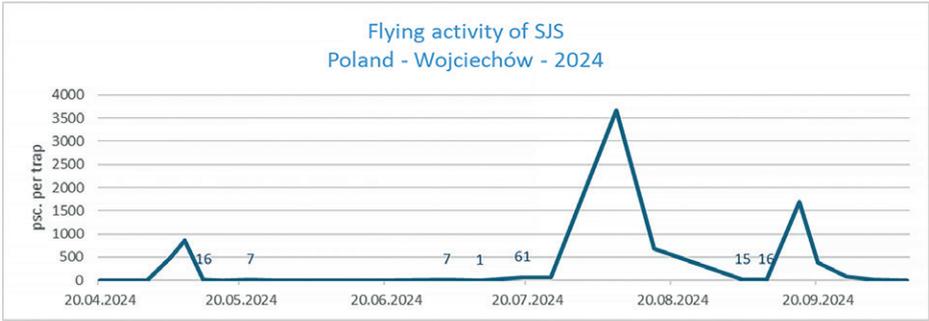


Delta trap used in Poland (left) and males of SJS (in microscope magnification) captured in the trap (right)



SJS males captured on a pheromone trap (left) and adult male with the characteristic dark band across the back and long antennae (right)





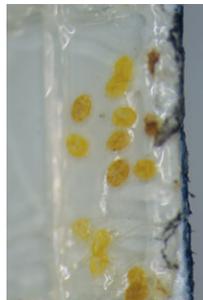
Monitoring of SJS crawlers

Fruit growers can also monitor crawling nymphs. They are monitored through visual inspection or with double-sided tape placed on tree branches where SJS are present. Monitoring should be carried out twice a week from mid-June using a high-quality hand lens. Monitoring both flight activity and nymphal crawling provides important data for determining the correct treatment date.



Two-sided sticky trap

SJS first instar nymph monitoring. Black isolation two-sided sticky tape (coated with a thin layer of petroleum jelly, owing to its elasticity it's much more better than paper ones) placed with sticky side up is a good tool for monitoring of hatching SJS larvae, especially in the beginning of their move.



Crawlers on twig and the first instar nymphs captured on sticky tape

Degree day method

SJS is a cold-blooded organism, meaning it cannot regulate its body temperature internally. Its activity is closely correlated with atmospheric conditions, primarily air temperature, which provides the heat units necessary for development. The rate of individual development is therefore dependent on the amount of heat absorbed by the insect over a given period. Higher air temperatures result in more heat being accumulated by the organism, which accelerates the rate of development.

The concept of threshold temperatures defines the thermal limits within which the insect can develop. The minimum (base) threshold temperature is the air temperature below which insect development is stopped. Prolonged exposure to low temperatures can suspend life processes, leading the insect into a dormant state. Conversely, the maximum threshold temperature is the air temperature above which the pest's development slows down, potentially causing irreversible changes in its physiology or death. The minimum and maximum threshold temperatures for the SJS are 7.3°C and 32°C, respectively.

By determining threshold temperatures and collecting data on atmospheric conditions for a specific location (e.g. from a private weather station), it is possible to predict the emergence of various developmental stages of the SJS. Thus the growing degree day method (GDD) is a useful tool for predicting insect growth. The developmental rate of insects (and other invertebrate pests) is directly proportional to the amount of time they spend within the temperature range required for their development. This physiological time can be described using accumulated heat units, also known as degree-days, which represent a species-specific constant value necessary for individuals to develop from one stage to the next one. This requires the calculation of cumulative heat units, expressed in degree-hours or degree-days, which reflect the relationship between temperature and the duration of exposure. One degree day is accumulated when the average temperature for a day is one degree over the lower limit (base temperature) needed for development.

For most users simple calculation according to the following formula provides sufficient ability to predict major events in insect development:

$$\text{GDD} = (T_{\max} + T_{\min}) / 2 - T_{\text{base}}$$

Where:

GDD is Growing Degree Days

T_{\max} is maximum daily temperature,

T_{\min} is the minimum daily temperature,

T_{base} is the temperature of low developmental threshold for the insect

The starting point for accumulating GDDs can be determined by either a fixed calendar date (e.g. March 1) or a biological reference point known as a biofix. A biofix is established on the date the first consistent flight occurs (adult is detected in a pheromone trap on two or more consecutive days). Since SJS activity varies from year to year in relation to weather conditions, using a biofix is generally more accurate, and reduces the duration of GDDs calculation. In southeastern and central Poland, the first males of SJS are typically detected in May, with the biofix occurring at early, mid, or late May, depending on the year. The insect's developmental stages are closely linked to the growth phase of the host plant, both being temperature-dependent. Male flight usually occurs after petal fall (BBCH 67-69), therefore pheromone traps for SJS should be placed in infested orchards before bloom (at the white or pink apple bud stage, BBCH 56-57), and examined daily to determine the biofix date. GDDs accumulation is a useful tool for predicting scale crawler activity and timing insecticide applications effectively.

Crawlers emergence begins at approximately 220-290 GDD_{7.3'}, and the peak (optimum timing for crawler control) is usually noted at 370-450 GDD_{7.3} from biofix.

Control

Early spring

The first option for protecting orchards against SJS is a pre-emergence oil treatment in early spring. Covering the pest with a thin, air-impermeable layer makes it difficult for the insect to breathe and leads to its death. According to the legislation of individual countries, plant-based or mineral oils, or a combination of oil and insecticides, may be used. In cases of heavy infestation, this treatment is not sufficient and must be repeated, with particular attention given to applications during the growing season. The actual treatment is determined based on winter pest control (pest threshold: 10 live nymphs per 1 meter of branches) or fruit damage observed in the previous year. The application

should be carried out after the temperatures exceed 7.3 °C (beginning of bud swelling to bud phase called “mouse ear”).

Growing season

Further treatments can be applied during the growing season. This treatment is aimed at the beginning of the mass emergence of 1st instar nymphs, usually in mid to late June – based on the meteorological conditions of the year. The timing of the growing season treatment can be determined by two different signalling models:

a) visual inspection according to the presence of the first mobile nymphs

Visual inspection of dispersing nymphs by double-sided sticky tape placed on the branches or inspection under a binocular microscope or magnifying glass (see chapter Monitoring).

b) by catches on the trap in combination with the sum of effective temperatures (GDD)

The basis of monitoring of the SJS is to monitor the flight activity of males using pheromone traps. In the case of monitoring the sum of effective temperatures, treat at $GDD_{7.3}=400-450$ °C, where Biofix is the first catch of males in the pheromone trap. Pest threshold is 10 and more live females per 1 meter of branches. Due to the prolonged hatching of nymphs, the treatment needs to be repeated after 10 to 14 days.

In the **Czech Republic**, the product Mospilan 20 SP (and other products with the same active ingredient acetamiprid) at a dose of 0.25 kg/ha is registered against SJS in stone fruits. For other crops it can be used as a secondary efficacy.

The second officially registered product effective on the breeding nymphs is Movento 100 SC with the active substance spirotetramat at a dose 2.25 L/ha (0.75 L/ 1 m of tree crown height). The valid registration is for apple trees. For other crops it can be used under secondary efficacy. However, the registration for this product expired on 24.11.2024 and it can only be used until stocks are exhausted, up to 7. 5. 2026. Registered products based on spinosad, cyantraniliprole and pyriproxyfen (pear and apple trees only - secondary efficacy), according to foreign experience, are effective too. But in the Czech Republic these products have no indication against SJS.

In **Hungary**, the product Mospilan 20 SP with the active substance acetamiprid, and its various brand names (Gazelle 20 SG, Rafting, Spilan 20 SG), is authorized for use in apple and quince orchards at a dose of 0.25-0.4 kg/ha. For peach and nectarine, the dose is 0.2-0.3 kg/ha. Control against scale insects is recommended during crawler emergence and male swarming periods, with a maximum of 2 applications per year.

Movento and Movento 100 SC, containing the active substance spirotetramat, are registered for peach, apricot, plum, cherry, and sour cherry, the maximum dose is 1.5 L/ha (0.5 L / 1 m of tree crown height). The authorization for this product expired on 30.04.2024, and it can only be used until stocks are exhausted, but no later than 30.10.2025. A single treatment may be sufficient for mild infestations, while two treatments may be necessary for severe infestations or to protect against the second generation. The first should be applied 1-2 weeks after the beginning of crawler emergence.

Additionally, Harpun, a product containing the active substance pyriproxyfen, is authorized for use in apple orchards at a dose of 1 L/ha, once a year. It is recommended to apply it during crawler emergence.

Paraffin oil-based dormant sprays can be used (e.g., Catane, Ovispray, Vektafid A), as well as paraffin oil-based products combined with polysulfide sulfur (e.g., Nevikén, Nevikén Extra, Vektafid S, Agrokén), and oil-based copper-sulfur formulation (Olajos Rézkén). The concentration of the active substances and the number of treatments depend on the crop type, its phenological stage, and the level of infestation. It is important to strictly follow the specific recommendations for each product.

In **Poland** two of plant protection products against SJS in fruit plants (Agree 50 WG and FiTTER) are registered for organic farming.

Agree 50 WG with the active substance *Bacillus thuringiensis* subsp. *aizawai* strain GC-91 at a dose 2 kg/ha for a single application is registered in apple. It can be used 3 times per growing season. Interval between treatment is at least 7 days. The product should be applied from the bud bursting stage when green leaf tips covering the flowers are visible (BBCH>53).

FiTTER with the active substance fatty acids C14–C20 at a dose 10 L/ha for a single application. It can be used 9 times per growing season. Interval between treatment is at least 7 days. The interval between a block of three treatments is 28 days. The product should be applied as soon as the first symptoms of the pest appear, from the inflorescence development stage to the stage when the fruit reaches half of its typical size (BBCH 51–75).

Exirel 100 SE with the active substance cyantraniliprole at a dose 600 ml/ha for a single application is registered in apple, pear, cherry, sweet cherry and plum. It can be used twice per growing season. Interval between treatment is at least 10 days. The product should be applied from the beginning of fruit development to the stage of fruit harvest maturity (BBCH 71–87). Carry out the treatment at the time of hatching and migration of larvae. The other trade name of Exirel 100 SE is Irazu 100 SE.

Sivanto Prime with the active substance flupyradifurone at a dose 0.9 L/ha for a single application is registered in apple and pear. It can be used once per growing season (every second year in the same place). Timing of application is based on monitoring, during migration of larvae, usually after flowering from the bud growth stage to the stage when fruits reach 90 % of typical size (BBCH 71–79).

Movento 100 SC are registered for apple, pear, peach, apricot, the maximum dose is 2-2.5 L/ha (up to 2 times per season). However, the registration of the insecticide Movento 100 SC has changed and it can be sold until 30.06.2025 and used until 31.10.2025.

Country	Product Name	Active Ingredient	Recommended Dose (usage)	Protection Duration (days)	Usage Specifications
Czech Republic	Mospilan 20 SP/ Gazelle, Acetguard, Yoroï, Alphamiprid 20 SP	acetamiprid	0.25 kg/ha	AT	stone fruits - on crawling nymphs, pome fruits - only side effect
	Movento 100 SC	spirotetramat	2.25L/ha, max. 0.75 L/ 1 m of height canopy	21	apples, other fruit crops can benefit from the side effect
	Exirel	cyantraniliprole	0.6-0.75L/ha	7	side effect
	SpinTor	spinosad	0.3-0.8L/ha	3-7	side effect
	Harpun	pyriproxyfen	1L/ha	98-126	side effect, apple, pear
Poland	Agree 50 WG	<i>Bacillus thuringiensis</i> ssp. Aizawai szczep GC-91	2.0 kg/ha	AT	apple
	Exirel 100 SE / Irazu 100 SE	cyantraniliprole	0.6L/ha	7	apple, pear, cherry, sweet cherry, plum (up to 2 treatments per season)
	FITTER	Kwasy tłuszczowe C14-C20	10L/ha	1	apple (up to 9 treatments)
	Sivanto Prime	Flupyradifurone	0.9L/ha	14	apple, pear 1 treatment per season (at a dose of 0.9, treatment every other year on the same plantation)
	Movento 100 SC	spirotetramat	2-2.5L/ha	21	apple (up to 2 treatments per season) and other fruit crops
Hungary	Mospilan 20 SG, Gazelle 20SG, Rafting, Spilan 20 SG	acetamiprid	0.25-0.4 kg/ha	7	apple and quince at a dose of 0.25-0.4 kg/ha, for peach and nectarine, the dose is 0.2-0.3 kg/ha
	Movento, Movento SC 100	spirotetramat	1.5L/ha max. 0.5L/ 1m of height canopy	21	stone fruits (apricot, peach, plum, cherry, sour cherry)
	Harpun	pyriproxyfen	1L/ha	AT	apple

Country	Product Name	Active Ingredient	Recommended Dose (usage)	Protection Duration (days)	Usage Specifications
Hungary	Catane, Ovispray	Paraffin oil (Highly refined mineral oil, CAS 97862-82-3)	1–2.5% (V/V)	15	apple, pear and stone fruits (apricot, peach, plum, greengage, cherry, sour cherry)
	Vektafid A	Paraffin oil (CAS 97862-82-3)	10-27L/ha	7-10	apple, pear, peach, nectarine, apricot, cherry, plum, japanese plum
	Nevikén	Calcium polysulfide (CAS 1344-81-6) and Paraffin oil (CAS 8042-47-5, 72623-86-0)	25-50L/ha	AT	pome fruits (apple, pear, quince, medlar), stone fruits (cherry, sour cherry, apricot, peach, plum), berries (blackcurrant, redcurrant, gooseberry, raspberry, blackberry, elderberry, jostaberry)
	Nevikén Extra, Vektafid S	Calcium polysulfide (CAS 1344-81-6) and Paraffinic oil (CAS 8042-47-5, 72623-86-0)	25-50L/ha	7-10	berries in dormant state 2-3%, vegetation period 0.5-1%
	Agrokén	Calcium polysulfide (CAS 1344-81-6) Paraffin oil (CAS 72623-86-0, 97862-82-3) and Ethoxylated fatty alcohol (Non-ionic surfactant)	25-50L/ha	AT	pome fruits, stone fruits and berries
	Olajos Rézkén	Copper (in the form of copper oxychloride); Sulphur and Paraffin oil	3-4L/ha	10	dormant spray for pome fruits 3-4%, stone fruits and berries 3%

Country	Product Name	Active Ingredient	Recommended Dose (usage)	Protection Duration (days)	Usage Specifications
Serbia	Closer 120 SC	Sulfoxaflor	0.2 L/ha	10	before inflorescence emergence (BBCH 51-59), until the end of flowering - ripening (BBCH 69-85)
	Nitropol S	Paraffin oil	1.3%		apple: BBCH 10 (dormant stage); pear, cherry, sour cherry, apricot, hazelnut, blueberry, currant
	Galmin	Paraffin oil	1-5%		in apple: 3–4% at BBCH 00-09 and 5% at BBCH 10-11 early in spring; apple, grapevine, pear, peach, apricot, plum

Symptoms of damage on plants

- on the skin of fruits reddish halos around each individual insect. Blotchy skin coloration may be unsightly but fruits are safe to consume
- feeding through the bark can cause reddish-purple staining to the underlying sapwood
- light to moderate infestations: leaf wilting, branch dieback, stagnated growth, or overall stunting
- heavy infestations: branch dieback or the death of entire plants

The presence of scale insects on fruit trees manifests through a wide range of symptoms which may initially appear inconspicuous but can gradually lead to a significant decline in plant health and economic yield. San José scale is particularly damaging, with both larvae and adult females feeding on plant sap. Their saliva contains toxins that interfere with cellular function.

On fruits, especially apples, characteristic reddish-purple spots appear at the feeding site, usually as one of the earliest visible signs of infestation. These discolorations are caused by a toxic reaction in the plant tissues. Infested fruits

often become deformed, remain undersized, and show diminished flavour and storage quality. Premature fruit drop may occur in more severe cases.

On woody plant parts (such as shoots, branches, and trunk) scale insects form dense colonies that resemble a dusty grey or brown coating. Beneath this waxy covering are the adult insects and their developmental stages, which, through prolonged feeding, damage the vascular tissue and disrupt the flow of nutrients. As a result affected shoots gradually weaken, wilt, and may eventually die. In young trees a heavy infestation can lead to the plant complete collapse. Beyond direct feeding damage the plant overall vitality is reduced with increasing susceptibility to fungal diseases and frost injury.



The bark covered with a layer of SJS



SJS damage on apple trees



SJS early fruit damage



SJS new scale on fruit



SJS attacked fruits in early summer



SJS late fruit damage

Sensitivity of different varieties

Based on literature data, it can be stated that plant varieties characterized by permanent resistance to feeding by the San José Scale have not been observed so far. As studies indicate, differences in colonization between varieties do not result from innate genetic resistance, but from complex interactions between the pest, the host plant, and environmental factors (microclimate, location of cultivation, distance/proximity to colonized plants, presence of natural enemies, health condition of plants, etc.).

Resistance in plants on the SJS feeding can be explained by:

- morphological structure: a thicker skin of fruits and shoots makes it more difficult for larvae to penetrate the tissue; hairs on the surface of shoots and leaves limit larvae attachment;
- biochemical composition: some cultivars contain higher concentrations of phenols and defensive compounds (e.g., flavonoids), which limit larval development; changes in sap content can affect larval survival;

- tolerance to SJS feeding: certain plant cultivars (e.g., old apple cultivars) can withstand small populations of the San Jose scale without significant yield loss.

As shown in some studies, apple cultivars ‘Jonathan’ and ‘Golden Delicious’ are more susceptible than cultivars such as ‘Freedom’ or ‘Enterprise’ (cultivars with partial resistance).

In contrast, some wild plum and pear species exhibit resistance due to their thicker skin and the presence of natural inhibitors of larval growth. Peach cultivars with hairy skins may be less colonized by the scale. Resistance to the SJS is not constant, but it limits population density and reduces the rate of colonization. In integrated pest management, planting less susceptible cultivars is recommended as a means to limit scale populations. However, regardless of the cultivar’s susceptibility/resistance level, orchard monitoring is necessary, as high pest pressure can cause damage even in tolerant cultivars.



SJS overwintering stages



SJS moveable stage – first instar nymphs (crawlers) on twigs



The visibility of symptoms may vary depending on the apple’s skin colour, with yellow apples potentially showing symptoms more clearly

Resistance of cultivars to the SJS feeding according to literature data

Species	Cultivar	Resistance	Comments
Apple (<i>Malus domestica</i>)	Jonathan	high susceptibility	frequent heavy infestations
	Golden Delicious	high susceptibility	regular control usually required
	Red Delicious	moderate susceptibility	requires monitoring
	Freedom	partial resistance (tolerance)	lower population density
	Enterprise	partial resistance (tolerance)	better results in integrated protection
	Idared	moderate susceptibility	requires monitoring
	Spartan	moderate susceptibility	possible limited colonization
	Cox's Orange Pippin	high susceptibility	regular control usually required
Pear (<i>Pyrus communis</i>)	Konference	moderate susceptibility	dependent on local conditions
	Williams	high susceptibility	severe infestations without control
	Wild pear (<i>P. communis</i> subsp. <i>pyraster</i>)	low susceptibility (resistance)	thicker skin limits colonization
Plum (<i>Prunus domestica</i>)	Stanley	moderate susceptibility	population monitoring needed
	Wild plum (<i>P. cerasifera</i>)	low susceptibility (resistance)	rarely colonized
Peach (<i>Prunus persica</i>)	Redhaven	moderate susceptibility	fruit hairiness limits larvae
	Elberta	high susceptibility	requires frequent monitoring
	local cultivars with hairy skin	low susceptibility (resistance)	hairiness physically limits colonization

Natural enemies of SJS

Parasitoids

Parasitoids play an important role in regulations of pests' population. Invasive species, that have escaped from their complex of natural enemies in new locations, can spread uncontrollably and increase their populations. One of the control methods is to introduce natural enemies from the place of origin. There were released several parasitoid species in Europe in the last century, but for Central Europe are important mainly two of them (*Encarsia perniciosi* and *Aphytis proclia*, family Aphelinidae). SJS parasitoid complex included about 20 species in Central Europe. Some of them are hyperparasitoids, which kill SJS parasitoids and decrease parasitism rate. All Hymenoptera parasitoids or hyperparasitoids belong to the superfamily Chalcidoidea. Most important are species from the family Aphelinidae, while Encyrtidae and Azotidae are usually rare. Hyperparasitoids belong to the family Signiphoridae. Diagnostic of Chalcidoidea is difficult, but for the purpose of crop protection is sufficient to distinguish only two genera, which adults are captured in pheromone traps for SJS, and larvae/pupae are frequently found under SJS scales on the branches.

Encarsia spp.

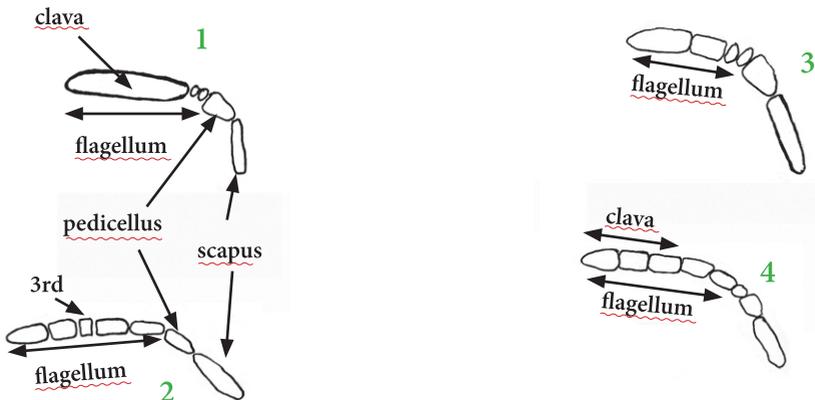
The body is usually less than 1 mm. Flagellum of antennae with at least 5 segments, including 2–3 segmented clava. The most important parasitoid of SJS in central Europe is *Encarsia perniciosi* (Tower, 1913) (= *Prospaltella perniciosi*) with a body 0.4–0.7 mm long. Adults are dark. Females lay eggs inside the body of SJS. Larvae develop inside as endoparasitoid and pupate in the same place protected by the skin of SJS. Adults escape through exit holes chewed by mandibles. The rest of the SJS skin remains under the scale.

Aphytis spp.

Most important is *Aphytis proclia* (Walker, 1839), but other species could be locally abundant. Adults are pale yellowish; their body is about 1 mm long. Flagellum of antennae with at most 3 fenicular segments and one segmented clava. Larva is ectoparasitoid (develops outside SJS body) and it is possible to see small larva on the body of SJS. At the end of development, it consumes the rest of SJS body (no remnants are presented) and pupate under SJS scale. The color of pupa is yellow, and dark excrements are visible around the end of the body.

Other parasitoids or hyperparasitoids of SJS

Hyperparasitoids develop in the larvae of primary parasitoids, reduce parasitism rate in the next generation and have negative impact on biological control. Most common hyperparasitoid of SJS in Central Europe is *Thysanus ater* from family Signiphoridae. This family is distinguished by antennae. The last segment (*clava*) is very long, longer than other segments in *flagellum* (2–4 short anelli). Other two genera from this family were reared from SJS as hyperparasitoids. Probably hyperparasitoids (but direct evidence is lacking) are also species from genus *Ablerus* (family Azotidae). Adults have red eyes and usually white color on antennae and dark pattern on the wings. Antennae have 5 segments in *flagellum*, 3rd segment is shorter than 2nd and 4th. Encyrtidae are primary parasitoids of SJS, but not as important as Aphelinidae. From other (hyper)parasitoids of SJS are distinguished by different shape of antennae, body and different color. *Arrhenophagus chionaspidis* have similar antennae as Signiphoridae but the last segment is stouter and tarsi are 4-segmented.



Antennae: 1) Signiphoridae, 2) Azotidae, 3) *Aphytis*, 4) *Encarsia*

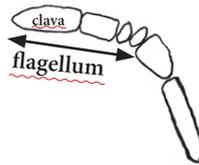
Monitoring of parasitoids by pheromone trap

Females of parasitoids are attracted by pheromone of SJS, and are captured together with males of SJS in pheromone traps. You can compare the ratio between SJS and parasitoids. Sometimes there could be only parasitoids in the pheromone trap, and it is possible to use peak of parasitoids for timing of pesticide application against SJS larvae.

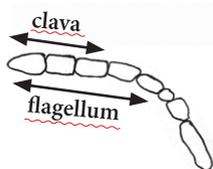
A diagnostic key to adults of *Aphytis* and *Encarsia* in pheromone traps

In pheromone traps are usually only these two genera of Chalcidoidea. From non-target Hymenoptera are distinguished by combinations of characters: body size (<1.3 mm), body color, shape and number of flagelomers in antenna, tarsi 5-segmented, wing venation reduced.

Color of body yellow, shape of antenna – *flagellum* with at most 3 fenicular segments and one segmented *clava*..... *Aphytis* sp.



Color of body dark, antenna – *flagellum* with at least 5 segments, including 2–3 segmented *clava*..... *Encarsia* sp.



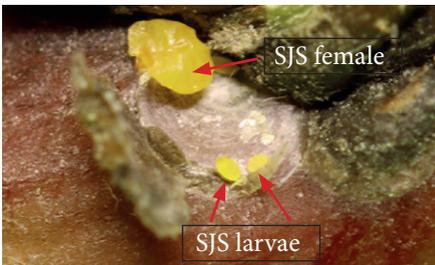
Monitoring of parasitism rate

Parasitoids attack females of SJS. Larvae are developed inside or outside of the female body and adult parasitoid chews through the scale of SJS (but not always – the holes in the scale are only an indicative indicator of parasitism rate). Parasitism rate is evaluated at least one month after adult parasitoid catches in the pheromone traps or during winter time. All female scales are checked for the presence of escape holes or remnants of parasitoids.



Exit hole in the scale of SJS from adult parasitoid it is not always present – some parasitoids escape between the scale and the bark (it is not visible).

1. Unparasitized SJS females – there is no external larva on the body or inside the female body; is not seen any shape of parasitoid pupa with two dark eyes. The body of dead female is flat, with no exit hole in the skin.

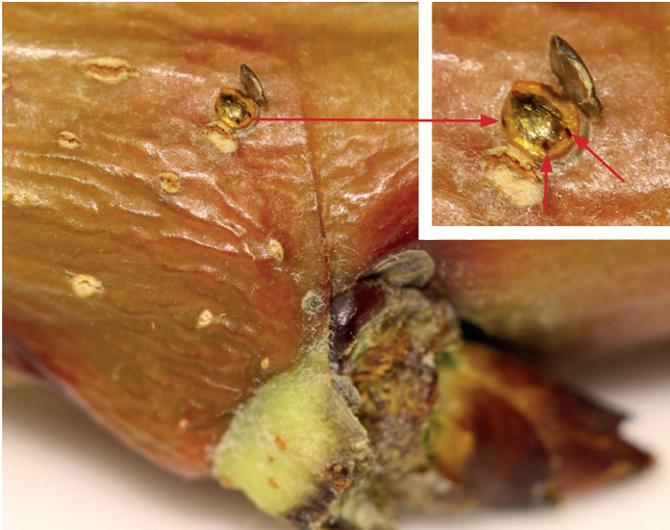


SJS female with 2 SJS larvae



Two unparasitized females of SJS

2. *Encarsia sp.* – larva develops inside the SJS body, no excrements are present under scale. Pupa is also inside of SJS body – it is possible to see its shape and 2 dark eyes. Hatchet adult – body of SJS female is not flat, it has concave shape, inside are remnants of *Encarsia* pupa and there is an exit hole from the adult in the skin.



3. *Aphytis sp.* – larva develops outside SJS body (ectoparasitoid). Pupa is outside SJS body, color is yellow, dark excrements are present. Hatchet adult – exuvia and excrements are present, but no body of SJS female is under scale.



Yellow pupa



Exuvia and dark excrements around, no SJS female body visible



How to support SJS parasitoid

Introduction to the orchard

- parasitoids are usually present in the orchard – they are imported together with SJS
- if not, you can place branches from different orchard with parasitized SJS in interrow – females of SJS die (they can not survive on dry branches), but parasitoids complete their development and colonize orchard

Support parasitoid population – side effect of insecticides

- most sensitive stage to insecticide is adults, larvae and pupae are protected by SJS scale
- if possible, don't spray any poison insecticide (e.g. pyrethroids, spinosad) during adults occurrence in the orchard (monitoring with pheromone traps)
- parasitoids survived winter under SJS scale on the branches – winter pruning and branch mulching destroyed part of parasitoid population – if possible, leave branches with parasitoid in the orchard till adults emerges (it is usually not possible in large, intensive orchards)

Predators

Very little is known about the predators of the SJS, as this type of predation is very difficult to determine. However, there are generalists predator species, and it is therefore highly likely that the SJS is also part of their diet. These primarily include lady beetles (e.g. *Harmonia axyridis*, *Coccinella septempunctata*), earwigs (e.g. *Forficula auricularia*), lacewings (e.g. *Chrysoperla carnea*), spiders, omnivorous bugs (e.g. *Orius laevigatus*) etc.

However, it is important to note that the effectiveness of predators in the biological control of the SJS can be influenced by the availability of alternative food sources and the population density of the pest itself. In some cases, their predation on scale insects may be limited if other, more preferred food sources are present.

Ladybirds

The most commonly occurring species of ladybird in orchards is the harlequin ladybird (*Harmonia axyridis*), followed by the seven-spot ladybird (*Coccinella septempunctata*). In contrast to the common ladybird, which is native to Europe, the harlequin ladybird is an invasive species native to East Asia. Historically, this particular species of ladybird has been intentionally introduced to other continents, including Europe. However, in the context of biological pest control, the harlequin ladybird is an effective predator. In general, we can say that ladybird species from genera *Coccinella*, *Lindorus*, *Oenopia*, *Pharoscyminus* and *Platynaspis* could play important roles in biological control of the SJS.



Seven-spot ladybird - adult



Ladybirds eggs



Seven-spot ladybird - larva



Young larvae eating aphids



Harlequin ladybird - larva and adults



Harlequin ladybird - pupae

The common green lacewing (*Chrysoperla carnea*)

Although lacewings are best known as predators of aphids, their larvae feed on a wide range of soft-bodied insect pests, including scale insects and armored scales. Members of the Chrysopidae family play an important role in the natural pest control of fruit crops, acting as predators of a variety of pests. The common green lacewing is most often found in fruit orchards, which represents only one species within a diverse and complex group of organisms that can be challenging to identify. This species is widely distributed across the world, occurring in numerous regions including Asia, Europe, New Zealand, Africa, and North and South America.



The common green lacewing - egg



The common green lacewing - larva



The common green lacewing – adults



Earwigs

Approximately 1.800 species of earwigs are known to exist globally. However, within orchards in the Czech Republic, Poland, Hungary, and Serbia, the European earwig (*Forficula auricularia*) is the most prevalent. The European earwig is the largest and most common member of this genus. It is an omnivorous species, with a diet consisting primarily of small insects, and it also feeds on the eggs of other insects. The European earwig is known as a generalist predator. Adults and nymphs are important predators of many pests of fruit crops, including the SJS.



The European earwig - adult



The European earwig eating aphids

In certain instances, the European earwig may be considered as a pest affecting stone and soft fruits. In such cases, overpopulation can result in considerable economic damage and yield losses. In apple orchards, the negative effects of the European earwig, such as fruit damage, appear to be insignificant in comparison to the benefits of biological control.

Minute pirate bugs (*Orius spp.*)

Orius spp., commonly known as minute pirate bugs, are recognized as generalist predators that feed on a variety of soft-bodied arthropods, including aphids, thrips, mites, and the eggs and larvae of various insect pests. While specific documentation of *Orius spp.* preying on the SJS is limited, their predatory behavior suggests potential in managing populations of this pest. The most well-known species of predatory bug is *Orius laevigatus*.

A key to the identification of San José scale and other armored scale insect pests noted on apple orchards in V4 region (based on macroscopic features of females)

It is **IMPORTANT** to note that without microscopic diagnostic features, scale insect species **CANNOT** be identified with complete certainty!

1. - Cover of female elongate, oyster or pear shape, brown or white2



<https://www.inaturalist.org/photos/464113908>



<https://www.inaturalist.org/photos/505864604>

- Cover of female oval or round, white or gray3



<https://www.inaturalist.org/photos/477312790>

2. - Covering scale elongate, brownish or gray, oyster shell-shaped, ca. 1.8-3.3 mm long; ventral test white. The body of female white to reddish-yellow, elongate spindle-shaped, distinctly lobed laterally.....

***Lepidosaphes ulmi* (Linnaeus)**; common name: apple oystershell scale



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<https://www.inaturalist.org/photos/464908529>

- Female scale is oystershell-shaped, broad, convex, expanding posteriorly, usually more or less curved, white, 2.5-3.5 mm long, exuviae yellowish. Adult female spindle-shaped, 1.3-1.7 mm long. Adult female dark purple, with eggs or young also dark purple.....

.....***Chionaspis salicis* (Linnaeus)**; common name: willow scale



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<https://www.inaturalist.org/observations/96085223>

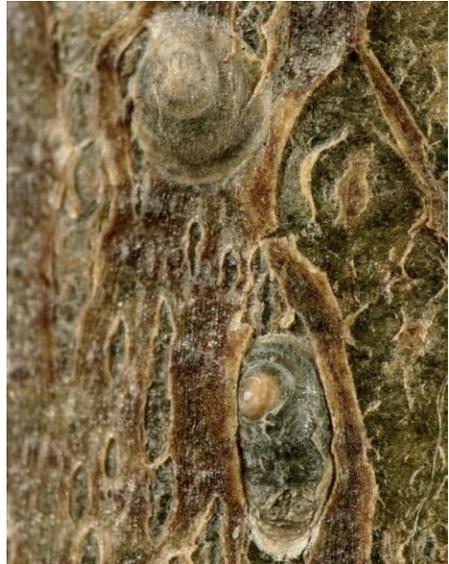
3. - Cover of female circular to wide oval, usually gray; exuviae central or sub-central, on the trunk and twigs, sometimes on leaves and fruits

.....genus: ***Diaspidiotus*, *Comstockaspis***

- ***Diaspidiotus marani* Zahradnik:** (Marani's scale) Cover of female circular, moderately convex, dark gray, diameter 1.8-2.1 mm, exuviae central or subcentral. Adult female pear-shaped, dark yellow, ca. 1.5 mm long
- ***Diaspidiotus pyri* (Licht.):** (pear scale) Cover of female circular, moderately convex, dark brown, diameter 1.8-2.1 mm, exuviae central or subcentral. Adult female pear-shaped, live yellow
- ***Diaspidiotus ostreaeformis* (Curtis):** (ostreiform scale) Cover of female circular, convex, dark gray, diameter 1.4-1.9 mm, exuviae subcentral rarely central. Adult female pear-shaped, live lemon yellow, ca. 1.2-1.5 mm long

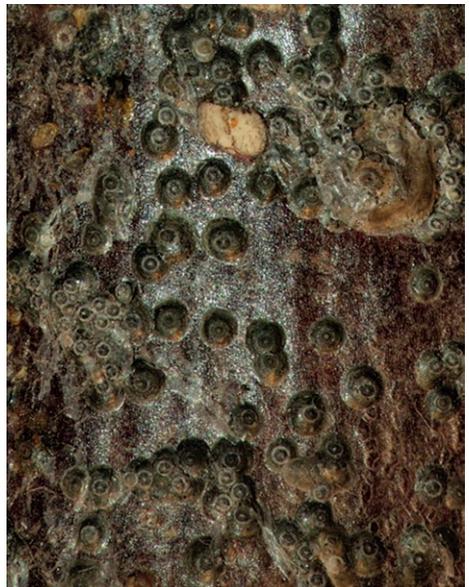
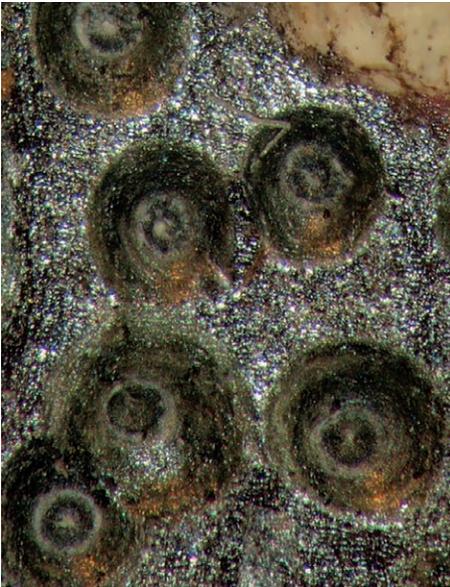


<https://www.inaturalist.org/photos/232465776>



<https://www.inaturalist.org/photos/232465790>

- ***Comstockaspis perniciosa* (Comstock)** (San José scale) Cover of female almost circular, slightly convex, light to dark gray, diameter 1.5-2.2 mm, exuviae central or subcentral. The first instar exuviae gives a craterlike appearance to cover. Young adult female pear-shaped, yellow, eggs laying females almost circular, reddish-yellow 0.8-1.2 mm long



- Cover of female circular or subcircular, white to yellowish white, usually gray; exuviae central or subcentral, diameter 1.5-2.8 mm. Adult female broadly oval or piriform, with strongly lobed margin, orange yellow, ca. 0.9-1.1 mm long

.....*Pseudaulacaspis pentagona* Targ.-Tozz common name: mulberry scale



<https://www.inaturalist.org/photos/443012467> <https://www.inaturalist.org/photos/477312790>



<https://www.inaturalist.org/observations/265957227>

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Wearing C.H., de Boer J.A., 2014. Temporal distribution of San José scale *Diaspidiotus perniciosus* (Hemiptera:Diaspididae) on an apple tree. N. Z. Entomol., 37, 61–74.

INTERESTING LINKS

Comstockaspis perniciososa (QUADPE)[Overview] | EPPO Global Database

<https://extension.umd.edu/resource/san-jose-scale/>

<https://idtools.org/tools/1044/index.cfm>

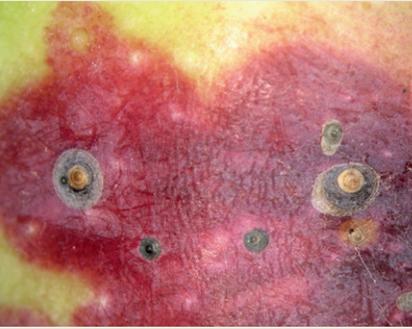
<https://scalenet.info/>

<https://scalenet.info/fams/Diaspididae>

<https://www.gbif.org/>

Vyhledávání v registru přípravků

<https://novenyvedoszer.nebih.gov.hu/Engedelykereso/kereso>



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