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Original Research

Biology and bioecology of *Nidularia balachowskii* Bodenheimer (Hem: Coccoidea: Kermesidae) scale insect in *Quercus* sp oak trees: Chalabeh region, Kermanshah

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ABSTRACT:

The *Nidularia balachowskii* (scale insect) is a member of the Kermasidae family which exclusively feeds on oak trees. This study was conducted on *Quercus branti* in Zagros forests during 2015 and 2016. The biological phases of the pest on twigs were individually collected, counted and recorded in the laboratory via stereo microscope. Given the average temperature and relative humidity of the region, this insect has first and second instar nymphs. It overwinters as young female, and fertile females appear on the first half of April. The dorsal side of second instar nymphs is adults is fully embroidered with an orderly mosaic design, created by the longitudinal and transverse grooves behind the body. Spawning takes place on the second half of April. The eggs are hatched during 10^{th} to 20^{th} of April and thus first instar nymphs appear. First instar nymphs move on the host in the hot weather of noon to search for a decent place. Often they choose the shaded area of twigs and trunks to locate, so as to protect themselves from the direct radiation of the sun. Second instar nymphs lived from May 5 to June 20, 2015. When the second instar nymphs turn into adults, their white waxy coating gradually molts. Young adult insects are convex, brown and embroidered in mosaic designs (resulting from longitudinal and transverse grooves in the lateral region of the back). They have a long lifespan and spend summer, fall and winter in a diapause state. In April of the following year, their bodies become bulky and gall-like and later begin to spawn. Population dynamic and spatial distribution of this insect are described using Taylor Power Law models and the Iwoa's Index.

Keywords:

Acorn, Biology, Population, *Nidularia*, Scale insects.

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INTRODUCTION

Oak trees belong to the family Fagaceae and constitute the major vegetation of Zagros forests. *Quercus persica*, *Q. infectoria* and *Q. brantii* species are relatively more frequent than other species. Having expanded in 11 provinces in the country with a total area of 6 million hectares, these forests comprise 12 percent of Iran's forests and serve multiple ecological roles such as biodiversity, soil conservation and water quality and quantity improvement (Sabeti, 2008). Several insects and diseases in oak forests cause damage (Swiecki and Bernhardt, 2006). Among insects, 632 species of *Coccoidea* belonging to 15 families in the world have been reported to live on oak species of *Quercus* sp (Ben-Dov *et al*., 2013). In the Mediterranean region, 27 species of *Coccoidea* feed on oak trees. (Spodek *et al*., 2013). So far in Iran, 20 species of scale insects belonging to four families (*Diaspididae* (15 species), Kermesidae (2 species), *Asterolecaniidae* (2 species) and *Coccidae* (1 species) have been reported to live on oak trees (Moghaddam, 2004).

To date, 89 species of scale insects from the Kermesidae family have been reported as exclusively living on oak as host, out of which 39 species belong to the region of Palearetic and two species to Iran. Kermesidae scale insects are mainly located on the main oak trunks and twigs and feed on the nutriment juice, causing branch dieback, growth loss and sometimes the drying out of the trees. A small number of these insects feed on the juice of leaves (Ben-Dov *et al*., 2013; Bullington and Kosztarab, 1985; Hamon, 1977; Pellizzari *et al*., 2012; Podsiadlo, 2012; Solomon *et al*., 1980). The *Nidularia* is a member of Kermesidae family with 3 species (Ben-Dov *et al*., 2013). *N. pulvinata* (Planchon) is studied in Italy (Viggiani, 1991), *N. Japonica* Kuwana is reported in China (Liu *et al*., 1997) and *N. balachowskii* Bodenheimer and its biology is studied in Israel (Spodek *et al*., 2016). The last species has also been reported in Iran and Turkey (Ben-Dov *et al*., 2013; Bodenheimer, 1941; Moghaddam, 2004).

Studying and comparing *N. balachowskii* biology with five other species of Kermes revealed that all six species are single-generation, spawning, reproducible through parthenogenesis and feed from oaks. *Kermes* sp. overwinters as first instar nymph, while *N. balachowskii* overwinter as mature insects (Spodek *et al*., 2016 and Spodek *et al*., 2016). Study of the species belonging to Kermesidae family showed that all of them are single generation (Bullington and Kosztarab, 1985). However, the study of *K. quercus* (Linnaeus) in Poland depicted that this scale insect has a generation every two years (Podsiadlo, 2012). The life span of overwintering first instar nymphs is 14 months (and the remainder of their life is completed during the spring of the second year). Female scale insects belonging to Kermesidae family have three nymphal stages (Bullington and Kosztarab, 1985). There are no males involved in most scale insects reproduction in this family and they reproduce through parthenogenesis (Hamon, 1977). *N. balachowskii* Bodenheimer and *K. quercus* (Linnaeus) from Iran have both been reported to live on oak trees in western regions (Moghaddam, 2004). Nevertheless, no studies have been conducted so far to delve into the details of their biological or morphological features. Hence, the aim of this study is to investigate the biological features and spatial distribution and changes of *N. balachowskii* (Kermesidae) scale insect population in natural conditions.

MATERIALS AND METHODS

This study was conducted on *Quercus branti* in Zagros forests during 2015 and 2016. Five infested trees were randomly selected at the intervals of 100 to 150 meters and were marked by colored strips for the purpose of investigation. The biology of the pest was examined in natural conditions through sampling the infected oak twigs. Sampling intervals were decided according to the prior information, observations and experience; *i.e*.

every ten days throughout the year. Having settled on the twigs of the host, first instar nymphs of the scale insect of this family begin to nurture at one fixed point and never move. Thus the sampling unit was decided at every 20 cm in the middle of the cut-off twigs. To determine the number of required samples, a preliminary sampling was conducted on March 30, 2015 as follows: 10 infested trees were randomly selected at the area of the study and four twigs at the diameter of hand fingers were selected in four main geographical directions and were cut off by garden scissors. The cut-off twigs were next placed in the suitable nylon bags and transferred to the laboratory for observation by stereomicroscope and detailed examination (Podsiadlo, 2012). Finally based on the collected data, the relative preliminary sampling error (RV) was calculated according to equation (1).

SE: Preliminary Sampling Standard Error

$\bar{x}$:Data mean obtained from preliminary sampling (1)

$$RV = \frac{SE}{\bar{x}} \qquad (1)$$

Where, the RV value is less than 0.25, the number of required samples for sampling is decided according to equation (2):

$$N = \left(\frac{t.SD}{D.\bar{x}}\right)^2 \qquad (2)$$

t : t value in table t-student

SD : Standard deviation of preliminary sampling

D : Maximum error accepted which is 0.2-0.25.

$\bar{x}$: Data mean obtained from the preliminary sampling (1).

In cases of emergency, samples were stored in the refrigerator and every single twig was examined at appropriate intervals. The number of eggs, first instar nymphs, second instar nymphs and mature females before and after spawning were directly counted and recorded. To determine the average number of *N. balachowskii* scale insect eggs, a number of twigs infested by the spawning of scale insect were selected. Next the body of 20 scale insects were chopped off from the host (such that the mouthparts are not separated from the host). Eggs in the brood chamber (Figure 2) were spread on a paper for the purpose of counting and bodies were preserved as the first state so that the remaining eggs in the body are hatched later and added to the existing number (to achieve this, the twigs were placed in containers with very little water so as to avoid the drying out of twigs and early death of the treated scale insects) (Ben-Dov *et al*., 2013). This way the number of each scale insect eggs was counted in 2 to 3 stages.

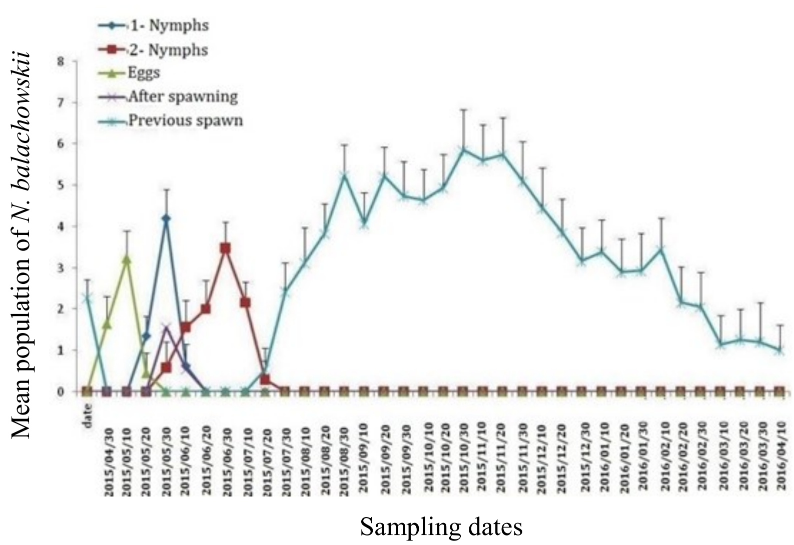


Figure 1. Population fluctuations curve of the different biological stages of *N. balachoweskii*, at Kermanshah

The spatial distribution pattern of the pest was determined using Law of Taylor's power

To determine the spatial distribution pattern of adult insects and young females (applicable to other stages) of this pest, Taylor regression method was applied (Nestel *et al*., 1995) through which data for each sampling was identified separately and the respective mean and variance were calculated (Nestel *et al*., 1995). Based on the law, relationship (3) applies between S2 (population variance) and $\bar{x}$ (population density mean).

$$S2 = a\bar{x}\ b \qquad (3)$$

In order to measure a and b (Taylor coefficients), regression relation (4) applies between logS2 and log $\bar{x}$ values (4).

$$Log(s2) = log(a) + b\ log(\bar{x}) \qquad (4)$$

a: is the intercept which depends on the sample size.

b: is the grade-line and an index to show the population distribution type.

Smaller, equal and larger values of one for grade-line represent uniform, random, and cumulative distributions respectively (4).

The Iowa index

This index is in fact the regression gradient between m * (the Lloyd congestion average index) and $\bar{x}$ (population mean) calculated through the following formula.

$$\bar{x}\ \beta + m^* = \alpha \qquad (5)$$

$$m^* = \bar{x} + \frac{(s^2)}{\bar{x}} - 1 \qquad (6)$$

Here α is population tendency to accumulate (if positive) or disinclination (if negative) and β represents the population distribution type (Nestel *et al*., 1995). Significance test of the difference between the calculated regression grade-line (b Taylor and β Iawa index) and one

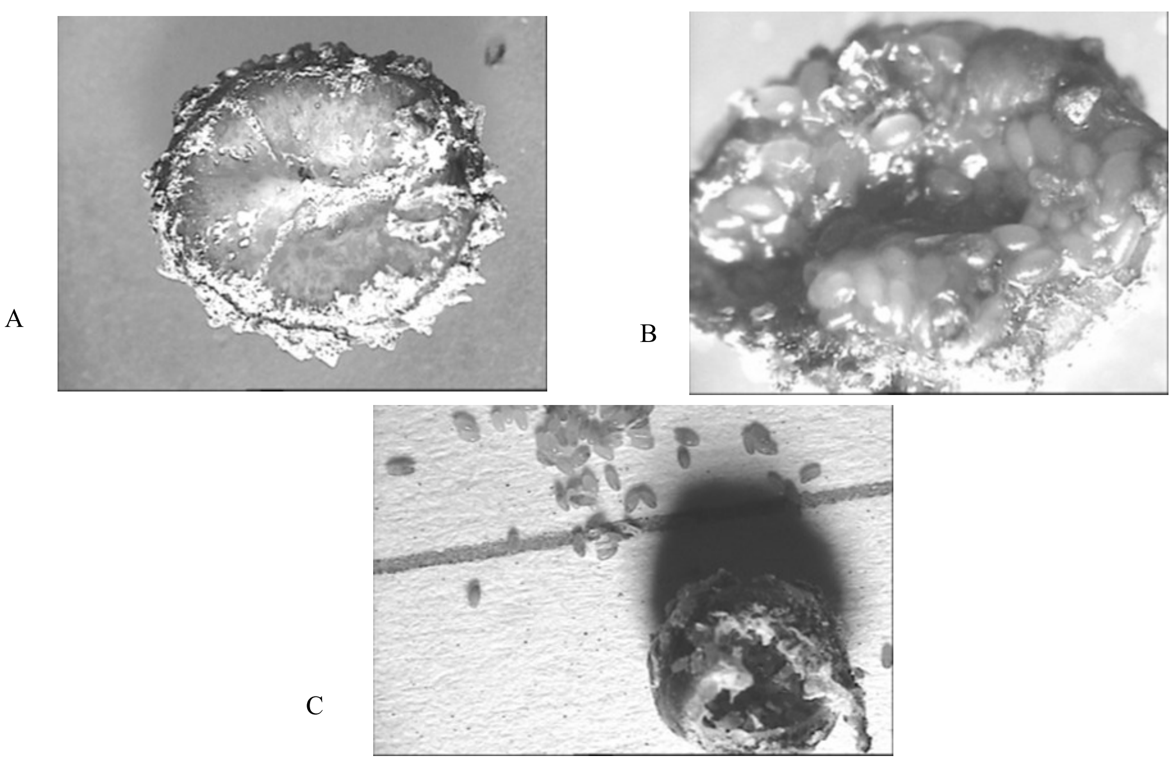


Figure 2. Ventral view of reprodactive female, *N. balachoweskii*, A. Before dissection; B. After dissection and C. Venteral view of reproductive female's brood chamber; The eggs within brood chamber have been exit for the count

Table. 1. The relationship between average density biological processes of *N. balachowskii* and the average temperature in 2015

Life stages	*B*	R^2	*F*	P_{value}
Egg	0.005±0.009	0.011	0.413	0.525 ns
1st instar	-0.001±0.001	0	0.009	0.924 ns
2nd instar	0.010±0.011	0.023	0.821	0.371 ns
Mature before spawning	0.022±0.029	0.016	0.552	0.463 ns
Mature before spawning	0.001±0.004	2E-05	0.092	0.764 ns

s ns:No significant difference *: significant difference at the level of 0.05 **: significant difference at the level of 0.01

is measured by t statistics in formula (7).

$$t = \frac{|\text{slope} - 1|}{SE_{slope}} \qquad (7)$$

The 't' value calculated by 't' in the table is next compared to n-2 degree of freedom. If the absolute value of the calculated 't' is greater than the 't' value in table, there is a significant difference between b-Taylor and β-Iawa indices and one. Hence the spatial distribution of the pest is cumulative. Nevertheless if the difference with number 1 is not significant, the distribution is random (Liu *et al*., 1997).

Culturing and collecting parasitoids

a. Infested twigs in nature were enclosed in a transparent plastic cage (made from mineral water containers) so as to collect parasitoids (if any) once released.

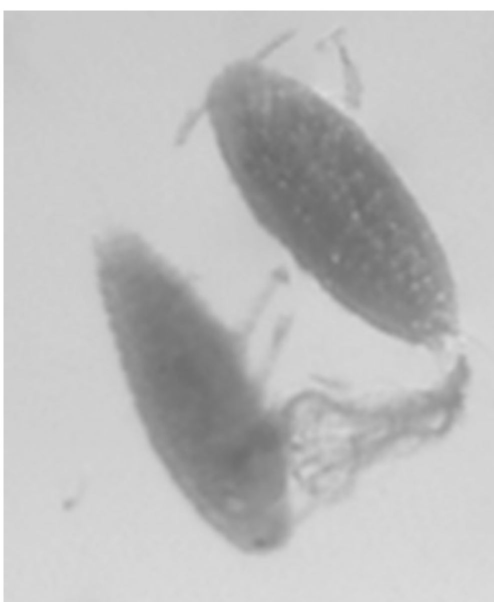
b. Infested twigs were enclosed in transparent plastic containers in the laboratory.

The twigs were finally perpendicularly placed in the culturing container with a small amount of water to prevent their drying and early death of parasitic scale insects. Culturing containers were kept under normal laboratory conditions until the release and collection of parasitoids. Other natural enemies were collected directly and stored at 75% alcohol to be identified later.

RESULTS

N. *balachowskii* population variation under Kermanshah weather condition with regular sampling during 2015-2016 revealed that it is a single-generation insect and spent winter as full young female insect. This scale insect survived June, summer, autumn and winter (10 to 11 months) on biennial or perennial twigs as a young female. Body of the young, overwintering females were relatively convex and brown. They fell out

A



B

Figure 3. First nymphal instar of *N. balachoweskii,* just after hatching
A. Ventral view of slide-mounted specimen. B. dorsal view of macroscopic specimen

of hibernation in the first half of April, and their fairly convex body grew and became bulky and gall-like due to nurturing. Growth and development of the ovaries are one of the major reasons for the bulking of body. Fertile light brown females were spherical in shape. Each mature female insect laid (150-100) 350 eggs on average. Fertile mature scale insects emerged in early April and were most frequent in the mid-April. Given the climatic conditions of the area, spawning started from mid-April and lasts for about 15 days (Figure 1).

The female insect kept the eggs in the brood chamber (Figure 2). First instar nymphs appear late in April and mainly spread on the host plant. Once they swallow stylet in the host body tissue, they remained there for the rest of their lives and continue nurturing. The population of first instar nymphs was maximized during the first 10 days of May. First instar nymphs often move on the host during the hot hours of noon and mostly settled in the shaded areas of twigs (away from noon sun rays). Some also resided in the wounds and crevices of trunks and twigs of host.

Prior to residing on host, first instar nymphs were cream-gray in color, had legs, distinctive eyes, a short three-segmented siphon, six-segmented antenna (Figure 1), two rows of marginal setae (telescopic short and thick) and two long thin hair at the end of their body.

White waxes were dispersed in the form of fine particles, rings, semicircles and arches at the back, probably resulting from wax-secreting glands. When the first instar nymphs were placed on the host and converted to

Table 2. The relationship between average density biological processes of *N. balachowskii* and average humidity in 2015

Life stages	*B*	R^2	*F*	P_{value}
Egg	-0.005±0.004	0.047	1.724	0.198 ^{ns}
1st instar	-0.002±0.005	0.005	0.219	0.643 ^{ns}
2nd instar	-0.011±0.005	0. 124	2.55	0.120 ^{ns}
Mature before spawning	0.016±0.014	0.037	1.009	0.322 ^{ns}
Mature before spawning	-0.001±0.002	0.010	0.384	0.540 ^{ns}

^{ns}:No significant difference

second instar nymph, most of their body attachments disappear or undergo gradual changes. At first the cuticle of the marginal setae separated and the throaty hair was replaced by a telescopic hair. Long antenna which were at first perpendicular to the body became abdominal and parallel to the body and gradually disappeared along with the legs. Sprained glands are more active in the lateral dorsal side. They produce felt-like string dense wax coatings. This even coating was split into longitudinal and transverse grooves on the back and sides in the form of square blocks. As a result, second instar nymphs were identified on the host through their white felt-like yet relatively thick coat with a mosaic design.

On the other hand, their microscopic features included attenuated antenna and legs and a dense band of submarginal tubular ducts (matchstick). The role of these ducts was to secrete the glue-stick wax that causes the body to stick to the host. The lifespan of second instar nymphs are about two months. The population was at peak in the mid-May, when they appeared as

Table 3. Taylor's power law regression parameters for mean of the nymphal stages of *Nidularia balachowskii*

Intercept ± SE	b ± SE	t_b (d_f)	t_{table} α=0.05	R^2	P_{value}	Spatial distribution
0.010±0.015	-0.270±0.087	14.59	2.042	0.073	0.01	Binomial

Table 4. Iwao's regression parameters for mean of the nymphal stages of *Nidularia balachowskii*

	α ± SE	β ± SE	t_b (d_f)	t_{table} α=0.05	R^2	P_{value}	Spatial distribution
1394	0.034±0.017	1.37±0.30	1.236 (34)	2.042	0.967	0.01	Cumulative

Table 5. Taylor's power law regression parameters for mean of the different nymphal stages of *Nidularia balachowskii* in

Life stages	Intercept ± SE	*b±SE*	t_b (d_f=34)	t_{table} α=0.05	R^2	P_{value}	Spatial distribution
Egg	0.009±0.019	-0.046±0.152	6.881	2.042	0.002	0.762 ns	Binomial
1st instar	0.008±0.019	-0.183±0.129	9.170	2.042	0.055	0.165ns	Binomial
2nd instar	0.015±0.024	-0.320±0.122	10.819	2.042	0.010	0.013 ns	Binomial
Mature before spawning	0.357±0.074	-0.062±0.331	3.208	2.042	0	0.853 ns	Binomial
Mature before spawning	0±0.009	0.063±0.068	13.779	2.042	0.024	0.360 ns	Binomial

ns: No significant difference

white points in the wounds and crevices of the branch and trunk of oak trees.

The white coating of second instar nymphs appreaded at the end of this stage gradually molts and the fairly convex brown body of the young females emerged with a mosaic pattern and remained on the host until the spring of the following year in the diapause state. In the spring of the following year, fertile females appeared. They were similar to young overwintering females, except being relatively more convex (gall-like) and they died shortly after spawning (Figure 1).

According to Table 1 and Figures 3, 4 and 5, there is a positive correlation between temperature variations and population dynamics of the nymphal stages, as well as the total mature and immature stages, whereas there is no significant relationship between the population dynamics in all *N. balachowskii* life stages and the temperature variations. Moreover according to Table 2 and Figures 6 and 7, there is a negative correlation between moisture variations and population dynamics of spawning and post- spawning first and second instar nymphs. Nevertheless, the correlation is significant in the adult stage before spawning and there is no significant relationship between population dynamics in all *N. balachowskii* life stages and moisture variations

Determining spatial distribution pattern

The study of Taylor and Iowa indices for the whole life cycle of *N. balachowskii* scale insect showed that the regression grade-line in Iowa' model in 2015 is significantly larger than one. In other words, the spatial distribution in 2015 is cumulative which is probably caused by the following factors: the heterogeneity of habitat and environment, as well as behavior and factors that are not related to environmental conditions. In the Taylor power law model, the regression grade-line has a significant difference with one, hence the distribution is uniform. In the Iowa model, the regression grade-line in 2015 has a significant difference with one and the distribution is cumulative.

Based on the determination of coefficients values, the Iowa model (R^2 = 0.967) is more correlated with the data compared to Taylor model (R^2 = 0.073) and better fits the data of the pest compared to Taylor insect. Hence it seems more appropriate for the estimation of population distribution type (Table 3, 4, 5 and 6).

DISCUSSION

To date, 89 species of scale insect from the Kermesidae family have been reported, most of which are monophagous and feed on *Quercus* sp oak. Two species, *i.e*., *Kermes quercus* (Linnaeus) and *Nidularia balachowskii* Bodenheimer have been registered in the list of scale insects of Iran almost 73 years ago, while so far no studies have been conducted on them. There are a number of uncertainties about the Kermesidae scale insect. For example according to some sources, the female in the family has three nymphal stages (Bullington and Kosztarab, 1985), whereas several oth-

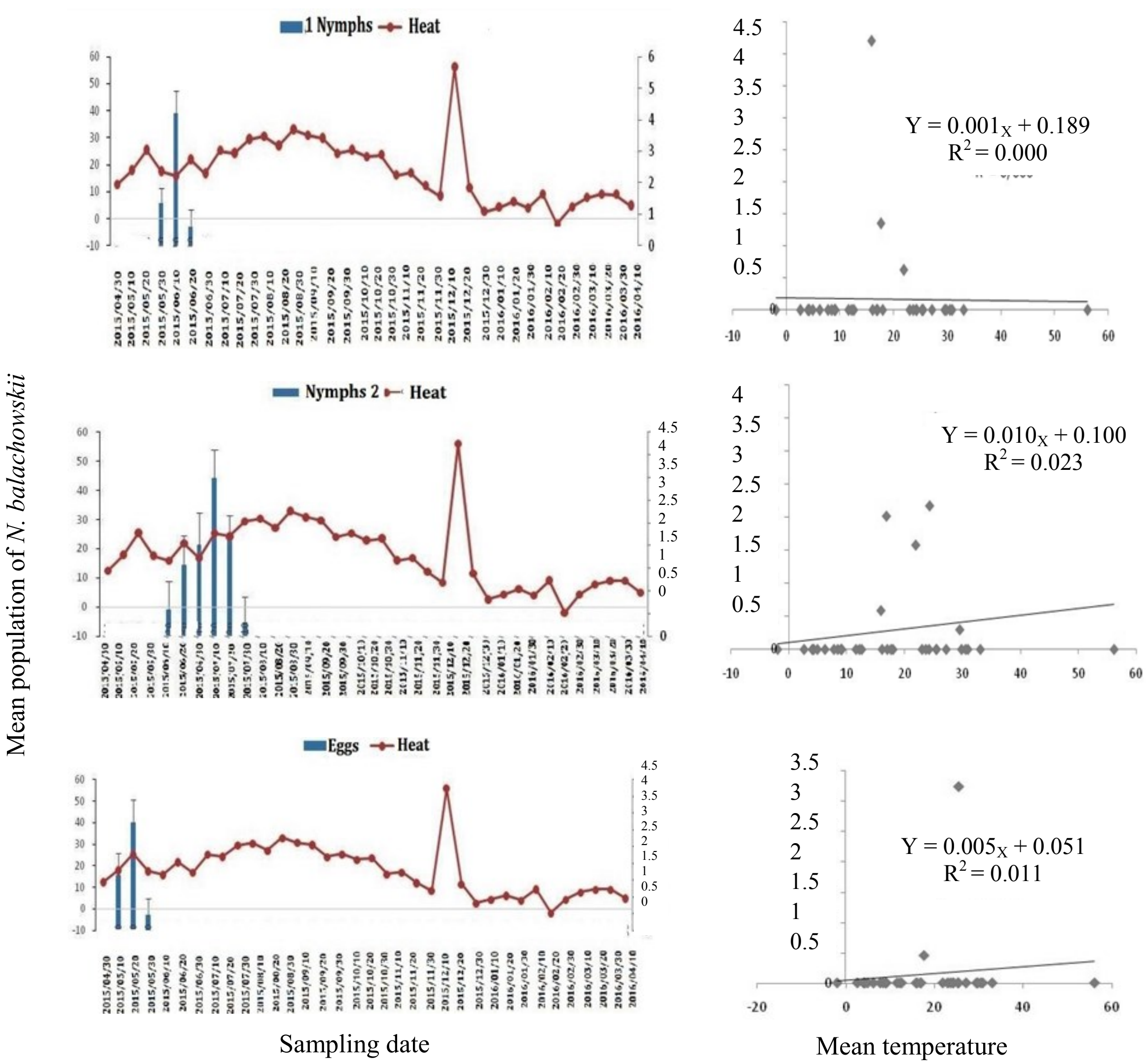


Figure 4. The curve of average population density of nymphal stages one and two and egg of *N. balachowskii* and the average temperature in Kermanshah, 2015

er sources have identified four and five nymphal stages for males and females, respectively. (Spodek *et al*., 2016). Third and fourth instar nymphs are not described and the method of their differentiation is not provided. However using photos of nymphal stages, male and females are differentiated (Spodek *et al*., 2016). But no mention is made to the difference between third and fourth nymphs. First and second instar nymphs are easily recognizable in terms of macroscopic and microscopic characteristics. Yet the detection of third and fourth instar nymphs is complex due to macroscopic and microscopic characteristics.

Despite many efforts to detect third and fourth instar nymphs, molted skins were not found and no convincing features to differentiate second and third or third and fourth instar nymphs by preparing perparasion were observed. Therefore, only two nymphal stages were considered for female *N. balachoweskii*. Male scale insect was not found in the observations and the number of nymphal stages is not determined. *Nidularia* scale insects are similar to Kermes scale insects in many respects like biological and morphological characteristics. These features include gal-like body, mosaic design on the back, dorsal white felt-like wax covering in second instar nymphs, single generation, monophagous (oak) and the eggs being kept in brood chamber until hatch-

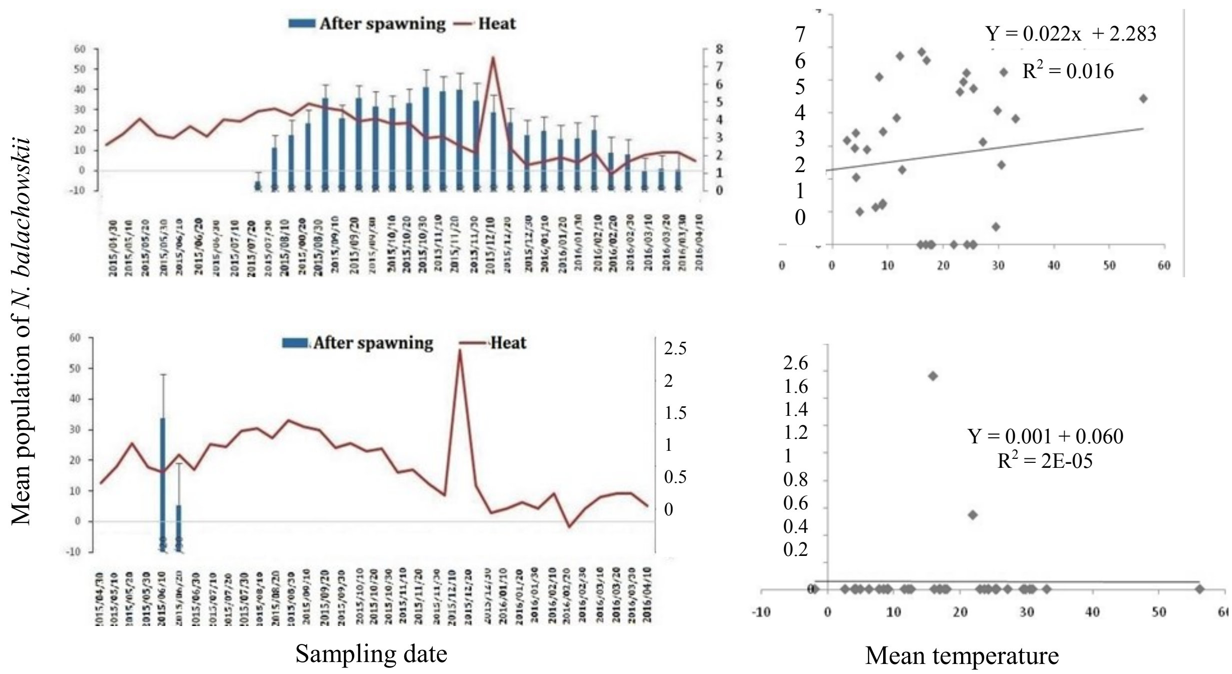


Figure 5. The curve of average population density of pre reproductive and post reproductive stages *N. balachowskii* and the average temperature in Kermanshah , 2015

ing. Scale insects are mostly located on the trunk and biennial or perennial twigs and after spawning, their dead body remains there for one to two years. *Nidularia* (Kermesidae) species in the world include *N. balachowskii* Bodenheimer, *N. pulvinata* (Planchon) and *N. Japonica* Kuwana (Ben-Dov *et al*., 2013). Several characteristics of *N. balachowskii* are compared to the other two species and briefly explained below. For the purpose of comparison, *N. plevinata* and *N. japonica* features are written in parenthesis. The *N. balachowskii* scale insect in Iran differs from the (*N. pulvinata*) in terms of the following features: second instar nymphs have a short white short string waxy and felt-like coat in the dorsal section. This casing is covered with mosaic design (young nymphs have a delicate and brittle wax layer at the back).

The type of dorsal embellishment is not explained. When the second instar nymph becomes mature, the felt-like coating (the laminar wax layer) gradually molts. The mature female has a laminar wax coating on the lateral-dorsal section (wax dorsal-lateral covering or nest-like egg sack). The *N. balachowskii* scale insect in Iran differs from the (*N. japonica*) in the following areas: the mature female has a laminate-like sheathing on the lateral-dorsal side (the lateral-dorsal waxy cover is in the form of a nest-like egg sack). The

Table 6. Iwao's regression parameters for mean of the different nymphal stages of *Nidularia balachowskii* in 2014

Life stages	α ± SE	β ± SE	t_b (d_f=34)	t_{table} α=0.05	R^2	P_{value}	Spatial distribution
Egg	0.012±0.012	1.416±0.029	14.344	2.042	0.975	0.01	Cumulative
1st instar	0.031±0.025	1.29±0.044	6.59	2.042	0.962	0.01	Cumulative
2nd instar	0.029±0.020	1.45±0.037	12.162	2.042	0.979	0.01	Cumulative
Mature before spawning	0.242±0.053	1.166±0.020	8.3	2.042	0.990	0.01	Cumulative
Mature before spawning	-0.002±0.005	2.052±0.036	29.222	2.042	0.989	0.01	Cumulative

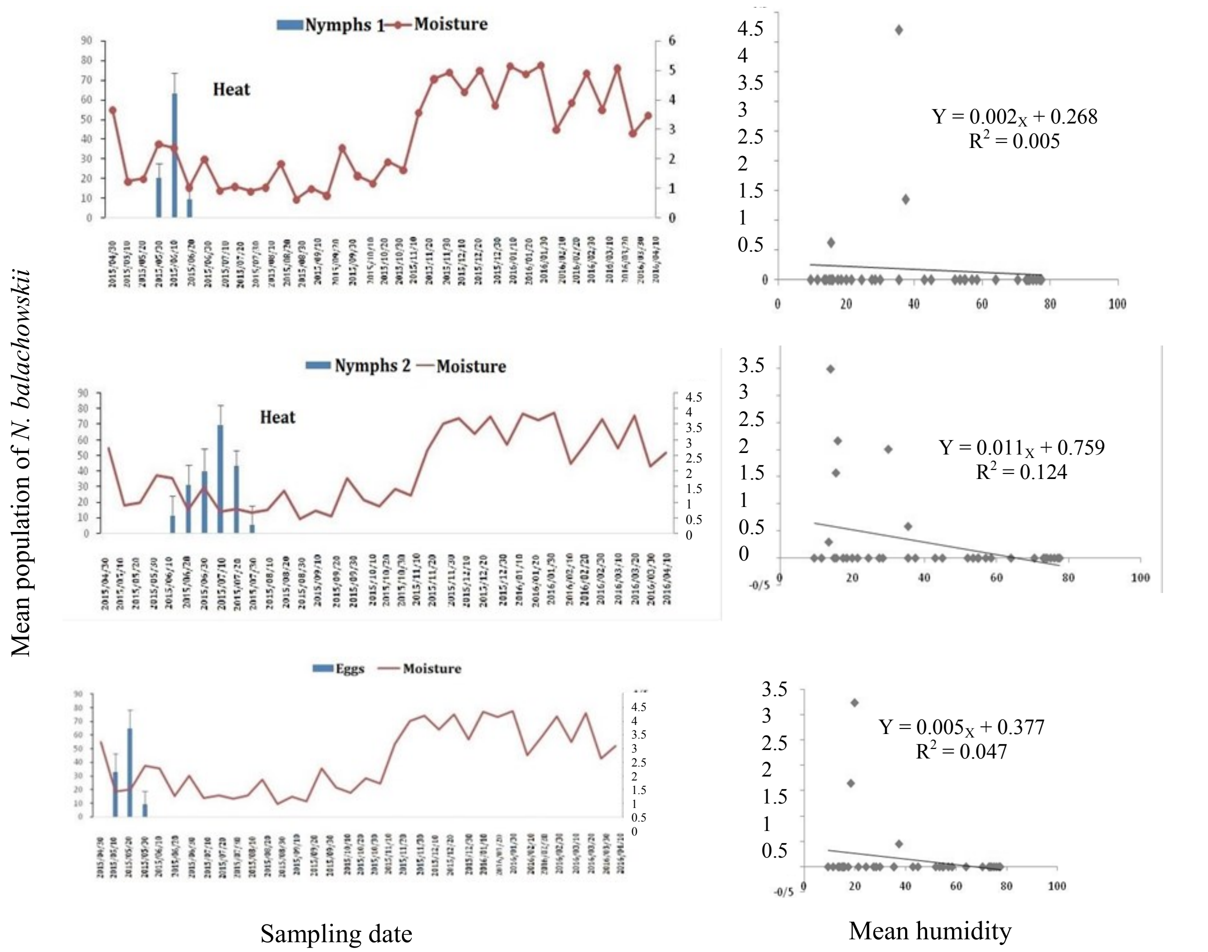


Figure 6. The curve of average population density of egg, first and second nymphal stages of *N. balchowsky* and the average humidity in Kermanshah, 2015

N. balachowskii scale insect in Iran is similar to that of Israel since they both have the following features: single generation, host, settlement spot on the host, gall-like shape, placement of eggs in the brood chamber, dorsal mosaic surface (second instar nymph and mature pest), white waxy layer on the lateral-dorsal surface of young female, overwintering and the period of dried out female bodies survival.

The *N. balachowskii* scale insect in Iran differs from that of Israel in the following areas: the host of *Quercus branti* (*Q. ithaburensis*) does not produce sap (produces it) and the female mature scale insect's body is covered with a layer of wax strip (as is seen in the picture, the wax is felt-like). It must be noted that the coating is different from that of second instar nymph and young female. Females have two nymphal phases (four nymphs) and no male is involved (have male). In this case, it has been stated that there is no male involved in most gal-like scale insects of the Kermesidae family reproduction (Hamon, 1977) and parthenogenesis occurs instead. During the maturation stage, this scale insect goes through summer and winter diapause. That is why they spend 9-10 months of the year as young adult females on the host. Yet Spodek *et al*. (2016) argue that since young females of this scale insect excrete sap during summer, autumn and winter, they are active and growing. In other words, they do not go through summer and winter diapause. In this study, it was observed that some oak trees are not only infested with multiple species of scale insect, but also to aphid. Sap secretion by some species of Isoptera such as scale insects attracts symbiotic ants. Scale insects secrete less

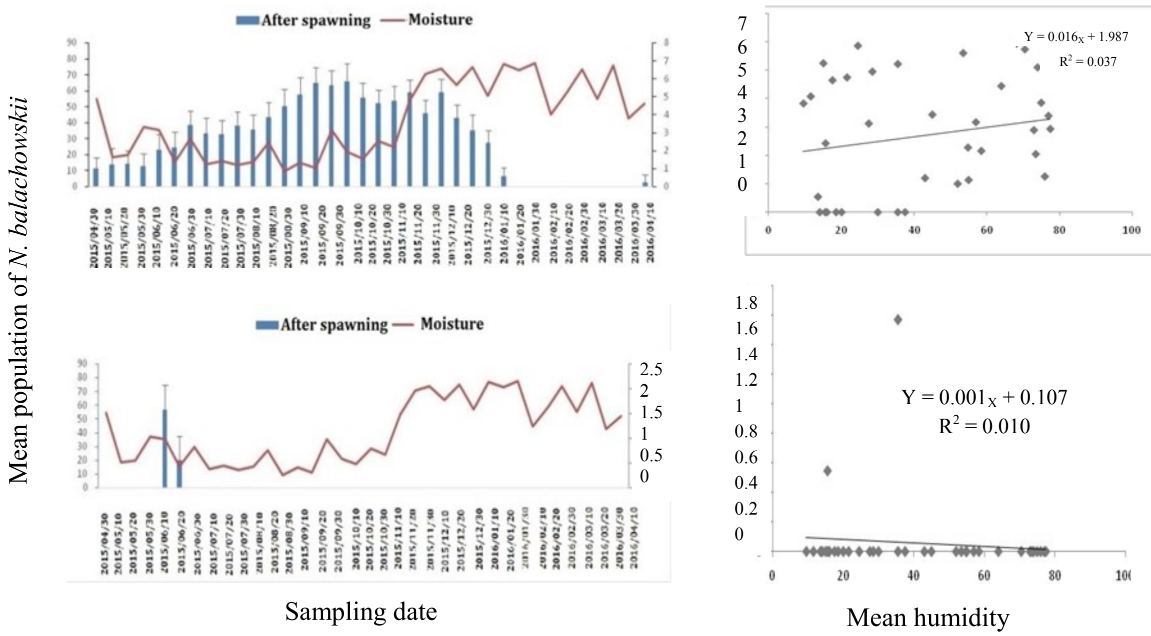


Figure 7. The curve of average population density of pre reproductive and post reproductive stages *N. balachowskii* and the average humidity in Kermanshah , 2015

sap compared to aphids. Spodek *et al*. (2016) studied the symbiotic ants fauna with *N. balachowskii* scale insect.

They believe that the excretion of sap by young females indicated the activity and growth of this insect during the summer, autumn and winter. Compared to the points above, *N. balachowskii* scale insect does not produce sap in the oak forests of Kermanshah. Even if it does, the production is so insignificant that cannot be detected with the naked eye. Since sap of the infested trees were apparently invisible even with intense infestation, the activity of ants on the oak trees were not related to the intangible amount of sap secretion by *N. balachoweskii*, but to the presence of aphids, a matter which calls for further investigation. Multiple Coccoidea feed on phloem and some others on parenchymal cells. Phloem is rich in sugar and hence the insects they feed produce more sap. Yet insects that feed on parenchymal cells have little sap secretion (if any). The *N. balachowskii* scale insect settles on the woody (old) oak parts such as the main trunk and biennial or perennial woody twigs.

This scale insect seems to feed on the host skin's parenchyma cells. Therefore, its sap is barely recognizable and can only be detected and collected by symbiotic ants. The stylet length of insects feeding on phloem is relatively shorter than the ones feeding on the parenchyma cells, and the length remains constant at different nymphal stages. First instar nymphs are settled on the main trunk and the biennial or perennial twigs and continue to nurture in that area until the adults die. With respect to these points, if phloem nourishes this scale insect, the sap must be secreted in all circumstances at large amounts. However as previously mentioned, this insect does not secrete sap. Now, if we assume that the parenchyma cells of the host's skin nourish the insect, it should have a relatively tall stylet and the length of the stylet must grow with the age of nymph, a matter which needs detailed investigation.

With regard to the steady length of stylet at each stage of growth, the radius of nurturing is constant. Hence from the evolutionary point of view, it seems that scale insects feeding on parenchyma require a relatively longer stylet in the higher growth stages to gain more food. Yet it seems that scale insects which at various ages feed on phloem have a fixed length of stylet. Aside from production or non-production of sap, constant or variable stylet length, too, can be a method to differentiate these two groups of scale insects. When measuring adult insect population on the host, one must be wise to distinguish dead and last year's insects from new mature ones and not to include them in the statistics. The body of this scale insect remains on the host for 1-2 years because of the sticky wax secreted through Submarginal tubular ducts (matchstick ducts) during activity. The body of old and new scale insects are very similar, making the distinction hard and in need of accuracy and practice. Awareness of the changes in each pest population is the first step in managing the pests. As the results of this study depict, this pest has one generation per year and its spatial distribution pattern is cumulative. Although its damage to oak is apparently insignificant, using the results of this study and knowledge of the spatial distribution pattern of the pest facilitates the development appropriate sampling plans and accelerates the estimation of this pest density at the lower cost. It also helps to make the best pest control decision in integrated pest management programs. Spatial distribution and changes of the population are among the major ecological features of the insect population which can be used in designing sampling programs, particularly the sequential sampling used for deciding to control or manage the population of pests. Knowledge of the spatial distribution pattern of insects' populations can provide important information about the behavioral features of species, along with the impact of environmental factors on their population. Among the practical features of spatial distribution are its application in modeling, determining the appropriate sampling method and designing sampling programs. Multiple researchers have recognized the damage caused by Kermesidae scale insect including branch dieback, growth loss and even the drying out of oak trees at times (Ben-Dov *et al*., 2013, Bullington and Kosztarab, 1985, Hamon, 1977, Pellizzari *et al*., 2012, Podsiadlo, 2012, Solomon *et al*., 1980). The field observations of the researchers in this study showed that *N. balachowskii* scale insect have not inflicted major damage even in high populations.

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