ECOLOGIA BALKANICA

2014, Vol. 5, Special Edition April 2014 pp. 75-79

Vital Strategy for Cicada orni L. Survival in the Regional Park Maremma (Italy)

Peter Genov[1], Atidzhe Ahmed[1]*, Stefka Kitanova[2]

1 - Institute of Biodiversity and Ecosystem Research, Bulgarian Academy of Sciences, 2 Gagarin Str., Sofia, BULGARIA

2 - Forest Research Institute – Sofia, Bulgarian Academy of Sciences, 132, St. Kliment Ohridski Blvd., Sofia, BULGARIA

* Corresponding author: atidje_dj@abv.bg

Abstract. The study took place in the period 1991-2000, in the Regional Park Maremma, Central Italy (42˚39′N, 11˚ 05′E). It is with an area of 9800 ha, covered by Mediterranean vegetation: *Pinus halepensis* Mill., *Pinus pinea domesticus* L., *Quercus ilex* L., *Q .pubescens* Willd., *Arbutus unedo* L., *Phillirea latifolia* L., *Erica multiflora* L., *Pistacia lentiscus* L., *Rosmarinus officinalis* L. The larvae of *Cicada orni* L. live in the soil and it with three-year life cycle. When it starts going out of the skin it becomes a pray for some animals, among them ants and wild boar, as it does not move. During one only observation it was established the presence of 222 cicada skins on the sand only some of which reached to fly. On the sand there were also signs from lizards, snakes, birds, hedge hocks, foxes, wild boars, etc. After a deep analysis it was established that their number decreased 30 times from the ground to the trees crowns where the adults live. During 10 years were collected data about the flying dynamics of cicada in order to answer the following hypothesis: what is the life strategy which the insect uses to survive among the numerous enemies. During this analysis there were reached four answers: first – it is a mass; second – it flies in late spring and early summer when the number of other insects is abundant and the enemies feed on them, third – most of the birds are over with the looking after their smalls which need great amount of food, and forth – the mornings in May are colder and more with moisture and this makes the insect slow and it could be a pray fro the birds and mammals as well.

Key words: *Cicada orni*, Maremma, survival.

Introduction

Investigations on cicada density in different habitats in Maremma Regional Park were done by PATTERSON *et al.* (1991), in relation of studying the dimensions, and individual area and food of *Garrulus glandarius* (L., 1758). In 1995 in order to establish the influence of enemies on the number of cicada in the Park a new investigation was realized by PATTERSON *et al*. (1997). In it was established that from the ground to the crown of the trees where the adults live the number decreased by 30 fold. A reason for that was the observation of 222 cicadas went out from the soil and only for few of them the chitin remains were found as an approval that they flew. On the sand there were also signs from lizards, snakes, birds, hedge hocks, foxes, wild boars, etc. During the going out the insect is not in move so it is under the attacks of ants and predator insects. After this investigation the interest to this noisy and numerous insect did not decrease so during the next years were collected data on its flight dynamics in order to answer the following hypothesis:

what life strategy is formed during the evolution in order to survive, because despite the numerous enemies the insect is numerous. To test the life strategy hypothesis related to the species survival despite the strong pressure by enemies. In order to achieve them the following tasks were set: observation of the going out from the skin after going out from the soil; establishment of the cicada density in the soil depending on the holes on the surface; observation of the cicada flight in the summer; establishment of the reproduction behaviour and life span of the adult; analysis of the life cycle and strategy for survival.

Material and Methods

The investigations took place in the period 1991-2000, in the Regional Park Maremma – Toscana, Central Italy. The park is with an area of about 9800 ha, covered by Mediterranean vegetation: *Pinus halepensis* Mill., *Pinus pinea domesticus* L., *Quercus ilex* L., *Q. pubescens* Willd., *Arbutus unedo* L., (*Olea europea* L.), *Juniperus oxycedrus macrocarpa* L., *Juniperus phoenicea* L., *Phillirea latifolia* L., *Erica multiflora* L., *Erica arborea* L., *Pistacia lentiscus* L., *Rosmarinus officinalis* L.

In order to establish the cicada density soil sample were taken (50x50x30 cm). During the sampling it was observed that before they go to the surface the larvae make a small hole which cannot be seen as on it there are needles or grass. It was sufficient to remove the needles or the grass and to count the holes to know the number of ready to fly larvae. In order to compare if the number of holes is the same as the number of larvae 28 soil samples were taken and on 36 samples with the same dimensions the holes were count. The results were compared using t-Student test and they showed no significant difference between them. To study the dynamics of the flight randomly 23 pine trees were chosen. From them during 10 years every 15 days after the first song was registered, were collected all the skins at a distance 1 m around the tree. Many observations were also done – the process of imago going out of the skin, behavior of males during mating, manner of feeding.

Results and Discussion

Observation of imago going out from the skin after going out from the soil

The cicada is an insect with metamorphosis development and the adult larva looks like the imago. During the soil sampling there were three dimension types of larvae, clearly distinguished so it means that the life cycle is three-year, which is also found in other publications (CIAMPALINI & LOVARI 1985; PATTERSON *et al*., 1991). The larvae live in the soil at a depth of 30-40 cm as the main part of the root system of *Pinus pinea domesticusu* and *Pinus halepensis* L. are at this depth and the larvae feed on the assimilates from the roots. This does not mean that they do not feed on other plant but the samples are taken from this habitat only. In the roots they form a small camera and spend there 3 years. The cuticle is elastic so they can grow without changing the skin.

During the first decade of June (5-10), the song of male cicadas is starting. To the sunset the larva goes out from the soil and starts moving and finds a vertical thing to climb on. The time is limited and if it does not find a thing stays on the ground which is dangerous as to be eaten by enemies. More – the horizontal pose of the skin is not very comfortable because the wings cannot be open normally. After it succeeds to climb it stays fro a moment and the skin is broken. From this part the head is seen, it breaths and the body becomes larger, the front part of the insect appearing. The first pair of legs, which in the larva are now normal, is as in other insects. This way, half appearing, it starts inclining backwards and oscillates from time to time, moving all the legs. This helps to the folded fine and soft wings to become hard and open. After legs, body and wings being hard enough, it stands and fixes with its front legs to the skin and takes the abdomen out. The skin although being inert is so hard fixed that can support the insect weight with doubled volume. In this moment the colour of the insect is pale-rose or pale-green and it was suggested it is related to the sex. But after that is was observed that both sexes have similar colours. The sex ratio of the newly appeared

81 specimens was 34 male and 47 female or 1.0:1.4. After all the parts of the external chitin skeleton being hard enough the insects move to the tree bark. The process lasts 1.5 to 2 h. To the morning the cicada's body becomes grey as the tree bark and one should be very careful to find it. It helps to the survived until this moment insects to rescue to the sunrise being still due to cool temperature, from the numerous birds walking around the tree stems as *Mirops apiaster* L., coming in flocks, followed by *Upupa epops* L. Making noise with the wings and sounds they force the insects to fly and capture them. Over passing all the circumstances they survive and meet the new worm day – in cloudy weather, before and after rain they do not sing (QUARTAU *et al.*, 2000) so in the forest their voices are heard and this lasts about three months.

Establishment of the cicada density in the soil depending on the holes' number on the soil

As it was mentioned above, before coming to the surface, the larvae make a vertical hole which cannot be seen as on it there are pine needles or grass. It was sufficient to remove the litter and to calculate the holes to establish the ready for flying larvae. To validate if the number of holes is the same as for the ready to fly insects 28 samples were taken. From 36 samples with the same dimensions the holes were calculated. The results were compared with t-Student test and they showed that no significant difference between both samples. This allowed to evaluate the quantity of ready to fly larvae according to the hoes found (Table 1).

Table 1. Difference between holes calculated * and the number of the found in samples (50x50x30 cm) ** ready to fly larvae (1996-1997)

Number of samples	36*	28**
Number of larvae	85	85
SD	2,36	3,07
t-Student	P = 0.9852; no difference	

Investigation of cicada flight dynamics in summer

During 10 years the first (5-10 June) and the last (8-15 September) song of the male cicada was recorded. Then every 15 days were collected all the skins on the stems at a distance of 1 m around them – 23 pine trees, in order to establish the fly dynamics of cicada. From Table 2 it can be seen that most actively the cicada go out during the second 15-day period and then decreases. During the last period in some years there were no flying adult insects. During some of the years, cicada number dynamics if different despite that the flight cycle is the same, most insects fly during the second period. It could be suggested that it depends on the soil hardness which does not allow some of the larvae to open the surface and to reach the trees roots. There was observed a tendency of increasing the number every third year, with the exception of 1996, in which the highest number of cicada was recorded in the Park. There was established a significant difference between the periods of flying with the exception of the first and third where the activity of flying is the same (Table 3). Possible reasons could be that in June the larvae did not reach their physiological maturity to go out from the soil and the morning temperatures are lower, and the humidity is abundant as the grass is not dry. For the third period the reason is clearer – most of the insects have flown.

Table 2. Number of cicada skins collected every 15 days after registration of the first song during the period 1991-2000

controls	I	II	III	IV	V	total
1991	245	693	404	224	60	1626
1992	181	397	230	39	34	881
1993	661	915	125	33	0	1734
1994	156	462	102	21	0	741
1995	252	597	323	27	0	1199
1996	428	2299	504	111	102	3444
1997	126	286	84	16	0	512
1998	210	1269	236	17	2	1734
1999	127	415	26	22	0	590
2000	94	360	83	28	13	578

Table 3. Significant differences in cicada flight dynamics in the period 1991-2000 in cycles of 15 days starting after first song registration

Controls	I	II	III	IV	V
I		0.02	n.s.	0.01	0.01
II			0.01	0.01	0.01
III				0.01	0.01
IV					0.01
V					

Establishment of reproductive behaviour and life span of the adult insect

After being in the tree crown the males sing in order to attract females. Also a competition starts as on the pine there are some males surrounding a female and trying to reach her singing differently and most probably the length and power of it are of vital importance for the female. The power and length of the sound are an indicator for the good condition of the male and the female most probably chooses the ones with more resistance (KREBS & DRAVES, 2002). After the copulation the females lays the eggs in the barks holes, covered by white cotton-like matter. Within some time they enclose and the miniature larvae can penetrate into the hard soil and reach to some roots to suck assimilates. The front legs which serve to dig are about 50% from the body mass. It is not clear yet where the whole energy is found and where from the water drops are coming. Many evening it was observed many cicadas on the bark of *Juniperus phoenicea* L. sucking assimilates.

It was calculated how long do these insects live. The larvae stop going out about 10-15 August as after these dates there were no new skins on the sample trees and the last song was registered around 10-15 September – meaning after a month.

Analysis of the life cycle and the strategy for species surviving

During this analysis some answers were reached but not to the main one – what is the species strategy to survive. One of the possible answers could be that it is a massive but this probably could not rescue it in May when all the birds look after their smalls and the insect is large, slow and in addition – noisy. It cannot change (shorten) its life cycle in order to have more generations as three could not be divided into two. There are some comments from KREBS & DRAVES (2002). In some species avoiding increasing of generations is reached by periodical not spatial synchronization which can explain bicycles of some cicadas being 13 or 17 years. These

insects live in the soil as larvae during 13 and 17 years and after that the adults fly. Cicadas with 17-year cycle are 3 species with millions of adults flying at the same time around a large space so to become a pray is not likely. Some scientists had questions why 13 and 17 years but not 15 or 18? A long period between two flights is an advantage to eliminate the predators and parasites – as there are no cicadas during 13 and 17 years, can die or use other prays. These long biological cycles most probably evolved as a form for surviving, as an evolutionary key with which prolonging the cycle cicadas won. Actually this length 13 and 17 years are the first figures which do not allow a predator to synchronize with the cicada using a shorter cycle to coincide with cicada's flight. For example if the cicada is with a cycle of 15 years, the predator with 3 or 5 years could synchronize with cicada and meet it every 3 or 5 generations. More possible is to be extinguished the adults cicadas was observed in the beginning or ending of the flight but not in the middle, when they are very abundant and this is probably their strategy.

The cicada is abundant in mid-summer in pine wood and deciduous wood, in olive wood but at the same time in the open spaces is full of grasshoppers and other insects – so it is not the only one mass victim and the most part of the birds grew their smalls yet, and despite the larger number they only feed but not collect food for the growing and hungry all the time smalls. On the other hand the high temperatures, dry weather and low humidity increase the movement of the insects and they become more difficult pray for some of the low-mobility enemies. More – the fruit mature and there are many plant seeds and some enemies change their diet as for example *Sturnus vulgaris* L. Also the migrations start. All this is in favour of cicada later flying strategy.

Conclusions

Flying of the cicada is during the end of spring and summer when there are many other insects and it is not the only pray. High summer temperatures make it very movable and it becomes a difficult pray for the enemies. At the end of summer many fruit mature and some of the enemies move to plant diet.

References

CIAMPALINI B., S. LOVARI. 1985. Food habitats and trofic niche overlap of the badget (*Meles meles*) and the red fox (*Vulpes vulpes*) in Mediterranean costal area. - *Zaischrifte Sauuguterkunde* 50: 226-234.

KREBS J. R., N. B. DAVIES. 2002. *Ecologia e comportamento animale.* Bollati Boringheieri, Torino, 483 p.

PATTERSON I. J., P. CAVALLINI, A. ROLANDO. 1991. Density, range size and diet of the Europaen Jay *Garrulus glandarius* in Maremma Natural Park, Tuskany, Italy, in summer and autumn. - *Ornis Scandinavca*, 22: 79-87.

PATTERSON I. J., P. CAVALLINI. 1996. The volume of sound as index to the relative abundance of *Cicada orni* L (Homeptera: Cicadidae) in different habitats. - *Entomologst's Gazette*, 47: 206-210.

PATTERSON I. J., G. MASSEI, P. GENOV. 1997. The density of cicadas *Cicada orni* in Mediterranean coastal habitats. - *Italiian Journal of Zoology*, 64: 141-145.

QUARTAU J. A., S. SEABRA, A. SANBORN. 2000. Effect of ambient air temperature on the calling song of *Cicada orni* Linnaeus, 1758 (Hemiptera: Cicadidae) in Portugal. - *Acta Zoologica Cracoviensia*, 43: 193-198.

Received: 15.10.2013
Accepted: 02.03.2014