RESEARCH ON THE EVOLUTION OF *Amathes c-nigrum* L. SPECIES (ORD. *Lepidoptera*, FAM. *Noctuidae*) UNDER CENTRAL OF MOLDAVIA CONDITIONS

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Abstract

The larvae of the *Amathes c-nigrum* L. species are polyphagous pests which attack plants from spontaneous flora, most crop plants, beets, grain legumes, forage legumes, flax, tobacco, potato, medicinal plants, ornamentals plants, vines. Especially after the winter, the mature larvae, produce significant damage in spring, when they attack all the green parts of the plants. In most cases, the larvae of the the *Amathes c- nigrum* L. species cause damage along with similar larvae of other Noctuidae species. Adult collection with a light trap, observations and measurements made during 1993 – 2012, showed that *Amathes c- nigrum* L. species was present in the study area, each year, the number of specimens collected ranged from 4 specimens (2002) to 201 specimens (2006), the average collections for the 20 years of observations was of 74,1 specimens. The emergence of the first adults was recorded in the first decade of May, the insect flight continued without interruption until the end of September. During this time were identified two flight curves, first made by the adults of the hibernating generation, which recorded a flight peak in the first decade of June. The second flight curve was made by the adults of the summer generation (the insect first annual generation) and reached the top flight in the second decade of August. The observations and measurements have shown that under the Central Moldova conditions, the insect presented two generations per year, the hibernation occurs in mature larvae stage in the deeper layers of soil.

Key words: *Amathes c-nigrum* L., abundance, light trap, coefficient of variation, flight

The *Amathes c-nigrum* L. popular known as blackish owl, belong to the *Noctuidae* family, which comprises a group of butterflies whose larvae are polyphagous pests which attack most crop plants. This species with widespread is common in our country, but with large variations of individuals (Ciochia, Codrescu, Rizescu, 1984; Kankare and col., 2002; László, 2003; Ivas, Muresan, 2011).

The larvae lead solitary life, so often the attack goes unnoticed but often they accept food territory adjacent to the larvae of other species such as: *Agrotis segetum* Den. et Schiff., *Agrotis exclamationis* L., *Agrotis ipsilon* Hufn., etc.

Polyphagous species, it prefer plants from spontaneous flora, and of the cultivated plants beets, forage plants, legumes for grain (peas, soybeans), flax, tobacco, potato and some medicinal plants; the straw cereals and maize are occasionally attacked. The larvae bearing plants in the neck zone and sometimes even the leaf blade, if they are in 3 – 5 leaves stages will dry, in more advanced stages, they puncture the stem over the neck and dig galleries in the root, tubers or over the stem. In this situation, the plants stalled in growth, the central leaf withers and gradually the whole plant dries, recorded many gaps in the crop (Ionescu and col., 1963, 1965, 1966; Popov and Paulian, 1973, 1974; Paulian and Popov, 1968, 1969; Malschi, 2008; Trotus and col., 2013).

In the last half century, various species of owls from Noctuidae family were constantly monitored throughout classical methods but also with the help of synthetic sex pheromones in order to determine prognosis attack and to issue warnings, in case of mass larval occurrence, in order to limit the populations below the economic pest threshold (Roşca and col., 1995; Stan and col., 1996; Roşca and Istrate, 2005; Robinson and col., 2010; Trotus and col., 2013; Trotus and col., 2013).

In this paper we present data on the *Amathes C – nigrum* L. species bioecology, under the Center of Moldova conditions.

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MATERIAL AND METHOD

The research were conducted during 1993 – 2012, at A.R.D.S. Secuieni, establishment situated in the western part of the Moldavian Central Plateau, between the geographic coordinates of 26º5 'east longitude, 46°5' north latitude and at an altitude of 205.7 m above the sea level. The area where the unit is located has a temperate continental climate (D.f.b.x. Köpen), the average annual temperature is 8.7°C and the amount of rainfall is 547 mm.

The research consisted of collecting and recording the adults of *Amathes C – nigrum* L. species with the help of a light trap, the recorded data led to the determination of the flight intensity and time of the peak flight and the species variability coefficient for the area in which we carried out the research (Baciu, 2011). In the field were conducted observations and determinations which consisted in ground surveys and determinations that established the larvae density, the frequency of the attack producedby larvae, the emergence, evolution and the duration of the insect development stages.

The results led to the establishment of the species biological cycle for the Center of Moldova conditions.

To achieve a clearer presentation the period of the 20 years of observations and determinations was divided into four stages as follows: phase I cover the period from 1993 to 1997, phase II (1998 – 2002), phase III (2003 – 2007) and phase IV (2008 – 2012).

RESULTS AND DISCUSSIONS

The total number of the adults of *Amathes C – nigrum* L. species, collected in phase I (1993 – 1997) was of 356 specimens. In this phase the flights were almost constant, the number of annual catches ranged from 55 specimens/trap/year (1996) to 87 specimens/trap/year (1997) (*table 1*).

In the second phase (1998 – 2002), the total number of adults collected was of 289 specimens, the lowest flight was recorded in 2002 when the annual number of insects collected was of 4 specimens, and the most intense flight was realized in 1998 when the totalnumber of catches was of 144 specimens/trap/year (*table 2*).

In 2003 – 2007 period (phase III) were collected 488 specimens, the most intense flights were recorded in 2006 (201 specimens/trap/year) and 2005 (100 specimens/trap/year), and in 2003, 2004 and 2007 the number of the catches ranged between 52 specimens/trap/year and 70 specimens/trap/year (*table 3*).

In the fourth phase (2008 – 2012) the totalnumber of adults collected was of 349 specimens, the most intense flights occurred in 2008 and 2009 of 104 respectively 129 specimens/trap/year, and in 2010, 2011 and 2012 the number of catches was between 21 specimens/trap/year and 49 specimens/trap/year (*table 4*).

Analyzing the catches recorded at the light trap during 1993 – 2012 period it was found that the *Amathes C – nigrum* L. species, was present in the study area, in every year, the number of the specimens collected ranged from 4 specimens/trap/year (2002) to 201 specimens/trap/year (2006), the average of the catches for the entire period was of 74.1 specimens (*table 5*).

Calculating the variability coefficient of the adults of *Amathes C – nigrum* L. species collected in the 1993 – 2012 period, it was found that:

- the average value of the variability coefficient (C_V(S%)) was of 22.36% which qualify the species into the abundant species category for the study area;
- out of the 20 years analyzed, the variability coefficient was higher than the annual average, in nine years, the species flight was characterized as intense, in other nine years, the variability coefficient was greater than 10% the flight being characterized as a medium flight and in two years the C_V(S%) values were less than 10% and the species flight was reduced (*table 6*).

Calculating the share of the years, depending on the flight intensity it was found that in the analyzed period, in 45% of the years the species flight was intense, in 45% the flight was medium and in 10% of the years the flight was reduced (*table 6*).

Based on the obtained results it was found that between the annual catches and the variability coefficient of the recorded annual population was obtained a direct correlation, the correlation coefficient (r = 1) being statistically ensured (*figure 1*).

Analyzing the number of adults collected annually, depending on the thermic regime of the experimentation years it was found that the highest number of insects (794 specimens), which is 53.6% of the total have been collected in the years characterized as normal, 34.5% in the years characterized as warm and 11.9% in the cold years (*figure 2*).

Pursuing the flight of *Amathes C – nigrum* L. species depending on the annual rainfall it was found that the highest number of insects in a proportion of 44.3% were collected in the years characterized as dry, 29.1% ofthe total were collected in the years characterized as normal and 26.6% in the rainy years (*figure 3*).

The average flight curves made by the adults of *Amathes C – nigrum* L. species during 1993 – 2012 period started in the first decade of May, with the registration of the first adults which began flying that continued without interruption

until the end of September. During this range April – September have been identified two flight curves, first performed by the adults of the hibernating generation, which registered a peak flight in the first decade of June.

The second flight curve, was conducted by the adults of the summer generation (insect first annual generation), and the peak flight was recorded in the second decade of August (*figure 4*).

The observations and determinations made on the emergence and duration of the development stages of the insect led to the establishment of the *Amathes c-nigrum* L. species biological cycle under Secuieni conditions. The insect presented twq generations per year, the species hibernation was realized by mature larvae, in soil.

The hibernating larvae migrated from deeper soil layers, in the top layers, at the plants roots leve land in neck area, in the first days of the second decade of April, the larval stage was of 15 days, after which at the end of the third decade of April the first pupae were recorded. The duration of the pupal stage was of 11 days, at the end of the first decade of May the first adults were recorded which stepped up the flight and which have lodged the eggs for the species first generation, at the middle of the second decade of May. The length of the first generation or the summer generation as i tis called, was on average of 67 days.

The second generation or the hibernating generation has evolved from the end of the second decade of August until the end of the first decade of October. During this time two development stages of the insect have successiving, the egg and larva stages, the larvae from the last ages (IV and V) receded into the soil for hibernation and continued the development and evolution of insect biological cycle in the next year (*table 7*).

Table 1

Adults number of *Amathes c-nigrum* L. species, collected in light trap during 1993 - 1997

Year / Month	Decade	1993	1994	1995	1996	1997	Total decade
April	I	0	0	0	0	0	**0**
	II	0	0	0	0	0	**0**
	III	0	0	0	0	0	**0**
May	I	0	0	0	2	0	**2**
	II	0	0	0	17	0	**17**
	III	0	6	2	5	5	**18**
June	I	7	6	15	7	12	**47**
	II	0	2	4	5	21	**32**
	III	3	2	1	1	2	**9**
July	I	1	0	0	2	0	**3**
	II	5	0	2	0	0	**7**
	III	1	1	5	0	1	**8**
August	I	7	9	7	1	10	**34**
	II	20	13	20	5	1	**59**
	III	11	11	13	5	0	**40**
September	I	15	10	7	5	34	**71**
	II	3	0	3	0	1	**7**
	III	0	0	2	0	0	**2**
October	I	0	0	0	0	0	**0**
Total year		**73**	**60**	**81**	**55**	**87**	**356**

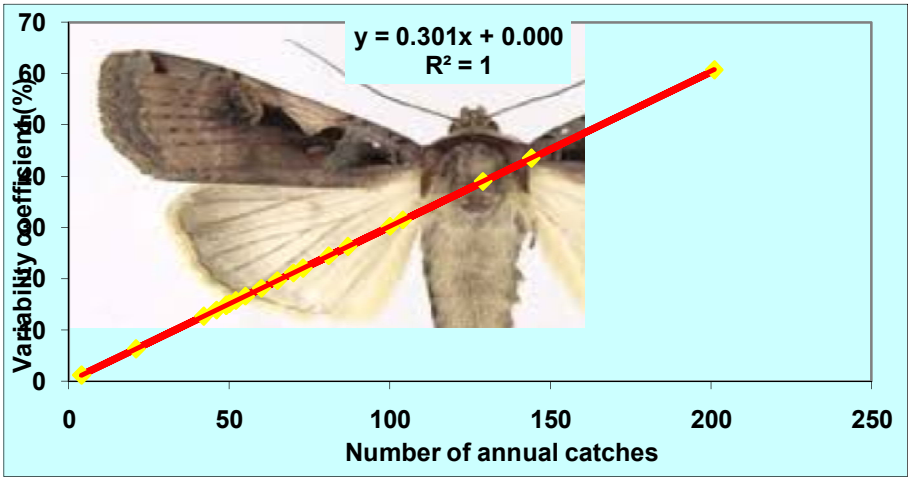

Figure 1 **The correlation between annual collecting number and the variability coefficient**

Table 2

Adults number of *Amathes c-nigrum* L. species, collected in light trap during 1998 - 2002

Year / Month	Decade	1998	1999	2000	2001	2002	Total decade
April	I	0	0	0	0	0	**0**
	II	0	0	0	0	0	**0**
	III	0	0	0	0	1	**1**
May	I	0	0	3	0	2	**5**
	II	2	0	3	0	1	**6**
	III	20	0	6	2	0	**28**
June	I	33	12	3	1	0	**49**
	II	3	14	2	0	0	**19**
	III	3	1	1	0	0	**5**
July	I	6	2	0	0	0	**8**
	II	0	0	0	0	0	**0**
	III	14	0	0	0	0	**14**
August	I	18	0	5	12	0	**35**
	II	27	11	3	12	0	**53**
	III	7	2	7	12	0	**28**
September	I	6	0	10	10	0	**26**
	II	5	0	7	0	0	**12**
	III	0	0	0	0	0	**0**
October	I	0	0	0	0	0	**0**
Total year		**144**	**42**	**50**	**49**	**4**	**289**

Table 3

Adults number of *Amathes c-nigrum* L. species, collected in light trap during 2003 - 2007

Year / Month	Decade	2003	2004	2005	2006	2007	Total decade
April	I	0	0	0	0	0	**0**
	II	0	0	0	0	0	**0**
	III	0	0	0	0	0	**0**
May	I	0	0	0	0	0	**0**
	II	1	0	0	0	9	**10**
	III	6	0	0	0	6	**12**
June	I	18	7	0	0	0	**25**
	II	9	9	4	0	0	**22**
	III	2	5	1	0	2	**10**
July	I	0	2	0	0	0	**2**
	II	0	3	3	0	0	**6**
	III	0	4	6	0	0	**10**
August	I	0	0	12	1	7	**20**
	II	0	10	18	113	23	**164**
	III	17	3	55	66	6	**147**
September	I	5	2	1	21	9	**38**
	II	7	2	0	0	3	**12**
	III	0	5	0	0	2	**7**
October	I	0	0	0	0	3	**3**
Total year		**65**	**52**	**100**	**201**	**70**	**488**

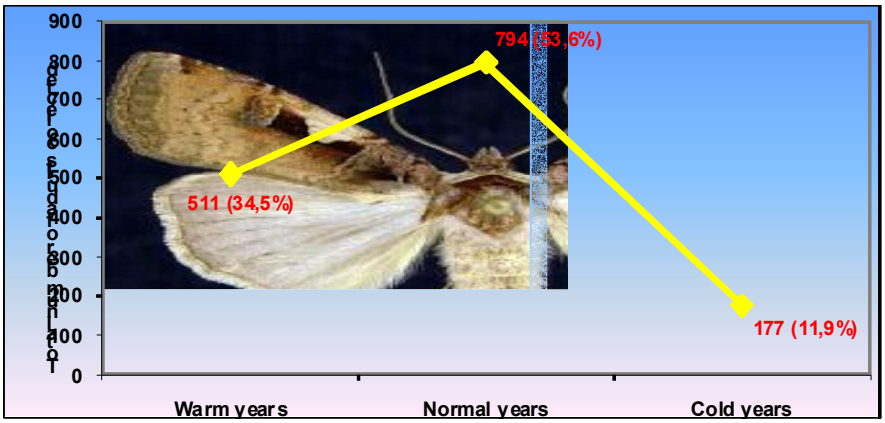

Figure 2 **The adults flight variation of *Amathes c-nigrum* L. species depending on the thermal regime**

Table 4

Adults number of *Amathes c-nigrum* L. species, collected in light trap during 2008 - 2012

Year / Month	Decade	2008	2009	2010	2011	2012	Total decade
April	I	0	0	0	0	0	**0**
	II	0	0	0	0	0	**0**
	III	0	0	0	0	0	**0**
May	I	0	0	0	0	0	**0**
	II	0	0	1	0	0	**1**
	III	1	0	1	0	1	**3**
June	I	0	1	5	6	0	**12**
	II	0	4	2	2	0	**8**
	III	0	10	1	1	0	**12**
July	I	1	1	0	0	0	**2**
	II	0	0	2	0	0	**2**
	III	11	6	7	0	2	**26**
August	I	35	2	7	0	3	**47**
	II	25	12	13	4	1	**55**
	III	20	42	3	9	8	**82**
September	I	11	42	1	12	4	**70**
	II	0	9	1	12	2	**24**
	III	0	0	2	3	0	**5**
October	I	0	0	0	0	0	**0**
Total year		**104**	**129**	**46**	**49**	**21**	**349**

Table 5

The variability coefficient of *Amathes c-nigrum* L. population, for Secuieni - Neamt conditions, 1993 - 2012

No. crt.	Year	Total number of adults collected (Abundance)	Dif. from the average (no.)	Variability coefficient C_V(S%)	Climatic characterization	
					T° annual average	Annual rainfall
1	1993	73	- 1,1	22,02	7,8	552,2
2	1994	60	- 14,1	18,11	10,0	423,7
3	1995	81	6,9	24,44	8,9	476,1
4	1996	55	- 19,1	16,59	7,8	646,2
5	1997	87	12,9	26,25	8,1	572,1
6	1998	144	69,9	43,45	8,6	638,1
7	1999	42	- 32,1	12,67	9,8	511,8
8	2000	50	- 24,1	15,09	10,4	509,6
9	2001	49	- 25,1	14,79	9,3	656,4
10	2002	4	- 70,1	1,20	9,6	512,8
11	2003	65	- 9,1	19,61	8,9	458,6
12	2004	52	- 22,1	15,70	9,8	507,1
13	2005	100	25,9	30,18	9,1	753,3
14	2006	201	126,9	60,65	9,0	560,3
15	2007	70	- 4,1	21,12	10,3	530,3
16	2008	104	29,9	31,39	9,8	505,2
17	2009	129	54,9	38,93	9,7	449,6
18	2010	46	- 28,1	13,89	8,9	683,0
19	2011	49	- 25,1	14,79	8,8	425,5
20	2012	21	- 53,1	6,34	9,3	455,2
Average		**74,1**	**0,00**	**22,36**	**9,2**	**541,36**

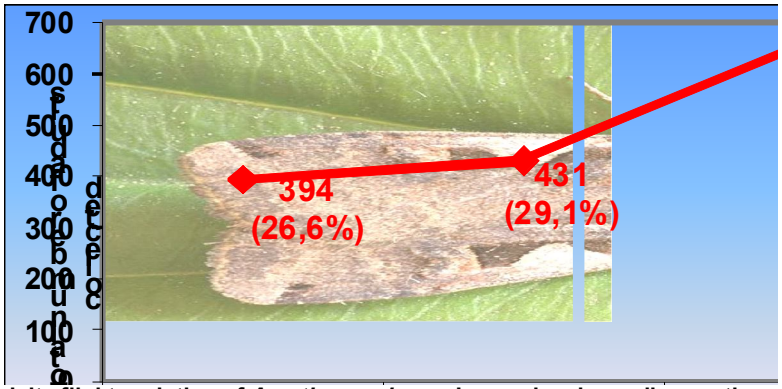

Figure 3 **The adults flight variation of *Amathes c-nigrum* L. species depending on the rainfall regime**

Table 6

Flight characterization of *Amathes c-nigrum* L. species depending on the variability coefficient

No. crt.	Variability coefficient C_V(S%)	Observation years	Flight characterization - C_V	Characterization of the climatic year T/P	The share of the years depending on the flight intensity
1	60,65	2006	S ≥ 20% intens flight	N/N	45% (9 years)
2	43,45	1998		N/R	
3	38,93	2009		WD	
4	31,39	2008		W/D	
5	30,18	2005		N/R	
6	26,25	1997		N/N	
7	24,44	1995		N/D	
8	22,36	Average 1993-2012	Abundance >	100% (20 ani)	
9	22,02	1993		C/N	
10	21,12	2007		W/N	
11	19,61	2003	S ≥ 10% medium flight	N/D	45% (9 years)
12	18,11	1994		W/D	
13	16,59	1996		C/R	
14	15,70	2004		W/D	
15	15,09	2000		W/D	
16	14,79	2001		N/R	
17	14,79	2011		N/D	
18	13,89	2010		N/R	
19	12,67	1999		W/D	
20	6,34	2012	S ≤ 10% reduced flight	N/D	10% (2 years)
21	1,20	2002		W/D	

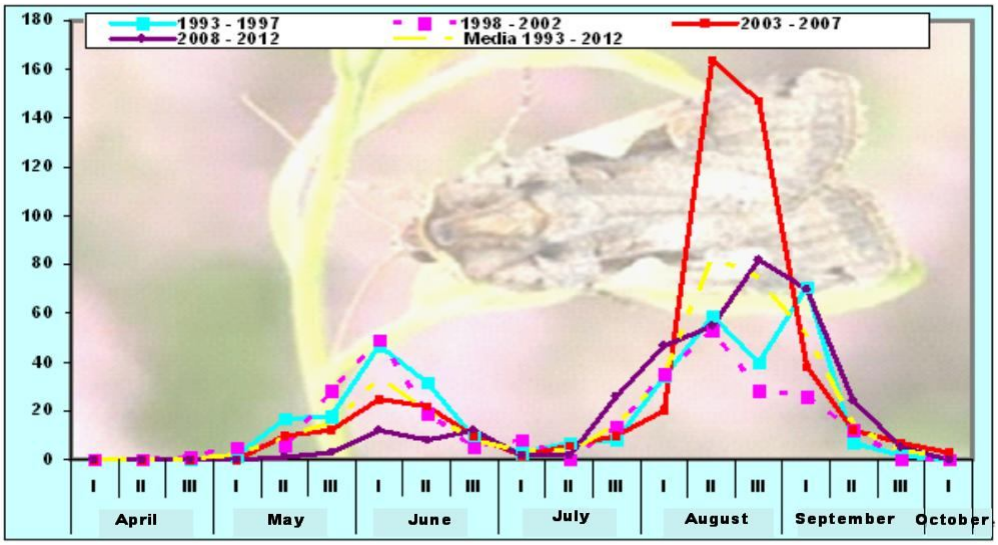

Figure 4 **The flight curve performed by the adults of *Amathes c-igrum* L. species, during 1993 – 2012**

Table 7

The *Amathes c-nigrum* L. species evolutionary cycle duration, under Secuieni - Neamt conditions

Insect stage	Calendar month	Stage occurrence date	Stage duration (days)	Generation
Larva	April	12.04	15	Second generation (hibernating)
Pupa	April	27.04	11	
Adult	May	09.05	35	
Second generation (hibernating)			**61**	
Egg	June	14.06	10	First generation (summer)
Larva	June	24.06	36	
Pupa	July	30.07	10	
Adult	August	09.08	11	
First generation (summer)			**67**	
Egg	August	20.08	9	Second generation (hibernating)
Larva	August	29.08	45	
	September			
	October	12.11		
Second generation (hibernating)			**54**	

CONCLUSIONS

The number of adults of *Amathes c-nigrum* L. species, collected during 1993-2012 was of 1482 specimens from which: 356 specimens in first phase (1993-1997), 289 specimens in the second phase (1998-2002), 488 specimens in the third phase (2003-2007) and 349 specimens in the fourth phase (2008-2012).

The variability coefficient of the species was in average, for the period in which the research were conducted, of 22.36% which qualify the species into the insect class with intense flight for the study area. During the observation period, in 45% of the years the species has recorded an intense flight, in 45% the flight was medium and in 10% it was reduced. The highest number of insects were collected in the years characterized as warm and drought, followed by the normal years in terms of temperature and rainfall, and the lowest catches were obtained in the rainy and cold years.

The flight of the adults of *Amathes c-nigrum* L. species began in the third decade of April or the first decade of May and continued without interruption until the end of September or early October. During this period, April-October, there were recorded two flight curves, the first with the flight peak in the third decade of May or the first decade of June, and the second with a flight peak in the second or third decade of August.

The *Amathes c-nigrum* L. species presented under Secuieni conditions, two generations per year, first, of summer whose duration was of 67 days, and the second hibernating which ensures the species continuity and evolution in the coming years.

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