RESEARCH REGARDING THE EVOLUTION OF *Autographa gamma* L. SPECIES IN CENTER OF MOLDAVIA CONDITIONS

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Abstract

Autographa gamma L. species is a polyphagous pest that attacks most crop plants, but prefer beets, soya, beans, potato, flax, hemp, and from legumes crops: cabbage, tomatoes, cucumbers, cauliflower. The attack occurs in hearths, where at larvae density above ETP (economical threshold pest) of 3 - 5 larvae/sqm is necessary crop protection measures. Adult collection with a light trap, observations and measurements made during 1993 – 2012, showed that *Autographa gamma* L. species was present in the study area, each year, the number of specimens collected ranged from 7 specimens (2002) to 157 specimens (1993), the average collections for the 20 years of observations was of 47,75 exemplare. The emergence of the first adults was recorded in the second or third decade of Aprilie, the insect flight continued without interruption until the end of the first decade of October. During this time, two flight curves were identified, first made by the adults of the hibernating generation, which recorded a flight peak in the second or third decade of May. The second flight curve was made by the adults of the summer generation and reached the top flight in the first or 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 larvae stage in the deeper layers of soil.

Key words: *Autographa gamma*, abundance, light trap, variability coefficient, flight.

Popularly known as the gamma owl, *Autographa gamma* L. species is a migratory insect, polyphagous, common to us, widespread in Europe, North Africa and Asia.

The attack is produced by larvae and is manifested by the appearance of holes of various sizes, on plant leaves. Only in cases of strong attack they completely destroyed the limb, ribs and even the petiole.

Due to the holes produced by larvae on the leaves, the photosynthesized surface is reduced causing production decreases at the attacked plants. In case of invasion may compromise the crops. The larvae are polyphagous, attacking the most cultivated plants, but prefer beets, soya, beans, potato, flax, hemp, and from legumes crops: cabbage, tomatoes, cucumbers, cauliflower (Barbulescu and col. 2002, Popov and col. 2007, Teodorescu and col. 2003).

The attack occurs in hearths and doesn't prefer the presence of another species. In case it is found, in field, the presence of several larvae on plants, above ETP (economical threshold pest): 3-5 larvae/sqm (Beratlief and Nicolescu, 1985) and when 10% of plants shows holes are required pest control measures in order to reduce crop losses.

In the last 5-10 years when forecasting and warning service was reduced to cancellation, the research regarding the knowledge and bioecology of the harmful species, the way of attack and the factors that influence the attack scale present a special importance in limiting populations under ETP (economical threshold pest) in case of larvae mass appearances, in reducing the larvae attacks.

In this paper, are presented data regarding the bioecology of *Autographa gamma* L. species in Center of Moldavia conditions.

MATERIAL AND METHOD

The research were conducted during 1993 – 2012, at A.R.D.S. Secuieni, establishment situated in SE of Neamt county, between the geographic coordinates of 26º5´ east longitude and 46º5´ north latitude, 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. Kőppen), the average annual temperature is 8.7 ºC, and the annual amount of rainfall is 547 mm.

The research consisted of collecting and recording the adults of *Autographa gamma* L. species, with the help of a light trap.

The trap was installed in the experimental field of ARDS Secuieni, the collections and records were

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made annually from 1 April until 31 October. The observations and harvesting of biological material were made every morning and chloroform was completed in the evening.

In the laboratory, collected insects were sorted, separated by species and recorded in the register, on which it was established :

- Species abundance for the study area;
- The beginning and end of the flight;
- Flight duration;
- Flight intensity and flight peak time.

Based on the annual catches was calculated the species variability coefficient, using the formula:

$$Cv\%(s\%) = \frac{s}{x}x100$$

Depending on the values obtained, the insects flight has been characterized as:

- intense, when s≥ 20%;
- medium, when s≥ 10%;
- reduced, when s≤10%.

It has been estimated the regression equations (y = a + bx, where y is the specific value of the variability coefficient (Cv), and x represents the specific annual average of the catch).

In the field were conducted observations and determinations which consisted in ground surveys and determinations that established 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.

RESULTS AND DISCUSSIONS

The number of insects collected at the light trap, during 1993 – 2012, was of 6188 specimens, of which 955 were recorded at *Autographa gamma* L. species (*table 1*).

Calculating the share of the species, after the number of adults collected, it was found that the recorded species were present in the studied area in percentages ranging from 4.35 % to 23.9 %, the *Autographa gamma* L. species has recorded a share of 15.4 % (*figure 1*).

Analyzing the evolution of *Autographa gamma* L. species, it was found that this species was present in the study area in each year of the studied period, the total number of the adults collected in the first phase (1993 – 1997) was of 392 specimens. The most intense flight were recorded in 1993, when there were 137 specimens, followed by 1995 with 84 specimens, and in 1994, 1996, 1997 the number of adults collected was lower, ranging from 42 specimens/year to 58 specimens/year (*table 2*).

In the second phase (1998 – 2002), the number of adults collected was of 210 specimens, the most intense flight was recorded in 2001, when were collected 93 specimens, and the lowest flight was realized in 2002, when were totaled 9 specimens (*table 3*).

In the third phase (2003 – 2007), were collected 166 specimens, the most intense flights were recorded in 2004 and 2005, when were collected 47 respectively 53 specimens/year, and in 2003, 2006, 2007, the flights were almost constant, the number of adults collected ranged between 12 and 27 specimens (*table 4*).

In the fourth phase (2008 – 2012), the total number of adults collected was of 187 specimens, the adult flight totalized 21 specimens in 2011 and 54 specimens in 2010 (*table 4*).

Analyzing the number of adult collected during 1993 – 2012 period, it was found that the *Autographa gamma* L. species was present in the study area, in every year, the number of the specimens collected ranged from 7 specimens/year (2002) to 157 specimens/year (1993), the average of the catches for the 20 years of observation was of 47.75 specimens (*table 5*).

The variability coefficient C_V (s %) of the species for 1993 – 2012 period, was of 22.36 % and ranged between 3.26 %, in 2002 and 73.52 %, in 1993 (*table 5*).

Characterizing the adult flight of *Autographa gamma* L. species, after the annual variability coefficient value, compared to the average variability coefficient value for the entire period it was found that:

- the value of 22.36 % qualify the species into the abundant species category for the study area;
- out of the 20 years analyzed, in 11 years, the variability coefficient of trhe species was ≥ 20 %, which characterized the insect flight as intense, in 5 years, the variability coefficient value was ≥ 10%, the flight being characterized as medium, and in 4 years, the variability coefficient was ≤ 10 %, and the species flight was reduced.

Calculating the share of the years, depending on the flight intensity it was found that in the analyzed period, in 55 % of the years the species flight was intense, in 25 % the flight was medium and in 20 % of the years the flight was reduced (*table 6*).

From the calculation and interpretation of the data it was found that between the annual catches and the variability coefficient there is a direct correlation, the correlation coefficient (r) for *Autographa gamma* L. species was equal to 1 (*figure 2*).

Following the evolution of insect flight, depending on the thermic regime of the years in which the determinations were made it was found that the highest number of catches, of 389 specimens, representing 40.7% of total was recorded during the years characterized as normal, 293 specimens (30.7%) in cool years and 273 specimens (28.6 %), in warm years (*figure 3*).

Analyzing the flight evolution of *Autographa gamma* L. species, depending on the rainfall regime it was found the insect preference to precipitations deficit, the highest number of catches, of 350 specimens (36.6%) was recorded in dry years, followed by 311 specimens (32.6%) in normal years and 294 specimens (30.8%), in the years characterized as rainy years (*figure 4*).

Table 1

The number of specimens collected in the light trap during 1993 – 2012

Species	Phase I 1993 - 1997	Phase II 1998 - 2002	Phase III 2003 - 2007	Phase IV 2008 - 2012	TOTAL
Agrotis segetum	445	292	463	266	1466
Agrotis exclamationis	478	183	484	121	1266
Amathes C - nigrum	356	289	488	349	1482
Autographa gamma	**392**	**210**	**166**	**187**	**955**
Mamestra oleracea	74	98	80	16	268
Mamestra persicariae	121	75	138	123	457
Mamestra W - latinum	14	65	93	123	294
TOTAL					**6188**

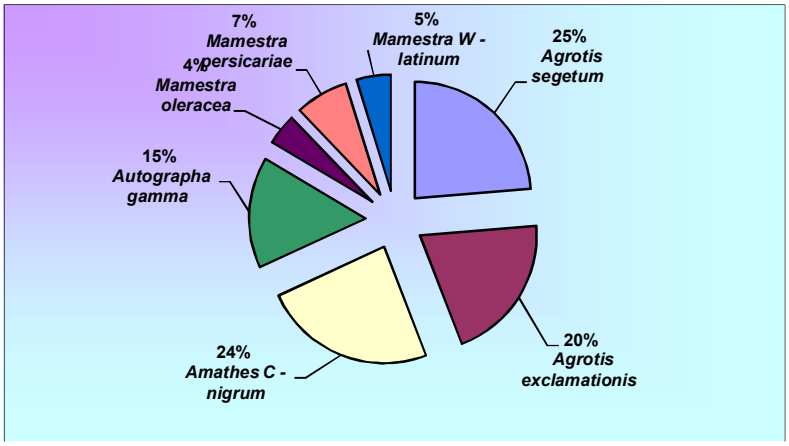

Figure 1 **The share of species, by the number of insects collected**

Table 2

Adults number of *Autographa gamma* L. species, collected in light trap during 1993 – 1997 – phase I

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	3	0	0	**3**
	II	0	0	0	14	1	**15**
	III	0	0	3	0	1	**4**
June	I	0	0	12	0	0	**12**
	II	0	3	3	0	1	**7**
	III	3	2	1	3	1	**10**
July	I	4	3	18	5	11	**41**
	II	14	3	8	9	11	**45**
	III	31	16	10	6	5	**68**
August	I	58	7	11	1	2	**79**
	II	19	1	4	1	0	**25**
	III	19	5	1	5	0	**30**
September	I	7	11	4	4	8	**34**
	II	2	6	3	3	1	**15**
	III	0	1	3	0	0	**4**
October	I	0	0	0	0	0	**0**
Total year		**157**	**58**	**84**	**51**	**42**	**392**

From the analysis of the average flight curves, for the four corresponding stages of 1993 – 2012 period, it was observed that the first adults appeared in the second or third decade of April, adults that began and continued the flight without interruption until the end of the first decade of October.

During this range, April – October, have been identified two flight curves, first performed by the adults of the hibernating generation, which

peak flight was recorded in the second or third decade of May and the second flight curve was realized by the adults of the summer generation, but also by waves of migratory adults, with the peak flight in the first or second decade of August (*figure 5*).

In all the observation years, the second flight curve was more intense compared to the first, with peak flight trends more numerous, generated by waves of migratory butterflies, *Autographa gamma* L. species being described in the specialized literature as a migratory species.

Table 3

Adults number of *Autographa gamma* L. species, collected in light trap during 1998 – 2002 – phase II

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	2	0	0	0	0	**2**
May	I	1	0	0	3	3	**7**
	II	0	0	0	0	0	**0**
	III	1	0	0	1	0	**2**
June	I	2	0	0	1	3	**6**
	II	1	14	0	2	1	**18**
	III	3	3	2	2	0	**10**
July	I	3	0	2	7	0	**12**
	II	6	0	1	15	0	**22**
	III	11	1	4	19	0	**35**
August	I	6	1	12	18	0	**37**
	II	0	1	11	6	0	**18**
	III	0	0	1	13	0	**14**
September	I	5	0	9	6	0	**20**
	II	2	0	5	0	0	**7**
	III	0	0	0	0	0	**0**
October	I	0	0	0	0	0	**0**
Total year		**43**	**20**	**47**	**93**	**7**	**210**

Table 4

Adults number of *Autographa gamma* L. species, collected in light trap during 2003 – 2007 – phase III

Year / Month	Decade	2003	2004	2005	2006	2007	Total decade
April	I	0	0	0	0	0	**0**
	II	0	0	0	0	1	**1**
	III	0	0	0	0	0	**0**
May	I	0	0	0	0	1	**1**
	II	0	0	1	0	3	**4**
	III	0	0	6	0	2	**8**
June	I	0	0	0	0	4	**4**
	II	0	1	0	0	4	**5**
	III	0	3	1	0	0	**4**
July	I	0	2	3	0	0	**5**
	II	4	2	13	0	0	**19**
	III	1	3	8	0	0	**12**
August	I	0	4	3	0	2	**9**
	II	0	1	5	0	4	**10**
	III	0	8	12	18	4	**42**
September	I	4	5	1	4	0	**14**
	II	3	9	0	5	0	**17**
	III	0	9	0	0	0	**9**
October	I	0	0	0	0	2	**2**
Total year		**12**	**47**	**53**	**27**	**27**	**166**

Following the emergence and flight evolution it can be interpreted that in Central of Moldavia conditions, the *Autographa gamma* L. species has two generations/year:

- the second generation (G_2) or the hibernating generation, which evolves in spring, in April and May;
- the first generation (G_1) or the summer generation, which evolves in June, July and first days of August;
- the hibernating generation (G_2) which evolves in August, September and first days of October, through the egg and larval stages, the larval stage is the hibernating stage which ensures the species evolution in the next year (*table 8*).

Table 5

Adults number of *Autographa gamma* L. species, collected in light trap during 2008 – 2012 – phase IV

Year		2008	2009	2010	2011	2012	Total decade
Month	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	2	0	0	**2**
	II	2	0	0	3	0	**5**
	III	0	0	0	1	0	**1**
June	I	2	0	1	0	0	**3**
	II	0	0	2	0	0	**2**
	III	0	0	4	1	3	**8**
July	I	8	12	3	0	10	**33**
	II	0	4	1	0	3	**8**
	III	1	6	9	5	3	**24**
August	I	0	3	2	1	2	**8**
	II	7	8	6	4	0	**25**
	III	6	5	3	1	2	**17**
September	I	4	5	2	3	8	**22**
	II	0	1	8	2	6	**17**
	III	0	0	11	0	1	**12**
October	I	0	0	0	0	0	**0**
Total year		**30**	**44**	**54**	**21**	**38**	**187**

Table 6

The variability coefficient of *Autographa gamma* L. population, for Secuieni – Neamt conditions, during 1993 – 2012 period

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	157	109.25	73.52	7,8	552.2
2	1994	58	10.25	27.16	10.0	423.7
3	1995	84	36.25	39.34	8.9	476.1
4	1996	51	3.25	23.88	7.8	646.2
5	1997	42	-5.75	19.67	8.1	572.1
6	1998	43	-4.75	20.14	8.6	638.1
7	1999	20	-27.75	9.37	9.8	511,8
8	2000	47	-0.75	22.01	10.4	509.6
9	2001	93	45.25	43.55	9.3	656.4
10	2002	7	-40.75	3.28	9.6	512.8
11	2003	12	-35.75	5.62	8.9	458.6
12	2004	47	-0.75	22.01	9.8	507.1
13	2005	53	5.25	24.82	9.1	753.3
14	2006	27	-20.75	12.64	9.0	560.3
15	2007	27	-20.75	12.64	10.3	530.3
16	2008	30	-17.75	14.05	9.8	505.2
17	2009	44	-3.75	20.60	9.7	449.6
18	2010	54	6.25	25.29	8.9	683.0
19	2011	21	-26.75	9.83	8.8	425.5
20	2012	38	-9.75	17.79	9.3	455.2
Average		**47.75**	**0.00**	**22.36**	**9.2**	**541.4**

The data obtained due to the observations carried out under Secuieni – Neamt conditions, are very close to those obtained and published by Stan and col. (1994, 1996) which states that *Autographa gamma* L. is a highly migratory species, the flight realized by the adults of the hibernating generation is more reduced due to a low resistance of the larvae to hibernation, and the fertility of the hibernating population is lower than the summer generation.

CONCLUSIONS

The number of adults of *Autographa gamma* L. species, collected during 1993 – 2012, was of 955 specimens, from which: 392 specimens were collected in first phase (1993 - 1997), 210 specimens in the second phase (1998 – 2002), 166 specimens in the third phase (2003 – 2008) and 187 specimens in the fourth phase (2009 – 2012). The variability coefficient of the species for 1993 – 2012 period, was of 23.36 % which qualify the species into the insect class with intense flight for the study area.

Table 7

Flight characterization of *Autographa gamma* 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	73.52	1993	S ≥ 20% intense flight	C/N	11 years (55 %)
2	43.55	2001		N/R	
3	39.34	1995		N/S	
4	27.16	1994		W/D	
5	25.29	2010		N/R	
6	24.82	2005		N/R	
7	23.88	1996		C/R	
8	22.36	Average 1993 - 2012	Abundance	100 % (20 years)	
9	22.01	2000	S ≥ 20% intense flight	W/D	
10	22.01	2004		W/D	
11	20.60	2009		W/D	
12	20.14	1998		N/R	
13	19.67	1997	S ≥ 10% medium flight	N/N	5 years (25 %)
14	17.79	2012		N/D	
15	14.05	2008		W/D	
16	12.64	2007		W/N	
17	12.64	2006		N/N	
18	9.83	2011	S ≤ 10% reduced flight	N/D	4 years (20 %)
19	9.37	1999		W/D	
20	5.62	2003		N/D	
21	3.28	2002		W/D	

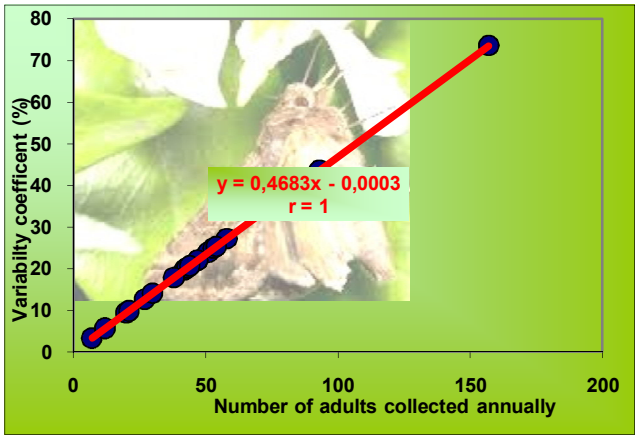

Figure 2 **The correlation between the number of adults collected annually and the variability coefficient at *Autographa gamma* L. species**

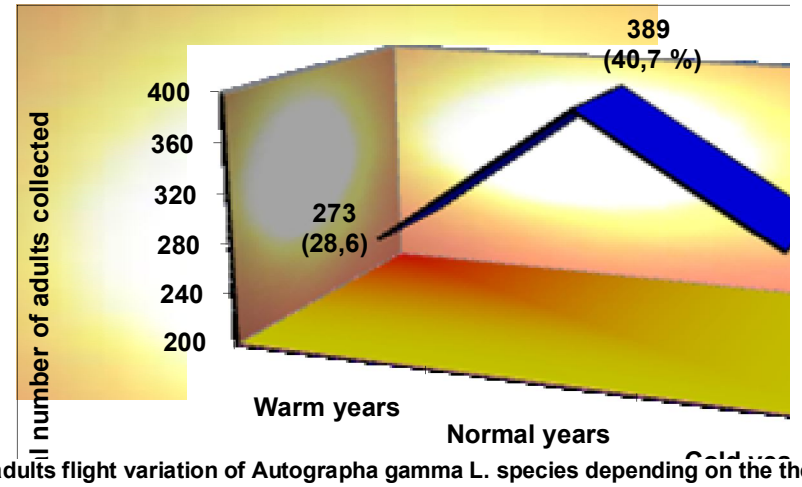

Figure 3 **The adults flight variation of Autographa gamma L. species depending on the thermal regime**

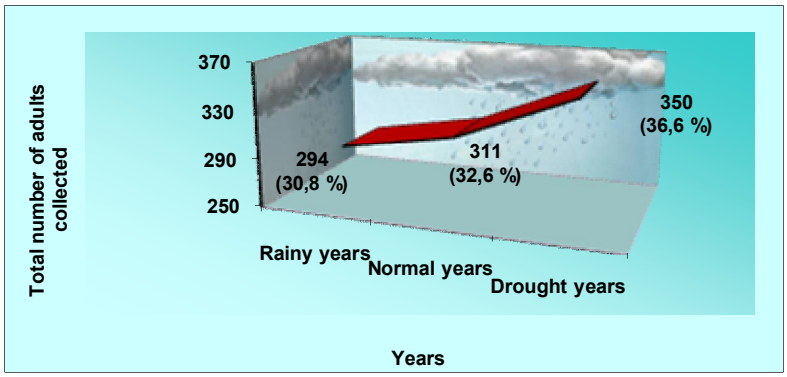

Figure 4 **The adults flight variation of *Autographa gamma* L. species depending on the rainfall regime**

Table 8

The evolution of *Autographa gamma* L. species in Secuieni – Neamt conditions

Insect stage	Calendar month	Generation
Larva	April	Second generation (hibernating)
Pupa	May	
Adults	May	
HIBERNATING GENERATION		
Egg	June	First generation (summer)
Larva	June	
Pupa	July	
Adults	August	
FIRST GENERATION		
Egg	August	Second generation (hibernating)
Larva	August - October	
SECOND GENERATION (HIBERNATING)		

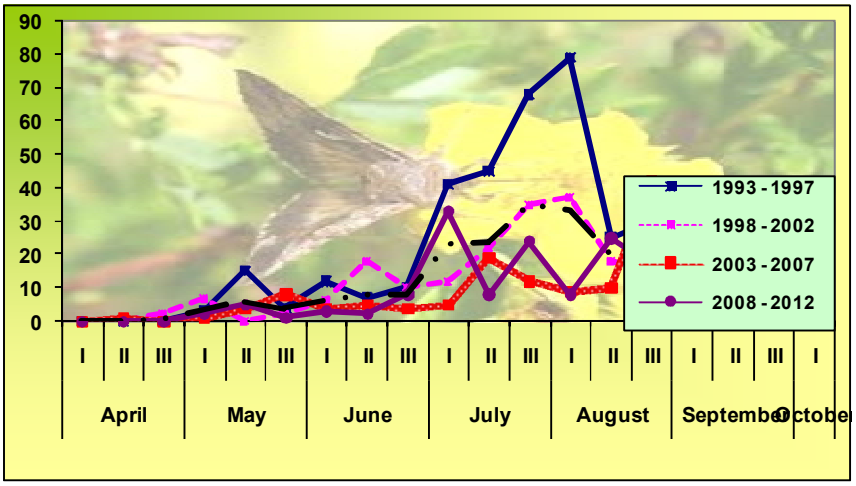

Figure 5. The flight curve performed by the adults of *Autographa gamma* L. species, during 1993 – 2012

Of the 20 years of observation, in 55% of the years, the species has recorded an intense flight, in 25% of the years, the conducted flight was characterized as medium, and in 20% of the years it was reduced.

The highest number of insects were collected in the years characterized as normal years in terms of temperature and dry years in terms of precipitation.

The flight of the adults began in the second or third decade of April and continued without interruption until the end of the first decade of October.

During this period, April – October there were recorded two flight curves, the first with the flight peak in the second or third decade of May, and the second with a flight peak in the second decade of August.

In all the observation years the first flight curve was lower in intensity, due to the low resistance to winter of the hibernating stage and due to the low fertility of the hibernating populations.

The second flight curve was much more intense than the first curve, at this, in addition to the local population, they were added waves of hibernating adults.

According to the flight evolution result that in Secuieni – Neamt conditions, the *Autographa gamma* L. species develops two generations/year, a summer generation and an hibernating generation, which ensures the species continuity and evolution in the coming years.

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