ASPECTS REGARDING THE COLORING OF ADULT INSECTS OF *NEZARA VIRIDULA*

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Abstract. *The Nezara viridula insect is part of the group of Pentatomidae, which refers to stink bugs that play an important role in ecosystems. This species is actually a pest for plants and can also create discomfort in the places where people live. Sometimes it has been observed that in vegetation the insect has a color and in the wintering areas another. In the present paper we wanted to see what are the color categories and how (when) they are changing. Observations were made, therefore, in a short period of time, during 2 months of autumn in 2018 (September and October). Five places were selected, both from vegetation (on the plant) and from pre-wintering (in plant bush, under fresh leaves fallen on the ground, inside the houses and the terraces of the houses) to collect individuals who were subsequently undergoing laboratory coloring studies. The results showed different characteristics with different background color palettes in body of the adult and also in changing of their color. The 4 color phases were cataloged like as follows: standard phase, phase I, phase II, phase III and phase IV. Statistical values of the number of insects included these categories, shown that in Phase II most of the individuals analyzed were present ($\bar{x}$=8.20 ind. with s=5.05 ind.), followed by standard category ($\bar{x}$=4.40 ind./s=9.20 ind.). Regarding the evolution of specimens found in different places at one time, it was establish that at the beginning of September the insects belonging the standard category with color green (of the vegetation) have predominate in samples while at last decade of October those from IV category (with brown color of winter). In conclusion, to the autumn, the insect is changing the color gradually with the decreases in temperature and fall of the leaves of the host plants.*

Keywords*: Insect, pest, Nezara viridula, vegetation, winter, color body.*

INTRODUCTION

The *Nezara viridula* insect is part of the Insecta class, the Pentatomidae family and is believed to be Ethiopian origin. Nowadays, it has expanded to areas around the globe. It is present in Africa, Asia, America, and Europe, the small and large islands in the Pacific.

An analysis of the presence of the insect on the globe shows that it is common in tropical, subtropical, temperate areas, and especially in oceanic areas. Europe is more present in the south and south-east. In Italy, the first appearance was reported in 1985 (COLAZZA ET AL., 1985), and in Romania 7 years later (GROZEA ET AL., 2012).

It can develop up to 4-5 generations per year in warmer areas and 1-2 generations in cooler, temperate areas. The number of generations per year differs, sometimes not knowing the cause. Sometimes, the plants with which they feed themselves can cause their extension or limitation (MARCU AND GROZEA, 2017). The insect is known to be very polyphagous (Todd, 1989), feeding many plants from over 30 botanical families. In Italy, as well as in other parts of Europe, the species is considered an important pest for both cultivated and wild plants, producing crop losses in crop plants (COLAZZA ET AL., 1986; MARCU AND GROZEA, 2017).

The adult form of the species *Nezara viridula*, which is the stage of morphological identification of the species, is characterized by a flattened and wavy form with a length of 12.1-13.1 mm (SQUITER, 2010); according to other authors, their size may reach 17 mm (MCPERSON, 1982). The antennas have different green and black color segments. The wings

are green or brown as appropriate and the legs have the apical yellow part, the eyes are red or dark. The body coloration is green in the vegetative and diapause season or before of winter season (SQUITER, 2010). There is a link between temperature and the photoperiod that causes the insect to enter the diapause (ALI AND EWIESS, 1977) and probably determines the color change, but this is not very clear.

There are some general information about color of insects. So, these are considered among the most colorful organisms by the tegument's characteristics expressed by color, drawing and punctuation. They have a wide range of colors, from hot to cold, individual or mixed. The warm colors are: yellow, red and orange, and the cool colors are green, blue and purple. The brown color is printed directly into the cuticle and shows the colors from the lightest to the darkest depending on the melanin content. The green color is due to the presence of plant chlorophyll, which is found in the hemolymph and tegument (SAITO AND SHIMODA, 1977).

About *Nezara viridula* insect coloring are few references in the literature, so we wanted to see when it begins to change its color and under what conditions.

MATERIAL AND METHODS

The color observation of *Nezara viridula* was carried out during two month (September and October) in 2018, at laboratory of Diagnosis and Phytosanitary Expertise which operates in the Faculty of Agriculture from the BUASVM "King Mihai I of Romania".

Insect specimens were previously harvested from several locations, both on plants (in August) and in the habitats where they were thought to be present during the winter pre-seasons (in September and October) (Table 1).

Table 1

Data on *Nezara viridula* specimens used in the study (habitats, number, data of collection)

No. crt.	Collected places	Number of individuals collected*	Date of collection
1	on the plant	25	September 15, 2018
2	in plant bush	16	October 15, 2018
3	under fresh leaves fallen on the ground	18	October 18, 2018
4	the terraces of the houses (outside)	22	October 20, 2018
5	inside the houses	15	October 23, 2018

**the number of individuals collected at a given time (predefined by climatic conditions) for a duration of 3-4 hours on the day mentioned above*

The individuals collected from each place (which is detailed in Table 2) were previously observed macroscopically and then put in transport containers and taken to the laboratory for analysis at the binocular magnifier (Figure 1).

Each day of collection was chosen based on the presence or absence of favorable factors. The most favorable days were those without wind, precipitation and sunny for an easy work.

Table 2

GPS coordinates and description of collection points

No. crt.	Lat.	Long.	Description of collected place
1	N45° 4533.424	E21° 1329.636	The Botanical Park, Timișoara, Timiș County
2	N45°4400.928	E21°1302.822	The park of University (Campus BUASVM), Timișoara
3	N45°4611.072	E21°1612.414	Green Forest, Dumbravita, Timiș County
4	N45° 4606.120	E21° 1226.261	The terrace of the private house, Timioara, Timiș County
5	N45°4605.322	E21°1327.350	Private house, Timișoara, Timiș County

Figure 1. Observations on the binocular magnifier on adults by Nezara collected from various habitats (the detailed work was done in the DEF laboratory)

RESULTS AND DISCUSSION

The observations made in the autumn of 2018 on the coloring of the insects (adult form) of *Nezara viridula* highlighted several phases of color, in individuals collected from different places like: on the plant, inside the houses, the terraces of the houses (outside), in plant bush and under fresh leaves fallen on the ground. After the morphological analysis at the laboratory and the division of individuals into categories we noticed that they were in 4 of them. The analyzed samples showed different characteristics with different background color palettes. Also, dark colored spots were observed on the ventral side, which grew larger and eventually changing the darker in darker color.

The 4 color phases were cataloged and described as follows:

Standard Phase: the body, both dorsal and fully green ventral, with the obvious characteristic punctuation (the 4 white points in the scout area); is also the standard category (also described in the specialized literature) (Figure 2).

Phase I: the body is almost entirely green, with a distinct brown spot in the ventral; and some yellowish-brown diffuse points on both sides (Figure 3-left).

Phase II: the body has a brownish-green color, more brown than green, with some diffuse green spots on the ventral and dorsal side (Figure 3-middle).

Phase III: the body has a brown-violet color, with few green areas (on the ventral and dorsal side) (Figure 3-right).

Phase IV: the body is brown-reddish-violet, with a lot of small whitish points, the color is uniform on both the dorsal and ventral (Figure 2-bottom).

Table 3

Incorporating insects (collected from different places and dates) in phases/categories as part of the process of color change

Date of collection/number of insect	The phase of insect color				
	Standard Phase	Phase I	Phase II	Phase III	Phase IV
September 15, 2018	21	4	1	0	0
October 5, 2018	1	13	2	0	0
October 10, 2018	0	12	4	0	0
October 20, 2018	0	12	4	2	0
October 23, 2018	0	0	0	5	9
X	*4.40*	*8.20*	*2.20*	*1.40*	*1.80*
s	*9.29*	*5.85*	*1.79*	*2.19*	*4.02*
Sx	*1.70*	*1.07*	*0.33*	*0.40*	*0.73*
CV	*211.13*	*71.32*	*81.31*	*156.49*	*223.61*
Sx%	*38.55*	*13.02*	*14.85*	*28.57*	*40.82*

Figure 2.

The standard color of an active adult of *Nezara viridula* who feeds on plant tissue (Photo by Grozea, September 1, 2018)

The autumn-winter color of an adult of *Nezara viridula* who retreats to the diapause (Photo by Grozea, October 22, 2018)

In Table 3 there are presented gross and statistical values of the number of insects included in the five categories (in the period observed by us and mentioned to Material and method) or phases of the adult color of *Nezara viridula*. Thus, it can be seen that in Phase II, most of the individuals analyzed were present ($\bar{x}$=8.20 ind. with s=5.05 ind.). And in the standard category could be included enough adults ($\bar{x}$=4.40 ind./s=9.20 ind.). In Phase 2, Phase 3 and Phase 4 ($\bar{x}$=2.20

ind. with s=1.79 ind./ $\bar{x}$=1.40 ind. with s=2.19 ind./ $\bar{x}$=1.80 ind. with s=4.02 ind.), the recorded values showed that the number was lower than Phase 1 and Phase Standard.

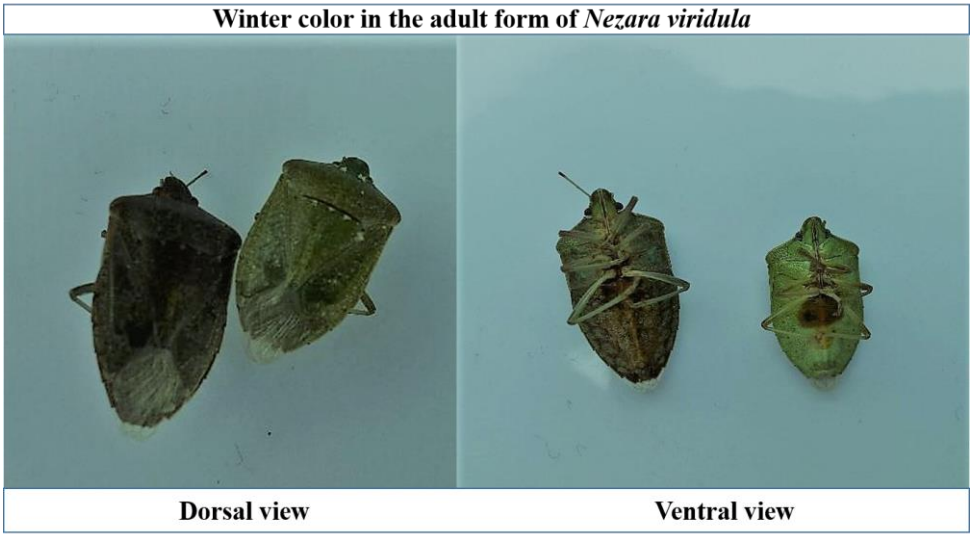

Figure 3. The morphological aspect of dorsal and ventral view on adult of *Nezara viridula* (Photo by Grozea, September-October, 2018)

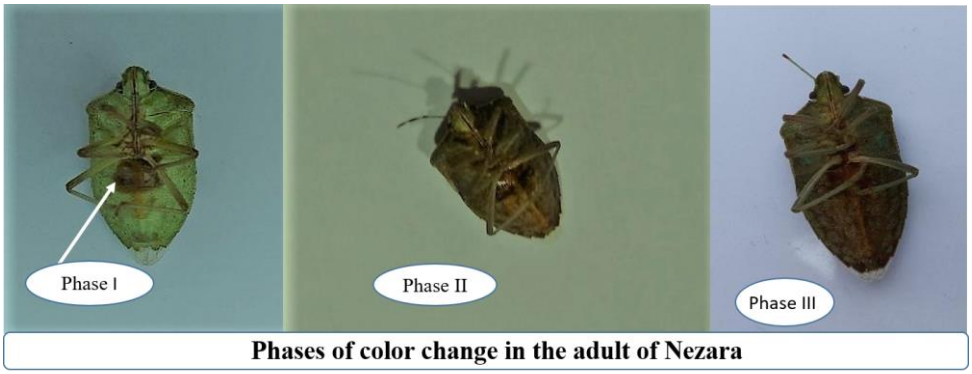

Figure 4. The phases of coloristic in adult of *Nezara viridula* (Photo by Grozea, September-October, 2018)

Following the evolution of the number of specimens found in different habitats at one time, it was found that at the beginning of September the insects of the standard category (characteristic for the color of the vegetation) predominated (Figure 5) and at the end of the study period the ones in the IV (with insects that have already taken the color of winter, brown).

Insects of I color category had an increasing evolution, registering a peak (maximum) on October 5, they were present throughout the study period in all the analyzed sites. The situation was similar for insects in category II (color II). Those in Category III (color III) were present only towards the end of the period (the last decade of October). An analysis of the graphs shows that vegetation color (green) (standard) has sharply declined from September to

October, and those with winter color suddenly appeared in the last decade of October (phase IV/ color IV).

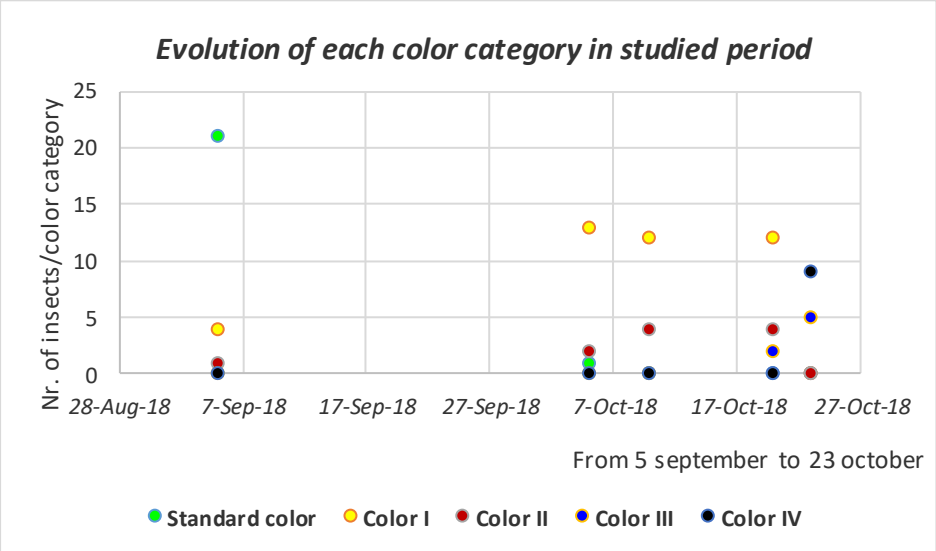

Figure 5. Evolution of number of insects (*Nezara viridula*) from each color category in pre-winter period (from September-October) collected from diverse habitats

CONCLUSIONS

The color of *Nezara viridula* adult insects is changing gradually, probably with the installation of low temperatures, especially during the night (characteristic of the autumn-winter season) known that in the cold season these prefer to retreat to warm places.

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BIBLIOGRAPHY

ALI M, EWIESS M. A., 1977. Photoperiodic and temperature effects on rate of development and diapause in the green stink bug, *Nezara viridula* (Heteroptera: Pentatomidae). J. Acta Phytopathologica Academiae Scientiarum Hungaricae, 12(3/4): 337-347 (EG).

CABI, 1998. *Nezara viridula*- Distribution map of plant pests. Invasive Species Compendium (UK).

COLAZZA S, CIRICIOFOLO E, BIN F, 1985. First observations on damage by *Nezara viridula* (L.) (Het., Pentatomidae) to soyabean in Central Italy. Atti XIV Congresso Nazionale Italiano di Entomologia sotto gli auspici dell'Accademia Nazionale Italiana di Entomologia, della Societa Entomologica Italiana e della International Union of Biological Sciences. Palermo - Erice - Bagheria, 28 maggio-1 giugno 1985 Palermo, Italy; Accademia Nazionale Italiana di Entomologia, 371-378 (IT).

COLAZZA S, CIRICIOFOLO E, BIN F, 1986. Nezara viridula (L.) injurious to soyabean in central Italy (Rhynchota Pentatomidae). Informatore Agrario, 42(34):79-84 (IT).

GROZEA I., STEF R., VIRTEIU A.M., CARABET A., MOLNAR L., 2012. Southern green stink bugs (*Nezara viridula L.*) a new pest of tomato crops in Western Romania. Research Journal of Agricultural Science, 44(2):24-27 (RO).

MARCU V., GROZEA I., 2017. The monitoring results of the green stink bugs (*Nezara viridula* L.) in Caras Severin County. Research Journal of Agricultural Science, 49 (4): 174-179 (RO).

MC PHERSON J.E, 1982. Southern Illinois University Press.The Pentatomoidea (Hemiptera) Of Northeastern North America, 240pp (US).

SAITO H., SHIMODA M., 1977. Insecti-cyanin of Agrius convolvuli, Purification and characterization of the biliverdin-binding protein from the larval hemolymph. Zoological Science, 14: 777–783.

SQUITIER J.M., 2010. Featured creature fact sheets: southern green stink bug, *Nezara viridula* (Linnaeus) (Insecta: Hemiptera: Pentatomidae). EENY-016. University of Florida (US).

TODD J.W., 1989. Ecology and behavior of *Nezara viridula*. Annual Review of Entomology, 34:273-29 (US).