

**SOME DATA FOR THE COLOR/PATTERN POLYMORPHISM  
OF *PHILAENUS SPUMARIUS* (L.) (HEMIPTERA:  
APHROPHORIDAE) IN SINOP POPULATION, TURKEY**

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**ABSTRACT:** The color/pattern polymorphism of *Philaenus spumarius* L. (Hemiptera: Aphrophoridae) was investigated in Sinop, Turkey (West- Black Sea Region). 660 adult spittlebugs were analyzed according to their phenotype and phenotype frequency in Sinop populations. The adult spittlebugs were collected between April-September 2016. In the study area eight different phenotypes; three of them which were non melanics and five melanics were detected. Non melanics are POP (*populus*), TYP (*typicus*) ve TRI (*trilineatus*); melanics are MAR (*marginellus*), LAT (*lateralis*), FLA (*flavicollis*), LCE (*leucocephalus*) and QUA (*quadrimaculatus*). Without sex difference, non melanic frequency was 94.55% and melanic frequency was 5.45% in Sinop populations and melanic forms limited to females. TYP is predominant in females whereas POP in males.

**KEY WORDS:** *Philaenus spumarius*, color polymorphism, Sinop, Turkey

The meadow spittlebug *P. spumarius* (L.) is one of the most common species occurring in terrestrial habitats in temperate regions (Stewart & Lees, 1996). Because of its color/pattern variation, it has become a focal point for polymorphism studies for many years (Drosopoulos, 2003). *P. spumarius* fed on a variety of plants including nitrogen-fixing plants, and distributed in forests, grasslands and scrubs (Thompson, 1984).

Adults of this taxon have inherited color/pattern polymorphism on the dorsal and ventral surfaces (Halkka & Halkka, 1990; Yurtsever, 2000). Although it is known that there are more than 16 phenotypes worldwide, 11 of these phenotypes are more common (Halkka & Halkka, 1990). These phenotypes are categorized as melanics and non-melanics. Three of phenotypes are non-melanics and called as POP (*populus*), TYP (*typicus*) and TRI (*trilineatus*). The non-melanic forms are light-COLOred and have shapes and lines of dark colors. Melanic phenotypes are termed as MAR (*marginellus*), LAT (*lateralis*), FLA (*flavicollis*), GIB (*gibbus*), LCE (*leucocephalus*), QUA (*quadrimaculatus*), ALB (*albomaculatus*) and LOP (*leucoptthalmus*), and they show color lines or shapes. The dorsal color/pattern polymorphism is determined by seven alleles at a single locus with complex dominance and co-dominance relationships (Yurtsever et al., 2010).

The occurrence and frequencies of phenotypes have a distinct geographic variation. Although 11 phenotypes are common in the natural populations, some phenotypes are rare or absent in several populations (Halkka et al., 2001). In New Zealand populations, there are only TYP, POP and FLA phenotypes. In addition, melanics are usually limited to females. But, a few populations deviate from this general rule. For example, melanics are expressed in both sexes in several British populations (Lees & Dent, 1983). These variations arise from environmental conditions and different evolutionary forces. Because of that, numerous studies

have been carried out on ecology and genetics of this species that has a wide distribution in the Holarctic Region (Halkka & Halkka, 1990). In Turkey, faunistic records have been reported from different areas related to *P. spumarius* (Lodos & Kalkandelen, 1981). Also, there are a few polymorphism studies in Turkey populations: Istranca mountain population (Yurtsever & Sal, 2003), some Thrace populations (Yurtsever, 2001), The Central Black Sea-Samsun populations (Zeybekoğlu et al., 2004), North Western Black Sea populations (Yurtsever et al., 2010) and island populations of western parts of Turkey (Yurtsever, 2018).

The present study reports some data about phenotypes and phenotype frequencies of *P. spumarius* for the first time from Sinop (Turkey). Sinop Peninsula located in the northern part of Turkey and it's also a transition area between Western and Middle Black Sea region.

## MATERIAL AND METHOD

The samples evaluated in the study are collected from Sinop (41°12' - 42° 06' N and 34°14' - 35°26') and its surroundings which is located to the east of the Western Black Sea region of Turkey. The collection of samples was carried out periodically between April and October 2016. Adults were collected by using sweeping net over the plants and removed with an aspirator. At each locality an hour was spent on average of one hour was spend fortnightly. The localities were selected from three main routes of Sinop. The first route is the center of the city, Ayancık, Türkeli and Erfelek districts. The localities in this route are at the height of 30-1049 m. Plants which belongs to the family Rosaceae, Fabaceae, Poaceae, Ranunculaceae and Asteraceae are widely spread, including *Quercus* spp., *Phillyrea latifolia*, *Cistus creticus*, *Smilax* sp., *Geranium* sp., *Taraxacum officinale* and various species. The second route is Gerze and Boyabat districts. The selected localities are at the height of 150-870 m. *Fagus* sp., *Ulmus* sp., *Pinus* spp., *Triticum* spp. and other species of Poaceae and Asteraceae are among the common plants of this route. This region also includes agricultural areas. Saraydüzü, Durağan and Dikmen districts make up the third route and the determined localities are at the height of 150-470 m. *Populus* spp., *Clematis* sp. are common plant species and also various taxa of Fabaceae, Poaceae, Salicaceae in this route. Adults were collected from selected meadows, open areas in the forests, forests and over the vegetation cover at the edge of the water.

Collected specimens were labeled and brought to the laboratory. The specimens were prepared by binocular stereomicroscope, diagnosed and made into museum material. Phenotypes were categorized according to Halkka et al. (1973) and Stewart and Lees (1996).

## RESULTS

A total of 660 specimens (312 males and 348 females) were collected from the localities of Sinop province (Table 1). 8 phenotypes with different colors and patterns were determined. Non-melanic phenotypes are POP (populus), TYP (typicus) TRI (trilineata); melanic phenotypes are MAR (marginellus), LAT (lateralis), FLA (flavicollis), LCE (leucophthalmus) and QUA (quadrimaculatus) (Fig. 1). Without sex difference, the ratio of non-melanic phenotypes (POP + TYP + TRI) was 94.55%, and the ratio of melanic phenotypes (MAR + LAT + FLA + LCE + QUA) 5.45% (Fig. 2). The proportion of melanic phenotypes seen in the whole population was 1.5%, LAT 1.5%, FLA 1.4%, LCE 0.45% and QUA 0.45%. Among male and female adults, the POP phenotype was 56% and 27%, TYP 36%

and 52%, TRI 8% and 10.6%, respectively. The rates of melanic phenotypes frequency was 3.2% for MAR, 2.9% for LAT, 2.5% for FLA, 0.9% for LCE and 0.9% for QUA. In the present study, it was also determined that melanic forms were in low frequency and limited only to females (Fig. 3).

## DISCUSSION

*P. spumarius* exhibits exuberant polymorphism. It is known that the majority of *P. spumarius* populations have a rate of over 80% of non-melanic phenotypes (Halkka et al., 1975; Boucelham & Ratikainen, 1988). The frequency values of non-melanic and melanic phenotypes in Sinop populations are similar to those. Furthermore, in some populations in the UK, melanic phenotypes have 95% and they can be seen in both sexes. But the populations examined in Sinop, melanic phenotypes are limited to females as similar to the reported other populations from Turkey as well as. Melanic form was not found in male specimens. This distinction between the sexes is associated with another locus interacting with the main color/pattern locus (Yurtsever, 2001). The dominant phenotypes were POP by 56% in males and TYP by 52% in females. These results are similar to other Turkey populations too (Yurtsever, 2001; Yurtsever & Sal, 2003; Zeybekoğlu et al., 2004).

There are seven different alleles responsible from different phenotypes. Expression of "t, T, M, L, F, C and O" alleles results in "POP+TYP, TRI+VIT, MAR, LAT, FLA, LCE+GIB+FLA and QUA+ALB+LOP" phenotypes, respectively (Halkka et al., 1973; Stewart & Lees, 1996). The alleles responsible from other morphs are unknown. When eight phenotypes were evaluated, it was determined that there were at least six different alleles in the Sinop population. In Samsun population, the phenotypes expressed by 'O' allele could not determine (Zeybekoğlu et al., 2004). In the contrary, Sinop population has this allele. There is no similar study from the Eastern Black Sea Region, and it should be studied to compare the results.

In previous studies, nine phenotypes (POP, TYP, TRI, MAR, FLA, LCE, GIB, ALB, LOP) were identified from the Western Black Sea region of Turkey. LAT and QUA phenotypes were not reported in Western Black Sea populations previously (Yurtsever et al., 2010). In the present study, these two morphs were found in the Sinop population. On the other hand, GIB, ALB and LOP phenotypes which were reported by Yurtsever et al. (2010) were not observed in Sinop.

The variation in the frequency of 16 morphs worldwide is explained by factors such as vegetation type, urban industrial pollution, thermal selection and elevation. The melanics may be directly by urban industrial pollution and height. In the some European and North American populations, the frequency of TRI phenotype shows a negative correlation with height. In addition, the presence or absence of some alleles in populations is thought to be the result of selective effects such as the founder effect and genetic drift, like as Gökçeada case (Turkey). Only POP and TYP phenotypes were found in this island population, and it was thought that the population established by the individuals carrying only the alleles causing to these two morphs (Yurtsever, 2018).

It is seem that the temperature factor is very effective on the population density of *P. spumarius*, because population sizes are small in Sinop provinces according to the hot areas. Sinop province has a cool and rainy Mediterranean climate (Kılınç & Karaer, 1995). It is thought that the temperature and humidity is not suitable sufficiently for survive the nymphs in this region. Because the most

important climatic factors in distribution of *P. spumarius* are temperature and humidity (Akdeniz, 2008).

*P. spumarius* is a polyphagous species and has a wide variety of host plants. It has been reported so far that 20 different plant species belonging to Boraginaceae, Celastraceae, Iridaceae, Ranunculaceae, Apiaceae, Salicaceae, Asteraceae, Fabaceae and Poaceae in Turkey (Kaygın & Ekici, 2017). In the present study, the numbers of different morphs changed according to localities. Five phenotypes in Gerze and Erfelek; four phenotypes in Boyabat and Ayancık; and two phenotypes were determined in other localities. However Boztepe Peninsula all of these eight phenotypes. Boztepe Peninsula (Fig. 4) is at 0-200 m height and surrounded by sea on three sides. It is connected to mainland by a tombolo. *Sarcopoterium spinosum* (L.) Spach, which is a spiny dwarf shrub, constitutes 70-80% of the woody plants in the area and this vegetation is termed as phrygana (Elmas & Kutbay, 2017). Also, the number of individuals collected from this peninsula was more than it's in the other localities. Having all the morphs and high number of individuals can be related to Mediterranean type vegetation. Microclimate of this area could maintain more suitable conditions for nymphs. In addition, spiny vegetation could protect the individuals from predators, and ensure to be a population with high number.

Polymorphic species provide good examples to understand evolutionary process. It is very important to determine the factors affecting the distribution of alleles in populations. Evolutionary forces or other selective factors that shape this variation in natural *P. spumarius* populations can be demonstrated by comparisons and genetic studies. (Yurtsever & Sal, 2003).

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Figure 1. Eight dorsal COLOR/pattern phenotypes distributed in Sinop populations. First row from right; POP, TYP ve TRI; second row from right; MAR, LAT, LCE; third row from right; FLA and QUA.

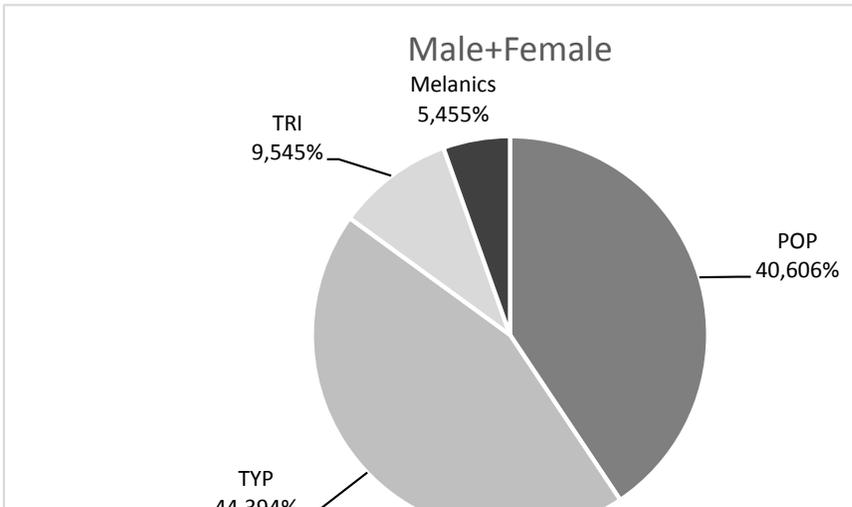


Figure 2. Percentage of phenotypes of *Philaenus spumarius* found in Sinop.

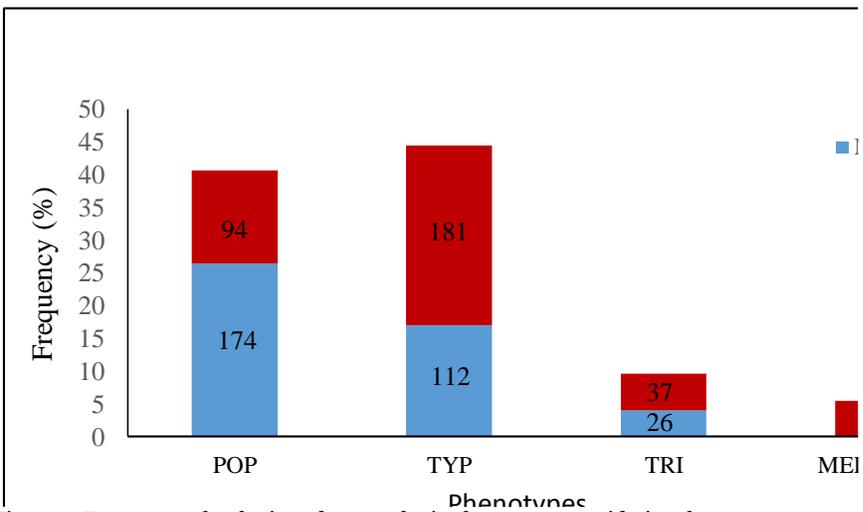


Figure 3. Frequency of melanic and non melanic phenotypes considering the sexes.

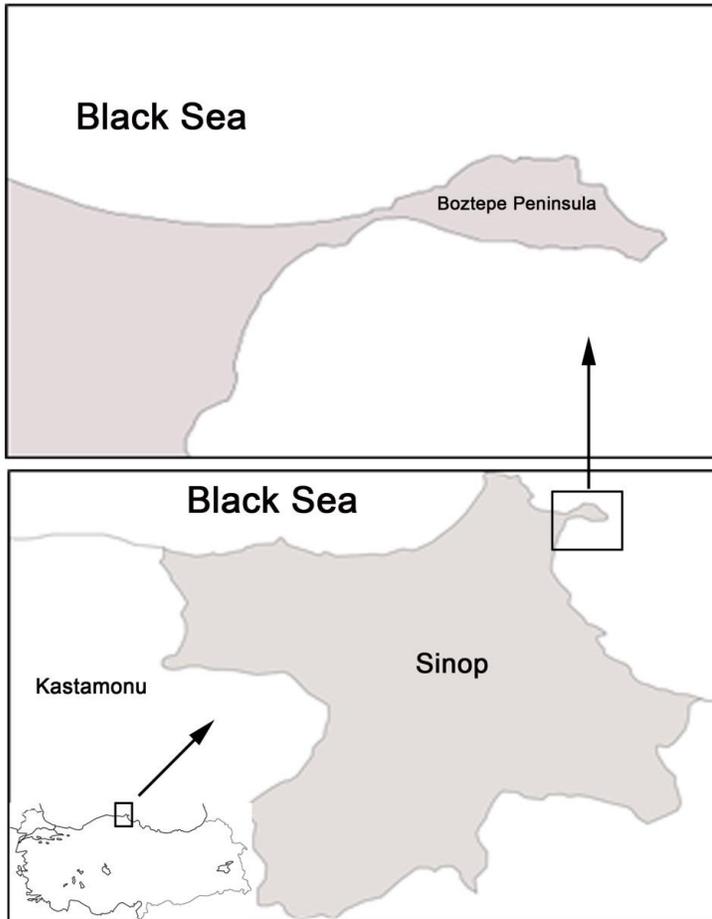


Figure 4. Boztepe Peninsula (Sinop).

Table 1. Frequencies of 8 phenotypes collected from Sinop.

Phenotypes	Male	Female	Total
POP	174	94	268
TYP	112	181	293
TRI	26	37	63
MAR	0	11	11
LAT	0	10	10
FLA	0	9	9
LCE	0	3	3
QUA	0	3	3
<b>Total</b>	<b>312</b>	<b>348</b>	<b>660</b>