

## *Distribution and Activity of Caspian Whip Snake Dolichophis caspius (Gmelin, 1789) (Reptilia: Colubridae) in South-Western Bulgaria*

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**Abstract.** The purpose of the study is to supplement, summarize and analyse data about the distribution and activity of *Dolichophis caspius* in south-western Bulgaria. The new data about the species were collected from 1991 to 2019 during herpetological surveys. The total number of records until now is 420: 148 of them can be found in previous publications, and 272 are reported for the first time. There are published data about 10 pieces of shed skins, and other 17 are newly registered. All data available indicate, that *D. caspius* is widespread in the study area. The species spreads northward throughout Zemen Gorge in the Struma River valley, and northward throughout Momina Klisura Gorge in the Mesta River valley. It is the most common snake in these areas (up to 1000-1100 m a.s.l.) where 12 other snake species also occur. *D. caspius* is active from the third decade of March till the first decade of November. No winter activity of the species has been recorded, despite the active search in December, January and February in some years. The period of activity can be divided in three – a period of very low, low and high activity. The snake is very warm-loving. It remains active even during the hottest months, and was observed only during the day most often around mid-day and 4 p.m.

**Key words:** Serpentes, colubrid snakes, ecology, ethology, biogeography, Balkan Peninsula.

### Introduction

The Caspian Whip Snake (or the Large Whip Snake), *Dolichophis caspius* (Gmelin, 1789), is one of the largest, swiftest and strongest European snakes. In the recent past this Whip Snake was regarded as a subspecies of *Dolichophis jugularis* (Linnaeus, 1758), but today it has a rank of a species. Until recently, in addition to the nominate form (*D. caspius caspius*) the subspecies *D.*

*caspius eiselti* (Zinner, 1972) was also included (see ZINNER, 1972). It is considered now that the taxon *D. caspius eiselti* belongs to the species *D. jugularis*, so *D. caspius* is a monotypic species (see CATTANEO, 2012; 2018).

The geographical range of the Caspian Whip Snake spreads over south-eastern Europe and the extreme part of western Asia: Hungary, S Romania, E Bosnia-Herzegovina,

Croatia, Macedonia (now North Macedonia), S Montenegro, Serbia, Albania, Bulgaria, Greece (including many islands), W Turkey (including Imroz Island), Moldavia, S Ukraine, SW Russia (Dagestan), extreme NW Georgia, extreme NE Turkey and extreme NE Azerbaijan (WALLACH *et al.*, 2014). In Bulgaria the species is widespread in the lower parts, up to about 800-1100 m a.s.l., where the climate is warmer (BESHKOV & NANEV, 2002; BISERKOV *et al.*, 2007; STOJANOV *et al.*, 2011). As an exception, the species was found in Maleshevska Mountains (south-western Bulgaria) at 1580 m a.s.l. (BESHKOV, 1974). In south-western Bulgaria this snake is distributed in some parts of the valleys of Struma and Mesta Rivers, as well as on the slopes of the surrounding mountains (BISERKOV *et al.*, 2007; STOJANOV *et al.*, 2011). The species is a East Sub-Mediterranean faunal element and its significance for the zoogeographical subdivision of Bulgaria was defined by PULEV (2016) to be quite great. *D. caspius* was defined as an *indicator species* which range delineates very well the boundaries of the Sub-Mediterranean areas in the country.

The Caspian Whip Snake occurs in natural, but also in anthropogenic habitats. It was registered in some large cities in Bulgaria - Russe (KOVATSCHEFF, 1912), Plovdiv (MOLLOV & VELCHEVA, 2010), Blagoevgrad (PULEV & SAKELARIEVA, 2013), and Burgas (NATCHEV *et al.*, 2016).

Concerning its activity, according to ZINNER (1972) "throughout its distributional range the species hibernates between December and March; the time of highest activity is from April to June; the mating season is between the end of March and the end of May; the eggs are laid about 1½ to 2 months after mating". In the territory of Bulgaria, the species is active from late March/early April to late October, and the copulation takes place in May/early June (BESHKOV & NANEV, 2002; BISERKOV *et al.*, 2007; STOJANOV *et al.*, 2011). The results from a research conducted in south-western Bulgaria by DYUGMEDZHIEV *et al.* (2019)

indicate that in 2018 the species emerged from hibernation during the third decade of March and the first decade of April. There are also 2 published records of winter activity in Bulgaria (see BURESCH & ZONKOV, 1934; BESHKOV, 1964). In the territory of the country the Whip Snake is active only during the day (BESHKOV & NANEV, 2002; BISERKOV *et al.*, 2007; STOJANOV *et al.*, 2011).

Data about the distribution and activity of the Caspian Whip Snake in south-western Bulgaria are reported by BURESCH & ZONKOV (1934), BESHKOV (1964, 1974), BESHKOV & NANKINOV (1979), BESHKOV & GERASIMOV (1980), BESHKOV & DUSHKOV (1981), NÖLLERT *et al.* (1986), KANTARDZHIEV (1992), BISERKOV (1995), PETROV & BESHKOV (2001), PESHEV *et al.* (2005), NAUMOV (2005), PETROV *et al.* (2006), PULEV & SAKELARIEVA (2011, 2013), TZANKOV *et al.* (2011), DOMOZETSKI (2013), POPGEORGIEV *et al.* (2016), GROZDANOV *et al.* (2016), MALAKOVA *et al.* (2018), MANOLEV *et al.* (2019), CAS (2010-2019), BALEJ & JABLONSKI (2006-2019), and DYUGMEDZHIEV *et al.* (2019). Most publications contain the place and date (sometimes the time) of registration, the individuals observed (number, age, condition), the shed skins, and more recent papers include also geographical coordinates of the locations.

The main purpose of the study is to supplement, summarize and analyze data about the distribution and activity (seasonal and 24-hour) of *D. caspius* in south-western Bulgaria.

### Material and Methods

The new data about the Caspian Whip Snake were collected from 1991 to 2019, more intensively during the last years - 2013-2019 (more than the half of the records), and with single records in some years (1991, 1994, 1999-2001, 2004, 2007). The species has been registered during herpetological surveys (field trips) in various habitats. It has been searched for, day and night, in different months (including in December, January, and February in some years), and in various weather conditions. The specimens killed on

the road have been registered both accidentally and as a result of targeted searches. The dead individuals have been defined as “fresh” when their death occurred within 48 hours before their registration.

Unpublished data from the collection of the Regional Historical Museum in the city of Blagoevgrad (RHMB), collected in south-western Bulgaria in 1978, 1980, 1982, and 1984, were also used for the present research. All published and new data about observed alive and dead individuals, and shed skins have been used to specify the spread of the species in south-western Bulgaria. All data (published and new) about alive, “fresh” road-killed and other found “fresh” dead specimens have been included in the analysis of the seasonal activity pattern. The twenty-four-hour activity pattern has been analysed based on all published and new data about the alive active individuals for which the time of observation was recorded.

The separate locations of the species (both new and published) were grouped according to their affiliations to the squares of the Universal Transverse Mercator (UTM) grid with a resolution of 5×5 km. The grid-cells were indicated by the codes of the 10-km quadrates of Military Grid Reference System (MGRS; spatially identical with UTM) and capital letters (A-D) were used to denote the separate 5×5 km squares within every 10×10 km square (A indicates the southwestern square, B - the northwestern, C - the southeastern, and D - the northeastern). Mapping and map visualization were done in the projection coordinate system “WGS 84 UTM 35N” by means of ArcGIS v. 10.1 (ESRI, Redlands, CA, USA).

Most of the new records have been collected by the authors of the paper: A. Pulev [AP], G. Manolev [GM], L. Domozetski [LD], B. Naumov [BN], and L. Sakelarieva [LS]. Some of the data have been collected separately or in collaboration with the authors by other colleagues (see the Acknowledgements). The collectors have been noted with their initials in Appendices 3 and 4.

Data which are not included in some previous publications (NAUMOV, 2005; PULEV & SAKELARIEVA, 2011; 2013; DOMOZETSKI, 2013; MALAKOVA et al., 2018) are added in this article and marked with \*\* in Appendices 1 and 2.

All data of observation (locality, geographic coordinates, altitude, date and time, the number, age and condition of individuals) are summarized in tables and the localities are marked on a map.

### Results and Discussion

The total number of records of *Dolichophis caspius* in south-western Bulgaria until now is 420: 148 of them can be found in previous publications, and 272 are reported now for the first time (see Appendices 1 and 3).

Records of more than 168 individuals have been published till now (not always detailed). At least 135 of them were alive at the time of their registration, 11 were found dead (probably killed by people) and 22 were road-killed (15 of them “fresh”). The number of reported adults is the highest (n=55), followed by the number of juveniles (n=13) and subadults (n=8). Exact dates, geographic coordinates or sufficiently precise locations have been specified for most of the records (three of them were during the hibernation period), while the information about the time of observation is extremely scarce (see Appendix 1).

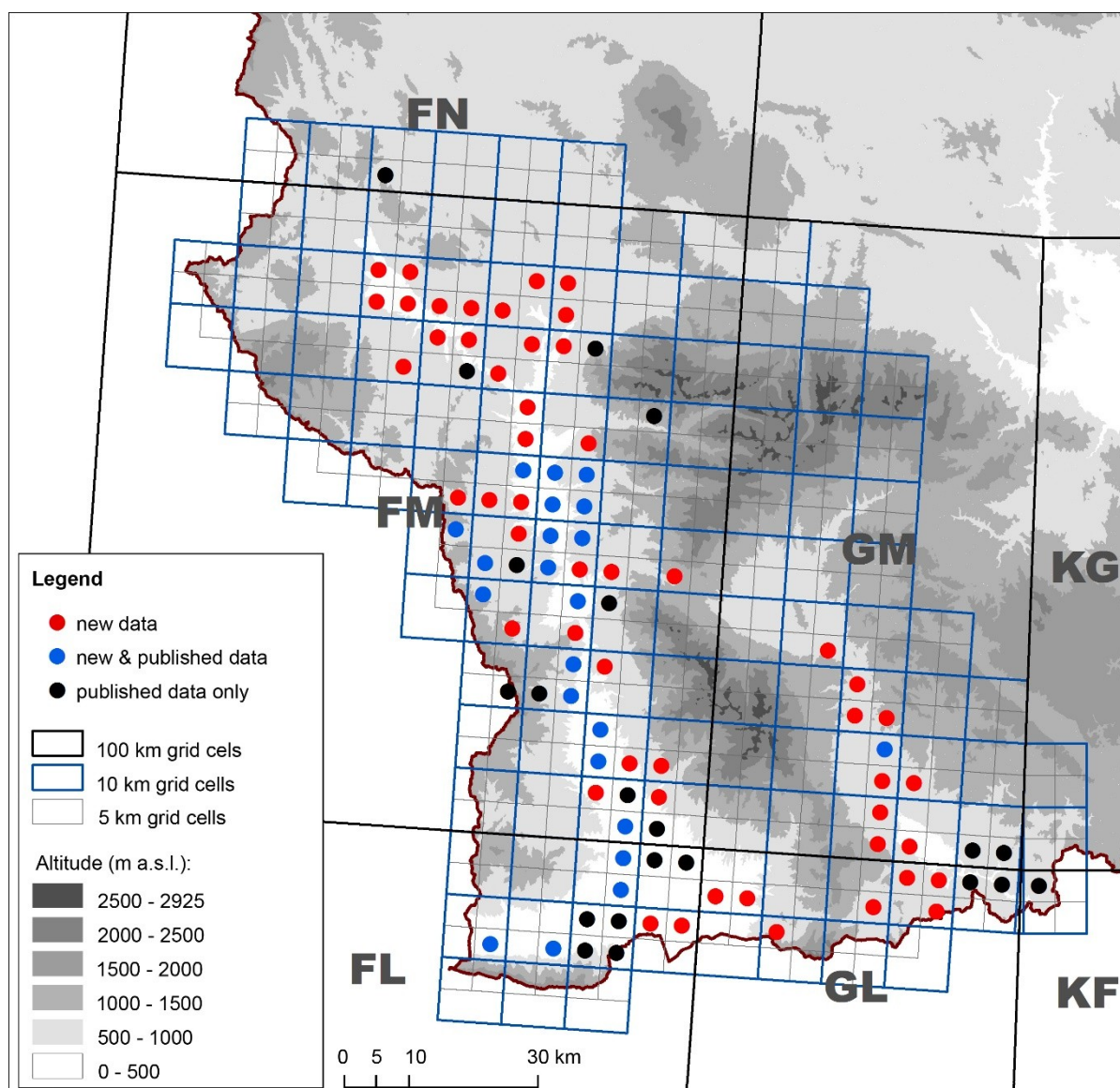
The new data about *D. caspius* in south-western Bulgaria include 272 records (263 field observations and 9 museum specimens) of 293 individuals. Most of them (163, 148 of which “fresh”) have been registered killed on the road, but the number of the alive individuals was not small as well (127). The dead ones found, without specified cause of death, were only 3. Most of the individuals registered were adult (n=225), and the number of subadults (n=38) and juveniles (n=30) was significantly smaller (see Appendix 3).

There are published data about 10 pieces of shed skins, and other 17 pieces are newly

registered (16 of adult individuals, and 1 of juvenile) in 11 localities (see Appendices 2 and 4).

The large number of published (102) and new (283) exact locations indicate, that the Caspian Whip Snake is widespread in the study area. The species spreads northward throughout Zemen Gorge in the Struma River valley, and northward throughout Momina Klisura Gorge in the Mesta River valley. It is the most common snake in these areas (up to 1000-1100 m a.s.l.),

where according to BESHKOV & NANEV (2002) 12 other snake species also occur. The known localities of *D. caspius* in the research area fall into 94 squares of a 5 km UTM grid. The published localities refer to 43 squares (for 22 of them new data are presented here as well), and the new ones fall in other 51 squares (Fig. 1). The presence of “white spots” on the map in the areas, where the species is likely to occur, as described above, is due to the less explored or unexplored territories.



**Fig. 1.** Distribution of *Dolichophis caspius* in south-western Bulgaria, based on a 5 km UTM grid.

The species is found mainly in the plain-hilly belt. The new records are from areas with altitude up to 1000-1100 m, which corresponds to the publications of BESHKOV & NANEV (2002), BISERKOV *et al.* (2007) and STOJANOV *et al.* (2011) about the vertical distribution of *D. caspius* in the country. As the altitude increases, the number of registrations sharply decreases. In the range 700-1000 m a.s.l. there are only 11 new records, and other 8 have been reported in previous publications (the highest of which was from 936 m, TZANKOV *et al.*, 2011) (see Appendices 1, 2 and 3). Above 1000 m a.s.l. the species was registered only three times – two of the records are reported now (from 1036 and 1095 m a.s.l.) (see Appendix 3), and the third one was published by BESHKOV (1974). It was from 1580 m a.s.l., but against the background of this study such altitude seems rather like an exception.

The species is found at the highest altitudes in the territory of south-western Bulgaria. Reaching altitudes of 1000-1100 m by this plain-hilly species is probably due to the warmer climate, the great difference in altitude, and the suitable habitats in this part of the country. Most of the other reptile species (see PULEV *et al.*, 2018a) also occur at a higher altitude in south-western Bulgaria compared to other parts of the country.

This research confirmed the conclusion made by PULEV (2016) that the Caspian Whip Snake has significant role for the zoogeographical subdivision of Bulgaria, as its range delineates very well the boundaries of the Sub-Mediterranean areas in the country. The species has been indicated as a typical representative of Sub-Mediterranean biogeographic space in southern Romania (DRUGESCU & GEACU, 2004).

The distribution of *D. caspius*, as well as of two other reptile indicator taxa defined by PULEV (2016) – *Testudo graeca iberica* Pallas, 1814 and *Podarcis tauricus* (Pallas, 1814), show the presence of two Sub-Mediterranean zoogeographical areas in south-western Bulgaria. They cover the valleys of Struma and Mesta Rivers, as well

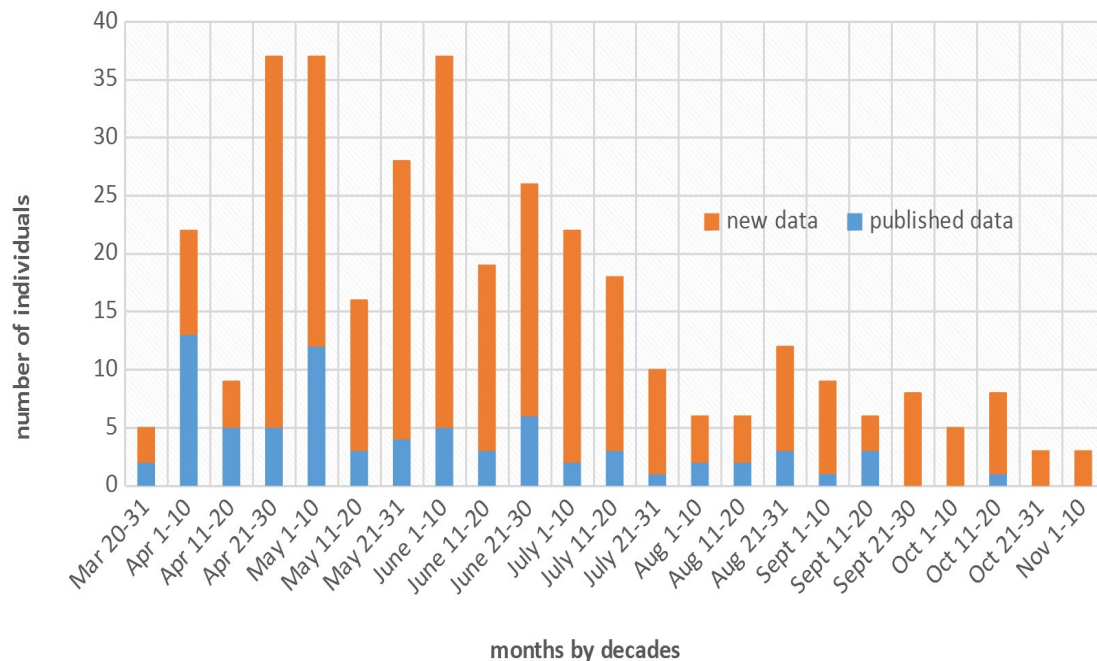
as the slopes of the surrounding mountains, from the boundaries of the Struma and Mesta Mediterranean areas (see PULEV *et al.*, 2018b) to 800-1100 m a.s.l. Struma Sub-Mediterranean area can expand to the north covering the entire Zemen Gorge, and Mesta Sub-Mediterranean area can end northward including the entire Momina Klisura Gorge. The two areas are isolated from each other by Slavyanka, Pirin and Rila Mountains.

The large number of published (76) and new (276) records of active individuals, “fresh” road-killed or other dead ones indicates that *D. caspius* in south-western Bulgaria is active for most of the year. The species is active from the third decade of March till the first decade of November and most active during the third decade of April, the first decade of May and the first decade of June. It is the least active in the beginning and at the end of the active period (Fig. 2). The annual activity corresponds (generally) to what is reported by BESHKOV & NANEV (2002), BISERKOV *et al.* (2007) and STOJANOV *et al.* (2011) for the territory of Bulgaria, as well as to what is published by ZINNER (1972) for the whole range, but the present research offers more details. The activity pattern of the species in south-western Bulgaria is similar to that of another snake – *Malpolon insignitus* (Geoffroy Saint-Hilaire, 1827) (see PULEV *et al.*, 2018a), although the latest survey was presented by months rather than decades and includes a much smaller number of records.

The period of activity of *D. caspius* in south-western Bulgaria can be divided in three – a period of very low, low and high activity. The period of very low activity covers the time before and after hibernation (the third decade of March, the third decade of October and the first decade of November). The earliest spring registration of an active individual is from March 26, and the latest autumn one is from November 08 (see Appendix 3). Both individuals were recorded in sunny and warm weather. They were subadults, and were moving very slowly (in semi-torpid state). Probably emerging and entering hibernation depend on the meteorological conditions of the year and on the habitats (type, location, altitude, exposure), i.e.

vary to some extent. Therefore, we assume that in addition to the indicated period of very low activity, emerging from and entering hibernation include the first decade of April and the second decade of October. Thus, in different years, the populations of the species in south-western Bulgaria emerge from hibernation within 2 decades and enter hibernation within three. A

recent study by [DYUGMEDZHIEV et al. \(2019\)](#) shows the same period of emerging from hibernation (the third decade of March and the first decade of April). The very low activity at the end of the active period (the third decade of October and the first decade of November) was identified in that study, although this activity is not surprising.



**Fig. 2.** Number of observed individuals of *Dolichophis caspius* per decades in south-western Bulgaria.

The high activity period includes the time from the first decade of April to the second decade of July with a peak around the middle (a total of 11 decades). Decreases in values during some of the decades (the second of April, the second of May and the second of June) are probably due to irregular and insufficient observations. The period of high activity can be related to the reproductive behavior – emerging from hibernation (active eating, territorial behavior, finding a partner, copulation) to laying eggs. We do not have data on copulation of this species in the territory of south-western Bulgaria, but we do have one observation from a territory very close to the

one surveyed (in North Macedonia) from the middle of the high activity period. On 27.05.2018, 12:15 p.m. 2 copulation individuals were registered near the Bulgarian church in Star Doyran (N41°11'19" E22°43'08", 163 m a.s.l.). A copulation from the same decade of May (22.05.2006) was registered also in Hungary by [BELLAAGH et al. \(2008\)](#).

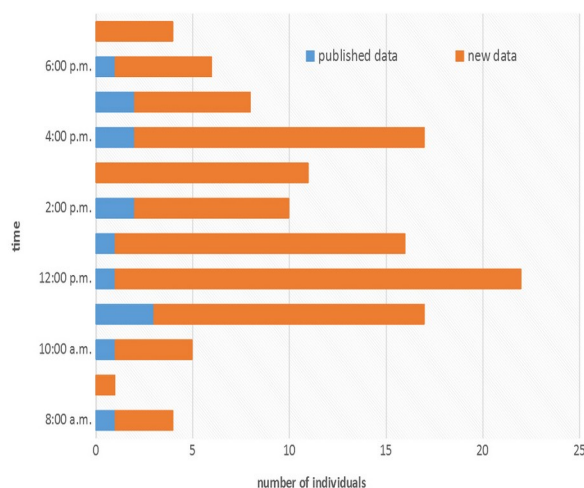
The low activity period starts from the third decade of July and ends by the second decade of October, including a total of 9 decades. It covers the time from laying eggs to preparing for hibernation. Activity is stable during this period with no sharp downturns and peaks that outline any trend. The differences in the values in the separate

decades can also be explained by irregular and insufficient number of observations.

No winter activity of the species has been recorded in south-western Bulgaria, despite the active search in December, January and February. The two reported observations are from other parts of the country - in the vicinity of the town of Septemvri on 18.12.1930 (BURESCH & ZONKOV, 1934), and near the village of Lakatnik on 02.02.1955 (BESHKOV, 1964). The winter activity of the species reported by BESHKOV (1977) and BESHKOV & NANEV (2002) probably refers to the one registered in Lakatnik. The lack of such activity in south-western Bulgaria (though it is possible) indicates that this behavior is rather an exception for *D. caspius*.

The diurnal activity of the Caspian Whip Snake reported by BESHKOV & NANEV (2002), BISERKOV *et al.* (2007) and STOJANOV *et al.* (2011) in the territory of the country has been confirmed completely. Information is available about 121 live individuals (107 new and 14 published records) with an exact time of registration. The snake was only observed during the day from 7:55 *a.m.* to 7:05 *p.m.* (recorded in this study). The highest activity is recorded around mid-day, there is a second peak around 4 *p.m.* While during the high and low seasonal activity the registrations are at different times of the day, during the very low activity period (emerging from and entering hibernation) the records are only from the warmer part of the day (between 10:40 *a.m.* and 4:25 *p.m.*, maximum around and after mid-day) (see Appendices 1 and 3, Fig. 3). Similar data about the activity of *Vipera ammodytes* (Linnaeus, 1758) in Bulgaria were reported by BESHKOV (1993a). No nocturnal activity of the Caspian Whip Snake was recorded during the study, unlike other mainly daily active snake species (*Natrix natrix* (Linnaeus, 1758), *Natrix tessellata* (Laurenti, 1768), *Zamenis situla* (Linnaeus, 1758), *Zamenis longissimus* (Laurenti, 1768), and *Vipera ammodytes*) which have been registered in the night during the research period.

During the warmest and driest months of the year (July, August), *D. caspius* has been found throughout the day, including in the hours with the highest temperatures - 1:00-4:00 *p.m.* (see Appendix 3). This shows the great heat resistance of the species reported by other authors too. BESHKOV (1993a) writes that in the southern half of Kresna Gorge and the neighboring parts of the Maleshevska Mountains, in June and July, when daytime temperatures are particularly high (between 1:00 and 2:30 *p.m.*), the largest number of specimens of *D. caspius* was collected (compared to other snakes in the area).



**Fig. 3.** Number of observed individuals of *Dolichophis caspius* per hours in south-western Bulgaria.

The activity pattern of the species in south-western Bulgaria shows that it is very warm-loving - it emerges from hibernation relatively late, it is even active during the hottest months as well as in the hours with the highest temperatures.

The species has been found in urbanized habitats in the study area. There are a number of records not only from the city of Blagoevgrad (including from the city center), but also from many smaller settlements (see Appendices 1 and 3). Possible prerequisites for this are the availability of suitable micro-habitats and a

good nutritional base. According to its level of synanthropy after the classification given by KLAUSNITZER (1990) *D. caspius* was determined as a *hemerodiaphoric* species for the city of Blagoevgrad (PULEV & SAKELARIEVA, 2013) and for the city of Plovdiv (MOLLOV, 2014; 2019).

Most of the individuals recorded are adults (n=225) and their ratio to the subadults is 6:1. The very small number of juveniles (n=30) is probably due mainly to their small size. It is much more difficult to observe alive juvenile individuals in the wild, as well as to record road-killed ones. Since their small size makes them difficult to kill on the road. Juveniles may be much more cautious and less active than adults and subadults, since they have many natural enemies, have no reproductive behavior. On the other hand, the large number of adult and subadult individuals can be partly explained by the long life of the species. It matures at 3-4 years of age and lives up to 10-15 years (ZINNER, 1972; ARNOLD, 2002).

Different authors (BESHKOV, 1993b; ARNOLD, 2002; NATCHEV *et al.*, 2016; TYTAR & NEKRASOVA, 2016; SPEYBROECK *et al.*, 2016) note that the Caspian Whip Snake is often killed by traffic. Specific cases of road-killed specimens are found in many publications (for example PULEV & SAKELARIEVA, 2011; MALAKOVA *et al.*, 2018; MANOLEV *et al.*, 2019; BALEJ & JABLONSKI, 2006-2019; SAHLEAN *et al.*, 2019). There are even specialized studies addressing the problem of reptiles killed on the road (containing data about *D. caspius*) as those published by TOK *et al.* (2011), KAMBOUROVA-IVANOVA *et al.* (2012), COVACIU-MARCOV *et al.* (2012), MOLLOV *et al.* (2013). According to ARNOLD (2002) the basks on roads is the main reason for the frequent road killing in its entire range, while SPEYBROECK *et al.* (2016) indicate the species active foraging strategy. NATCHEV *et al.* (2016) reported both reasons for the city of Burgas and the surrounding area (south-eastern Bulgaria).

The large number of road-killed specimens in south-western Bulgaria (found

in both previous and present studies) could not be related only to the above mentioned reasons. We have data for both cases, but they are rare. For example, the juvenile individual of *D. caspius* registered on 04.06.2017 (MALAKOVA *et al.*, 2018) pursued subad. *Lacerta viridis* (Laurenti, 1768) on the road - a case of foraging behavior. The published ad. *D. caspius* recorded on 13.10.2018 by MANOLEV *et al.* (2019) was sunbathing on the road. Much larger is the number of registrations at which individuals are observed to cross the road during their daily movements without knowing the exact reason for this. For example, those published by MANOLEV *et al.* (2019): 1 subad. on 01.07.2018, 1 juv. on 19.09.2018, 1 subad. on 19.09.2018, the records from this study: 1 ad. on 29.04.2012, 1 ad. on 11.06.2016, 1 ad. on 20.05.2017, 1 ad. on 10.06.2017, 1 ad. on 31.05.2018, 1 ad. on 02.06.2018, 1 juv. on 11.05.2019, 1 ad. on 07.07.2019, 1 subad. on 07.07.2019, 1 ad. on 10.08.2019, and others. *D. caspius* is the most widespread snake up to 1000 m a.s.l. with high population densities in the study area. The large size of the species also makes it very vulnerable to traffic (this is the largest snake in Bulgaria - see BESHKOV, 1964; TELENICHEV *et al.*, 2019). Last but not least, the diurnal activity of the species probably contributes to its killing on the road (traffic is much busier during the day).

#### Acknowledgements

The authors would like to thank to all colleagues who have provided their personal data (Boyan Petrov [BP], Bogoljub Sterijovski [BS], Dragan Chobanov [DC], Dobrin Dobrev [DD], Emilian Stoynov [ES], Georgi Gogoushev [GG], Hristo Peshev [HP], Irina Lazarkevich [IL], Krasimir Donchev [KD], Krasimir Stoyanov [KS], Lilia Philipova [LP], Miroslav Ivanov [MI], Mario Langourov [ML], Maria Naumova [MN], Martin Stanchev [MS], Nikolay Karaivanov [NK], Oleg Krastev [OK], Rayka Ivanova [RI], Stoyan Lazarov [SL], Stoyan Mihaylov [SM], and Zharko Velev [ZV]), to Rayka Ivanova and Tonya Marinova (Regional Historical



Museum in the city of Blagoevgrad) for the assistance provided in checking the museum collections, to Krasimir Stoyanov (South-West University "Neofit Rilski") for the advice on drafting the manuscript.

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Received: 17.09.2019  
Accepted: 20.12.2019