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FLIGHT SEASONALITY OF DRAGONFLIES (INSECTA, ODONATA) IN NORTHEASTERN UKRAINE

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Сезонная динамика лёта стрекоз (Insecta, Odonata) на северо-востоке Украины. Хрокало Л. А., Шешурак П. М. — На основе полевых наблюдений и обработки коллекционного материала за 1992–2004 г. приведены данные по периодам лёта стрекоз северо-восточной части Украины (Киевской, Черниговской, Сумской, Черкасской и Харьковской областей). Уточнены данные сроков лёта в пределах Украины для *Chalcolestes parvidens* Artobolevsky, *Coenagrion armatum* Charpentier, *Brachytron pratensis* Mueller, *Aeshna affinis* van der Linden, *Anax imperator* Leach, *Gomphus vulgatissimus* Linnaeus, *Ophiogomphus cecilia* Geoffroy, *Cordulia aenea* Linnaeus, *Epiheca bimaculata* Charpentier, *Sympetrum danae* Sulzer, *Leucorrhinia rubicunda* Linnaeus, *L. caudalis* Charpentier. Построены графики сезонной динамики лёта для 13 видов. Все 55 зарегистрированных видов стрекоз распределены между 6 сезонными группами. Проведено сравнение оригинальных и литературных данных по количеству видов, находящихся в фазе имаго по сезонам года.

Ключевые слова: стрекозы, Odonata, периоды лёта, сезонные группы.

Flight Seasonality of Dragonflies (Insecta, Odonata) in Northeastern Ukraine. Khrokalo L. A., Sheshurak P. M. — Data on seasonal flight periods of Odonata in Northeastern Ukraine (Kyiv, Chernigiv, Sumy, Chekasy and Kharkiv administrative regions) based on field observations and a review of material collected during 1992–2004 are provided. It resulted in revised datasets on flight seasonalities for *Chalcolestes parvidens* Artobolevsky, *Coenagrion armatum* Charpentier, *Brachytron pratensis* Mueller, *Aeshna affinis* van der Linden, *Anax imperator* Leach, *Gomphus vulgatissimus* Linnaeus, *Ophiogomphus cecilia* Geoffroy, *Cordulia aenea* Linnaeus, *Epiheca bimaculata* Charpentier, *Sympetrum danae* Sulzer, *Leucorrhinia rubicunda* Linnaeus and *L. caudalis* Charpentier. The graphs of flight seasonalities of 13 frequently occurred species are plotted. All 55 species recorded are distributed among six seasonally defined groups. Own field data on the numbers of species occurring during seasons of year as adults, and the data from the literature are compared.

Key words: dragonflies, Odonata, flight periods, seasonal groups.

Introduction

Flight period and adult numbers of different dragonfly species are determined for two general reasons, duration and synchronism of adult emergence and period of adult life. Synchronism and period of emergence are conditioned by peculiarities of life cycles. P. S. Corbet (1954) divided temporal Odonata into two ecological types. The first type, “spring species” is characterized by a winter diapause in the penultimate or final larval stage of all specimens of the population, which makes mass synchronous spring emergence possible. In the second ecological type, “summer species” the diapause of most individuals does not occur in the final larval stages. Instead, eggs, larvae of different stages or adults overwinter. The process of emergence of “summer species” is asynchronous and prolonged over a lengthy period.

Duration of the adult stage is affected by species peculiarities, by the climate and weather (directly or indirectly). For example, an indirect influence of the weather can be found in the quantity and availability of food.

Phenologic data is usually obtained during faunistic and ecology investigations. Thus, general information on the flight periods of dragonflies was contained in faunistic papers of different Ukrainian regions. Flight

seasonality of Odonata was the theme of studies in central and western parts of Ukraine (Артоболевский, 1927; Горб, Павлюк, 1993; Горб и др., 2000), in the Transcarpathian lowland of the Zakarpats'k region (Добей, Бондарчук, 1998), in Donets'k region (Олигер, 1980) and in the South (Kherson government and Crimea) (Браунер, 1902).

Material and methods

Adult dragonflies were caught by using an entomological net, 40 cm diameter with a collapsible stick 2,5 m long. Damselflies (*Zygoptera*) were collected by "mowing" the general coastal vegetation. Most *Anisoptera* were caught by directed net sweeps, one at a time. Exuviae were gathered by hand on objects protruding from water or from submerged and coastal vegetation.

Material was collected at 124 sites, situated within the Kyiv, Chernihiv, Sumy, Cherkasy and Kharkiv administrative regions of Ukraine. 7795 imago and 246 exuviae were collected and identified. Of these, 1197 specimens were accepted from N. Matushkina collection, the remainder were collected by the authors during 1992–2004.

The relative quantity for each species was estimated by limited logarithmic scale (Pesenko, 1982). Indices of relative quantity were established according to general numbers of collected specimens as follows: 1–6 specimens – very rare species; 7–40 – rare; 41–260 – common; 261–1600 – frequent; > 1600 – abundant.

Graphs of the seasonal flight periods of Odonata were plotted for 13 frequent species by calculating the proportion (%) of specimens caught each ten-day period with respect to the total number of specimens caught during the whole flight period. Confidence intervals were determined by the angles δ method, which followed conversion of radians into percents. Such method gives more exact results for low deals (< 0,2) (Песенко, 1982; Плохинский, 1970).

Results and discussion

55 species of Odonata were recorded in the area of study. Data from the literature on the flight periods of dragonflies in Ukraine were tabulated, together with original data from our study of the relative quantity of species and their flight periods in Northerneastern Ukraine (tabl. 1).

Thus, more detailed information was revealed on the flight periods in Ukraine of 12 Odonata species: *Chalcolestes parvidens* Artobolevsky, *Coenagrion armatum* Charpentier, *Brachytron pratensis* Mueller, *Aeshna affinis* van der Linden, *Anax imperator* Leach, *Gomphus vulgatissimus* Linnaeus, *Ophiogomphus cecilia* Geoffroy, *Cordulia aenea* Linnaeus, *Epitheca bimaculata* Charpentier, *Sympetrum danae* Sulzer, *Leucorrhinia rubicunda* Linnaeus and *L. caudalis* Charpentier.

In addition, one case of an overwintering *Sympetrum sanguinum* adult was recorded, a threadbare mature male on 6.05.1997 in the environs of Yaduty village (Borzna district, Chernigiv region).

In Northeastern Ukraine, 8 very rare species, 15 rare species, 19 common species and 13 frequent species were collected. The large numbers of specimens of frequent species collected enabled graphs of adult seasonality to be plotted (fig. 1–13).

Ukrainian dragonflies were divided into six seasonal groups according to their flying periods (Горб и др., 2000). Species of Northeastern Ukraine were distributed among these groups as follows.

1. Species which overwintered as adults (belonging to the "summer" ecological type according to Corbet's classification (Corbet, 1954). Overwintering adults began to fly early spring on the first sunny days. Copulation and oviposition occurred in May. Adults of this generation were active in flight until summer. Larvae developed during a two-three month period. In general, asynchronous emergence started at the beginning of August (although in some years this may be earlier). Adults of the summer generation flew until a stable frost established. Two species (*Sympetma paedisca* and *S. fusca*) belonged to this seasonal group.

2. Spring species. Odonata species from this group were characterized by a mass synchronous emergence from the end of April until the beginning of June ("spring species" according to P. S. Corbet (1954). Copulation and oviposition usually took

Table 1. Terms of adult flying and indices of relative quantity of Odonata species for Northeastern Ukraine
Таблица 1. Сроки лёта имаго и показатели относительной численности видов стрекоз для северо-восточной части Украины

Family, species	Sources of data	Months									Indices of relative quantity
		IV	V	VI	VII	VIII	IX	X	XI		
Calopterygidae											
<i>Calopteryx virgo</i> (Linnaeus, 1758)	1		**	***	***	** ?					Common
	2		**	***	***	*					
<i>C. splendens</i> (Harris, 1782)	1		***	***	***	***	** ?				Frequent
	2		***	***	***	***	*				
Lestidae											
<i>Lestes dryas</i> Kyrby, 1890	1			***	**	**	*				Common
	2			*	**	**	*				
<i>L. sponsa</i> (Hansemann, 1823)	1		**	***	**	**	**	**	**		Frequent
	2			*	**	**	*				
<i>L. barbarus</i> (Fabricius, 1798)	1			***	**	**	**	*			Common
	2			***	**	**	**	*			
<i>L. virens</i> (Charpentier, 1825)	1		?	***	**	**	**	**	**		Common
	2			*	**	**	**	*			
<i>Chalcolestes parvidens</i> (Artobolevsky, 1929)	1							**	*		Rare
	2			*	**	**	**	*			
<i>Sympetma fusca</i> ^o (van der Linden, 1823)	1	**	**	*	**	**	**	*			Rare
	2		*		*	**	*				
<i>S. paedisca</i> (Brauer, 1877)	1	**	**	**	**	**	**	**	**	**	Common
	2	**	**		*	**	**	*			
Platycnemididae											
<i>Platycnemis pennipes</i> (Pallas, 1771)	1		**	**	**	**	*				Frequent
	2		**	**	**	**	*				
Coenagrionidae											
<i>Coenagrion armatum</i> (Charpentier, 1840)	1		**	*							Very rare
	2	*	**								
<i>C. hastulatum</i> (Charpentier, 1825)	1	*	**	**	**	*					Common
	2		**	**	*						
<i>C. pulchellum</i> (van der Linden, 1823)	1		**	**	**	**	*				Frequent
	2		**	**	**	*					
<i>C. puella</i> (Linnaeus, 1758)	1		**	**	**	**	*				Frequent
	2		**	**	**	*					
<i>C. lunulatum</i> (Charpentier, 1840)	1		**	**							Very rare
	2			*							
<i>C. ornatum</i> (Selys, 1850)	1		*	**	**	*					Very rare
	2			*							
<i>Erythromma najas</i> (Hansemann, 1823)	1	*	**	**	**	**	*				Frequent
	2		**	**	**	**	*				
<i>E. viridulum</i> Charpentier, 1840	1		??*	**	**	**	*				Common
	2		*	**	**	**	*				
<i>Ischnura pumilio</i> (Charpentier, 1825)	1		**	**	**	**	**	*			Rare
	2		**	**	**	*					
<i>I. elegans</i> (van der Linden, 1823)	1		**	**	**	**	*				Frequent
	2		**	**	**	**	*				
<i>Enallagma cyathigerum</i> (Charpentier, 1840)	1		**	**	**	**	**	*			Frequent
	2		**	**	**	**	*				

Continue tabl. 1

Family, species	Sources of data	Months									Indices of relative quantity
		IV	V	VI	VII	VIII	IX	X	XI		
Aeshnidae											
<i>Brachytron pratensis</i> (Mueller, 1768)	1		***	***							Rare
	2		***	***	***						
<i>Aeshna mixta</i> (Latreille, 1805)	1			***	***	***	***	***	**		Common
	2				**	***	***				
<i>A. affinis</i> van der Linden, 1823	1			***	***	***	*				
	2			***	***	***	**				
<i>A. viridis</i> Eversmann, 1836	1			***	***	***					Rare
	2			**	***						
<i>A. cyanea</i> (Mueller, 1764)	1				***	***	***	***	***		Common
	2				***	***	***				
<i>A. grandis</i> (Linnaeus, 1758)	1		**	***	***	***	***	***			Rare
	2			***	***	***					
<i>Anax imperator</i> Leach, 1815	1		*	***	***	***	***	***			Common
	2		**	***	***	***	***	*			
<i>Anax parthenope</i> (Selys, 1839)	1		**	***	***	*					Very rare
	2			*							
<i>Anaciaeschna isosceles</i> (Mueller, 1767)	1		***	***	**						Common
	2		**	***	**						
Gomphidae											
<i>Stylurus flavipes</i> (Charpentier, 1825)	1		*	***	***	***	*				Rare
	2			***	**						
<i>Gomphus vulgatisimus</i> (Linnaeus, 1758)	1		***	***	*						Common
	2		***	***	***	*					
<i>Ophiogomphus cecilia</i> (Geoffroy, 1785)	1			**	***	***	*				Very rare
	2			***							
Corduliidae											
<i>Cordulia aenea</i> (Linnaeus, 1758)	1	*	***	***	*						Frequent
	2		***	***	***	*					
<i>Somatochlora metallica</i> (van der Linden, 1825)	1		**	***	***						Rare
	2		**	***	***						
<i>S. flavomaculata</i> (van der Linden, 1825)	1		**	***	***	**					Rare
	2		*	***	**						
<i>Epiheca bimaculata</i> (Charpentier, 1825)	1		***	***							Common
	2		***	***	*						
Libellulidae											
<i>Orthetrum cancellum</i> (Linnaeus, 1758)	1		**	***	***	***					Common
	2			***	***	*					
<i>O. albistylum</i> (Selys, 1848)	1		*	***	***	**					Rare
	2		*	***	*						
<i>Libellula depressa</i> Linnaeus, 1758	1	**	***	***	***	*					Common
	2		***	***	*						
<i>L. fulva</i> Mueller, 1764	1		**	***	***	**					Rare
	2		**	***	*						
<i>L. quadrimaculata</i> Linnaeus, 1758	1	*	***	***	***	***	??				Frequent
	2		***	***	*						

Continue tabl. 1

Family, species	Sources of data	Months									Indices of relative quantity
		IV	V	VI	VII	VIII	IX	X	XI		
<i>Crocothemis erythraea</i> (Brulle, 1832)	1		*	***	***	***	***	***			Very rare
	2			***	**						
<i>Sympetrum flaveolum</i> (Linnaeus, 1758)	1		*	***	***	***	***				Frequent
	2			***	***	***	**				
<i>S. pedemontanum</i> (Allioni, 1766)	1			**	***	***	***				Rare
	2				**	**					
<i>S. danae</i> (Sulzer, 1776)	1				**	***	***	*			Rare
	2				***	***	***				
<i>S. vulgatum</i> (Linnaeus, 1758)	1			***	***	***	***	***	***	***	Frequent
	2			**	***	***	***	***	**		
<i>S. striolatum</i> (Mueller, 1764)	1			**	***	***	***	***	**		Very rare
	2					*					
<i>S. sanguineum</i> (Mueller, 1764)	1			***	***	***	***	***	**		Frequent
	2			***	***	***	***	***	*		
<i>S. meridionale</i> (Selys, 1841)	1				***	***	***				Common
	2				***	***	***				
<i>S. depressiusculum</i> (Selys, 1841)	1			**	***	***	***	***	*		Rare
	2					*	**				
<i>Leucorrhinia dubia</i> (van der Linden, 1825)	1		**	**	?						Rare
	2		**								
<i>L. pectoralis</i> (Charpentier, 1825)	1		***	***	***						Common
	2		***	***							
<i>L. rubicunda</i> (Linnaeus, 1758)	1			***	***						Common
	2		***								
<i>L. caudalis</i> (Charpentier, 1840)	1		**	***	*						Rare
	2		*	***	**						

Notes. The star (*) means the 10-day period in which adults was found; ? – the literature data needs confirmation; ° – flying of spring (overwintered) generation of *Sympecma fusca* was recorded from the end of March (in Crimea – in the end of February) according to the literature data.

In column of sources of data: 1 – literature data for the whole territory of Ukraine, 2 – data from original study for northeastern Ukraine.

place from the end of May until the middle of June. Some specimens flew in the middle of summer. Nine species *Coenagrion armatum*, *Coenagrion hastulatum*, *Brachytron pratense*, *Anaciaeschna isosceles*, *Epithea bimaculata*, *Libellula quadrimaculata* (fig. 10), *Leucorrhinia dubia*, *L. pectoralis* Charp, *L. rubicunda* belonged to this seasonal group.

3. Spring-summer species. The flight period of the species of this seasonal group was split between spring and summer. A mass synchronous emergence took place for some of the species (“spring” ecological type by Corbet’s classification), but emergence of others was asynchronous, prolonged from the beginning of spring until the middle of summer (“summer” ecological type by Corbet’s classification). Thirteen species belonged to this group: *Calopteryx virgo*, *Coenagrion lunulatum*, *C. ornatum*, *C. puella* (fig. 3), *C. pulchellum* (fig. 4), *Gomphus vulgatissimus*, *Sylurus flavipes*, *Cordulia aenea* (fig. 9), *Somatochlora metallica*, *S. flavomaculata*, *Libellula depressa*, *L. fulva*, *Leucorrhinia caudalis*.

4. Summer species (belong to the “summer” ecological type by Corbet’s classification). Species of this group were characterized by an asynchronous emergence, which took place from the beginning to the middle of summer. Adults usually flew until the end of the summer, but some specimens flew in the beginning of the autumn. Eight species

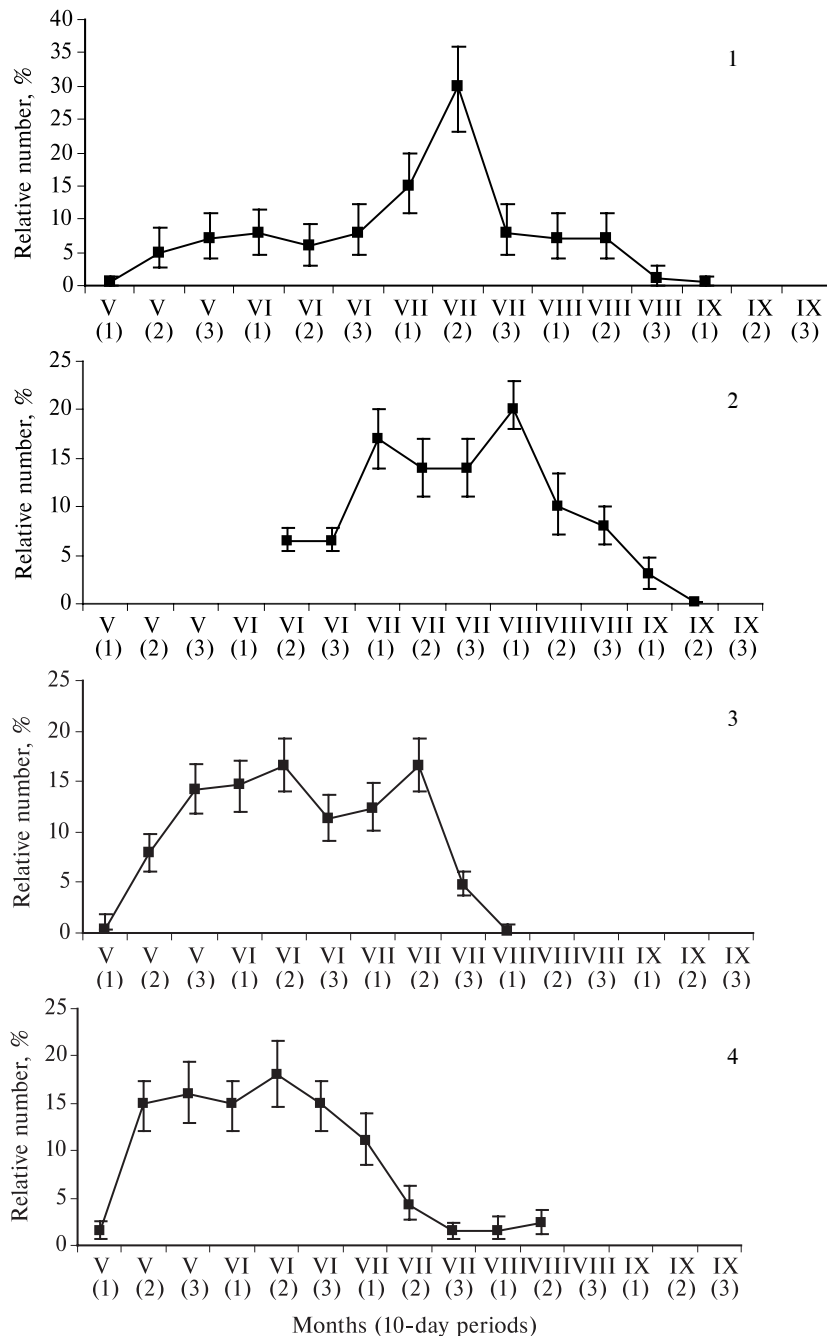


Fig. 1—4. Seasonal dynamics of flying: 1 — of *Calopteryx splendens*; 2 — of *Lestes sponsa*; 3 — of *Coenagrion puella*; 4 — *Coenagrion pulchellum*.

Рис. 1—4. Сезонная динамика лёта: 1 — *Calopteryx splendens*; 2 — *Lestes sponsa*; 3 — *Coenagrion puella*; 4 — *Coenagrion pulchellum*.

identified in this group were: *Lestes dryas*, *Erythromma viridulum*, *Aeshna grandis*, *Ae. viridis*, *Anax parthenope*, *Ophiogomphus cecilia*, *Orthetrum albistylum*, *O. cancellatum*.

5. Summer-autumn species (belong to the “summer” ecological type by Corbet’s classification). Adult flew in the summer and autumn. Emergence of such species was asynchronous; therefore there was no one distinct peak in the number of flying specimens (fig. 2, 11, 12, 13). Durations of adult flight activity in the autumn depended on

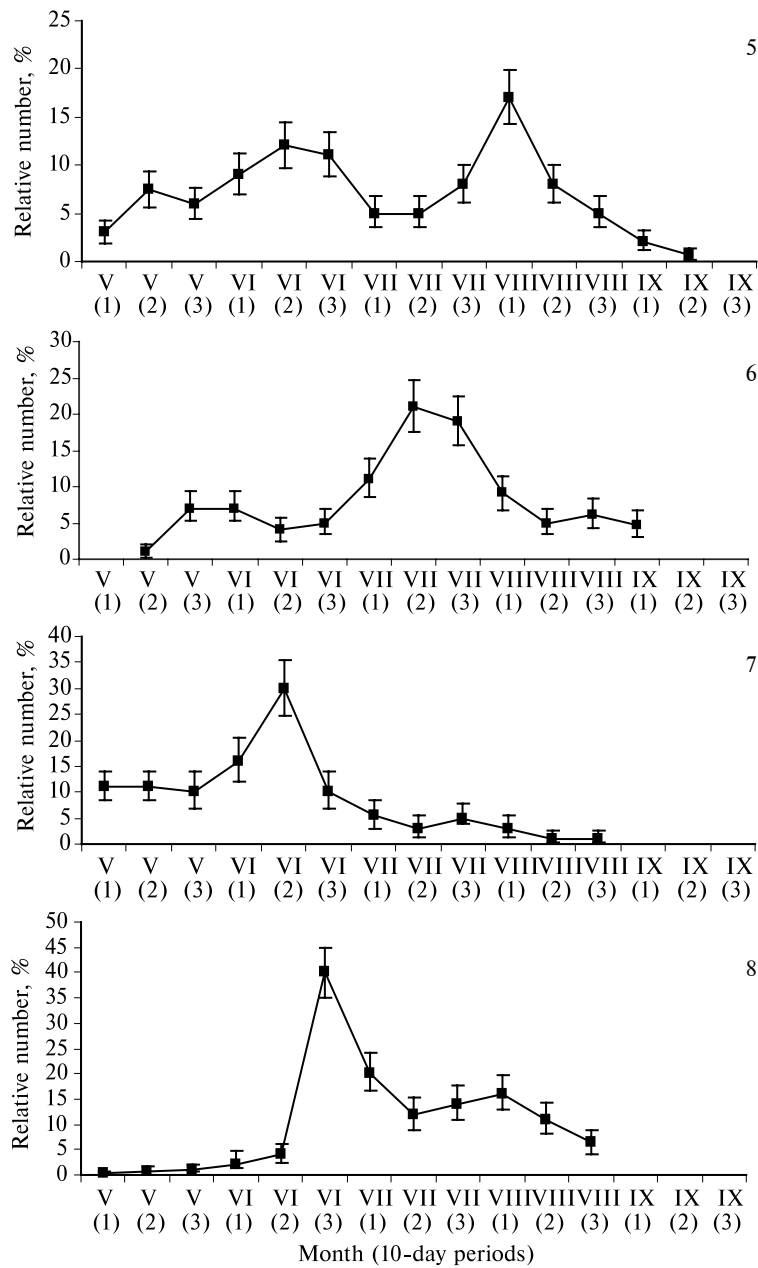


Fig. 5—8. Seasonal dynamics of flying: 5 — of *Ischnura elegans*; 6 — of *Platycnemis pennipes*; 7 — of *Erythromma najas*; 8 — *Enallagma cyathigerum*.

Рис. 5—8. Сезонная динамика лёта: 5 — *Ischnura elegans*; 6 — *Platycnemis pennipes*; 7 — *Erythromma najas*; 8 — *Enallagma cyathigerum*.

weather condition. Sixteen species belonged to this group: *Lestes barbarus*, *L. sponsa* (fig. 2), *L. virens*, *Chalcolestes parvidens*, *Aeshna mixta*, *Ae. affinis*, *Ae. cyanea*, *Crocothemis erythraeae*, *Sympetrum flaveolum* (fig. 11), *S. pedemontanum*, *S. danae*, *S. vulgatum* (fig. 12), *S. striolatum*, *S. sanguineum* (fig. 13), *S. meridionale*, *S. depressiusculum*.

6. Trans-seasonal species. Flying activity of species of this season group was recorded from the beginning of spring until the middle of autumn. All such species belong to the “summer” ecological type according to P. S. Corbet’s classification

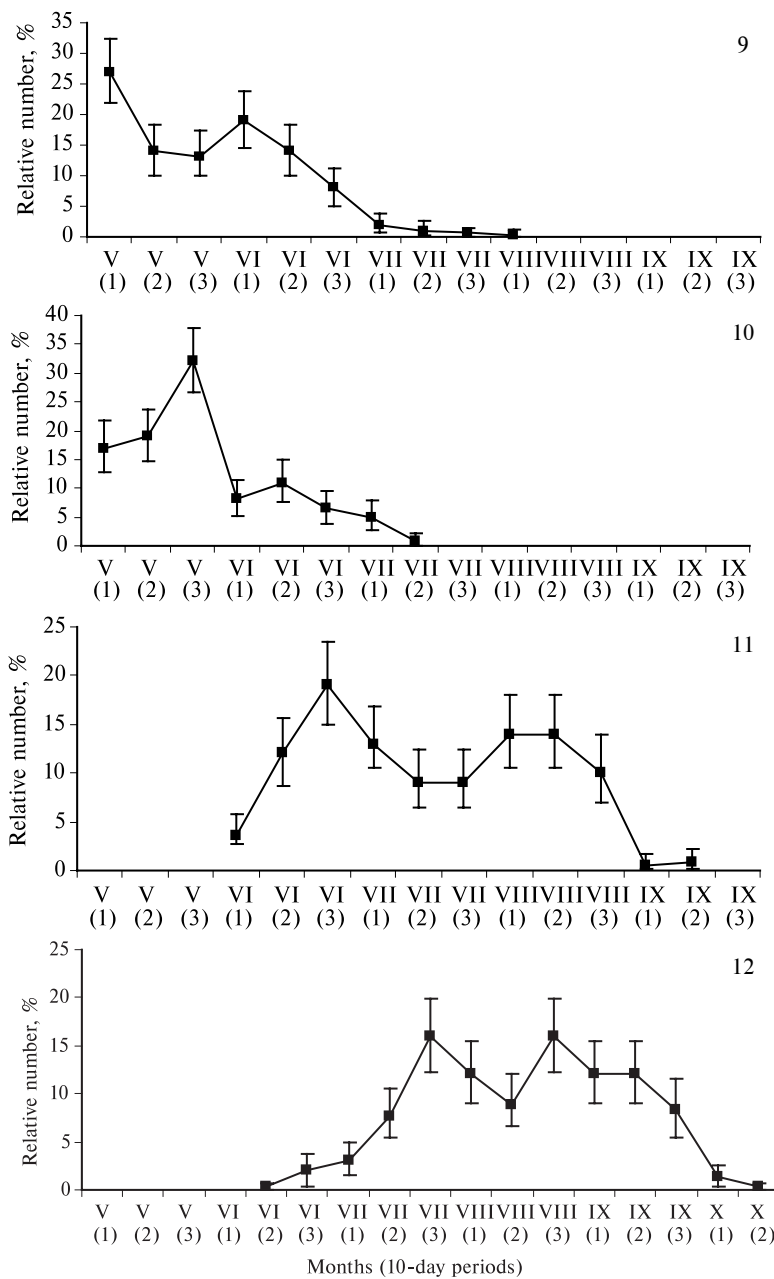


Fig. 9–12. Seasonal dynamics of flying: 9 – of *Cordulia aenea*; 10 – of *Libellula quadrimaculata*; 11 – of *Sympetrum flaveolum*; 12 – of *Sympetrum vulgatum*.

Рис. 9–12. Сезонная динамика лёта: 9 – *Cordulia aenea*; 10 – *Libellula quadrimaculata*; 11 – *Sympetrum flaveolum*; 12 – *Sympetrum vulgatum*.

(1954). Most of these species had a single peak in the number of flying specimens, which often occurred in the middle of summer (fig. 1, 6, 7, 8). However, sometimes, two peaks values in the number of flying specimens were recorded (fig. 5). This may be explained by the different influence of external factors, such as photoperiod and air temperature on different age cohorts (Corbet, 1999). Seven species were found in this group: *Calopteryx splendens* (fig. 1), *Erythromma najas* Hans. (fig. 7), *Enallagma cyathigerum* (fig. 8), *Ischnura pumilio*, *I. elegans* (fig. 5), *Platycnemis pennipes* (fig. 6), *Anax imperator*.

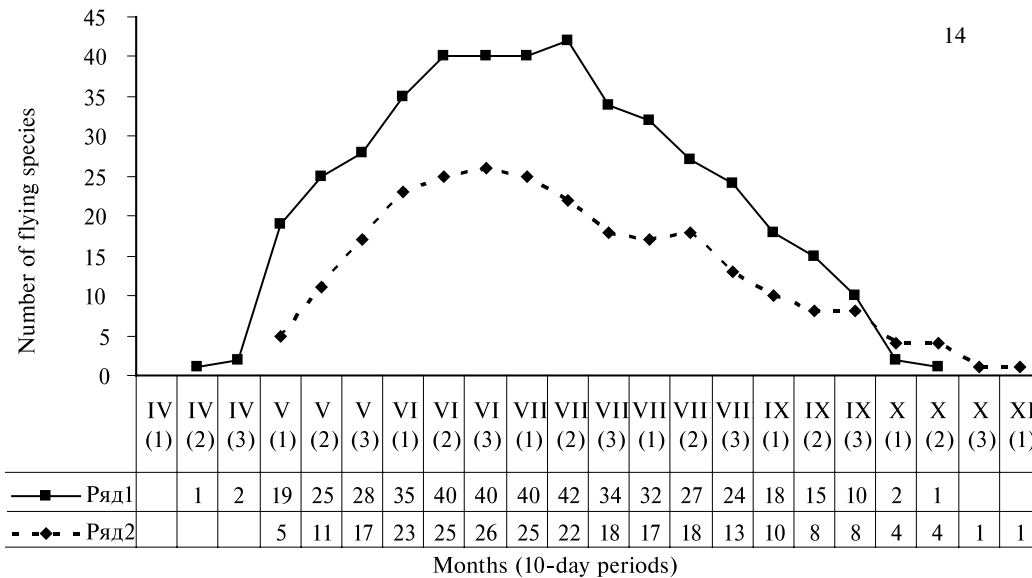
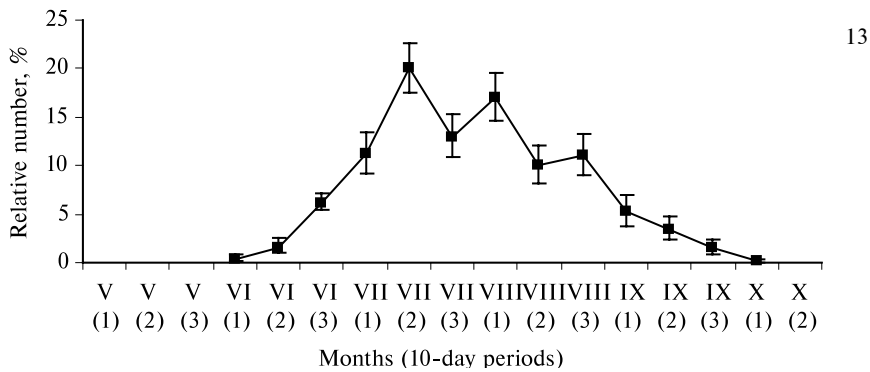


Fig. 13. Seasonal dynamics of flying of *Sympetrum sanguineum*.

Рис. 13. Сезонная динамика лёта *Sympetrum sanguineum*.

Fig. 14. Seasonal dynamics of the number of flying species (species in the adult): row 1 – original data from observations in Northeastern Ukraine; row 2 – literature data (Gorb et al., 2000) of observations in Kyiv region.

Рис. 14. Сезонная динамика количества летающих видов (видов в фазе имаго): ряд 1 – оригинальные данные исследований северо-востока Украины; ряд 2 – литературные данные (Горб и др., 2000) исследований в Киевской обл.

The numbers of species flying at the same time during all seasons differed between the territories of Ukraine. Thus, in Southeast (Donets'k and Lugans'k regions) the number of species gradually increased from the beginning of May until the second 10-day period of June, then remained stable (about 30 species) up to the second 10-day period of July. The maximum numbers of species flying (33 ones) was reported in the first 10-day period of July. During August and September the number of species in flight decreased more slowly then increased in the beginning of summer (Олигер, 1980).

In western regions of Ukraine the maximum number of flying species (43) was recorded in the middle of July; extent of increase of species number from the end of April to middle of summer coincided with decrease that at beginning of November (Горб, Павлюк, 1993; Горб и др., 2000).

Our data for Northeastern Ukraine showed that the total number of species with individuals in flight gradually increased from the middle of April (1 species) to the middle of June (40 species) and then remained stable for approximately thirty days. The

number of species in adult peaked (42 species) in the middle of June and gradually decreased during August and September. The latest flights of adults were recorded in the second 10-day period of October (fig. 14).

Comparing our data with that recorded in the literature (Горб, Павлюк, 1993; Горб и др., 2000), obtained in 1990–2000 in Kyiv region revealed certain differences (fig. 14). Thus, the maximum number of species in flight (26) was previously reported to occur in the middle of June, about two 10-day periods earlier than our data indicated. In addition, the total number of species previously reported was less than ours. These differences can be explained in relation to character, activity of observations and sizes of the territories under investigations. In our study, *Sympsectra paedisca* flew during autumn until the end of the second 10-day period of October, but it flew until the first days of November in the study by S. M. Gorb et al. (Горб и др., 2000). The exact timing of the end of flying is affected by the beginning of winter diapause, which is set by changeable weather conditions.

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