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The Social Structure of Fallow Deer Populations (*Cervus dama*) in Steppe Areas of Ukraine

Key words: fallow deer, *Cervus dama*, steppe zone, social structure, herd, aggregation, ethology, management, population, Ukraine

Introduction

In the Late Pleistocene the fallow deer inhabited Southern Europe, Asia Minor and Northwest-ern Africa, but was exterminated by humans. In 1829-1864 the species was introduced to Tasmania, Australia, New Zealand, and some later to South Africa, Madagaskar, Peru, and Chili. In the 15th century the Romans brought the species to Europe from the Middle East. Since the 1980s this animal has occurred in many European countries (SIEFKE 1978). In Ukraine, it was repeatedly introduced by landlords, but this gullible deer was eradicated everywhere during the revolution events in 1905–1917. The specimens lived in the Askania Nova Zoo were luckier. They had been brought from Germany in 1889–1914 by Friedrich Falz-Fein (n = 12) and quickly adapted to new conditions. However, only 10 animals (9 ♀) had survived by 1924, and their inbreeding resulted in appearance of many albinos and melanists in the Askania Nova's herd. Seven additional animals, taken from other zoos in 1953–1961, managed to increase heterozygosity and reduce unfavourable effects of the inbreeding. Offspring of the Askania Nova's fallow deer were later distributed over Ukraine and neighbouring countries (TREUS 1968). At present, the largest populations of the species are on Biriuchy Island (n ≈ 1700),

Dzharylhach Island (n ≈ 200), in a hunting farm "Ecofilter" (n ≈ 100), in Askania Nova Reserve (n ≈ 75), and Tavria Recreational Park (n ≈ 50) (Fig. 1).

Given the occurrence of fallow deer in open landscapes of the steppe zone, we assume it interesting to study the dynamics of the population social structure in the course of the species annual biological cycle.

Material and Methods

The materials for this paper were predominantly collected in the Azov-Syvash National Nature Park from 2008 to 2015. That period was characterized by the absence of hunting on wild ungulates save for their capture with special traps to reintroduce them into other areas (Fig. 2) and infrequent selection shooting. In addition, a social structure of fallow deer was studied during fieldtrips to Dzharylhach Island (2013–2015), Tavria Recreational Park (1989–2015) and the hunting farm "Ecofilter" (2010–2015).

In the spring seasons of 1985, 1986 and 1989 the animals on Biryuchy Peninsula and Dzharylhach Island were observed and photographed from the board of the airplane. As a result, we obtained information about the structure of 73 aggregations of the fallow deer, containing

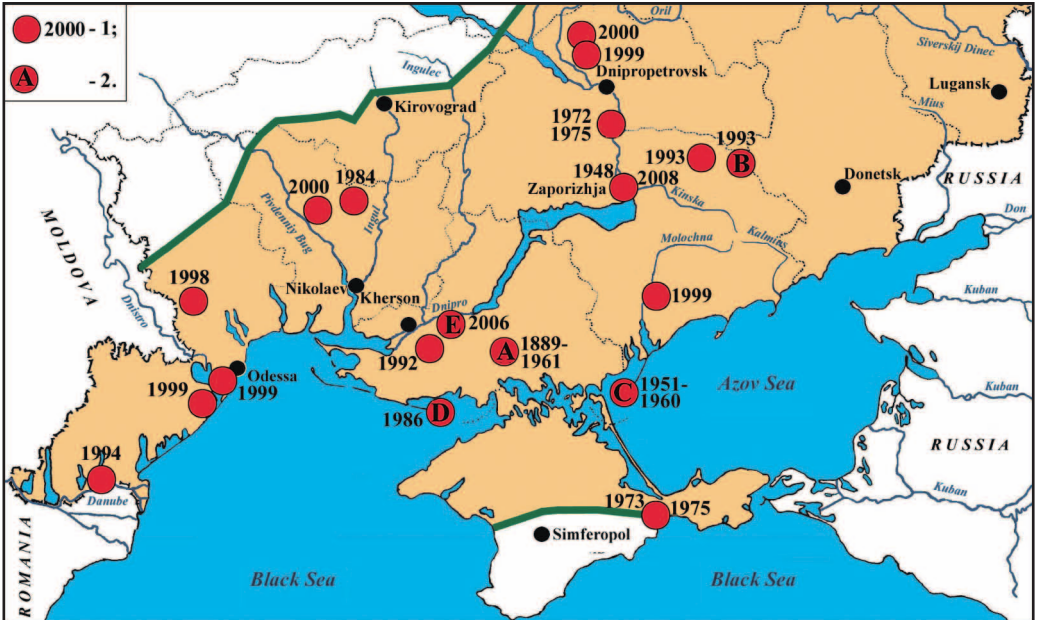


Fig. 1 Locations of the fallow deer introduction into Ukrainian steppe zone: 1 – Location and year of the first release of the animal; 2 – Current population: A – Askania-Nova Reserve; B – Tavria Recreational Park; C – Biriuchy Peninsula (Azov-Syvash National Nature Park); D – Dzhyrylhach Island; E – hunting farm “Ecofilter”



Fig. 2 A fallow deer male in a trap (Azov-Syvash National Nature Park, Biriuchy Peninsula: 13.09.2009) (Photo by A. Volokh)

1,676 mammals. A total of 12,097 fallow deer, recorded over the entire research period (from 1985 to 2016), allowed us to make a comprehensive analysis of the population social structure dynamics. Unfortunately, because of various reasons (fog, long distances, lack of horns, etc.), we failed to identify the structure of 161 aggregations, consisted of 3,018 individuals with the herd index of 18.8 ± 1.73 (1–112).

In our materials, analyzed below, the term “herd” is understood as any number of individuals, united by different biological links, and also as solitary animals. Although the latter does not correspond to this concept, the important role of individuals in the formation of herds is nevertheless undoubted.

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Discussion

In a social organization of wild ungulate populations their ability to unite in groups is especially important. It improves information exchange

among animals and is a kind of adaptation to their most optimal existence. In an ethological population structure the following types of organization are distinguished: family, company, herd and gathering (BASKIN 1967). Ecologists identify the following reasons that contribute to the formation of various social associations or aggregations of animals:

- 1) differences in habitat conditions;
- 2) dynamics of weather conditions;
- 3) reproduction-related processes;
- 4) social attraction.

Temporal Dynamics of the Fallow Deer Aggregations

In populations of the fallow deer the herd index was steadily increasing throughout a year from June to April, inclusively. In January–February it was quite stable.

In winter, solitary specimens (10.1 %) and the herds, consisting of 2 (14.6 %) animals were rarely seen, but there were numerous families of 3–5 (29.2 %), large companies of 6–10 (24.7 %), and small gatherings of 11–20 (16.7 %) animals.

Significant aggregations of 21–35 (4.4 %) fallow deer were rare, and larger gatherings were not formed at all. The average value of the herd index in winter was 6.9 ± 0.64 , ranging from 1 to 35 animals (Table 1).

Table 1 Herd dynamics of fallow deer during the year

Months	Number		M±m	Limits	Std. Dev.
	herds	animals			
December	47	266	5.7±0.69	1-24	4.72
January	34	246	7.2±1.23	1-35	6.84
February	58	415	7.2±1.10	1-38	8.40
March	56	622	11.1±1.30	1-46	9.69
April	170	3,117	18.3±1.67	1-115	21.80
May	141	937	6.7±0.73	1-48	8.71
June	43	129	3.0±0.36	1-11	2.35
July	382	1,414	3.7±0.19	1-32	3.64
August	385	1,612	4.2±0.20	1-34	3.88
September	347	1,416	4.1±0.20	1-25	3.64
October	99	493	5.0±0.53	1-25	5.24
November	280	1,430	5.1±0.30	1-45	4.97
<i>Total</i>	<i>2,042</i>	<i>12,097</i>	<i>5.9±0.20</i>	<i>1-115</i>	<i>8.67</i>

A characteristic feature of the fallow deer as a biological species is separation of males from all other animals and formation of male groups. In winter, from all the totality of solitary animals and herds ($n = 89$), only 17 (19.1 %) were represented by 1–4 males of different age (1.9 ± 0.23). During all winter, in some herds of 5–35 individuals we observed 1–7 adult males. In 10 (11.2 %) cases, they live both in small herds and large gatherings together with females and other deer.

The early spring, being the most extreme survival season, reduced the percentage of solitary individuals (3.6 %) and pairs (5.4 %). The percentage of family herds of 3–5 (26.8 %) and companies of 6–10 (23.2 %) individuals slightly decreased as well. However, in March, the percentage of large gatherings, ranging from 11 to 46 (41.0 %) animals, significantly increased. This month part of herds (12.5 %) was represented only by males with the herd index of 4.1 ± 0.86 (2–9) individuals. However, the dominating aggregations contained adult fe-

males with half-grown fawns (60.7 %), already difficult to distinguish from their mothers. These herd structures mainly consisted of companies and gatherings, the size of which in our study areas was rather large (12.7 ± 1.66) and ranged between 2 and 46 individuals (Fig. 3). During the year, the largest maximum herd index in the fallow deer populations was registered in April, when a lot of grass appears on marine islands and spits. This month showed the lowest number of solitary animals (3.5 %) and groups (7.1 %) of 2 individuals. In all April populations a large percentage of herds included 3–5 (21.8 %), 6–10 (14.7 %), 11–20 (25.9 %) and 21–40 (14.7 %) animals. Large gatherings of 41–50 (4.7 %) and even 61–115 (7.6 %) deer were common (Fig. 4). It should be noted that a share of herds consisting of males (14.7 %) was quite large in April; in these herds 3.5 ± 0.69 (1–18) animals were recorded. In May the herd index of the fallow deer reduces noticeably, because many females leave their herds before fawning and live separately. The



Fig. 3 A gathering of fallow deer ($n \approx 40$) consisting of females and fawns after severe winter (Azov-Syvash NNP, Biriuchy Peninsula: 29.03.2010) (Photo by A. Volokh)



Fig. 4 A large spring herd of fallow deer on Biriuchy Peninsula ($n \approx 55$), containing animals of different sex and age (27.04.2010) (Photo by A. Volokh)

percentage of solitary animals this month made up 17.0 %; half of them were adult females. In May, the percentage of herds consisting of 2 (23.4 %), 3–5 (25.5 %) and 6–10 (16.3 %) specimens also considerably increased. Large gatherings, the largest of which amounted to 11–20 (11.4 %) and even 21–50 (6.4 %) animals, completely disappeared. In male herds there were found 1 (18.6 %), 2 (25.6 %), 3–5 (36.2 %) and 9–23 (19.3 %) animals. In spring, in studied populations the percentage of solitary animals were 8.7 %, aggregations of 2 animals – 13.1 %, of 3–5 – 24.0 %, of 6–10 – 16.6 % and of 11–20 – 20.7 %. On the contrary, large gatherings of 21–50 (13.6 %), and very large ones of 61–115 (3.3 %) animals were scanty in the spring season. The average herd index in spring constituted 12.7 ± 0.89 , ranging from 1 to 115 deer (Table 1).

In summer, when a majority of females give birth to their fawns (VOLOKH 2014), the herd index is the lowest in the annual biological cycle. The minimum was recorded in June, when a significant percentage of solitary animals (32.6 %) was represented exclusively by females (64.2 % of the entire number of solitary individuals). The main population structure this month was represented by families with 3–5 (34.9 %) animals. Pairs, however, were also common as well (20.9 %). Companies of 7–11 animals were also rather frequent (12.0 %), but in June we never observed large gatherings of

them. It should be noted that when young males have their antlers started growing, they leave their families and join herds consisting of only males (Fig. 5). It occurs approximately in early June, when many animals around 1 year age have only 2–3 cm antlers. Only in exceptional cases these animals can be found in other aggregations, which were joined by their mothers. July was also characterized by a low herd index. The percentage of solitary individuals in July slightly reduced (26.7 %) and the majority of them (53.2 %) was represented by non-pregnant or not fawned yet females. The others (46.8 %) were adult males. In pairs (25.1 %), females with newborn fawns were dominant (37.5 % of the number of pairs), then males (33.3 %) and females without fawns (28.7 %). Yearlings were very rare (0.5 %). Due to the emergence of a large number of fawns, the percentage of families with 3–5 (29.3 %) animals significantly increased. To a lesser extent, there increased the percentage of companies of 6–10 (12.2 %) individuals. Other gatherings of deer, including combinations of 11–32 (6.7 %) animals of different sex and age (from adult males or adult animals of both sexes to unions of several mothers with their children of the current and past year of birth or with non-pregnant females), were rather rare in July.

In August, when the fawning of fallow deer completely stops, the average herd index slightly increased, though its maximum index in



Fig. 5 Young males (~ 1 year) of fallow deer in the herd, consisting of males of different age (18.07.2010) (Photo by A. Volokh)

populations remained unchanged. The percentage of solitary individuals naturally decreased, constituting 17.1 %. However, if in July and June they were considerably dominated by females, in August this advantage somewhat reduced (females = 51.6 %, males = 48.4 %). This month, compared with July, practically did not change the percentage of herds with 2 individuals (27.1 %); more than half of them were females with fawns (51.4 %). Nevertheless, the herds, companies and gatherings, including adult animals of both sexes simultaneously, were rather common (15.8 %). In August, a large part of deer populations was also represented by groups of 3–5 (33.1 %) animals. Companies of 6–10 deer (15.8 %) were the most numerous among herd formations for the entire summer. Besides, in August, in different populations there were found gatherings of 11–20 (6.5 %) and 21–34 (0.5 %) animals.

The percentage of solitary individuals and aggregations, consisting only of males, was 28.2 % in August, with the herd size equaling 2.9 ± 0.21 (1–10) animals. The ratio of 2-year-old and older animals to yearlings was 15.3 : 1.0. It means that 93.9 % of males may already be involved in breeding and, consequently, 6.1 % were young animals.

In the areas of our research the percentage of herds, consisting only of females, was 30.0 % in August, with the herd index equalling 2.1 ± 0.17 (1–12) deer. This month, a significant part of deer populations was represented by herds of females with fawns (41.9 %), consisting of 5.0 ± 0.31 (2–21) animals. In 17 cases, they were sons (1.6 ± 0.19) which met with their mothers and newborn fawns, and in 13 cases - daughters (1.4 ± 0.21) of the last year. In general, in contrast to the spring season, the fallow deer populations in summer had a high portion of solitary animals (22.4 %), largely represented by adult females (50.0 % of animals). The summer season was also characterized by numerous herds, consisting of 2 (23.0 %) animals, since a large number of females born per 1 fawn. Families and groups consisting of 3–5 (31.4 %) animals were even more frequent; among them dominated aggregations of males of different age (35.3 % of the herds of this size) which included 3.8 ± 0.09 (3–6) specimens. A significant number of herds were made up by

2 females and 1 fawn (7.5 %), 2 females and 2 fawns (8.6 %) or 1 female and 2 fawns (3.9 %), along with complex compositions of animals of different sex and age. In summer, the percentage of companies formed of 6–10 individuals were 14.0 %, almost the same as it was in spring. A characteristic feature of the summer season was also a low frequency of small gatherings of 11–20 animals (5.7 %) and of relatively large gatherings, containing 21–34 (3.5 %) animals. In summer, a significant part of herds (34.5 %) was represented only by males, with their herd size reaching 3.2 ± 0.14 (1–11) individuals. The average herd index in summer was 3.9 ± 0.13 , and ranged from 1 to 34 animals.

September in South Ukraine is usually characterized by warm weather and noticeable reduction in natural forage, as a result of regular droughts. Consequently, it has led to a slight decrease in the herd index of the fallow deer populations (Table 1). However, a closer examination shows that the statistical difference between August and September is insignificant ($t = 0.36$; $p = 0.72$). The average standard deviation (SD) was almost equal to that of August, and it also indicates no serious changes in the social structure. The percentage of solitary animals remains practically unchanged (20.2 %), and among them adult males dominated (74.3 %). Though, in contrast to the summer season, the proportion of families with 2 individuals declined (19.9 %). The most frequently such pairs were represented by females with fawns (37.7 %), only males (30.4 %) or only females (15.9 %), and by males and females together (4.4 %). However, the most numerous in September were families and different herds of 3–5 (38.0 %) individuals. They mostly contained females and fawns (21.0 %), females, fawns and daughters of the last year (17.4 %), only males (15.7 %) or only females (11.4 %). In the latter case the male herd index was 3.4 ± 0.14 (3–5), and that of females – 3.5 ± 0.17 (3–5). Companies of 6–10 individuals were rare in September (15.0 %), the same as gatherings of 11–25 (6.9 %) animals. In the first autumn month the fallow deer populations had 106 (30.6 %) herds, represented only by males ($n = 229$). These male herds included 2.2 ± 0.16 (1–9) individuals. Except for this, other males were found only in 14.1 % aggregations of different

structure, with females present as well. It indicates that low-intensity precopulation processes were already taking place in that time. In October, when the animal organisms are preparing to the beginning of the rut, the population structure is somewhat reformed. It was accompanied by increase in the number of solitary animals to 30.3 %, most of them (95.6 %) were represented by adult males. Compared to September, the percentage of herds with 2 individuals slightly decreased (14.1 %); almost half of them were males. The decrease was also recorded in the percentage of family groups of 3–5 (25.3 %) animals, while companies of 6–10 (14.1 %) animals and aggregations of 15–25 (11.1 %) animals remained similar to those in September. In addition, in October, the males (26.3 %) were recorded in many herds where the females were also present.

Undoubtedly, all these changes for the fallow deer as a polygamic species indicate the start of the run. In November, when the run reaches its peak, the percentage of solitary animals reduced to 16.8 %, among them 82.39 % were adult males. The most frequently they were animals which lost their mating competitions, and rarer those which left their harems after copulation. In November, the percentage of herds including 2 individuals also slightly increases (17.9 %). Most part of it was represented by adult females and fawns (24.5 %), a lesser part – by pairs, most likely of non-breeding males (20.4 %), and also pairs formed by adult males and females (16.3 %). A significant part among

solitary animals and herds in November was represented by aggregations of 3–5 (33.9 %) animals, almost one third of which (28.4 %) were harem groups. These formations were also composed of male herds of different age (8.3 %), containing of 3.5 ± 0.33 individuals. Companies of 6–10 individuals were rather frequent in November (20.7 %); almost half of them (43.1 %) were represented by complex harem associations. However, in 39.9 % of companies the females were present without adult males. In the end of autumn, gatherings of 11–45 deer, with the herd index of 16.5 ± 1.49 , were comparatively frequent (10.7 %). Unfortunately, because of fog, we could not identify the structure of 24 November herds (7.1 ± 1.23), which contained 171 animals.

It should be separately noted that a family is the most important part of the fallow deer population social structure (Fig. 6). Throughout a year, in spite of the processes of reproduction and reformation of herds, associated with changes in forage concentrations and different physiological processes, a dominant role is always belong to an adult female. It is the female which plays a role of the consolidation centre for other deer of different sex and age, and also, drawing an analogy with us, this animal is especially important for its innumerable children and grandchildren from different generations. The hunters should never forget about it, especially when they are ready to pull the trigger ...

Interestingly, the sex and age structure of the fallow deer herds, inhabiting a big enclosure



Fig. 6 A family of the fallow deer in summer (A) – 07.07.2008 and autumn (B) – 20.11.2008. (Photo by A. Volokh)

(800 ha) of Askania Nova Reserve, and their distribution in the area were characterized by considerable instability. Their herds, companies and gatherings of 2 to 50 individuals, consisting of animals of different sex and age, could be found in any part of the enclosure or even in a mixed herd with deer and moufflons (LOBANOVA, 1989).

Summarising the studies of the fallow deer herd index in the autumn season, it should be noted that it was equal to 4.6 ± 0.17 , ranging from 1 to 45 animals. In contrast to the summer period, the autumn had few solitary animals (20.1 %), mostly represented by adult males (81.0 % of the number of the solitary animals) and, to a lesser extent, by adult females (15.7 %).

The herds of 2 animals were also scanty (18.2 %) in autumn, a third of them was represented (30.3 %) by females and fawns, a lesser part (27.3 %) was pairs of adult males and the least (18.9 %) – pairs of adult females. Mixed groups of adults of different sex were rare (8.3 %), as well as groups of adult males and yearlings (3.8 %). In the autumn season, compared to summer, the percentage of herds consisting of 3–5 animals remained practically the same (34.9 %). The most numerous were families of 3.5 ± 0.07 individuals, consisting of adult females, fawns and yearlings (46.3 %).

Groups of adult males (12.7 %), of adult males, females and their fawns (10.7 %) were much rarer, and the rarest were groups of adult females and males (7.1 %). In autumn, the percentage of companies consisting of 6–10 (17.8 %) animals exceeds that of summer. Their most noticeable structures were the herds, containing adult females, fawns and yearlings (38.8 %). The percentage of companies consisting of adults of both sex and fawns was quite considerable (27.1 %). Companies of males (6.2 %) and females (5.4 %) were rare. The autumn season was also characterized by low occurrence (9.0 %) of relatively large concentrations containing 11–45 deer. In those, containing 11–20 animals, in most cases (60.4 %) 1–7 males (2.3 ± 0.29) were found in aggregations with 2–18 females (7.3 ± 0.49), 1–7 fawns (4.0 ± 0.26) and 1–6 yearlings (2.8 ± 0.53). Only two large herds were completely consisted of males of different age. One of them

($n = 13$) was revealed on 12.09.2009, and the second ($n = 19$) – on 07.1.2012. Part of small gatherings was represented exclusively by females, fawns and yearlings (19.4 %). The largest aggregations (20–45 individuals) looked like unions of animals of different sex and age, in which adult and young females dominated in number.

Of a total number of individuals ($n = 323$), included in the latter aggregations, the percentage of adult males were only 7.6 %, whereas the percentage of adult females was 58.6 %, fawns – 29.1 % and yearlings – 4.7 %. In addition to the above-mentioned variants, in all seasons among companies and gatherings there were found diverse combinations of animals of different sex and age. However, they were scanty, and there was no sense to analyze their structure thoroughly. It should be noted that in the Azov-Syvash NNP some fawns without adults were found in all seasons, in spite of the absence of hunting. The reasons of their autonomy still remain unknown.

Comparing temporal dynamics of the fallow herd indices on Biryuchy Island, where the long-term permanent studies have been made (Table 2), we should note their significant stability. This stability had been observing since 2009, in spite of the fact that in that period 2,444, and in 2015 – 1,720 individuals were recorded. Insignificant dynamics of standard deviation also confirms weak changes of the herd index in time. No correlation was found between the population density and herd index. With $P = 0.05$, the correlation coefficient was strikingly low ($r = -0.01$). In all years the average herd size was close to the size of the family group.

According to our long-term studies, the average herd index of the fallow deer on Biryuchy Island was 4.8 ± 0.13 , and in general in the steppe zone of Ukraine – 5.9 ± 0.20 animals. The most frequent were solitary animals (nearly 20 %) and family groups of 2–5 individuals (more than 51 %). Companies of 8–10 animals were rather numerous. In some years, in spring, there were gatherings of 46–115 deer, but their occurrence was insignificant (Table 3).

In general, the herd is an important discreet part of the fallow deer population social structure.

Table 2 Between-year dynamics of the fallow deer herd index on Biryuchy Peninsula

Year	Number		M±m	Limits	Std. Dev.
	herds	animals			
2008	47	151	3.2±0.36	1-15	2.46
2009	360	1,546	4.3±0.20	1-27	3.86
2010	395	2,478	6.3±0.40	1-48	7.84
2011	126	652	5.2±0.50	1-35	5.61
2012	77	406	5.3±0.70	1-33	6.13
2013	104	431	4.1±0.30	1-15	3.05
2014	202	817	4.1±0.30	1-34	4.22
2015	408	1,756	4.3±0.22	1-45	4.52
<i>Total</i>	<i>1,719</i>	<i>8,237</i>	<i>4.8±0.13</i>	<i>1-48</i>	<i>5.44</i>

Table 3 Occurrence of fallow deer herds in the steppe zone of Ukraine

Number of individuals	Distribution		Number of individuals	Distribution		Number of individuals	Distribution	
	Abs.	%		Abs.	%		Abs.	%
1	379	18.6	7	72	3.5	26-30	13	0.6
2	415	20.3	8-10	144	7.1	31-35	9	0.5
3	245	12.0	11-12	76	3.7	36-50	21	1.0
4	226	11.1	13-15	67	3.2	51-100	9	0.5
5	166	8.1	16-20	51	2.5	101-115	3	0.2
6	117	5.7	21-25	29	1.4	<i>Total</i>	<i>2042</i>	<i>100.0</i>

Use of Biotopes

According to our original observations and results of the studies carried out in countries with rather large populations of the fallow deer, the most optimal for the species are forest-steppe areas (GREGSON, PURCHAS, 1985; PUTMAN, 1985; MEHLITZ, 1989; PFANNENSTIEL, 2014). However, it can also inhabit cultural landscapes (SIEFKE, 1978) and farms with the absence of forest (RAMBOTTI 1985; REINKEN 1998).

In South Ukraine, a rather high herd index (6.2) of the fallow deer was revealed in steppe areas, as well as the maximum recorded number of animals. In true steppes the percentage of solitary animals was 16.8%. Pairs were rather frequent (19.5%), though families of 3–5 (32.3%) animals were the main structural unit in this biotope. Companies of 6–10 (17.2%) were also numerous in the steppe; much rarer were gatherings of 11–20 (9.9%) and 21–50 (3.5%) individuals. Large gatherings of 61–115 (0.8%)

animals were exclusively rare (Table 4); they were found in April, in the period of intensive vegetation of plants. Coastal meadows were equally important biotopes of the fallow deer in the steppe zone of Ukraine. They fail in concentration and variety of forage if compare them with floodplain meadows, but the average herd index in this biotope was similar to that in the steppe areas. Despite the fact we speak about the same animals, demonstrating significant similarity in occurrence of solitary individuals (18.8%), pairs (23.6%) and families of 3–5 (28.5%) specimens, the meadows more frequently than steppes supported companies of 6–10 (13.9%), and also gatherings of 11–20 (8.3%) and 21–48 (6.9%) deer. We never saw large aggregations containing over 50 animals. Almost all the largest aggregations of the fallow deer in meadow communities were found in the middle of May (Fig. 7). Only one of them (35 animals grazing on a meadow with vegetating plants) was revealed in winter – 18.01.2011.

Table 4 Distribution of the fallow deer per biotopes

Biotopes	Number		M±m	Limit	SD
	herd	animals			
Deciduous forests	178	666	3.7±0.35	1-36	4.66
Wetlands	27	120	4.4±0.97	1-21	5.03
Fields	10	39	3.9±1.45	1-18	4.81
Meadows	144	889	6.2±0.74	1-48	8.76
Reedbeds	69	441	6.4±0.85	1-45	7.05
Steppes	1,611	9,936	6.2±0.23	1-115	9.34
Gardens	5	19	3.8±0.37	3-5	0.84
<i>Total</i>	<i>2,044</i>	<i>12,110</i>	<i>5.9±0.20</i>	<i>1-115</i>	<i>8.87</i>



Fig. 7 A gathering of the fallow deer ($n \approx 25$) on the coastal meadow (Azov-Syvash NNP, Biriuchy Peninsula: 16.05.2008) (Photo by A. Volokh)

Though the maximum value of the average herd index of the fallow deer was recorded for reedbeds, statistically it did not exceed that for meadow and steppe ($t = 0.30$) biotopes. Occurrence of solitary individuals in reedbeds was 20.3 %, and herds of 2 individuals – 10.2 %. Similar to other biotopes, the most frequent were families of 3–5 (33.3 %) and companies of 6–10 (18.8 %), rarer – gatherings of 11–20 (11.6 %) deer. However, there were never recorded such large aggregations as it was in open landscapes. In reedbeds, the largest were gatherings of 21–45 animals (5.8 %). In forest areas the herd index was slightly smaller (3.7) than in the previous biotopes. However, the percentage of solitary animals in forests equalled to 32.6 % and herds of 2 animals – 26.4 %.

These values are maximal for our fallow deer populations and were never recorded in other biotopes. In forests, the lowest frequency of families consisting of 3–5 (21.9 %) individuals was also recorded. Besides, we encoun-

tered gatherings of 6–10 (11.8 %) in small deciduous forest stands; gatherings of 11–20 (6.2 %) and 21–36 (1.1 %) deer were much rarer. In the Dnieper floodplain forests near the city of Kherson, the fallow deer herd index (4.4 ± 0.97) was statistically similar ($t = 0.72$) to that of plakor deciduous forests (3.7 ± 0.35) due to high resemblance of ecological conditions. In a small population of ~100 individuals, the percentage of solitary animals in 2011–2015 equalled 25.9 % and that of herds of 2 individuals – 29.6 %. In reedbeds, families of 3–5 (22.2 %) and companies of 6–10 (11.1 %) animals were much rarer than in other biotopes. The maximum herd sizes amounted to 11–21 individuals, but such herds were rarely occurred (11.2 %). In spite of a relatively small amount of material the future herd index of the fallow deer in reedbeds would hardly exceed the current level. The fallow deer found in fields and gardens were migrants which came out of the limits of their main habitats. Since the data

about the deer residence in these biotopes are extremely scanty and occasional we do not analyse them. However, they give evidence that these areas are also quite suitable as habitats for the fallow deer. In general, its herd index in open areas of the steppe zone of Ukraine constituted 6.15 ± 0.22 (1–115), and in closed areas – 4.5 ± 0.33 (1–45) individuals, that is significantly smaller ($t = 2.91$) when $P = 0.01$.

Conclusions

In the steppe zone of Ukraine the fallow deer social structure significantly varies during its annual biological cycle. The herd index in the populations gradually increases from June (minimum) to February and further, reaching its maximum in April. At the same time, though the animal populations differ in their numbers and density, the herd index remains rather stable between years, and coincides with the size of the family group.

Abstract

The Social Structure of Fallow Deer Populations (*Cervus dama*) in Steppe Areas of Ukraine

In a social organization of wild ungulate populations their ability to unite in herds is especially important. The herd index of the fallow deer equalled 6.9 ± 0.64 (1–35) individuals in winter and 12.7 ± 0.89 (1–115) individuals in summer that is the maximum value during their annual biological cycle. It results from social attraction of animals and their concentration in the areas with the highest resources of qualitative forage. In summer, the herd index decreased to 3.9 ± 0.13 (1–34) deer, because females fawned and separated with their fawns from different age-sex groups. By autumn, this index had increased to 4.6 ± 0.17 (1–45) individuals. For a long period of time (2008–2015), the average size of the fallow deer's herd was

similar to that of the family group and made up 5.9 ± 0.20 individuals. The highest values (6.15 ± 0.22 : 1–115 individuals) in the steppe zone of Ukraine were registered in open areas (steppe, meadow, sparse reedbeds), and the lowest ones (4.5 ± 0.33 : 1–45 individuals) were observed in closed areas (plakor and floodplain deciduous forests).

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